JPPI Vol 11 No 2 (2021) 153 - 171

Jurnal Penelitian Pos dan Informatika

32a/E/KPT/2017

e-ISSN 2476-9266
p-ISSN: 2088-9402

Doi: 10.17933/jppi.v11i2.335

The Role of the Information and Communication Technology Sector in the Indonesian Economy

Karina Maryana[1] Sartika Djamaluddin[2]

Program Pascasarjana Ilmu Ekonomi, Fakultas Ekonomi dan Bisnis, Universitas Indonesia[1]
Departemen Ilmu Ekonomi, Fakultas Ekonomi dan Bisnis, Universitas Indonesia[2]
Depok, Jawa Barat, Indonesia, 16424[12]

karina.maryana@gmail.com

Received: 27 January 2021 ; Revision: 30 December 2021; Accepted: 30 December 2021

Abstract

The contribution of ICTs to the overall production system in the economy is considered as one of the factors for growth and development of the national economy. The purpose of this research is to investigate the contribution of the ICT sectors to the Indonesian economy through the role of the ICT sectors in encouraging the growth of other sectors with linkage analysis, multiplier analysis and causative matrix analysis. Furthermore, this study investigates the sources of growth in the ICT sectors by decomposing the sources of change in its output. In particular, the input-output approach is adopted to describe the production activities and diffusion of the ICT sectors in the Indonesian economy for the period 2000-2014. The results show that apart from having large output multipliers, the ICT Manufacturing sector also encourages exports. The results of the decomposition show that the influence of the previous technology coefficient has a significant contribution to the output of the ICT sectors. However, these values have diminished in recent periods so that the role of the Indonesian ICT sectors as a GPT sector has become less than optimal.

Keywords: decomposition, economic growth, ICT sector, input-output, linkages

INTRODUCTION

The role of information and communication technology (ICT) on economic growth has been extensively reviewed in the economic literature. Since the mid-1990s, the majority of research at the firm, industry, and country levels has identified a positive and significant correlation between ICT investment and economic performance (Greenan, Mairessee, Topiol-Bensaid, 2001; Jorgenson, 2001; Draca et al., 2008). The economic impact of ICTs is closely related to the extent to which ICT technology diffuses throughout the economy. This linkage is partly because ICT is a network technology in which the more people and companies use the network, the more benefits it generates. However, diffusion and the multidimensional effects of ICTs on the economy cause different impacts of ICT between regions. Thus, in assessing the impact of ICTs on the economy of a region, it is important to consider the structure of the economy by taking into account the interactions of the ICT sectors with other sectors in the region. In the economy, changes that occur in a sector not only affect the sector itself but also affect other sectors. The influence of the ICT sectors on the economy is made possible by increasing the creation of value added goods and services, thereby increasing overall economic productivity; and through the use of ICT sectors goods and services as input in the production of goods and services in other sectors, thereby increasing their efficiency and productivity. This process demonstrates the relationship between dynamic economic sectors, not only between production sectors but also with final demand for consumption, exports and investment. Therefore, in looking at the contribution of the ICT sectors to the national economy, looking at the proportion to GDP formation is not enough. The contribution of a sector to the economy also needs to be seen through the multiplier effect it creates and the linkage of the sector to other production sectors.

From a review on recent literature, contribution estimation of the ICT sectors in Indonesia mostly covers activities of the downstream sector (especially the telecommunications sub-sector) while the value added of the upstream sector (for example the electronics manufacturing sub-sector) is not taken into account. This is due to the absence of a clear definition and classification of the ICT sectors in Indonesia. This estimation certainly does not reflect the real contribution of the ICT sectors to the Indonesian economy. To describe the ICT sectors in Indonesia as a whole, an investigation into the contribution of the ICT sectors needs to cover the ICT Manufacturing sector, the ICT Media and Content sector and the ICT Services sector according to international industry classification standards (UNCTAD, 2008).

The development of ICT in Indonesia can be seen from the access and use that continues to increase along with the development of various supporting infrastructure for ICT. In the ICT Services sector, particularly telecommunications, all indicators show a positive trend. With a population of 260 million people, the ICT services sector in Indonesia has the potential to increase economic output through all the advantages it creates in other sectors such as retail, transportation, health and so on (Mckinsey, 2016). In the ICT Media and Content sector, in addition to public investment through government spending projects for state-owned broadcasters, there are foreign investments with growing value from 2004 to USD 148.5 million in 2017. In the 2011-2016 period, the growth of the ICT Media and Content and ICT Services sectors to GDP, although fluctuating, was always above the national economy with an average growth of 10.4%. In the ICT Manufacturing sector, although the proportion of investment in the three ICT sectors to total national investment tended to decline, the proportion of GDP in the ICT sectors continued to increase during the 2000-2014 period. In 2000, the ICT sectors contributed 1.31% of Indonesia's GDP. In 2014, the contribution of the ICT sectors GDP increased to 7.08%.

Considering the continuing spread of ICTs and their importance for economic growth and that the use of ICTs has become an irreversible trend in the world economy, the ICT sectors needs to be given priority in development. Efforts to increase the development of the ICT sectors need to be accompanied by a quantitative investigation of the impact of this sector on the Indonesian economy. Based on the role of ICT as general-purpose technology, it is important to understand the extent of the ICT sectors affecting other economic sectors. In addition, looking at the diffusion of ICT in Indonesia, it is interesting to investigate whether this increasing diffusion is accompanied by an increase in the ICT production side thus influencing structural changes in the ICT sectors. This could be done by investigating the source of its growth. In order to fully described the contribution of the ICT sectors to the economy, the ICT sectors in this study needs to be understood in a broad sense based on the definition and classification of the OECD (2009) and UNCTAD (2008), which includes ICT Manufacturing, ICT Media and Content, and ICT Services. This study attempts to answer the following two research questions concerning the formulation of the problem:

1. What was the contribution of the ICT sectors to the output of the Indonesian economy?
2. What are the determinants of output growth of the ICT sectors in the Indonesian economy?

This study applies Input-Output (IO) analysis to investigate the contribution of the ICT sectors to the Indonesian economy through the role of the ICT sectors output in the economy and through the interrelatedness between sectors. Further, this study investigates the determinants of the ICT sector's output growth by decomposing the sources of its output change. Based on the definition and classification of the OECD (2009) and UNCTAD (2008), what is meant by the ICT sectors in this study includes the ICT Manufacturing sector, ICT Media and Content, and ICT Services. This classification aims to describe the contribution of the ICT sectors in the economy as a whole. The estimations in this study use Indonesia's national level data for the period 2000-2014 from the World Input-Output Database (WIOD). This study has limitations in the form of data that only allows analysis to be carried out until 2014. However, with the available data, this study has analyzed the rapid development of the ICT sectors from 2000 to 2014. From 2015 to 2019, economic conditions and ICT sectors policies did not show any significant changes. Thus, it can be assumed that the structure of production and the structure of the economy in general has not experienced significant changes and the policy implications are still valid.

During the 1960s, technology, human resources, and skills were identified as important factors for supporting economic growth (Uzawa, 1965; Sheshinski, 1967). Schultz (1961) first introduced the term "a new paradigm of economic growth" when emphasizing the importance of human capital. The subsequent studies that developed in the 1980s and thereafter began to place the importance of technology and human capital. Romer (1986) took into account the knowledge factor as an input to the production function and found that the growth model generated different results compared to the traditional one. Technology has become more important after the emergence of the concept of general-purposed technology (GPT) which affects all sectors and encourages innovative activities across the socio-economic system. GPT is characterized by its two roles as a supporting technology and as a complementary to innovation. As an a supporting technology, GPT functions more as a technology that opens up new opportunities than offers a complete final solution ehile as a complementary to innovation, GPT allows productivity in the downstream sector to increase as a consequence of innovation in GPT. This complementary phenomenon amplifies the effect of innovation in GPT and allows the resulting productivity to be transferred to other parts of the economy (Bresnahan and Trajtenberg, 1995). At the firm level, although there is positive relationship found (Greenan, N., Mairessee, J., Topiol-Bensaid, A., 2001; Bugamelli and Pagano, 2004; Castiglione, 2009), ICT alone is not sufficient to affect productivity. The contribution of ICT to productivity that varies between regions and between industries shows that, in diffusion, ICT as a GPT requires complementarity, namely the interaction between ICT, human capital, and organizational innovation (Black and Lynch, 2001).

Theoretically, there are two models that that explain the important role of ICT in the development of an ICT-based economy. The first model examines the role of ICTs through the concept of technological paradigms (Dosi, 1982; Perez, 2004). The theory of the ICT technology paradigm ensures that the impact of ICT is comprehensive both in quality and quantity, both in the structure of the techno-economic system and in the institutional socio-economic system. The second model was developed by several neo-classical economists such as Helpman (1998) and Bresnahan and Trajtenberg (1995) who view ICT as GPT. Unlike conventional technology, GPT has three different characteristics, namely pervasiveness, improvement, and innovation spawning. Pervasiveness means GPT is used as input for many manufacturing and service industries through which its influence spreads in the economy. Improvement shows room for improvement, experimentation and elaboration and the costs of GPT continue to fall. And innovation spawning means that the application of GPT to the manufacturing and service industries supports the creation of new products and new production processes (Bresnahan and Trajtenberg, 1995). Both theoretical models confirm the deep and broad impact of ICTs on the economy. Therefore, assessing the impact of ICTs on economic growth and development must always take into account the pervasive effects of ICTs and structural changes on other sectors of the economy.

Within the framework of input-output analysis, although most empirical studies on the impact of ICTs on the economy conclude a positive effect, various studies have produced mixed results on whether ICT produces a salient effect compared to other sectors. A single country study conducted by Bazzazan (2009) evaluated the impact of ICTs on the Iranian economy by dividing the economy into six main sectors. The results showed that on the demand side, the ICT sectors was placed in the fourth rank

among the six sectors and accounts for 8.6% of Iran's total output. Meanwhile, from the supply side, ICT also placed in the fourth rank among the six sectors with an economic contribution of 9.5% of the total output of Iran's economy. Toh and Thangavelu (2013) explored the influence of ICTs on production growth in Singapore during the 1990-2000 period in the concept of inter-sectoral linkages captured by the IO model. The authors emphasized that the development and use of ICT were the main drivers in the transformation from a traditional economy to a knowledge-based economy. The results of the analysis showed that the ICT sectors was the main link for the expansion of high value added manufacturing and electronic exports for the Singapore economy. Another study by Kecek et al. (2016) investigated the role of ICTs in the Croatian economy. The results of this study indicated that there is no multiplier difference in the ICT output compared to other sectors. In addition, the Croatian ICT sectors productivity index did not change much between 2004 and 2010. Duc and Linh's (2020) research on the ICT sectors in Vietnam showed that although the impact of the domestic ICT sectors on Vietnam's economy in the 2007-2016 period increased over time, in general it did not stands out compared to other sectors. From the intermediate demand and final demand derived, the ICT media and content sector and the ICT services sector revealed significant diffusion and important inter-sectoral links between the ICT and non-ICT sectors in the economy. A study on the aggregate level of the Indonesian telecommunications sub-sector for the period 1975-2008 by Rohman and Bohlin (2013) concluded that the telecommunications sub-sector in Indonesia in that period provided benefits through cellular innovation which made the cost of penetration of ICT relatively low and hence increased ICT diffusion. However, the effect of changing technology coefficients on the output of the telecommunications sector was decreasing, indicating the low ability of the telecommunications sector to build relationships between other industrial sectors.

METHODOLOGY

The method used to achieve the objectives of this study is the input-output (IO) analysis method for it is able to provide a comprehensive picture of economic interrelationships which include 1) the structure of output and value added of each economic activity in a region; 2) intermediate input structure, namely the use of goods and services by production activities in an area; 3) the structure of the provision of goods and services from both domestic production and imports; and 4) the structure of demand for goods and services by production activities, final demand for consumption, investment and exports. In an open and static IO model, transactions used in the preparation of IO tables must meet three basic principles, namely: 1) homogeneity, namely the assumption that each sector produces only one type of output with a single input structure and that there is no automatic substitution between outputs from various sectors; 2) proportionality, namely the assumption that the relationship between input and output in production is a linear function in which the increase in input use by a sector is proportional to the increase in output produced; and 3) additivity, namely the assumption that the total effect of production activities in various sectors is the sum of the effects on each of these sectors. Based on these assumptions, there are several limitations to the IO model. First, because the input and output ratios are constant throughout the analysis period, producers can not adjust for changes in their inputs or change the production process. Second, changes in prices do not affect the proportion of inputs, only changes in final demand affect the inputs to production. While this assumption seems limiting in capturing the economic dynamics of ICTs, it does not diminish the ability of the IO method to investigate the impact of ICT performance on the economy. In order to estimate the economic impact of a particular sector, taking into account the reliability of sectoral level analysis, a detailed IO table is needed to understand the impact of changes in one sector on other sectors.

Preparation of IO tables is carried out to create an all set IO tables to be used for analysis in order to answer research questions. Authors synchronized the definition and classification of the ICT sectors from the OECD (2009) with the classification in the WIOD IO table (2016). Furthermore, the authors synchronized the classification of the Indonesian economic sectors from BPS (2010) with ones in the WIOD IO table (2016). In summary, the OECD's ICT sectors definition and classification includes 99 products at the 4-digit ISIC Rev.4 level. Meanwhile, the IO WIOD table consists of 56 sectors mainly at the 2 digit level of ISIC Rev.4. By synchronizing the two, the ICT sectors in this study is then aggregated from the 7 sectors in the WIOD IO table, namely C26 as the ICT Manufacturing sector, J58, J59-J60 as the ICT Media and Content sector, and J61, J62-J63 as the ICT Services sector. For analysis purposes, the 56 sectors from the IO WIOD table are grouped into 20 broader sectors. The criteria used for sectoral grouping in the IO table include the classification of Indonesia's economic sectors from BPS which

consists of 17 sectors, the definition and classification of the ICT sectors from the OECD, and the potential impact of ICT on each sector. Among these twenty sectors, three of them (N10, N11, N12) are ICT sectors and seventeen are non-ICT sectors.

The input-output (IO) analysis method developed by Leontief (1986) is a practical method for conducting quantitative macroeconomic analysis. The IO table presentation form is a matrix. From the table form shown in Figure 1, two balanced balance equations can be made as follows:

row equation:

$$\sum_{j=1}^{n} x_{ij} + f_i = X_i \quad \forall_i = 1, \dots, n \qquad (1)$$

column equation:

$$\sum_{i=1}^{n} x_{ij} + v_j + m_j = X_j \quad \forall_j = 1, \dots, n \qquad (2)$$

where X_{ij} is the value of the flow of goods or services from sector i to sector j; f_i is the total final consumption; v_j is value added and m_j is import. The definition of a balanced balance is that the amount of production (output) is equal to the amount of input.

The flow between industries can be transformed into coefficients (called input coefficients or technology coefficients) by assuming that the amount of various purchases is fixed for a level of total output and there is no possibility of substitution between an input raw material and another input raw material or in other words, a material raw inputs are purchased in a fixed proportion. These coefficients are:

$$a_{ij} = {}^{x_{ij}}/_{X_j} \quad \text{or} \quad x_{ij} = a_{ij} X_j \qquad (3)$$

By combining equations (1) and (3), we get:

$$\sum_{j=1}^{n} a_{ij} X_j + f_i = X_i \quad \forall_i = 1, \dots, n \qquad (4)$$

or in matrix notation the equation can be written as $AX + f = X$ where $a_{ij} \epsilon A_{nxn}$; $f_i \epsilon f_{nx1}$ and $X_i \epsilon X_{nx1}$. Matrix A shows the interdependence between sectors in an economy; each coefficient a_{ij} shows the amount of input required from sector i for each unit of output of sector j. By manipulating the equation above, the basic relationship from the IO table is obtained:

$$(I - A)^{-1} f = X \qquad (5)$$

where $(I - A)^{-1}$ is usually called the Leontief inverse matrix (input multiplier matrix). The Leontief inverse matrix summarizes all the effects of a change in the production of one sector on the total production of another sector into a coefficient known as the b_{ij} multiplier. This multiplier is the number shown in the matrix $(I - A)^{-1}$.

	Producers as Consumers				Final Demand	Export	Total Output
Producers	1	2	...	n			
1	x_{11}	x_{12}	:	x_{1n}	f_1	e_1	X_1
2	x_{21}	x_{22}	:	x_{2n}	f_2	e_2	X_2
:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:
n	x_{n1}	x_{n2}	...	x_{nn}	f_n	e_n	X_n
Value Added	v_1	v_2	...	v_n			
Import	m_1	m_2	...	m_n			
Total Input	X_1	X_2	...	X_n			

Figure 1. Input-output table

To investigate the contribution of the ICT sectors to the Indonesian economy through interrelatedness between the ICT sectors and other sectors, authors used linkage, multiplier and causative matrice analysis. The backward linkage indicates that the expansion of a sector's production will attract more production activities than other sectors that provide input to the expanding sector. The forward linkage shows that the expansion of a sector's production will increase the production activities of other economic sectors that use the products of the expanding sector as input. From equation (5) it can be seen that the impact due to changes in the final demand of a sector on the output of all economic sectors (B_j) can be formulated as:

$$B_j = b_{1j} + b_{2j} + \cdots + b_{nj} = \sum_i B_{ij} \qquad (6)$$

The amount of impact is also referred to as the power of dispersion index which shows a backward linkage, formulated as follows:

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

From the equation above, it can also be seen that the total output impact of sector i as a result of changes in the final demand for all sectors (B_i)) can be formulated as follows:

$$B_i = b_{i1} + b_{i2} + \cdots + b_{in} = \sum_j B_{ij} \qquad (8)$$

The number of impacts is also referred to as the sensitivity for dispersion index which indicates a forward linkage, formulated as follows:

$$IDK_i = \frac{\sum_{j=1}^{n} b_{ij}}{\frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}} \quad (9)$$

In calculating the multiplier value, the output multiplier $OM_j = \sum_{i=1}^{n} b_{ij}$ is used to see how the total output changes as a result of the change in final demand. The size of the multiplier coefficient really depends on the relationship between certain sectors and other economic sectors as shown in the Leontief inverse matrix. If a sector plays an important role in overall economic activity, there will be a stronger interaction between one sector and another. In other words, the greater the output multiplier, the more important the role of the sector is in economic output.

The causative matrix in the input-output framework is used to evaluate changes between the two matrice which in this study are specifically aimed at identifying the connectivity of the ICT sectors throughout the economy. The derivation of the causative matrix in this study is based on Roy, Das, and Chakraborty (2002). Where A is the technical coefficient matrix and B is the Leontief inverse matrix where $B = (I - A)^{-1}$, both are used to calculate the Markovian matrix as follows:

$$B_M^t = B^t(M^t)^{-1} \text{ dan } B_M^{t+1} = B^{t+1}(M^{t+1})^{-1} \quad (10)$$

In equation (10), M is the diagonal matrix m_{ii} which is the sum of the column i matrix B so that the transition matrix B_M^t is assumed to be related to the transition matrix B_M^{t+1} with the formula:

$$B_M^{t+1} = C\ B_M^t \quad (11)$$

where C is the causative matrix which explains the change between the B_M^t matrix and the B_M^{t+1} matrix with $b_{M_{ij}}^t = \sum_k c_{ik} b_{M_{kj}}^{t+1}$. The matrix C is obtained by inverse B_M^t as follows:

$$C = B_M^{t+1}\ (B_M^t)^{-1} \quad (12)$$

After the matrix is fully filled with dimensions $n\ x\ n$, all the diagonal elements of the matrix (c_{ii}) are compared with 1 while the sum of all non-diagonal elements $(\sum_{k \neq i} c_{ik})$ is compared to 0. The time dynamic equation is presented as follows:

$$b_{ij}^{t+1} = c_{i1}b_{1j} + c_{i2}b_{2j} + \cdots + c_{in}b_{nj} \quad (13)$$

Roy, Das, and Chakraborty (2002) classified the results on a causative matrix as shown in Table 1.

Table 1. Classification of the result of the causative matrice calculation

Definisi	$\sum_{k \neq i} c_{ik} < 0.0$	$\sum_{k \neq i} c_{ik} > 0.0$
	The impact of a decrease in output caused by the final demand for other sectors	The impact of an increase in output caused by the final demand for other sectors
$c_{ii} > 1.0$ The impact of increasing relative endogeneity of the sector compared to other sectors	IV	I
$c_{ii} < 1.0$ The impact of reducing the relative endogeneity of the sector compared to other sectors	III	II

Source: Roy, Das, and Chakraborty (2002)

To answer the second research question, the authors investigate the sources of growth in the ICT sectors using decomposition analysis methods. The analysis of growth factor decomposition was proposed by Chenery (1960) in identifying sources of structural change and industrial growth. In the context of growth, structural decomposition techniques are used to separate growth into several variables to measure the contribution of certain determinants. In looking at the total changes in several aspects of the economy in more detail from the changes in the contributions made by its various components, two or more IO data sets are required. Roy et al. (2002) in a study on the contribution of the information sector to the Indian economy defines the main parameters of economic shifts, as follows:

1. The final domestic demand effect occurs when an increase in economic output is allocated to meet the needs of the domestic market.
2. The import substitution effect is calculated from the changes in the ratio of imports to total demand. Supply sources are an integral part of the economic structure and it is assumed that imports are a perfect substitute for domestic goods.
3. The export effect occurs when output growth is driven by export-oriented demand (foreign demand).
4. The technology coefficients effect represents the widening and deepening of relations between industries over time due to changes in production technology and substitutions between various inputs.

The decomposition of changes in economic output between two time periods can be summarized as follows:

Table 2. Decomposition of ICT output growth sources

Factor	Equation

Changes in ICT output	$\hat{z}(x_1 - x_0) = \hat{z}[R_1(\hat{u}_1 d_1 + e_1) - R_0(\hat{u}_0 d_0 + e_0)]$
Domestic final demand effects	$\hat{z}R_1\hat{u}_1(d_1 - d_0)$
Export effect	$\hat{z}R_1(e_1 - e_0)$
Import substitution effect	$\hat{z}R_1(\hat{u}_1 - \hat{u}_0)(d_0 + w_0)$
Technology coefficient effect	$\hat{z}R_1\hat{u}_1(A_1 - A_0)x_0$

Source: Roy, Das, Chakraborty, 2002

In Table 2 above, $\hat{z}$ denotes the identity matrix, x_i denotes the total output in the economy in year i so that the change in output between the two time periods is marked by $x_1 - x_0$. Furthermore, d_i denotes final domestic demand, w_i denotes total intermediate demand, and e_i denotes total exports. Then $\hat{u}_i$ is the diagonal matrix of domestic supply ratios obtained from $\frac{x_i - e_i}{d_i + w_i}$, A_i is a technology matrix and R is $(I - \hat{u}A)^{-1}$, x_i, d_i, w_i, e_i are vectors.

RESULT AND DISCUSSION

Based on Table 3, it is known that the ICT Manufacturing, ICT Media and Content, and ICT Services sectors in 2000 together contributed to the creation of national output by 2.86% or 1.68%, 0.37%, and 0.81% respectively. The output structure during the 2000-2003 period shows that the ICT Manufacturing sector provided a greater contribution than the other two ICT sectors. Meanwhile, in the 2004-2014 period, the contribution of the ICT Services sector outperformed the contributions of the other two ICT sectors. In 2014, the ICT Services sector contributed 2.2% of the total production output of the economy followed by the ICT Manufacturing sector at 1.27%. The ICT Media and Content sector contributed a relatively low share of output at only 0.64% in 2014. The 2001-2006 period was a period of rapid growth of ICT services with total gross output 5 times higher in 5 years. The growth in the ICT services sector, especially in the telecommunications sub-sector, can be attributed to the deregulation carried out by the government during that period in the form of opening up free market competition after a long monopoly phase, thus encouraging investment for development. During that period, the government also granted a license to operate CDMA and 3G services. The overall output structure of the ICT sectors during the observation period shows a relatively small proportion of the contribution of the ICT sectors to the creation of national output. In 2014, the production of the ICT sectors contributed 4.11% of the output of all sectors in the Indonesian economy. This value is a low portion of output compared to the output portion of several traditional Indonesian sectors such as Agriculture, Forestry and Fisheries at 8.41% and Mining and Quarrying at 7% in the same year.

Table 3. Gross output share of ICT sectors in Indonesian economy

Year	ICT Manufacturing	ICT Media and Content	ICT Services	Total ICT	Total Economy
2000	1.68%	0.37%	0.81%	2.86%	100%
2001	1.80%	0.34%	0.80%	2.93%	100%
2002	1.79%	0.44%	1.12%	3.35%	100%
2003	1.53%	0.47%	1.30%	3.30%	100%
2004	1.57%	0.53%	1.62%	3.72%	100%
2005	1.45%	0.55%	1.82%	3.82%	100%
2006	1.46%	0.57%	1.91%	3.94%	100%
2007	1.48%	0.62%	2.10%	4.20%	100%
2008	1.60%	0.61%	2.07%	4.28%	100%
2009	1.39%	0.65%	2.23%	4.27%	100%
2010	1.30%	0.68%	2.37%	4.35%	100%
2011	1.23%	0.66%	2.28%	4.17%	100%
2012	1.29%	0.66%	2.29%	4.23%	100%
2013	1.33%	0.65%	2.27%	4.26%	100%
2014	1.27%	0.64%	2.20%	4.11%	100%

Based on the input structure for the ICT sectors presented in Table 4, the total input for each sector is divided into value added and intermediate input from domestic production and imports. During the observation period, it is known that the proportion of added value in the ICT Services sector and the ICT Media and Content sector from year to year is higher than the ICT Manufacturing sector. In

2014, the proportion of value added in the total output of the ICT Services sector and the ICT Media and Content sector was 64.90% and 53.44%, respectively, while the proportion of value added in the ICT Manufacturing sector was only 25.64%. From Table 4, it is also known that the proportion of imports of the ICT Manufacturing sector continued to increase, reaching 29.16% in 2014. The increasing proportion of imported intermediate input from 2000 to 2014 and the decreasing proportion of value added in the ICT Manufacturing sector from 2005 to 2014 shows a higher production costs in the Indonesian ICT Manufacturing sector.

Table 4. Input structure of ICT sectors

Sector	ICT Manufacturing			ICT Median and Content			ICT Services		
Year	Intermediate Input		Value Added	Intermediate Input		Value Added	Intermediate Input		Value Added
	Domestic	Import		Domestic	Import		Domestic	Import	
2000	53.47%	15.57%	30.96%	49.94%	10.91%	39.15%	21.49%	3.55%	74.95%
2001	50.38%	17.60%	32.02%	47.94%	10.90%	41.16%	24.88%	2.45%	72.67%
2002	51.63%	15.39%	32.98%	49.59%	7.22%	43.19%	27.30%	2.18%	70.52%
2003	53.23%	13.11%	33.66%	50.06%	4.49%	45.44%	29.65%	1.87%	68.47%
2004	49.17%	15.85%	34.99%	47.45%	4.52%	48.03%	31.35%	2.08%	66.57%
2005	44.38%	19.35%	36.27%	43.10%	6.00%	50.90%	31.82%	3.42%	64.76%
2006	52.48%	13.96%	33.56%	43.48%	5.06%	51.46%	32.32%	2.89%	64.79%
2007	50.07%	18.11%	31.82%	42.10%	5.83%	52.08%	31.90%	3.25%	64.85%
2008	42.00%	26.83%	31.17%	39.89%	7.23%	52.88%	31.28%	3.73%	65.00%
2009	45.27%	25.38%	29.35%	40.95%	5.75%	53.30%	31.72%	3.27%	65.01%
2010	43.58%	28.66%	27.76%	39.65%	6.50%	53.85%	30.79%	4.18%	65.03%
2011	43.91%	28.42%	27.68%	39.41%	6.75%	53.83%	30.59%	4.38%	65.03%
2012	43.00%	29.26%	27.74%	39.22%	6.91%	53.87%	30.86%	4.11%	65.03%
2013	43.17%	29.06%	27.77%	39.11%	6.98%	53.91%	31.19%	3.77%	65.04%
2014	43.04%	29.16%	27.79%	39.29%	6.80%	53.91%	31.62%	3.34%	65.04%

Based on the output structure of the ICT sectors in Table 5, the total output of each sector is divided into intermediate consumption, final consumption, and exports. During the observation period, the proportion of intermediate consumption in the ICT Media and Content sector's total output of was continued to increase from 32.34% in 2000 to 75.26% in 2014. Thus, information services (publishing, newspapers, broadcasting) have served other sectors by well, possibly through inputting data into production and business processes, marketing, and advertising services. The ICT Services sector, prior to 2010, served mostly intermediate consumption, while starting in 2010 the proportion of intermediate consumption and final consumption in this sector was almost equal, namely 47.31% and 49.74% respectively in 2014. There is an inverse trend between the proportion of exports and intermediate consumption as well as domestic consumption in the output structure of the ICT Manufacturing sector. From year to year the export orientation of the ICT Manufacturing sector continued to decline to 45.27% in 2014. However, the proportion of exports in the ICT Manufacturing sector was still higher than the output used as final consumption and domestic consumption where it reached 23.13% and 31.59% respectively in the year 2014.

Table 5. Output structure of Indonesian ICT sectors

Year	Sector	Intermediate Demand	Final Demand	Export
2000	ICT Manufacturing	0.00%	0.00%	100.00%
	ICT Media and Content	32.34%	66.81%	0.85%
	ICT Services	54.79%	42.68%	2.53%
	Total ICT	19.69%	20.71%	59.60%
2001	ICT Manufacturing	0.08%	8.43%	91.49%
	ICT Media and Content	40.35%	58.86%	0.79%
	ICT Services	61.30%	36.21%	2.48%
	Total ICT	21.29%	21.73%	56.98%

Year	Sector	Intermediate Demand	Final Demand	Export
2002	ICT Manufacturing	3.07%	21.25%	75.69%
	ICT Media and Content	58.82%	40.14%	1.04%
	ICT Services	62.83%	34.89%	2.27%
	Total ICT	30.35%	28.28%	41.37%
2003	ICT Manufacturing	4.80%	25.43%	69.77%
	ICT Media and Content	74.77%	22.70%	2.54%
	ICT Services	67.64%	29.64%	2.72%
	Total ICT	39.53%	26.70%	33.77%
2004	ICT Manufacturing	3.96%	24.22%	71.82%
	ICT Media and Content	71.88%	21.95%	6.17%
	ICT Services	65.77%	31.89%	2.34%
	Total ICT	40.61%	27.23%	32.16%
2005	ICT Manufacturing	1.68%	23.49%	74.84%
	ICT Media and Content	61.20%	19.21%	19.58%
	ICT Services	63.88%	33.90%	2.22%
	Total ICT	39.95%	27.84%	32.21%
2006	ICT Manufacturing	13.38%	28.41%	58.21%
	ICT Media and Content	67.97%	16.81%	15.23%
	ICT Services	58.30%	39.11%	2.59%
	Total ICT	43.09%	31.91%	25.00%
2007	ICT Manufacturing	15.38%	32.91%	51.70%
	ICT Media and Content	71.26%	17.58%	11.16%
	ICT Services	52.61%	44.44%	2.95%
	Total ICT	42.29%	36.40%	21.31%
2008	ICT Manufacturing	17.57%	34.11%	48.32%
	ICT Media and Content	71.61%	18.43%	9.97%
	ICT Services	50.01%	46.72%	3.27%
	Total ICT	40.92%	37.97%	22.36%
2009	ICT Manufacturing	16.31%	22.80%	60.89%
	ICT Media and Content	77.20%	16.17%	6.63%
	ICT Services	48.90%	48.22%	2.89%
	Total ICT	42.58%	35.06%	22.36%
2010	ICT Manufacturing	20.24%	27.56%	52.19%
	ICT Media and Content	75.80%	15.84%	8.37%
	ICT Services	46.37%	49.44%	4.19%
	Total ICT	43.17%	37.63%	19.20%
2011	ICT Manufacturing	21.76%	30.88%	47.36%
	ICT Media and Content	73.24%	16.43%	10.32%
	ICT Services	45.57%	49.54%	4.89%
	Total ICT	42.87%	38.80%	18.33%
2012	ICT Manufacturing	19.72%	28.83%	51.45%
	ICT Media and Content	72.81%	17.00%	10.19%
	ICT Services	45.65%	50.08%	4.27%
	Total ICT	41.99%	38.46%	19.54%
2013	ICT Manufacturing	23.10%	32.32%	44.58%
	ICT Media and Content	75.05%	16.61%	8.34%
	ICT Services	45.99%	50.58%	3.43%
	Total ICT	43.28%	39.64%	17.07%
2014	ICT Manufacturing	23.13%	31.59%	45.27%
	ICT Media and Content	75.26%	17.79%	6.95%
	ICT Services	47.31%	49.74%	2.95%
	Total ICT	44.15%	39.19%	16.66%

The economic impact theory of ICT suggests that an important contribution of the ICT sectors lies in the spillover effect which reflects the consumption of ICT products and services by other sectors in the economy. The application of ICT supports other sectors of the economy to make changes in business processes and business models, contributes to the growth of new products and services, thereby enhancing the performance of these sectors and the economy as a whole. Ten sectors with data expenditure from Indonesia can be seen in Table 6. From this table it is known that the user of intermediate input from the ICT Manufacturing sector is the ICT Manufacturing sector itself and the ICT Media and Content sector. Meanwhile, the input produced by the ICT Media and Content sector are mostly used by the Education sector. The input produced by ICT Services sector are mostly used by the ICT Services sector itself and Finance and Insurance Activities sector. Overall, beside the ICT sectors themselves, several other sectors that use products from the ICT sectors as input for production include the Wholesale and Retail Trade, Finance and Insurance Activities, Professional, Scientific and Technical Activities, and the Education sector. These ten sectors are dynamic thus require highly skilled labor. According to Perez (2004), the sectors with ICT-intensive inputs support the expansion of the ICT market at an early stage and promote other economic sectors to apply ICTs in production and business activities.

Table 6. ICT expenditure in intermediate cost of high ICT using sectors in 2014

Sector	ICT Manufacturing	ICT Media and Content	ICT Services	Total ICT
Wholesale and Retail Trade	1.263%	1.219%	5.003%	7.485%
ICT Manufacturing	34.711%	0.876%	0.842%	36.428%
ICT Media and Content	6.623%	10.154%	8.150%	24.927%
ICT Services	6.652%	5.590%	40.356%	52.598%
Finance and Insurance Services	0.374%	5.610%	10.907%	16.892%
Real Estate Activities	0.026%	2.515%	2.937%	5.479%
Professional, Scientific and Technical Activities	3.618%	6.226%	7.680%	17.524%
Administrative and Support Activities	0.520%	7.090%	5.673%	13.284%
Education	2.667%	10.860%	2.241%	15.768%
Human Health and Social Work Services	2.553%	0.836%	1.734%	5.123%

The linkage analysis in this study was carried out by calculating the forward linkage, backward linkage, multiplier value and causative matrix. Within the framework of the input-output model, production by a particular sector has two kinds of economic effects on other sectors in the economy. On the demand side, when the ICT sectors increases its output, there will be an increase in demand from the ICT sectors for goods or services from other sectors whose goods or services are used as input for ICT production. The relationship between the ICT sectors and the input provider sector is termed backward linkage and is indicated by the value of the power of dispersion index. On the supply side, an increase in output in the ICT sectors also means that there is an increase in supply from the ICT sectors for sectors that use ICT goods or services in their production. The linkage between the ICT sectors and the ICT user sectors as an input is termed a forward linkage and is shown through the sensitivity for dispersion index.

The relationship between the ICT sectors and other sectors in the economy is shown in Table 7. From the demand side, during the observation period, the ICT Manufacturing sector and the ICT Media and Content sector showed a higher power of dispersion index than the average sectors index in the economy, respectively worth 1.07 and 1,026 in 2014. Meanwhile, the power of dispersion index of the ICT services sector was always below the average sectors index in the economy during the year observed. However, it tends to increase from time to time. This power of dispersion index shows that the ICT sectors, especially ICT Manufacturing and ICT Media and Content, has the ability to attract other sectors that produce intermediate inputs for ICT sectors production output. From the supply side, during the observation period, the sensitivity for dispersion index for ICT sectors are below the average sectors in the economy. Among the the three, the ICT Services sector had the best sensitivity index from 2000-2014. This sensitivity index shows that the ICT sectors lack the power to encourage other sectors to increase production by providing ICT output as intermediate input in the production process of other sectors. These imply that investment

in the ICT sectors is able to increase total output but does not increase the spread of the ICT sectors in Indonesia.

Table 7. ICT Linkages (in unit)

Year	Sector	Output Multiplier	Power of Dispersion Index (Backward Linkage)	Sensitivity for Dispersion Index (Forward Linkage)
2000	ICT Manufacturing	1.858	1.201	0.646
	ICT Media and Content	1.768	1.143	0.759
	ICT Services	1.323	0.855	0.783
2001	ICT Manufacturing	1.814	1.156	0.638
	ICT Media and Content	1.757	1.120	0.719
	ICT Services	1.369	0.873	0.797
2002	ICT Manufacturing	1.872	1.153	0.634
	ICT Media and Content	1.823	1.123	0.741
	ICT Services	1.413	0.870	0.829
2003	ICT Manufacturing	1.919	1.153	0.627
	ICT Media and Content	1.855	1.114	0.745
	ICT Services	1.459	0.876	0.849
2004	ICT Manufacturing	1.832	1.121	0.634
	ICT Media and Content	1.793	1.097	0.760
	ICT Services	1.483	0.907	0.904
2005	ICT Manufacturing	1.730	1.084	0.635
	ICT Media and Content	1.698	1.063	0.749
	ICT Services	1.484	0.929	0.935
2006	ICT Manufacturing	1.901	1.154	0.681
	ICT Media and Content	1.723	1.046	0.748
	ICT Services	1.508	0.916	0.929
2007	ICT Manufacturing	1.852	1.131	0.695
	ICT Media and Content	1.695	1.036	0.772
	ICT Services	1.500	0.916	0.944
2008	ICT Manufacturing	1.702	1.054	0.720
	ICT Media and Content	1.649	1.021	0.778
	ICT Services	1.485	0.920	0.951
2009	ICT Manufacturing	1.785	1.074	0.683
	ICT Media and Content	1.696	1.020	0.778
	ICT Services	1.506	0.906	0.945
2010	ICT Manufacturing	1.733	1.072	0.718
	ICT Media and Content	1.661	1.028	0.798
	ICT Services	1.480	0.916	0.963
2011	ICT Manufacturing	1.731	1.080	0.729
	ICT Media and Content	1.651	1.030	0.793
	ICT Services	1.475	0.920	0.954
2012	ICT Manufacturing	1.713	1.074	0.725
	ICT Media and Content	1.642	1.030	0.795
	ICT Services	1.477	0.926	0.961
2013	ICT Manufacturing	1.713	1.077	0.746
	ICT Media and Content	1.636	1.028	0.800
	ICT Services	1.484	0.933	0.962
2014	ICT Manufacturing	1.713	1.070	0.738
	ICT Media and Content	1.642	1.026	0.791
	ICT Services	1.494	0.933	0.955

Next, multiplier is used to see the effect of creating the overall output in the economy for every one unit change in final demand in the sector. In 2014, the ICT Manufacturing sector output multiplier reached 1,713. This value indicates that each one million USD increase in output produced by this sector will encourage an increase in the national economic output by 1.713 million USD. During the observation period, the output multiplier of the ICT Media and Content sector and the ICT Services sector always ranked second and third with a value of 1,642 and 1,494 in 2014. Amir and Nazara (2005) stated that the larger the output multiplier value indicates the increasingly important role of the sector in the economic output so that it can be called a leading sector. From the proportion of output and the output multiplier value, it can be concluded that although the larger proportion of output to total economic output since 2004 has been generated by the ICT Services sector, the multiplier effect of domestic production in the ICT Manufacturing sector is more prominent than the other two ICT sectors.

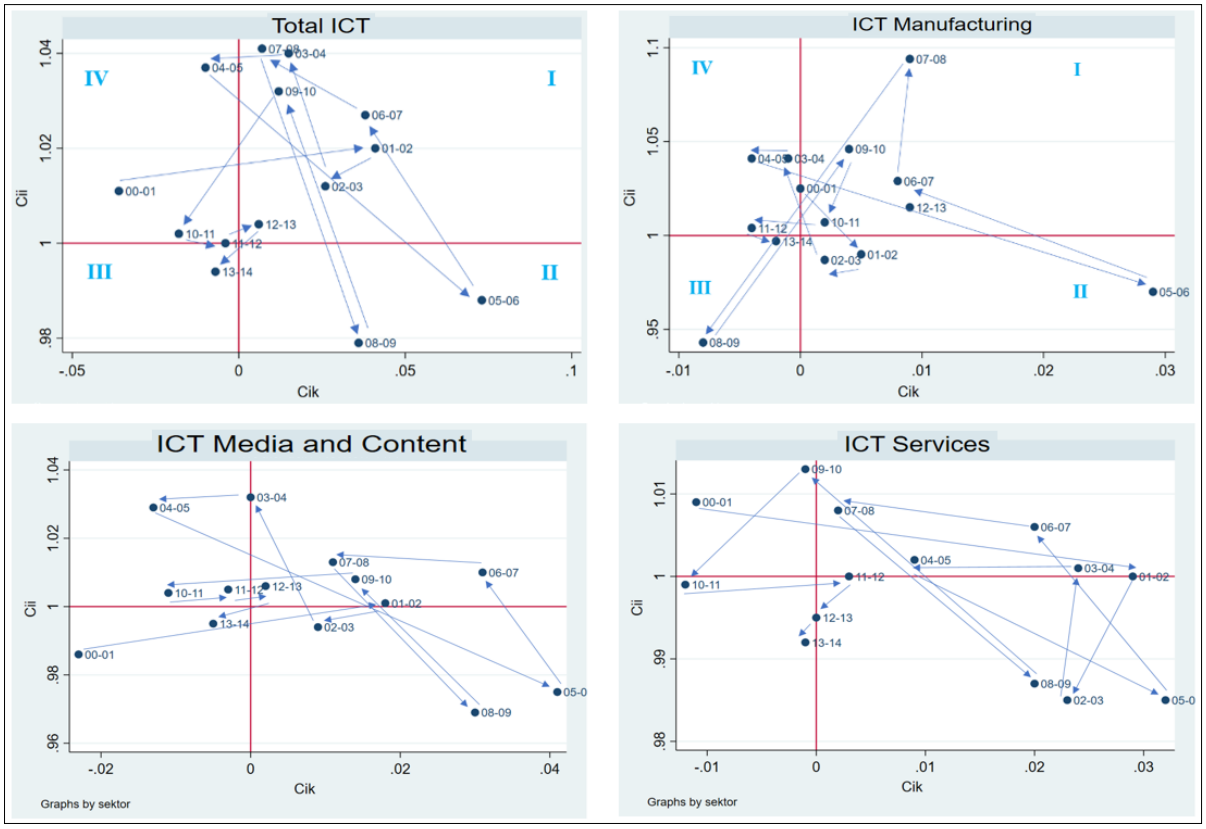

Figure 2. ICT sectors transition

To see indications of changes in the linkages of the ICT sectors with other sectors during the 2000-2014 period, a causative matrix are applied. The causative matrix approach has the advantage of capturing direct changes in interactions with other sectors as well as relative changes due to the presence of other sectors. Based on Table 3.3, the quadrant is divided into four categories in which the threshold value for c_{ii} is 1 and c_{ik} is 0. The transition pattern of the ICTs sector can be summarized as follows:

a. quadrant I: in this quadrant the values of $c_{ii} > 1.0$ and $c_{ik} > 0.0$, which means that, relative to the impact on other sectors, the final demand for the ICT sectors is increasingly stimulated by the output of the ICT sectors itself and simultaneously there is a proportional increase in final demand for other sectors driven by output of the ICT sectors
b. quadrant II: in this quadrant the values of $c_{ii} < 1.0$ and $c_{ik} > 0.0$, which means, relative to the impact on other sectors, the final demand for the ICT sectors is increasingly stimulated by the output of other sectors and simultaneously there is a proportional increase in the final demand for other sectors driven by the output of the ICT sectors

c. quadrant III: in this quadrant the values of c_{ii} < 1.0 and c_{ik} < 0.0, which means that, relative to the impact on other sectors, the final demand for the ICT sectors is increasingly stimulated by the output of other sectors and simultaneously there is a proportional decline in the final demand for other sectors driven by the output of the ICT sectors
d. quadrant IV: in this quadrant the values of c_{ii} > 1.0 and c_{ik} < 0.0, which means, relative to the impact on other sectors, the final demand for the ICT sectors is increasingly stimulated by the output of the ICT sectors itself and a proportional decline in the final demand for other sectors is simultaneously driven by the output of the ICT sector.

Figure 2 shows that the ICT sector transition during the 2000-2014 period is unstable. At the start of the period 2000-2001, the ICT sector was in quadrant IV. In the 2001-2002 period the ICT sector transitioned to quadrant I and remained in quadrant I in the 2002-2003 and 2003-2004 periods. In the period 2004-2005 and 2005-2006 the ICT sector moved to quadrant IV and quadrant II. Finally, the ICT sector is in Quadrant III in the 2013-2014 period. From the transition of the ICT sector, it is known that in the early period the ICT sector was in quadrant IV which means that during that period the ICT sector absorbed all changes in final demand to form its own output and at the same time the impact of the output of the ICT sector on the final demand of other sectors decreased. In the period 2005-2006 and 2008-2009, the ICT sector succeeded in reaching quadrant II. This implies that during this period the final demand for the ICT sector was able to influence the final demand for other sectors as well as increasingly act as a catalyst by distributing its products to other sectors. In other words, the ICT sector became more interactive with other economies during this period. From the sub-sector point of view, the ICT sector transition in quadrant II occurred for the ICT Manufacturing sector in the 2001-2002, 2002-2003, and 2005-2006 periods; for the ICT Media Content sector in the period 2002-2003, 2005-2006, and 2008-2009; and for the ICT Services sector in the period 2002-2003, 2005-2006, and 2008-2009. This shows that the linkage of the three ICT sectors, in each of these periods, with other sectors has increased. However, in the recent period of observation there has been a decline in the ability of the ICT sector to stimulate final demand for other sectors, as indicated by the transition of the ICT sector to quadrant III. In general, during 2000-2014, both in total and per sub-sector, the ICT sectors was more concentrated in quadrant I. This shows that in several periods the increase in the final demand for the ICT sectors was more stimulated by the final demand for the ICT sectors itself, and in balance, the output of the ICT sectors is able to stimulate the final demand for other sectors. Although this suggests the lack of ability of the ICT sectors to directly drive the final demand for other sectors, the increase in demand for ICT sectors products reflects the widespread adoption of ICT in several other sectors.

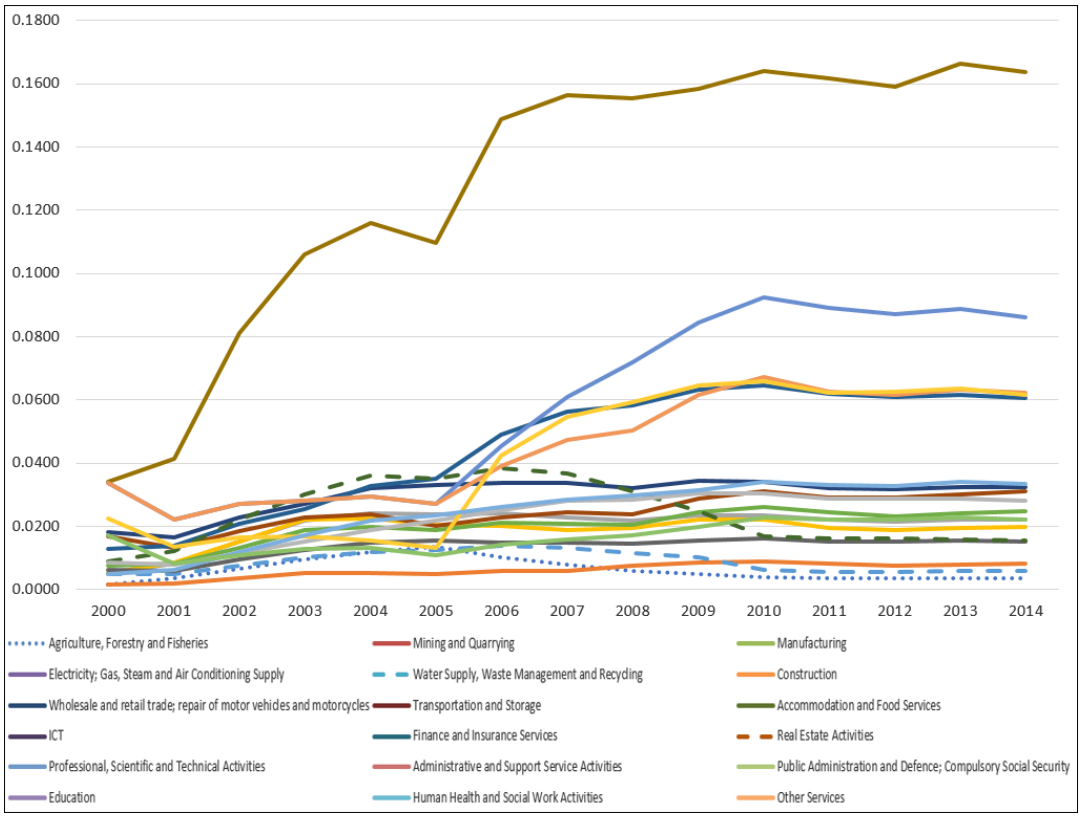

Figure 3. Coefficient of ICT in various sectors in 2000-2014

The dynamics of the transition of the ICT sectors between quadrants can occur due to changes in the ICT sector itself, the sectors that uses ICT output, and the sectors that provides input for producing ICT. Changes in these sectors occur due to the transfer of technology from old techniques to new techniques (Helpman & Trajtenberg, 1998). Adoption of technology will gradually change productivity where productivity slows down in the first phase of adoption and then increases in the next phase. Apart from technology adoption, changes in productivity are also influenced by the type of service. Strohmaier and Rainer (2016) showed that the impact of labor productivity was greater in the service-oriented sectors compared to consumer-oriented sectors such as trade. This is because in the service-oriented sector, competition tends to be at the technology level which demands higher skilled labor. Meanwhile, in the trade sector, the use of ICT aims to replace the workforce in order to remain competitive at cost levels.

The above findings are corroborated by measuring the intensity of ICT in various sectors as shown in Figure 3. The increase in ICT diffusion occurred in several sectors in the economy, especially in the 2001-2010 period. Several industries with an increasing proportionally increasing role in stimulating ICT output relative to the final output production of other sectors as shown by the line elements of the ICT sector are the Finance and Insurance Services, the Education and the Professional, Scientific and Technical Activities sectors. The increase in ICT intensity was also seen in the Transportation and Storage, the Other Services, and the Accommodation and Food Services sectors. This shows that these sectors have used ICTs to improve the production process so that they can maintain their respective advantages and competitiveness. With the exception of three sectors namely the Agriculture, Forestry and Fisheries, the Water Supply, Waste Management and Recycling, and the Real Estate sectors, most sectors have shown an increase in the intensity of ICT, especially in the 2001-2010 period. This reinforces the view that ICT diffusion occurred and was widespread in other sectors of the economy in the 2001-2010 period. However, the intensity of ICT in various sectors after 2010 has tended to stagnate in line with the transition of the ICT sector in the most recent period where the final demand for other sectors has been less stimulated by the output of the ICT sector.

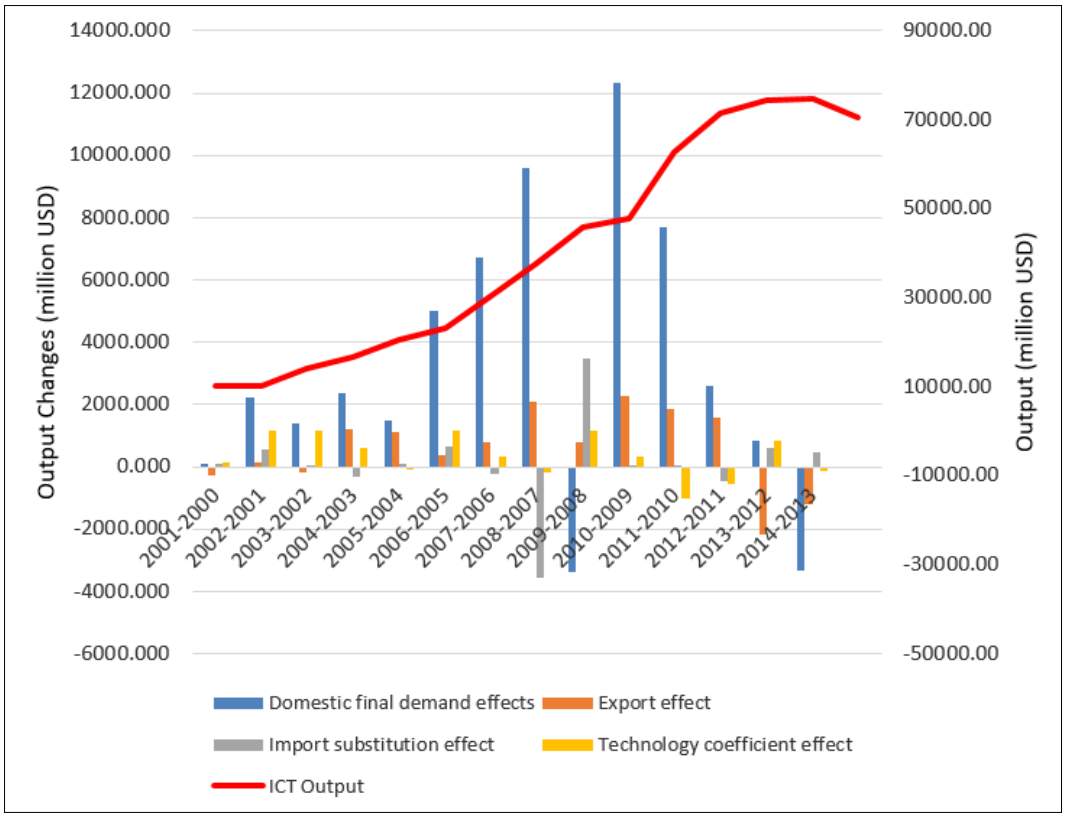

Figure 4. Sources of growth of Indonesia's ICT Sector

From the findings of the position of the ICT sectors in the Indonesian economy in the previous section, an analysis is then carried out on the factors that cause changes in the output of the ICT sector. Figure 4 shows the decomposition of the sources of growth in the ICT sector calculated from the formula in Table 2. In general, it is found that although the output of the ICT sector continues to grow, the contribution of the ICT sector to the output of other sectors in the economy has decreased. Judging from the source of growth, this is because the output of the ICT sector is mostly used to meet domestic final demand. The decomposition in Figure 4 shows that the composition of changes in the output of the ICT sector in the 2000-2014 period was more influenced by the effect of domestic final demand. The proportion of changes in ICT output caused by factors other than domestic final demand, especially the technology coefficient factor, is very small and the proportion has continued to decline over the mentioned period.

Further information regarding the decomposition of changes in output in the ICT Manufacturing, ICT Media and Content and ICT Services sectors is presented in Table 8. Although in the ICT sectors as a whole the effect of domestic final demand is greater than other effects, there are several effects with significant value in certain periods when detailing the ICT sector. In the ICT Manufacturing sector, in addition to the domination of domestic final demand, output growth in this sector was also contributed by the export effect, especially in the 2003-2004, 2008-2009 and 2011-2012 periods. The import substitution ratio in the ICT Manufacturing sector was high in the period 2000-2001, 2001-2002, 2005-2006, and 2012-2013. Meanwhile, the technology coefficient effect has also been a source of growth for the ICT Manufacturing sector in certain periods, namely 2000-2001, 2001-2002, 2005-2006, 2009-2010, 2010-2011, and 2012-2013. However, the proportion of the technology coefficient effect in that period was still smaller than the effect of domestic final demand.

In the ICT Media and Content sector, the output growth from the technology coefficient effect was relatively greater than the other effects in the 2001-2002, 2002-2003 period, and the highest was in 2008-2009. Meanwhile, in 2003-2004, 2005-2006, 2006-2007, although the effect of the technology coefficient played a significant role, the proportion was relatively smaller than the effect of domestic demand. Migration trials from analogue to digital broadcasting systems which have become technological demands internationally which began in 2000 might be the reason for the increasing technology coefficient in this sector. In the 2004-2005 period, the export effect of the ICT Media and Content sector was quite significant. Meanwhile, in

other periods, the export effect of the Media and ICT Content sector was quite low and stable. In the 2009-2010 period there was a negative magnitude on the effect of import substitution. It is possible that during this period the sector relied on imported technology products as well as foreign copyrighted media programs for final consumption.

In the ICT services sector, output growth from the effect of technology coefficients was quite large in the period 2000-2001, 2001-2002, 2002-2003, 2003-2004, and 2008-2009. This is possible because the period 2000-2008 was the period of the emergence of CDMA and 3G technology and the reduction in interconnection rates by the government. The export effect of the ICT services sector was quite high in the 2009-2010 and 2010-2011 periods with a value of USD 2291,043 million and USD 1861,406 million, respectively. However, the ratio of the technology coefficient and the export effect is not too large when compared to the effect of domestic final demand in the same period. Given that most of the output is consumed as final demand, the role of the ICT services sector in supporting other sectors as intermediate demand is low.

The effect of the previous technology coefficient makes a significant contribution to the output of the ICT sectors. However, these values have diminished in recent periods so that the role of this sector is not significant as a GPT sector. In the ICT Manufacturing sector, these findings indicate that the industries in this sector produce more products in the consumer electronics segment than industrial electronics and components. In the ICT services sector, software production, use of cellular phones for productive uses such as access to banking, information services, government information, health and payment systems are still low. In the Telecommunications sub-sector as part of the ICT Services sector, Rohman and Bohlin (2013) concluded that this latest finding indicates that the telecommunications sector as part of the ICT Services sector has failed to expand and deepen relations between industries and other sectors.

Table 8. Sources of growth of Indonesia's ICT Sector (in million USD)

Sector	Decomposition	00-01	01-02	02-03	03-04	04-05
ICT Manufacturing	The Final domestic demand effect	261.57	719.56	435.62	512.54	89.87
	The import substitution effect	-253.06	85.24	-389.62	824.30	337.77
	The export effect	264.52	494.46	-16.85	-394.67	-241.44
	The effect of technology coefficients	1.45	105.94	66.20	-31.40	-84.58
ICT Media and Content	Efek permintaan akhir domestik	-537.03	209.93	29.30	221.28	74.90
	Efek ekspor	-11.05	16.36	83.48	205.97	576.94
	Efek substitusi impor	343.62	56.10	-28.65	48.62	32.64
	Efek koefisien teknologi	56.91	417.76	415.83	104.99	-293.00
ICT Services	Efek permintaan akhir domestik	-252.05	1187.50	823.04	1553.39	1587.35
	Efek ekspor	-40.37	57.83	165.89	190.26	229.52
	Efek substitusi impor	18.37	31.39	7.60	-70.67	-44.19
	Efek koefisien teknologi	156.20	749.45	800.99	658.00	317.16

Sector	Decomposition	05-06	06-07	07-08	08-09	05-06
ICT Manufacturing	The Final domestic demand effect	953.47	1595.05	3681.59	-2604.68	953.47
	The import substitution effect	-5.42	395.18	1489.41	1224.76	-5.42
	The export effect	885.38	-18.40	-1494.91	8.75	885.38
	The effect of technology coefficients	625.66	134.97	178.06	-184.22	625.66
ICT Media and Content	Efek permintaan akhir domestik	689.86	886.82	776.58	171.61	689.86
	Efek ekspor	92.83	35.35	138.80	-302.14	92.83
	Efek substitusi impor	-58.63	-44.58	11.17	77.56	-58.63
	Efek koefisien teknologi	341.78	340.55	-39.73	825.11	341.78
ICT Services	Efek permintaan akhir domestik	3510.73	4189.84	3344.44	2071.77	3510.73
	Efek ekspor	347.01	390.47	461.46	-270.54	347.01
	Efek substitusi impor	-0.47	-23.47	23.73	213.09	-0.47
	Efek koefisien teknologi	-197.91	-313.20	-628.44	857.13	-197.91

Sector	Decomposition	09-10	10-11	11-12	13-14	09-10
ICT Manufacturing	The Final domestic demand effect	2263.75	1560.20	498.99	-786.31	2263.75
	The import substitution effect	373.88	281.60	1705.74	-582.01	373.88
	The export effect	329.94	452.31	-511.95	-131.75	329.94
	The effect of technology coefficients	219.92	78.96	-173.63	-74.91	219.92
ICT Media and Content	Efek permintaan akhir domestik	1901.56	1336.53	467.75	-465.19	1901.56
	Efek ekspor	653.18	602.05	1.40	-238.03	653.18
	Efek substitusi impor	-117.41	-41.59	40.71	266.66	-117.41
	Efek koefisien teknologi	139.40	-508.97	-145.41	-140.71	139.40
ICT Services	Efek permintaan akhir domestik	8169.78	4707.74	1616.15	-1962.86	8169.78
	Efek ekspor	1380.55	1070.79	-279.62	-372.60	1380.55
	Efek substitusi impor	-27.92	-70.21	26.00	167.88	-27.92
	Efek koefisien teknologi	-334.20	-894.46	-98.57	165.53	-334.20

CONCLUSION

The purpose of this study is to investigate the contribution of the ICT sector in the Indonesian economy, to investigate the relationship between the ICT sector and other sectors in the economy, and to investigate the determinants of output growth in the ICT sector using the input-output decomposition analysis method. In achieving these objectives, this study used a sectoral approach based on the definition of the ICT sector which includes ICT Manufacturing, ICT Media and Content, and ICT Services.

From the analysis in the previous section it can be concluded that firstly, the contribution of the output of the ICT sectors to the total Indonesian economy is relatively small. However, the ICT impact theory emphasizes the ability of the ICT sectors to spread and stimulate other sectors, so that even though all three are relatively small economic sectors in terms of output, the ICT sectors can still be the driving force of the economy. Among the three ICT sectors, the contribution of output to the total economy of the ICT Services sector is greater than the other two.

Secondly, through backward linkage analysis, ICT Manufacturing sector and ICT Media and Content sector have a major direct influence in changing the overall output of the economy by attracting sectors that produce intermediate inputs in producing ICT output.

Thirdly, the output multiplier of the ICT Manufacturing sector is higher than the other two ICT sectors during the observation period. These results reveal that although the ICT Manufacturing sector has lower output than the ICT Services sector, the spillover effect on the economy is higher than the other two.

Fourthly, through the transition to the ICT sectors during the 2000-2014 period, the increase of ICT sectors' final demand is stimulated by the final demand for the ICT sectors itself and, at the same time, the use of ICT products by other sectors has been increasing which shows the widespread adoption of ICT.

Fifthly, through an analysis of the sources of output growth, it is found that changes in the output of the ICT sectors are used more to meet domestic final demand. The effect of the technology coefficient on the output growth of the ICT sectors has diminished in recent periods so that the role of the ICT sectors as a GPT sector has not been significant. This finding provides an indication that it is possible that the economic impact of the ICT sectors will fluctuate due to the dominant portion of domestic final demand as a source of output growth.

To increase the contribution of the output of the ICT sector in the economy, it is necessary to strengthen the linkage of the ICT sector with other sectors, especially the main sectors of ICT users such as the Professional, Scientific and Technical Activities, the Financial and Insurance Activities, and Education for these sectors can increase the adoption of ICT across the economy.

Research Limitations

This study has limitations in the form of data that only allows analysis to be carried out until 2014. However, with the available data, this study has analyzed the rapid development of the ICT sector from 2000 to 2014. From 2015 to 2019, economic conditions and ICT sector policies did not show any significant changes. So it can be assumed that the structure of production and the structure of the economy in general has not undergone significant changes.

Another limitation is that the use of the WIOD IO table cannot accommodate the wholesale trading activities of computers, peripherals, software, equipment and wholesale trading of electronic and telecommunication spare parts which should be grouped into the ICT Services sector. This is because the two subsectors are aggregated into the wholesale trade sector apart from cars and motorbikes.

REFFERENCES

Amir, H., & Nazara, S. (2005). "Analisis Perubahan Struktur Ekonomi (Economic Landscape) dan Kebijakan Strategi Pembangunan Jawa Timur Tahun 1994 dan 2000: Analisis Input-Output".

Bazzazan, F. (2009). *The Importance of ICT in Iran Input-Output Approach*. Paper presented at International Conference on Information and Financial Engineering, IEEE Computer Society.

Black, S. E. & Lynch, L. M. (2001). How To Compete: The Impact Of Workplace Practices And Information Technology On Productivity. *The Review of Economics and Statistics*, MIT Press, vol. 83(3), pages 434-445, August.

Bugamelli, M., & Pagano, P. (2004). Barriers to Investment in ICT. *Applied Economics*, 36(20), 2275-2286.

Castiglione, C. (2009). ICT Investment and Firm Technical Efficiency. Paper Presented at EWEPA 2010, June, in Pisa, www.semanticscholar.org/paper/ICT-Investments-and-Technical-Efficiency-in-Italian Castiglione/1126e0aeff6d647602909ff59a062ce7d339bfba.

Chenery, H. B. (1960). Patterns of industrial growth. *The American Economic Review*, 50(4), 624–654.

Dosi, G. (1982). Technical Paradigms and Technological Trajectories. *Research Policy*, 11, 147-162.

Draca, M., Sadun, R. Faber, B. Kretschmer, T. Overman, H. (2008). The Economic Impact of ICT: First Interim Report. Centre for Economic Performance, London School of Economics.

Duc, D. T. V., Linh, D. H. (2020). Analysing ICT Economic Impact in Vietnam. *Research in World Economy*, 11.

Greenan, N., Mairessee, J., Topiol-Bensaid, A. (2001). Information Technology and Research and Development Impacts on Productivity and Skills: Looking for Correlations on French Firm-Level Data. In *Information Technology, Productivity, and Economic Growth: Intenational Evidence and Implications for Economic Development*, M. Pohjola, Ed. Oxford University Press, Cambridge, U.K., 119-148.

Helpman, E. (Ed.). (1998). General-purpose technologies and economic growth. Cambridge: MIT Press.

Helpman, E., Trajtenberg, M., 1998. Diffusion of general purpose technologies. In: Helpman, E. (Ed.), *General Purpose Technologies and Economic Growth.* MIT Press, Cambridge, pp. 85–119 (Chapter 3).

Jorgenson, D. W. (2001). Information Technology and the U.S. Economy (Presidential Address to the American Economic Assosiation). American Econ Rev. 91, 1, 1-32.

Kecek D., Hrustek N. Z., Dusak V. (2016). Analysis of multiplier effects of ICT sectors: a Croatian Case. *Croatian Operational Research Review*, 7, 129-145.

Keller, W. (2004). International Technology Diffusion. *Journal of Economic Literature*, 42(3), 752-782.

Leontief, W. (1986). *Input-Output Economics*. 2nd ed., Oxford University Press: New York, Oxford.

Lipsey, R. G., Carlaw, K. I., and Bekar, C. T. (2005). Economic transformations. General purpose

McKinsey. (2016). *Unlocking Indonesia's Digital Opportunity*. Available at https://mckinsey.com.

Niebel, T. (2018). ICT and economic growth – Comparing Developing, Emerging and Developed Countries. *World Development*, Elsevier, vol. 104(C), pages 197-211.

OECD. (2009). *Information Economy Product Definitions Based on the Central Product Classification.* Geneva.

Perez, C. (2004). Technological Revolutions, Paradigm Shifts, and Socio-Institutional Change, in: R. Erik (Eds.), *Globalization, Economic Development and Inequality: An Alternative Perspective*, Cheltenham, UK, Northampton, MA, USA: Edward Elgar, pp. 217-242.

Rohman, I. K. & Bohlin, E. (2013). Decomposition Analysis of the Telecommunications Sector in Indonesia: What Does the Cellular Era Shed Light on?, *Telecommunications Policy*, Elsevier, vol. 38(3), pages 248-263.

Roller, L. H & Waverman, L. (2001). Telecommunications Infrastructure and Economic Development: A Simultaneous Approach. *American Economic Review*. 91. 909-923.

Romer, P. M. (1986). Increasing Returns and Long-run Growth, *Journal of Political Economy* 94(5).

Roy, S., Das, T., & Chakraborty, D. (2002). A study on the Indian Information Sector: an Experiment

with Input-Output Techniques. *Economic System Research*, 14 (2), pp.107-128.

Schultz, T. (1961). Investment in human capital. *The American Economic Review*, 51(1), 1-17.

Sheshinski, E. (1967). Optimal Accumulation with Learning by Doing. In: Karl, S., Ed., *Essays on the Theory of Optimal Economic Growth*, MIT Press, Cambridge, 31-52.

Steinmueller, W. E. (2001). ICTs and the Possibilities for Leapfrogging by Developing Countries. *Intenational Labour Review*, 140(2), 193-210

Stiroh, K. J. (2002). Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?. *The American Economic Review*, vol. 92, No. 5.

Strohmaier, R. & Rainer, A., 2016. Studying general purpose technologies in a multi-sector framework: The case of ICT in Denmark. *Structural Change and Economic Dynamics*, Elsevier, vol. 36(C), pages 34-49.

Toh, M. H., & Thangavelu, S. M. (2013). An Input-Output Study of the Singapore Information Sector. *Economic Systems Research*, 25(2), 233–244.

UNCTAD. (2008). *International Standard Industrial Classification of all Economic Activities (ISIC), Rev.4*. Department of Economic and Social Affairs, Statistics Division, New York.

Uzawa, H. (1965). Optimum Technical Change in An Aggregative Model of Economic Growth. *International Economic Review*, 6(1), 18-31. doi:10.2307/2525621

WIOD. (2016). World Input-Output Database. Available at di www.wiod.org.