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The Impact of ICT Goods Imports on Economic Growth: Evidence from Asia-Pacific Countries*

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Sang-Chul Yoon†
Department of International Trade, Dankook University, South Korea

Abstract

Purpose – This paper empirically investigates the relationship between Information and Communication Technology (ICT) goods imports and economic growth with a focus on the 13 Asia-Pacific economies during 2005-2016. In particular, this paper extends the study by breaking down the data of Asia-Pacific countries into High Income Countries (HICs) and Low Income Countries (LICs) according to the difference of income levels.

Design/methodology – Our empirical model employs the standard growth model based on the Barro (1998)-type growth framework. Using static panel-data technique, we estimate the effect of ICT goods imports on economic growth in the 13 Asia-Pacific economies. In addition, we also estimate a difference of the ICT goods imports–economic growth link between HICs and LICs.

Findings –The estimation results indicate that ICT goods import has a significant positive effect on economic growth, while ICT goods export has a positive but statistically insignificant effect on it. When we break down the panel data into HICs and LICs in order to gain further insight, ICT goods imports has been effective in spurring growth in only LICs but not in HICs. The other supplementary results show that both domestic investment (GCF) and life expectancy (LE) have a significantly positive impact on economic growth in both HICs and LICs.

Originality/value – The main findings of the paper suggest that ICT goods imports has a positive effect on economic growth in only LICs but not in HICs. This result supports the so-called 'leapfrogging' hypothesis through ICT goods imports in the Asia-Pacific countries, in which LICs are gaining more from ICT goods imports than HICs.

Keywords: Asia-Pacific Countries, Economic Growth, HICs, ICT Goods Imports, LICs
JEL Classifications: F14, O47, O53

1. Introduction

Over the past decades, the great diffusion of Information and Communication Technology (ICT) has caused a dramatic transformation of the world into an information society. Now we have much better access to information, knowledge, and wisdom than before in terms of scale, scope, and speed due to ICT infrastructure such as mobile phones, Internet, and broadband (Bahrini and Qaffas, 2019). The ICT diffusion has improved the efficiency of resources allocation, reduced production costs, and promoted demand and investment in all economic sectors (Grimes, Ren and Stevens, 2012; Pradhan, Arvin and Norman, 2015; Vu, 2011). Therefore, ICT has a significant impact on the growth and structural change in both developed and developing economies (Yoon Sang-Chul, 2018).

The rapid pace of advances in ICT has been maintained over decades and will continue

*This present research was conducted by the research fund of Dankook University in 2018.
†**First and Corresponding author:** yoon@dankook.ac.kr

well into the future. However, the frontier of these advances has shifted away from individual devices to integrated systems of integrated devices of truly staggering complexity (Jorgenson and Vu, 2016). Regarding the growing importance of ICT and the way it is transforming the world, many academicians and researchers have focused on studying the impact of ICT on economic growth at the industry level, at the national level, and at the cross-country level (Bahrini and Qaffas, 2019). The previous study reveals that many theories recognize that ICT plays an increasingly key role in speeding up economic growth, but empirical studies on this relationship have produced mixed results (Sassi and Goaied, 2013; Vu, 2011).

On the other hand, the standpoint of growth models indicates that the links between trade openness and growth should be stronger through imports than exports, and this is especially true for certain types of imports (Awokuse, 2008; Cavallo and Landry, 2010; Greenwood, Hercowitz and Krusell, 1997; Lee, 1995). In a wide range of growth models, sustained growth will only be possible in the long run if there are large sustained productivity gains to counteract the tendency towards the diminishing returns induced by the accumulation of capital (Herrerias and Orts, 2013). These gains can specially arise from ICT goods imports. Recently new technologies are usually embodied in intermediates and ICT goods and it is through ICT accumulation that they gradually become incorporated into the economy.

This paper investigates the impact of ICT goods imports on economic growth in Asia Pacific countries over the period 2005-2016. In this analysis, we focus on three issues that have been insufficiently analyzed in the ICT's effects literature. First, most previous studies covered the ICT investment or diffusion's effect on growth, paying limited attention to the ICT goods imports' effect on growth. This study contributes to the ICT's effects literature by focusing on ICT goods imports which improve both the efficiency of ICT accumulation and the efficiency of domestic production process due to the technological progress embodied in these imported goods. Second, this study contributes to the ICT's effects literature by focusing on Asia-Pacific countries which are still emerging region experiencing rapid growth. Third, this paper focuses on the impact of the ICT goods imports on economic growth by breaking down the panel data of selected Asia-Pacific countries into High Income Countries (HICs) and Low Income Countries (LICs) according to the difference of income levels (Yoon Sang-Chul, 2016).[1]

This paper contributes to the ICT's effect on economic growth in selected Asia-Pacific countries by focusing on ICT goods imports over the period 2005-2016. The estimation results show that ICT goods imports has a positive and significant effect on growth, while ICT goods exports has a positive but insignificant effects on growth. The results also show that both domestic investment (GCF) and life expectancy (LE) are positively related to economic growth significantly, while labor force (LAB) is significantly and negatively related to economic growth.

Moreover, this paper extends the study by breaking down the data of Asia-Pacific countries into HICs and LICs. The means of all variables between HICs and LICs are different and statistically significant in the statistical *t* test. This test result implies that comparing the two groups (HICs and LICs) could be an appropriate strategy in order to examine whether the impact of ICT imports on economic growth in LICs is larger than in HICs. When we break down the panel data into HICs and LICs focusing on different types of income levels, the main findings of the paper thus suggest that ICT goods imports has a positive effect on economic growth in only LICs but not in HICs. This result is in contrast to previous studies such as Lee, Gholami and Tong (2005) and Niebel (2018). However, the result confirms the so-called 'leapfrogging' hypothesis through ICT goods imports in the Asia-Pacific countries, in which LICs are

[1] In this analysis, we use above 20,000US$ and below 10,000 US$ (GDP per capita in 2010) as the classification basis of HICs and LICs (See Table A in the Appendix).

gaining more from ICT goods imports than HICs. As a control variable, both domestic investment (GCF) and life expectancy (LE) are revealed to have significant and positive effects on growth in both Asia-Pacific HICs and LICs. Of the other control variables, labor force (LAB) has a significantly negative impact on growth in Asia-Pacific HICs, while foreign direct investment (FDI) has a significantly negative impact on growth in Asia-Pacific LICs.

The remainder of this paper is organized as follows. Section 2 discusses the related literature. Section 3 shows the model specification and data. Section 4 provides the empirical results, and Section 5 presents concluding remarks.

2. Literature Review

The worldwide rapid progress of ICT in the last three decades has attracted increasing attention among many economists who have focused on studying the impact ICT diffusion on the economic growth of developed and developing economies (Bahrini and Qaffas, 2019). The contemporary theories such as neo-Schumpeterian theories (Pyka and Andersen, 2012) and neoclassical growth theory have highlighted the existence of a significant positive link between ICT and growth. These theories suggest that ICT creates added value at the firm level and at the sectoral level and therefore leads to the improvement of productivity and economic growth at the country level (Aghaei and Rezagholizadeh, 2017).

While theoretical studies have shown a positive effect of ICT on economic growth, several empirical results on this relationship have produced mixed results. On the one hand, numerous studies have confirmed the presence of a significant positive impact of ICT diffusion on economic growth (Aghaei and Rezagholizadeh, 2017; Niebel, 2018; Pradhan, Arvin and Norman, 2015; Pradhan, Girijasankar and Bagchi, 2018; Sassi and Goaied, 2013). Sassi and Goaied (2013) found a positive and statistically significant impact of ICT diffusion on economic growth in the Middle East and North Africa (MENA) countries during 1960-2009. Pradhan, Arvin and Norman (2015) investigated the nature of causal relationships between ICT infrastructure, financial development, and economic growth in 21 Asian countries over the period 2001-2012. They concluded that both ICT infrastructure and financial development matter in the determination of the long-run economic growth of Asian countries. Aghaei and Rezagholizadeh (2017) found that every 1 percent increase in ICT investment led to 0.52 percent economic growth in the Organization of Islamic Cooperation (OIC) countries over the period 1990-2014. Using data from G-20 countries over the period 2001-2012, Pradhan, Girijasankar and Bagchi (2018) found a positive association between ICT infrastructure and economic growth. Based on a sample of 59 countries for the period 1995-2010, Niebel (2018) confirmed the previously reported positive relationship between ICT capital and GDP growth. However, the estimation results for the subsamples of developing, emerging and developed countries did not reveal statistically significant differences in the output elasticity of ICT between these three groups of countries.

On the other hand, some empirical studies that investigated the relationship between ICT diffusion and economic growth in developing countries have not find conclusive results (Lee, Gholami and Tong, 2005; Pohjola, 2002; Pradhan, Arvin and Norman, 2015; Yousefi, 2011). Pohjola (2002) did not find any statistically significant correlation between ICT investment and economic growth in the 43 developing countries during 1985-1999. Using the time series data from 1980 to 2000, Lee, Gholami and Tong (2005) showed that ICT had a positive impact on economic growth only for many developed countries and newly industrialized countries (NIEs), but not for East Asian developing countries. The study by Yousefi (2011) used World Bank data for the period 2000-2006 and found an insignificant impact of ICT capital investment on output growth for developing countries. Pradhan, Arvin and Norman (2015)

confirmed that neither ICT infrastructure nor financial development plays a significant role in the long-run economic growth of western Asian countries, which includes rich Arab oil producers.

The empirical literature on ICT and growth in developed and developing countries examines differing country groups and time periods, which limits the comparability and generalizability of the results. Therefore, the rather ambiguous empirical evidence might be explained by different analytical approaches and the use of data sets covering different countries and time periods (Niebel, 2018). In contrast to the previous studies, we shed light on the ICT goods imports' effectiveness in spurring economic growth by focusing on Asia-Pacific countries during 2005-2016. Specially we examine whether the gains from ICT goods imports are different between Asia-Pacific HICs and Asia-Pacific LICs.

3. Model Specification and Data

In this section, we use the standard growth model based on the growth framework for panel data from Barro (1998) and Barro and Sala-i-Martin (1995) in order to estimate the ICT goods imports-economic growth relationship. We specify a log-linear growth equation except foreign direct investment, life expectancy and inflation variables. This proves to be convenient for estimation because the parameters can be interpreted as elasticities.

The dependent variable is the GDP per capita. The key explanatory variables of interest are ICT goods exports and ICT goods imports as determinants of economic growth. The model also incorporates the other explanatory variables. We select the government policy group of variables to contain foreign direct investment, domestic investment, and inflation and the demographic variable of labor force and life expectancy. All explanatory variables except inflation are expected to have positive relationships with economic growth. However, inflation is expected to have negative links with economic growth.

A Barro (1998)-type growth framework using static panel-data technique has the following form:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln ICTX_{it} + \beta_2 \ln ICTM_{it} + \phi Z_{it} + \varepsilon_{it} \quad (1)$$

where Y is GDP per capita (current US$), $ICTX$ is ICT goods exports (current US$), $ICTM$ is ICT goods imports (current US$). Z is the vector of commonly used control variables, in which FDI is foreign direct investment (net inflows, % of GDP), GCF is gross capital formation (current US$), LAB is labor force (total), LF is life expectancy (total years), INF is inflation (GDP deflator, %), and the subscripts i and t are indexes for country and year, respectively. Finally, ε_{it} is the error term and includes a time-constant country effect μ_i; a time-specific effect τ_t; and an idiosyncratic error term ν_{it} as follows:

$$\varepsilon_{it} = \mu_i + \tau_t + \nu_{it}$$

where ε_{it} are i.i.d. over the whole sample with variance δ_ε^2. We use the FE and RE estimators to estimate β_0, …, ϕ. We anticipate that the signs of the coefficients of all control variables except inflation are positive but that of inflation is negative.

The main data source to analyze the ICT goods imports-economic growth link is the World Development Indicators of the World Bank. The database contains data for GDP per capita (current US$), ICT goods exports (% of goods exports), ICT goods imports (% of goods imports), foreign direct investment (net inflows, % of GDP), gross capital formation (% of GDP), labor force (total), life expectancy (total years), inflation (GDP deflator, %). The analysis was based on yearly data from a cross section of 13 Asia-Pacific countries. We

particularly focus on data from 6 HICs and 7 LICs over the recent period 2005-2016. Appendix Table A1 describes the sample of Asia-Pacific countries used in this study. It shows that the list of sample countries of 13 Asia-Pacific countries, of which 6 countries are in the HICs and 7 countries are in the LICs. Appendix Table A2 reports the descriptive statistics of the main variables used in the analysis.

4. Empirical Results

This section presents empirical evidence of the panel data using different estimation techniques in order to find the appropriate measure for analyzing the ICT goods imports-economic growth relationship in 13 Asia-Pacific countries. We use the static FE and RE econometric technique to find the most appropriate one. Comparing the FE estimators and the RE estimators, we will check substantial differences between the two by the Hausmann test. The FE and RE estimation results in order to find the most consistent estimates are presented in Table 1. We can see substantial differences between FE and RE estimators. However, the Hausmann test strongly rejects the RE model, for the p-value of the estimated chi-square statistics is very low. Therefore, FE model is the more appropriate of the two models.

Table 1 presents the estimation results for 13 Asia-Pacific countries as a whole by estimating the static equation (1). The FE estimation results for 13 Asia-Pacific countries indicate that ICT goods imports has a positive effect on economic growth at the 1% level of significance in all columns, while ICT goods exports has a positive but insignificant effect on economic growth except column (3). Each unit of ICT goods imports raises annual per capita GDP growth by 6.1-11.2%. This finding implies that ICT goods imports is revealed to have a strongly positive relationship with economic growth in Asia-Pacific countries over the sample period.

This paper also reports the other supplementary results pertaining to the growth effects of the control variables such as foreign direct investment (FDI), gross capital formation (GCF), labor force (LAB), life expectancy (LE) and inflation (INF) on economic growth in 13 Asia-Pacific countries. The FE estimation results reported in all columns show that both GCF and LE have positive and significant effect on economic growth, while LAB has negative and statistically significant effect on economic growth. They also show that each unit of domestic investment measured by GCF index increases economic growth by 64.2-67.8% and each unit of life expectancy measured by LE index increases economic growth by 3.4-3.7%, while each unit of labor force by measured by LAB index decreases economic growth by 48.0-55.8%. These findings indicate that GCF as well as LE has a positive effect on economic growth, LAB has a negative effect on economic growth. Table 1 also shows in all columns that FDI has positive but statistically insignificant effects on economic growth, while INF has negative and statistically insignificant effect on economic growth.

More specifically, we extend the impact of ICT goods imports on economic growth by disaggregating the selected 13 Asia-Pacific countries into 6 HICs and 7 LICs in order to gain further insight. In Table 2, we compare the means of selected economic variables between two groups of countries. Eight variables are chosen. The statistical *t* test reveals that the means of the two groups in seven variables except ICT goods exports (lnICTX) are different and significant at 1% level respectively, while the result for the variable measuring ICT goods exports (lnICTX) is different and significant at 5% level. The statistical inference from *t* test is very limited. However, they imply that HICs and LICs are statistically different according to the difference of income levels.

When we estimate the growth impact of ICT goods imports on Asia-Pacific countries by

breaking down Asia-Pacific countries into HICs e and LICs, we should work with few panels and many periods in terms of observation (6-7 countries and 12 years).

Table 1. ICT Goods Imports and Growth Relationship in the Selected Asia-Pacific Countries

	Dependent variable: $\log Y_{it}$					
	(1) FEM	**(2) REM**	**(3) FEM**	**(4) REM**	**(5) FEM**	**(6) REM**
$\log CTX_{it}$	0.016	0.007			0.015	-0.001
	(.0129)	(.0128)			(.0207)	(.0247)
$\log CTX_{it-1}$			0.025*	0.011	-0.003	-0.005
			(.0135)	(.0133)	(.0226)	(.0266)
$\log CTM_{it}$	0.076***	0.034			0.112***	0.063
	(.0252)	(.0244)			(.0360)	(.0417)
$\log CTM_{it-1}$			0.061**	0.026	0.008	-0.033
			(.0250)	(.0247)	(.0331)	(.0386)
FDI_{it}	0.000	-0.001	0.001	-0.000	0.000	-0.002
	(.0019)	(.0019)	(.0020)	(.0019)	(.0019)	(.0019)
$\log GCF_{it}$	0.678***	0.750***	0.666***	0.739***	0.642***	0.773***
	(.0363)	(.0325)	(.0377)	(.0337)	(.0372)	(.0312)
$\log LAB_{it}$	-0.558***	-0.872***	-0.545***	-0.863***	-0.480***	-0.886***
	(.1625)	(.0370)	(.1739)	(.0386)	(.1692)	(.0328)
LE_{it}	0.037***	0.042***	0.034***	0.043***	0.035***	0.040***
	(.0110)	(.0081)	(.0122)	(.0092)	(.0118)	(.0081)
INF_{it}	-0.004	-0.006***	-0.003	-0.005**	-0.003	-0.007**
	(.0019)	(.0022)	(.0023)	(.0023)	(.0022)	(.0024)
Constant	-3.6734*	0.704	-3.154	0.8450	-4.479	0.932*
	(2.2006)	(.6444)	(2.3352)	(.6727)	(2.2937)	(.5552)
Observations	156	156	143	143	143	143
R-squared	0.9300	0.9880	0.9145	0.9877	0.9217	0.9906
F-statistics	258.27***		187.94***		158.28***	
Wald chi^2		3470.27***		2947.29***		5135.69***
Hausman test (the estimated chi-squre statistics)	18.86***		126.61***		38.94***	

Notes: 1. Standard errors in parentheses.
2. *, **, *** denote significance at the 10, 5, 1% level, respectively.

If the number of observations over time is large and that of cross-section units is small, there is expected to be little difference in the values of the parameters estimated by the FE model and RE model. The choice then depends on computational convenience, which is likely to be in favor of the FE model (Gujarati, 2015, 338). In this study, we also consider a static specification in equation (1) and use the static FE model to find the most appropriate specification in analyzing the ICT goods imports–economic growth relationship.

Table 2. Comparison of Means of Selected Economic Variables: HICs and LICs, 2005-2016

Indicator	High Income Countries	Low Income Countries	t test
ln Y (current US$)	10.5174	7.9182	***
ln ICTX (current US$)	23.8013	22.9294	**
ln ICTM (current US$)	24.2959	23.2451	***
FDI (net inflows, % of GDP)	9.8375	4.1429	***
ln GCF (current US$)	25.7789	24.9870	***
ln LAB (total)	16.0000	17.7201	***
INF (GDP deflator, %)	1.5970	5.2080	***
LE (total)	81.7561	72.0008	***

Notes: 1. The *t* test value, comparing the two groups (HICs and LICs) is calculated by using the Welch *t*-statistic as follow:

$$t = \frac{m_H - m_L}{\sqrt{\frac{S_H^2}{n_H} + \frac{S_L^2}{n_L}}}$$

where a) m_H and m_L represent the mean value of the group HICs and LICs, respectively; b) n_H and n_L represent the sizes of the group HICs and LICs, respectively; c) S_H^2 and S_L^2 are the standard of deviation of the two group HICs and LICs, respectively.

2. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 3 provides the FE estimation results for the HICs and LICs. The estimation results in the Asia-Pacific HICs reveal that ICT goods imports has negative and significant effects on economic growth except column (6), while the ICT goods export has positive but insignificant effect on economic growth. These findings suggest that ICT goods imports has a negative and significant relationship with economic growth in Asia-Pacific HICs.

We also control for the other explanatory variables such as FDI, GCF, LAB, LE and INF on economic growth in 6 Asia-Pacific HICs. The FE estimation results reported in all columns show that domestic investment measured by GCF index has positive and significant effect on economic growth, and foreign direct investment measured by FDI index also has a positive but statistically insignificant effect on economic growth except column (6). Each unit of domestic investment measured by GCF index is revealed to increase economic growth by 80.0-81.1%. This finding indicates that domestic investment has a very strongly positive effect on economic growth in Asia-Pacific HICs. The estimation results also indicate that LAB has a negative and statistically significant effect on economic growth, while LE has a positive and statistically significant effect on economic growth. Each unit of labor force measured by LAB index is revealed to decrease economic growth by 82.7-92.8%, while each unit of life expectancy measured by LE index is revealed to increase economic growth by 6.9-7.9%. These findings indicate that LE has a weakly positive effect on economic growth, while LAB has a strongly negative effect on economic growth.

On the other hand, the FE estimation results for the Asia-Pacific LICs show that ICT goods imports has positive and significant effects on economic growth, while ICT goods export has positive but statistically insignificant effects on economic growth. Each unit of the ICT goods imports raises annual real per capita GDP growth by 9.6-10.8%. These findings suggest that ICT goods imports has a positive relationship with economic growth in Asia-Pacific LICs.

Table 3. ICT Imports and Growth Relationship in the Asia-Pacific HICs and LICs

	Dependent variable: $\log Y_{it}$					
	High-Income Countries			Low-Income Countries		
	(6) FEM	(7) FEM	(8) FEM	(9) FEM	(11) FEM	(12) FEM
$\log ICTX_{it}$	0.005		-0.097	0.017		0.020
	(.0584)		(.1270)	(.0153)		(.0236)
$\log ICTX_{it-1}$		0.043	0.127		0.018	-0.012
		(.0579)	(.1238)		(.0152)	(.0257)
$\log ICTM_{it}$	-0.115		0.102	0.107***		0.096**
	(.0707)		(.1350)	(.0302)		(.0437)
$\log ICTM_{it-1}$		-0.167**	-0.247**		0.108***	0.044
		(.0634)	(.1205)		(.0298)	(.0408)
FDI_{it}	0.003**	0.002	0.007	-0.022***	-0.022***	-0.022***
	(.0016)	(.0015)	(.0044)	(.0074)	(.0076)	(.0075)
$\log GCF_{it}$	0.806***	0.811***	0.800***	0.655***	0.622***	0.612***
	(.0752)	(.0615)	(.0733)	(.0469)	(.0488)	(.0482)
$\log LAB_{it}$	-0.928***	-0.880***	-0.827**	-0.161	-0.185	-0.194
	(.2878)	(.3082)	(.3294)	(.2276)	(.2313)	(.2264)
LE_{it}	0.069***	0.079***	0.076***	0.031**	0.033**	0.034**
	(.0163)	(.0186)	(.0194)	(.0154)	(.0163)	(.0160)
INF_{it}	-0.006	-0.006	-0.007	0.000	0.002	0.002
	(.0046)	(.0042)	(.0044)	(.0028)	(.0028)	(.0028)
Constant	1.786	0.251	-0.312	-10.572***	-9.525***	-9.735***
	(2.7398)	(2.9827)	(3.2605)	(3.4888)	(3.5279)	(3.4647)
Observations	72	66	66	84	77	77
R-squared	0.9154	0.9152	0.9162	0.9490	0.9388	0.9440
F-statistics	91.19***	81.78***	61.99***	186.01***	138.09***	114.32***

Notes: 1. Standard errors in parentheses.
2. *, **, *** denote significance at the 10, 5, 1% level, respectively.

This paper also reports the other supplementary results pertaining to the growth effects of the control variables such as FDI, GCF, LAB, LE, and INF on economic growth in 7 Asia-Pacific LICs. The FE estimation results reported in all columns show that domestic investment measured by GCF index has positive and significant effects on economic growth, while foreign direct investment measured by FDI index has negative and statistically significant effects on economic growth. They also show that each unit of domestic investment measured by GCF index increases economic growth by 61.2-65.5%, while each unit of foreign direct investment measured by FDI index decreases economic growth by 2.2%. These findings indicate that domestic investment has a strongly positive effect on economic growth, while foreign direct investment has a weakly negative effect on economic growth. Table 3 also shows that LAB has negative but statistically insignificant effects on economic growth, while INF has positive but statistically insignificant effects on economic growth. This indicates that both LAB and INF do not have any significant impact on economic growth in Asia-Pacific LICs. The estimation results also indicate that LE has a positive and statistically significant effect on economic growth. Each unit of life expectancy measured by LE index is revealed to

decrease economic growth by 3.1-3.4%. These findings indicate that LE has a weakly positive effect on economic growth.

When we compare the estimation results from HICs with those from LICs, our findings are as follows. First, we observe that ICT goods imports has a positive and significant effect on economic growth in Asia-Pacific LICs, while it is a negative and significant in Asia-Pacific HICs. In these estimation results, the growth elasticities of ICT goods imports in LICs are significantly larger than those in HICs. These results are in line with the validity of the 'leapfrogging' through ICT argument as identified by Steinmueller (2001).[2] Second, the estimating results indicate that both domestic investment (GCF) and life expectancy (LE) significantly and positively affects economic growth in both Asia-Pacific HICs and LICs. Third, the estimating results show that foreign direct investment (FDI) significantly and negatively affects economic growth in Asia-Pacific LICs, while labor force (LAB) significantly and negatively affects economic growth in Asia-Pacific HICs.

5. Concluding Remarks

This study focuses on Asia-Pacific countries which are still emerging region experiencing rapid growth in order to capture the effect of ICT goods imports on economic growth during 2005-2016. Moreover, this paper examines the different ICT goods imports' effects on economic growth according to the difference of income levels by breaking down the panel data of the selected Asia-Pacific countries into HICs and LICs. Thus, we estimate a difference of the ICT goods imports–economic growth link between HICs and LICs. In this analysis, we also use the static econometric technique, which is preferable in the long panel analysis.

The estimation results for the 13 selected Asia-Pacific countries show that ICT goods imports has a positive and significant effect on growth, while ICT goods exports has a positive but insignificant effects on growth. The results also show that both domestic investment (GCF) and life expectancy (LE) are positively related to economic growth, while labor force (LAB) is negatively related to economic growth.

Furthermore, this paper extends the study by breaking down the data of the Asia-Pacific countries into HICs and LICs. The main findings of the paper suggest that ICT goods imports has a positive effect on economic growth in only LICs but not in HICs. This result supports the so-called 'leapfrogging' hypothesis through ICT goods imports in the Asia-Pacific countries, in which LICs are gaining more from ICT goods imports than HICs. As a control variable, both domestic investment (GCF) and life expectancy (LE) are revealed to have significant and positive effects on growth in both Asia-Pacific HICs and LICs. Of the other control variables, labor force (LAB) has a significant and negative growth impact in Asia-Pacific HICs, while foreign direct investment (FDI) has a significant and negative impact in Asia-Pacific LICs.

The results of this analysis imply that economic growth in the developing countries would be stimulated directly by increased ICT goods imports. This is because by the 'leapfrogging' effect, the growth elasticities of ICTs in developing countries could be significantly larger than those in developed countries. To benefit from ICT goods imports, the policymakers in developing countries should increase the absorptive capabilities to produce or use ICTs, and the complementary technological capabilities. They are also required to promote access to

[2] Steinmueller (2001, 194) point out that "ICTs have the potential to support the development strategy of 'leapfrogging', i.e. by passing some of the processes of accumulation of human capabilities and fixed investment in order to narrow the gaps in productivity and output that separate industrialized and developing countries".

equipment and know-how to make productive use of latest ICTs.

In particular, the data set of 13 Asia-Pacific countries represents countries with larger GDP growth during the sample period. Therefore, a selection bias which limits the generalizability of the results being only valid to a certain extent might be present. Additional analyses based on larger sample sizes with respect to the time span and the number of countries should be able to use more refined econometric methods. Furthermore, complementary firm level studies could help to gain deeper insight into the growth effects of ICT in developing countries.

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Appendix

Table A. List of Selected Asia-Pacific Countries

13 Selected Asia-Pacific Countries			
HICs	**GDP per capita in 2010 (US$)**	**LICs**	**GDP per capita in 2010 (US$)**
Australia	51,936.89	Cambodia	785.69
Hong Kong	32,550.00	China	4,560.51
Japan	44,507.68	Indonesia	3,113.48
Korea	22,086.95	Malaysia	9,071.36
New Zealand	33,692.01	Philippines	2,129.50
Singapore	46,569.68	Thailand	5,075.30
		Vietnam	1,310.37

Note: We use above 20,000US$ and below 10,000 US$ (GDP per capita in 2010) as the classification basis of HICs and LICs in this analysis.

Table B. Descriptive Statistics (2005-2016)

Variable	Obs.	Mean	Std. Dev.	Min	Max
All 13 Asia-Pacific countries					
Y (current US$)	156	19869.22	19300.22	474.2239	67990.29
ICTX (current US$)	156	7.94e+10	1.22e+11	1355712	5.89e+11
ICTM (current US$)	156	5.89e+10	8.08e+10	6.78e+07	3.68e+11
FDI (net inflows, % of GDP)	156	6.7712	9.9366	-3.6228	58.5188
GCF (current US$)	156	4.34e+11	9.44e+11	1.16e+09	5.02e+12
LAB (total)	156	8.93e+07	2.03e+08	2178626	7.87e+08
LE (total years)	156	76.5032	5.5285	63.088	84.2781
INF (GDP deflator, %)	156	3.5413	4.3254	-5.9921	22.6733
The 6 Asia-Pacific high-income countries (HICs)					
Y (current US$)	72	38679.1	11712.42	18291.92	67990.29
ICTX (current US$)	72	7.75e+10	6.76e+10	3.48e+08	2.51e+11
ICTM (current US$)	72	6.56e+10	6.07e+10	2.09e+09	2.61e+11
FDI (net inflows, % of GDP)	72	9.8375	13.6761	-3.6228	58.5188
GCF (current US$)	72	3.37e+11	4.10e+11	2.39e+10	1.41e+12
LAB (total)	72	1.88e+07	2.30e+07	2178626	6.71e+07
LE (total years)	72	81.7561	1.3295	78.1683	84.2781
INF (GDP deflator, %)	72	1.5970	1.9903	-1.8952	6.2587
The 7 Asia-Pacific low-income countries (LICs)					
Y (current US$)	84	3746.459	2878.522	474.2239	11183.73
ICTX (current US$)	84	8.11e+10	1.55e+11	1355712	5.89e+11
ICTM (current US$)	84	5.31e+10	9.47e+10	6.78e+07	3.68e+11
FDI (net inflows, % of GDP)	84	4.1429	3.0404	0.0567	13.0580
GCF (current US$)	84	5.16e+11	1.23e+12	1.16e+09	5.02e+12
LAB (total)	84	1.50e+08	2.61e+08	6807867	7.87e+08
LE (total years)	84	72.0008	3.3339	63.088	76.403
INF (GDP deflator, %)	84	5.2080	5.0457	-5.9921	22.6733

Notes: 1. The 6 Asia-Pacific high-income countries above $20,000 (GDP per capita in 2010) are Australia, Hong Kong, Japan, Korea, New Zealand, Singapore.
2. The 7 Asia-Pacific low-income countries below $10,000 (GDP per capita in 2010) are Cambodia, China, Indonesia, Malaysia, Philippines. Thailand, Vietnam.