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A Pooled Mean Group Estimation on ICT Infrastructure and Economic Growth in ASEAN-5 Countries

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ABSTRACT

This study empirically investigates the effects of infrastructures for information and communications technologies (ICT) on economic growth in selected ASEAN countries over the period 1980–2010. The studies of ICT infrastructure have received much attention in recent literature for its potential contribution towards growth and productivity. However, there is little empirical evidence on the effects of ICT infrastructure on growth performance, particularly for ASEAN countries. This study examines recent data using the pooled mean group estimator (PMGE). The availability of ICT infrastructure is captured by the number of subscriptions for both fixed line and mobile phone, the number of telephone lines, the number of mobile cellular subscriptions and the number of internet users. Empirical results show statistically significant positive correlations for all four variables. This study concludes that ICT infrastructure is a key driver of ASEAN economic growth.

Keywords: ICT Infrastructure, economic growth, panel cointegration, pooled mean group estimator.

JEL Classification: Q43

INTRODUCTION

Infrastructure has been recognized for its role in the development of a country. Infrastructure is a popular subject in economic literature and has been acknowledged as an important factor in sustaining and promoting economic growth. Infrastructure, as defined in the 1994 World Bank Report, includes public services (power and gas,

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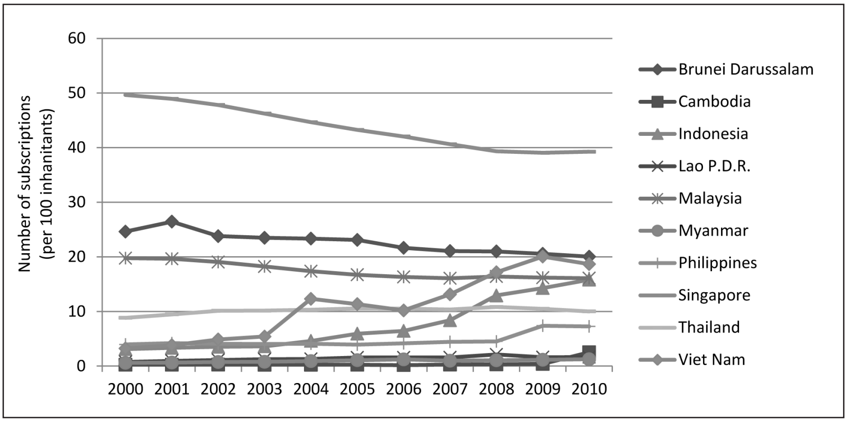
water and sanitation), public works (roads) and other transportation infrastructures (harbours and airports). Gramlich (1994) further defines infrastructure as “the tangible capital stock owned by the public sector”. The term ICT may refer to traditional technologies as well as newer technologies. Examples of traditional technologies are radio and television, while newer technologies include phone, computer and internet. However, for the purpose of this study, we only focus in the aspects of newer technology.

ICT infrastructure is considered one of the powerful tools to boost economic growth via economic reform, as supported in the 2001 OECD Ministerial Report. The report asserts that ICT has the potential to contribute to more rapid growth in the future. A reviewin the World Development Report (1994)highlights that infrastructure may influence economic development through its effects on economic growth, poverty alleviation and environment. Countries with adequate and efficient supply of infrastructure services would have higher productivity growth than countries with lower and inefficient infrastructure services. The literature has identified many ways through which ICT infrastructure may contribute to growth. One of them is through increasing productivity across all sectors, where it improves intra-firm communication and thus result in better management (Grace, Kenny, and Qiang, 2003). Besides increasing productivity, ICT infrastructure also promotes better governance through increased participation, accountability, efficiency and transparency in the public sector. In addition, the contribution of ICT infrastructure can be seen through improved networking, such as access to new markets or services. Access to new markets helps market expansion, achieve economies of scale and lower transaction costs. This is very crucial as today’s global economy requires not only a modern, but also an efficient information infrastructure. ICT infrastructure can also influence growth through improving information flows and reducing the cost of retrieving information. Sridhar and Sridhar (2007) point out that ICT infrastructure provides information regarding prices, job opportunities, and market conditions.Market can perform better with good communication network, especially when it involves costly physical transport.

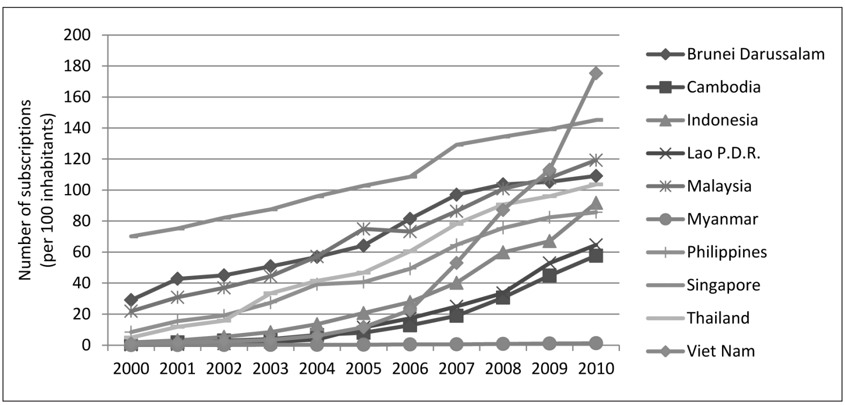
Figures 1 to 4 shows a significant gap in the development of ICT infrastructure among ASEAN countries. In Figure 1, the number of fixed telephone subscriptions is very low in Cambodia, Myanmar, Laos, Philippines and Indonesia, while Singapore records the highest number for the year 2010. Figure 2 shows that Singapore, Thailand, Brunei and Malaysia have considerably higher number of mobile cellular subscriptions compared to the rest of ASEAN countries. The number of mobile cellular subscriptions is also higher than the number of fixed line subscriptions, where rapid increase in the mobile phone penetration and coverage could be a result of liberalization of telecommunication sector in most countries. Figures 3 and 4 shows that Singapore, Malaysia and Brunei record the highest percentage of internet users and the number of fixed internet subscriptions among all ASEAN countries.

This study attempts to investigate the relationship between ICT infrastructure and economic growth in selected ASEAN countries by using the pooled mean group estimator (PMGE) proposed by Pesaran, Shin and Smith (1999).The PMGEis an intermediate estimator that allows the short-term parameters to differ between groups while imposing equality of the long-term coefficients between groups.



Source: International Telecommunication Union (ITU) 2011

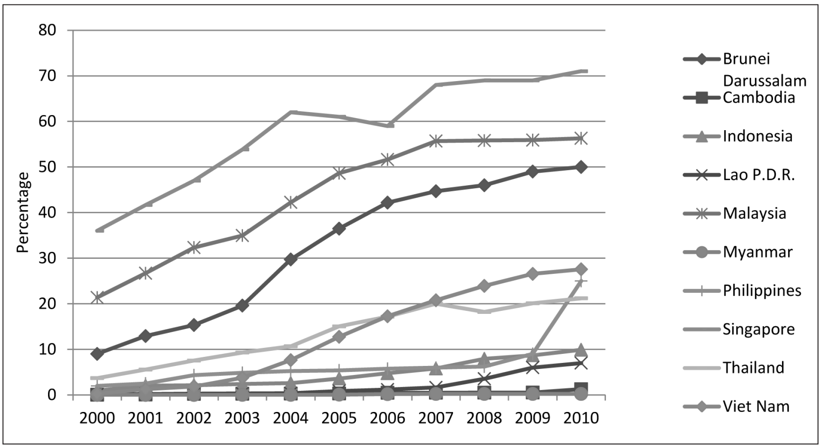
Figure 1 Fixed telephone subscriptions



Source: International Telecommunication Union (ITU) 2011

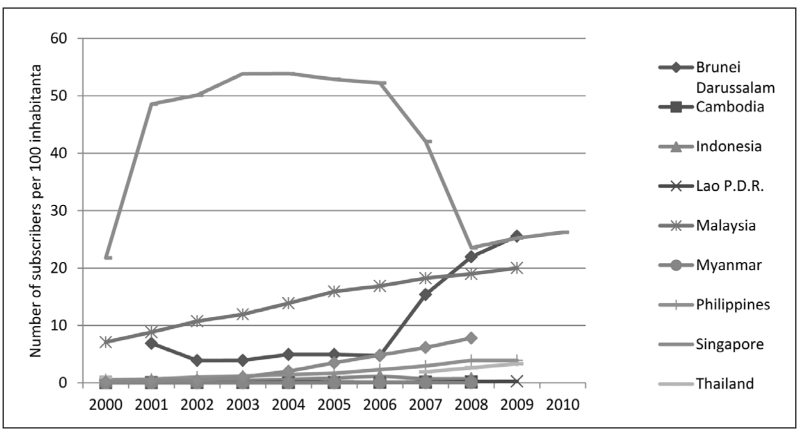
Figure 2 Mobile cellular subscriptions

Although there is a growing body of literature examining the association between ICT and economic growth, there are not many studies which use PMGEon ASEAN countries. The structure of the paper is organized as follows. Section 2 provides a brief summary of previous studies on relationships between ICT infrastructure and economic growth. Section 3 describes the data and the methodology adopted in this study. Section 4 provides the discussion of results. The last section concludes our findings.



Source: International Telecommunication Union (ITU) 2011

Figure 3 Internet users



Source: International Telecommunication Union (ITU) 2011

Figure 4 Fixed internet subscriptions per 100 inhabitants

A THEORETICAL MODEL ON THE RELATIONSHIP BETWEEN INFRASTRUCTURE AND GROWTH

The literature has identified the channels through which infrastructure may affect growth. Authors (Agénor and Moreno-Dodson, 2006, Fourie, 2006) argue that infrastructure may spur growth through two channels: conventional channel and new channel. Through "conventional" channel, infrastructure may affect growth by affecting productivity of private inputs. Higher stock of infrastructure may increase the productivity of other inputs which in turn lower production costs. This higher productivity may further increase the rate of return on private capital and exert a positive effect on growth.

In addition to its direct productivity effects on private inputs, infrastructure may also affect growth through private investment. Higher return on private capital may induce higher investment. Many of past studies that have looked at this relationship (Mitsui, 2004; Agenor, 2004; Reinikka and Svenson, 2002) found a positive relationship between infrastructure and private investment. In short run, infrastructure may affect growth through changes in output and relative prices. A decrease in marginal cost of inputs, as a result of increase in marginal productivity of all factors of production, will increase the level of private capital. Another channel of how infrastructure affects growth is through a crowding out effect on private investment spending through the financial system. An increase in public infrastructure may have a negative impact on growth through its crowding out effect.

Besides "conventional" channels, recent studies have identified new channels through which infrastructure may exert an impact on economic growth. Other than its direct impact on labour productivity through conventional channel, infrastructure is also believed to have an indirect effect on workers' productivity (Agenor and Neardinis 2006, Ferreira, 1999). This occurs through time saving and cost saving benefit due to better provision of public infrastructure. Public infrastructure may also affects growth through adjustment costs associated with private capital formation. For example, adjustment costs can be reduced by facilitating the reallocation of capital from one sector to another in response to changes in relative prices.

Other indirect impact of infrastructure is on the durability of private capital as infrastructure requires regular maintenance. Proper and regular maintenance of infrastructure would help to enhance the productivity effects of public infrastructure on private capital and to provide avenue for job creation. Furthermore, infrastructure may also contribute to better health and better education attainment. For example, having clean water and sanitation may contribute to health improvement. Many past studies that have examined the impact of infrastructure on health outcomes. For example, past studies (Newman *et al*., 2002; Leipziger *et al*., 2003; Wagstaff and Claeson, 2004) have found the positive impact of infrastructure in reducing infant mortality.

LITERATURE REVIEW

Previous studies have examined infrastructure from various aspects, such as energy, financial, information and communication technologies (ICT), and transport. While all these aspects are important for driving a country's growth and development, more attention has been given to ICT infrastructure which includes teledensity, density of computers and internet usage. There is a growing body of evidence linking ICT infrastructure to economic growth. Early studies include Jipp(1963), Bee and Gilling (1967) and Hardy (1980). Jipp (1963) found a positive relationship between the income of a nation and telephone density. Bee and Gilling (1967) studied the relationship between telephone usage and facilities and economic performance using data from 29 countries at different stages of development. Hardy (1980) examined the effects of telecommunication penetration on growth. His results only show the significant impact of the telephone but not the radio. Another study was done by Norton (1992), based on a sample of 47 developed and developing countries. Norton (1992)examined the influence of telephone infrastructure on growth rates by duplicating the framework of Kormendi and Meguire (1985). In tackling the issue of reverse causality, he included the initial-year value of the stock of telephones in the cross-section model. He found that the two measures of telecom infrastructure have a positive and significant impact on mean growth rates.

The relationship between infrastructure and economic growth was further explored by Aschaeur (1989a, 1989b), Munnel (1992), Canning (1999), Calderon and Serven, (2003), and Calderon (2009), among many others. The debate about the effects of infrastructure started following the work of Aschauer (1989a) whose study was based on the Cobb-Douglas production function framework and found a significant positive relationship between the stock of public infrastructure capital and growth for the U.S. economy. However, his findings were criticized by many, including Jorgensen (1991), Holtz-Eakin (1994), Baltagi and Pinnoi (1995), and Cashin (1995). The disagreements are spurred by issues on unit roots and spurious correlation (Jorgensen, 1991), endogeneity of public capital (Cashin, 1995) and measurement errors in the public capital proxies (Baltagi and Pinnoi, 1995). Subsequently, Madden and Savage (2000) used OLS and instrumental variables estimation to control for the possible endogeneity between telecommunications capital and GDP. They investigated the effects of telecommunications on the level and growth of GDP for a cross-section of 43 countries over the period 1975 to 1990, and showed that there is a large effect of telecommunications capital on the level of GDP. Meanwhile, Röllerand Waverman (2001) explicitly model and estimate the effectsof telecommunications infrastructure on economic growth across 21 OECD economies, taking into account the two-way causation between them by using simultaneous approach.The finding revealed telecommunications contribute about 33 per cent of growth in the OECD countries. By using the framework of Röllerand Waverman (2001), Sridhar and Sridhar (2007) estimated a system of equations that endogenizes economic growth and telecom penetration by adding a mobile phone variable to the model. The estimation was done separately to see the effects of each variable. The results provided evidence that cellular services contribute significantly to national output. With some modifications, Waverman, Meschi, and Fuss (2005) followed the work of Röllerand Waverman (2001) and found that mobile telephony has a positive and significant impact on economic growth in developing countries.

More recent study that examines the ICT impact on economic growth was done by Vu (2011). The study applied Generalized Method of Moment (GMM) for dynamic panel data analysis and the findings showed that for the average country, the marginal effect of the penetration of internet users was larger compared to those of mobile phones and personal computers. However, the marginal effect of ICT penetration is found to be inversely related to the number of penetrations. Another study that employed the method of GMM was Nasab and Aghaei (2009) who investigate the ICT impact on economic growth in OPEC member countries for the period 1990-2007. The findings reveal that ICT have a significant impact on economic growth and suggest the need to implement specific policies that facilitate investment in ICT for growth enhancement. Unlike Nasab and Aghaei (2009) who focus on OPEC countries, Lee, Levendis, and Gutierrez (2009) analysed the effects of mobile phones on economic growth in Sub-Saharan countries. They correct the potential endogeneity between economic growth and telephone expansion by using the generalized method of moments. They also consider varying degrees of substitutability between mobile phones and landlines as in Waverman, Meschi, and Fuss (2005). It is found that the marginal impact of mobile telecommunication services is even greater where landline phones are rare.

While there have been increasing empirical studies on the impact of ICT on growth, there are a limited number of empirical attempts that applied the pooled mean group (PMG) estimator. Nevertheless, this method has been used in other studies. For example, Ndambendia andNjoupouognigni (2010) and Tan (2009) study the relationship between foreign aid and economic growth while Bangake and Eggoh (2012) used this estimator when examined the relationship between the savings and investment rates for 37 African. In other studies, Ismail(2008) applied PMG when investigates the issues of convergence and economic growth in the

ASEAN. Goswami and Junayed (2006)estimate the bilateral trade balance model for the USA vis-à-vis her 19 OECD trading partners for the period.

With this background, this study makes contribution with respect to previous literature by employing the pooled mean group (PMG) estimator to examine the impact of ICT on growth in ASEAN-5. In addition, this study use different proxies for ICT and specifically focuses on ASEAN countries.

DATA AND METHODOLOGY

Data

This study employs annual data from 1976 to 2010 for Indonesia, Malaysia, Thailand, Singapore and the Philippines. The selection of countries and length of study period are determined by the availability of data for all required variables. We define our dependent variable as real GDP per capita (constant 2000 US$). The independent variables are population growth, gross fixed capital formation, trade openness and selected ICT infrastructure measures. The ICT infrastructure is represented by the number of subscriptions for both fixed line and mobile phone, the number of telephone lines, the number of mobile cellular subscriptions and the number of internet users, where data for each category is as per 100 inhabitants. All variables are generated from the World Development Indicator (WDI) World Bank Online Database (2011).

Methodology

Panel Unit Root Test

This study applies panel unit root tests instead of traditional unit root tests to increase testing power from additional information provided by the pooled cross-section time series. Prior to PMGE analysis, panel root tests are required to determine the order of integration of the variables. In this study, we use a widely used unit root test proposed by Im, Pesaran and Shin (2003), hereinafter known as IPS. IPS is less restrictive and more suitable compared to unit root tests developed by Levin, Lin and Chu (2002) and Breitung (2000); which do not allow heterogeneity in the autoregressive coefficient. IPS provides a solution to Levin and Lin's serial correlation problem by assuming heterogeneity between units in a dynamic panel framework. IPS specifies an Augmented Dickey-Fuller (ADF) regression with an individual intercept and a time trend for each cross section, as follows:

$$\Delta y_{it} = \beta_i + \rho_i y_{i,t-1} + \sum_{j=1}^{\rho_i} \phi_{ij} \Delta y_{i,t-j} + \varepsilon_{it}; \quad i = 1, 2, \ldots\ldots N; \;\; t = 1, 2, \ldots, T. \qquad (1)$$

where y_{it} is a selected variable in country i and year t, β_i is the individual fixed effect and ρ is selected to make the residuals uncorrelated over time. The null hypothesis is that $\rho_i = 0$ for all *i* whereas the alternative hypothesis is that $\rho_i < 0$ for some *i* = 1, 2, ….N_1 and $\rho_i = 0$ for i = N_{1+1}, ……., N. The IPS statistic is based on averaging individual Augmented Dickey-Fuller (ADF) statistics to produce a standardized test, and can be written as follows:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}$$

where t_{iT} is the ADF *t-statistic* for country *i* based on the country-specific ADF regression, as in Equation (1). The *t* statistic is assumed to be normally distributed under 0 *H* and the critical values for given values of *N* and *T* are provided in Im *et al*. (2003).

Panel Cointegration Test

Next, we conduct a panel cointegration test after identifying the order of cointegration. In this study, we use the panel cointegration test advocated by Westerlund (2007) which enable us to avoid the common factor restriction problem. The null hypothesis is that the variables are not cointegrated. The null hypothesis is tested by inferring whether the error correction term in a conditional error correction model is equal to zero. If the null of no error correction hypothesis is rejected, then the null hypothesis of no cointegration is also rejected.

Westerlund (2007) proposed four different statistics to test panel cointegration based on least squares estimates of α_i and its t-ratio. The statistics can be grouped into two: panel statistics and group mean statistics. Panel statistics are based on pooling the information regarding the error correction along the cross-sectional dimension of the panel whereas the group mean statistics do not exploit this information. While two of the four tests are panel tests with the alternative hypothesis that the whole panel is cointegrated (H_1: $\alpha_i = \alpha < 0$ for all *i's*), the other two tests are group-mean tests which test against the alternative hypothesis that there is evidence of cointegration for at least one cross-section unit (H_1: $\alpha_i = \alpha < 0$ for at least one *i*). The panel statistics, denoted as P_τ and P_α, test the null hypothesis of no cointegration against the simultaneous alternative that the panel is cointegrated, whereas the group mean statistics of P_τ and G_α test the null hypothesis of no cointegration against the alternative, that is at least one element in the panel is cointegrated. One advantage of using Westerlund's (2007) panel cointegration tests is that the time series are allowed to be of unequal length.

Pooled Mean Group Estimation

In order to estimate the effects of ICT infrastructure on economic growth, this study applies the method of pooled mean group estimation (PMGE) of dynamic heterogeneous panels by Pesaran *et al*. (1999). Panel analysis on the unrestricted specification for the autoregressive distributed lag (ARDL) model for time periods $t = 1, 2, \ldots, T$ and groups $i = 1, 2, \ldots, N$; and the dependent variable y is:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \gamma'_{ij} \, x_{i,t-j} + \mu_i + \varepsilon_{it} \tag{2}$$

where y_{it} is a scalar dependent variable, x_{it} is the k × 1 vector of explanatory variables for group *i*, μ_i denotes the fixed effects, λ_{ij}'s are scalar coefficients of the lagged dependent variables, y'_{ij}'s are k × 1 coefficient vectors.

The re-parameterised form of Equation (2) can be formulated as follows:

$$\Delta y_{it} = \phi_i y_{i,t-1} + \beta_i' x_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \gamma'_{ij} \, \Delta x_{i,t-j} + \mu_i + \varepsilon_{it} \tag{3}$$

It is assumed that the disturbance terms ε_{it}'s are independently distributed across i and t, with zero means and $\sigma_i^2 > 0$ variances. It is assumed further that $\phi_i < 0$ for all *i*'s. Thus, there exists a long-run relationship between y_{it} and x_{it} which is defined by:

$$y_{it} = \theta' x_{it} + \eta_{it} i = 1, 2, \ldots\ldots N; \quad t = 1, 2, \ldots\ldots T$$

where $\theta_i = -\beta_i' / \theta_i$, is the k × 1 vector of the long-run coefficients and η_{it}'s are stationary with possibly non-zero means (including the fixed effects). Hence, Equation (3) can be written as:

$$\Delta y_{it} = \phi_i \eta_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \gamma'_{ij} \, \Delta x_{i,t-j} + \mu_i + \varepsilon_{it} \tag{4}$$

where $\eta_{i,t-1}$ is the error correction term given by Equation (4) and thus ϕ_i is the error correction term coefficient measuring the speed of adjustment towards the long-run equilibrium.This parameter is expected to be significantly negative, implying that variables return to a long-run equilibrium.

The PMGE method of estimation allows short-run coefficients, intercepts and error variances to vary across countries but constrains the long-run coefficients to be equal. This implies that $\theta_i = 0$ for all *i's*. In order to estimate short-run coefficients and the common long-run coefficients, Pesaranet *et al*. (1999) adopted the pooled maximum likelihood estimation (MLE) approach by assuming that the disturbances ε_{it} are normally distributed. The estimators are denoted by:

$$\widehat{\phi}_{PMG} = \frac{\sum_{i=1}^{N}\widetilde{\phi}_i}{N}, \quad \widehat{\beta}_{PMG} = \frac{\sum_{i=1}^{N}\widetilde{\beta}_i}{N} \widehat{\lambda}_{jPMG} = \frac{\sum_{i=1}^{N}\widetilde{\lambda}_{ij}}{N}, \quad j = 1, \ldots, p-1 \text{ and,}$$

$$\widehat{\gamma}_{jPMG} = \frac{\sum_{i=1}^{N}\widetilde{\gamma}_{ij}}{N}, \quad j = 0, \ldots, q-1, \quad \widehat{\theta}_{PMG} = \widetilde{\theta}$$

RESULTS AND DISCUSSION

Panel Unit Root and Panel Cointegration Tests

First, we conduct a panel unit root test prior to running the cointegration analysis of the panel data. We adopt the IPS method proposed by Im *et al*. (2003). Table 1 shows the statistics from the panel unit root tests. The variables are labelled as lrgdpc for real GDP per capita, pop for population, lgfcffor gross fixed capital formation, ltofor trade openness, lfm for fixed line and mobile phone subscribers, ltl for number of telephone lines, liufor number of internet users, and lmcs for mobile cellular subscribers. The test statistics suggest that all variables are non-stationary at level. However, all variables are stationary at first-difference as all panel unit root tests reject the null hypothesis of non-stationarity at one per cent level of significance. Thus we can conclude that panel variables are integrated of order one, I(1).

Table 1 IPS panel unit root test

Variables	Level	First Difference
lrgdpc	-1.0190	-3.7740***
pop	-2.0548	-3.0017***
lgfcf	0.6474	-4.8842***
lto	0.2503	-6.7530***
lfm	2.8210	-3.3742***

All variables, except population, are in natural log form. Asterisks ***, ** and * indicate statistical significance at one, five and ten per cent level, respectively.

Panel Cointegration Test

The concept of cointegration was first introduced by Granger (1981), and further developed by Engle and Granger (1987) and Phillips and Ouliaris(1990). Existing panel cointegration tests can be categorized into two groups: tests that take cointegration as the null hypothesis (such as McCoskey and Kao, 1998) tests that take no cointegration as the null hypothesis (Pedroni, 1999; Kao, 1999).

Having found that all variables are stationary at first difference and cointegrated of order one, which is I (1), our next step is to apply the cointegration test using the first-differenced variables. The cointegration test identifies the presence of long-run relationships among integrated variables. For this purpose, we employ four error-correction-based panel cointegration tests proposed by Westerlund (2007). Westerlund tests show the presence of cointegration among cointegrated variables. The tests are based on structural dynamics rather than residuals without imposing a common factor, and take no cointegration as the null hypothesis. In order to choose optimal lag and lead lengths for each series, we use the AIC criterion while the Bartlett kernel window width is set to 4(T/100)2/9 ≈ 3.

Table 2 summarizes the result of Westerlund's cointegration tests. In testing for the existence of a long-run relationship between fixed line and mobile phone subscription, all test statistics reject the null hypothesis of no cointegration at the ten per cent level, two of the tests reject the null hypothesis at the five per cent level and one test reject the null hypothesis at one per cent level. Results suggest that cointegration exists and theseries are expected to move together in the long-run.

Table 2 Westerlund (2007) panel cointegration test

	Stat	**Z-value**	***p*-value**
G_τ	-3.232	-2.182	0.015
G_α	-18.345	-1.938	0.026
P_τ	-5.380	-1.345	0.089
P_α	-19.347	-3.480	0.000

G_τ and G_α are group mean statistics that test the null hypothesis of no cointegration against the alternative hypothesis of cointegration among some of the selected countries. P_τ and P_α are the panel statistics that test the null of no cointegration against the alternative hypothesis of cointegration among all of the selected countries.

Pooled Mean Group Estimation (PMGE)

Table 3 presents the regression results obtained from the PMGE method. For comparison purposes, results obtained using the mean group estimator (MGE) is also reported. The constraint of common long-run coefficients from MGE has yielded higher standard errors and speed of adjustment. This outcome is expected since the MGE procedure is less restrictive, and thus potentially inefficient. In

Table 3 The Effects of ICT Infrastructure on Economic Growth

	MGE(1)	PMGE(1)	MGE(2)	PMGE(2)	MGE(3)	PMGE(3)	MGE(4)	PMGE(4)
pop	-0.128 (0.141)	-0.124*** (0.038)	-0.215 (0.194)	0.015 (0.022)	0.299 (0.332)	0.019 (0.015)	-0.380* (0.202)	-0.303*** (0.012)
lgfcf	0.364*** (0.094)	0.212*** (0.042)	0.224 (0.300)	-0.756*** (0.128)	0.215 (0.175)	-0.310 (0.228)	0.107* (0.064)	0.039 (0.039)
lto	-0.113 (0.365)	0.454*** (0.093)	0.016 (0.464)	1.476 *** (0.284)	0.101 (0.135)	0.471* (0.278)	-0.038 (0.047)	0.038 (0.032)
lfm	0.282 (0.176)	0.046** (0.018)						
ltl			0.531** (0.245)	1.420*** (0.145)				
lmc					0.094*** (0.015)	0.078*** (0.022)		
liu							0.018*** (0.005)	0.026*** (0.003)
Error-correction term	-0.41 [0.100]	-0.23 [0.059]	-0.34 [0.013]	-0.05 [0.288]	-0.79 [0.004]	-0.11 [0.447]	-0.89 [0.053]	-0.90 [0.046]
No. of observation	88		170		88		64	
Hausman statistics	1.91 [0.75]		9.43 [0.05]		1.57 [0.81]		0.34 [0.99]	

Notes: All variables except population growth are expressed in natural logarithms. Standard errors in brackets; * indicates significant at 10%; ** significant at 5%; *** significant at 1%. Hausman test for pool ability is a test for the equivalence of PMGE and MGE. If the null hypothesis is accepted (i.e. p-value greater than 0.05) we can accept homogeneity of cross sectional long-run coefficients. P-values are in square brackets.

testing the hypothesis of slope homogeneity, we use the Hausman (1978) test. The p-values associated with the Hausman test for PMGE and MGE is greater than 0.05 and does not reject the long-run homogeneity restriction hypothesis. The speed of adjustment of the error-correction process shows negative values for all variables but only statistically significant for two variables, namely the number of fixed and mobile subscriptions and the internet users.

Based on model PMGE(1), all coefficients of the core variables show the predicted signs and are statistically significant at one percent level. However, the Hausman test cannot reject the null hypothesis that the PMGE is significantly different from the consistent MGE. We find that the long-run coefficient of the number of fixed line and mobile phone subscriptions per 100 inhabitants is significant at one per cent level and contribute positively to the growth rate in the long-run. This coefficient implies that for a one per cent increase in the number of fixed and mobile subscriptions per 100 inhabitants, real GDP per capita increases by 0.05 per cent. The existence of a long-run relationship between the number of fixed and mobile subscriptions and real GDP per capita is confirmed by a significantly negative error correction term. The size of the average coefficient of 0.23 suggests that the estimated speed of adjustment to the long-term relationship is about 23 percent annually, and the system is reversed to achieve equilibrium in about five years. To test for robustness, we include alternative measures of the ICT infrastructure such as the number of telephone lines, mobile cellular subscriptions and internet users. The inclusion of these alternative measures yields similar results. With regard to all specifications, the results lead to long-term coefficients which are statistically significant with expected positive signs. This finding supports the results of previous empirical evidence on the positive effects of telecommunication on growth (Madden and Savage, 1998; Röller and Waverman, 2001; Waverman, Meschi and Fuss, 2005; and; Sridhar and Sridhar, 2007).

CONCLUSION

This study analyses the effects of ICT infrastructure on economic growth in ASEAN-5 countries. There is a growing consensus within ASEAN that ICT infrastructure has a significant role to achieve the goal of regional economic integration and establish the ASEAN Economic Community (AEC) as a single market production base by 2015. The AEC Blueprint has identified ICT infrastructure as one of the areas that can create and promote competitiveness and ASEAN can achieve greater competitiveness by collectively leveraging ICT as a region. In moving forward towards establishing the AEC by 2015, the ICT development gap continues to be a challenge among ASEAN countries. As an acknowledged key driver in economic and social transformation, it is therefore important for ASEAN to reap the potential benefits of ICT infrastructure.

This study examines data on ICT infrastructure and economic growth for the period 1976-2010 in selected ASEAN countries namely Indonesia, Malaysia, Thailand, Singapore and the Philippines. This study employs a new technique of pooled mean group estimator and finds statistical significance for all ICT infrastructure variables, which are captured by the number of fixed and mobile phone subscriptions, telephone lines, mobile cellular subscribers and internet users. The findings provide support on the importance of ICT as a tool to accelerate economic growth in ASEAN countries. Hence, more efforts should be geared towards encouraging and improving the ICT sector. From the perspective of policy makers, our results suggest that having sufficient and efficient telecommunication infrastructure is essential for fostering economic growth, particularly for other ASEAN countries such as Cambodia, Laos, Myanmar and Vietnam (CLMVs) whose ICT infrastructure are still lagging far behind. The planning of ICT development will have a great impact on the success of ASEAN in becoming an economic community in 2015. At present, each of ASEAN members is on a different level of ICT development and the challenge is to reduce the gap across the region.

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