Global digital divide: determinants of cross-country ICT development with special reference to Southeast Asia

Debbra Toria Nipo; Imbarine Bujang; Ting Siew King
Faculty of Business Management
Universiti Teknologi MARA (UiTM) Sabah, Malaysia

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Abstract
Information and communication technology (ICT) tools are regarded as imperative not only for enabling the economy to grow at a healthy rate, but also for elevating the socioeconomic conditions and standards of the society. In concurrence with the widespread diffusion of ICT, lies the phenomenon called digital divide – a complex issue pertaining to unequal access, use and applications of ICT among countries and peoples. This paper attempts to measure the contribution of conventional factors such as affordability, infrastructure, trade openness and urbanization, with added emphasis on the role of financial development in explaining cross-country development of ICT among Southeast Asian countries. Using panel data for 4 countries for the period 1994 – 2011, findings of this study revealed that GDP is the most significant determinant in explaining digital divide – consistent with findings from previous research efforts. Financial development also appear significant in most models adopted in all three ICT tools, implying the need for these countries to improve their financial markets to avoid falling further behind in promoting a digitally inclusive society.

Introduction

Modern technologies are the catalyst to cultivating innovation-driven economic growth. Access to information and communication technology (ICT) becomes increasingly important in all aspects of development. As rate of technology diffusion, investment and development soared over the years, the gap between society in terms of access, usage and share in benefits have considerably risen as well. Unfortunately, efforts to promote diffusion and change in technology may not be accepted by all countries due to difference in cultural and social systems. To a greater extent, these constraints – alongside economic and political ones – limits the use of ICT to improve well-being of the people. This is where the problem of digital divide stems from.

Over the past few decades, the notion 'digital divide' offers a great deal of discussion as the issue encompasses not only the nation's economic outlook, but also its social and political aspects. OECD (2001) defines digital divide as "gaps between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access in ICTs and to their use of the Internet for a wide variety of activities". When digital divide prevails in the economy, there is a concern that the poorer group of society without access to technology would be further side-lined in the ICT age.

In Asia, the same concern of poverty and digital divide still holds. Despite having acquired a substantial market share in the production of ICT goods, Asian countries seem to be lagging behind in the adoption of ICT compared to non-Asian countries. Another worthy point to mention is that, the digital divide phenomenon which occurs in Asian countries may not be caused by the same factors as in non-Asian countries. For example, as most ICT tools are designed in English, proficiency in the language may appear to be an important determinant in explaining the adoption of ICT in non-English speaking countries like Asia.

An estimation made by ITU World Telecommunication for the year 2013 pointed out that Asia & Pacific recorded a 32% Internet penetration rate globally. With an estimated 7.1 billion of population in 2013, there are almost as many mobile-cellular subscriptions as people in the world, with more than half in the Asia Pacific region (estimated 3.5 billion out of 6.8 billion total subscriptions). Mobile cellular penetration rates stand at 96% globally, 128% in developed countries and 89% in developing countries – where most Southeast Asian countries are.

Table 1: Digital Access Index (DAI) in selected countries across Asia

Country	Digital Access Index (DAI)	Country	Digital Access Index (DAI)
Brunei Darussalam	0.55	Mongolia	0.35
Cambodia	0.17	Myanmar	0.17
China	0.43	Philippines	0.43
Hong Kong	0.79	Singapore	0.75
Indonesia	0.34	South Korea	0.82
Japan	0.75	Taiwan	0.79
Macao	0.64	Thailand	0.48
Malaysia	0.57	Vietnam	0.31

Source: Internet World Stats (2013)

Because of inadequate diffusion and adoption of advanced ICT, Dedrick and Kraemer (1998) have also argued that East Asian countries are lacking the ability to climb out of low-margin electronic manufacturing, into high-margin service sectors such as innovative software design and development as well as IT services. Nevertheless, there are some very advanced countries with wide uptake of IT such as Japan, Korea and Singapore. For other countries such as Myanmar, Cambodia and Laos, IT has shown little growth and development in such technologies. Between these extremes, lies countries such as China, Thailand and Malaysia with high IT uptake, accompanied by a significant level of digital divide as well.

In light of such evidence, this paper attempts to deepen the stock of knowledge at hand regarding determinants of global digital divide, with additional emphasis on the role of financial development. The analysis includes three measures of ICT developments (telephone lines, Internet and mobile phone) over a relatively long period from 1994 to 2011. The global digital divide in this case will be examined with particular reference to selected Asian countries namely, Indonesia, Malaysia, Thailand and Philippines. While there are many previous works that have examined the determinants of global digital divide (for example, Chinn and Fairlie, 2004; Dewan and others, 2005; Shchetinin and Baptiste, 2008) this paper attempts to uncover the difference in factors that explain the digital divide phenomenon when the Asian region is being put under study instead, rather than the common non-Asian regions.

The remaining sections of this paper is organized as follows: Section 2 discusses the body of literature relating to digital divide, its determinants and the role of finance, whereas Section 3 lays out the data and methodology adopted to carry out the research and test the variables. Data analysis and interpretation of statistical findings obtained from the empirical analysis are discussed in Section 4. Last but not least, Section 5 summarizes the entire research with relevant conclusions and appropriate recommendations.

Literature Review

Several studies have assessed the penetration of ICT on an international scale whereby the digital gap is examined against a set of macro indicators such as income, GDP per capita, human capital and industrial competitiveness. Srinuan (2011) in his empirical study of Thailand, has specifically grouped the determinants of digital divide into two; one on the demand side and another on the supply side. On the demand side, the factors considered are accessibility and affordability. Accessibility is determined by the ease at which individual can physically reach the ICT service, while affordability is concerned with how charges placed by provided affect the individual's ability and willingness to pay for the service. The components under the affordability factor are typically linked to the price of service as well as individual's income. On the other hand, the only factor considered under the supply side determinants is availability. Availability measures the extent to which the provider possesses necessary resources, such as technology infrastructure and service, to fulfill the needs of individual user.

Wong (2002) meanwhile, conducted a study on regional global digital divide targeting the Asian countries. He argued that although Asian countries acquire large share in the production of ICT goods globally, their level of ICT adoption are still far behind compared to non-Asian countries. The study confirmed the presence of wider disparity in the intensity of ICT adoption, than the disparities in GDP per capita among Asian countries. Wong (2002) further suggested the likelihood of the digital divide to become more severe in the future. Following in the efforts of such regional study is Hiroshi Ono (2005), who attempts to evaluate extent and causes of digital inequality in the three countries of East Asia – Japan, South Korea and Singapore. By using logistic regressions to estimate the determinants of ICT usage, it was found that the key determinants of digital inequality in all three countries are household income, education and gender, although there is substantial difference in their magnitudes. Despite the high overall diffusion rates of ICT in all three developed countries mentioned above, there is still a distinct divide in access and usage of ICT between various demographic groups.

In general, GDP per capita – being one of the key determinants in explaining global digital divide – has been verified to be positively related to ICT diffusion and adoption as observed in most past research efforts. Among research authors that confirms such assertion is Shchetinin and Baptiste (2008). Using the Generalized Method of Moments estimator to investigate the determinants of digital divide, their findings show that GDP per capita has positive impact on Internet diffusion in developed countries. Apart from that, in a study investigating socio-economic factors driving the digital divide based on a panel of 40 countries from 1985-2001, Dewan, Ganley and Kraemer (2005) also pointed out the positive relationship between IT penetration and GDP. Additionally, they highlight how the marginal impact of a rise in GDP is noticeably higher in countries at a high level of IT penetration. The significance of GDP in causing disparity of ICT access and use is also underlined by Srinuan, Rohman and Bohlin (2009). With particular focus on ASEAN countries, the findings show that higher GDP per capita yields a higher digitization index, which in turn tends to increase as the market becomes more competitive.

Recent empirical research in finance and growth has also established that financial development has a positive impact on economic growth. The link between finance and the real sector typically stresses on the role of financial market in mobilizing savings and financing both personal and corporate investment. Following this, technology and human skills as well as institutions with oversight roles must be sufficiently in tandem with the level of the financial system to provide the needed support to the real sector (Mordi, 2010).

In addition to the above conventional link, Saint-Paul (1992) also lays emphasis on another link, namely the impact of financial markets on technological choice. In his model, the interactions between financial markets and technological choice result in an outcome where multiple equilibria are possible. This is based on the view that financial markets allow riskier technologies while technological choice affects the viability of financial market. The perception is that, people will opt for less productive but flexible technologies. Producers in this case do not face much risk, thus resulting in very little incentive to develop financial markets. On the other hand, if financial markets are developed, the need to have it further developed will surface as technology becomes more specialized and risky. As affirmed by Cooper and John (1998), there exists a strategic complementarity between financial markets and technology, because both are instruments that can be used for diversification

In the context of global digital divide, Yartey (2006) conducted a study evaluating the role of financial development and financial structure in explaining cross-country ICT diffusion. The paper finds that financial structure does not have significant relationship with ICT development, contrary with financial development measured by credit and stock market development. This strengthens the importance of financial development as determinant of ICT development, which subsequently implies that countries with underdeveloped financial markets may sink even further in the information-poor and non-communicating side of the prevailing digital divide.

Data and methodology

Empirical estimation of data in this paper uses static regression method. Estimation is made using longitudinal or panel data, based on a sample of 4 countries (Malaysia, Indonesia, Philippines and Thailand) against a 18-year period from 1994 to 2011. Selection of all variables was decided entirely based on data availability. The sole source for data collection of these variables is World Bank's World Development Indicator. Logarithmic transformation of data is then undertaken to better meet the assumptions that the variables are approximately linear and normal in distribution.

The dependent variable used in this paper is ICT development. It is measured in terms of 3 different ICT tools: telephone lines per 100 people, Internet users per 100 people and mobile cellular subscriptions per 100 people. To assess the diffusion and adoption of ICT, a set of factors or determinants are used as independent variables to test their effects on ICT development measured separately by the ICT tools mentioned above. The variables are categorized as economic (GDP per capita), infrastructural (electricity consumption), external (FDI and trade openness), demographic (population and urban population) and financial development factors (stock market development and credit market development). These categories of variables are chosen based on their importance in previous studies and data availability.

The impact of all explanatory variables in explaining the adoption of ICT in the country are estimated using the following static regression model.

Model 1:

$$\ln \mathrm{ICT}_{it} = \alpha_i + \beta_{i1} \ln \mathrm{FDI}_{it} + \beta_{i2} \ln \mathrm{TO}_{it} + \beta_{i3} \ln \mathrm{GDP}_{it} + \beta_{i4} \ln \mathrm{SMD}_{it} + \beta_{i5} \ln \mathrm{CMD}_{it} + \varepsilon_{it}$$

Model 2:

$$\ln \mathrm{ICT}_{it} = \alpha_i + \beta_{i1} \ln \mathrm{FDI}_{it} + \beta_{i2} \ln \mathrm{TO}_{it} + \beta_{i3} \ln \mathrm{GDP}_{it} + \beta_{i4} \ln \mathrm{POP}_{it} + \beta_{i5} \ln \mathrm{UPOP}_{it} + \beta_{i6} \ln \mathrm{ETRIC}_{it} + \varepsilon_{it}$$

Model 3:

$$\ln \mathrm{ICT}_{it} = \alpha_i + \beta_{i1} \ln \mathrm{FDI}_{it} + \beta_{i2} \ln \mathrm{TO}_{it} + \beta_{i3} \ln \mathrm{GDP}_{it} + \beta_{i4} \ln \mathrm{POP}_{it} + \beta_{i5} \ln \mathrm{UPOP}_{it} + \beta_{i6} \ln \mathrm{SMD}_{it} + \beta_{i7} \ln \mathrm{CMD}_{it} + \beta_{i8} \ln \mathrm{ETRIC}_{it} + \varepsilon_{it}$$

where ICT = a measure of ICT development (telephone lines per 100 people, Internet users per 100 people, mobile cellular subscriptions per 100 people) of the country i in year t

FDI = control variable representing foreign direct investment as percentage of GDP of the country i in year t

TO = control variable representing trade openness as percentage of GDP of the country i in year t
GDP = control variable representing income or GDP per capita of the country i in year t
POP = control variable representing total population in the country of the country i in year t
UPOP = control variable representing urban population of the country i in year t
SMD = control variable representing stock market development (measured as stock market capitalization) of the country i in year t
CMD = control variable representing credit market development (measured as domestic credit to private sector) of the country i in year t
ETRIC = control variable representing electricity consumption of the country i in year t

Estimations are done separately with three different models for each ICT tool – telephone mainlines, Internet and mobile phones. Model 1 estimates using only economic, financial and external factors as independent variables. This is constructed based on theoretical predictions that other variables (infrastructural and demographic factors) have ambiguous effects or little contribution in explaining the digital divide phenomenon. Model 2 estimates using all predetermined factors as independent variables with the exception of financial development variables, whereas Model 3 estimates with all categories of variables, including financial development. These two models are designed to examine the degree of influence or significance financial development has in explaining digital divide.

Findings

Table 2: Summary Statistics of Measures of ICT Development

Variables	Year	Mean	Std. Deviation	Minimum	Maximum
Telephone lines	1994	5.4295	6.0239	1.2534	14.1731
	2011	11.2117	5.7649	3.7489	15.8437
Internet	1994	0.0363	0.0454	0.0011	0.0996
	2011	31.4950	20.8706	12.2800	61.0000
Mobile phones	1994	1.0925	1.2718	0.0397	2.8295
	2011	110.1143	12.4323	99.3018	127.0353

Note: All measures are per 100 population.

Table 2 above depicts summary statistics of measures of ICT development used in the estimation model. It is evident that the global diffusion and adoption of all three ICT tools have grown to a great extent. Diffusion rate of telephone lines, Internet and mobile phones each has more than doubled from the base year. Mobile phones particularly, recorded the greatest escalation from an average of 1.0925 per 100 in 1994 to 110.1143 per 100 in 2011. This is followed by second highest growth which is Internet, from an average of 0.0363 per 100 in 1994 to 31.4950 per 100 in 2011. Despite the slow rise, telephone lines still multiplied from an average of 5.4295 per 100 in 1994 to 11.2117 per 100 in 2011.

Table 3: Model Estimation 1
(Dependent variable: Telephone mainlines per 100 population)

	Model 1	**Model 2**	**Model 3**
lnFDI			
coefficient, β	0.0321	0.0959	0.0934
t-value	0.59	1.99	1.94
ρ-value	(0.558)	(0.051)**	(0.057)**

lnTO			
coefficient, β	0.3650	-0.3549	-0.6347
t-value	2.26	-1.09	-1.79
ρ-value	(0.027)**	(0.281)	(0.078)*
lnGDP			
coefficient, β	0.9049	-0.1639	-0.4441
t-value	8.97	-0.84	-1.62
ρ-value	(0.0001)***	(0.406)	(0.111)
lnPOP			
coefficient, β		-0.4917	-0.4167
t-value		-2.13	-1.67
ρ-value		(0.037)**	(0.099)*
lnUPOP			
coefficient, β		0.8933	0.8944
t-value		4.59	4.34
ρ-value		(0.0001)***	(0.0001)***
lnSMD			
coefficient, β	-0.2378		0.2173
t-value	-1.96		1.43
ρ-value	(0.055)**		(0.159)
dlnCMD			
coefficient, β	-0.4202		0.0854
t-value	-1.37		0.32
ρ-value	(0.176)		(0.751)
lnETRIC			
coefficient, β		1.3054	1.5560
t-value		5.51	5.14
ρ-value		(0.0001)***	(0.0001)***
Constant			
coefficient, β	-2.4945	-4.6913	-4.9182
t-value	-9.13	-2.92	-2.68
ρ-value	(0.0001)***	(0.005)**	(0.009)**
BP LM test			
Chi(2), χ^2-stats	3.06	1.56	1.84
ρ-value	(0.0804)*	(0.2112)	(0.1755)
Hausman Test			
Chi(2), χ^2-stats	-61.50	11.62	10.21
R^2 (between)	0.7769	0.8559	0.8557
F-stats	43.18	64.35	43.74
ρ-value	(0.0001)***	(0.0001)***	(0.0001)***

Note: ***, ** and * are significance at 1%, 5% and 10% respectively.

Table 3 shows the statistical results from estimating the model using telephone mainlines as the dependent variable. The results of the Breusch-Pagan LM test for all three models reveal that data cannot be pooled (ρ-values are all insignificant), thus they have to be regressed using the OLS method.

In Model 1, results reveal that trade openness, GDP per capita and stock market development are all significant at 5% significance level. Among these three variables however, only trade openness and GDP per capita are positively associated with ICT development measured by telephone mainlines per 100 population. Although FDI has positive relationship, it is statistically not significant. Also appearing as insignificant is the negatively associated credit market development variable. R^2 of Model 1 shows that 77.69% of the total variation in telephone mainlines can be explained by the total variation in log of FDI, log of trade openness, log of GDP per capita, log of stock market development and first differenced log of credit market development. The result of F-test also shows that overall, the model is highly significant.

In Model 2, GDP per capita does not appear significant as in Model 1 and has a wrong negative as well. FDI, total population and urban population are all statistically significant, while electricity consumption shows to be highly significant. Among these four significant variables, only FDI, urban population and electricity consumption are positively associated with ICT development. Unlike in Model 1, trade openness has negative and insignificant relationship with telephone mainlines. Value of R^2 in this model is better than that of Model 1, as 85.59% of the total variation in telephone mainlines can be explained by the total variation in log of FDI, log of trade openness, log of GDP per capita, log of total population, log of urban population and log of electricity consumption. Overall, F-test indicates that the model is also highly significant at 1% confidence level.

In Model 3, reveals that although financial development is being accounted for, the statistical findings are rather similar to that of Model 2. With an additional significant variable which is trade openness, FDI, total population, urban population and electricity consumption all appear significant. Among these five significant variables, only FDI, urban population and electricity consumption have positive relationship with ICT development. GDP per capita in this model, again is statistically not significant and negatively associated as in Model 2. As for financial development variables, both stock market development and credit market development enter with insignificant positive coefficients. This model has a value of R^2 that is as high as that of Model 2, which is 85.57%. This means that 85.57% of the total variation in telephone mainlines can be explained by the total variation in all variables specified.

Table 4: Model Estimation 2
(Dependent variable: Internet usage per 100 population)

	Model 1	**Model 2**	**Model 3**
lnFDI			
coefficient, β	-0.2354	0.1649	0.1162
t-value	-1.37	1.49	1.13
ρ-value	(0.177)	(0.142)	(0.264)
lnTO	5.5329	0.8325	1.1231
coefficient, β	5.70	0.99	1.42
t-value	(0.0001)***	(0.325)	(0.160)
ρ-value			
lnGDP			
coefficient, β	4.8594	-2.1794	-1.3107
t-value	11.21	-4.66	-2.15
ρ-value	(0.0001)***	(0.0001)***	(0.036)**
lnPOP			
coefficient, β		16.8130	15.3612
t-value		5.78	4.91
ρ-value		(0.0001)***	(0.0001)***

lnUPOP			
coefficient, β		-3.9270	-3.4594
t-value		-1.57	-1.41
ρ-value		(0.121)	(0.163)
lnSMD			
coefficient, β	-2.6716		-0.2840
t-value	-5.86		-0.83
ρ-value	(0.0001)***		(0.411)
dlnCMD			
coefficient, β	-3.0938		-0.6308
t-value	-3.31		-1.08
ρ-value	(0.002)**		(0.283)
lnETRIC			
coefficient, β		8.2437	6.7067
t-value		5.38	4.53
ρ-value		(0.0001)***	(0.0001)***
Constant			
coefficient, β	-22.1234	-121.3927	-111.8205
t-value	-7.93	-7.76	-6.33
ρ-value	(0.0001)***	(0.0001)***	(0.0001)***
BP LM test			
Chi(2), χ^2-stats	5.93	75.59	38.82
ρ-value	(0.0149)**	(0.0001)***	(0.0001)***
Hausman Test	447.22	-2.32	-46.34
Chi(2), χ^2-stats			
R^2 (between)	0.9270	0.5915	0.6347
F-stats	27.19	119.80	69.85
ρ-value	(0.0001)***	(0.0001)***	(0.0001)***

Note: ***, ** and * are significance at 1%, 5% and 10% respectively.

The next analysis is based on statistical results for Internet usage as tabulated above. Table 4 displays findings from estimating the model using Internet usage as the dependent variable. Unlike in earlier findings where telephone mainlines act as the dependent variable, the Breusch-Pagan LM test in this case results in high significance of ρ-values, thus suggesting that data can be pooled. Looking at the values of χ^2 generated by the Hausman test, all three models are to adopt the fixed effects model; although theoretically, the random effects model is more appropriate considering that the level of Internet usage across entities may change from one time period to another due to other external factors.

In Model 1, results suggest that all variables except FDI, appear highly significant. Trade openness and GDP per capita have positive relationship, while both financial development variables are negatively associated with ICT development measured by Internet usage. FDI has an unexpected negative sign and is statistically insignificant. The high R^2 value signifies that 92.70% of the total variation in Internet usage can be explained by the total variation in log of FDI, log of trade openness, log of GDP per capita, log of stock market development and first differenced log of credit market development. Result of F-test suggests that the model is highly significant overall.

In Model 2, appearing highly significant are GDP, total population and electricity consumption. Among these three variables, only GDP enters with an unexpected negative coefficient whereas the other two are positively associated with Internet usage. FDI, trade openness and urban population are all statistically insignificant, with urban population being the only variable that has negative relationship. The R^2 value in this model is much lower than that of Model 2, as only 59.15% of the total variation in Internet usage can be explained by the total variation in log of FDI, log of trade openness, log of GDP per capita, log of total population, log of urban population and log of electricity consumption. The model however, is also highly significant overall at 1% significance level based on the F-test result.

In Model 3, results show that, after controlling for financial development variables, the three variables that appeared highly significant in Model 2 also appear as significant in this model which are GDP per capita, total population and electricity consumption. Total population and electricity consumption have positive relationship while GDP per capita is negatively associated with ICT development measured by Internet usage. On the other hand, FDI, trade openness, urban population and both financial development variables are found to be statistically insignificant. Out of these five variables, only urban population, stock market development and credit market development have negative relationship with Internet usage. The value of R^2 in this model is slightly better than Model 2 but, still lower than that of Model 1. It implies that 63.47% of the total variation in Internet usage can be explained by all specified variables. Overall, the model is as highly significant as other models at 1% significance level based on the result of F-test.

Table 5: Model Estimation 3
(Dependent variable: Mobile phones per 100 population)

	Model 1	**Model 2**	**Model 3**
lnFDI			
coefficient, β	0.0102	0.0010	0.0030
t-value	0.30	0.03	0.08
ρ-value	(0.766)	(0.980)	(0.936)
lnTO			
coefficient, β	-0.0959	0.0073	-0.1613
t-value	-0.95	-0.03	-0.59
ρ-value	(0.344)	(0.977)	(0.556)
lnGDP			
coefficient, β	-0.2658	0.0436	-0.2878
t-value	-4.23	-0.29	-1.36
ρ-value	(0.0001)***	(0.776)	(0.179)
lnPOP			
coefficient, β		-0.0054	0.0762
t-value		-0.03	0.40
ρ-value		(0.977)	(0.692)
lnUPOP			
coefficient, β		-0.1382	-0.1026
t-value		-0.90	-0.65
ρ-value		(0.373)	(0.520)

lnSMD			
coefficient, β	0.1597		0.1864
t-value	2.11		1.59
ρ-value	(0.039)**		(0.117)*
dlnCMD			
coefficient, β	0.1463		0.1301
t-value	0.76		0.63
ρ-value	(0.447)		(0.531)
lnETRIC			
coefficient, β		-0.2107	0.0261
t-value		-1.13	0.11
ρ-value		(0.261)	(0.911)
Constant			
coefficient, β	0.9433	2.0178	1.1990
t-value	5.54	1.52	0.85
ρ-value	(0.0001)***	(0.133)	(0.399)
BP LM Test			
Chi(2), χ^2-stats	0.72	2.35	1.23
ρ-value	(0.3974)	(0.1255)	(0.2670)
Hausman Test			
Chi(2), χ^2-stats	-1.83	32.45	24.90
R^2 (between)	0.3009	0.2776	0.3101
F-stats	5.34	3.91	3.32
ρ-value	(0.0004)***	(0.0023)**	(0.034)**

Note: ***, ** and * are significance at 1%, 5% and 10% respectively.

Following estimation results for Internet usage is the regression results estimated using mobile phones subscriptions per 100 population as the dependent variable. In Table 5 above, the results of Breusch-Pagan LM test for all three models are similar to that of model specifications using telephone mainlines as the dependent variables – in the sense that, data cannot be pooled due to the insignificant ρ-values. Therefore, OLS regression is performed instead.

In Model 1, results display that only two out of five specified variables - which are GDP per capita and stock market development are significant at 5% significance level. Only stock market development variable is positively linked to ICT development measured by mobile phones subscriptions, whereas GDP per capita has a wrong negative relationship. FDI, trade openness and credit market development in this model meanwhile are statistically insignificant, with trade openness being the only variable with negative coefficient. The small R^2 value of 0.3009 shows that only 30.09% of the total variation of mobile phones subscriptions can be explained by the total variation in log of FDI, log of trade openness, log of GDP per capita, log of stock market development and first differenced log of credit market development. Results of F-test reveals that this model is overall highly significant at 1% significance level.

In Model 2, all variables surprisingly appear statistically insignificant. Half of the six specified variables are positively associated with mobile phones subscriptions and they are FDI, trade openness and GDP per capita. On the other hand, entering with negative coefficients are total population, urban population and electricity consumption. This model has a lower R^2

value than that of Model 1, where only 27.76% of the total variation in mobile phones subscriptions can be explained by log of FDI, log of trade openness, log of GDP per capita, log of total population, log of urban population and log of electricity consumption. Overall, F-test result of this model signifies that it is significant at 5% significance level.

Model 3 reveals that just like in Model 2, all variables are statistically insignificant. Trade openness, GDP per capita and urban population have wrong negative coefficients, whereas the rest of the variables enter with insignificant positive coefficients. Value of R^2 in this model is slightly better than that of Model 1, but is still weak. It indicates that only 31.01% of the total variation in mobile phones subscriptions can be explained by all the specified variables. Just as in Model 2, this model is also overall significant at 5% significance level based on the result of F-test.

Conclusion and recommendation

This paper has examined with econometrical tools the role of economic, infrastructural, external and demographic, alongside financial development variables in explaining adoption of ICT in four Southeast Asian countries - Indonesia, Malaysia, Philippines and Thailand. In hope to shed light on how distinct the digital divide phenomenon is across the globe, the Asian region is particularly selected first before it is narrowed to the aforementioned countries. It can be observed that provision of service and usage of ICT tools (telephone lines, Internet and mobile phones) are dispersed unevenly across countries and are collectively lesser compared to non-Asian regions.

Based on the empirical analysis conducted in this paper, there are several general pattern and major findings. GDP per capita is found to have significant relationship with ICT development in most specification models. Consistent with the body of evidence in previous studies of Shchetinin and Baptiste (2008) as well as Srinuan, Rohman and Bohlin (2009), significance of GDP supports the economic demand theory in the sense that higher earnings help to ease the entry and saturation process of technology among the population. On the other hand, FDI and trade openness have shown heterogeneous statistical results. Both variables emerged insignificant in most specification models, and this is far deviating from findings of past researchers of the same sphere of study (Gholami et. al., 2006; Shirazi et. al., 2010; Hassan, 2003). Although it is surprising to find that there is no support for the influence of FDI and trade openness on ICT development, this may just mean that diffusion and adoption of ICT is not hindered by trade restrictions established by the countries.

Another important outcome of the statistical analysis in this paper is the slight significance of financial development variables. The two measures of financial development variables - stock market development and credit market development – mostly appear significant when the demographic and infrastructural factors are not under consideration. It can also be observed that stock market development seem to have greater degree of influence in ICT development as compared to credit market development. This is somewhat consistent with the study conducted by Yartey (2006) which revealed that financial development matters more than financial structure in influencing development of ICT. As precisely theorized by Yartey (2006), total population and urban populations have also been found insignificant in most specification models in this study. This evidence confirms that demographic factors measured in terms of the two variables mentioned above have vague impacts on development of ICT. In addition to the insignificance of the demographic factors, empirical results have also hinted at the importance of ICT infrastructure. Measured as electricity consumption, this variable appeared highly significant in all model specifications. This is consistent with the study conducted by Quibria et.

al. (2003) who found that infrastructure is one of the crucial factors in influencing the levels of information technologies.

The conclusion of this paper highlights the role of economic and financial development variables in explaining this global digital divide phenomenon. The findings provide a strong drive and motivation for these Asian countries to improve their economic and financial conditions. Thus, planning and implementing sound ICT strategies and policies is necessary in order to harness its full potential. Barriers such as lack of financial incentive and ICT infrastructure particularly in non-urban areas, should also be tackled effectively in efforts to close the digital gap at a micro level. Future public policies should therefore, be designed with such focus in mind to successfully build a digitally inclusive society within the Asian region and bridge the global digital divide.

References

Asia-Pacific Economic Corporation. (2002). The New APEC Economy: Innovations, Digital Divide and Policy, 2002. Report, Economic Committee (EC).

Billon, M., Lera-Lopez, F., & Marco, R. (2010). Differences in Digitalization Levels: A Multivariate Analysis Studying the Global Digital Divide. Review of World Economics.

Chinn, M. D., & Fairlie, R. W. (2004). The Determinants of the Global Digital Divide: A Cross-Country Analysis of Computer and Internet Penetration.

Chinn, M. D., & Fairlie, R. W. (2007). The determinants of the global digital divide: a cross-country analysis of computer and internet penetration. Oxford Economic Papers-new Series.

Cooper, R., & John, A. (1988). Coordinating Coordination Failures in Keynesian Models. Quarterly Journal of Economics CIII, 3, 441-463.

Dasgupta, S., Lall, S., & Wheeler, D. (2005). Policy Reform, Economic Growth and the Digital Divide. Oxford Development Studies, 33(2), 229-243.

Dedrick, J., & Kraemer, K. L. (1998). Asia's computer challenge: Threat or Opportunity for the United States and The World. New York: Oxford University Press.

Guillen, M. F., & Suarez, S. L. (2005). Explaining the Global Digital Divide: Economic, Political and Sociological Drivers of Cross-National Internet Use. Social Forces, 84(2), 681-708.

Hargittai, E. (1999). Weaving the Western Web: Explaining Differences in Internet Connectivity Among OECD Countries. Telecommunications Policy.

Hassan, M. K. (2003). FDI, Information Technology and Economic Growth in the MENA Region.

ITU (2003). World Telecommunication/ICT Development Report. International Telecommunication Union. Geneva.

Kiiski, S., & Pohjola, M. (2002). Cross-country diffusion of the Internet. Information Economics and Policy, 14(2), 297-310.

Kraemer, K. L., Ganley, D., & Dewan, S. (2005). Across the Digital Divide: A Cross-Country Multi-Technology Analysis of the Determinants of IT Penetration.

Mordi, C. N. (2010). The Link Between the Financial (Banking) Sector and The Real Economy. Economic and Financial Review, 48/4.

Organisation for Economic Co-operation and Development (OECD). 2001. Understanding the Digital Divide. Paris: OECD.

Ono, H. (2005). Digital Inequality in East Asia: Evidence from Japan, South Korea and Singapore. Asian Economic Papers.

Quibria, M. G., Ahmed, S. N., Tschang, T., & Reyes-Macasaquit, M. (2003). Digital Divide: Determinants and Policies with Special Reference to Asia. Journal of Asian Economics, 13(6), 811-825.

Saint-Paul, G. (1992). Technological Choice, Financial Markets and Economic Development. European Economic Review.

Shchetinin, O., & Baptiste, M. (2008). How to Overcome the Digital Divide? The Determinants of Internet Diffusion.

Srinuan, C., Rohman, I. K., Srinuan, P., & Bohlin, E. (2009). Digital Divide in ASEAN Countries: How wide is the gap and what is the role of independent regulator?

Wong, P. K. (2002). ICT Production and Diffusion in Asia Digital Dividends or Digital Divide? Information Economics and Policy.

Yartey, C. A. (2008). Financial Development, The Structure of Capital Markets, and The Global Digital Divide. Information Economics and Policy