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Effects of ICT Development on Economic Growth in Emerging Asian Countries

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Introduction

One of the prominent characteristics of well-performing developing economies is the large-scale economy-wide diffusion of information and communication technologies (ICT). ICT diffusion, through increased Internet and mobile cellular phone subscriptions, can positively affect economic growth (Sassi & Goaied, 2013; Khayyat et al., 2014; Shahiduzzaman & Alam, 2014) in three different ways. First, it can assist economy-wide technology diffusion and innovation. Second, it can improve the quality of decision making by economic agents. And finally, it can raise the output level by creating demand for goods and services and by lowering costs of production (Vu, 2011). Waverman et al. (2005) argued that an average of 10 additional mobile phones per 100 people would increase per capita GDP growth by approximately 0.59 percent in the low income countries. Although the development of ICT infrastructure has been a major challenge, there is a considerable rise in the number of Internet and mobile users in many developing countries in Asia. The number of mobile subscriptions in most of these countries has gone up from a mere 0 to 50 per 100 inhabitants from 2000 to 2012. In few cases such as China, India and Sri Lanka, these numbers are as high as 80.76, 69.92 and 91.63, respectively (ITU, 2014). Interestingly, the number of mobile subscriptions in many Asian countries such as Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand exceeds their respective total population.[1] Table 9.1 shows the rising trend of mobile subscriptions in Asian emerging countries from 2000 to 2012. Overall, the developing countries from this region have seen the fastest growth in ICT with 6 out of the 25 top performers on ICT Development Index coming from the Asia-Pacific region.

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Table 9.1 Mobile phone subscribers (per 100 people) in selected emerging countries from Asia

	Year												
Country	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Bangladesh	0.2	0.4	0.8	1.0	2.0	6.3	13.2	23.5	30.2	34.4	45.0	55.2	62.8
China	6.7	11.2	15.9	20.7	25.6	29.8	34.8	41.0	47.8	55.3	63.2	72.1	80.6
India	0.3	0.6	1.2	3.0	4.7	8.0	14.5	20.2	29.5	44.1	62.4	73.2	69.9
Indonesia	1.8	3.1	5.1	8.5	13.7	20.9	28.0	40.4	60.0	68.9	87.8	102.5	114.2
Korea	58.3	62.9	69.7	72.1	78.2	81.5	85.0	93.3	95.3	99.5	104.8	107.7	109.4
Malaysia	21.9	30.9	37.1	44.7	57.6	75.6	73.9	87.1	101.5	108.5	119.7	127.5	141.3
Pakistan	0.2	0.5	1.1	1.6	3.2	8.1	21.5	38.3	52.7	55.5	57.3	61.8	67.1
Philippines	8.3	15.3	19.0	27.3	39.1	40.5	49.1	64.5	75.4	82.3	89.0	99.1	106.5
Singapore	70.1	74.4	80.1	84.1	91.2	97.5	103.8	125.2	132.3	138.7	145.4	150.1	152.1
Sri Lanka	2.3	3.5	4.8	7.1	11.2	16.9	26.9	39.3	54.2	79.2	83.6	87.6	91.6
Thailand	4.9	12.0	27.4	33.5	41.4	46.5	60.9	80.2	93.4	99.5	108.0	116.3	127.3

Source: ITU (2014)

Concomitant to these changes, developing and emerging countries from South East and South Asia have also experienced remarkable economic performance in recent years. Average growth rates of the developing countries from this region are 8.8 percent and 6.6 percent, respectively (World Bank, 2014). While the existing literature provides sufficient evidence on the positive contribution of the ICT in enhancing economic growth in developed countries (Kraemer & Dedrick, 2001; Colecchia & Schreyer, 2002; Jalava & Pohjola, 2002, 2008; Yousefi, 2011), the relationship between ICT and economic growth in developing countries is far from conclusive.[2] The purpose of this chapter is to analyze the role of ICT development on growth in Asian countries. Specifically, we examine the impact of mobile phones and Internet penetration on GDP growth in 11 outperforming countries from this region,[3] which are characterized as emerging and most outward looking in terms of policies adopted toward better management of productions and markets. Selection of these countries is motivated by their average growth rates and vigorous ICT policies to achieve microeconomic efficiency, growth, and advancement toward development.

From the methodological perspective, this investigation was conducted using the following steps. In the first step, we provide two case studies to shed light on individual country-specific strategies and outcomes that are related to ICT policies. Country-specific studies were conducted to examine the heterogeneous institutional and policy level changes made by the countries that play a crucial role in expediting the process of ICT-related diffusion and management of ICT growth. Hence, these case studies help us understand specific ICT-related activities rather than just analyze broad econometric results. Specific activities are difficult to capture in a panel data analysis because of data limitations. To ensure our countries were heterogeneous enough to make common policies generalizable, we selected one country (Korea) from the high ICT user group and another (Bangladesh) from the moderate ICT user group (see Table 9.2 for common policies for different groups of countries). Second, we constructed a panel dataset over the period from 2000 to 2012 to evaluate the overall impact of ICT on economic growth of the 11 selected Asian countries. Third, the well-known Fisher panel unit root test was applied to check for stationarity of macroeconomic variables. Finally, we used the system-generalized method of moments (*system*-GMM) technique, which is an information-efficient means for obtaining consistent coefficient estimates (Blundell & Bond, 1998).

The rest of the chapter is organized as follows. Section 2 discusses the existing literature on the relationship between ICT development and

economic growth and the common ICT policies of the emerging Asian countries. Section 3 presents two specific case studies. Section 4 provides a discussion on the econometric methodology used in this chapter. Section 5 presents and analyzes the empirical results. Section 6 provides the conclusion.

Literature review

The ICT-growth nexus

Despite the conventional belief that ICT investment affects output positively, the role of ICT in enhancing economic growth is not clear in the literature. Researchers have used different estimation strategies and different countries to examine this relationship. Unavailability of sufficient time series data has always been a problem for researchers to conduct country-specific studies. This is particularly true for developing countries since the earliest data on ICT is only from the late 1980s. Hence, researchers have had to wait until recently to have an acceptable sample size in order to undertake time series estimations. Using a Granger causality framework for six ICT leading countries from Europe (Sweden, Iceland, Denmark, Finland, Luxembourg, and Switzerland), Khalili et al. (2014) found unidirectional causality running from ICT to economic growth in the long run over the period 1990 to 2011. Shahiduzzaman and Alam (2014) found that ICT investment had a significantly positive impact on output, labor productivity, and technical progress in Australia, although the contribution of ICT capital has slowed down in recent years.

Because of the insufficient data points, most of the research work had to use different panel techniques in order to study the ICT–growth nexus in developing countries. Kraemer and Dedrick (1994) found a positive relationship between ICT investment and economic growth in a panel of 12 Asia Pacific countries from 1984 to 1990. Similar results were found by Pohjola (2001) for a set of 23 OECD countries. A number of research papers claimed that the growth effect of ICT in developing countries is statistically insignificant. Lee et al. (2005) employed an augmented neoclassical model and found a positive contribution of ICT investment in developed and newly industrialized countries (NIEs), but an insignificant relationship in developing countries. Similarly, Dewan and Kraemer (2000) could not establish the beneficial effects of ICT investment in developing countries. Such an insignificant nature of the relationship may be due to the fact that the rapid accumulation of ICT eliminates unskilled workers and excludes poor people from the labor

market in developing countries (Aghion & Howitt, 1998). Hence, the aggregate macroeconomic effect was not discernible.

Dimelis and Papaioannou (2010) used the GMM approach and found that the growth contribution of ICT was stronger in developing countries than that of developed ones between 1993 to 2001. According to their results, 1 percentage point growth in ICT investment caused 0.24 and 0.12 percentage point growth in output per worker in developing and developed countries, respectively. In a similar study, Yousefi (2011) used a panel of 62 countries and found a positive impact of ICT investment on economic growth in high-income and upper-middle-income countries from 2000 to 2006. The size of the estimated coefficients varies from 0.22 for high-income countries to 0.35 for upper-middle-income countries. ICT investment could not produce any statistically significant growth impact in lower middle-income countries.

One important caveat of the existing literature is a lack of data on private sector investments in ICT. Hence the literature mainly focused on public sector initiatives. Recent studies have attempted to overcome this limitation by using the data on ICT penetration as a proxy for ICT development. Different indicators including the number of personal computers and Internet, in-land telephone, and mobile phone subscriptions have been used to measure the penetration of ICT. For a set of 102 developed and developing countries, Vu (2011) found that the marginal effect of ICT penetration on growth in 2000 was 0.02, 0.03, and 0.08 for personal computers, mobile phones, and Internet users, respectively. Sridhar and Sridhar (2007), however, employed a dataset of 63 developing countries from 1990 to 2001 and argued that a one percentage point increase in the number of mobile phone subscriptions could increase the growth rates of GDP by 0.025 percentage points, while a single percentage point rise in the subscription of landlines could increase GDP growth by 0.016 percentage points.

For the last one decade, there has been a tremendous rise in the number of mobile phone and Internet subscriptions in developing countries. During the same period, the total number of land-phone users has gone down significantly. Therefore, instead of land-phones, subscriptions to mobile phones and the Internet were used as measures of ICT development. In a recent study, Sassi and Goaied (2013) conducted a regional study using the data from 17 countries from the Middle East and North Africa from 1960 to 2009 and argued that the ICT penetration (Internet, telephone, mobile) had a significant and positive causal effect on economic growth.[4]

Most of the papers discussed above do not take into account the simultaneity issue that may arise from econometric estimations on ICT development and economic growth. While ICT development can affect the economic growth of a nation, the reverse causality is also a possible outcome. Statistical methods can produce dubious results if reverse causality is not taken into account. In summary, the existing literature has two major shortcomings: (1) improper selection of the dataset and (2) methodological deficiency. Our study aims to overcome these issues and analyze the ICT–growth nexus for a set of emerging Asian countries, which not only experienced high rates of economic growth but also undertook vigorous ICT policies in the last two decades. Some of the important policy measures of these countries are explained below.

ICT policies in emerging Asian countries

Most of the emerging countries from Asia have undertaken ICT policies in the last 15 years. While South Asian countries introduced ICT policies in the late 1990s or early 2000s, countries from the South Eastern region pioneered these policies by the early 1990s. By the late 1990s or early 2000s, developed countries had already started enjoying the benefits of the rapid diffusion of ICT (Dahl et al., 2011). During the same time, the use of ICT in emerging countries at different levels was very limited. For example, in the year 2000, the number of Internet users in the Netherlands and United States were 47.38 percent and 43.08 percent of the total population, respectively, while the same number for India was only 0.53 percent (ITU, 2014). The governments of the developing nations immediately recognized the potential gains from ICT use for the purpose of economic development and formulated policies that laid emphasis on creating a reliable infrastructure to manage and operate the public and private sectors efficiently. In Table 9.2, we divide the countries into two groups, based on the level of ICT penetration. The first panel of the table presents the common policies implemented by moderate ICT user countries, while the second panel presents the common policies of the high ICT user emerging countries in Asia. It is evident from Table 9.2 that the countries took extensive measures for ICT penetration through decentralizing ICT growth outside the capital, extending mobile and Internet networks outside urban areas, providing financial incentives to help the ICT industry, bringing secondary schools within Internet connectivity, and creating policies to encourage large capital investment. New incentives, including tax breaks and reduction of duties, were created to develop the domestic software industry and import ICT products such as mobile phones.

Table 9.2 Common ICT policies in Asian emerging countries

Country	Year (initial ICT)	Year of revised ICT policy	Common ICT policies
			Moderate level of ICT use
Bangladesh	2002	2009	• Decentralize ICT growth outside the capital
China	2001	2011	• Ensure ICT literacy for all public service
India	1998	2012	• Accelerate the construction of broadband networks in rural areas
Indonesia	2001	2010	• Improve Internet and IP telephony services
Pakistan	2000	2012	• Provide financial assistance to ICT professionals for skill development
Philippines	1994	2011	• Encourage e-commerce, e-payments, and e-transactions
Sri Lanka	2005	2014	• Develop strong marketing, promoting, and branding countries' ICT production and their services in the global market
Thailand	1996	2011	• Financial incentives to help the players in the ICT industry to compete internationally • A framework for better protection of intellectual property • Government organizations should attempt to provide as much as information and services through mobile platform • Most schools will be serviced with broadband connectivity • Ensure that most universities provide global standard ICT education
			High level of ICT use
Republic of Korea	1996	2006	• By providing high bandwidth communications, a company's engineers, designers, and marketers could collaborate in real-time even if they work in different countries
Malaysia	1996	2011	• Through technology such as video-conferencing, sharing of multimedia documents, and email • Construction of high quality infrastructure, from information super highways to state-of-the-art telecommunications and high-speed broadband connections • Construction of broadband wireless cities
Singapore	1980	2006	• Accelerating the use of ICT in primary schools • Universities and government funded organizations are offering free ICT training or if not, with a minimal fee • Government gives large amounts of its annual budget to Internet connectivity of rural schools

Sources: Government of the People's Republic of Bangladesh (2009); Government of India (2012); Government of Pakistan (2012); Commission on Information and Communications Technology (2011); Ministry of Science and Technology (2011); UNCTAD (2006); Hong (2011); Amiri et al. (2013).

Within a few years, emerging economies achieved remarkable success in ICT diffusion. In China, the percentage of individuals using Internet increased from 1.78 in 2000 to 16 in 2007. During the same period, the subscriptions to mobile phones per 100 individuals increased from 6.66 to 41.02. After the initial success, most of the countries faced legal issues related to privacy policies of ICT use and business development through ICT. Under the circumstances, the countries revised their respective policies, in which they aimed to ensure cyber safety of consumers and build the infrastructure for real-time transactions to facilitate e-businesses. Other policies were created to enhance the level of ICT education in elementary schools. Despite inherent differences in the pace of digitization among different countries, ICT policies in emerging countries were able to achieve remarkable progress in the diffusion of ICT.

ICT policies in Korea and Bangladesh: country case studies

ICT development in Korea

The Republic of Korea is considered as one of the success stories of how ICT development transformed an agricultural economy into a big economic power. The development of the ICT sector in Korea can broadly be divided into five phases (RTR, 2006). In the first phase, Korea designed the first national information technology (IT) plan with the objective of building IT infrastructure to support key areas including public administration, defense, finance and education, which eventually facilitated the delivery of services such as issuance of certificates, public announcements, reports and statistics (RTR, 2006: 61). All these services were made available online reducing the processing time of public services. The main focus of the second phase of ICT development in Korea involved a massive government investment to build the Information Super Highway, which enabled the citizens to enjoy high-speed Internet services at a cheaper rate. In the third phase, Korea established a master plan, Cyber Korea 21, under the E-Government Initiatives. The World Bank Information Solution Group report states that, ". . .CYBER KOREA 21 was one of the most important policies to cope with the changing environment as a result of the Asian financial crisis. Through these plans, Korea came one step closer to a knowledge-based society with the construction of an advanced information infrastructure, the introduction of various information systems in public services and in the private sector, as well as growth in the overall IT industry" (World Bank, 2004).

With the success of the earlier phases of ICT development, the fourth phase focused on the advancement of the already developed technology. The number of both broadband and mobile subscribers rapidly increased, while renewed efforts to build new technologies continued. Currently in the fifth stage, ICT has become an essential part of the Korean society. "The changing face of the ICT environment is leading toward a society where intelligent sensors and devices can network with each other and humans to create a "'ubiquitous world' bringing with it new opportunities for human development." (RTR, 2006: 65).

Digitization in Bangladesh

Bangladesh is currently lagging behind in the technological capacity of its government. However, recognizing the importance of ICT development and digitization, the current Government of Bangladesh has expressed a desire for digitization in the current development plan, 'Vision 2021' and outlined a plan to digitize the country by 2021.

The first ICT policy came into effect in Bangladesh in the year 2002. The prime focus of this policy was to build the infrastructure for ICT. However, only 8 out of the 103 policy directives were largely accomplished. While 64 were partially accomplished, 34 remained totally unaddressed (BEI, 2010). Since 2009, the present government, led by the Bangladesh Awami League, has pledged their commitment to building a 'Digital Bangladesh' and undertaken a series of projects to deliver efficient services to the citizens. Both mobile phones and the Internet are playing important roles in providing the desired services to the citizens. Key sectors, such as public administration, health and education have already experienced significant digitization in last few years. As the BEI (2010) report discusses, most ministries have completed the automation and infrastructure development projects successfully. In order to encourage e-commerce, the central bank of Bangladesh has introduced the online e-payment gateway. Mobile phones are used to obtain medical advice from doctors on a 24/7 basis in case of emergency and to disseminate health care information. Using the Internet services, health-related statistical information is now managed online. Both mobile phones and the Internet are now used to circulate public examination results. E-books have been made available online for all public schools. Students can now register online for participating in public examinations. Some public institutions even provide online admission systems to their students. Considerable internal automation has taken place in the education sector in the last five years. These projects include establishment of

computer labs in educational institutions, development of multimedia contents for students, and self-learning multimedia teachers' training materials (BEI, 2010: 19).

Unlike Korea, the role of the private sector in ICT development in Bangladesh is rather sporadic. A few non-governmental organizations (NGOs), however, have been making important contributions to poverty reduction with the help of ICT initiation. One example is the Village Phone (VP) program, which was developed by an NGO called the Grameen Telecom (GTC) in collaboration with the microcredit facilities of the Grameen Bank. In this program, mostly women villagers were provided with small loans to buy mobile phones that helped them to collect important information for their businesses and, thereby, reduced their dependence on middlemen and created a direct nexus with their clients (World Bank, 2009). Richardson et al. (2000) pointed out a number of benefits of the VP program on poverty reduction. First, it reduced both transaction and transportation cost. Authors estimated a gain in consumer surplus of 2.64 to 9.8 percent of mean monthly household income. Second, because foreign remittance is an important source of earnings in rural households in Bangladesh, the families were able to receive accurate information about exchange rates using mobile phones. Lastly, the VP program also raised the income of the households of the VP operators. Richardson et al. (2000) found that the rise in income was as high as approximately 40 percent in some households of the VP operators.

Similar to Korea and Bangladesh, all the emerging countries from Asia have either developed the ICT sector or are in the process of improving it. Hence, it is expected that such changes will eventually affect the growth rates of the total economy. Nevertheless, the existing literature has not addressed this issue. We aim to fill this gap by estimating the eventual growth effect of ICT development in a set of emerging Asian countries while accommodating other estimation-related methodological issues discussed in the literature review.

Methodology

Behavioral equation

The econometric framework used in this chapter is a modified version of the conventional neoclassical growth model proposed by Solow (1956), in which the real GDP (Y) is a function of labor (L) and capital (K). To accommodate the potential effect of ICT development, we introduce ICT stock (I) as an additional factor input. Hence, the production function takes the following form:

$$Y = f(K, L, I) \tag{9.1}$$

We use two different measures of ICT development: (a) total number of mobile phones (C) and (b) total number of Internet subscriptions (N). Therefore Equation (9.1) can be replaced by the following two equations:

$$Y = f(K, L, C) \tag{9.2a}$$

$$Y = f(K, L, N) \tag{9.2b}$$

Assuming Equations (9.2a) and (9.2b) to be linear, taking logs and differencing, the following equations explain the determinants of the GDP growth:

$$y = \alpha + \beta_1 k + \beta_2 l + \beta_3 c \tag{9.3a}$$

$$y = \gamma + \delta_1 k + \delta_2 l + \delta_3 n \tag{9.3b}$$

where lower case letters denote the growth of individual variables, and β_1 and δ_1 are output elasticities of investment, and β_2 and δ_2 are output elasticities of labor. β_3 and δ_3 represent output elasticities of mobile phone subscriptions and Internet subscriptions, respectively.

Output is generally a highly persistent series (Diebold & Rudebusch, 1989; Bond et al., 2001). To accommodate this, we incorporate the lagged growth rate (y_{-1}) as an additional regressor. Therefore, the behavioral equations take the following forms:

$$y = \alpha + \beta_0 y_{-1} + \beta_1 k + \beta_2 l + \beta_3 c \tag{9.4a}$$

$$y = \gamma + \delta_0 y_{-1} + \delta_1 k + \delta_2 l + \delta_3 n \tag{9.4b}$$

where both β_0 and δ_0 represent the coefficients of the lagged growth rate of GDP. The above equations are estimated using a panel of 11 emerging Asian countries for the period 2000 to 2012. Additionally, to accommodate the potential effect of population growth, we replace GDP growth (and lagged GDP growth) with per capita GDP growth (and lagged per capita GDP growth, ypc) in equations (9.4a) and (9.4b), and estimate the effects of ICT development on per capita GDP growth.

$$ypc = \alpha + \beta_0 ypc_{-1} + \beta_1 k + \beta_2 l + \beta_3 c \tag{9.5a}$$

$$ypc = \gamma + \delta_0 ypc_{-1} + \delta_1 k + \delta_2 l + \delta_3 n \tag{9.5b}$$

Table 9.3 Average growth rates in selected emerging countries from Asia from 2000–2012

Countries	Average GDP growth
Bangladesh	5.93
China	10.03
India	6.97
Indonesia	5.38
Korea	4.30
Malaysia	5.08
Pakistan	4.10
Philippines	4.82
Singapore	5.62
Sri Lanka	5.59
Thailand	4.23

Source: World Bank (2014)

While the selection of the time period is constrained by the availability of data, country selection is influenced by average growth rates since 2000 along with rigorous ICT policies in recent years. All these countries have an average growth rate of at least 4 percent from 2000 to 2012 (see Table 9.3) and therefore, following Das and Paul (2011), we categorize these countries as emerging.

Data on both ICT variables are collected from the ICT Statistics published by the International Telecommunication Union (ITU, 2014). Other variables have been collected from the World Development Indicators (WDI) published by the World Bank (2014). Investment is defined as the logarithmic difference of real gross capital formation. Conventionally, an economically active population is used as a proxy for the labor force.[5] The growth rate of this variable is used as a measure of the labor force growth.

Unit root test

Since Equations (9.4a), (9.4b), (9.5a), and (9.5b) have dynamic specifications, an instrumental variable (IV) technique should be employed to estimate these equations. This technique can be used with stationary (at levels) time series variables. However, the presence of unit roots in the time series macroeconomic variables (i.e., non-stationarity) has been widely discussed in the literature (see, e.g., Nelson & Plosser, 1982), in which case a panel cointegration technique is more appropriate than IV.

To find out the level of stationarity, we use the Fisher type test developed by Maddala and Wu (1999). This test assumes that all series are non-stationary under the null hypothesis. Unit root results are presented in Table 9.4.

It is evident from the unit root results that all variables are stationary at levels. Therefore, an IV technique that does not presume non-stationarity can be applied to estimate ICT's effects on economic growth in Asian emerging countries. In this regard, we use the *system-GMM* approach, which is an information-efficient means of obtaining consistent estimates.

Empirical results

Empirical results from estimating Equations (9.4a) and (9.4b) are presented in Table 9.5. All three estimated versions of the growth equation fulfill the Arellano–Bond criteria for valid specification. The Hansen Test does not reject the null hypothesis that the GMM instruments are valid and exogenous. In both models, the coefficient for investment is positive and significant at the 1 percent level. The magnitude of this variable is approximately 0.14 suggesting that, on average, approximately 14 percent of economic growth can be explained by capital formulation in emerging Asia. The lagged growth rate is not significant although this variable always possesses the correct sign. Therefore, output is not persistent in our model. The growth in labor force is significant and negative in the first model but insignificant in the second. Because labor force is proxied by the economically active population, the coefficient should be pondered with considerable statistical error.

Both measures of ICT development are positively significant. The coefficient for the growth in mobile phone is approximately 0.017

Table 9.4 Results from Fisher type panel unit root tests

Variable	Test statistics
Growth of GDP	103.32***
Growth of GDP per capita	85.60***
Investment	152.38***
Growth in labor force	54.34***
Growth in mobile phone	183.95**
Growth in Internet connections	135.82***

Notes: (1) *** implies significance at the 1% level. (2) Null hypothesis is that the series contains unit roots.

implying that 1.7 percent of the GDP growth can be explained by the mobile phone subscription in Asian emerging countries. The magnitude of the Internet subscription coefficient is 0.021. Similar growth impacts for both ICT variables are perhaps due to the fact that the Internet-using population is also using mobile phones for communication purposes. With a voluminous increase of smartphone usage, Internet and mobile phones go hand in hand in today's world.

In order to find out if population growth has any discernible effect, we estimate the econometric specifications with growth rate of GDP per capita as the dependent variable (as defined in Equations 9.5a and 9.5b). The results are presented in Table 9.6. While the coefficient for growth in mobile phone is again 0.017, Internet subscription coefficient is found to be 0.018. Therefore, no major changes in our estimates are apparent due to change in the economic growth variable. This shows the stability of the model specification.

A strong homogenous and significant effect of ICT development on the economic growth of these emerging Asian countries has been evident from the above discussion. In the face of a voluminous increase in ICT-related activities, governments could formulate

Table 9.5 System GMM results for a full panel of 11 emerging Asian countries

Dependent variable: rate of growth of GDP		
Explanatory variable	**Equation (9.4a) coefficient**	**Equation (9.4b) coefficient**
Constant	0.040*** (3.84)	0.037*** (3.47)
Growth of GDP (lagged)	0.243 (1.56)	0.243 (1.68)
Investment	0.137*** (3.89)	0.147*** (3.58)
Growth in labor force	–0.654** (–2.29)	–0.454(–1.65)
Growth in cellular phone	0.017** (2.35)	–
Growth in Internet connections	–	0.021* (2.01)
Arellano-Bond Test for AR(1)	–2.45** (*P*-value: 0.014)	–2.57*** (*P*-value: 0.010)
Arellano-Bond Test for AR(2)	–1.30 (*P*-value: 0.193)	–1.27 (*P*-value: 0.203)
Hansen Test of Over identification Restrictions	4.58 (*P*-value: 1.000)	9.85 (*P*-value: 1.000)
Number of groups	11	11
Number of observations	121	121

Notes: (1) ***, ** and * imply significance at the 1% level, 5% level and 10% level respectively. (2) *t*-statistics are in the parentheses. (3) Instrument variables: growth in food production index (lagged), growth in labor force (second lagged), investment (second lagged), growth in ICT variables (lagged), growth of GDP (second lagged).

Table 9.6 System GMM results for a full panel of 11 emerging Asian countries

Dependent variable: rate of growth of GDP per capita		
Explanatory variable	**Equation (9.5a) coefficient**	**Equation (9.5b) coefficient**
Constant	0.047*** (4.04)	0.044*** (3.44)
Growth of GDP per capita (lagged)	0.222 (1.29)	0.225 (1.40)
Investment	0.124*** (3.74)	0.133*** (3.37)
Growth in labor force	–1.488*** (–4.81)	–1.270*** (–3.84)
Growth in cellular phone	0.017** (2.62)	–
Growth in Internet connections	–	0.018** (2.23)
Arellano-Bond Test for AR(1)	–2.36** (*P*-value: 0.018)	–2.46** (*P*-value: 0.014)
Arellano-Bond Test for AR(2)	–1.24 (*P*-value: 0.214)	–1.21 (*P*-value: 0.226)
Hansen Test of Over identification Restrictions	6.87 (*P*-value: 1.000)	8.27 (*P*-value: 1.000)
Number of groups	11	11
Number of observations	121	121

Notes: (1) *** and ** imply significance at the 1% level and 5% level, respectively. (2) *t*-statistics are in the parenthesis. (3) Instrument variables: growth in food production index (lagged), growth in labor force (second lagged), investment (second lagged), growth in ICT variables (lagged), growth of GDP per capita (second lagged).

policies in order to achieve higher economic growth. As investment is highly significant, a certain portion of the investment can be guided toward ICT development, which will enable these countries to enjoy complementary growth impact from both investment and ICT development.

Conclusion

In this chapter, an attempt is made to examine whether the high diffusion of ICT in the emerging Asian countries leads to higher economic growth. The study begins with a critical analysis of various ICT policies adopted by this region. We found that most of these countries started to adopt ICT policies in the last 15 years and achieved remarkable success. Two countries, Korea and Bangladesh, were chosen for country-specific case studies. In Korea, policies covered government initiation of IT infrastructure development, massive government-led investment to build the information super highway, engulfing all government-related activities under the e-governance umbrella, and most importantly, building a

knowledge-based society by constructing an advanced information system led by both the private and public sector.

Formal development of ICT policies is rather a recent phenomenon in Bangladesh, which suffered from non-existence of the much-needed holistic and centralized approaches for a quicker and sustainable success of the sector. The present government has come up with such initiatives by launching the 'Vision 2021' in 2009 to digitize the country. The success of this vision is yet to be realized and hence not available for detailed research. However, key policies of Vision 2021 include digitization of the public sector. Key sectors of the government including health and education have already experienced significant digitalization.

We then conducted econometric analysis to reveal the impact of ICT development on economic growth of Asian emerging countries. Our results show a positive association between ICT diffusion and economic growth for this region. Approximately 2 percent of the total economic growth could be explained by the growth of mobile subscriptions. Internet diffusion also revealed similar growth impact for this region. Results remained similar and consistent even after adjusting for population growth. It can thus be argued that ICT development is imperative for economic growth in these countries. It has also been observed, especially from an analysis of the ICT policies of various countries, that government-led policy initiatives are key to the development of the sector. In future, if these countries want to benefit from the sector, a private–public partnership building along with guided investment toward this sector would be a key to success.

Notes

1 This simply suggests that one individual owns multiple cell phones, which makes the number of mobile phone subscribers larger than the total population.
2 See Andrianaivo and Kpodar (2011), Yousefi (2011) and Lee, Gholami and Tong (2005).
3 Bangladesh, China, India, Indonesia, Korea Republic, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, and Thailand
4 The results may suffer from sample selection issue as the number of Internet and mobile phone subscribers are on the rise from the late '80s or early '90s. Hence, we believe that any dataset starting from 1960 may produce spurious empirical results.
5 See Das et al. (2012). Economically active population is the number of people of working age (16–65 years old) who are either in work or are looking for work.

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