A Longitudinal Study on the Global Digital Divide Problem: Strategies to Close Cross-Country Digital Gap

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ABSTRACT

In this paper, we examine the trends in the diffusion and utilization of information and communication technology (ICT) in twenty-five selected underdeveloped, developing and developed countries from 1995 to 2003. The study uses a multivariate statistical method to measure the digital divide across the twenty-five countries. The empirical analysis showed that the digital gap across underdeveloped, developing and developed countries have widened over the sample period. Factors contributing to the increase in the digital gap will be discussed in this paper. Strategies and policies to bridge the digital divide will be presented in this paper.

1. INTRODUCTION

Our lifestyles have changed dramatically over the last three decades due to proliferation, diffusion and utilization of information and communication technology (ICT). ICT is an integral tool that helps in the development of mankind across the globe. Geographical distances and location are no longer a burden, as ICT can provide reliable communication and flow of information to the most remote area. All that is needed in a country is the appropriate infrastructure support system for ICT diffusion to happen.

Since the classical work of Solow (1956), the factors that contribute to a nation's growth has been widely discussed and debated in the literature. In recent years, several empirical studies have showed that ICT have increased the productivity, efficiency and market reach of firms all over the world (e.g. Gurbaxani et al. 1998; De Gregario, 2002; Criscuolo & Waldron, 2003). Other studies have showed that investment in ICT infrastructure and human resource are important drivers for achieving sustainable economic growth in developed countries over the last four decades (e.g. Lau and Tokutsu, 1992; Kraemer and Dedrick ,1993; Kim, 2003). While the literature have highlighted that most developed countries have benefited from ICT, similar development have not been witnessed among underdeveloped and developing countries. This is because most underdeveloped and developing countries do not have proper infrastructure to support ICT diffusion in the economy. This problem is further compounded by the low ICT literacy among the population. Thus, underdeveloped and developing countries face the threat of falling behind in the race of competitiveness in the information economy.

The different rate of adoption to the information economy is often known in the literature as the 'digital divide'. Digital divide can be defined as the gap that exists across countries in terms of the access to ICT. Over the years, various studies attempted to measure the digital divide and provide solutions to bridge the gap between the 'have and have nots'. Among the most significant studies were undertaken by the OECD (1999, 2001). These studies identified communication infrastructures (e.g. computer, television and telephone), income, education level and demographic profiles as the major factors that influence the digital gap between countries. Most of these studies measured the digital divide using several ICT indicators and much of the analyses have been descriptive.

The primary focus of this paper is to empirically measure the digital gap across underdeveloped, developing and developed countries using a new econometric framework developed by Nair & Kuppusamy (2003). In this method, the sample countries will be clustered into five bands. Band 1 countries have the highest ICT adoption and skilled intellectual capital, while Band 5 countries have the lowest ICT adoption and skilled intellectual capital. Between Band 1 and Band 5, there are three other groupings of countries with varying levels of ICT adoption and skilled intellectual capital. The trends in the digital gap (ICT infrastructure gap and intellectual capital gap) between the five bands will be measured in this paper. Factors that contributed to the digital divide will be discussed in this paper. Policies and strategies to close the digital divide will be explored in this paper. The rest of the paper is organized as follows. Section 2 provides a brief discussion on the econometric method used to measure the digital divide across underdeveloped, developing and developed countries. Section 3 presents the empirical results. Factors contributing to the digital divide will be discussed in Section 4. Strategies and policies to close the

digital divide across underdeveloped, developing and developed countries will be discussed in Section 5. Concluding remarks are given in Section 6.

2. THE EMPIRICAL MODEL TO MEASURE THE GLOBAL DIGITAL DIVIDE

One of the key assumptions of the Nair and Kuppusamy (2003) framework is that countries undergo three different stages of development in the information economy. These stages of development are characterized as Phase I (underdeveloped), Phase II (developing) and Phase III (developed). Descriptions of each stage of development are given in Table 1. In this paper, we argue that within the different stages of development, there are five different homogenous bands/clusters of countries with different level of ICT development (as given in Figure 1). In the Underdeveloped stage, we have one band of countries, which we refer to as Band 5 – Starter (B5). In the Developing stage, there are also two distinct bands of countries, which we refer to as Band 4-Adopter (B4) and Band 3-Adapter (B3). In the Developed stage, there are two bands of countries, which we refer to as Band 2-Adepter (B2) and Band 1- Pace Setter (B1). In the present framework, the gaps in ICT infrastructure and intellectual capital will be the measures for the digital divide across the countries. The widening of the gaps between the bands over time represents the increase in the digital divide across the sample countries. The sample countries and the variables used in this study are given in the Appendix. The empirical method to track the performance of the different countries in terms of the ICT development is clearly outlined in Nair & Kuppusamy (2003).

3. THE EMPIRICAL ANALYSIS

3.1 ICT infrastructure

The band configuration based for the ICT infrastructure is provided in Table 2. The US was in Band 1 in all the five periods. Sweden and Norway, which was in Band 3 in 1995 leapfrogged to Band 1 in 1997. In 2001, both countries were clustered in Band 2, before moving back up to Band 1 in 2003. Australia was in Band 3 in 1995 and moved up to Band 2 in 1997. In the next two years, Australia remained in this band, before moving to Band 3 in 2003. Finland was in Band 3 in 1995. From 1997 onwards, Finland was clustered in Band 2. Ireland and South Korea was in Band 4 in 1995 and 1997. From 1999 onwards, Ireland moved to Band 3, while South Korea remained in Band 4 in the next three periods. Singapore was in Band 3 in 1995, before moving to Band 2 in 1997. Singapore moved up to Band 2 in 1997 and remained in this band until 2001. In 2003, Singapore moved down to Band 3.

Switzerland was in Band 2 in 1995 and 1997. In 1999, Switzerland moved to Band 1, together with US, Sweden and Norway. In 2001, this country moved back to Band 2 before moving back to Band 1 in 2003. New Zealand, UK, Canada and Germany were in Band 3 in 1995. These countries moved to Band 2 in 1997. While Canada and New Zealand remained in Band 2 in 1999 and 2001, UK and Germany moved to Band 3 in 1999. In 2001, UK remained in Band 3 while Germany moved on to Band 2. By 2003, Canada, New Zealand and Germany were clustered in Band 3, while UK moved on to Band 2 (the single country in this band). Japan was in the last position of Band 3 in 1995 before being the single country in the same band in 1997. Thereafter, Japan remained in the same band until 2003.

Developing countries in the South East Asia region (Malaysia, Thailand, the Philippines, and Indonesia) was clustered in Band 4 and Band 5 in all the sample years. Malaysia was in Band 5 in 1995 (the leader of this band). In 1997, Malaysia was clustered in Band 4 (in the last position) behind Ireland, Taiwan, and South Korea. By 1999, Malaysia again became the leader of Band 5, and remained in this band in 2001. In 2003, Malaysia was clustered in Band 4, behind Taiwan and South Korea, and ahead of Chile. Thailand, the Philippines and Indonesia were in Band 5 in all the five selected years. These countries had lower ICT infrastructure development than Malaysia in all the years. The Latin American countries (Chile, Mexico and Brazil) were clustered mostly in Band 5. Chile was in Band 5 in 1995 and 1997, before moving on to Band 4 in 1999. In 2001, Chile was again in Band 5 and remained in this band in 2003. Mexico and Brazil was in Band 5 in all the five years (mostly in the upper position of the band). Other developing countries (China, India and South Africa) were also in Band 5 in all the five years.

The differences in the mean figure for the thirteen variables over the sample period measured the digital gap between the bands. The mean for the thirteen variables have been increasing in all the bands from 1995 to 2003. However, the growth rate for underdeveloped, developing and developed countries varied over the years. The growth rate in the thirteen variables is much higher for countries in the upper bands (developed countries) compared to that in the lower bands (underdeveloped and developing countries). The varying growth levels for the thirteen variables indicate the widening of digital gap across countries in the upper and lower bands. For example, in 1995,

there were about 95 Internet users per 1000 people in Band 1 countries, while there were only close to 2 Internet users in Band 5 countries. Similarly in the same year, there were 360 computers per 1000 people in Band 1 countries, while there were only 23 computers per 1000 people in Band 5 countries (which consists of all underdeveloped and developing countries). The number of Internet users in 1999 in Band 1 countries was recorded at 346 people, while Band 5 countries had only 30 Internet users in the same year. In 2003, while the Internet users increased to 508 per 1000 users, the growth of Internet users in Band 5 countries was about 54 users per 1000 people. In terms of PC ownership, the number of computer owners per 1000 people in Band 1 countries in 1999 and 2001 was 468 and 695, respectively. However, the number of computer owners in Band 5 countries was 42 and 50, respectively.

In summary, the empirical evidence showed that all bands and countries have seen an increase in the ICT infrastructure and ICT adoption from 1995 to 2003. However, the rate of growth in the upper band countries (developed countries) is significantly higher than that in the lower band countries (underdeveloped and developing countries) over the sample period. This provides clear evidence of the widening of the digital gap across underdeveloped, developing and developed countries.

3.2 Intellectual Capital

Table 3 shows the band configuration for the intellectual capital development factor. Three countries, namely, the US, Canada and New Zealand have experienced a phenomenon called as 'leapfrogging', whereby these countries have moved from Band 3 in 1995 and (bypassed Band 2) to Band 1 in 1997. The US and Canada remained in this band in the next three years. New Zealand moved to Band 2 and Band 3 in 1999 and 2001, respectively. By 2003, New Zealand was in Band 2. Switzerland was clustered in Band 1 in 1995 and 1997. By 1999, Switzerland moved to Band 2 and remained in this band in the next two years. Norway was in Band 1 in 1995 and in Band 2 in 1997. In 1999, Norway moved to Band 3, before moving back to Band 2 in 2001. Norway remained in this band in 2003. Finland was in Band 2, Band 1 and Band 3 in 1995, 1997 and 1999, respectively. By 2001, Finland was clustered in Band 2, before slipping to Band 3 in 2003. Sweden was in Band 2 and Band 1 in 1995 and 1997. In the next three years, Sweden was clustered in Band 2. Germany and Japan were in Band 3 in the entire five years. Australia and Ireland were in Band 4 in 1995. In 1997, Australia moved to Band 3, while Ireland leapfrogged to Band 1. From 1999 onwards, both countries were clustered in Band 2. The UK and Singapore were in Band 4 in 1995. Both countries moved on to Band 3 in 1997. From 1999 onwards, the UK remained in Band 3. Singapore however, slipped from Band 3 in 1999 to Band 4 in 2001. By 2003, Singapore was again in Band 3. Taiwan and South Korea was in Band 4 and Band 5, respectively in 1995. From 1997 onwards, Taiwan and South Korea remained in Band 3 and Band 4, respectively.

South Africa and Malaysia were grouped in the same cluster over the five years period. In 1997, both countries were in Band 5. By 1999, both countries moved up to Band 4, and remained in this band until 2003. Brazil (the Latin American countries) and Thailand were in Band 5 in 1995, before moving on to Band 4 in 1997. In the next three years, both countries were clustered in Band 5. The other Latin American countries (i.e. Mexico and Chile) were in Band 5 in 1995 and moved on to Band 4 from 1997 onwards. Finally, the larger Asian countries (Philippines, India, China, and Indonesia) were also grouped in Band 5 from 1995 to 2003.The empirical analysis also showed that the mean for the six variables that characterize the intellectual capital factor in the respective bands (and countries) have increased over the sample period. The differences in the mean for each of the variables measure the Intellectual gap across the countries. It is found that the Intellectual gap across the countries have not diminished over the sample period. This shows that the Intellectual gap across underdeveloped, developing and developed countries have not changed much over the sample period. Countries that have higher ICT literacy and skilled workforce seem to benefit more from the information economy. This is clear evidence of the growing digital gap across underdeveloped, developing and developed countries.

4. FACTORS CONTRIBUTING TO THE DIGITAL DIVIDE

From the empirical analysis above, the countries with the highest development in ICT also have the highest development in intellectual capital. That is, countries in the top three bands (Band 1 to Band 3) in the ICT infrastructure factor are also in the top three bands in the intellectual capital factor. A disturbing trend is emerging from this empirical study. That is, the digital divide (ICT infrastructure and intellectual capital) across underdeveloped, developing, developed countries have widened over the sample period. In the next section, we will examine four main factors that may have contributed to the digital divide across underdeveloped, developing and developed countries.

4.1 Limited Accessibility to ICT infrastructure and services

Most developed countries have good ICT infrastructure facilities that provide efficient and cost effective ICT connectivity to their people. Most underdeveloped and developing countries on the other hand, have very low or obsolete ICT infrastructure that does not support implementation of cost effective technologies. Thus, ICT diffusion in these countries is low. Internet penetration rates in North America and some countries in Europe and Asia Pacific region have been exceptionally strong. However, a significant proportion of the population in Band 5 countries has very limited access to basic telecommunication infrastructure. For example in 2002, the number of telephone per household in India, Indonesia and Philippines were 0.07, 016 and 0.26, respectively (WITSA, 2002).

The low accessibility to ICT infrastructure in underdeveloped countries is due to low-income levels and uneven distribution of wealth. A significant proportion of the populations in these countries have low purchasing power. Thus, they are unable to afford ICT services. Given a small segment of the population in the underdeveloped and developing countries are able to afford the state-of-art ICT infrastructure and services, most ICT providers in these countries are unable to achieve economies of scale. This has resulted in the higher cost of ICT infrastructure and services in underdeveloped and developing countries. In many of the underdeveloped countries, the number of public ICT access points is also limited due to high ICT setup cost and maintenance cost. In many underdeveloped and developing countries, both the ICT services are beyond the reach of most people, especially the underprivileged group of people. Lack of affordability of ICT services is one of the major factors for the widening of the digital gap across underdeveloped, developing and developed countries. Table 3 shows the ICT Affordability Index (IPI) for the twenty-five countries. The IPI measures the percentage of income per capita spent per year on ICT services in these countries. The IPI shows that purchasing power of ICT services is significantly lower in many underdeveloped and developing countries.

4.2 Lack of Competition in the ICT sector

Telecommunication is a key infrastructure for a competitive information economy. In many of the underdeveloped and developing countries, the telecommunication sector is characterized by either a monopoly or an oligopoly market structure. Although many of these countries have privatized their telecommunication sector in the 1990s, this has not increased greater competition in the ICT sector. Privatization of state-own-enterprises in these countries has resulted in private monopolies. The monopoly or oligopoly ICT market structure in the underdeveloped and developing countries have hindered the sustainable development of the ICT sector in these countries in several ways. First, the cost of telephone and Internet access fees in underdeveloped and developing countries are significantly higher than in developed countries. The high ICT cost in these countries has resulted in lower ownership of telephones and lower Internet usage. Second, with lack of competition in the local ICT sector, the ICT service providers are less inclined to introduce state-of-art technologies that are cost-effective and high in quality.

In many of these countries, broadband rollout has been slow. On the other hand, countries in the upper bands (developed countries), where competition in the ICT sector is high, and the pace of broadband roll out has been fast. The broadband charges in these countries have been falling. People in developed countries have been able to benefit from cheaper ICT user cost and better quality of ICT services. The absence of a broadband strategy and lack of competition in the ICT sector in underdeveloped and developing countries have resulted in constant disruption and poor quality of the ICT services. Even customers that can afford the ICT services eventually lose interest in using the services provided by local ICT providers because the cost does not justify the quality of the service the customers were getting. Poor quality of ICT services also hindered the introduction of the much needed 'killer contents' or 'killer applications' to the various segments of the population in underdeveloped and developing countries.

Third, due to lack of affordability of ICT services, especially in the rural areas, many of the ICT service providers focus on developing the ICT infrastructure in areas where there are high concentrations of middle and upper income population. These service providers neglect the disadvantaged and low income earning populations that are predominantly in the rural areas.

4.3 Low ICT Awareness and Literacy

Low adoption of ICT services and widening of the digital divide across countries in underdeveloped and developing countries are attributed to low level of ICT skill. The low ICT skills in underdeveloped and developing countries are attributed to several factors. First, most of the schools in these countries are not equipped with adequate ICT infrastructure. Further, there is a serious shortage of teachers that are proficient in ICT applications in

the primary, secondary and institutions of higher learning in these countries. In many of these countries, the number of public ICT training facilities is also scarce. Thus, the level of ICT awareness and literacy among all segments of the population in underdeveloped and developing countries are significantly lower than in developed countries.

Second, in many underdeveloped and developing countries, English is not the main medium of education or communication. Much of the ICT related applications and services are in English language. Hence, a significant proportion of the population that is not proficient in English, are unable to use the English-based ICT applications and services.

Third, the private sector in underdeveloped and developing countries invests very little in human resource development. This is attributed to the fact that there is significant migration of workers from low paying jobs to higher paying jobs and from rural areas to urban areas. The problem is further exacerbated by the migration of highly skilled workers from underdeveloped and developing countries to developed countries. There is little incentive for firms in underdeveloped and developing countries to invest in human resource development, given that most of the workers will leave the firm for better employment and career prospects elsewhere once they receive the relevant human resource training.

4.4 Weak Electronic Business Environment

The widening of the digital divide among underdeveloped, developing and developed countries is also attributed to the viability of the business environment in these countries. Table 4 shows the level of e-commerce development in the twenty-five countries. The e-commerce development in these countries are measured by the revenue generated by e-commerce per capita, business to business (B2B) and business to consumers (B2C) trade. Note that the level of e-commerce development in developed countries is significantly higher than in the other countries. Several factors contribute to the low e-commerce development in underdeveloped and developing.

First, in many of the underdeveloped and developing countries, the high cost of leased-lines hinders small and medium-sized enterprises (SMEs) from adapting to the e-commerce environment. This is because for the smooth functioning of the e-commerce environment, a 24 hours high-speed leased line connection is required. Due to this, SMEs are unable to provide reliable and real-time communication and transfer of information with suppliers, logistic operators and clients – functions that are vital for effective management of their supply chain. Lack of reliable ICT infrastructure also hinders e-commerce applications such as online banking and electronic trade in many underdeveloped and developing countries.

Second, electronic government (e-government) initiatives in most underdeveloped and developing countries are non-existent or rather patchy. Government is the largest service provider in any economy. Hence, electronic government initiatives are critical in setting the pace for e-commerce development in the country. Governments in developed countries have been very successful in not only developing an effective e-government infrastructure, but also providing various fiscal and non-fiscal incentives for SMEs to use the government electronic delivery systems. The disparate e-government developments and usage among underdeveloped, developing and developed countries have contributed to increasing digital divide across these countries.

Third, key to sustainable development of e-commerce environment is a legal framework that facilitates secure and reliable commerce and trade in the digital economy. Most developed countries have established the relevant legislation and acts to promote a stable e-commerce environment (e.g., Acts on digital signature, uniform computer information transaction, online infringement liability and other cyber-laws). However, e-commerce-related legislation and law in underdeveloped and developing countries are non-existent. The lack of proper legislation to protect consumers in the digital economy resulted in low online consumer participation in the information economy. Further, the low e-commerce in underdeveloped and developing countries is attributed to low usage of credit cards in these countries. Fourth, the low level of e-commerce in most underdeveloped and developing countries are due to the lack of local content in these countries. The lack of content developers (advanced suppliers) and low level of ICT sophistication (advanced buyers) hinder existing operators from introducing new e-commerce services and innovation.

5. STRATEGIES AND POLICIES TO BRIDGE THE DIGITAL DIVIDE

In the previous section, we have highlighted some of the key drivers that have contributed to the widening of the digital divide across underdeveloped, developing and developed countries. In this section, we will examine

some of the strategies and policies that can will facilitate the convergence in ICT development (i.e., reduce the digital divide) across underdeveloped, developing and developed countries.

5.1 Widening Accessibility to ICT infrastructure and services

In many underdeveloped and developing countries, significant proportions of the population cannot afford ICT services due three major factors. First, income levels in these countries are low. Second, cost of ICT services are significantly higher than in developed countries. Third, the numbers of public facilities that provide affordable ICT services are limited in these countries. The strategies to increase the income of the people in these countries require long-term macroeconomic and microeconomic reforms, which is beyond the scope of this paper. In this paper, we will identify cost effective ways to connect people in underdeveloped and developing countries. Thus, reduce the digital divide across underdeveloped, developing and developed countries. To overcome the digital divide problem, underdeveloped and developing countries should have a clear and coherent ICT development policy. An integral part of this policy should be a multi-strategy cost-effective ICT infrastructure plan. This includes a combination of conventional wired telecommunications service, wireless and digital power line (DPL). Fixed telephone lines have been an important part of the ICT infrastructure in many developed countries. The fixed line technology has helped developed countries stay competitive in the global economy over the last five decades. In many underdeveloped and developing countries, the number of fixed telephone lines is scarce – hindering sustainable socioeconomic development of these economies. The cost of building fixed lines is considerable. These countries in general need to invest more to upgrade the ICT infrastructure in the country (which includes basic and advanced telephone networks, Internet backbone, interconnection and access points). Over the last decade, new technologies have emerged to provide cheaper alternatives to connect people to the global information network. Among the new technologies, include the satellite technology and the Very Small Aperture Terminal (VSAT) technology. These new technologies can enhance connectivity to the global economy with a fraction of the cost of fixed line technology (old telephone networks and coaxial cables). Access to Wireless devices and WAP technologies are also important for increasing the number of Internet users. These new technologies can also connect rural communities and people in remote areas at a faster pace. The wireless and WAP technology is also cheaper than traditional fixed line technology.

The DPL technology (especially Internet Protocol Version 6) is one of the most recent and quickest methods to bridge the digital divide. It allows for the transmission of information over power lines. This new technology is not a solution for the entire digital divide problem. It provides a cheaper alternative to increasing broadband connectivity to homes without additional cabling and infrastructure. For this reason the DPL technology is known as the "last-half-mile technology" (Palet, 2003). Since power lines are ubiquitous, it has the potential of providing ICT services in the most remote regions in underdeveloped and developing countries. Among the countries that have successfully deployed DPL commercially are the US, Germany, France, Brazil, Austria and Switzerland (Ismail, 2005). Countries in Band 5 such as China, India and Indonesia (where electricity network penetration is higher than telephone penetration) will be able to rollout broadband and voice over IP at a much faster pace using DPL technology than traditional technologies. Wireless, satellite, mobile and DPL technologies are some of the alternate technology to the fixed-line telecommunication. These new technologies are able to provide wider, faster and cost-effective access to ICT services. Governments in underdeveloped and developing countries should channel a larger proportion of their national budget from traditional telecommunication infrastructure towards these new ICT infrastructure and support services.

Income levels in underdeveloped and developing countries are low. Hence, personal computers (PC) ownership is also low in these countries. A measure to increase the accessibility to ICT services is through the promotion of public community centers, which could be located in schools, universities, public libraries, post offices and government hospitals. To keep the ICT services affordable, users should only be charged the local telephone access cost. Commercial Internet and Cybercafés can also play an important role in providing affordable ICT access. The number of commercial Internet and cybercafés are significantly lower in underdeveloped and developing countries compared to that in developed countries. For example, in 1998 there were 286 registered cybercafés in Mexico (Whiston and Choi, 2002). On the other hand, in 2000 Taiwan had 2000 cybercafés while South Korea had 16,000 'PC-bangs' or 'PC-rooms' (Whiston and Choi, 2002). The PC-bangs provided affordable and high quality ICT services for Koreans. Youth were the largest users of the PC-bangs in Korea. To increase greater access to ICT services, governments in underdeveloped and developing countries should encourage private sector to establish commercial cybercafés. Private sector's participation in providing ICT services will also reduce government burden in providing such services.

5.2 Increasing Competition in the ICT Sector

As mentioned in the previous section, lack of competition in the telecommunication sector in many underdeveloped and developing countries is hindering the development of the ICT sectors. This subsequently hinders the competitiveness and socioeconomic development of these countries. To raise the quality of the ICT infrastructure and lower the cost of the ICT services, governments in underdeveloped and developing countries should foster greater competition in the ICT sector. These include easing the regulation for entry in to the market, favorable pricing conditions and increase foreign ownership.

Allowing new entrants into the ICT sector can raise the level of competitiveness, forcing incumbent service providers to adapt to new technologies. For example, prior to 1997, Korea Telecom (KT) was the sole provider of local call services. Hanaro Telecom (HT) was allowed to enter the local calls market in 1998. In 1999, HT introduced its broadband service (ADSL-Asymmetric Digital Subscribers Line) to power its local calls and high speed Internet service. HT's strategy was done to differentiate itself from KT. By the end of 1999, HT captured 91 percent of the ADSL market. To counter the growing market share of HT, KT also introduced the ADSL service. By the end of 2000, both KT and HT increased their subscribers with KT regaining a larger market share of 63.8 percent HT's market share during that period was 31.4 percent (Ueki, 2003). Due to deregulation of the ICT sector, South Korea is considered to have one of the most advanced broadband Internet infrastructure and mobile phone systems. It boasts to have one of the highest Internet and mobile penetration rates in the world. Intense competition alone is not sufficient to provide access to all segments of the population. Intense competition may result in the dismantling of local service providers without significantly increasing ICT access rate. In a highly competitive environment, ICT operators may opt to provide service in areas that are densely populated, neglecting rural communities and remote areas. One way to overcome this problem is for governments to make it mandatory for operators to provide ICT services in the rural and remote areas of the country. For example, as part of the licensing agreement, ICT service providers in South Africa are required to provide their services to rural and poor areas as part of the nation's development plan (Polikanov and Abramova, 2003).

5.3 Creating an ICT savvy population

Increasing the number of PCs or improving the ICT infrastructure alone will not solve the digital divide problem. If the literacy level (especially ICT literacy) is low, then ICT adoption level will also be low, even if the country has the most sophisticated ICT infrastructure. ICT infrastructure is a necessary condition for the development of the information economy. However, intellectual capital (ICT literacy) is a necessary and sufficient condition for the creation of a competitive information economy. Given that education is a "public good", governments in underdeveloped and developing countries should play a major role in building the nations' intellectual capital and ICT literacy. A holistic approach to human resource development should be implemented. Here, level of ICT literacy across all segments of the population should be continuously upgraded. Governments in underdeveloped and developing countries should increase their investment in upgrading the ICT infrastructure and training nationwide in pre-schools, junior and senior high schools. All schools should be equipped with adequate number of PCs, software and Internet network points. In countries where English is not the main medium of instruction in schools, both English language education and ICT training in local languages should be increased. For the latter initiative to be effective, ICT content in local languages should be encouraged. Special financial allocation should be made available for ICT content development in local languages.

One of the major hindrances in many underdeveloped and developing countries is lack of ICT proficient teachers. To overcome this problem, teachers training programs should institute mandatory ICT proficiency courses. Teachers should be required to pass ICT proficiency exams before undertaking their teaching duties. Teachers should also be required to upgrade their ICT knowledge and skills every three years so that they are well informed on the latest technology and teaching pedagogy in the digital environment. In colleges, polytechnics and universities, besides improving the ICT infrastructure, curriculum in the different discipline areas should be reviewed and refined to meet the requirements of the information economy. This can be done by the establishment of 'Government-Industry-University Knowledge Consultative Group' (GIUKCG), whose role is to ensure that curriculum taught in high schools, colleges, polytechnics and universities meets the needs of the new economy. The GIUKCG can also play a role in the development of training programs that are relevant for upgrading the skills and competencies of the workforce. ICT-related certification programs that meet global standard should be introduced as part of the continuous ICT skills upgrading plan. Schools, colleges, polytechnics and universities can be the harbinger for enhancing ICT literacy in the country. Various programs can be designed to help industry and government to upgrade their ICT skills and knowledge. An 'ICT Skills Enhancement Partnership Program' (ISEPP) should be introduced, where schools and institutions of higher learning can assist SMEs, government agencies, government-linked companies and senior citizens to upgrade their ICT skills. The ICT centers can also provide SMEs technical consulting, hands-on ICT training and assistance for selecting appropriate ICT technology. Under the ISEPP, funds from government and industry should be channeled to the ICT centers in schools and institution of higher learning for assisting the various communities upgrade their ICT skills.

5.4 Creating a Vibrant Electronic Business Environment

The e-business environment is important in closing the digital divide across the countries. Access to reliable and cost-effective ICT services and adequate local content development are important for the sustainable development of the e-business environment. Some of the strategies mentioned above on ICT infrastructure, ICT literacy and deregulation of the ICT sector are important for the sustainable development of the e-business environment in underdeveloped and developing countries.

Other policies that are important for the effective development of the e-business environment are the rapid deployment of the e-government delivery and procure systems. Most governments in underdeveloped and developing countries have been slow in implementing the e-government initiatives. Not to be left behind in the information economy, underdeveloped and developing countries should speed-up the implementation of the e-government system in their country, and benchmark the e-government implementations to global standards. Adhering to global standards and best practices are important for the creation of a competitive and sustainable e-business environment. This includes strengthening accountability, ethics, data management, data dissemination and security features pertaining to the e-delivery systems. For the sustainable development of the e-business environment, governments in the developing countries should develop the necessary legal and legislative framework for the smooth implementation and operation of e-commerce. This includes fine-tuning and strengthening existing legislative framework pertaining to intellectual property, consumer protection and privacy of information. The new legal framework should also foster investor confidence in the digital environment. This entails strengthening the regulatory framework to stem out credit card fraud and e-corruption. E-corruption occurs when an economic agent is able to benefit from using the digital medium at the expense of others. Often, e-corruption occurs because lack of efficient ICT infrastructure management and poor intellectual capital support. Outsourcing of key business functions (such as management of confidential information and authentication & encryption functions) to unreliable agents can contribute to the abuse or misuse of the digital medium. This may undermine investor confidence in e-commerce.

6. CONCLUSION

This empirical study showed that countries that have invested heavily in ICT infrastructure and intellectual capital are at the forefront of the competitiveness race. Hence, these countries are the beneficiaries of the greater wealth creation in the information economy. Using a new econometric approach, this study showed that a troubling trend has emerged in the global economy over the last eight years (1995 to 2003). That is, the global digital divide across underdeveloped, developing and developed countries has widened over the sample period. The widening of the digital gap is attributed to the following factors in underdeveloped and developing countries: 1) Limited access to affordable ICT infrastructure and services; 2) Lack of competition in the ICT sector; 3) Low ICT literacy; and, 4) Weak e-business environment.

Several policies, strategies that underdeveloped, and developing countries should adopt to catch with more developed countries in the shortest period were examined in this paper. There are four major strategic thrusts that underdeveloped and developing countries should focus on to enhance their competitiveness in the information economy. First, underdeveloped and developing countries should use cost-effective technologies that provide the widest ICT coverage across all segments of the population. Several leapfrogging technologies have been proposed in this paper to achieve this objective. Second, governments should open the domestic ICT sector to greater competition. This will have dual effect of raising the quality of ICT service and lower the cost of these services. Third, underdeveloped and developing countries should invest more on intellectual capital and raising the ICT literacy in the country. Fourth, to close the digital divide and create a competitive economic environment, governments in these countries should create a vibrant e-business ecosystem. In conclusion, the global environment is changing at a warp speed. All countries and organizations must change with the time or face the risk of falling behind in the information economy.

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APPENDIX

Figure 1: Stages of development in the information economy

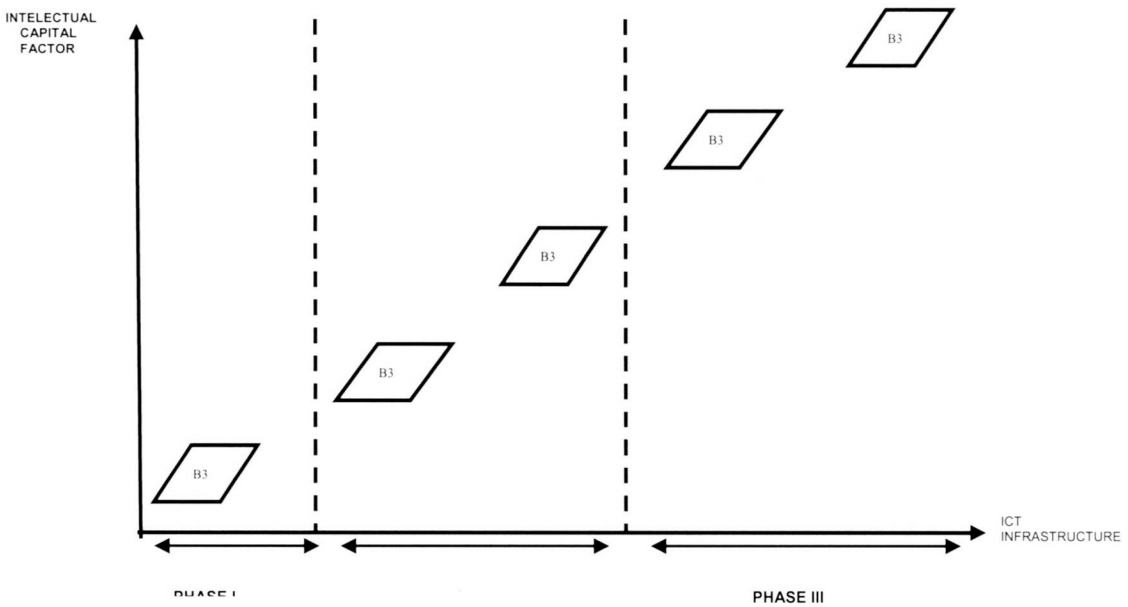

Table 1: Stages of Development in Information Economy

Phase of Development	Description
Phase I: Underdeveloped	There is a lack of proper ICT infrastructure and intellectual capital in countries in this stage. ICT policies and strategies are fragmented and ineffective in increasing the level of productivity and efficiency in the firms, industries and the overall economy.
Phase II: Developing	In this stage, both the ICT infrastructure and intellectual capital are at moderate levels. The absorbability of the workforce is higher than countries in the underdeveloped stage. This allows for better assimilation of new ICT infrastructure. ICT is better integrated into the main core economic activities than in countries in Phase I. Thus, the level of efficiency and productivity in countries in Phase II are higher than in Phase I.
Phase III: Developed	Countries in this stage experience continuous innovation in the ICT sector. Countries in this stage of development have higher development of ICT infrastructure and high number of skilled people. A high proportion of the economic agents in these countries are users of ICT. The level of ICT awareness and literacy are high.

Sample countries:

Australia	Brazil	Canada	Chile	China	Finland
Germany	India	Indonesia	Ireland	Japan	Korea
Malaysia	Mexico	New Zealand	Norway	Philippines	Singapore
South Africa	Sweden	Switzerland	Taiwan	Thailand	United Kingdom
United States					

Variables Used in the Study:

Thirteen indicators were used in this study to captures the level and quality ICT development in the countries.

A1. Number of Internet Users per 1000 people
A2. IT Hardware expenditure per capita, US$
A3. Software expenditure per capita, US$
A4. IT Services expenditure per capita, US$
A5. Number of PCs used in the education sector per 1 million people
A6. Number of PCs used in home per 1 million people.
A7. Number of PCs used in the business and government sectors per 1 million people.
A8. Number of telephone lines per household
A9. Telecommunication investment per capita, US$
A10. Computers per 1000 people
A11. Number of mobile telephone users per 1000 people
A12. Computer power per 1000 people (*share of total millions instructions per second (MIPS)*) - data for this variable was not available for two years, that is, 1999 and 2001. These years was calculated using the following formula (Moore, 1965):

$$\text{Computer power per capita} = \frac{[\text{computer power per capita } x \text{ population}]\ x\ 2}{\text{population of current year}}$$

A13. Distribution systems (*an index of the efficiency of distribution systems in a country*), where:

$$I_{DS} = \begin{cases} 1 \text{ if the distribution system is less efficient} \\ 10 \text{ if the distribution system is efficient} \end{cases}$$

Six factors were used to measure the level and quality of the human capital in the sample countries. The factors are as follows.

B1. Skilled labour (*an index of availability of skilled labour in a country*). This is shown as:

$$I_{SL} = \begin{cases} 1 \text{ if skilled labour is not easily available in a country} \\ 10 \text{ if skilled labour is highly available in a country} \end{cases}$$

B2. Science & Education (*an index of science education adequately taught in compulsory schools).* This is shown as:

$$I_{SE} = \begin{cases} 1 \text{ if science education is not adequately thaught in compulsory schools} \\ 10 \text{ if science education is adequately thaught in compulsory schools} \end{cases}$$

B3. Entrepreneurship (*an index of entrepreneurship is widespread in the economy*)

$$I_{EN} = \begin{cases} 1 \text{ if entrepreneurship is not not widespread in the country} \\ 10 \text{ if entrepreneurship is not not widespread in the country} \end{cases}$$

B4. Public education expenditure per capita, US$ - there were some missing data for this variable, namely for 1997, 1999 and 2001. This was computed using the following formula:

$$\text{Public education expenditure per capita} = \frac{[\text{public education expenditure in \% of GDP x GDP}]}{\text{population}}$$

B5. Qualified engineers (*an index for number of qualified engineers in a country*). This is shown as:

$$I_{QE} = \begin{cases} 1 \text{ if qualified engineers are not easily available in a country} \\ 10 \text{ if qualified engineers are highly available in a country} \end{cases}$$

B6. The educational system (*an index of an educational system that meets the needs of a competitive economy).* This is shown as:

$$I_{EC} = \begin{cases} 1 \text{ if education is less efficient} \\ 10 \text{ if education is highly efficient in meeting the needs of the competitive economy} \end{cases}$$

Source of the Data:

The data A13, B1, B2 B3,B5, and B6 are from IMD (1996-2004).

The remaining data series are from WITSA (2002)

Table 2: Band classification for ICT Infrastructure factors

1995	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Switzerland	Norway	Ireland	Malaysia
			Sweden	Taiwan	Chile
			Finland	Korea	SouthAfrica
			Australia		Mexico
			NewZealand		Brazil
			Singapore		Thailand
			Canada		Philippines
			UK		China
			Germany		India
			Japan		Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	84.59	38.59	25.87	4.75	1.41
X2	599.81	499.29	501.44	127.45	17.41
X3	153.99	243.12	98.41	21.42	4.02
X4	371.13	463.26	226.03	47.76	7.83
X5	777.82	1121.70	683.19	372.26	54.54
X6	22329.10	11364.56	14101.55	5088.11	1218.57
X7	147277.20	120090.24	65597.89	32021.32	2429.88
X8	187011.15	113782.30	106322.55	53546.07	13610.37
X9	0.94	0.90	0.99	1.04	0.25
X10	340.00	191.20	225.53	115.87	52.53
X11	52.70	47.40	69.79	24.80	7.85
X12	11829.97	5939.97	6679.32	2433.66	391.97
X13	8.78	8.32	7.74	5.51	5.00

1997	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Singapore	Japan	Ireland	Chile
	Norway	Australia		Taiwan	SouthAfrica
	Sweden	Switzerland		Korea	Brazil
		Canada		Malaysia	Mexico
		Finland			Thailand
		NewZealand			Philippines
		UK			China
		Germany			India
					Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	351.00	100.15	61.60	25.50	5.87
X2	452.18	337.54	379.07	122.62	19.44
X3	147.91	129.46	84.34	23.51	4.70
X4	431.75	234.50	318.21	42.91	10.46
X5	771.56	779.28	1222.69	386.08	62.21
X6	24326.67	15193.88	11808.74	5376.13	1678.12
X7	163891.58	127085.63	68144.57	35827.90	4645.37
X8	210951.52	151783.52	109909.65	57019.23	15451.00
X9	1.02	0.99	0.96	0.97	0.25
X10	388.67	316.63	228.00	149.75	22.11
X11	315.57	204.10	228.80	92.18	17.32
X12	42428.08	33122.64	23826.05	15465.71	1937.52
X13	8.06	8.12	5.44	5.11	4.85

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Finland	UK	Taiwan	Malaysia
	Sweden	Australia	Japan	Korea	SouthAfrica
	Norway	Singapore	Ireland		Chile
	Switzerland	Canada	Germany		Brazil
		NewZealand			Mexico
					Thailand
					Philippines
					China
					India
					Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	346.97	264.49	185.35	128.87	30.22
X2	544.14	321.47	314.50	123.28	23.27
X3	238.62	132.94	122.05	29.02	6.02
X4	534.24	285.50	288.22	94.32	12.82
X5	877.75	809.78	884.43	377.71	92.89
X6	32744.67	28038.26	13328.26	14617.70	2571.32
X7	232480.98	154453.56	119679.93	54718.78	6352.69
X8	248521.35	203127.32	123996.93	78789.17	27317.45
X9	1.54	1.62	1.39	1.67	0.48
X10	468.62	474.64	349.62	220.70	41.75
X11	493.41	372.17	359.90	496.32	66.78
X12	158291.34	138080.05	102015.08	58265.38	9786.61
X13	7.85	8.24	6.95	5.14	4.62

2001	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Sweden	UK	Taiwan	Malaysia
		Norway	Ireland	Korea	SouthAfrica
		Switzerland			Chile
		Finland			Brazil
		Singapore			Mexico
		Canada			Thailand
		Australia			China
		Japan			Philippines
		NewZealand			India
		Germany			Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	501.59	426.76	281.35	436.05	75.90
X2	427.71	380.24	341.38	180.45	25.57
X3	339.03	193.44	174.11	28.69	6.89
X4	699.45	423.82	316.71	52.36	14.56
X5	933.83	981.13	805.19	423.85	93.27
X6	57312.93	34787.99	23224.25	18309.35	3902.97
X7	284211.40	180235.45	133771.34	95951.47	15037.53
X8	456000.80	247370.98	149700.21	110938.53	39984.70
X9	1.98	1.80	1.51	1.74	0.55
X10	639.00	560.20	476.50	398.60	59.80
X11	435.00	615.24	753.50	744.50	184.50
X12	785046.00	529740.64	442644.73	235536.89	39481.37
X13	7.14	7.55	3.62	5.70	4.42

2003	B1	B2	B3	B4	B5
	US	Sweden	UK	Japan	Malaysia
	Australia	Switzerland		Ireland	Chile
		Norway		Germany	SouthAfrica
		Finland		Taiwan	Brazil
		Singapore		South Korea	Mexico
		Canada			Thailand
		NewZealand			China
					Philippines
					Indonesia
					India
	Mean	Mean	Mean	Mean	Mean
x1	485.64	492.63	360.14	360.58	84.52
x2	480.00	426.05	383.56	267.71	27.42
x3	221.84	213.39	229.11	66.35	7.06
x4	521.35	454.48	432.15	169.49	16.09
x5	949.29	893.71	775.31	845.67	99.69
x6	46540.74	40631.29	28600.57	16334.66	3846.15
x7	264424.05	209289.51	178593.47	127116.14	16211.45
x8	429449.36	256822.15	165265.41	146358.09	39477.19
x9	1.69	1.80	1.61	1.67	0.60
x10	697.55	639.97	546.50	435.23	68.12
x11	538.10	672.95	831.94	772.64	178.24
x12	711037.65	582769.18	429874.09	351967.97	43822.35
x13	8.07	8.12	5.89	5.80	5.64

X1: Internet users per 1000 people
X2: IT hardware expenses per capita, US$
X3: Software expenses per capita, US$
X4: IT Services expenses per capita, US$
X5: Telecommunication investment per capita, US$
X6: PC in education per 1 million people
X7: PC in home per 1 million people
X8: PC in business & government per 1 million people
X9: Number of telephone lines per household
X10: Computer per 1000 people
X11: Mobile phone users per 1000 people
X12: Computer power per 1000 people (MIPS)
X13: Distribution system (efficient)

Table 3: Band classification for Intellectual Capital factors

1995	Band 1	Band 2	Band 3	Band 4	Band 5
	Switzerland	Finland	Germany	Australia	Korea
	Norway	Sweden	Japan	Ireland	Malaysia
			US	UK	Brazil
			Canada	Singapore	S.Africa
			N.Zealand	Taiwan	Chile
					Mexico
					Thailand
					Philippines
					India
					Indonesia
					China
	Mean	Mean	Mean	Mean	Mean
X1	6.26	6.57	6.19	6.03	4.98
X2	5.76	5.21	5.05	6.13	4.16
X3	6.36	6.66	6.15	6.42	6.11
X4	2572.40	1910.20	1319.40	666.20	137.90
X5	7.10	5.40	6.70	6.40	4.90
X6	6.14	5.70	5.32	6.31	3.56

1997	Band 1	Band 2	Band 3	Band 4	Band 5
	Sweden	Norway	Australia	S.Africa	Philippines
	US		UK	Korea	China
	Canada		Germany	Chile	India
	Finland		Japan	Malaysia	Indonesia
	Switzerland		Singapore	Mexico	
	New Zealand		Taiwan	Brazil	
	Ireland			Thailand	
	Mean	Mean	Mean	Mean	Mean
X1	6.61	6.39	6.36	4.71	5.99
X2	5.68	5.30	6.19	4.94	4.65
X3	6.49	5.54	5.52	6.41	5.44
X4	1462.95	2532.82	962.64	425.82	72.13
X5	6.37	6.70	6.31	5.57	5.41
X6	5.96	5.11	5.49	3.79	4.06

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	US	New Zealand	Norway	Singapore	Thailand
	Canada	Sweden	Finland	South Africa	Philippines
		Switzerland	Germany	Korea	India
		Ireland	UK	Malaysia	Brazil
		Australia	Japan	Mexico	China
			Taiwan	Chile	Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	7.13	6.99	6.57	6.30	6.31
X2	6.26	5.90	6.22	4.93	5.26
X3	6.22	6.29	5.54	5.65	5.61
X4	1343.94	1973.59	804.90	358.33	74.98
X5	7.24	6.64	6.71	6.24	6.58
X6	6.84	5.56	5.06	4.26	4.20

2001	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Norway	Germany	Korea	Thailand
	Canada	Switzerland	New Zealand	Malaysia	Brazil
		Sweden	UK	South Africa	Philippines
		Ireland	Singapore	Chile	India
		Australia	Taiwan	Mexico	China
		Finland	Japan		Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	7.00	6.69	6.76	5.84	6.29
X2	5.11	5.82	5.50	4.49	4.42
X3	6.90	6.44	5.65	5.56	5.37
X4	2457.02	1796.52	1042.33	527.19	119.16

2003	Band 1	Band 2	Band 3	Band 4	Band 5
	Canada	Australia	Finland	Malaysia	India
	US	Switzerland	Singapore	Chile	Philippines
		Ireland	Taiwan	South Korea	Thailand
		Sweden	Germany	SouthAfrica	Brazil
		Norway	Japan	Mexico	China
		New Zealand	UK		Indonesia
	Mean	Mean	Mean	Mean	Mean
x1	6.99	6.67	6.83	5.60	5.81
x2	5.87	5.39	5.71	4.35	4.46
x3	6.00	6.10	5.30	5.70	5.50
x4	2647.02	1722.55	1086.93	541.67	143.00
x5	7.65	7.45	7.08	6.70	6.36
x6	6.40	6.54	5.56	4.42	4.32

X1: Skilled labour (availability in a country)
X2: Science & education (adequately taught in schools)
X3: Entrepreneurship (common in a country)
X4: Public education expenses per capita, US$
X5: Qualified engineers (availability in a country)
X6: Education system (competitive education system in a country)

Table 4: ICT Purchasing Power (IPP) Measurement in Percentage for 2002

COUNTRIES	IPP Measurement (in %)
Norway	3.53
Canada	6.36
Singapore	6.51
US	7.70
Japan	8.46
Taiwan	9.32
Finland	9.71
Korea	10.23
United Kingdom	10.71
Ireland	13.14
Germany	13.24
Australia	15.30
Switzerland	16.07
New Zealand	16.68
Sweden	17.17
Thailand	27.58
South Africa	28.17
Malaysia	29.23
Mexico	31.05
Philippines	40.74
Chile	41.39
China	51.03
Brazil	67.05
India	81.12
Indonesia	96.68

Notes:

1. *The IPP was measured using the following formulae:*

$$IPP = \left(\frac{\text{Fixed Telephone Cost} + \text{Mobile Phone Cost} + \text{Internet Cost}}{\text{Gross National Income per Capita}} \right) \times 100$$

2. *Fixed Telephone Cost was measured for 5 hours per month for 12 months. The Fixed Telephone Cost consists of Local Telephone Cost and International Telephone Cost.*
3. *Mobile Phone Cost was measured for 10 hours per month for 12 months.*
4. *Internet Cost was measured for 5 hours per month for 12 months.*
5. *Data Source: Local Telephone Cost, Internet Cost and Gross National Income are from World Development Indicators; International Telephone Cost is from 2002 World Competitiveness Yearbook IMD; Mobile Telephone Cost is from 2004 World Competitiveness Report IMD.*

Table 4: E-Commerce Development in 2001

COUNTRIES	INTERNET COMMERCE PER CAP (US$)	B2C (US$)	B2B (US$)
India	1.11	96.9	1055
Indonesia	2.11	106.5	344.3
China	4.47	1314.1	4333.5
Philippines	6.05	135	332.5
Thailand	7.37	85.9	377.4
Brazil	26.23	698.6	3874.9
Malaysia	32.35	257.7	523
Chile	34.61	33.5	499.6
Mexico	41.79	106	3990.3
Korea	175.26	2668.2	5702.5
Ireland	274.19	170.9	878.6
Taiwan	339.4	2010.9	5563.1
New Zealand	350.12	296.1	970.8
Australia	444.69	2583.4	6057.3
Finland	476.98	446.9	2017.6
Germany	526.86	6227.7	37102.1
Singapore	535.57	485.6	1949.2
United Kingdom	620.83	6674.5	30203.4
Sweden	734.04	1243.2	5268.9
Canada	786.63	4167.7	20278
Japan	794.55	10092.7	90873.6
Norway	850.28	590.1	3245.7
Switzerland	867.19	901.4	5319.1
US	983.64	66500	206989
South Africa	na	na	na

Notes:

1. *B2C is (Business to Consumer Commerce) and B2B is (Business to Business Commerce) is in US$ (millions).*
2. *Data on Internet Commerce, B2C and B2B for South Africa was not available.*
3. *Data Source: Digital Planet 2002, WITSA.*