ASEAN AND COMPETITIVENESS IN THE KNOWLEDGE ECONOMY

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ABSTRACT

In this paper, we examined the competitiveness of ASEAN countries in terms of development in the knowledge economy. Here two broad factors called the REACH and RICH factors were used to measure the competitiveness of countries in the knowledge economy. The REACH factors measure the connectivity of countries to the knowledge economy. On the other hand, the RICH factors measure the quality of the intellectual capital, innovation, interaction/strategic cooperation and integrity systems of the countries. The empirical analysis showed that with the exception of Singapore, the other ASEAN countries are falling behind in terms of competitiveness in the knowledge economy. Policies and strategies to enhance ASEAN countries competitive position in the knowledge economy are examined in this paper.

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1. INTRODUCTION

The drivers of economic growth and competitiveness have been topics of extensive research and debate, stemming from the fact that traditional factors of production (land, capital and labour) no longer play a major role in the socio-economic developments of countries. Today, smaller countries such as Finland, Ireland and Singapore – each with a relatively small labour force and land limitations, have experienced rapid accumulation of wealth and competitiveness over the last two decades. On the other hand, larger economies (with bigger labour force and abundant natural resources) have been experiencing loss of competitiveness over the same period. This phenomenon has been associated with the notion of knowledge economy – an economy that has high technology industries, such as computing and telecommunications, and sectors, which is defined as a highly skilled workforce such as finance and education (OECD, 2001).

Some economists are of the opinion that 'opening-up' and participation in the global economy are the key factors for smaller economies and developing countries in achieving increased economic competitiveness. Others argue that a more open global economy will likely favour richer countries with better technology and know-how. Thus, "widening the disparities between the rich and poor, imprisoning many developing countries in relative poverty" (Persaud, 2001).

There have been numerous research papers and books written on the forces that have transformed the socio-economic developments over the last three decades (see for e.g. Shapiro and Varian, 1999; Fulmer, 2000; Meyer, 2000; Evans and Wurster, 2000 & Johnston and Bate, 2003). The general consensus from these studies is that three major forces have continuously played a key role in shaping the global economy. The three forces are: *Globalization*, *Liberalization*, and *Innovation*. These three forces are interdependent and reinforce one another.

Innovation, especially in the areas of Information and Communication Technology (ICT) is seen to be a crucial force which speed the process of globalization and liberalization. The widespread diffusion of ICT has been recognized as a formidable force that has accelerated the competitiveness of many countries. Empirical studies have shown that technology is a powerful instrument for increasing productivity and economic growth. See for example studies by Solow, 1956; Lichtenberg, 1995; Kwon and Stoneman, 1995; Brynjolffson and Hitt, 1996; Lehr and Lichtenberg, 1999; Oliner and Sichel, 2000 and Greenan et al., 2001.

Acknowledging the importance of ICT in economic development, many developing countries have invested heavily in ICT infrastructure and human capital development - and ASEAN is not an exception. Since early 1990s, ASEAN have invested significantly in ICT. For example, in 1993, the ASEAN countries had invested a total of USD14.8 billion in ICT. This amount increased to USD25.7 billion in 1997. By 2001, the total ICT investment in the ASEAN region increased to USD29.5 billion (WITSA, 2002).

The primary objective of this paper is to assess if the above-mentioned investments have enhanced the competitiveness of ASEAN countries in the knowledge economy. Here, we define knowledge economy as 'an economy that has close integration of the 7-I's (details of the 7-I's is given in Section 5), which results in creation of high economic value, thus competitiveness'. The competitiveness of the countries was examined using two broad categories of factors called the REACH and RICH factors. The REACH factors measure the level of connectivity in the knowledge economy. The RICH factors measure the level of developments with respect to intellectual capital, innovation, interaction/strategic cooperation and integrity.

In this paper, the level of developments with respect to the REACH and RICH factors in these countries is compared with the productivity growth (labour productivity, industry productivity, service productivity and overall productivity). The linkage between REACH, RICH and the productivity in the sample countries were measured using the empirical model developed in Nair and Kuppusamy (2003). Due to the limitation in the data for the new ASEAN countries (Myanmar, Laos, Cambodia, Vietnam and Brunei), our benchmarking

study was restricted to the five founding members of ASEAN – Indonesia, Malaysia, the Philippines, Singapore and Thailand (henceforth referred to as ASEAN-5).

The empirical results showed that despite the strategic policies adopted to increase the developments of the REACH and RICH factors, most of the ASEAN countries (except for Singapore) are falling behind developed countries in terms of ICT diffusion and productivity growth. In this paper, a new framework to harness the forces of innovation and ICT is proposed to enhance the competitiveness of the ASEAN countries in the knowledge economy.

The rest of the paper is organized as follows. Section 2 provides a review of empirical literatures that examined the relationship between knowledge economy initiatives and economic development in various countries. Section 3 provides a discussion on the ICT initiatives undertaken in the ASEAN countries. Section 4 provides a brief discussion on the empirical method to measure the competitiveness of the countries. The empirical result is given in Section 5. In Section 6 strategies and policies to enhance the competitiveness of the ASEAN countries are examined. Section 7 provides the concluding remarks.

2. A LITERATURE REVIEW ON K-ECONOMY INITIATIVES AND ECONOMIC DEVELOPMENT

Since 1950s, many economists have argued that knowledge, technology and innovation are key drivers for sustained economic growth and productivity. Generally, the literatures on the relationship these key drivers of the economy and economic performance can be categorized into two groups, that is, studies at country level (single country or a group of countries) and studies at firm level.

2.1 Country Level Studies

At the country level, there seems to be much focus on the correlation between, technological development (especially in ICT) and economic development in the developed countries. Lau and Tokutsu (1992) investigated the contribution of ICT to economic growth in the US over the period 1960 to 1990. The empirical result showed that significant proportion of economic growth in the US was attributed to ICT investment. Kraemer and Dedrick (1993) examined the impact of ICT investment on productivity and economic growth in eleven Asia Pacific countries for the period 1983 to 1990. They found that there exists positive correlation between ICT investment and economic growth over the eight years period. This was more evident in countries that invested heavily on ICT, such as Singapore, South Korea and Japan.

Dewan and Kraemer (1998, 2000) showed that ICT investment had positive relationship with economic growth in the developed countries. Further, the contribution of ICT investment in the developed countries was found to be increasing over time (Dewan and Kraemer, 2000). However, ICT investment made in the developing countries was found to have insignificant relationship with economic growth. Pohjola (2000) found similar result as Dewan and Kraemer (2000), that is, ICT was found to play a significant role in economic growth in the developed countries. However, the impact of ICT on economic performance in developing countries was found to be statistically insignificant.

Niininen (1998) examined how investment in ICT contributes to economic growth in Finland over the period 1983 to 1996. This study found strong relationship between ICT and real GDP growth in Finland. Brynjolffson and Hitt (2000) explored the relationship between ICT and productivity growth in the US over a seven-year period (1987 to 1994). The authors found that ICT had significantly contributed to productivity growth in the US over the sample period. Schreyer (2000) analyzed the economic growth in the G7 countries and found that ICT made a positive contribution to labour productivity in all G7 countries.

Daveri (2000) updated Schreyer's (2000) work and extended it to another eleven OECD countries. He found similar results as what Schreyer found, that is, ICT contributes substantially to output growth in the 1990s for all sample countries, although the magnitudes differ across these countries.

Kraemer and Dedrick (2001) studied the growth rates in ICT investment and labour productivity for 42 countries from 1985 to 1995. They found that the annual growth rate in ICT investment per worker was highly correlated with labour productivity growth. Oulton (2001) estimated the contribution of ICT investment to GDP growth in the UK from the year 1989 to 1998. The results showed that the GDP growth in the UK was significantly attributed to ICT investment. Wiel van der (2001) analyzed the effect of ICT investment in Holland and found that labour productivity growth in Holland was strongly influenced by ICT investment.

Hernando and Nuńez (2002) measured the contribution of ICT capital to output and labour productivity growth in Spain. They showed that the usage of ICT as a capital input has made a positive contribution to output and productivity growth in the country, specifically during the second half of 1990s.

More recently, Kim (2003) examined the impact of ICT on productivity and economic growth in South Korea over the period 1971 to 2000. The results showed that ICT capital contributed significantly to the output growth, and had strong positive effect on the growth of labor productivity.

2.2 Firm Level Studies

Firm level studies have also showed positive and significant relationship between ICT investment and output growth. Brynjolffson and Hitt (1993) examined the role of ICT investment to productivity growth in 367 large US companies over the period 1987 to 1991. The authors concluded that ICT investment provided positive returns (in terms of higher labour productivity and multi-factor productivity) to US companies over the sample period. Brynjolffson and Hitt (1996) and Lehr and Lichtenberg (1999) have showed that a significant proportion of the US manufacturing firms experienced high returns from ICT investment during the 1990s.

Doms et al., (1997) and McGuckin et al., (1998) found that the US firms that had advanced technological equipment and work processes, experienced higher productivity growth. Gurbaxani et al., (1998) estimated the return of ICT investment in 3600 US firms over the period 1987 to 1994 and found strong evidence of positive returns to ICT investment.

Licht and Moch (1999) conducted a study on the productivity effect of ICT investment (i.e. computer terminals, UNIX workstations and personal computers) in Germany's service sector over the period 1975 to 1999. The authors found that personal computers had significant impact on labour productivity compared to the other two ICT equipments. Stolarick (1999a, 1999b) found positive relationship between ICT investment and productivity in the US manufacturing industry.

Becchetti et al., (2000) analyzed the impact of ICT investment on productivity and efficiency in 5,000 small and medium enterprises (SMEs) in Italy over the period 1995 to 1997. The empirical result showed that the effect of ICT investment on firm efficiency is more visible at firm level data by decomposing it into software and telecommunications investment. They also found that software investment increases demand for skilled labour and average labour productivity.

Studies in other parts of the world also found very similar results. For example refer to studies by Greenan and Mairesse (1996) for France; Bartelsman et al., (1996) for Netherlands; Motohashi (2001) and Atrostic et al., (2002) for Japan; Milana and Zeli (2001) and De Gregario (2002) for Italy and Criscuolo and Waldron (2003) for the UK.

2.3 Summary

In summary, both country level and firm level studies have highlighted innovation and new technological advancements, especially in ICT over the last three decades have played a key role in increasing productivity and competitiveness of countries and firms. In the next section, we will examine the key initiatives implemented to transform ASEAN countries to be more knowledge-driven countries.

3. KNOWLEDGE ECONOMY DEVELOPMENTS IN ASEAN

In this section, we will review the strategies and policies implemented in ASEAN to transform the countries into knowledge-driven economies. Here, we will examine the knowledge economy developments in the ASEAN founding countries (Singapore, Malaysia, the Philippines, Thailand and Indonesia), new ASEAN countries (Laos, Brunei Darussalam, Myanmar, Cambodia, and Vietnam), and in ASEAN collectively.

3.1 Knowledge economy developments in ASEAN Founding Countries

3.1.1 Singapore

Singapore is one of the most advanced ASEAN countries and has been at the forefront of knowledge economy since the last thirty years or so. This country has implemented strategic ICT policies since the late 1970s. One of the earliest efforts to modernize the country was the creation of a five-year Civil Service Computerization (CSS) program in 1981. The main focus of this plan was to computerize the government agencies for the purpose of enhancing the productivity level in the government agencies (Low, 1999).

In 1985, the National IT Plan (NITP) was implemented to strengthen the computerization of the nation. In this plan, strong integration of the government and the private sector was done via the electronic data interchange networks. During this period, the Small Enterprise Computerization Program (SECP) and Small Enterprise Computerized Accounting Program (SECAP) were introduced to help small medium enterprises (SMEs) to upgrade their business operations and efficiency.

Singapore also focused on building domestic research & development capabilities in the country. To this end, the educational system was revamped to provide more ICT related syllabus. For example, the government phased out the British education system at primary and secondary school level and incorporated a German education system – one that concentrates more on mathematical and technical competencies (Low and Toh, 1991).

In 1992, Singapore implemented the IT2000 plan, with the purpose of transforming Singapore into an 'Intelligent Island'. Specific attention were given to development of ICT-based workforce, improved personal and community communications via ICT, building of advanced infrastructures in the island, and to enhance innovation in the public and private sectors. A decade after the implementation of IT2000, ICT diffusion in the country increased significantly. For example, Singapore had more than 400,000 broadband users in 2001. In addition, 365 schools and higher learning institutions in Singapore have broadband access (CNet Asia, 2001).

In line with the changes in the global ICT landscape, the Singapore government developed a fourth strategic plan called as the Infocomm 21 (Information and Communications Technology for the 21st Century) in 1999. The primary role of the Infocomm 21 is to prepare the local ICT sector to face greater competition from global industries. In July 2000, SingTel (a government linked telecommunication company) liberalized the asynchronous digital subscriber line (ADSL). The Information-Comm

Development Authorities (IDA) introduced the Open Policy in 2002. This policy focused at further opening up the broadband services in Singapore (Ang et al., 2003).

In addition, the government also implemented the e-Government Action Plan under the provision of Infocomm 21. The main objective of this plan is to bring e-government services even closer to the citizens through a one-stop e-Citizen portal that enables related government services to be accessed conveniently via computers. The e-Citizen portal has won a number of international accolades, and is one of the main contributory factors to Singapore's e-government services being ranked number two in the world in three consecutive years (Writz and Wong, 1999).

3.1.2 Malaysia

Since mid 1980s, Malaysia has taken various initiatives to transform Malaysia into a knowledge economy. The Technology Park Malaysia (TPM) was established in 1988 with the purpose of assisting development of local technologies and commercialization of R&D findings. The primary role of the TPM is to support growth of ICT industrialization and become an interface between industry, government, research institutes and universities in Malaysia. In 1992, the Malaysian Technology Development Corporation (MTDC), a joint venture organization between government and the industry, was established. The MTDC's role is to promote commercialization of local research projects and monitors the development of venture capital funding in the country (MASTIC, 2000).

The National IT Council (NITC) was created in 1996. NITC envisioned being the main ICT policymaking body in the country. In the same year, NITC launched the National IT Agenda (NITA), which served as the main framework for the systematic development of ICT in Malaysia. Among the main initiative framed under NITA was the formation of the Multimedia Super Corridor (MSC) in 1996.

MSC leverages on ICT to provide conducive environment for the development of creativity and innovation in the country. This is done by providing conducive operating environment to local and foreign ICT-based companies with the objective of enabling faster technology transfer and quicker ICT adoption in Malaysia. Apart from being a center for technology transfer, MSC also aims to build up local content development. To this end, seven flagships were introduced under the MSC, which includes *electronic government*, *smart school system*, *multipurpose card system*, t*elehealth*, *research and development (R&D) cluster*, *e-commerce* and *technoprenuer* (NITC, 2003). At present, each flagship is at different stages of development.

Apart from the MSC, Malaysia also implemented strategic Science and Technology (S&T) policies that promote technological innovation and economic development in the country. Under the various Malaysian Plans, specific concentration was given to increase the research and development (R&D) activities by both the private and public sectors.

Funding mechanisms for R&D activities, especially in the areas of ICT has increased over the years. The Intensification of Research in Priority Areas (IRPA) fund was introduced in 1987. Initially, this fund was meant only to support public sector R&D projects. However in the later years, IRPA funding was extended to R&D projects undertaken by the private sectors. In each successive Malaysian Plans, funding allocation for IRPA was increased substantially. For example, under the 5th Malaysian Plan (1986-1990), a total of RM414 million was allocated. Under the 6th Malaysian Plan (1991-1995), a total of RM589 million was allocated for IRPA program. This subsequently increased to RM755 under the 7th Malaysian Plan and RM1 billion under the 8th Malaysian Plan (Ministry of Finance Malaysia, 2001-2005).

Further, three main R&D development grant schemes were also established in the country, namely, the Industrial Research and Development Grant Schemes (IGS), MSC Research and Development Grant Scheme (MGS) and the Demonstrator Applications Grant Scheme (DAGS). These schemes basically provide funding for ICT- based R&D projects undertaken by local companies.

Other financial support systems were introduced over the last four years to support the adoption of new technology and the discovery of new technology. These supports were targeted to SMEs. A Venture capital fund was formed to help the local companies undertake research and commercialize their research findings. For example, the ICT Fund was established in 2000 with an allocation of RM500 million. Further, the Technology Acquisition Fund (ATF) was also established (with an allocation of RM250 million) to fund purchasing of high technology equipment and machinery and the patenting process (Ministry of Finance Malaysia, 2001-2005).

3.1.3 The Philippines

Since early 1960s, the Philippines government has taken steps to embrace the knowledge economy, with particular emphasize on computerizing the country. In 1971, the National Computer Centre (NCC) was established to computerize the government (www.ncc.gov.ph). In 1994, the Philippines implemented the National Information Technology Plan (NITP2000) that serves as the country's main ICT strategic plan to catapult the country into the information age.

In February 1998, the Philippines implemented the National Information Technology Plan (IT21). This plan provides the vision and strategy to bring the country into the new economy. In 1999, the Department of Trade and Industry announced the 'ISP.COM': The Internet Strategy for the Philippines that focus on attracting foreign direct investment in ICT industry and ICT enabled services (Tipton, 2002). In 2000, the Government Information Systems Plan (GISP) was implemented in the Philippines. The GISP aims to create a system of governance that leads to faster and better delivery of public goods and services; greater transparency in government operations; increased capacities of public sector organizations; and proactive participation of citizens in governance (www.neda.gov.ph/GISP).

In terms of human capital development, the Philippines have adopted several plans that provide free computer access in schools. In 1999, Microsoft Corporation provided free PCs to high schools under the Microsoft Philippines' Connected Learning Community (CLC) program. At the moment, a total of eight schools have benefited from this program (ITU, 2002a).

In May 2000, the Personal Computers for Public Schools program were launched. Benefiting from a loan of $11.75 million from Japan, the government has donated new or second hand computers to nearly 1000 schools in the country. Here, each schools were given 20 PCs and free ICT training and support (ZDNet Asia, 2001). Further, the Foundation for Information Technology Education has encouraged telecommunication firms to donate free Internet service to 1000 schools in the Philippines (Education News, 2001).

Recognizing the potential growth of ICT and e-commerce in the country, the Philippines enacted the E-Commerce Act in 2000. This law provides the appropriate environment to encourage e-commerce growth in the country. Further, this law also mandates all government services to be done online.

In 2003, the ITECC envisioned the ePhilippines that encompasses five strategic thrusts – development of world-class ICT service providers in the Philippines, electronic government, cheap and affordable Internet services to all walks of life, development of ICT skilled workforce, and creation of relevant cyber laws (ITU, 2002a).

3.1.4 Indonesia

Development of knowledge economy in Indonesia roots from the liberalization of the telecommunication sector, that is, P.T.Telekomunikasi Indonesia (Telkom) and P.T.Indonesian Satelite Corporation (Indosat) in early 1990s. During this period, the mobile telecommunication market also grew stronger when the Mobisel (a Telekom joint venture

company) launched an analogue NMT network in Indonesia. An analogue AMPS network called as Nacional was launched in the country in 1991.

In October 1996, Excelcomindo (a private telecommunication company) launched the GSM network service in Indonesia, marking beginning of mass mobile service in the country. In July 1999, Indonesia launched 'The Blueprint of the Indonesian Government's Policy on Telecommunications'. The Blueprint provides measures to improve the telecommunication sector via liberalization and regulatory transparency. At end of 2000, there were seven mobile phone operators in Indonesia (ITU, 2002b).

In 1996, the National Steering Committee for IT Competitiveness (Nusantara-21) was created to drive Indonesia's ICT development. World Bank provided $35 million loan for the Nusantara-21 project. Specifically, this project aimed at creating a national information infrastructure, development of multimedia applications, and establishment of public access points (ITU, 2002b).

Indonesia also set up the Indonesian Telematics Coordinating Team (TKTI) in 1997, which consists of the cabinet ministers and the Vice President of the country. This team is responsible for defining government's policy in the area of telematics. In 2001, Indonesia implemented a Five Year Action Plan for the development of ICT in the country. Under this plan, ICT will play a key role in the education system of the country by way of enhancing collaboration between ICT industry and the education institutions. Further, Indonesia has laid out plans to introduce ICT education in the vocational school program as well as intensify its undergraduate and postgraduate ICT programs. A new Communication and Information Ministry was formed in 2001 and responsible of overseeing the Five Year Action Plan.

In 2001, the Utilization of Computer with Application Programs in Indonesian Language program was implemented with the objective of creating computer software in Indonesian language. This is seen as important due to lack of English literate people in the country. Since 2001, the ICT training in schools program was implemented with the purpose of training teachers and students using ICT, especially the Internet. In September 2002, Indonesia conducted a computer assisted learning media training program for 800 high school teachers from 200 schools (Yuhetty, 2002). The private sector also contributed significantly in educating the public on ICT awareness. In 2001, the Millennium Internet Road show was conducted by the Association of Indonesian Internet Service Providers in nearly 15 provinces in Indonesia.

Since 2002, strategic alliances between the Centers for Information and Communication Technology for Education (Pustekkom), the Directorate of Secondary Education and the Directorate of vocational Education has enabled the introduction of an e-learning program called as 'e-dukasi'. The specific aim of this program is to improve the quality of education in high school and vocational school by using the Internet.

3.1.5. Thailand

Similar to developments in the other ASEAN countries, development of knowledge economy in Thailand is still at infancy. In 1986, the National Electronics and Computer Technology Centre (NECTEC) were created in Thailand. The NECTEC was responsible for promoting usage of ICT as a tool for economic expansion (Tipton, 2002). Since July 2000, Thailand has been promoting the '*e-Thailand'* framework that is aimed to strengthen national competitiveness via ICT usage. In November 2000, the government endorsed the '*e-Thailand'* framework with specific focus on e-society, e-government, e-trade, e-service, e-investment, e-commerce, and information infrastructure (NITC, 2000).

In recent years, several other key initiatives have been undertaken in the national ICT development thrusts in Thailand, namely, the SchoolNet Thailand, the Government Information Network (GINet) and the Software Park project. The SchoolNet Thailand project aims to increase ICT usage in the Thai education system. Here, Internet access in Thai schools is free of charge. By early 2001, a total of 2,184 schools in Thailand had Internet access and 673 schools had their own websites (www.school.net.th).

The GINet project aims to computerize the government agencies in Thailand by providing electronic based services. In 2000, twenty-one provinces in Thailand were connected with high-speed communication lines that enabled easier provision of electronic government services. Among the key service infrastructure are e-directory, secure e-mail and certification authority (CA). At the moment, a pilot CA has been set up to issue civil identity card using digital signature technology (www.gits.net.th).

In 1999, the Software Park project commenced with the purpose of accelerating customized software production in Thailand. Various hardware and software facilities have been provided in the Software Park building that enables local software operators and incubators to collaborate with regional and global players. To induce more players in the park, the government has provided tax incentives, investment privileges and cheap office rentals (www.swpark.or.th).

To stimulate e-commerce activities in Thailand, the government created a commercial trade website (www.thaiecommerce.net) in 1999, with specific focus on B2C and B2B transactions. More recently, the Thai Dot Com website was created by the Internet Thailand Company to provide free web hosting for e-commerce services to business partners (Montreevat, 2002).

In March 2002, the Thailand government endorsed a policy framework for Thailand ICT development for the year 2001-2010 called as the *IT 2010*. *IT2010* has set the key development objectives to exploit the benefits of information and communications technology to transform Thailand to a knowledge economy.

3.2 Knowledge Economy Development in the Other ASEAN Countries

3.2 .1. Vietnam

Since adoption of the '*doi moi*' or open economic policy in early 1990s, Vietnam experienced rapid economic growth, fuelled largely by export and inflow of foreign direct investment (FDI). With the aim of becoming an industrialized country by 2020, Vietnam began to implement strategic ICT policies since early 1990s. For instance, in 1991, a policy to promote ICT development was introduced during the Communist Party's Resolution (26-NQ/TW) (Doanh, 2002). In August 1993, a five year national IT development program was implemented, followed by the creation of a Special Office of the Steering Committee that oversees the development of ICT in the country.

Apart from policy creation, the government has also concentrated in improving the ICT infrastructure, especially the telecommunication sector. Several high-tech parks such as the Hoalac High Technology Park and the Quangtrung Software Park, was developed in the country recently. These parks play an important role as technology hub for ICT based companies to undertake their activities.

Although a latecomer, Vietnam realized the importance of having ICT-savvy workforce in the country. To this end, Vietnam established seven universities that specialize in ICT courses since 1994. Apart from that, the government's vocational institutions have also started offering IT based courses to students since mid 1990s.

The low level of industrial development has not proliferated growth of innovation in Vietnam. Although the country has higher number of R&D workers compared to countries such as Thailand (Doanh, 2002), nevertheless, nearly 73 percent of the R&D workers in Vietnam are employed in the public sectors (namely in national R&D centres, ministries or government agencies. Since mid 1990s, a number of multinational corporations (MNCs) have established its operation in Vietnam. Most of these companies are involved in production of IT hardware and software. In 1999, almost 65 percent of hardware produced in Vietnam is supplied to local consumers.

Growth of Internet and electronic commerce has been phenomenal in Vietnam. By end of 1999, a total of 75,000 Internet account were recorded in the country. Vietnam Datacommunication Company (VDC) is the sole provider of Internet network in Vietnam.

3.2.2. Cambodia

Generally, development of knowledge economy in Cambodia has been rather slow. This is because only one aspect of the knowledge economy has been growing rapidly in Cambodia, which is the telecommunication sector. The number of mobile users surpasses the number of fixed phone users by nearly 80 percent – one of the highest ratios in the world.

The responsibilities of overseeing the development of telecommunication sector have been given to the Ministry of Posts and Telecommunications of Cambodia (MPTC). Over the period 1994 to 1999, a total of US$131 million has been invested in the telecommunication sector in Cambodia (US Department of State, 2000). The rest of the funding was made in the form of aid from foreign countries, especially from Japan. The Japanese government funded a total of US$40 million for Phnom Penh telecommunication network during the 1990s.

Cambodia is a newcomer to the network of Internet, which began only in 1997. Joint cooperation between the Ministry of Post and Telecommunications together and the Canadian International Development Research Centre (IDRC) has seen the creation of Camnet – a local Internet Service Provider (ISP) in May 1997 (www.panasia.org). As of June 2001, a total 8,000 Internet users was registered in Cambodia.

In 2000, Cambodian government established the National Information Communications Technology Development Authority (NiDA), which oversees the creation of ICT Master Plan for Cambodia. This plan is currently under process. Several electronic commerce activities take place in Cambodia. For example, Rehab Craft -- a website that sells handicraft goods via the Internet, and the Cambodia Daily – an English language journal that offers its articles on its website (www.cambodiadaily.com) (ITU, 2002c).

3.2.3. Laos

Similar to Cambodia, knowledge economy development in Laos has been slow. The Ministry of Communication, Transport, Post and Construction (MCTPC) govern the development of the telecommunication sector in Cambodia. MCTPC is generally responsible for frequency management, telecom and post policy, long-term development strategy and licensing and regulation of telecommunication sector. In recent years, Laos has taken the initiative to develop a Master Plan for its telecommunication sector for the period 1990 to 2000. At the moment, Cambodia is developing a new master plan for the period 2003 to 2015.

Laos has shown impressive development in increasing its telecommunication penetration, with an annual growth of 20 percent over the period 1991 to 2000 (ITU, 2002d). In 1993, Laos launched the AMPS analogue cellular network. In 1994, AMPS was replaced with GSM 900 technology, which provides network to eighteen provinces in Laos. However, the number of mobile phone users remains low in Laos – only one third of total telephone users in Laos as at end of 2001 (ITU, 2002d).

Internet penetration remains low in Laos. In 1998, Globenet (a company created by an American expatriate in Laos) established the first Internet connection in Laos. Globenet also provides broadband wireless services to 50 costumers in Laos (Uimonen, 1999). In January 1999, the Lao National Internet Committee (LaNIC) launched its commercial Internet service in the country.

3.2.4. Myanmar

Development of knowledge economy in Myanmar is still at its infancy, largely because of the limitation in ICT diffusion and access. For example, telephone density in the country is one of the lowest in the world, of about 0.6 percent of the total population of 52

million people. There are only 50,000 personal computers in the whole of Myanmar (www.unesco.org).

In order to increase the development of knowledge economy in the country, Myanmar has been developing long-term strategies and policies to re-align Myanmar's path towards embracing knowledge economy. Among the main policies implemented in the country are focused in creation of ICT sector in the economy, integrating ICT in education, and digitizing the government (e-government).

Establishment of ICT sector in the economy is seen as an important tool to enhance economic development. To this end, Myanmar has established the Myanmar ICT Park which consists of Myanmar ICT Development Corporation, a consortium of fifty local companies that forms an ICT hub in the country. Moreover, this initiative is also aimed at creating ICT clusters that stimulates ICT related businesses in Myanmar.

Myanmar has a long history of integration of ICT in the education sector. Since 1970s, Myanmar has established distance education program that used radio, cassettes, and television programs as the tool of knowledge delivery. At present, there are two universities that provide full-scale distance education using ICT in Myanmar, namely, Yangon University of Distance Education and the Mandalay University of Distance Education (www.unesco.org). In order to further strengthen ICT usage in the education sector, Myanmar has also undertaken initiatives to integrate ICT in the education sector by way of increasing the use of ICT in schools, community learning centres (CLCs), and universities.

The Ministry of Education in Myanmar established the Myanmar Naing-Ngan Education Committee that coordinates the development of ICT in the education sector (www.unesco.org). To achieve this objective, this committee has launched several programs that use ICT in schools, such as the usage of multimedia classrooms in 400 schools in the country. In addition, the government has also launched an e-education program that uses satellite communication and electronic data broadcasting system to disseminate knowledge to more than 500 e-education learning centers in Myanmar (www.unescobkk.org).

3.2.5. Brunei Darussalam

In Brunei Darussalam, the development of knowledge economy is also slow but progressing moderately. The usage of ICT has expanded from in the business sector to public administration activities. The government has been focused and committed in developing ICT in the country, and this is evident when the government of His Majesty and Yang Di Pertuan of Brunei Darussalam has allocated more than BND 500 million in the 8th National Development Plan for this sector and the establishment of the BIT Council (Brunei National Information Technology Council).

On average, one in three households in non-rural and one in nine households in remote areas are connected to the Internet. These figures provide the base or benchmark for ICT interconnectivity and coverage before the full implementation of the IT Plan. Brunei has the highest telecommunication penetration, with telephone household penetration of over 95 per cent and mobile phone penetration of 40 per cent (Rosnani, 2002).

In June 2000, Brunei government introduced the Short Term Economic Recovery Program with the objective of improving ICT literacy rate in Brunei. In this program, schools were provided with computers and linked with Brunet, the government owned Internet service provider. This program involved a cost of $6.9 million (Rosnani, 2002).

In recent years, Brunei has introduced three legislatives that governs telecommunication, namely, the Telecommunications Successors Company Order 2001, the Authority for Info Communication

3.3. Collective ASEAN Initiatives

In the last thirty years, ASEAN have undertaken various measures to embrace knowledge economy, especially by using ICT. As early as in 1970, an *ad hoc* Committee on

Science and Technology was formed to look into ways to strategically increase ICT diffusion in the ASEAN region.

In 1974, the ASEAN Protein Project was initiated to address the nutrition problem among its economically poor members using ICT. Under this project, new generation low cost full fat soy flavor food were produced in Northern Thailand, and distributed to the other ASEAN countries (ASEAN, 2003).

Upon completion of the project in 1984, technological knowledge of the food production was later transferred to new members of the ASEAN, namely, Cambodia, Laos, Myanmar and Vietnam.

The Permanent Committee on Science and Technology (COST) was established in 1978 (Konstadakopulos, 2002). This committee was in charge of promoting technological development in the ASEAN region, and gave importance to development in R&D activities and increasing the number of skilled workers.

The ASEAN Science & Technology Fund was established in 1989 to provide seed funding for S&T based projects undertaken in the ASEAN region. More specifically, this fund supports two types of S&T projects, that is, policy development studies and information dissemination activities. For example, the ASEAN Journal on Science and Technology for Development (AJSTD) received substantial amount of funding under the first category.

To enhance competitiveness of the agriculture sector, utilization of ICT was promoted in the agriculture sector. To this end, the Quality Assurance System for ASEAN fruits (QASAF) project was implemented in 1996, with the help from Australian counterparts. This project provides a basis for ensuring high quality of fruits using ICT.

In recent years, ASEAN concentrated in undertaking regional cooperation in ICT, with specific focus on increasing the rate of technology transfer within ASEAN, commercialization and involvement of the private sector in ICT by forming the e-ASEAN group. Subsequently, in November 2000, the e-ASEAN Framework Agreement was established with the purpose of enhancing competitiveness in the ICT sector and closing the digital gap between member countries. In addition, the e-ASEAN Framework Agreement also seeks to develop the ASEAN Information Infrastructure that will promote the growth of electronic commerce in the ASEAN region (ASEAN, 2003).

In 2001, the Reference Framework for Electronic Commerce Legal Infrastructure was formed to cater the need for general principles, scope and legal effects concerning to electronic commerce transactions in ASEAN.

In essence, the Framework will also help in drafting electronic commerce laws in the member countries.

The ASEAN Committee on Science and Technology was established in late 2001 and was responsible for enhancing cooperation in space technology and its applications in the ASEAN region (United Nations, 2004). Further, the committee is also responsible to propose ways to involve government, industries and academia in joint space technology. Among the most significant proposal is a space technology transfer initiative among the ASEAN countries.

There have also been various initiatives to support technological development among the SMEs. For example, the increasing demand for electricity energy in the ASEAN region has increased the need for an alternative energy source. Thus, the Cogeneration of Heat and Energy (COGEN) project was initiated in ASEAN with the help of European Union (EU). The COGEN project provides an alternative eco-friendly energy source to the industries in the ASEAN region, especially the SMEs in the wood and agro-industrial sectors. Further, the EU has been matchmaking ASEAN companies that are involved in COGEN with European counterparts for production of advanced COGEN technology solutions (ASEAN, 2003).

4. MODELING COMPETITIVENESS IN THE KNOWLEDGE ECONOMY

In the previous section, we discussed some of the major k-economy initiatives undertaken in the selected ASEAN countries since 1980s. In this section, we will analyze the competitiveness of the five ASEAN countries in terms of knowledge economy developments

vis-à-vis the other developed and developing countries. The comparison was based on a new multivariate econometric method developed in Nair and Kuppusamy (2003).

The method measures the competitiveness of the ASEAN economies and twenty other countries based on two broad categories of factors called the REACH and RICH factors over the period 1995-2003.[1] The REACH factors capture the level of connectivity in the new economy (measured by the ICT infrastructure and infostructure).

The RICH factors capture the quality of intellectual capital/human capital, innovation, institutions, interactions, integrity (voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption) and incentives.[2]

Nair and Kuppusamy (2003) argued that countries undergo three distinct stages of development, which they call as the *Imitation*, *Integration* and *Innovation* stages. Within these stages of development (as shown in Figure 1 in Appendix I), they identify five homogenous groupings of countries that they call as *bands*. The band classification and stages of development are given as follows[3]:

Innovation Stage:	Band 1 (Pace-Setter) Band 2 (Adepter)
Integration Stage:	Band 3 (Adapter) Band 4 (Adopter)
Imitation Stage:	Band 5 (Starter)

Nair and Kuppusamy (2003) showed that countries undergo two types of leapfrogging - *inter-band leapfrogging* (refer to Figure 2 in Appendix I) and *intra-band leapfrogging* (refer to Figure 3 in Appendix I). Inter-band leapfrogging occurs when a country bypasses one or more stages of socio-economic development (bands). Intra-band leapfrogging occurs when a country bypasses one or more countries in the same band.

The band configurations for the REACH & RICH factors, and productivity indicators (labour productivity, industry productivity, service productivity and overall productivity) for the 25 countries were estimated using an empirical method developed in Nair and Kuppusamy (2003). The flowchart for the empirical method is shown in Appendix II. The definition and sources of the data used in this study are given in Appendix III.

In the next section, we will examine the impact of the k-economy initiatives undertaken in the ASEAN countries (as discussed in Section 2) based on the REACH-RICH factors and the productivity indicators over the period 1995 to 2003.

5. PERFORMANCE OF ASEAN-5 IN THE KNOWLEDGE ECONOMY

Due to the limitation in the data for the new ASEAN countries (Myanmar, Laos, Cambodia, Vietnam and Brunei), the empirical analysis was only conducted for the five founding members of ASEAN – Indonesia, Malaysia, the Philippines, Singapore and Thailand (henceforth referred to as ASEAN-5). The competitiveness of the ASEAN-5

[1] Though the ICT initiatives in the selected ASEAN countries began in the 1980s, however, data on the various ICT indicators was available from 1995 onwards.

[2] Data for the REACH and RICH factors were available from 1995-2003. However, data for the integrity factor were only available for the following periods: 1996, 1998, 2000, and 2002. The data for integrity is from Kaufman, Kraay and Mastruzzi (2003), while the data for the remaining REACH and RICH factors are from IMD World Competitiveness (1996-2004), WITSA 2002 and the United Nations Statistics Database.

[3] Note that countries in Band 1 have the highest intensity of development in REACH factor, RICH factor and productivity. On the other hand, countries in Band 5 have the lowest REACH factor, RICH factor and productivity.

countries was compared with other developed and developing countries. The tables for the empirical results are given in Appendix IV.

5.1 ICT infrastructure

The band configuration based for the ICT infrastructure is provided in Table 1. Singapore was clustered in the higher bands over the years. In 1995, Singapore was in Band 3. Singapore moved up to Band 2 in 1997 and remained in this band until 2001. In 2003, Singapore moved down to Band 3.

Malaysia was in Band 5 in 1995 (the leader of this band). In 1997, Malaysia was in the last position of Band 4. By 1999, Malaysia was again clustered in Band 5 and remained in this band until 2001. By 2003, Malaysia was clustered in Band 4. Meanwhile, Thailand, the Philippines and Indonesia are in Band 5 in all the five selected years. These countries had lower ICT infrastructure development than Malaysia in all the years.

In short, with exception for Singapore, all the other selected ASEAN countries (Malaysia, Thailand, the Philippines and Indonesia) have low ICT infrastructure development over the years in spite of the various ICT plans and initiatives undertaken since the middle of 1980s. We also note that there exists wide disparity between the ASEAN and the developed countries. We also observe wide disparities within the ASEAN countries (especially between Singapore and the other ASEAN member countries). For instance, while Singapore had an average of 36 Internet users per 1000 people in 1995, the other ASEAN countries had only 2 Internet users per 1000 people in the same year. By 2003, Singapore had an average of 416 Internet users per 1000 people, while the other ASEAN countries had only an average of 54 users per 1000 people.

5.2 Intellectual/human capital

Table 2 shows the band configuration for the intellectual/human capital development factors. The empirical result showed similar pattern with earlier findings – Singapore is ahead of the other ASEAN countries. Singapore was in Band 4 in 1995. In 1997, Singapore moved up to Band 3. Nevertheless, Singapore fell back to Band 4 in 1999, before moving up again to Band 3 in 2001, and remaining in this band in 2003.

Malaysia was in second position of Band 5 in 1995. In 1997, Malaysia moved up to Band 4 and remained in this band in the next four periods. Thailand was in Band 5 in 1995 and moved up to Band 4 in 1997. However in 1999, Thailand moved down to Band 5 and remained in this band until 2003. The Philippines and Indonesia were consistently in Band 5 over the selected five years. Note that Indonesia was in second last position in 1995 (higher than China) and was placed in the last position of Band 5 in the next four consecutive periods. The result showed that human capital development in Thailand, the Philippines and Indonesia is still low compared to that in Singapore and Malaysia.

5.3 Innovation

Table 3 shows the band configuration for the Innovation factors. We observe that Singapore was in Band 3 in 1995. In 1997 Singapore moved up to Band 2 and remained in this band until 1999. In 2001 Singapore moved down to Band 3 and remained in this band in 2003.

Malaysia was in the fourth position of Band 5 in 1995. In 1997, Malaysia was clustered in Band 4, behind South Africa and ahead of Chile. In the next three periods, Malaysia was again clustered in Band 5. Thailand, the Philippines and Indonesia were consistently in Band 5 over the five selected years. The Philippines and Thailand were in sixth and ninth position (in Band 5), respectively in 1995. Both the Philippines and Thailand moved up to third and sixth position of Band 5 in 1997, respectively.

In 1999, Thailand moved down to the seventh position, while the Philippines also slipped to ninth position in this year. In 2001, Thailand slipped further to eighth position, while the Philippines remained in ninth position. By 2003, Thailand moved up to sixth position of Band 5, while the Philippines was clustered in eight position of Band 5. Indonesia on the other hand was in the last position of Band 5 in all the five selected years.

In short, Singapore seems to be the most innovative ASEAN country over the period from 1995 to 2003. Note that the average figure shows that the innovation gap between Singapore and the other ASEAN countries have been widening over the years. However, Singapore's innovative capacity is significantly lower than that of countries in Band 1.

5.4 Interaction/Strategic cooperation

In this category, we have used two factors that measure the level of research and technological cooperation between universities, industry and the government. Table 4 shows the band classification based on the interaction factors.

We observe that some of the ASEAN countries have strong research and technological cooperation. In 1995, Singapore was in Band 1. By 1997, Singapore was clustered in Band 2 and remained in this band from 1999 to 2003.

Malaysia was in Band 4 in 1995. In 1997, Malaysia moved up to Band 3. By 1999, Malaysia fell to Band 4. Note that Malaysia was in first position of Band 4 in 1999 and moved down to the last position of Band 4 in 2001. In 2003, Malaysia moved back to Band 3.

Thailand was in Band 3 in 1995 and 1997. By 1999, Thailand fell to Band 5 and remained in this band until 2003. The Philippines was in Band 5 in the first two years - 1995 and 1997. By 1999, the Philippines moved up to Band 4 and remained in this band until 2001. In 2003, the Philippines were in Band 3. Indonesia was in last position of Band 5 in all the five selected years.

5.5 Integrity Systems

Table 5 gives the band configurations based on the Integrity factors. Among the five ASEAN countries, Singapore performs very well in the five sample periods - Singapore is placed in Band 1.

Malaysia was placed in Band 3 in 1996, 1998 and 2000. In 2002, Malaysia moved up to Band 2. The improvement in the overall integrity indicators may be attributed to the quick action taken by the Malaysian government to stabilize the economy from the onslaught of the 1997 Asian Financial Crisis.

Thailand and the Philippines were both in Band 4 in 1996, but moved to Band 3 in 1998, and remained in this band till 2002.

Among the ASEAN countries, Indonesia performs poorly in the integrity factors – Indonesia was in Band 5 in all the four periods. By 1998, Indonesia was the only country in Band 5.

The empirical analysis also showed a concerning trend in that the 'integrity-gap' between the upper band countries (Band 1 and Band 2) and Malaysia, Thailand, the Philippines and Indonesia has widened over the sample periods.

5.6 Productivity

Four types of productivity indicators were used in this study – labour productivity, industry productivity, service productivity and overall productivity. Table 5 provides the band configuration for the four productivity indicators.

Singapore was in Band 3 in 1995, before moving up to Band 2 in 1997. In 1999, Singapore fell to Band 3 again and remained in this band until 2003. Malaysia was in Band 4

in 1995 and moved up to Band 3 in 1997. By 1999, Malaysia was again clustered in Band 4 and remained in this band until 2003.

Thailand was clustered together with Malaysia in Band 4 in 1995 and with Brazil in 1997. By 1999 however, Thailand fell to Band 5 (leader of Band 5) and remained in this band in 2001. In 2003, Thailand moved up to Band 4. Indonesia and the Philippines were in Band 5 in all the selected years.

In summary, we observe that Singapore's productivity level has been very high compared to the other ASEAN countries. For example, the overall productivity in Singapore was nearly $42,000 per worker in 1995. However, Malaysia and Thailand's overall productivity was averagely at $11,000 in the same year, while Indonesia and the Philippines's overall productivity level were averaged at $3,500.

Similarly in 2003, Singapore's overall productivity was $44,000 while the other ASEAN countries had average productivity level, ranging from $9,000 to $22,000 per worker. We observe similar growth pattern for the other productivity measures. Note that during this period, Singapore's productivity levels were closer to that in developed countries (that is countries in Band 1).

5.7 Summary

From the above empirical analysis, despite the knowledge economy initiatives undertaken since 1980s, the ASEAN countries (except for Singapore) have consistently been placed in lower bands for the REACH-RICH factors and for the productivity indicators.

Singapore is the only ASEAN country that have successfully sustained in the higher bands (that is, between Band 1 to Band 3) for some of the factors. The empirical result also showed that the existing digital divide and knowledge gap between the developed economies and the ASEAN countries (except for Singapore) has increased over the years. The barriers that have hindered the socio-economic development of the ASEAN economies in the knowledge economy are as follows:

- Weak ICT infrastructure and infostructure due to limited government budget and lack of competition in the ICT sector.
- Private sector involvement in infrastructure development is limited due to outdate legislations.
- Institutions to support the development of the information and knowledge economy are non-existent or weak.
- Level of intellectual/human capital development is very low – absorbability very low.
- Serious 'brain-drain' problem – number of skilled workers low.
- Low level of education and skilled workers has led to very small advanced buyers and suppliers in these countries. This has hindered the development of new generation products in these countries.
- Level of research and development (R&D) very low.
- Lack of intellectual property rights protection.
- The internal and external Institutions of Corporate Governance weak and lack independence.
- Micro-level interaction (strategic cooperation) is weak and fragmented. [4]
- Macro-level interaction (regional cooperation) in ICT development is weak. [5]

The empirical analysis also showed that countries that have leapfrogged over the sample period are countries that have invested heavily in their infrastructure and infostructure, intellectual/human capital development, innovation (R&D), and strategic partnerships &

[4] Micro-level interaction is defined as strategic cooperation between government, universities and industries within countries.

[5] Macro-level interaction is defined as regional cooperation between governments, multinational companies, and research centers/universities across countries.

linkages (interaction). These include Finland, Switzerland, Sweden, South Korea and Singapore. Interestingly, the empirical evidence also suggests that the Latin American countries (Brazil, Chile and Mexico) have increased their competitiveness over the past decade and are serious competitors for the ASEAN countries. Table 7 provides the summary of band movements of the ASEAN-5 over the sample periods.

6. STRATEGIES TO ENHANCE ASEAN'S KNOWLEDGE COMPETITIVENESS

Based on the above empirical analysis, it is clear that the knowledge economy development and competitiveness among the ASEAN-5 countries varies. Singapore is leading the other ASEAN countries in terms of development in the k-economy, followed by a distant second by Malaysia. Thailand and the Philippines are in third and fourth place, respectively. Indonesia seems to be the least developed among the five ASEAN economies. The concerning trend is that the digital- and knowledge-gap between the other developed countries (countries in the upper bands – Band 1 and Band 2) and the ASEAN economies have been widening over the sample period.

In the last two decades empirical evidence suggests that innovation, especially in the areas of ICT have been a key driver in increasing productivity, and enhancing economic growth. However, the major beneficiaries of these developments have been the developed countries. The developing countries face several obstacles (mentioned earlier) in benefiting from the ICT revolution. The challenge for the ASEAN economies is to use ICT effectively to not only enhance their competitive position in the new economy.

In this section, we examine seven key strategies for increasing ASEAN's competitive position in the knowledge economy. These strategies are focused at strengthening the Institution, Infrastructure, Intellectual capital, Innovation, Integrity systems, Interaction, and Incentives (7I's) that are relevant for facilitating greater convergence in terms of socio-economic development and competitiveness in the ASEAN region.

6.1 Strengthening the Institutions

Key to the successful development of an economy is the focused and systematic management of the resources in the country. In many of the countries in the upper bands, innovation and technological developments are managed under a systematic framework called the National Innovation System (NIS). The NIS is "a collection of institutions that affect the creation, development, commercialization, and adoption of innovation in the economy" (Nelson, 1993). Key function of the NIS is to strengthen and continuously upgrade the 7-I's [Infrastructure, Institutions, Intellectual Capital, Innovation (R&D activities), Integrity, Interaction (strategic partnerships), and Incentives].

Within ASEAN, only Singapore and Malaysia have formed a separate council/ministry to strategically manage the country's innovation. It is proposed that the remaining ASEAN countries develop a similar framework to manage their innovation effectively. The National Innovation Councils/Ministries should also consider the active involvement of the following key institutions in the country, which are vital for facilitating the transition towards a knowledge-based society:

- An efficient Information Measurement and Tracking Systems Bureau (Statistics Department – modeled after Australian Bureau of Statistics or Statistics Canada).

- A Central Patent Office to facilitate easy registration and commercialization of patents.

- An Intellectual Property Bank (IP Bank) -- a registry to keep track of all the R&D projects currently undertaken (funded by public government and jointly funded by the private sector) by universities, research centers, research laboratories and industries in ASEAN. This body will also keep track of all the researchers in the different fields.

- A legal and regulatory body to facilitate science, technology and innovation developments (legislation pertaining to intellectual property, security, privacy, and consumer protection).

- A national and regional Standards Board to evaluate and ensure the standards and quality of the 7-I's in the region meets global standards.

- A regional Integrity Board that educates and ensures that 'best practices' are adhered to by all stakeholders in the formation of a competitive regional knowledge economy.

6.2 Infrastructure and Infostructure Development

The ICT Infrastructure in the ASEAN countries (except Singapore) is underdeveloped due two major barriers. First, government budgets are rather limited compared to that in the developed countries. The 1997 Asian financial crisis further exacerbated the financial constraints of the ASEAN economies to develop the ICT infrastructure.

Second, the ICT sector in the ASEAN region has very little competition compared to the markets in the developed countries. In many of the ASEAN economies these sectors are controlled by monopolies. Thus, the cost of ICT services in the ASEAN countries is much higher than in the developed countries. There is also a vast difference in the quality of the service provided in the ASEAN region compared to that in the developed countries.

In countries such as Thailand, the Philippines and Indonesia, access to the basic infrastructure such as electricity and personal computers are limited. Thus, accessing the Internet would be limited. In addition, due to small advanced buyers and suppliers in the ASEAN countries, the cost of ICT infrastructure and service are higher than in the advanced markets. Successful adoption to the knowledge economy will depend on the accessibility to affordable ICT infrastructure and associated services.

Not to be left behind in the knowledge economy, ASEAN member countries should intensify the development of ICT infrastructure and the various supporting sectors (e.g. electricity). Broadband capacity in the ASEAN region needs to be rolled out at a faster pace. Opening the ICT sector to greater competition may serve this purpose. For example, intense competition in the broadband market in South Korea was a key factor for lowering the cost of broadband access significantly -- the cost of broadband is one of the lowest in the world (Chotrani, 2002). To date, South Korea has one of the highest broadband penetration rates in the world.

In many parts of the ASEAN region, income levels are low for people to have access to personal computers (PC) and the Internet service. This can be overcome in several ways. First, governments in the region (especially in Malaysia, Indonesia, Thailand and Philippines) should develop a PC-Bank, where old PCs are recycled and sold at a much affordable rate. The recycled PCs should be given rural community centers for free-of charge. Second, all schools should be equipped with PCs and be linked to the Internet. Third, various soft loan schemes should be provided to assist people with low income to purchase PCs for their homes.

Another key factor in reducing the digital divide in the ASEAN region is for governments in the region to intensify their electronic delivery systems (EDS). Once the government EDS is in place, governments can then actively assist the SMEs to use the digital medium to enhance their efficiency and market reach.

6.3 Intellectual Capital Development

Over the last two decades, there have been significant attention given to education and training in the ASEAN region. However, the quantum and quality of education and training seem to lag behind the more developed countries.

Much of the innovation in ICT (hardware and software) have been from the developed countries where English has been the main medium of communication and education. Many of the discoveries in the ICT area have been published in leading academic and research journals where the medium of communication is in English. Further, significant proportion of content development and patents granted for the digital economy has been in English. ASEAN countries that have maintained English as the main language of education has had little difficulty in accessing innovation and discoveries published in leading journals in the field. However, countries that have their main language of education other than in English are finding it hard to keep abreast with developments in the science and technology areas (especially in ICT). To overcome this problem, many non-English speaking developed countries, and some countries within ASEAN (e.g. Malaysia) have reverted back to teaching science and technology subjects in English. ASEAN countries in the lower bands should consider introducing English as the main medium of education in the ICT, science and technology related areas.

In the developed countries, the proportion of students attending universities and colleges are much higher than that in the ASEAN and the other developing countries. In many countries in Band 1 and Band 2, besides significant investment in raising the quality of teaching and higher degree research (HDR) training, various financial incentives are in place to attract good students to undertake HDR programs, especially in the science and technology related areas.

In the ASEAN countries, shortage of qualified teachers/professors and lack of incentives for students have resulted in lower enrolments in tertiary institutions than in the developed countries. Further the number of universities in the ASEAN countries is small compared to countries in Band 1 and Band 2. For example, Sweden has a total of fifty higher educational institutions for a population of 9 million people (Lindskog, et al., 1998). To raise the competitiveness of the ASEAN economies, the quantum and quality of education in the ASEAN countries should converge to that in the more developed countries.

Successful adoption to the knowledge economy will depend on the absorbability of the people in the country in using the new technology. Here, the level of education and training play a key role in enhancing people's ability to use new technologies. Hence, ICT education should be incorporated at all levels of the education system (primary to tertiary level). Further, 'Industry-Government Consultative Group' should play a key role in the development of curriculum in high schools, polytechnics and universities. This is to ensure the curriculum taught is relevant, spark creativity and builds a pool of 'knowledgepreneurs'. Knowledgepreneurs are defined as "knowledge workers who are in the business of the exchange of their knowledge, an intangible product or the processes and products of their knowledge for cash or kind" (Abdulai, 2004).

Various fiscal and non-fiscal incentives should be put in place to encourage firms to invest in human capital development. In some of the developed countries, and in selected ASEAN economies (Singapore and Malaysia), there are various fiscal and non-fiscal incentives in place for the private sector to invest in human capital development.

In the new economy, mobility of skilled workers is very high and competition for them is intensive. Thus, retaining highly skilled workers is a serious challenge for many countries in the ASEAN region. Competition for highly skilled workers is a *'zero-sum' game*. Besides increasing supply of skilled workforce, there is a need to review carefully the 'brain-drain' problem and identify the key drivers behind this problem. Many studies have shown that poor remuneration, weak support systems, poor opportunities for professional development and rigidities in immigration regulations are some of the factors that fuel the 'brain-drain' problem. The following initiatives should be considered to reverse the 'brain-drain' problem in the ASEAN countries:

- Government, working in partnership with the private sector, should ensure that remuneration and benefits are globally competitive in areas that are strategic to ASEAN long-term growth and competitiveness.

- Ensure that facilities for R&D and professional development are competitive in priority areas of development.

- More liberal immigration policies (granting of permanent resident status) that will entice highly skilled workers to make ASEAN their home.

6.4 Enhancing the Innovative Capability

Innovation is an important driver for economic growth and competitiveness. In many of the upper band countries (Band 1 and Band 2), the quantum and quality of R&D is high compared to countries in the ASEAN region. Besides increasing the quantum for R&D projects, there is also significant investment in enhancing the R&D capabilities of the workforce in these countries – support for research training in universities, government and private sector are also high. With increased funding and support for R&D activities, countries in the upper bands are able to attract the best researchers and knowledge workers from around the globe.

To leapfrog to a higher stage of socio-economic development ASEAN economies should increase the both government and private sector R&D funding – comparable to that in the developed countries, i.e. 1-2 percent of the GDP. Further, the ASEAN countries should enhance the infrastructure and support systems for R&D activities – create a conducive environment for innovation to thrive. Other initiatives to enhance the R&D capacity in the ASEAN region include:

- Public sector in the ASEAN countries should take the lead in undertaking basic R&D activities. In addition, the public sector should improve opportunities to facilitate commercial spillovers from basic R&D to the private sector.

- Facilitate mobility of R&D personnel across the public and private sector, especially among SMEs.

- Strengthen technology transfer between government, industry and universities. This cooperation should be fostered across the ASEAN region.

- Simplify processes for patenting and commercialization of R&D. Universities and research centers should be encouraged to establish their own licensing offices to assist the registering patent applications and license negotiations.

- Set up an ASEAN Intellectual Property Bank, that will act as a registry and main source of information on the various R&D initiatives and research personnel in the region.

- Promote more local content development in local languages within the ASEAN region.

- Educate citizens and the private sector on Intellectual Property Rights (IPR). Further, enforcement of IPR should be intensified in the ASEAN region.

6.5 Strengthening the Integrity Systems

In many of the developing countries, is spite of the rapid capital investment “the public service is widely perceived to be unsatisfactory and deteriorating” (Shadrach and Ekeanyanwu, 2003). The poor service in the public sector is attributed to two major factors.

First, the access to these services by general public is weak due to poor quality of infrastructure and service. Second, there is no effective mechanism for the public to provide appropriate feedback. The latter has contributed to the lack of transparency, accountability and quality of services rendered to the public.

The weak governance systems within the public service tend to weaken the foundations of the internal and external institutions of corporate governance (ICG) within the private sector.[7] Thus, leading to potentially three types of market failures: *grabbing hands*, *tunneling* and *moral hazard*.[8]

As discussed in the previous section, developments in ICT over the last two decades have increased the level of productivity and market reach. ICT can play vital roles in achieving the following:

- Transparent and efficient functioning of the government and the private sector.

- Improve the flow of information and interaction (access to information and feedback mechanisms) between citizens, the government and the private sector.

- Strengthen the internal and external ICGs.

- Empower citizens to play an important role in public policy formulation and its implementation, irrespective of socio-economic status.

From the above discussions, ICT can be used to enhance the governance and transparency levels in countries. Evidence from Band 1 and Band 2 countries suggests that ICT has played an important role in increasing greater transparency and governance levels in these countries. Thus, raising the productivity levels and the quality of life for citizens. Many industry analysts and economist argue that governance and transparency will be important in determining the competitiveness and ratings of the corporations and countries in the region -- as Tapscott and Ticoll (2003) aptly describes, "transparency is a new form of power, which pays off when harnessed". To harness this force, ASEAN countries should consider the following initiatives:

- Speed the rate of e-government in the region and benchmark e-government implementations to global standards so that these technologies can meet the goals of e-government. These include strengthening accountability, ethics and security features pertaining to the electronic delivery systems – data management & data dissemination, and security features.

- Assist and educate the SMEs and citizens in the region on how to effectively use the digital medium to enhance governance and competitiveness.

- Foster strong and independent internal and external ICGs to stem out the above-mentioned market failures at all levels, including *E-corruption*.[9]

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[7] The internal ICG include the following: ownership structure, 'relational' board of directors, 'independent board of directors, and compensation plans. External ICG include: business groups, banks, information intermediaries, financial intermediaries, and regulators of the intermediaries (private and public). For more details on the functions of the ICGs, refer to Dyck (2000).

[8] 'Public grabbing hands' includes official in public service who ask for bribes in return for service. 'Private grabbing' hands is when insider of a privatized firm divert resources at the cost of stakeholders. 'Tunneling' is when managers and/or funds managers of a firm devise various mechanisms to transfer the investors' assets to themselves. 'Moral hazard' occurs when senior management is not held accountable for their decisions – they benefit irrespective of the performance of the enterprise. Thus, there is a tendency for them to take high-risk decisions.

[9] E-corruption is defined as an activity that is carried out by an economic agent for personal gain using the digital/electronic medium. Factors that contribute to e-corruption include: poor planning of technology,

- Provide the necessary infrastructure, training, support systems and incentives to empower citizens in the region to have access to and be functionally literate in digital medium – "e-citizenry".

6.6 Foster stronger Interaction and Regional Cooperation

Empirical evidence from the developed countries suggests that stronger interactions between the different economic agents have positive impact on economic growth and productivity. There are two levels of interactions that take place between innovating organizations, which will be discussed below.

6.6.1 Government, Industry and University Interaction

Strong government, industry and university (GIU) cooperation has several positive spillovers to the economy. First, it reduces the private sector and government burden on undertaking expensive and long-term R&D projects. Second, strong GIU will increase the probability of success of R&D initiatives. Third, cooperation between the different stakeholders also reduces the discovery time. Fourth, strong tripartite relationship between GIU would increase the flow of information between the three economic agents. This will facilitate quick feedback to the research community on the relevance of the R&D initiatives. Fifth, partnership between GIU will also increase the rate of commercialization of R&D activities and intellectual property (IP).

Strong GIU linkage also has significant impact on education, industrial training and higher degree research training. Education and training can be fine-tuned for the needs of the industry and the civil service. Strong GIU partnership can also help SMEs in accessing the pool of highly educated and skilled personnel from government and universities. Further, universities and government research laboratories can play a key role in assisting SME in building their research capabilities. Strong involvement in education and training by the private sector will also reduce government burden in upgrading the human capital in the country.

Linkages need not only be between GIU, this cooperation can extend to complementing firms from different industry sectors. These alliances can result in shared technology and access to complementary factors of productions, which are vital for the successful emergence of new areas of R&D and sources of growth.

From the above discussion, strong GIU/linkage has a "win-win-win" proposition for the government, industry and universities.[10] Thus, ASEAN governments should encourage close GIU collaboration in their countries and within the region. Further, governments in the ASEAN region should also encourage the development of 'bridging' organizations that will play an important role as an interface for GIU collaboration.[11]

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infrastructure and manpower support; and outsourcing of key functions such data management (especially of confidential/classified information), authentication and encryption functions to unqualified or unreliable agents.

[10] In the US, there are a number of programs that have successfully fostered close cooperation between government, industry and universities. This includes the following programs: *Manufacturing Extension Program* (MEP*), Small Business Innovation Research* (SBIR) Program, and *Small Business Technology Transfer* (STTR) Program, *Experimental Program to Stimulate Competitive Research* (EPSCoR), and the *State Industry University Cooperative Research Centers* (SIUCRC). These programs have proved successful in increasing R&D among small medium enterprises (SME) in the US. Similar programs exist in other Band 1 and Band 2 countries.

[11] Organizations such as TEKES in Finland, and closer to ASEAN – the Multimedia Development Cooperation, and MIMOS in Malaysia, are key organizations that play important roles as interface between GIU.

6.6.2 Regional Cooperation

Strong collaboration between countries and regional cooperation (especially among countries in Band 1 and Band 2) has resulted in several positive benefits. For example, collaboration among governments and firms across national borders can result in better allocation of resources across the region. Countries with high labour cost are able to access cheaper labour from other countries with larger labour force. Similarly, countries that do not have technological related expertise are able to get more savvy technology from the more developed ASEAN countries through stronger regional cooperation.

Regional cooperation also increases market reach – which is vital for countries with very small market, and allows firms in the region to be part of the global network. With increased internationalization and globalization of technology, standards and benchmarks there will be greater convergence in economic development between countries in the ASEAN region. Stronger regional cooperation in Europe over the last two decades has managed to reduce the digital gap, and increased socio-economic developments in countries within the European Union (EU).

In the context of the ASEAN countries, greater regional cooperation among member countries should be pursued, especially in the development of ICT infrastructure, human capital and R&D activities. The "regional cooperation can convert the multidimensional challenges of the digital divide into a digital dividend" (United Nations, 2004).

6.7 Incentives

Successful growth of countries will depend on the various incentives that enhance the level of the ICT infrastructure, Intellectual Capital, Innovation, Institutions, Integrity, and Interaction. Incentives are naturally inherent in each of the 6-I's. However, there are also several broad incentives that facilitate faster developments in the knowledge economy.

First, there should be a move towards harmonization tax regimes, fiscal and non-fiscal incentives in the region. This is to enhance innovation, encourage entrepreneurship, skilled labour mobility and encourage smoother flow of investment across the region.

Second, ASEAN countries also need to harmonize the regulatory environment and reduce institutional barriers across the region. Complex regulations and institutional procedures hinder innovation and entrepreneurship advancement. Inconsistencies in the regulatory framework within ASEAN has lead to uneven levels of growth and competitiveness, jeopardizing sustained economic growth across the region

Third, in many of the developed countries, there is a push towards the establishment of regional clusters.[12] ASEAN countries should consider the formation of economic clusters that are strategic to the region. Examples of clusters that are strategic to the ASEAN region include in the areas of biotechnology, agriculture, biomedical and bioinformatics. The incentives to form these regional clusters include the following:

- Better use of scarce resource across the region, thus increase overall productivity of the countries in the ASEAN region.

- Ability to attract FDI and enhance mobility of skilled workforce, thus raise the innovative capacity across the region.

- Increase the pace of globalization of indigenous technology, thus expanding market REACH.

[12] Clusters are defined as a system of interconnected firms and institutions whose value as a whole is greater than the sum of its parts (Porter, 1998).

- Creation of new generation products and services due to 'fusion' and 'fission' of the different complementing sectors, thus stimulate new business formation and innovative capacity of the region.

- Instead of competing with each other, cluster provides a platform for countries to complement one another in enhancing competitiveness and economic growth.

7. CONCLUSION

The paper examines the knowledge competitiveness of selected ASEAN countries (Indonesia, Malaysia, Philippines, Singapore and Thailand) vis-à-vis other developed countries and developing countries. The sample countries were benchmarked based on the following criterions: REACH factors, RICH factors and productivity.

The empirical studies showed that with exception for Singapore, the remaining ASEAN countries (Malaysia, Thailand, the Philippines, and Indonesia) are relegated to lower bands – countries with the low REACH and RICH factors. Correspondingly, the productivity levels (i.e. labour productivity, service productivity, industrial productivity and overall productivity) in these four countries are also low. The study also showed that the knowledge-gap between the developed countries and the selected ASEAN countries (Malaysia, Thailand, Philippines, and Indonesia) have widened from 1995-2003.

Strategies to reduce the knowledge gap within the ASEAN countries and between ASEAN and the developed countries were discussed in this paper. Key to increasing the knowledge competitiveness of countries in the ASEAN region is the effective management of infrastructure, intellectual capital, innovation, interaction, institutions, incentives, and integrity (the 7I's) in these countries. Increasing the quantum and quality of the 7I's is vital in transforming the ASEAN countries into knowledge-driven economies and help facilitate these economies to leapfrog to higher stage of socio-economic developments.

ACKNOWLEDGEMENTS

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Appendix I: Stages of Development in the Knowledge Economy

Figure 1: Linear Stages of Economic Development

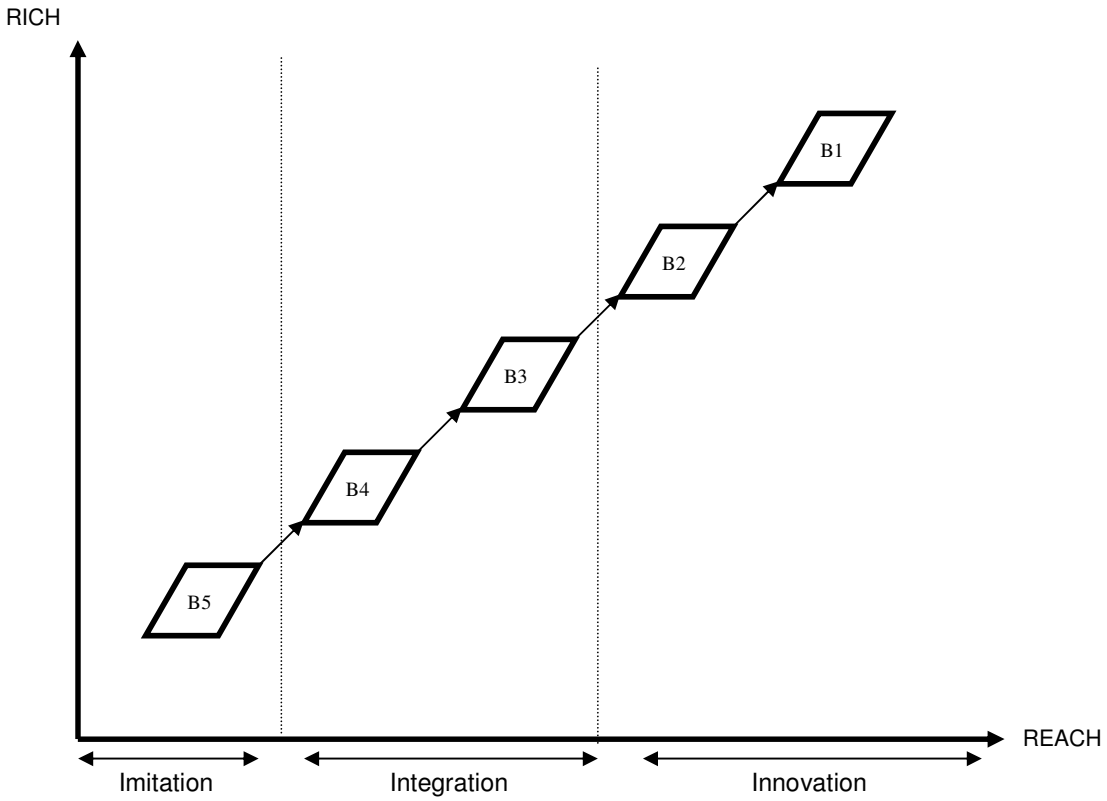


Figure 2: Inter-Band Leapfrogging (Non-Linear Economic Development)

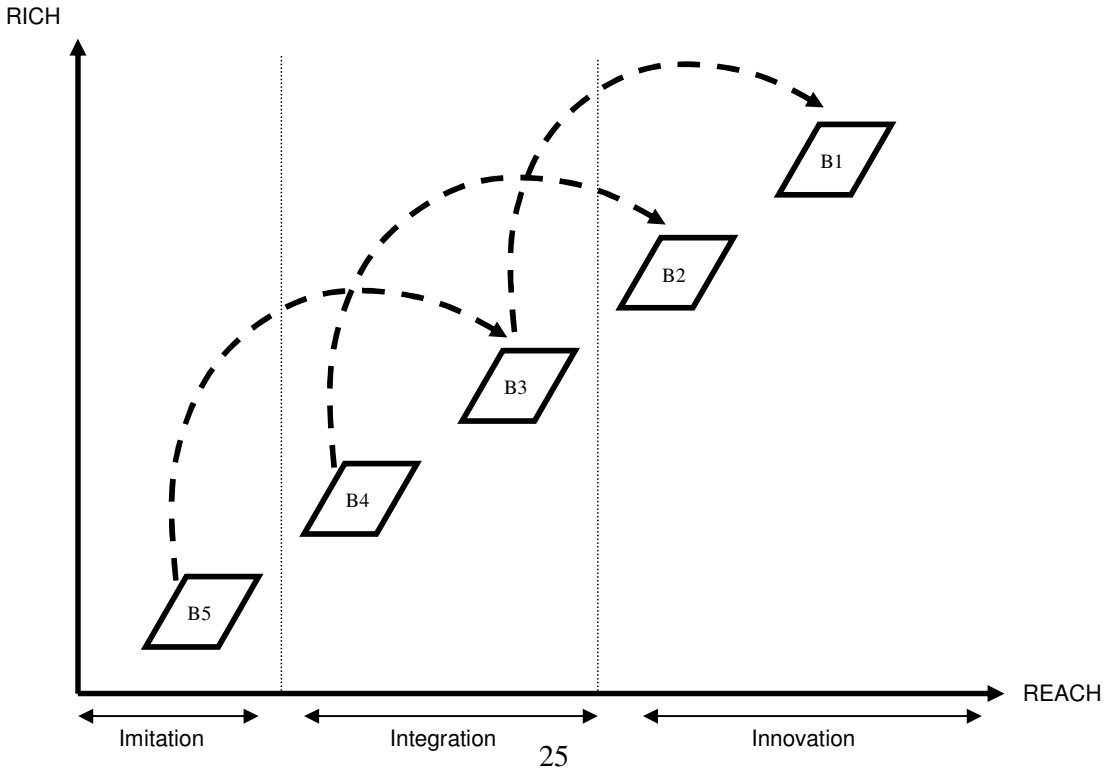
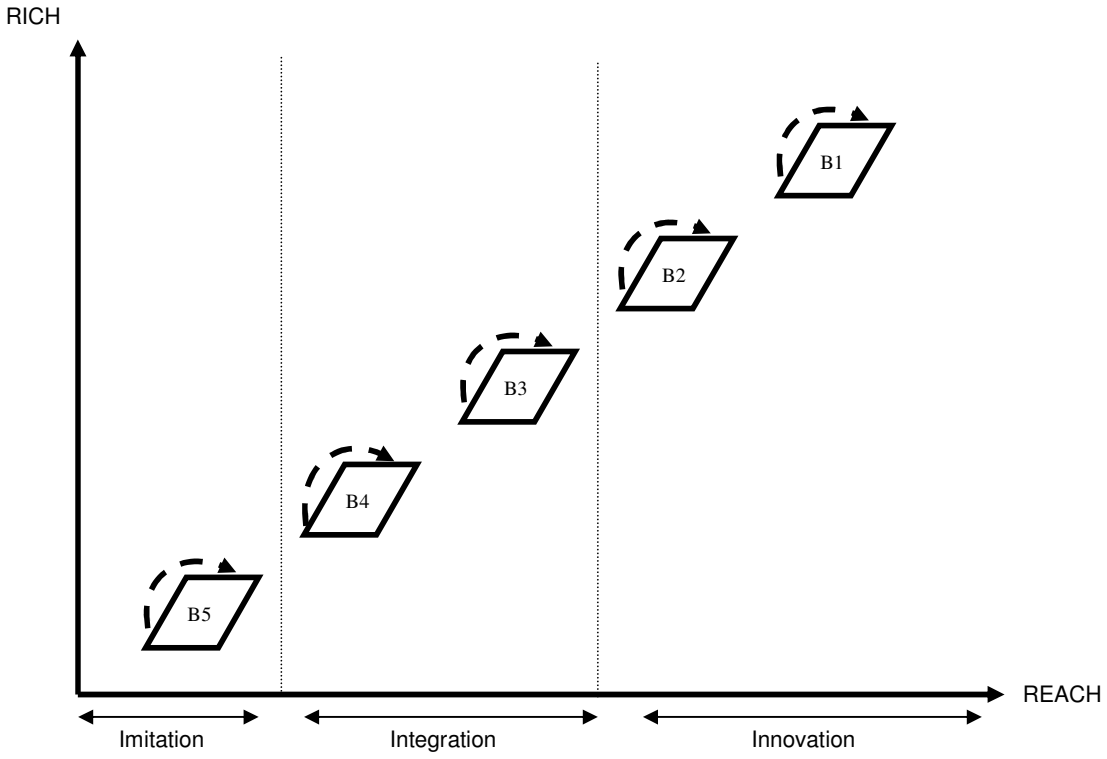
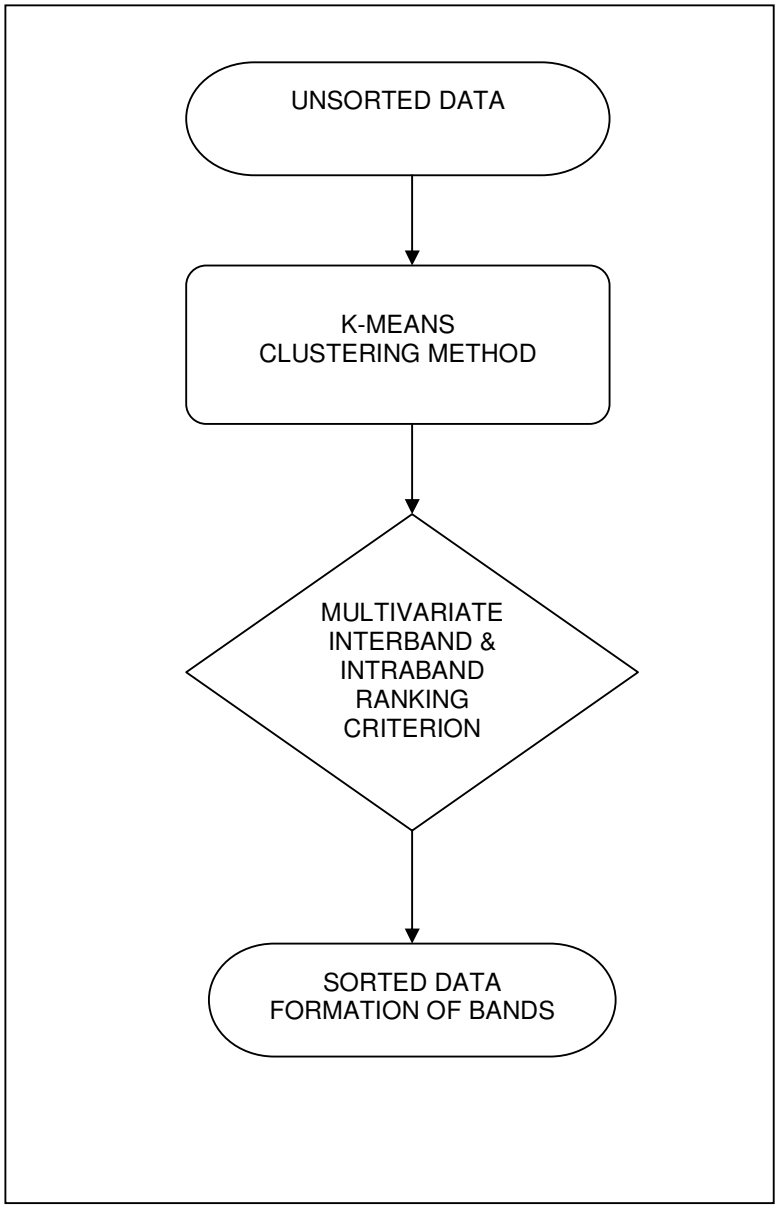


Figure 3: Intra-Band Leapfrogging (Non-Linear Economic Development)



Appendix II: Empirical Method

Flow chart for the band classification Algorithm



Appendix III: The data and data sources

The Data

In this study, we have used twenty-five sample countries (including five ASEAN countries), which consists of fourteen developed and eleven developing countries. The sample countries used in this study are as follows:

1. Australia	2. Brazil	3. Canada	4. Chile
5. China	6. Finland	7. Germany	8. India
9. Indonesia	10. Ireland	11. Japan	12. South Korea
13. Malaysia	14. Mexico	15. New Zealand	16. Norway
17. The Philippines	18. Singapore	19. South Africa	20.Sweden
21. Switzerland	22. Taiwan	23. Thailand	24.UK
25. The US			

Data Sources

In this study, we have used secondary data from several sources. They include the IMD World Competitiveness Report (1995-2003), Digital Planet 2002: The Global Information Economy, the World Intellectual Property Organization (WIPO), the United Nations Statistics Database and Kaufmann et al., (2003) governance database.

REACH Factors

Thirteen indicators that capture the level and quality of connectivity in the knowledge economy were used in this factor.

X1: Number of Internet Users per 1000 people
X1: IT Hardware expenditure per capita, US$
X3: Software expenditure per capita, US$
X4: IT Services expenditure per capita, US$
X5: Number of PCs used in the education sector per 1 million people
X6: Number of PCs used in home per 1 million people.
X7: Number of PCs used in business & government per 1 million people.
X8: Number of telephone lines per household
X9: Telecommunication investment per capita, US$
X10: Computers per 1000 people
X11: Number of mobile telephone users per 1000 people (*share of total millions instructions per second (MIPS)*)
X12: Computer power per 1000 people
X13: Distribution systems (*an index of the efficiency of distribution systems in a country*).

RICH Factors

A. *Intellectual Capital Development Factors* – six data that measures the level and quality of the human capital in the country were used under this factor.

X1: Skilled labour
X2: Science & Education (*an index of availability of skilled labour in a country*).
X3: Entrepreneurship (*an index of science education adequately taught in compulsory schools).*
X4:. Public education expenditure per capita, US$.
X5: Qualified engineers (*an index for number of qualified engineers in a country*).

X6: The educational system (*an index of an educational system that meets the needs of a competitive economy).*

B. *Innovation Factors* - innovation level in a country is characterized by eight factors listed below.

X1: R&D personnel in the business sector per 1000 people
X2: R&D personnel nationwide per 1000 people
X3: Total R&D expenditure per capita, US$
X4: Business R&D expenditure per capita, US$
X5: Basic Research (*an index of basic research that enhances long term economic and technological development*).
X6: Patents & Copyrights Protection (*an index of adequately protected intellectual property in a country).*
X7: Total Patent Productivity per 1000 R&D personnel.

C. *Interaction (Strategic Partnership) Factors* - the level of interaction (strategic partnership) is characterized by two factors.

X1: Research Cooperation (*research cooperation between companies and universities*).
X2: Technological Cooperation (*technological cooperation between companies*).

D. *Integrity Factors* – six governance factors were used for measuring integrity.

X1: Voice and accountability
X2: Political stability
X3: Government effectiveness
X4: Regulatory quality
X5: Rule of law
X6: Control of corruption

E. *Productivity Factors* - four types of productivity indicators were used in this study.

X1: Labour productivity, GDP per person employed per hour, US$.
X2: Industry productivity, related GDP (PPP) per person employed in industry, US$.
X3: Service productivity, related GDP (PPP) per person employed in services, US$,
X4: Overall productivity, GDP (PPP) per person employed in US$.

APPENDIX IV: Empirical results

Table 1: Band classification for REACH 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	94.50	35.50	35.87	6.75	1.61
X2	399.81	499.29	301.44	127.45	17.41
X3	153.99	243.12	98.41	21.42	4.02
X4	371.13	463.26	226.03	47.76	7.63
X5	777.82	1121.70	683.19	373.26	54.54
X6	22323.10	11364.56	14101.55	5088.11	1218.57
X7	147277.20	120090.24	85567.89	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	360.00	197.00	225.50	115.67	22.53
X11	92.70	47.40	89.78	24.80	7.95
X12	11829.97	5839.97	6679.32	3433.66	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	251.00	100.15	91.60	25.50	5.87
X2	462.16	337.54	379.07	122.69	19.44
X3	147.91	129.46	84.34	23.51	4.70
X4	401.75	234.50	318.21	42.91	10.06
X5	771.56	779.28	1222.60	386.08	62.21
X6	24326.67	15193.98	11808.76	5376.13	1678.12
X7	163891.98	127085.63	60144.57	39827.99	4645.37
X8	210051.52	151783.52	106909.65	67018.23	15650.00
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	99.18	17.32
X12	42428.08	33122.64	23826.08	15465.71	1937.52
X13	8.06	8.12	5.44	6.11	4.85

2003	Band 1	Band 2	Band 3	Band 4	Band 5
	US	UK	Singapore	Taiwan	SouthAfrica
	Sweden		Finland	Korea	Brazil
	Switzerland		Australia	Malaysia	Mexico
	Norway		Canada	Chile	Thailand
			Japan		China
			NewZealand		Philippines
			Germany		India
			Ireland		Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	508.23	360.14	415.92	301.75	53.68
X2	564.19	383.56	338.59	97.29	22.32
X3	298.40	229.11	140.75	17.65	6.19
X4	621.87	492.15	324.45	33.03	13.56
X5	940.90	775.31	972.81	324.28	69.68
X6	42738.33	28600.57	31016.91	13516.89	3097.38
X7	263475.63	178593.47	173796.63	67262.81	9779.77
X8	317853.12	155265.41	235874.64	93106.36	30287.64
X9	1.75	1.61	1.75	1.55	0.43
X10	695.53	546.50	574.35	238.04	50.40
X11	742.21	831.94	600.25	544.18	145.56
X12	647643.57	1288704.09	519871.74	172942.17	32267.89
X13	7.97	5.59	7.71	6.97	5.01

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
		New Zealand			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	20.02	6.02
X4	534.24	285.50	288.22	34.32	12.62
X5	877.75	808.78	884.43	377.71	82.89
X6	32744.67	28038.25	13328.28	14617.70	2571.32
X7	232480.98	154453.56	119679.90	54718.76	8352.69
X8	248521.35	203127.32	123996.93	78789.17	27317.65
X9	1.54	1.62	1.39	1.67	0.48
X10	468.62	474.66	343.62	220.70	41.75
X11	493.41	372.17	358.90	496.32	66.78
X12	156291.34	138080.05	102015.08	58265.38	9766.61
X13	7.86	8.24	6.95	5.14	4.63

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
		New Zealand			India
		Germany			Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	501.50	426.76	281.35	436.05	75.90
X2	477.71	380.24	341.38	160.65	25.57
X3	339.03	193.44	174.11	25.63	6.89
X4	699.45	423.82	316.71	52.38	14.56
X5	933.83	981.13	805.19	423.35	92.27
X6	57312.93	34787.99	23224.25	18309.35	3902.97
X7	284211.40	189235.45	133771.36	95951.47	15037.53
X8	456000.80	247970.98	149700.21	110908.53	38964.70
X9	1.98	1.60	1.51	1.74	0.55
X10	639.00	560.20	476.50	396.50	56.60
X11	435.00	615.24	753.50	744.50	164.50
X12	785046.00	529740.64	442644.73	235536.89	39481.37
X13	7.14	7.55	3.62	5.70	4.42

Table 2: 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	6.28	6.57	6.19	6.03	4.98
X2	5.78	5.21	5.05	6.13	4.16
X3	6.38	6.66	6.18	6.42	6.11
X4	2572.40	1910.20	1319.40	888.20	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	6.38	4.71	5.99
X2	5.68	5.30	6.19	4.94	4.85
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					
	B1	**B2**	**B3**	**B4**	**B5**
	US	N.Zealand	Norway	Singapore	Thailand
	Canada	Sweden	Finland	S.Africa	Phillipines
		Switzerland	Germany	Korea	India
		Ireland	UK	Malaysia	Brazil
		Australia	Japan	Mexico	China
			Taiwan	Chile	Indonesia
	Means	**Means**	**Means**	**Means**	**Means**
X1	7.136	6.991	6.573	6.308	6.307
X2	6.262	5.905	6.222	4.935	5.262
X3	6.22	6.29	5.54	5.65	5.61
X4	1343.94	1873.58	804.8	358.33	74.98
X5	7.245	6.648	6.712	6.243	6.588
X6	6.84	5.56	5.06	4.26	4.2

2001					
	B1	**B2**	**B3**	**B4**	**B5**
	US	Norway	Germany	Korea	Thailand
	Canada	Switzerland	N.Zealand	Malaysia	Brazil
		Sweden	UK	S.Africa	Phillipines
		Ireland	Singapore	Chile	India
		Australia	Taiwan	Mexico	China
		Finland	Japan		Indonesia
	Means	**Means**	**Means**	**Means**	**Means**
X1	7.007	6.698	6.768	5.848	6.29
X2	5.115	5.829	5.505	4.491	4.427
X3	6.907	6.44	5.651	5.561	5.378
X4	2457.02	1796.52	1042.33	527.18	119.16
X5	6.626	6.727	6.662	6.452	6.432
X6	5.72	6.61	5.35	3.61	3.99

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
		NewZealand	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	6.90	6.10	5.30	5.70	5.50
x4	2647.92	1722.55	1086.83	541.67	143.00
x5	7.65	7.45	7.08	6.70	6.36
x6	6.49	6.54	5.56	4.42	4.32

Table 3: Band classification for Innovation factors

1995	Band 1	Band 2	Band 3	Band 4	Band 5
	Japan	Sweden	Norway	Taiwan	SouthAfrica
	Switzerland	Finland	UK		Chile
		Germany	Canada		China
		US	Singapore		Malaysia
			Ireland		Brazil
			Korea		Philippines
			Australia		Mexico
			New Zealand		India
					Thailand
					Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	4.71	3.47	1.83	1.80	0.12
X2	7.20	5.56	3.88	3.31	0.50
X3	989.32	677.50	311.47	222.69	11.08
X4	671.95	444.83	179.64	128.16	2.93
X5	6.52	6.43	5.30	5.59	4.05
X6	7.61	7.93	7.34	6.38	4.82
X7	73.17	38.73	21.14	474.75	12.60

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	Switzerland	Norway	Taiwan	Korea	SouthAfrica
	Sweden	UK			China
	Finland	Canada			Malaysia
	US	Singapore			Chile
	Japan	Ireland			Brazil
	Germany	Australia			Mexico
		New Zealand			Thailand
					India
					Philippines
					Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	4.28	1.86	3.16	1.66	0.08
X2	6.64	3.47	4.74	2.74	0.34
X3	923.44	317.82	267.20	214.00	13.78
X4	653.15	180.97	169.87	121.51	4.80
X5	7.47	6.94	5.48	7.28	4.62
X6	8.35	8.08	7.26	4.61	5.59
X7	56.80	17.44	173.08	336.55	8.38

1997	Band 1	Band 2	Band 3	Band 4	Band 5
	Switzerland	Norway	Taiwan	SouthAfrica	China
	Japan	UK		Malaysia	Brazil
	Sweden	Canada		Chile	Philippines
	Finland	Ireland			Mexico
	US	Singapore			India
	Germany	Korea			Thailand
		Australia			Indonesia
		New Zealand			
	Mean	Mean	Mean	Mean	Mean
X1	4.13	1.99	3.01	0.15	0.06
X2	6.18	4.07	4.56	0.47	0.37
X3	857.52	346.75	252.08	17.47	7.34
X4	612.81	208.70	154.86	6.36	1.95
X5	6.38	5.56	5.15	5.11	3.32
X6	7.44	7.07	6.10	5.72	4.39
X7	58.97	31.26	395.15	14.83	5.87

2001	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	Japan	Germany	Taiwan	China
	Sweden	US	Norway	Korea	Chile
	Switzerland		Canada		South Africa
			UK		Brazil
			Singapore		Malaysia
			Ireland		Mexico
			Australia		India
			New Zealand		Thailand
					Philippines
					Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	5.17	3.64	2.23	2.53	0.12
X2	8.22	5.19	4.20	3.82	0.37
X3	896.74	1053.39	403.95	267.35	11.00
X4	659.09	764.42	244.35	182.32	5.28
X5	7.52	7.43	6.50	6.03	4.47
X6	8.53	8.30	8.32	6.52	5.54
X7	14.81	107.05	23.40	213.12	2.74

2003	Band 1	Band 2	Band 3	Band 4	Band 5
	Japan	Finland	Germany	Korea	Brazil
	US	Sweden	Norway		China
		Switzerland	Canada		Malaysia
			Singapore		South Africa
			UK		Chile
			Australia		Thailand
			Taiwan		Mexico
			Ireland		Philippines
			New Zealand		India
					Indonesia
	Mean	Mean	Mean	Mean	Mean
X1	5.14	5.38	2.54	2.00	0.12
X2	5.23	8.36	4.46	3.06	0.38
X3	1041.54	976.75	396.73	244.33	12.66
X4	756.45	730.43	234.33	172.40	6.72
X5	7.60	7.33	6.44	6.20	4.47
X6	7.76	8.67	7.77	5.18	4.80
X7	118.46	15.63	39.31	320.04	3.05

Table 4: Band classification for Interaction factors

1995	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	Australia	SouthAfrica	Malaysia	Philippines
	Sweden	UK	Ireland	Chile	India
	US	Canada	Thailand	Brazil	Mexico
	Singapore	New Zealand	Korea		Indonesia
	Japan	Norway	China		
	Switzerland				
	Germany				
	Taiwan				
	Mean	Mean	Mean	Mean	Mean
X1	5.71	4.70	4.13	3.38	2.53
X2	5.95	5.27	4.18	4.44	3.42

1997	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	Norway	Australia	SouthAfrica	Chile
	Switzerland	Singapore	UK	China	Brazil
		New Zealand	Malaysia	Korea	Philippines
		Germany	Thailand		India
		US			Mexico
		Taiwan			Indonesia
		Sweden			
		Canada			
		Japan			
		Ireland			
	Mean	Mean	Mean	Mean	Mean
X1	6.64	5.41	4.48	4.42	3.18
X2	6.38	5.49	4.93	3.71	3.58

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	Singapore	Japan	Malaysia	Korea
		Sweden		UK	India
		US		China	Mexico
		Canada		SouthAfrica	Thailand
		Switzerland		Philippines	Indonesia
		Germany		Chile	
		Taiwan		Brazil	
		Australia			
		Ireland			
		Norway			
		New Zealand			
	Mean	Mean	Mean	Mean	Mean
X1	6.93	5.21	4.02	3.89	2.73
X2	7.06	5.44	6.07	4.20	3.22

2001	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	US	Japan	UK	Thailand
		Sweden		New Zealand	Brazil
		Singapore		Norway	India
		Canada		Korea	China
		Ireland		Philippines	Mexico
		Switzerland		SouthAfrica	Indonesia
		Taiwan		Chile	
		Australia		Malaysia	
		Germany			
	Mean	Mean	Mean	Mean	Mean
X1	7.68	5.69	3.60	4.05	2.93
X2	7.70	6.06	6.02	4.58	3.58

2003	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	US	Taiwan	Japan	Thailand
		Sweden	Germany	UK	Mexico
		Canada	Norway	India	China
		Singapore	Malaysia	Korea	Indonesia
		Australia	Ireland	SouthAfrica	
		Switzerland	New Zealand	Brazil	
			Chile		
			Philippines		
	Mean	Mean	Mean	Mean	Mean
X1	8.2700	6.4183	5.3600	4.2283	3.3950
X2	8.2400	7.0833	6.0400	5.4050	4.0450

Table 5: Band classification for Integrity factors

1996	Band 1	Band 2	Band 3	Band 4	Band 5
	Singapore	NewZealand	Japan	Brazil	China
		Switzerland	Chile	Mexico	Indonesia
		Norway	Taiwan	Philippines	
		Finland	Malaysia	SouthAfrica	
		Sweden	Korea	Thailand	
		UK		India	
		Germany			
		Australia			
		Ireland			
		US			
		Canada			
	Mean	Mean	Mean	Mean	Mean
X1	0.38	1.53	0.62	0.18	-1.05
X2	1.29	1.16	0.75	-0.23	-0.06
X3	2.04	1.65	0.89	0.01	0.26
X4	1.95	1.31	0.83	0.23	0.34
X5	2.01	1.86	1.05	0.05	-0.12
X6	2.04	1.87	0.80	-0.13	-0.44

1998	Band 1	Band 2	Band 3	Band 4	Band 5
	Singapore	Switzerland	Malaysia	China	Indonesia
		Finland	Korea		
		NewZealand	Philippines		
		UK	SouthAfrica		
		Norway	Thailand		
		Sweden	Brazil		
		Ireland	Mexico		
		Canada	India		
		Australia			
		Germany			
		US			
		Taiwan			
		Japan			
		Chile			
	Mean	Mean	Mean	Mean	Mean
X1	0.01	1.30	0.32	-1.51	-1.33
X2	1.40	1.29	-0.10	0.29	-1.52
X3	2.50	1.88	0.21	0.18	-0.58
X4	1.65	1.27	0.40	-0.07	0.10
X5	2.24	1.89	0.24	-0.22	-0.97
X6	2.50	2.08	0.04	-0.20	-0.99

2000	Band 1	Band 2	Band 3	Band 4	Band 5
	Singapore	Finland	Taiwan	China	Indonesia
		Switzerland	Korea		
		Sweden	SouthAfrica		
		UK	Malaysia		
		Australia	Thailand		
		Ireland	Brazil		
		Canada	Mexico		
		NewZealand	India		
		Germany	Philippines		
		US			
		Norway			
		Japan			
		Chile			
	Mean	Mean	Mean	Mean	Mean
X1	1.35	1.34	0.45	-1.37	-0.52
X2	1.34	1.34	0.14	0.27	-1.85
X3	1.77	1.76	0.36	0.24	-0.49
X4	1.40	1.39	0.42	-0.20	-0.43
X5	1.93	1.92	0.22	-0.32	-0.90
X6	2.01	2.00	0.05	-0.34	-1.09

2002	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	Japan	SouthAfrica	China	Indonesia
	Switzerland	Taiwan	Thailand		
	Sweden	Korea	Mexico		
	NewZealand	Malaysia	Brazil		
	Norway		India		
	Australia		Philippines		
	Singapore				
	Canada				
	UK				
	Germany				
	Ireland				
	US				
	Chile				
	Mean	Mean	Mean	Mean	Mean
X1	1.43	0.56	0.35	-1.38	-0.49
X2	1.20	0.72	-0.08	0.22	-1.37
X3	1.86	0.96	0.09	0.18	-0.56
X4	1.66	0.87	0.24	-0.41	-0.68
X5	1.80	0.95	-0.08	-0.22	-0.80
X6	2.01	0.68	-0.14	-0.41	-1.16

Table 6: Band classification for Productivity factors

1995	Band 1	Band 2	Band 3	Band 4	Band 5
	Switzerland	Ireland	Canada	Korea	Brazil
	Norway		Sweden	Chile	Philippines
	Japan		UK	SouthAfrica	China
	US		Australia	Malaysia	India
	Germany		Singapore	Thailand	Indonesia
	Finland		Taiwan	Mexico	
			New Zealand		
	Mean	Mean	Mean	Mean	Mean
X1	35.74	27.10	21.33	5.39	1.72
X2	57503.34	14934.33	49523.81	33356.92	15347.80
X3	44830.95	68385.28	40786.68	23240.75	8059.99
X4	69539.80	44293.93	41629.45	11721.80	3396.35

1997	Band 1	Band 2	Band 3	Band 4	Band 5
	Ireland	US	New Zealand	Brazil	Philippines
		Norway	Chile	Thailand	China
		Germany	Korea		India
		Finland	SouthAfrica		Indonesia
		Australia	Malaysia		
		Japan	Mexico		
		Canada			
		Singapore			
		Switzerland			
		UK			
		Sweden			
		Taiwan			
	Mean	Mean	Mean	Mean	Mean
X1	29.98	25.89	14.64	5.85	3.08
X2	17895.90	56465.70	41515.91	24489.97	12060.04
X3	79546.83	46419.71	30327.66	20990.87	7576.82
X4	53433.10	48067.54	31094.88	12045.31	6675.37

2003	Band 1	Band 2	Band 3	Band 4	Band 5
	Ireland	Australia	Singapore	Chile	Philippines
	Norway	Finland	SouthAfrica	Malaysia	China
	US	Canada	New Zealand	Mexico	India
		Germany	Korea	Thailand	Indonesia
		UK		Brazil	
		Japan			
		Sweden			
		Switzerland			
		Taiwan			
	Mean	Mean	Mean	Mean	Mean
X1	43.13	31.05	22.35	9.88	3.97
X2	107720.00	63801.22	59260.23	32961.80	17839.75
X3	69168.33	55761.45	41403.16	24273.00	10770.00
X4	77194.67	56508.67	43697.50	21678.78	8580.25

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	Ireland	US	UK	Chile	Thailand
		Norway	SouthAfrica	Mexico	China
		Australia	Singapore	Malaysia	Philippines
		Germany	Taiwan	Brazil	India
		Canada	New Zealand		Indonesia
		Finland	Korea		
		Switzerland			
		Sweden			
		Japan			
	Mean	Mean	Mean	Mean	Mean
X1	32.56	28.01	19.96	10.16	3.37
X2	19634.14	61080.81	48722.45	30387.62	15402.00
X3	87272.19	47525.64	38887.73	22781.46	10097.07
X4	58020.98	50750.92	40563.74	21580.47	10806.02

2001	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Canada	SouthAfrica	Chile	Thailand
	Ireland	Australia	Singapore	Mexico	Philippines
	Norway	Germany	New Zealand	Malaysia	India
		Finland	Korea	Brazil	China
		Switzerland			Indonesia
		Japan			
		Sweden			
		Taiwan			
		UK			
	Mean	Mean	Mean	Mean	Mean
X1	36.48	29.39	22.23	10.27	4.21
X2	83565.09	56948.96	57661.01	32626.29	19219.63
X3	62180.44	54769.81	40950.98	23066.94	12126.09
X4	66298.86	54006.58	44260.98	22048.72	8825.24

Table 7: Summary of band transition of ASEAN-5 countries

Singapore	REACH	(3,2,2,2,3)
	Human Capital	(4,3,4,3,3)
	Innovation	(3,2,2,3,4)
	Interaction	(1,2,2,2,2)
	Integrity	(1,1,1,1)
	Productivity	(3,2,3,3,3)

Malaysia	REACH	(5,4,5,5,4)
	Human Capital	(5,4,4,4,4)
	Innovation	(5,4,5,5,5)
	Interaction	(4,3,4,4,3)
	Integrity	(3,3,3,2)
	Productivity	(4,3,4,4,4)

Thailand	REACH	(5,5,5,5,5)
	Human Capital	(5,4,5,5,5)
	Innovation	(5,5,5,5,5)
	Interaction	(3,3,5,5,5)
	Integrity	(4,3,3,3)
	Productivity	(4,4,5,5,4)

Philippines	REACH	(5,5,5,5,5)
	Human Capital	(5,5,5,5,5)
	Innovation	(5,5,5,5,5)
	Interaction	(5,5,4,4,3)
	Integrity	(4,3,3,3)
	Productivity	(5,5,5,5,5)

Indonesia	REACH	(5,5,5,5,5)
	Human Capital	(5,5,5,5,5)
	Innovation	(5,5,5,5,5)
	Interaction	(5,5,5,5,5)
	Integrity	(5,5,5,5)
	Productivity	(5,5,5,5,5)

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