Innovation and Competitiveness in the Information Economy: "Leapfrogging" Strategies for Developing Countries

Mahendhiran Nair* and Mudiarasan Kuppusamy
School of Business
Monash University Malaysia
No. 2, Jalan Kolej, Bandar Sunway,
46150 Petaling Jaya, Selangor
Tel: 603-56360600; Fax: 603-58804358

Abstract

In this paper, we examined the factors contributing to the innovative capacity of nations in the information economy. This study shows that ICT infrastructure is the *foundation condition* (necessary condition) for enhancing the innovative capacity of nations. However, developments in intellectual capital, interaction (cooperation among all the stakeholders in the economy and global networking), institutions, incentives and integrity systems are the *driver conditions* (necessary and sufficient conditions) for raising the innovative capacity of nations. The linkage between innovative capacity, competitiveness and wealth accumulation is also discussed in this paper. A new empirical framework was used to benchmark the performance of twenty-five developed and developing countries based on the foundation and driver conditions. The empirical model was also used to assess the performance of these countries on the innovative capacity, competitiveness (productivity) and wealth accumulation dimensions. The sample period for the empirical study was from 1995 to 2005. The empirical results showed that countries that have harnessed the foundation and driver conditions are leaders in innovation, competitiveness and wealth accumulation in the information economy. The study also identified countries that have "leapfrogged" in some of the dimensions mentioned above and the strategies responsible for facilitating the leapfrogging process. Results from this study provide useful directions for developing countries to leapfrog to higher stage of socioeconomic development.

Keywords: Innovation, competitiveness, leapfrogging, information-economy and developing countries.

* Please send all correspondence to the following author's email address: mahendhiran.nair@buseco.monash.edu.my

1. INTRODUCTION

Factors determining economic development and competitiveness have been of interest to policymakers and economists for a long time. More recently, the drivers of economic growth have been a topic of extensive research and debate, stemming from the fact that traditional factors of production (land, labour and capital) no longer play a major role in the socio-economic development of countries. For instance, countries such as Finland, Ireland and Singapore – each with a relatively small labour force and scarce land, are one of the most competitiveness nations in the world. These relatively smaller countries have experienced rapid accumulation of wealth 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.

Some economists argue that liberalization and deregulation can help countries to increase their economic competitiveness (McNaughton and Green, 2002). Others argue that a more open economy will likely favour richer countries with better technology and know-how. Varying levels of innovation in developed and developing countries is responsible for the "widening disparities between the rich and poor, imprisoning many developing countries in relative poverty" (Persaud, 2001). Thus, prosperity of countries depends on its innovative capacity. Porter and Stern (1999) argued that low innovative capacity will lead to lower productivity growth, especially in labour-constrained economies.

Innovation, especially in information and communication technology (ICT) has been able to de-couple space and time. This has lowered the cost of communication and opened new opportunities for developing countries to catch-up with more developed countries. The digital environment has also resulted in the emergence of new sectors that can raise the level of innovation and productivity in the conventional economic sectors in developing countries. Today, firms are able to obtain cheaper and better quality products and services from various markets around the globe at a faster pace. This allows firms to reduce their cost and diversify their business risks.

New multimedia and computing technology also allows firms to track and study the changes in the global market more quickly. Access to detailed information allows firms to produce a range of products that meets the needs of diverse markets around the world. For example, LEGO Group uses the digital medium to identify the changing market demand and even provide incentives for its customers to provide feedback in improving and designing new products (Hof, 2005). Thus, network savvy firms are able to pursue *economies of scope*.

In the information economy, firms are able to expand their customer base globally with relatively low marginal cost. For network-based firms, the market is not confined to the borders of the country it is operating from. The world becomes the market. This allows network-based firms to achieve *economies of scale* – a key source of achieving competitive advantage.

Increased cooperation among consumers facilitated by the ICT revolution has also led to positive network externalities. The Internet provides an avenue for consumers to exchange information and knowledge. The digital medium has also played a key role in fostering greater cooperation between firms, related organizations and consumers. In the information economy, organizations are able to tap into the collective intelligence of consumers, suppliers and other stakeholders. The digital infrastructure allows firms to take advantage of the 'network brain' that is made-up of millions of users, innovators and suppliers. For example, Proctor and Gamble (P&G) with a research budget of USD1.7 billion, uses a network of 80,000 independent

researchers from 173 countries to collectively solve research problems. P&G's investment in the network brain has led to increased product development from outside the organization from 20 percent to 35 percent in recent years (Hof, 2005).

While the information economy can bring significant benefits to developing countries, the benefits can only be realized if developing countries foster the development of a sustainable innovation eco-system. The primary objective of this paper is to examine the foundation condition (*necessary condition*) and driver conditions (*necessary and sufficient conditions*) that facilitate the creation of an innovative eco-system. In this paper, we will also discuss the linkage between innovative capacity, competitiveness and wealth accumulation of nations in the information economy. Here, we will use an empirical framework to benchmark the development of twenty-five selected developed and developing countries. The empirical study was conducted for the period 1995-2005. The study will identify the leaders and laggards in the information economy. The study will also identify nations that have leapfrogged stages of development and the strategies that have facilitated this leapfrogging process. Results from this study will provide valuable insights for developing countries in formulating strategies to 'catch-up' with more developed countries.

This paper is organized as follows. In Section 2, a new theoretical framework on the determinants of national innovative capacity in the information economy is discussed. In Section 3, an empirical method to benchmark national innovative capacity, competitiveness and wealth accumulation of countries is given. In Section 4, the empirical results are discussed. In Section 5, discussion on the policies and strategies to help developing nations to achieve sustainable development is provided. In Section 6, concluding remarks are given.

2. THE DETERMINANTS OF NATIONAL INNOVATIVE CAPACITY IN THE INFORMATION ECONOMY

There is general consensus that innovation is the key to competitiveness and wealth accumulation of nations (refer to studies by Coe and Helpman, 1995; Bayoumi et al., 1996; Cameron, 1996; Furman et al. 2002; Lundvall, 2002; and Porter, 2002). In this section, we will discuss the conditions for enhancing the innovative capacity of nations in the information economy.

In this paper, we argue that innovative environment of nations is a function of two major factors. The first factor is called the REACH-factor. This includes the necessary *ICT Infrastructure* that facilitates connectivity to the global economy. In the information economy, this entails technology such as computers, software and the Internet. The REACH-factor is what we call as the foundation condition for facilitating innovation in the information economy.

The second factor is called the RICH-factor. This factor is the driver condition for moving nations up the innovation value chain. The RICH-factor entail the following measures:

- Highly skilled and knowledge-intensive workers [*Intellectual Capital*].
- Global networking and strategic partnerships among all stake-holders in the economy [*Interaction*]
- Good governance, transparency, accountability, government effectiveness and rule of law [*Integrity*].
- The fiscal and non-fiscal incentives that fosters creativity and entrepreneurship [*Incentives*].
- Institutions that efficiently and effectively manage innovation [*Institutions*].

Both the REACH and RICH factors are important for the creation of a sustainable innovation eco-system. The link between the REACH and RICH factors, innovative capacity, competitiveness and wealth accumulation is given in Figure 1. The higher the REACH and RICH factors, the greater is the ability of a nation to foster a vibrant innovative culture and ethos - factors that are essential for helping the nation become more competitive and achieve a higher standard of living.

In this paper we argue that countries undergo three different phases of socioeconomic development. The first phase of economic development is called the *Imitation-Phase*, where countries' REACH and RICH factors are relatively low, resulting in weak innovative capacity. Most of the sectors in the economy are driven by the basic factors of production. The second stage of socioeconomic development is called the *Integration-Phase*. Countries in this stage have moderate development in the REACH and RICH factors, thus moderate innovative capacity. Most economic sectors in these countries incorporate new technology and know-how from more developed countries. The third stage of socioeconomic development is called the *Innovation-Phase*. In this stage, the REACH and RICH factors are high, hence the innovative capacity of these nations are also high. These nations are at the frontier of innovation.

Within the three different stages of socioeconomic development, there are five homogenous bands/clusters of countries with varying levels of innovative capacity and competitiveness (as given in Figure 2). In the Innovation-Phase, there are two bands called Band 1 (B1: *Pace-Setter*) and Band 2 (B2: *Adepter*). Countries in Band 1 are the leaders and set the pace for development. Countries in Band 2 are highly adept in sourcing factors of production for the information economy and building upon new technologies from more developed countries. In the Integration-Phase, there are two bands called Band 3 (B3: *Adapter*) and Band 4 (B4: *Adopter*). Countries in Band 3 are able to adapt quickly to technological changes. In some sectors within this band, the innovation tends to be improvements of existing technologies from countries in the higher bands. Countries in Band 4 are users of new technology and know-how from more developed countries. In the Imitation-Phase there is one band called as Band 5 (B5: *Starter*). Most of the countries in this band are at an infant stage of development in the information economy -- low levels in the REACH and RICH factors.

In this paper, we assume that at a given moment in time, based on the developments in the REACH and RICH factors, a country will be in a specific band. Countries in the same band are homogenous in terms of development. On the other hand, countries in different bands are heterogeneous in terms of development. Over time, as nations improve their REACH and RICH factors, their innovative capacity, competitiveness and wealth accumulation also increases (as shown in Figure 3).

In the information economy, stages of socioeconomic development of nations can be non-linear. That is, countries can leapfrog stages of development. In this study, we characterize two types of leapfrogging that occurs in the information economy. The first is called *the Inter-Band Leapfrogging*. This is the case when a country moves up in the direction of increasing the REACH and RICH factors by passing one or more stages of developments (bands). Here, a country may move from Band 5 to Band 3 (bypassing Band 4), Band 4 to Band 2 (bypassing Band 3) or Band 3 to Band 1 (bypassing Band 2) (as illustrated in Figure 4). The leapfrogging phenomenon captured in Figure 4 is called as a single-band leapfrogging. There is also the possibility of multiple-band leapfrogging. In this case a country will pass more than one stage of development (band). For a country to leapfrog to higher stage of socioeconomic development, the country will need to make significant improvements in both REACH and RICH factors.

The second type of leapfrogging that occurs in the information economy is called the *Intra-Band Leapfrogging*. This is a process where a country bypasses one or more countries in the same band. The frequency of Inter-Band Leapfrogging is correlated with the degree of competitiveness among the countries in the bands.

3. THE EMPIRICAL METHOD TO BENCHMARK NATIONAL INNOVATIVE CAPACITY, COMPETITIVENESS AND WEALTH ACCUMULATION

In this section we will discuss the empirical method and the data used to benchmark developments of twenty-five countries based on the following measures: REACH-factor, RICH-factor, innovative capacity, competitiveness and wealth accumulation.

3.1 The Algorithm

In this paper, we classify the countries into the respective bands based on the above-mentioned measures using the *k-means* clustering method. The flowchart for benchmarking algorithm is given in Figure 5.

Once the bands have been determined, the bands are ranked based on a criteria called as the *Inter-Band Ranking Criteria*. Let k_A be the number of characteristics of Band-*A* that is higher than that of a second band called Band-*B*. Similarly let k_B be the number of characteristics of Band-*B* that is higher than that of Band-*A*. If $k_A > k_B$, then Band-*A* is ranked higher than Band-*B*. If $k_A = k_B$, then we measure the percentage difference of each the characteristics of the two bands. Let δ_i be the percentage difference between Band *A* and Band *B* for the *s* characteristic for *s* = 1,…, S. The measure δ_i is defined as follows:

$$\delta_s = \left(\frac{X_{A,s} - X_{B,s}}{X_{B,s}} \right) \times 100 \qquad (1)$$

where, $X_{A,s}$ and $X_{B,s}$ are the *s*th characteristic for Band-*A* and Band-*B*, respectively. If $\sum_{s=1}^{S} \delta_s > 0$, then Band-*A* is characterized as being in a higher stage of development than Band-*B*, and vice-versa.

The countries in each of the bands are also ranked based on a similar criterion mentioned above. The country ranking within the bands is called *Intra-Band Ranking Criterion*. Let k_{C1} be the number of characteristics of Country-1 that is higher than that of a second country called Country-*2*. Similarly let k_{C2} be the number of characteristics of Country-2 that is higher than that of Country-*1*. If $k_{C1} > k_{C2}$, then Country-1 is ranked above Country-2. If $k_{C1} = k_{C2}$, a similar measure given in (1) is used to measure the country ranking within a band.

3.2 The Data

In this study, we have used twenty-five countries, which consisted of fifteen developed, and ten 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			

We have used secondary data from several sources. They include the IMD World Competitiveness Report (1995-2005), Digital Planet 2002: The Global Information Economy, the World Intellectual Property Organization (WIPO), and Kaufmann et al., (2003) governance database.

For the REACH factor, we have used thirteen indicators that capture the quantum and quality of connectivity in the information economy (given below). The variables X2 to X9 were obtained from the Digital Planet 2002: The Global Information Economy. The variables X1, X10 – X13 were obtained from the IMD World Competitiveness Report (1995-2005).

X1: Number of Internet users per 1000 people
X2: IT Hardware expenditure per capita, US$
X3: Software expenditure per capita, US$
X4: IT Services expenditure per capita, US$
X5: Telecommunication investment per capita, US$
X6: Number of PCs used in the education sector per 1 million people
X7: Number of PCs used in home per 1 million people.
X8: Number of PCs used in business & government per 1 million people.
X9: Number of telephone lines per household
X10: Computers per 1000 people
X11: Number of mobile telephone users per 1000 people
X12: Computer power per 1000 people (share of total millions instructions per second (MIPS)).
X13: Distribution systems (an index on the efficiency of the distribution systems in a country – with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).

We were able to find data for the following RICH factors: intellectual capital, interaction and integrity. However, data for incentives (both fiscal and non-fiscal) and institutional development for all the countries were not available. Hence, the band configurations for the countries using the incentives and institutions factors were not computed.

Six variables were used to capture the Intellectual Capital factor. All the six variables were obtained from the IMD World Competitiveness Report (1995-2005).

X1: Skilled labour (an index on the availability of skilled labour in a country - with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).

X2: Science & Education (an index on science education adequately taught in compulsory schools - with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).
X3: Entrepreneurship (an index on entrepreneurship development in the economy - with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).
X4: Qualified engineers (an index for the number of qualified engineers in a country - with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).
X5: The educational system (an index on educational system that meets the needs of a competitive economy - with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).
X6: Public education expenditure per capita, US$

Two variables were used to measure Interaction factor in the countries. Both variables were obtained from the IMD World Competitiveness Report (1995-2005).

X1: Research Cooperation (an index on research cooperation between companies and universities in a country - with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).
X2: Technological Cooperation (an index on technological cooperation between companies in a country - with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).

Six variables were used to measure the Integrity factor (given below). Each variable was characterized as –2.5 denoting the lowest level of governance in a country, while 2.5 denotes the highest level of governance in a country. These indicators were obtained from Kauffmann et al. (2003). These variables are only available for 1996, 1998, 2000 and 2002.

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

National Innovation Capacity was characterized by eight variables (given below). These variables were chosen so as to measure a country's (i) value for basic research; (ii) ability to attract people to the research profession; (ii) ability to attract funding for research and development activities; (iv) IP and copyright protection; and, (v) productivity of researchers. Variables X1 to X6 were obtained from the IMD World Competitiveness Report (1995-2005). Variable X7 was computed by dividing total patents granted for residents (obtained from the World Intellectual Property Organization (WIPO) database) with the number of R&D personnel nationwide (obtained from the IMD World Competitiveness Yearbook database).

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 that measures whether basic research enhances long term economic and technological development of the country- with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).
X6: Patents & Copyrights Protection (an index on whether intellectual property is adequately protected in the country- with 1 indicating the lowest score/the poorest while 10 indicating the highest score/the best).
X7: Total Patent Productivity per 1000 R&D personnel.

The competitiveness of the countries was measured using four productivity measures (given below). These variables takes into account the purchasing power parity across the countries. These variables were obtained from the IMD World Competitiveness Report (1995-2005).

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$.
X4: Overall productivity, GDP (PPP) per person employed in US$.

The wealth accumulation in the information economy of the nations was measured by three variables (given below). These variables were obtained from the Digital Planet 2002: The Global Information Economy.

X1: Business to Consumer e-commerce transaction per capita, US$
X2: Business to Business e-commerce transaction per capita, US$
X3: Internet commerce transaction per capita, US$

The wealth accumulation data had two limitations. First the data series was only available from 1999 to 2001. Estimated values for these variables were used for the years 2003 and 2005. Second, the data for South Africa was not available for the entire sample period. Thus, South Africa was not included in the wealth accumulation measure.

4. THE EMPIRICAL RESULTS

In this section, we report the results of the band classifications for the data using the empirical model discussed in Section 3. Here, we report the findings for 1995, 1997, 1999, 2001, 2003 and 2005 for all the measures except for the Integrity factor. Results for all the years from 1995 to 2005 are available from the authors. The band configurations for the Integrity factor were measured for 1996, 1998, 2000, and 2002.

4.1 Band Configurations for ICT Infrastructure

Table 1 provides the band configurations for the REACH factor. We observe that most developed countries were clustered within Band 1 to Band 3 in all the six years. We note that two developed countries, Sweden and Norway, have 'leapfrogged' from Band 3 in 1995 to Band 1 in 1997. Majority of developing countries were grouped in Band 5 in all the selected years.

Malaysia and Chile were in Band 5 in 1995. Malaysia moved to Band 4 in 1997, before falling back to Band 5 in 1999. Malaysia remained in this band in 2001. By 2003, Malaysia was again clustered in Band 4, before slipping back to Band 5 in 2005. Chile was clustered in Band 5 from 1995 to 2001. In 2003, Chile moved to Band 4, before moving back to Band 5 in 2005. Mexico, Brazil and South Africa were grouped in the higher positions of Band 5 vis-à-vis other developing countries (that is, China, India, Philippines, Indonesia, Thailand, and India). It is noted that the gap between Band 5 and the other bands have widened in many for many of the variables over the sample period. No intra-band leapfrogging occurred in the REACH factor.

4.2 Band Configurations for Intellectual Capital

The band configurations for the intellectual capital factor are given in Table 2. Most developed countries were clustered within Band 1 to Band 3 in all the years. The US, Canada and New Zealand have 'leapfrogged' from Band 3 in 1995 to Band 1 in 1997. Ireland has also 'leapfrogged' from Band 4 in 1995, to Band 1 in 1997. Most of the developing countries were clustered in Band 5 in all the years. Malaysia moved from Band 5 in 1995 to Band 4 in 1997. Malaysia remained in this band for the remaining periods. Chile, South Africa, Thailand and Brazil were in Band 5 in 1995. In 1997, these countries moved up to Band 4. In 1999, Thailand and Brazil moved back to Band 5, while Chile and South Africa remained in Band 4. These countries remained in these clusters in the next three years. China, Indonesia, India and the Philippines were in Band 5 in all the years.

4.3 Band Configurations for Interaction

The band configurations for the Interaction factor are given in Table 3. From the empirical analysis, we observe that developed countries perform well in this factor compared to developing countries. For example, Finland, Sweden, the US and Singapore were in Band 1 in most of the years. The developing countries were clustered between Band 3 and Band 5 in all the six years. South Africa was in Band 3 in 1995. From 1997 onwards, this country was clustered in Band 4. Thailand and China were in Band 3 in 1995. In 1997 Thailand remained in Band 3, while China moved to Band 4. Thailand was clustered in Band 5 in 1999, 2001, 2003 and 2005. Meanwhile, China was in Band 4 in 1999 and moved to Band 5 in 2001, 2003 and 2005. Malaysia was in Band 4 in 1995 and moved to Band 3 in 1997. In the next two years, Malaysia was in Band 4. In 2003, Malaysia moved to Band 3 before falling back to Band 4 in 2005. Chile and Brazil were in Band 4 in 1995, before moving down to Band 5 in 1997. In 1999 and 2001, Chile moved up to Band 4. By 2003, Chile was in Band 3 and moved to Band 4 in 2005. Meanwhile, Brazil moved down from Band 4 in 1999 to Band 5 in 2001. In 2003, Brazil was again in Band 4 and remained in this band in 2005.

4.4 Band Configurations for Integrity

Table 5 provides the band configurations for the Integrity factor. Most developed countries (such as Singapore, Finland, the US and Ireland) are clustered in Band 1 and Band 2 in all the four years. Developing countries were clustered in Band 3 to Band 5 in the four years (except for Chile). Chile was in Band 3 in 1996, before moving up to Band 2 in 1998 and remained there in 2000. Chile further moved up to Band 1 in 2002. Malaysia was clustered in Band 3 in 1996,

1998 and 2000. In 2002, Malaysia was grouped in Band 2. Thailand and the Philippines were clustered in Band 4 in 1996, but moved to Band 3 in 1998, and remained in this band till 2002. Brazil, Mexico, South Africa and India were placed in Band 4 in 1996. In 1998, these countries moved to Band 3 and remained here until 2002. China and Indonesia was placed consistently in Band 4 and Band 5 in all the four periods.

4.5 Band Configurations for National Innovative Capacity

Table 5 provides the band configurations for the innovative capacity of the countries. Developed countries were clustered in the upper bands (Band 1 to Band 3) in all the periods – denoting that these countries have high innovative capacity. Most developing countries were in Band 5 in all the six years. South Africa, Chile, and Malaysia were in Band 5 in 1995. These countries were clustered in Band 4 in 1997. By 1999, these countries moved back to Band 5 and remained in this band in the next three years (i.e. 2001, 2003 & 2005). The empirical analysis also showed that the innovation-gap between Band 5 and the other bands have increased over the sample periods. We also observe intra-band leapfrogging in this factor, particularly in Band 5. Brazil leapfrogged from seventh position in 1999 to fifth position in 2001. Brazil also leapfrogged to the top of Band 5 in 2003. In 2005, Brazil moved back to the fifth position of Band 5. Consistent with the theory discussed in Section 2, the empirical analysis show that countries that have advanced REACH and RICH factors have high innovative capacity.

4.6 Band Configurations for Competitiveness (Productivity)

The band clustering based for the productivity measures are given in Table 6. Consistent with the theory, countries (mostly developed countries) that are highly innovative, are also in the upper bands in the competitiveness (productivity) dimension. Most developing countries were clustered in the lower bands (Band 4 and Band 5) in most of the years. Brazil was in Band 5 in 1995 and moved up to Band 4 in 1997. Brazil remained in this band until 2005. Thailand was in Band 4 in 1995 and 1997. Thailand moved down to band 5 in 1999, and remained in this band in 2001. By 2003, Thailand was clustered in Band 4, before moving to Band 5 in 2005. China, the Philippines, Indonesia and India were consistently grouped in Band 5 in all the six years. The concerning trend is that the competitiveness-gap between developed and developing countries have also widened over the sample period.

4.7 Band Configuration Based for Wealth Accumulation

The band configurations for the wealth accumulation for the countries are given in Table 7. It is observed that most of the developed countries were clustered mostly in the top four bands in all the years. Ireland, New Zealand and Korea were in Band 5 in 1999. These countries moved to Band 4 in 2001, 2003 and 2005. Singapore was clustered in Band 5 in 1999. In 2001, Singapore moved up to Band 4 and remained in this band in 2003. In 2005, Singapore moved down to Band 5, but was the leader of this band. Most developing countries were clustered in Band 5 in the four periods. The empirical analysis also showed that the wealth-gap between the top four bands and Band 5 has widened over the sample period.

5. POLICY IMPLICATIONS: LEAPFROGGING STRATEGIES

The empirical analysis showed that as the REACH-gap and RICH-gap between developed and developing countries widened over the sample period, the innovation-gap, competitiveness-gap and the wealth-gap between these countries have also widened. The factors hindering the innovative capacity of developing countries include the following:

- Weak ICT infrastructure development due to limited government budget and lack of competition in the ICT sector;
- The levels of intellectual capital development in these countries are very low. This is compounded by the inability of these countries to attract highly skilled and knowledge workers from around the world.
- The cooperation among all the stakeholders in the economy is weak and fragmented. Further, networking among firms from developing countries and their counterparts in more advanced countries are weak in innovation-intensive sectors.
- Institutions of corporate governance and integrity are weak and lack independence.
- Quality of the public sector in developing countries is poor and unable to meet the needs of an information- and knowledge-driven economy.
- Fiscal and non-fiscal incentives in developing countries are not competitive in attracting the best knowledge workers and innovation-intensive firms. Serious 'brain-drain' plagues the developing world. Further, the tax incentives and research infrastructure support are not effective in encouraging small medium enterprises (SMEs) to invest in research and intellectual capital development.
- Institutions to support innovation are weak or not coordinated. Existing legislative framework in many of the developing countries are outdated and inadequate in protecting intellectual property. Further, the legislative framework is unable to support e-commerce and transactions in the digital economy.

In general, most of the countries that have leapfrogged or maintained their positions in the upper bands have implemented strategic and systematic long-term policies to enhance the development of infrastructure, intellectual capital, interaction (strategic partnerships and networking), integrity systems, incentives and institutions in the country. Thus, national innovative capacity is a path dependent phenomenon. Countries that fall behind will find it difficult to keep-up over time.

In this section, some of the pertinent policies and strategies that were adopted by countries that have leapfrogged, and countries that have maintained their positions in the top two bands will be discussed. Lessons from this discussion will be useful in identifying key policies and strategies that developing countries can adopt to 'catch-up' with the more evolved economies.

In the upper band countries, especially in Band 1 and Band 2, government and the private sector played a key role in enhancing the infrastructure for the information economy. Three key measures were under-taken in these countries to develop the ICT infrastructure. First, these countries invested heavily in building and upgrading ICT infrastructure. The cost of these developments were spearheaded by government and supported financially by the private sector. For example, the US government encouraged manufacturers and software companies to develop new technologies to allow higher bandwidth communications across the existing copper network

infrastructure. Approximately US$27 billion was spent by the telecommunication sector to build a global broadband network between 1998 and 2002. The US government also invested heavily in fibre-optic cable and other digital communication equipment in the country during this period (US Department of Commerce, 2001). These large capital investments into ICT infrastructure by the government and the private sector, have kept the US ahead of all the other countries in the sample.

Second, new technologies have been used in many of the advanced countries to facilitate faster connectivity to a wider segment of the population for a fraction of the cost. Among these technologies include satellite technology, the Very Small Aperture Terminal (VSAT) technology and the digital power line (DPL) technology. The latter technology allows for the transmission of information over the power line, which is ubiquitous across upper band countries. The DPL is also called the "last-half-mile technology, where homes and rural areas have access to broadband through existing power lines. Among the sample countries that have successfully deployed DPL are US, Germany, Switzerland and Brazil (Ismail, 2005).

Third, the telecommunication sectors in most of the advanced countries were liberalized in the 1990s. Intense competition in the telecommunication sector led to the significant reduction in the cost of telecommunication and the ICT services. Thus, increasing the ICT penetration rates (mobile phone and Internet). Competition in the ICT sector also has forced many of the telecommunication companies to deploy new telecommunication technologies such as broadband and 3G networks in these countries at a faster pace. For example, Finland has one of the highest numbers of mobile phone users in the world. Finland was one of the earliest countries in the European region to liberalize the telecommunication sector. In 2000, the government provided free 3G mobile licenses to all local telecommunication players (Salminen, 2003). This intensified competition in the telecommunication sector. Thus, driving down cost of telecommunication and raising the quality of the ICT service in the country. The opening of the ICT sector has also raised the innovative capacity of the Finnish firms – enabling Finland to be one of the most competitive countries in the world.

In an information economy, intellectual capital plays an integral role in enhancing the competitive position and development of a country. The empirical analysis from this study showed that countries that have high investment in intellectual capital development are mostly developed nations from North America, Europe and a few countries in Asia (Japan, Singapore and South Korea). With highly educated population, these countries are in a better position to benefit from the ICT revolution. Several measures were taken in these countries to raise the competitiveness of the workforce in these countries. First, in many of these countries, public expenditure on education account for a significant proportion of the national budget. For example in Canada, public spending on education for all levels (pre-school to tertiary) is very high – second largest public spending after the health care sector in the country. In 2001, public spending on education was around C$58.1 billion (15% of public spending). In 1999, the combined public and private expenditures on educational institutions (all levels of education) as a percentage of GDP were 6.6 percent. This is higher than the OECD countries mean of 5.5 percent, and larger developed countries such as US (6.5 percent), Germany (5.6 percent), UK (5.2 percent) and Japan (4.7 percent) (Statistics Canada, 2003).

Second, primary and secondary enrolments are high in many of the advanced countries. To encourage high enrolment in these countries, primary and secondary education is free-of-charge. Third, ICT literacy in many of the developed countries is high because of high usage of ICT in schools. Carefully planned educational programs that utilize ICT in primary and

secondary schools have been introduced. For example the 'School-Net Program' (part of the 'Canada Connected Program') funded by the federal government in Canada have been successful in raising the ICT literacy levels in Canada. Canada along with Australia and Finland has the highest proportion of schools (at least 80 percent) that have Internet access. The PC student ratio in Canada is the second highest with 7 students to a PC, only to be behind Australia (6 students to a PC) in 2000. The OECD average is 34 students to one PC (Statistics Canada, 2003).

Fourth, the level of enrolments in post-secondary education in many of the developed countries is also high due to various financial incentives provided to students enrolled in institutions of higher learning. These incentives were in the form of government study loan, scholarships and tuition fee waivers. Further, various educational programs (on-campus and on-line programs) have been introduced in tertiary institutions to cater for the working population. These types of programs are scarce in many of the developing countries. The various incentives and flexible educational programs in developed countries have raised the proportion of people with tertiary education. For example, in 2001, the proportion of Canadians in the age category of 25-64 years with either a college or a university qualifications was 40 percent. This is the highest among the developed countries. The proportion in the US, Ireland, Japan and Sweden are 37 percent, 36 percent, 34 percent and 32 percent, respectively. The number of individuals in Canada aged 25-64 with a tertiary qualification above a bachelor's degree has surpassed 1 million in 2001; this is 7 percent of the working population (Statistics Canada, 2003).

Fifth, an important factor that makes the education systems in developed countries relevant for the information economy is the strong linkages between educational institutions and industry. In many of the tertiary institutions in the developed countries, industry input is sought when developing new courses. This is to ensure the education and training programs are relevant to the needs of the new economy. There are also significant collaboration among industry and tertiary/research institutions in enhancing the teaching, learning and research nexus in these countries.

Sixth, besides increasing the supply of highly educated citizens that are able to meet the needs of the new economy, developed countries such as US, Canada, Australia, UK and Singapore have been successful in attracting highly educated workers from other countries (especially from developing countries – the lower band countries). Various 'brain-gain' programs have been implemented to attract the best knowledge workers to relocate to these countries. Among them are offers of permanent residency to the workers and their family members, increased funding for research and an attractive quality of life.

Innovation in the new economy is technologically more complex. A single product or service may require integration of knowledge and technology from several sections of an organization and/or from other organizations. Thus, strong cooperation between all stakeholders in the country is vital for the sustained development of innovation and competitiveness of the nation. In this section, we will discuss two types of partnerships that are vital for raising the innovative capacity and competitiveness of nations. First, strong partnership between government, industry and educational institutions are vital for the efficient flow of information, knowledge and innovation between these three stakeholders. Strong cooperation between government, industry and educational institutions will lead to the following:

- Increase the relevance of education and training in meeting the needs of the new economy;
- Reduce the burden of government in building the research infrastructure and human capital development;

- Raise the level of technology transfer between all the key stakeholders in the innovation value chain;
- Increase the R&D success rate; and,
- Increase the speed of commercialization of research.

Several measures taken in developed countries have fostered strong collaboration among all the stakeholders. One of the measures includes the formation of Industry Advisory Group in many educational institutions. The primary role of this group is to assist educational institutions develop curriculum that meets the needs of the industry.

Several programs have been established to enhance technological and scientific cooperation among public research centers, universities and industry in developed countries. Among the measures include programs to assist small medium enterprises (SMEs) to adopt more advanced technologies and innovation. In the US, regional based manufacturing centers and training centers funded by government were established to provide SMEs technical consulting, factory-site reviews, direct hands-on training, technology demonstrations and assistance with selecting the appropriate ICT equipments and software (Coburn, 1995). The government, either through an economic development body, or the education institutions, provides funding for these training centers. The Manufacturing Extension Program (MEP) and the Small Business Technology Transfer (STTR) Program in the United States (www.nist.gov) have been two successful programs that have strengthen the tri-partite cooperation between government, industry and institutions of higher learning. The latter program has been successful in increasing the transfer of technology from the universities/research centers to SMEs for developing commercial products.

In many of the developed countries, a number of fiscal and non-fiscal incentives are in place to foster in-country and cross-country collaboration. These incentives are in the form of tax deduction for R&D activities and technological cooperation with domestic firms. In some countries, government provides infrastructure support and access to domestic markets as a means to attract the best enterprises from around the world to relocate to their country.

The public sector has played a critical role in enhancing the innovative capacity in developed countries. However, "the public service in developing countries is widely perceived to be unsatisfactory and deteriorating" (Shadrach and Ekeanyanwu (2003)). There are very few avenues for the people to provide feedback on the quality and service that they are receiving. The poor public service in developing countries is due to the lack of physical infrastructure, low levels of investment in intellectual capital and more importantly the lack of political will. Countries with weak national integrity systems are prone to market failures such as corruption and moral hazard in the public sector. This can undermine investor confidence and hinder the inflow of the much-needed foreign direct investment for building a more innovative and resilient economy.

In developed countries, the electronic public delivery systems (electronic government initiatives) coupled with a strong and independent regulatory system have enhanced the service rendered by the public sector. The electronic government initiatives have played an important role in achieving the following in the developed countries:

- Transparent and efficient functioning of the public and private sector;
- Improve flow of information among all the stakeholders;
- Strengthen governance and integrity systems; and,

- Empowered all citizens to play a role in public policy formulation and implementation.

Countries that have sound integrity systems are in a better position to keep the cost of business transaction low, provide better value for customers and attract high-end foreign direct investment – key catalysts for enhancing the national innovative capacity.

The ICT revolution in the last two decades has increased the speed of business transaction, transmission of knowledge, rollout of new products and services. This has intensified the pace of innovation and commercialization of research. To keep up with the speed of innovation and economic development, various institutional changes were initiated in developed countries to better manage the resources in the country and get better return on the investments. Several key institutions were established to meet the needs of the country in a rapidly changing global environment. One such institutions is a high level committee to effectively manage the National Innovation System (NIS). Given the importance of this secretariat in setting the direction for the competitiveness of the nation, in most of the developed countries, the Prime Minister or President chairs this secretariat. The committee also includes the relevant ministries and institutions (public and private) that are responsible for the creation of a sustainable innovative ecosystem. The strategic objectives of this committee are to:

- Create and sustain a culture of innovation;
- Increase the diffusion of knowledge, science and technology;
- Foster networking within the nation and across the world;
- Accelerate research, entrepreneurship and commercialization of research; and,
- Strengthening the nation's resilience to respond effectively to globalization and changing global environment.

The committee for innovation provides a platform for discussion and debate on the appropriate policies and strategies for meeting the above-mentioned strategic objectives of the nation.

Another key institutional development for enhancing innovative capacity is the existence of a legislative framework for protecting intellectual property (IP). In most of the developed countries, IP rights are well defined. This enables the researchers and firms to reap the benefits of their research efforts, at the same time cover the cost of the research. Further, the patenting of research outcomes and new innovation in many of the developed countries are relatively simpler than that in developing countries. Various schemes are also in place in the developed countries to match the researchers with potential firms that will help commercialize the outcomes of their research findings.

6. CONCLUSIONS

In the knowledge-based economy, the only constant is 'change' - "innovation and change are inextricable tied together" (Porter, 1990). Innovation is a major source of competitiveness and wealth accumulation in the new economy. In this paper, we provide a new theoretical and empirical framework to understand the key drivers for innovative capacity of nations. Though the empirical analysis provided in this paper suffers from similar data and model limitations as in other empirical studies in the literature, it nevertheless does provide useful insights on the conditions that facilitate the creation of an innovative eco-system. Lessons from developed

countries provide valuable directions on the type of policies and strategies required to be competitive in the information economy.

In conclusion, the global environment is changing at a warp speed. All countries and organizations must change with the time or face the risk of falling behind in terms of competitiveness. Thus, effective and efficient management of the REACH-factor and the RICH factor are vital for facilitating developing countries to leapfrog to higher stage of innovative capacity, competitiveness and socioeconomic development.

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Figure 1: Key drivers for a sustainable innovation-ecosystem and competitiveness [7*i*-Framework for Competitiveness]

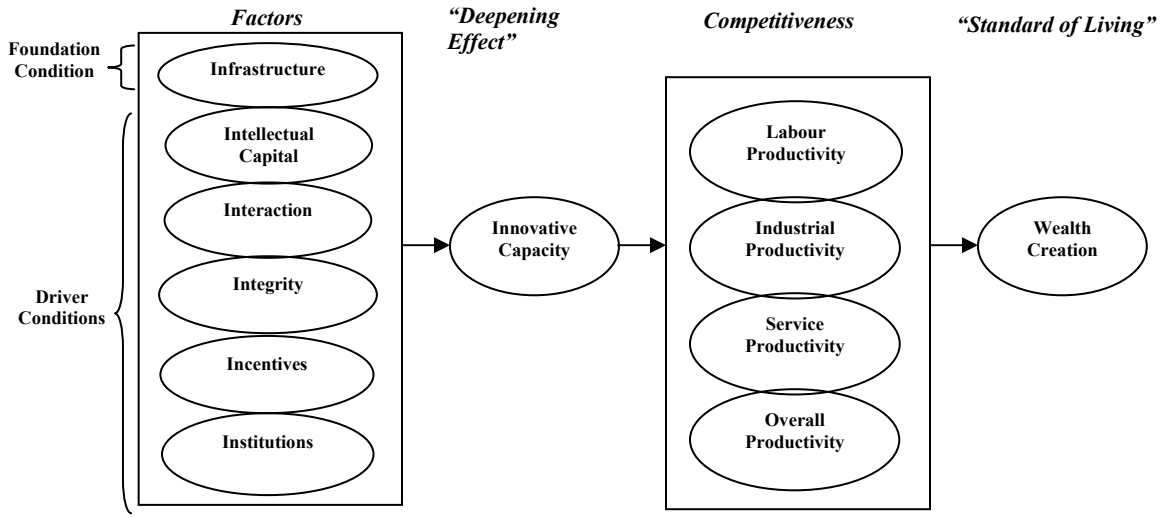

Figure 2: Socio-Economic Development in the Information Economy

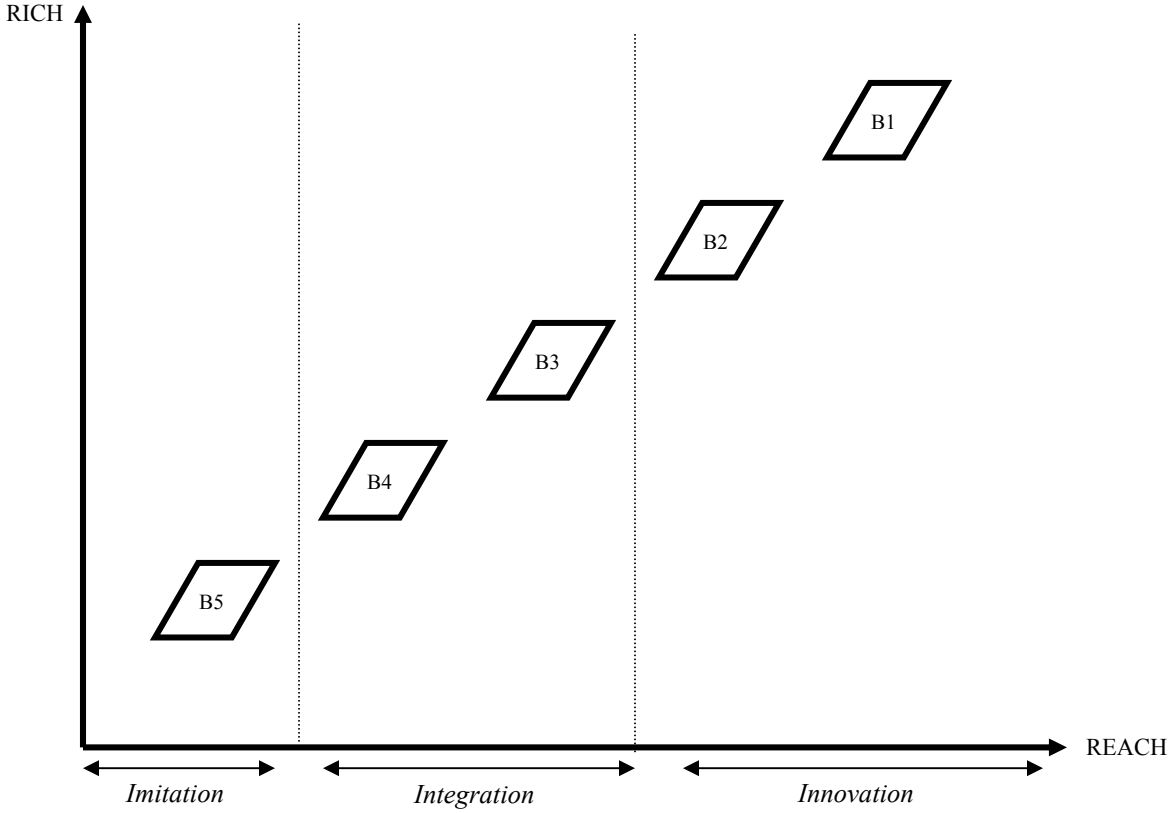

Figure 3: Moving up the value chain in the Information Economy

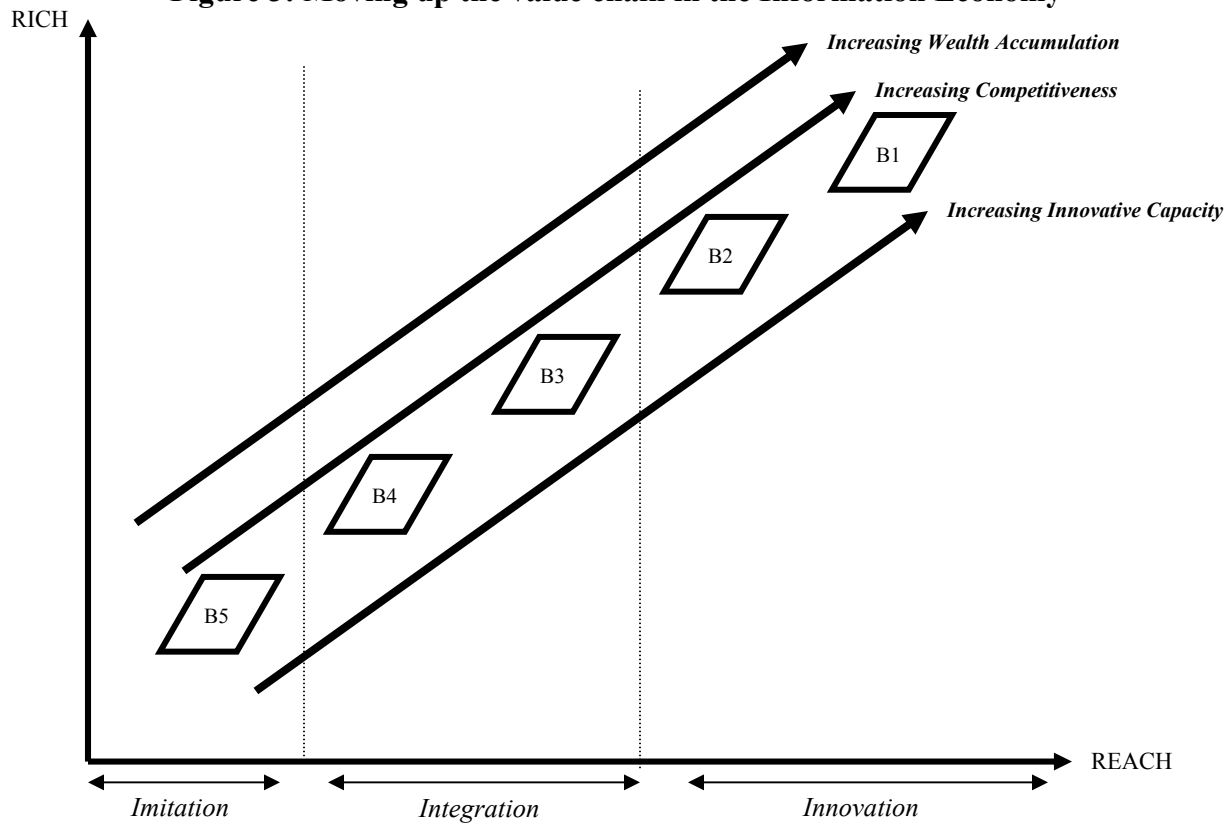

Figure 4: Inter-Band Leapfrogging in the Information Economy

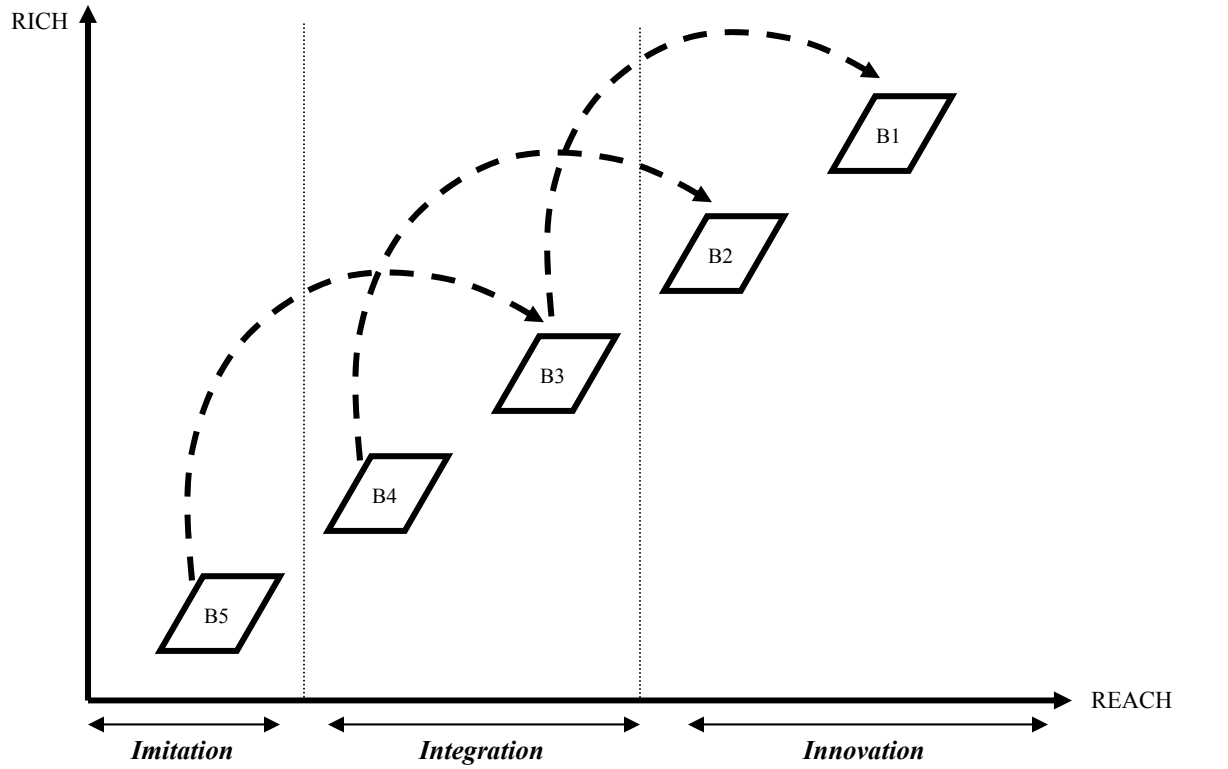

Figure 5: Algorithm for Benchmarking the Developments in the Information Economy

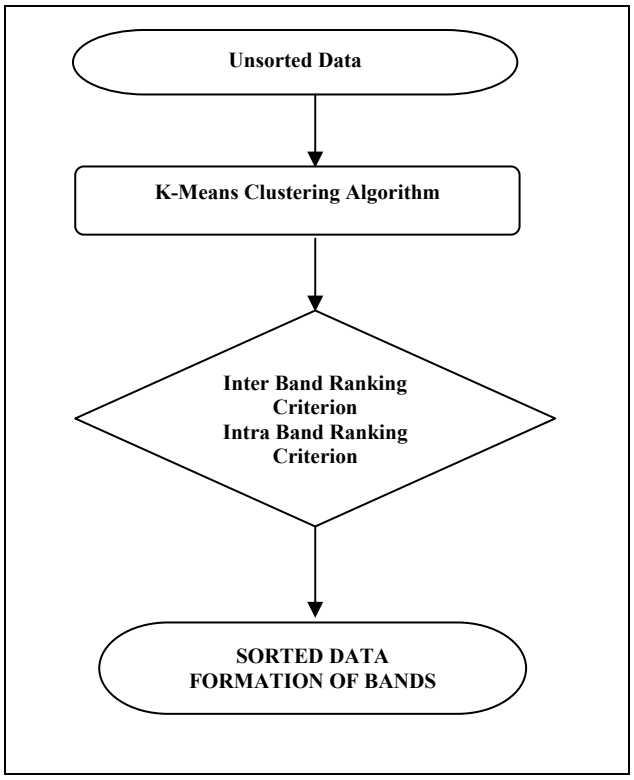

Table 1: Band Configurations for REACH factor

1995	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Switzerland	Norway	Ireland	Malaysia
			Sweden	Taiwan	Chile
			Finland	Korea	South Africa
			Australia		Mexico
			New Zealand		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	South Africa
	Sweden	Switzerland		Korea	Brazil
		Canada		Malaysia	Mexico
		Finland			Thailand
		New Zealand			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

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Finland	UK	Taiwan	Malaysia
	Sweden	Australia	Japan	Korea	South Africa
	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	South Africa
		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

2003	Band 1	Band 2	Band 3	Band 4	Band 5
	US	UK	Singapore	Taiwan	South Africa
	Sweden		Finland	Korea	Brazil
	Switzerland		Australia	Malaysia	Mexico
	Norway		Canada	Chile	Thailand
			Japan		China
			New Zealand		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

2005	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Sweden	UK	Ireland	Malaysia
		Switzerland		Taiwan	Chile
		Norway		Korea	South Africa
		Singapore			Brazil
		Finland			Mexico
		Australia			Thailand
		Canada			China
		Japan			Philippines
		New Zealand			India
		Germany			Indonesia
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	572.78	503.60	399.08	392.35	109.77
X2	634.82	407.85	397.65	229.62	28.78
X3	391.94	197.85	246.21	55.39	7.45
X4	780.96	443.15	546.14	93.63	16.19
X9	959.05	1004.47	810.60	597.18	105.97
X5	58270.16	39171.47	30271.19	21004.53	4332.27
X6	329842.68	221613.91	191649.45	106967.57	19756.69
X7	513959.62	274111.82	169302.19	137713.38	44745.20
X8	2.38	1.83	1.71	1.90	0.66
X10	725.48	622.14	541.98	422.20	73.62
X11	499.15	679.62	848.66	814.65	203.79
X12	1183857.12	862001.54	2286892.96	503215.88	69978.61
X13	7.99	7.96	4.60	5.59	5.10

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

Table 2: Band Configurations for Intellectual Factor

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	South Africa
			New 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	South 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	Band 1	Band 2	Band 3	Band 4	Band 5
	US	New Zealand	Norway	Singapore	Thailand
	Canada	Sweden	Finland	South Africa	Philippines
		Switzerland	Germany	Korea	India
		Ireland	UK	Malaysia	Brazil
		Australia	Japan	Mexico	China
			Taiwan	Chile	Indonesia
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	7.13	6.99	6.57	6.30	6.31
X2	6.26	5.90	6.22	4.93	5.26
X3	6.22	6.29	5.54	5.65	5.61
X4	1343.94	1873.58	804.80	358.33	74.98
X5	7.24	6.64	6.71	6.24	6.58
X6	6.84	5.56	5.06	4.26	4.20

2001	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Norway	Germany	Korea	Thailand
	Canada	Switzerland	New Zealand	Malaysia	Brazil
		Sweden	UK	South Africa	Philippines
		Ireland	Singapore	Chile	India
		Australia	Taiwan	Mexico	China
		Finland	Japan		Indonesia
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	7.00	6.69	6.76	5.84	6.29
X2	5.11	5.82	5.50	4.49	4.42
X3	6.90	6.44	5.65	5.56	5.37
X4	2457.02	1796.52	1042.33	527.18	119.16
X5	6.62	6.72	6.66	6.45	6.43
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	Korea	Thailand
		Sweden	Germany	South Africa	Brazil
		Norway	Japan	Mexico	China
		New Zealand	UK		Indonesia
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	6.99	6.67	6.83	5.60	5.81
X2	5.87	5.39	5.71	4.35	4.46
X3	6.90	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

2005	Band 1	Band 2	Band 3	Band 4	Band 5
	Canada	Australia	Finland	Singapore	India
	US	Ireland	Taiwan	Malaysia	Philippines
		Switzerland	Germany	Chile	China
		Sweden	Norway	South Korea	Brazil
		New Zealand	Japan	Mexico	Thailand
			UK	SouthAfrica	Indonesia
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	7.24	6.72	6.80	6.38	6.14
X2	5.63	5.97	5.44	5.12	4.71
X3	6.94	6.42	5.52	5.78	5.77
X4	2837.97	1813.94	1180.77	633.16	161.29
X5	7.27	6.95	6.69	6.83	6.67
X6	6.32	6.48	5.62	4.77	4.32

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

Table 3: Band Configurations for Interaction Factor

1995	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	Australia	South Africa	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	South Africa	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		South Africa	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		South Africa	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	South Africa	
		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

2005	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	US	Japan	New Zealand	Thailand
		Sweden		Malaysia	China
		Canada		UK	Mexico
		Switzerland		Philippines	Indonesia
		Singapore		South Africa	
		Taiwan		Chile	
		Ireland		Korea	
		Germany		Brazil	
		Australia		India	
		Norway			
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	7.89	5.84	3.80	4.26	3.22
X2	8.03	6.35	6.37	4.93	3.84

X1: Research cooperation
X2: Technological cooperation

Table 4: Band Configurations for Integrity Factor

1996	Band 1	Band 2	Band 3	Band 4	Band 5
	Singapore	New Zealand	Japan	Brazil	China
		Switzerland	Chile	Mexico	Indonesia
		Norway	Taiwan	Philippines	
		Finland	Malaysia	South Africa	
		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		
		New Zealand	Philippines		
		UK	South Africa		
		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	South Africa		
		UK	Malaysia		
		Australia	Thailand		
		Ireland	Brazil		
		Canada	Mexico		
		New Zealand	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	South Africa	China	Indonesia
	Switzerland	Taiwan	Thailand		
	Sweden	Korea	Mexico		
	New Zealand	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

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

Table 5: Band Configurations for National Innovative Capacity

1995	Band 1	Band 2	Band 3	Band 4	Band 5
	Japan	Sweden	Norway	Taiwan	South Africa
	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

1997	Band 1	Band 2	Band 3	Band 4	Band 5
	Switzerland	Norway	Taiwan	South Africa	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

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	Switzerland	Norway	Taiwan	Korea	South Africa
	Japan	Canada			Malaysia
	Sweden	UK			Chile
	Finland	Singapore			Philippines
	US	Australia			Mexico
	Germany	Ireland			India
		New Zealand			Brazil
					Thailand
					China
					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

2001	Band 1	Band 2	Band 3	Band 4	Band 5
	Finland	Japan	Germany	Taiwan	China
	Sweden	US	Canada	Korea	South Africa
	Switzerland		Singapore		Malaysia
			UK		Chile
			Norway		Brazil
			Australia		Philippines
			Ireland		Mexico
			New Zealand		Thailand
					India
					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

2005	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Finland	Germany	Korea	China
	Japan	Switzerland	Singapore		Malaysia
		Sweden	Canada		South Africa
			Taiwan		Chile
			Norway		Brazil
			Australia		India
			UK		Philippines
			Ireland		Mexico
			New Zealand		Thailand
					Indonesia
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	5.25	5.54	2.57	2.00	0.12
X2	5.19	8.60	4.44	3.04	0.39
X3	1061.22	998.10	402.24	242.05	13.06
X4	774.89	755.42	237.14	171.12	7.63
X5	7.78	7.58	6.76	7.41	4.82
X6	7.80	8.56	8.00	5.54	5.54
X7	121.36	14.76	38.43	385.95	3.03

X1: R&D personnel in business per 1000 people
X2: R&D personnel nationwide per 1000 people
X3: Total R&D expenses per capita, US$
X4: Business R&D expenses per capita, US$
X5: Basic research
X6: Patents & Copyright protection
X7: Patent productivity per 1000 R&D personnel

Table 6: Band Configurations for Competitiveness (Productivity)

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	South Africa		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

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	Ireland	US	UK	Chile	Thailand
		Norway	South Africa	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	South Africa	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

2003	Band 1	Band 2	Band 3	Band 4	Band 5
	Ireland	Australia	Singapore	Chile	Philippines
	Norway	Finland	South Africa	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

2005	Band 1	Band 2	Band 3	Band 4	Band 5
	Ireland	Australia	Japan	Chile	Thailand
	US	Canada	Switzerland	Mexico	Philippines
	Norway	Finland	Singapore	Malaysia	China
		South Africa	New Zealand	Brazil	India
		Taiwan	Korea		Indonesia
		Germany			
		UK			
		Sweden			
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	38.07	30.31	22.91	13.20	5.76
X2	94342.90	64854.24	54327.84	32590.74	19144.96
X3	66320.25	53509.00	45878.31	24212.40	13018.73
X4	69575.78	55157.66	43193.03	28425.54	13209.17

X1: Overall productivity
X2: Labour productivity
X3: Service productivity
X4: Industry productivity

Table 7: Band Configurations for Wealth Accumulation

1999	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Canada	Norway	Japan	Ireland
			Switzerland	Finland	Singapore
			Sweden	Germany	New Zealand
			UK	Australia	Korea
					Taiwan
					Malaysia
					Mexico
					Chile
					Brazil
					Thailand
					Philippines
					Indonesia
					China
					India
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	96.31	32.81	20.85	13.66	1.73
X2	198.39	217.29	116.49	71.67	5.52
X3	295.16	251.01	131.03	85.53	9.53

2001	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Switzerland	UK	New Zealand	Mexico
		Norway	Germany	Ireland	Chile
		Japan	Finland	Korea	Malaysia
		Canada	Australia	Singapore	Thailand
		Sweden	Taiwan		Brazil
					Philippines
					China
					Indonesia
					India
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	233.50	121.95	99.40	47.06	2.54
X2	726.44	684.00	381.73	161.17	14.75
X3	983.64	806.52	481.55	333.78	17.34

2003	Band 1	Band 2	Band 3	Band 4	Band 5
	US	Switzerland	Finland	Ireland	Mexico
		Norway	Japan	New Zealand	Chile
		Sweden	Australia	Korea	Malaysia
		Canada	Taiwan	Singapore	Brazil
		UK			Thailand
		Germany			China
					Philippines
					Indonesia
					India
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	400.64	224.38	213.40	96.20	4.43
X2	1566.32	1726.23	908.60	467.04	38.02
X3	2105.08	2032.76	1082.08	768.33	42.22

2005	Band 1	Band 2	Band 3	Band 4	Band 5
	Switzerland	US	Sweden	Ireland	Singapore
	Norway		Canada	Australia	Mexico
			UK	Taiwan	Chile
			Germany	Japan	Malaysia
			Finland	New Zealand	Brazil
				Korea	China
					Thailand
					Philippines
					Indonesia
					India
	Mean	**Mean**	**Mean**	**Mean**	**Mean**
X1	373.03	597.73	351.49	265.26	9.03
X2	4036.40	2718.07	3037.85	1242.94	79.31
X3	5031.91	3659.48	3425.76	1362.00	223.38

X1: B2C (US$) per capita
X2: B2B (US$) per capita
X3: Internet commerce (US$) per capita