Managing innovation in the network economy: Lessons for countries in the Asia Pacific region

Mahendhiran **Nair** and Tengku Mohd Azzman **Shariffadeen**

INTRODUCTION

The information or knowledge revolution has been under intense scrutiny and debate for several decades now. The spectacular rise of the Internet and the Web is the major reason for this wide interest. And yet, while information and knowledge are as important as the Internet if not more so, they often take a back seat in the debate. Their abstract and diffuse nature has made them less amenable to quantitative analysis, rendering the information and knowledge discourse largely descriptive, anecdotal, and qualitative. Orbicom was one of the pioneering organizations to make the connection between the digital and knowledge revolutions and to do it in a quantitative manner (Sciadas 2005). In its 'monitoring the digital divide' initiative, it formulated a fresh way of measuring the digital divide based on the *infostate* of a country, which results from the combination of its *infodensity* and its *infouse*.

In a similar spirit, this chapter presents a quantitative method of assessing the innovative capacity of countries. It is proposed as a framework enabling a more detailed analysis of what makes a country innovative, which in turn would make possible the setting of goals that would serve as guideposts on a country's journey toward greater innovativeness, productivity, and competitiveness. Such an analytic approach would help policymakers and government leaders manage the process of knowledge-based development to enhance the quality of life and well-being of a country's citizens.

In the last three decades, the Asia Pacific region has been one of the most dynamic in terms of socio-economic development. Many of the countries in the region were underdeveloped when they achieved independence in the 1940s–1960s. World War II decimated many of these economies, with conditions worsening further as a result of post-war regional conflicts. However, despite a bleak past, many of these countries were able to transform their economies into leading producers of automobiles, electronics, and other consumer durables. These transformations were made possible first by the adoption of industrialization, and lately, by the adoption of new technologies, including information and communication technologies (ICTs).

Still, although there has been significant socio-economic development in the region, many countries remain 'under-developed'. Some studies have shown that the widening ICT gap is a significant contributor to the increasing wealth gap between developed and other countries in the Asia Pacific region (cf. Nair et al. 2005; Sciadas 2005). The role of ICT in enhancing competitiveness and sustainable development has been widely debated in the literature. Studies by Gurbaxani et al. (1998), De Gregorio (2002), and Criscuolo and Waldron (2003) show that ICT has increased the productivity, efficiency, and market reach of firms all over the world. On the other hand, Lau and Tokutsu (1992), Kraemer and Dedrick (1993), and Kim (2003) argue that investment in ICT infrastructure alone is not sufficient for economies to achieve sustainable development, and that a skilled workforce is an important precondition for nations to benefit from ICT investments. This is supported by the infostate conceptual framework, where infodensity refers to the ICT capital and ICT labour stocks that complement info-use, which refers to the usage flows of ICT. In other words, a causal relationship between investments in human capital and infrastructure development on one hand, and the information and knowledge flows engendered by them on the other, produces higher levels of economic performance.

Realizing the potential of ICT in enhancing economic prosperity, Asia Pacific countries have increased investment in ICT over the past decade. The World Information Technology and Services Alliance (WITSA) predicts that the Asia Pacific region will outstrip other regions in ICT spending, with a compounded annual growth in ICT spending of 11.1 percent from 2005 to 2009 (WITSA 2006). However, it remains unclear whether ICT investment has helped countries in the region close the innovation gap with more evolved economies. While there is evidence that ICT does contribute significantly to socio-economic development, there is uncertainty about how this comes about and how it may be improved.

This chapter aims to empirically examine the linkage between ICT development and innovative capacity in Asia Pacific countries. More specifically, it looks at the gaps in ICT and innovative capacity between developed and other countries in the Asia Pacific region, and outlines measures to close the digital and innovation divides between countries. The chapter is organized as follows: a brief review of the network economy is provided, followed by an explanation of the proposed theoretical framework and empirical method to measure the national innovation ecosystem (NIE). The empirical results are then presented and discussed, followed by strategies for enhancing the NIE in the Asia Pacific region. The final section proposes a way forward.

REVISITING THE NETWORK ECONOMY

The network economy is also sometimes referred to as the information economy, virtual economy, digital economy, or electronic economy. The wide variety of 'network effects' manifesting the digitization of information contributes to socio-economic development via two channels. First, the digital medium has resulted in the emergence of new sectors related to software, hardware, systems, and ICT-related services. For some countries, these new economic sectors provide opportunities for higher value added products, and thereby, a more competitive and productive economy. Second, the interactive digital environment has opened up new dimensions for communication, commerce, trade, knowledge gathering, and technology transfer. This aspect of the network economy can be enjoyed by all countries, regardless of whether they aspire to develop an ICT economic sector. The only condition is that they learn to effectively apply ICT to all important economic sectors across the board. Since this enabling function of ICT is of great interest to most countries, we provide several developmental examples.

The digital medium facilitates communication and faster exchange of information between suppliers and consumers of goods and services. Multiple sourcing from the global markets allows firms to reduce their cost and diversify their market risks. Consumers are also able to use 'shopbots' (also known as 'shop robots') to quickly search for information on products and services at a relatively low cost. The new multimedia and computing technologies likewise allow firms to track and study changing global market trends, which in turn enables them to produce a wider range of products that meet the needs of diverse markets. For example, the LEGO Group (http://www.lego.com) uses the digital medium to identify changing market demand by providing various incentives for its customers to provide feedback on improving product designs. By such means network-savvy firms like the LEGO Group are able to pursue *economies of scope*.

In the network economy, the production of goods and services transcends the limitations of traditional factors of production, namely, land, labour, and capital. In the traditional economy, nations with large endowments of land, labour, and capital were in a better position to lead the innovation and competitiveness race. However, in the network economy, national competitiveness is a function of the level of connectivity to the global economy. Nations with a small land mass are able to move from 'place' (land), which is limited, to 'space' (cyberspace), which is unlimited. The relaxation of physical constraints has helped small nations to catch up with more developed countries.

In the digital space, there is also greater cooperation among buyers. This is changing how goods and services are produced and traded in global markets. For example, new technology like Skype (http://www.skype.com) pools unused and spare computing power to allow people to make free calls over the Internet. The cost of communication is significantly reduced — reportedly by as much as 90 percent (Hof 2005) — through the sharing of a resource (unused computer space). The increased cooperation among consumers facilitated by the ICT revolution has led to positive network externalities. The Web provides a platform for consumers to meet, share information, and exchange knowledge (e.g. ratings) about goods and services. Thus, 'cooperative consumer activism' spurred by the network revolution can determine the successful expansion of a firm's market reach. These firms provide a significant boost to the competitiveness and global presence of their host country.

The digital medium also plays a key role in fostering greater cooperation among firms, related organizations, and consumers. In the network economy, organizations are better able to tap into the 'collective intelligence' of consumers, suppliers, and other stakeholders. Instead of having a few researchers working to develop a new innovation, firms can take advantage of the 'network brain' that is made up of millions of people working on similar projects. For example, Procter & Gamble (P&G) with a research budget of USD 1.7 billion uses a network of 80,000 independent researchers from 173 countries to collectively solve research problems (Hof 2005). P&G's investment in the network brain has increased product development from outside the organization 20–35 percent (Hof 2005). There are thousands of enterprises like P&G that use network technologies to locate solutions and innovations outside their firms. Thus, the ICT revolution has enabled 'open innovation' on a grand scale.

Several empirical studies show that firms that have invested in ICT infrastructure and human capital development have benefited in terms of increased productivity and efficiency. For example, Baily (2002) found that greater use of ICT increased multi-factor productivity in the service sector in the United States (US) in the 1990s. Kumar (2002) concluded that investments in ICT and education contributed to economic growth in the US from 1964 to 2000. Becchetti et al. (2003) showed that ICT investments had a positive impact on the productivity and efficiency of small and medium-sized enterprises (SMEs) in Italy from 1995 to 1997. They also showed that telecommunications investment increased the development of new products and processes, while software investment increased the demand for skilled workers and improved labour productivity. A more recent study by Timmer and van Ark (2005) indicated that ICT contributed to the growth of labour productivity in the European Union (EU) and the US through ICT-capital deepening and total factor productivity growth due to the production of ICT goods. The study found that these two channels are responsible for labour productivity in the US surpassing labour productivity in the EU from 1995 to 2001.

In sum, the digital revolution has powered greater interdependence and interconnection between markets, economic agents, and nations. The so-called 'network effects' of the digital revolution have produced a critical mass of ICT users, with each user able to benefit from the shared information and knowledge made available by other users connected to the system. The enhanced convergence of new technologies and the development of highly integrated systems are blurring the boundaries between the different economic sectors and the roles of economic agents. Nations and enterprises that have learned to play by the 'new rules' of the network economy are in a better position to enhance innovative capacity and achieve sustainable socio-economic development.

In the next section, we apply this qualitative understanding of the dynamics of the network economy to derive an analytic framework for measuring innovative capacity that can be used for quantitative analysis.

MEASURING INNOVATIVE CAPACITY IN THE NETWORK ECONOMY

Joseph Schumpeter popularized the term 'creative destruction' for innovative capitalist products and methods that will continually displace old ones. Schumpeter (1934, 1942) gave numerous examples to illustrate the point, from factories wiping out blacksmith shops to automobiles replacing buggies and horses. In more recent times, the concept of creative destruction captures the underlying structural changes taking place in the knowledge-based economy whereby traditional corporations are being replaced by virtual teams and network-based organizations. Smaller nations and firms are demonstrating that they are equally capable of tapping into global markets to gain competitive advantage.

Here we present an analytic framework for examining the underlying structure of the network economy. We discuss the enabling environment that contributes to the innovative capacity of nations, and describe an empirical method to measure the 'building blocks' of the NIE and their contribution to the innovative capacity of nations. The empirical analysis also benchmarks NIE developments in Asia Pacific and other regions.

Framing the Innovation Challenge: Moving from Description to Measurement

In the industrial economy based on the manufacture of physical goods, larger economies such as Japan, Germany, the UK, and the US were the dominant players. However, with the rise of the network economy, smaller nations such as Finland, Hong Kong, Ireland, Singapore, and Taiwan have shown their ability to rapidly enhance their competitiveness, and in some sectors of the economy, these smaller economies have surpassed the traditional economic superpowers. Much of their success is attributed to investment in 'creative capital' and the development of a resilient NIE that continuously adapts to global technological changes.

Several studies show that innovation is an important source of socio-economic development. Romer (1986, 1990) has argued that technology coupled with human capital development and research and development (R&D) are important sources of economic growth. Lucas (1988) has shown that economic disparities between countries are a function of varying levels of stock of human capital to undertake innovative activities, with developed economies being more competitive in attracting the best knowledge workers from other countries, especially from underdeveloped economies. The 'brain drain' from underdeveloped economies undermines their innovative capacity and hinders sustained socio-economic development in these countries.

A number of economists have been critical of the traditional economic models that attempt to explain the different innovation levels of countries. They argue that such models fail to capture the enabling institutional framework for sustaining innovation. Among the pioneering works that attempt to capture the role of institutions in innovation are those by Nelson and Winter (1977) and Nelson (1981). Building on their ideas is the concept of national system of innovation, the key studies of which include those by Freeman (1987), Dosi et al. (1988), Lundvall (1992), Nelson (1993), and Edquist (1997).

In the national system of innovation literature, two schools of thought have emerged. The first school is led by Nelson (1993), who argued that the national system of innovation is centred on the institutions that coordinate and enable innovation in a country, including institutions that are responsible for rules and regulations. Nelson (1993, p. 4) defines the national system of innovation as a 'set of institutions whose interactions determine the innovative performance of a nation's firms'. The second school is led by Lundvall (1992), whose primary argument is focused on 'learning-by-doing' and 'learning-by-using'. Lundvall (1992, p. 2) describes the national system of innovation as 'constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge'. Lundvall's work contributed to the concept of the 'knowledge economy' (Godin 2006).

More recent studies have attempted to measure underlying factors that impact upon the innovative capacity of a country, which is defined by Furman et al. (2002, p. 900) as 'the ability of a country — as both political and economic entity — to produce and commercialize a flow of new-to-the-world technologies over the long term'. They argue that national innovative capacity is a function of three factors, namely *(i)* innovation infrastructure; *(ii)* the industrial cluster environment; and *(iii)* the linkage between *(i)* and *(ii)*. Innovation infrastructure is defined as key investments and policies that support innovation. These include investment in human capital development, financial support for science and technology development, and policies and regulations that promote research and commercialization. The 'cluster-specific environment', the second factor, is defined as the geographical locations of interconnected firms based on the Porter Diamond Model (Porter 1990) where the competitiveness of the clusters is dependent on the following drivers: the intensity of rivalry in the local market, demand conditions, the presence of local supporting industries, and the availability of high quality factor inputs.

Although Furman, Porter, and Stern's model (2002) captures the key drivers of national innovative capacity, it is not without limitations. One of these is that the three pillars of innovation are too broad, and thus are unable to capture the impact of technological infrastructure (especially ICT) on other key drivers such as human capital, regulations, institutions, and interactions between the key stakeholders in the system.

To overcome this limitation, Nair (2007) has proposed a model that measures the impact of ICT on the quantity and quality of human capital, strategic linkages, good governance, incentive systems, and institutions — all key pillars of the NIE. Nair (2007) argues that a nation's innovation capacity is dependent on the level of development of the NIE, which in the network economy is characterized by two important building blocks called the *foundation* and *driver* conditions.

The foundation condition captures the infrastructure that connects people to the global economy. Connectivity to the global economy contributes to economic development through two important channels. First, infrastructure spending, especially in ICT, can lead to economic growth through the production of ICT products and services. Second, ICT infrastructure investment has several spillover benefits to society, among these the creation of virtual communities leading to new generation products and services; increased global reach of enterprises; and ability to attract multiple sources of production inputs at a relatively low cost. These spillover benefits allow firms to simultaneously pursue *economies of scale* and *economies of scope*, both of which are important for achieving competitive and comparative advantage. It is arguable that these spillover effects are more important to most countries as they lead to higher levels of productivity and competitiveness in all economic sectors, and are not limited to the ICT sector alone.

The foundation condition is a necessary condition for sustained socio-economic development in the network economy. But it is not sufficient to stimulate innovation and economic development. A second set of conditions, called the driver condition, works in combination with the foundation condition to create an enabling environment to stimulate economic growth. The driver condition encompasses five factors that are vital for nations to move up the innovation value chain:

- Intellectual capital development, including the ability to increase the supply of a skilled workforce and sustain them in the economy.
- Interaction between stakeholders in the economy, especially between research institutions and enterprises, and between enterprises.
- Integrity and good governance (including adherence to best practices and global standards and benchmarks).

- Incentives to stimulate creativity and innovation, including fiscal and non-fiscal incentive policies that will encourage foreign enterprises to bring in high-technology investment and new know-how and encourage local enterprises to adopt new technologies and engage in R&D activities.
- Institutions for the effective operation of the network economy, including legal and regulatory institutions.

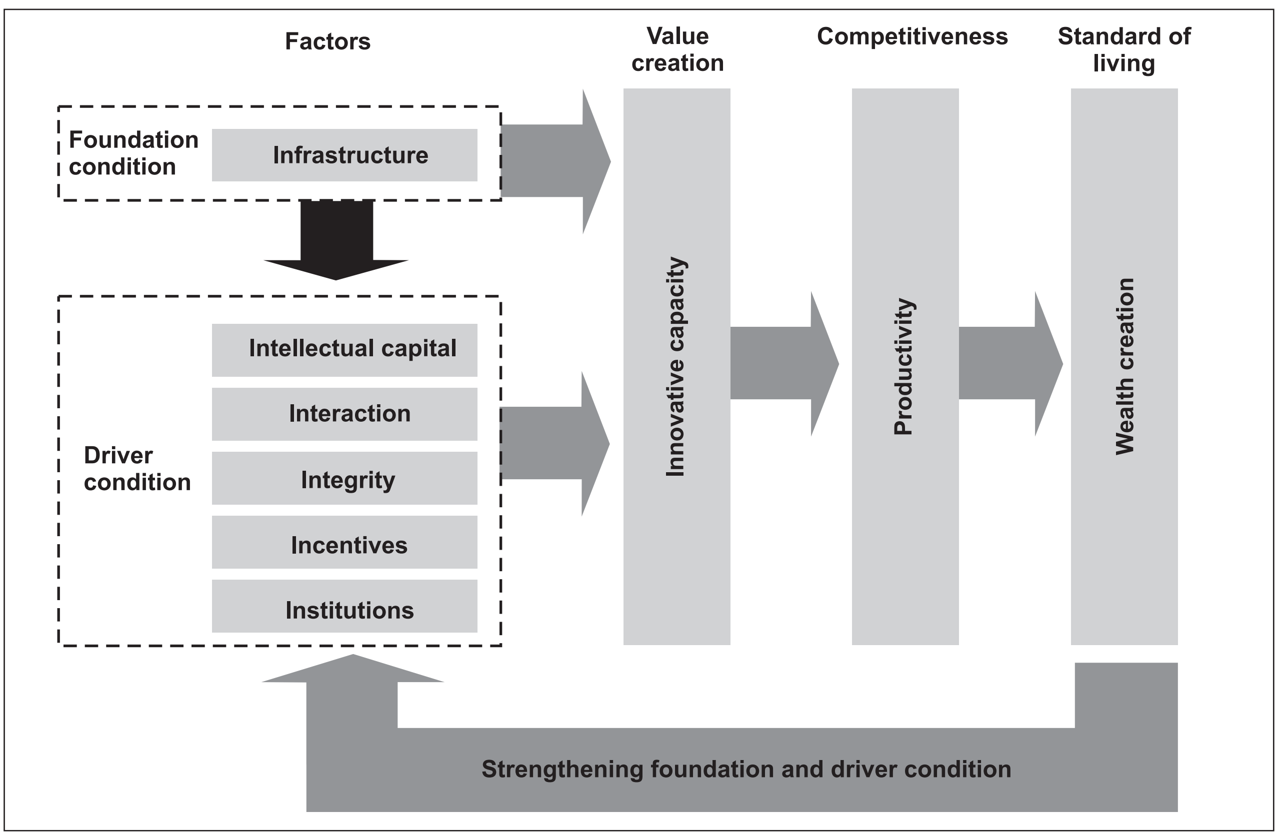
Figure 3.1 shows how the foundation condition and the driver condition together impact innovative capacity. A highly innovative country is able to create more value, and thus becomes more productive and competitive, which leads to greater opportunities for wealth creation and a higher standard of living. Greater wealth produces surplus income that may be reinvested to further improve the foundation and driver conditions, thereby closing the feedback loop. A well-managed innovative economy then becomes a mutually supporting system that produces sustained and accelerated growth.

The foundation condition contributes to innovative capacity in two distinct ways. First, it directly enhances the reach of all economic agents in the economy, which is an important feature of the network economy as discussed earlier. Second, the foundation condition operates in tandem with the driver condition to magnify the impact of the driver condition on innovative capacity.

The wide range of factors that influence innovative capacity as reported in the literature shows that the underlying structure of the economy is highly complex, characterized by interaction between and among many key institutions and stakeholders in the system. The inter-relationships between these institutions and stakeholders are the primary drivers and catalysts of the production, diffusion, and use of knowledge in the new economy. Key building blocks of the NIE were identified through detailed literature review, and these have been incorporated into the new innovation system framework presented here.

The proposed framework provides a holistic model of a complex system that makes it possible to analyze innovative capacity empirically and quantitatively. In the following section, we empirically examine the impact of the foundation and driver conditions on the innovative capacity of developed

Figure 3.1
The 'building blocks' of the new economy



(Source: Nair 2007)

and developing countries in Asia Pacific and other regions. In particular, the empirical models will assess whether a highly developed foundation condition is an important requirement for enhancing the impact of the driver condition on the innovative capacity of countries, both developed and developing.

Measuring the Impact of the Foundation and Driver Conditions on Innovative Capacity

Five empirical models are presented to measure the impact of foundation and driver conditions on innovation in Asia Pacific countries and in countries located elsewhere. Details of the models are provided in Appendix 3.1A to avoid technical complexity in the main presentation.

Model 1 seeks to answer the following questions:

- What is the impact of *foundation* and *driver* conditions on the *innovative capacity* of countries?
- Do the foundation and driver conditions *complement* each other, and if so, how?

In other words, the model should enable us to say whether the framework formulated is a useful measure of innovative capacity to begin with. It also allows us to show whether the foundation condition is an important 'precondition' for enhancing the contribution of the driver condition on innovative capacity.

The next four models compare the innovative capacity of selected developed and developing countries. Four groups of countries are considered:

1. Developed countries in Asia Pacific
2. Developing countries in Asia Pacific
3. Developed countries in other regions
4. Developing countries in other regions.

Model 2 seeks to answer the following questions:

- Is *innovative capacity* different in the four groupings of countries?
- How significant are these differences?

A comparison of innovative capacity among the four groups of countries will show the relative positions of each, as well as the significant differences between these country groupings, if any.

Model 3 seeks to answer the following questions:

- Is the contribution of the *foundation* condition to *innovative capacity* in the four groupings of countries different?
- How significant are the differences?

Model 4 seeks to answer the following questions:

- Is the contribution of the *driver* condition to *innovative capacity* different in the four groupings of countries?
- How significant is the difference?

Model 5 seeks to answer the following questions:

- Are the *complementary effects* of the *foundation* and *driver* conditions different in the four groupings of countries?
- How significant are the differences?

Data for the countries included in this study (listed in Table 3B.2, Appendix 3.1B) were obtained from the *Global Competitiveness Report* for three sample periods: 2001–2002, 2002–2003, and 2004–2005. A detailed discussion of the variables used in the study and the data sources is given in Table 3B.1 (Appendix 3.1B). Internet penetration rates were used as a proxy for the foundation condition. The driver condition was taken as the average of the variables measuring intellectual capital, interaction, integrity, incentives, and institutions. All of the variables used were converted to base 100 so that they can be formed as a composite index.

EMPIRICAL RESULTS

In this section, we discuss the empirical results obtained from the application of the five models. Figure 3.2 is the scatter plot for the foundation and driver conditions for 104 countries for the period 2004–2005. It shows that there is a positive correlation between foundation and driver conditions. This suggests that for these 104 countries there is a strong relationship between foundation and driver conditions.

Figure 3.3 is the scatter plot for the foundation condition against innovative capacity. The plot shows that as the foundation condition improves, the innovation capacity of countries increases.

Figure 3.4 is the scatter plot for the driver condition against innovative capacity. It shows that as nations improve their driver condition, their innovative capacity also improves. From Figure 3.3 to Figure 3.4, we observe that the driver condition has a greater explanatory power for innovation than the foundation condition. Both plots confirm that the foundation and driver conditions greatly influence innovative capacity and thus provide an effective means of measuring the NIE.

The estimated results for Models 1 to 5 are reported in Table 3B.3 (in Appendix 3.1B). Pair-wise comparisons between the coefficients in the models are reported in Table 3B.4. The key findings for the different models are thus summarized.

Figure 3.2

Scatter plot of the foundation and driver condition

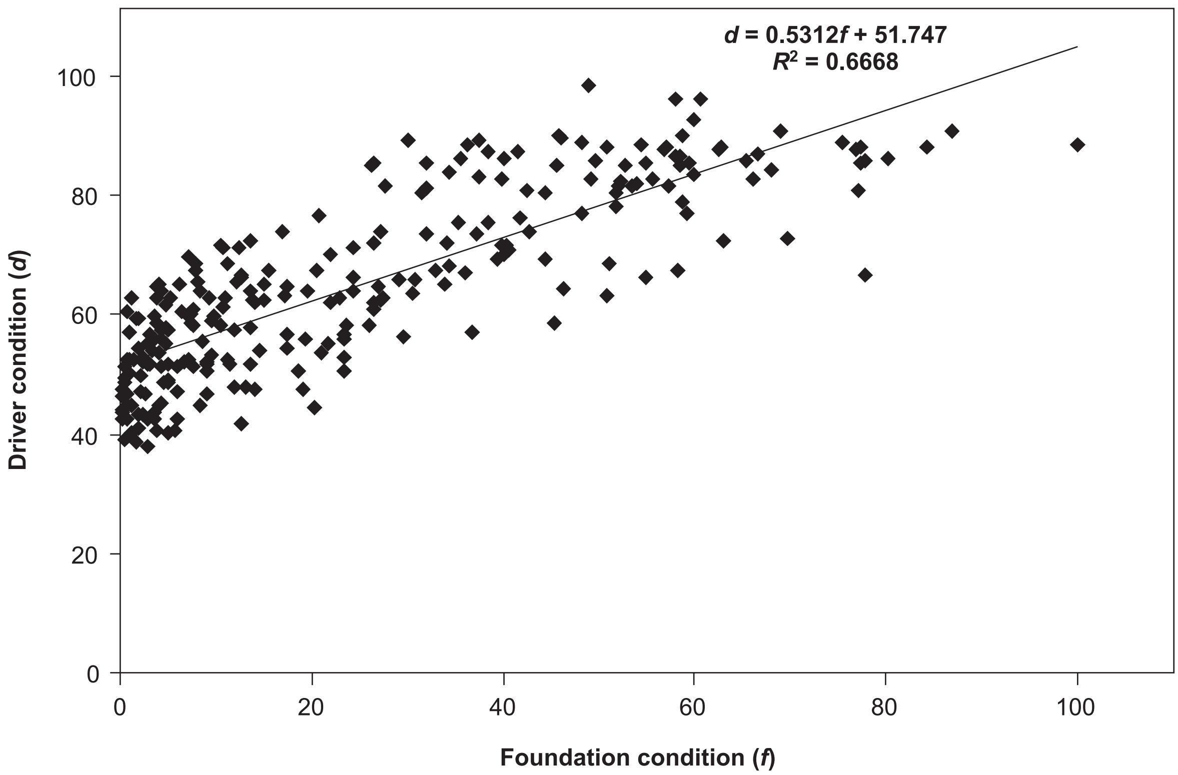


Figure 3.3

Scatter plot of the foundation condition and innovative capacity

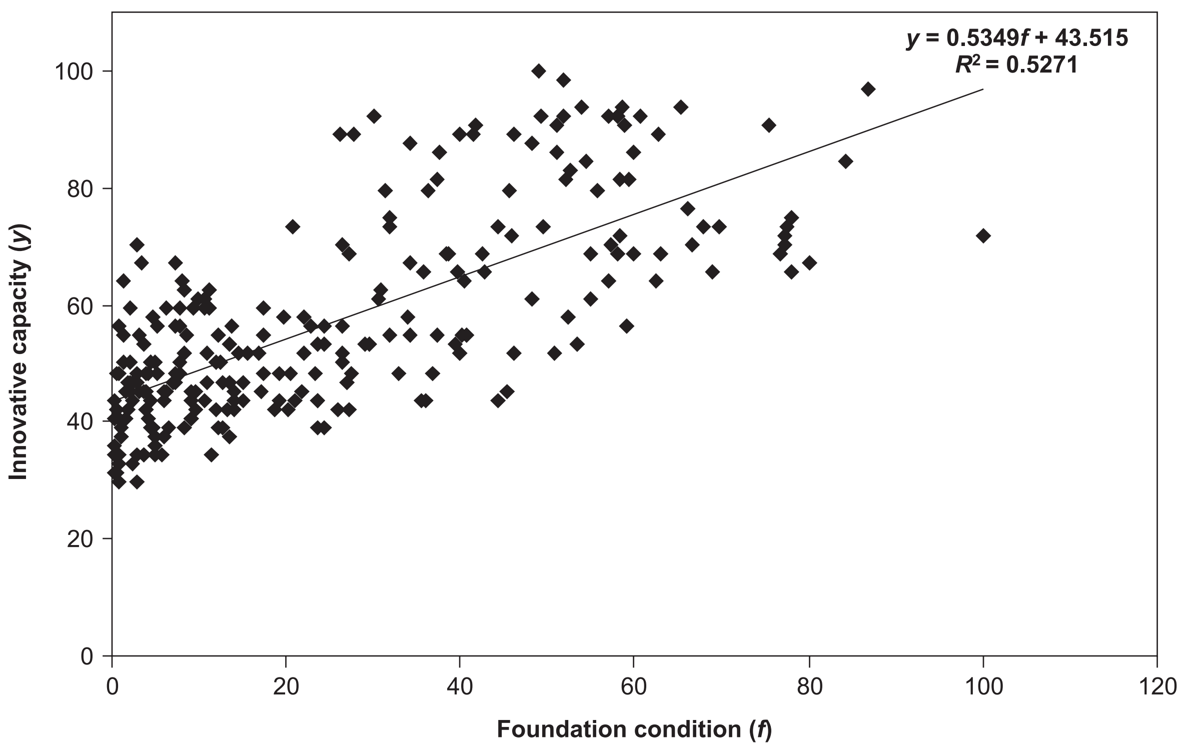
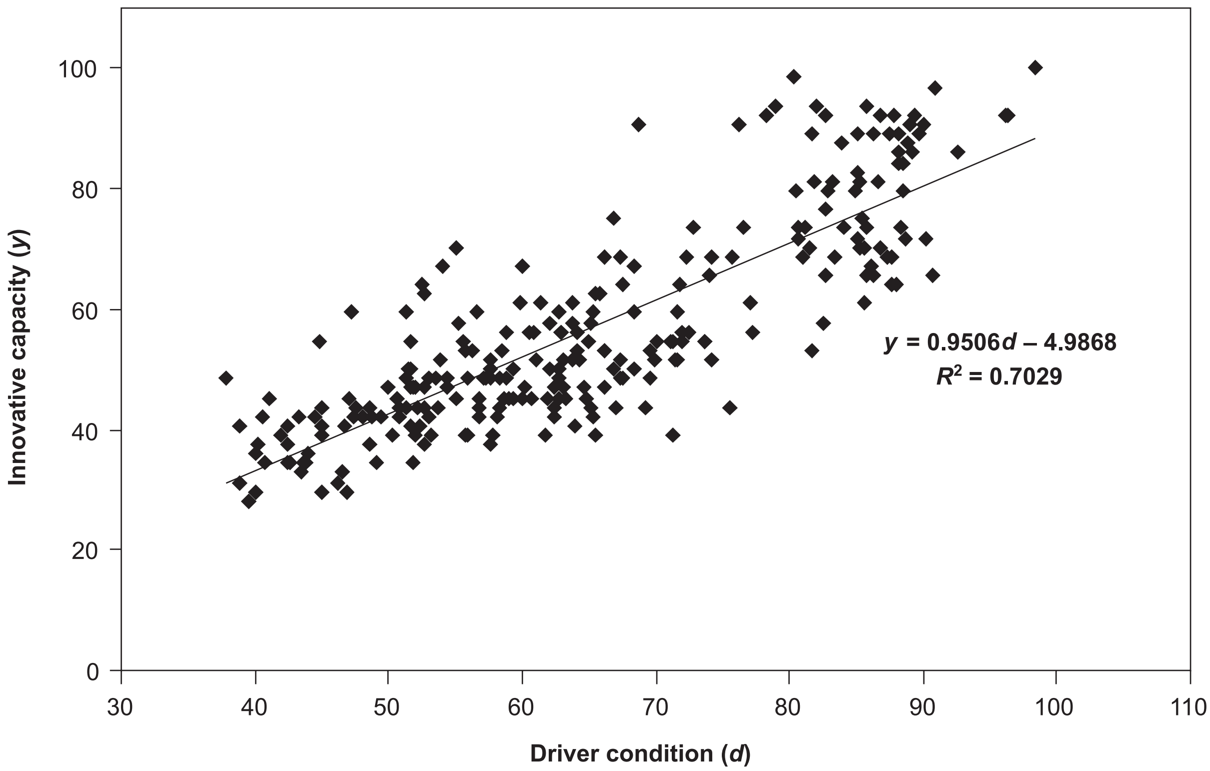


Figure 3.4
Scatter plot of driver condition and innovative capacity



The estimated results for Model 1 suggest the following:

- The foundation condition alone is not sufficient to raise the innovative capacity of nations.
- The driver condition is necessary to raise the innovative capacity of nations.
- Connectivity to the global economy via the Internet (the foundation condition) enhances the impact of the driver condition on the innovative capacity of nations, which demonstrates that the foundation condition is indeed a precondition for improving innovative capacity.

The empirical results for Model 2 were similar to those for Model 1. In particular, they support the following observations:

- The innovative capacity of developed countries in the Asia Pacific region is similar to that of developed countries in other regions.
- The innovative capacity of developed countries in the other regions is significantly higher than that of developing countries.
- The innovative capacity of developing countries in the Asia Pacific region is significantly higher than that of developing countries from other regions.

The empirical results for Model 3 suggest the following:

- The impact of the foundation condition on innovative capacity in developed countries in Asia Pacific and other regions is similar.
- The impact of the foundation condition on innovative capacity in developed countries is higher than that in developing countries.
- The impact of the foundation condition on innovative capacity in developing countries in the Asia Pacific region is similar to that in developing countries in the other regions.

The empirical results for Model 4 suggest the following:

- The impact of the driver condition on innovative capacity in developed countries in the Asia Pacific region is lower than that in developed countries in the other regions.
- The impact of the driver condition on innovation in developed and developing countries in the Asia Pacific region is similar.

- The impact of the driver condition on innovative capacity in developing countries in the Asia Pacific region is higher than that in developing countries in other regions.

The empirical results for Model 5 indicate the following:

- The impact of the foundation condition on enhancing the contribution of the driver condition to innovation in developed countries is higher than that in developing countries.
- The impact of the foundation condition on enhancing the contribution of the driver condition to innovation is similar in developed countries in both the Asia Pacific region and other regions.

In summary, the empirical analysis consistently shows that the contribution of the foundation and driver conditions to innovative capacity is higher in developed countries than in developing countries. This is to be expected, as innovation capacity tends to increase rapidly when institutions are in place to stimulate greater interaction and flow of information among all stakeholders in the economy. Further, the level of contribution of the foundation and driver conditions to innovative capacity in developed countries in the Asia Pacific region is similar to that in developed countries in other regions. Likewise, the contribution of the foundation and driver conditions to innovative capacity in developing countries in the Asia Pacific region is similar to that in developing countries in other regions.

The empirical analysis also suggests that a highly developed foundation condition is an important precondition for enhancing the contribution of the driver condition to innovation. It is not surprising that the developed countries are ahead of developing countries in the development of the foundation condition. This enables them to extract greater value from the driver condition, which is also higher, and ultimately become more innovative.

LESSONS FOR ASIA PACIFIC COUNTRIES AND POLICY IMPLICATIONS

The empirical results obtained using the new analytic framework suggests that the innovative capacity of countries in the Asia Pacific region varies according to the level of development of the NIE (i.e. the foundation and driver conditions). Most developed countries in the region have highly developed foundation and driver conditions, comparable to that found in other developed countries. Thus, they are as innovative and competitive as their counterparts in other regions. Further, the different levels of innovative capacity and competitiveness achieved by developed and developing countries in the Asia Pacific region can also be attributed to the varying levels of development of the building blocks of the NIE.

This analysis suggests that lower levels of development of the NIE in developing countries in the Asia Pacific region may be attributed to weak foundation and driver conditions. A weak foundation condition is due to the following:

- ICT services cost more and are of poorer quality in developing countries than in developed countries due to the highly concentrated market structure in developing countries.
- There is a lack of coordination in planning and in the implementation of ICT infrastructure development plans.

On the other hand, a weak driver condition is due to the following:

- The pool of skilled workers, especially technology-savvy workers, is smaller in developing countries due to a relatively weak education system and a serious 'brain drain' problem.
- Interactions among key stakeholders, such as government, the private sector, educational institutions, and social networks, are uncoordinated and patchy due to weak communication channels.
- The lack of transparent processes and systems, which leads to corrupt practices.
- Fiscal (grants, subsidies, scientific and technological infrastructure funding) and non-fiscal incentives (tax systems) to support R&D, patenting, and commercialization are not in place or not effectively implemented.
- There is no adequate legal and legislative architecture to support the development of a network-based and knowledge-intensive society. This includes lack of legislation or enforcement of intellectual property rights protection and shareholder protection, and lack of laws against corrupt practices and crimes related to the network economy.

Each of these is enough to cause serious problems for developing countries. But in combination their potential negative impact is far worse. Our empirical analysis based on the framework proposed shows that interaction between factors is a characteristic feature of the network economy. Thus, the framework could help clarify issues and challenges for policymakers seeking to manage their respective NIEs more effectively.

A weak foundation condition (ICT infrastructure) will not only limit the opportunities for people to acquire affordable and quality education and learning, but also hinder strategic linkages between all stakeholders in the economy (especially between government, industry, and enterprises); restrict the ability of firms to access cheaper resources (production materials, technology, human capital, and financing) from global markets; and reduce the opportunities to improve institutions and governance systems. To break away from the vicious cycle of a weak NIE and poor socio-economic development, developing countries in the region should simultaneously improve their foundation and driver conditions.

We now turn our attention to strategies to enhance the effectiveness of the NIE in the region.

An important feature of the NIE is the foundation condition that facilitates connectivity to the global economy. Developing countries in the Asia Pacific region should formulate a clear and coherent plan for developing their ICT infrastructure. The plan should address the digital divide within the countries and identify cost-effective measures to connect people to the global economy. This includes using 'last-mile' and satellite technologies. Such a plan should also raise awareness of effective use of ICT population. Tax incentives should be offered to encourage greater ownership of computers in homes and by SMEs (see 'Internet Connectivity in the Republic of Korea').

To increase the innovative capacity of countries in the region, equal emphasis should be given to raising the quality of the driver conditions. This entails increasing investments in education, especially in ICT in addition to science and technology. Schools in both rural and urban areas should be equipped with ICT, and school curricula should include the use of ICT in teaching and learning. Teachers should be trained in creative learner-centred ICT-supported pedagogies and encouraged to develop content in the local languages. Moreover, curriculum planning and development should involve industry to ensure that curricula are relevant for the formation of a competitive economy. To strengthen the teaching-learning-research nexus, the private sector should be encouraged to invest in human capital development and R&D programs (e.g. doctoral courses). The human capacity-building efforts of schools may be complemented by ICT training programs for the general public offered through publicly funded ICT telecentres (see 'Creative Learning Environment and the Content Industry in Finland').

The level of cooperation between government, universities, and enterprises is dependent on the level of transparency and effectiveness of the public sector in providing efficient and unbiased services. Effective implementation of ICT systems, such as in e-government, can improve access to information; the ability to bypass various levels of intermediaries, thus cutting transaction costs; and the participation of key stakeholders in public policy discussions. Former President of India, Abdul Kalam, aptly describes the key attributes of an e-government system that can instil greater respect for the public sector as 'transparent smart e-governance with seamless access, secure and authentic flow of information crossing the inter-departmental barrier and providing a fair and unbiased service to the citizens' (Kalam 2003). Greater transparency and good governance is urgently needed to ensure that the Asia Pacific region remains an attractive location for investors. Governments in the region should hasten the implementation of e-government and e-governance initiatives, and benchmark these initiatives to global best practices.

At the same time, an appropriate legal and regulatory framework for the protection of users of the digital medium, especially from high-priced but poor quality service arising from a monopolistic or oligopolistic market structure, should be in place.

Moreover, national policies to enhance innovation need to be better coordinated, for example, through the establishment of a coordinating council at the highest level of government, with membership coming from the public and private sectors as well as from civil society. This has been successfully implemented in some countries in the Asia Pacific and other regions.

Finally, developed countries could play an important role in helping developing countries to create a sustainable NIE and e-commerce environment. This is so not only because developing countries are confronted by competing demands for limited resources and thus find it difficult to provide basic ICT infrastructure and services, but also, and more importantly, because the global community stands to reap huge benefits from greater connectivity and interaction between all countries and their citizens.

THE WAY FORWARD

This chapter has sought to move beyond description to an empirical measurement and analysis of the innovative capacity of countries based on foundation and driver conditions. Decision-makers in the public and private sectors could apply this framework to gauge its value in addressing the challenges of the network economy.

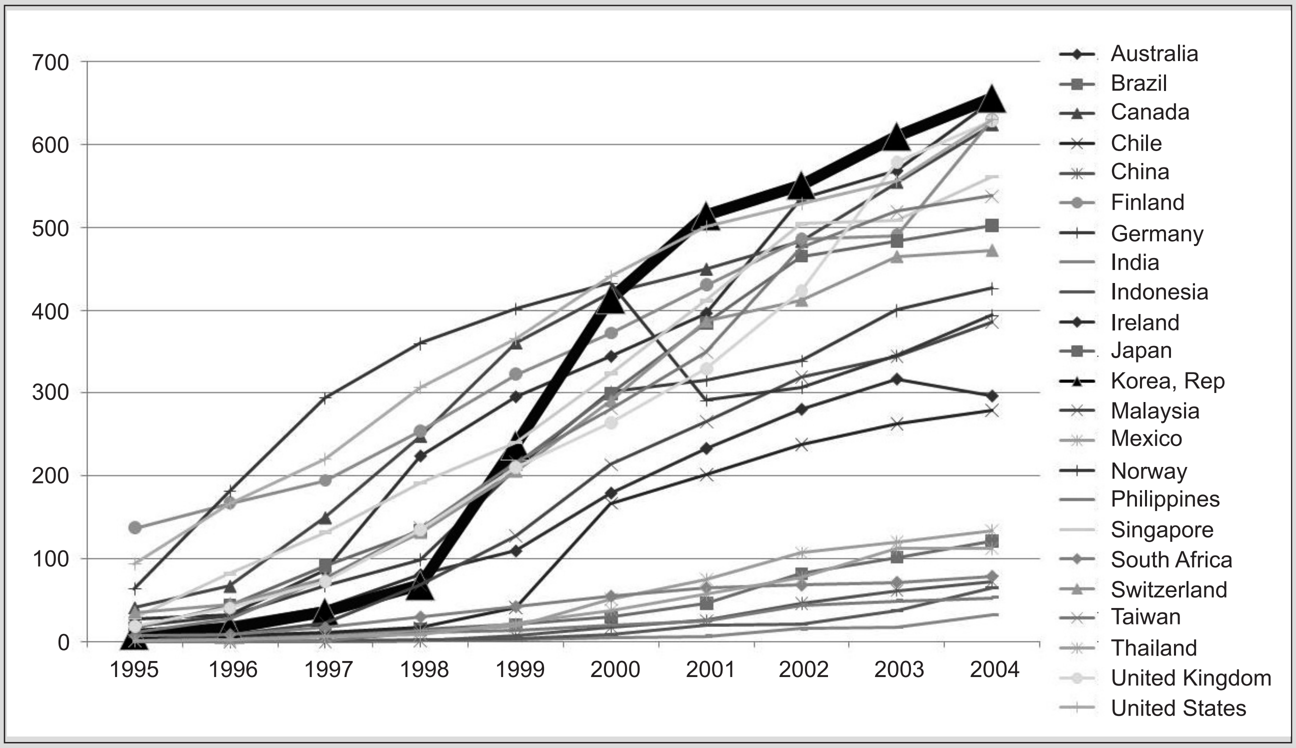
The empirical analysis shows that developed countries in the Asia Pacific region are as innovative as other developed countries. This is largely due to the rapid diffusion of ICT coupled with a high investment in human capital development; institutional reforms; competitive incentives systems; adherence to global standards; and strong linkages between enterprises, government, and educational institutions.

While several countries in the Asia Pacific have a well developed NIE, many other countries in the region have a weak or practically non-existent NIE. A combination of weak foundation

Internet Connectivity in the Republic of Korea

Internet penetration in the Republic of Korea has increased more rapidly than in most other countries (Figure 3.5). The number of Korean citizens with Internet access jumped from 68.3 per 1,000 persons in 1997 to 656.8 per 1,000 persons in 2004, with the largest increase taking place in 1998 (237.7 per 1,000). Most of those with Internet access now use broadband.

Figure 3.5
Korea's Internet penetration rate vis-à-vis other selected countries



(Source: http://earthtrends.wri.org/selectaction.php?theme=1)

This rapid increase can be attributed to five reasons. First, in 1998, an alternate mode of accessing the Internet was introduced in Korea, namely, via cable television, which was widely available. Second, the government launched the *Korea Information Infrastructure Project* to connect 144 cities across the country to the fast Internet services using optical cable networks. Third, the government deregulated the Internet broadband market, resulting in more service providers in the market. This lowered the Internet subscription rate and increased the quality of services. Fourth, the number of 'PC-bangs' (PC rooms) increased significantly, with close to 16,000 PC bangs established in 2000 to complement government efforts to increase Internet use (Whinston and Choi 2002). Fifth, the government recognized that the education system required a major overhaul to make it more relevant to the new economy and to increase the number of ICT-savvy citizens. The government connected all schools to the Internet. In 2001, compulsory computer education was introduced from first grade of elementary school, and computer use was required for more than 10 percent of the school curriculum (Im 2002). In addition, the Korean Education Network (KREN) was established in the early 1990s to provide high speed access to all public and private universities. In mid-2000 the government introduced the *Ten Million People Internet Education Project* to provide ICT training for people who were not ICT literate.

Korea's innovative capacity improved dramatically with the development of access infrastructure and the expansion of information use.

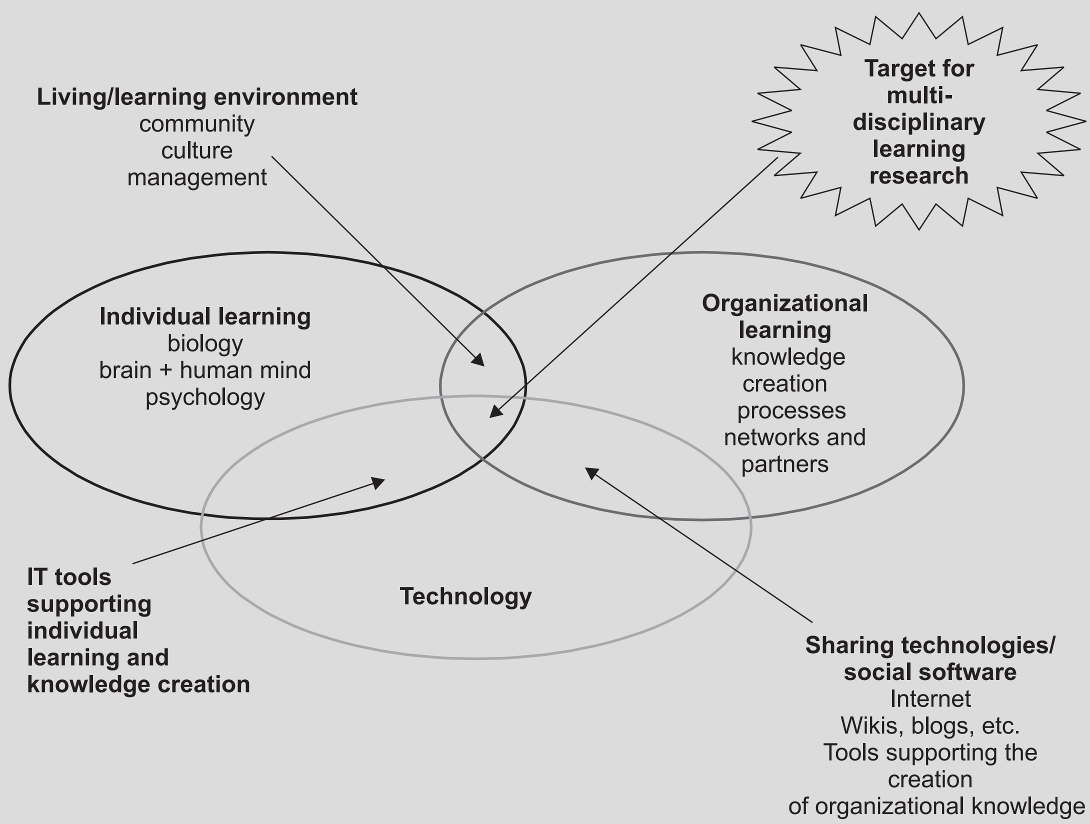
Coupling a Creative Learning Environment and the Content Industry in Finland

Finland's education system is recognized as one of the best in the world. The Programme for International Student Assessment (PISA) conducted in 2003 by the Organisation of Economic Co-operation and Development (OECD) showed that 15-year-old Finnish students were the top performers in literacy, mathematics, science, and problem solving.

ICT has been a cornerstone of Finnish educational enhancement, fostering independent learning and allowing students to acquire knowledge through networked communities across the globe. Young people in Finland today regard social networking software (the Internet, wikis, and blogs) and sharing technologies as important media for learning. They also recognize the importance of continuous and lifelong learning where knowledge is acquired not only in a formal setting, such as in schools and colleges, but also outside of the school system and throughout the lifespan (Figure 3.6). This learning model requires a living environment that facilitates learning.

Thus, as early as 1996, Finland's National Board of Education began implementing an ICT program to connect schools with information networks, train teachers in pedagogies suited to a digital environment, and develop ICT-enhanced teaching and learning materials. The ICT rollout in Finnish schools emphasized the following: collaborative teaching and learning environments; networking and teamwork, which are critical for promoting universal learning; multidisciplinary learning and research; and enhancing innovation among the younger generation. This program also led to the development of online education materials in the Finnish language, which met the government's objective of creating a new content and new media industry.

Figure 3.6



(Source: Academy of Academy of Finland and TEKES 2006) and driver conditions in these countries gives rise to economies that are dependent on resource-based sectors for socio-economic development. Due to the low utilization of technology, many of these sectors are not globally competitive. For such countries, the analytic framework proposed in this chapter should indicate critical areas for improvement, especially those that will produce the greatest dividends.

Weak foundation and driver conditions will not only hinder innovation, but also limit these countries' adaptability to major structural changes occurring in the global economy. To break away from the vicious cycle of socio-economic instability, developing countries in the Asia Pacific region must accelerate the development of the foundation and driver conditions and ensure that their 'blueprints' for innovation-based development are resilient to global technological and socio-economic tsunamis. Some strategies to strengthen the NIE of countries in the region have been presented. They may be able to stimulate further discussion toward the formulation of more specific policy options, directions, and recommendations.

This study is not without its limitations. One of these is the availability of quality data for developing countries, especially in the Asia Pacific region. Greater attention should be given to improving data collection mechanisms in this region and elsewhere. Up-to-date and accurate information, along with a longer span of the data series, will provide a more robust analysis about the relationships between each of the building-blocks of the NIE (infrastructure, intellectual capital, interaction, integrity, incentives, and institutions) and the innovative capacity of countries in the region. The short- and long-term dynamics between the building-blocks and innovative capacity can be modeled using more robust statistical methods such as panel data econometrics techniques.

Apart from improved data, we encourage more research in this area to enable the construction of more robust frameworks for measuring the innovation capacity of countries. This in turn would provide policymakers and planners with a sound empirical basis for managing their respective economies to achieve greater innovation, productivity, and competitiveness.

APPENDIX

Appendix 3.1A

Technical notes for the empirical models

The impact of foundation and driver condition on the innovative capacity of countries was estimated using the following model:

Model 1:

$$y_i = \beta_0 + \beta_1 f_i + \beta_2 d_i + \beta_3 (f_i \times d_i) + \theta_1 T_{03} + \theta_2 T_{05} + \varepsilon_{\text{i}}$$

where y_i is the innovative capacity of country *i*. The foundation and driver conditions for country *i* are denoted as f_i and d_i respectively. The time dummy variables for the period 2002–2003 and 2004–2005 are given as T_{03} and T_{05}, respectively. The residuals are denoted as ε_i, and are assumed to be normally distributed with mean 0 and variance σ^2. The other models estimated are discussed below.

Model 2:

$$y_i = \beta_0 + \beta_1 f_i + \beta_2 d_i + \beta_3 (f_i \times d_i) + \psi_1 DA_{1i} + \psi_2 DA_{2i} + \psi_3 DO_i + \theta_1 T_{03} + \theta_2 T_{05} + \varepsilon_i$$

Model 3:

$$y_i = \beta_0 + \beta_1 f_i + \beta_2 d_i + \beta_3 (f_i \times d_i) + \delta_1 (f_i \times DA_{1i}) + \delta_2 (f_i \times DA_{2i}) + \delta_3 (f_i \times DO_i) + \theta_1 T_{03} + \theta_2 T_{05} + \varepsilon_i$$

Model 4:

$$y_i = \beta_0 + \beta_1 f_1 + \beta_2 d_i + \beta_3 (f_i \times d_i) + \lambda_1 (d_i \times DA_{1i}) + \lambda_2 (d_i \times DA_{2i}) + \lambda_3 (d_i \times DO_i) + \theta_1 T_{03} + \theta_2 T_{05} + \varepsilon_i$$

Model 5:

$$y_i = \beta_0 + \beta_1 f_i + \beta_2 d_i + \beta_3 (f_i \times d_i) + \xi_1 (f_i \times d_i \times DA_{1i}) + \xi_2 (f_i \times d_i \times DA_{2i}) + \xi_3 (f_i \times d_i \times DO_i) + \theta_1 T_{03} + \theta_2 T_{05} + \varepsilon_i$$

where DA_{1i}, DA_{2i}, and DO_i are the dummy variables denoting developed Asia Pacific countries, developing Asia Pacific countries, and other developed countries, respectively. The β's, θ's, ψ's, δ's, λ's, and ξ's are the parameters of interest, and the signs of these estimated parameters will indicate if the explanatory variables have positive or negative impact on *y*.

Since the dependent variable was bounded between 0 and 100, the Double-Limit-Tobit (DLT) method (with heterosekdasticity corrected residuals) was used to capture the relationship between foundation-driver conditions and innovative capacity of countries in Models 1 to 5. The DLT was used in this study because the response variable is bounded in the interval [0, 100]. Details of the DLT model can be found in Greene (2003).

Pair-wise comparison between the coefficients for four country groupings in the models was conducted using the Likelihood Ratio Test (LRT) Statistic, where the distribution for the test statistic follows a chi-square distribution with 1 degree of freedom.

Appendix 3.1B

Table 3B.1

Data definition and sources

Capacity for innovation	Capacity for innovation	Companies obtain technology 1 = exclusively from licensing or imitating foreign companies 7 = by conducting formal research and pioneering their own new products & processes
Info-structure	Internet users	Internet users per 100 people
Intellectual capacity	Quality of public schools	The public (free) schools in your country are 1 = of poor quality 7 = equal to the best in the world
Incentives	Ease of access to loans	How easy is it to obtain a bank loan in your country with only a good business plan and no collateral? 1 = impossible 7 = easy
	Venture capital availability	Entrepreneurs with innovative but risky projects can generally find venture capital in your country 1 = not true 7 = true
	Access to credit	During the past year, obtaining credit for your company has become 1 = more difficult 7 = easier
	Subsidies and tax credits for firm level R&D	For firms conducting R&D in your country, direct government subsidies to individual companies or R&D tax credits 1 = never occur 7 = are widespread and large
Interaction	University-industry research collaboration	In its R&D activity, business collaboration with local universities is 1 = minimal or non-existent 7 = intensive and ongoing
	State of cluster development	How common are clusters in your country? 1 = limited and shallow 7 = common and deep
Institutions	Burden of regulation by public institutions	Complying with administrative requirements in the country 1 = burdensome 7 = not burdensome
	Property rights	Property rights, including over financial assets are 1 = are poorly defined and not protected by law 7 = are clearly defined and protected by law
	Intellectual property protection	Intellectual property protection in your country 1 = is weak or non-existent 7 = is equal to the world's most stringent
Integrity	Business cost of corruption	Do other firms' illegal payments to influence government policies, laws, or regulations impose costs or otherwise negatively affect your firm? 1 = impose large cost 7 = impose no cost/not relevant

Note: The data for internet users for the year 2005 were obtained from Porter et al. (2007).The remaining data were obtained from Porter et al. (2002, 2003, and 2004). All the variables were converted to base 100. The sample size used for this study was 75, 80, and 104, respectively for the three periods.

Table 3B.2
The list of countries

Asia Pacific developed countries	*Asia Pacific developing countries*	*Other developed countries*	*Other developing countries*	
Hong Kong	Bangladesh	Australia	Algeria	Lithuania
Japan	China	Austria	Angola	Macedonia
Korea	India	Belgium	Argentina	Madagascar
Singapore	Indonesia	Canada	Bahrain	Malawi
Taiwan	Malaysia	Cyprus	Bolivia	Mali
	Pakistan	Denmark	Bosnia & Herzegovina	Mauritius
	Philippines	Finland	Botswana	Mexico
	Sri Lanka	France	Brazil	Morocco
	Thailand	Germany	Bulgaria	Mozambique
	Vietnam	Greece	Chad	Namibia
		Iceland	Chile	Nicaragua
		Ireland	Columbia	Nigeria
		Israel	Costa Rica	Panama
		Italy	Croatia	Paraguay
		Luxembourg	Czech Republic	Peru
		Malta	Dominican Republic	Poland
		Netherlands	Ecuador	Romania
		New Zealand	Egypt	Russian Federation
		Norway	El Salvador	Serbia & Montenegro
		Portugal	Estonia	Slovak Republic
		Slovenia	Ethiopia	South Africa
		Spain	Gambia	Trinidad & Tobago
		Sweden	Georgia	Tunisia
		Switzerland	Ghana	Turkey
		United Kingdom	Guatemala	Uganda
		United States	Haiti	Ukraine
			Honduras	United Arab Emirates
			Hungary	Uruguay
			Jamaica	Venezuela
			Jordan	Zambia
			Kenya	Zimbabwe
			Latvia	

Note: The developed countries were defined based on the IMF classification. Since there were insufficient data for countries in the least developed classification (based on IMF classification) for the Asia Pacific region, the IMF classifications for 'emerging countries' and 'under-developed countries' were grouped into one country classification called the 'developing country' classification.

Table 3B.3
The empirical results

Explanatory variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Constant	11.1816**	16.5301	8.8264**	18.1143*	7.4237***
DA_{1i}		8.1292**			
DA_{2i}		2.8376***			
DO_i		10.8679*			
f	−0.1729	−0.0614	0.1901	0.0907	0.4959**
d	0.6913*	0.5717*	0.7411*	0.5361*	0.7635*
$f_i \times d$	0.0041***	0.0017	−0.004138	−0.0005	−0.0089**
$f_i \times DA_{1i}$			0.2537*		
$f_i \times DA_{2i}$			0.0749		
$f_i \times DO_i$			0.3250*		

(*Table 3B.3 continued*)

(*Table 3B.3 continued*)

Explanatory variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
$d_i \times DA_{1i}$				0.1191*	
$d_i \times DA_{2i}$				0.0555***	
$d_i \times DO_i$				0.1696*	
$f_i \times d_i \times DA_{1i}$					0.0139*
$f_i \times d_i \times DA_{2i}$					0.0014
$f_i \times d_i \times DO_i$					0.0150*
T_{03}	−3.2491**	−2.9553**	−2.9439**	−2.9588**	−3.0098**
T_{05}	−4.2857*	−3.3365**	−3.5327**	−3.2677**	−3.5908**

Note: The symbols *, **, and *** denote statistical significance at the 1%, 5%, and 10% significance levels, respectively.

Table 3B.4

Pair-wise comparison between country groupings

Test	*LRT-Stats*	*Decision*
Model 2		
$H_0 : \psi_1 = \psi_2$ $H_A : \psi_1 \neq \psi_2$	1.2663	Accept Null Hypothesis, H_0.The innovative capacity in developed and developing countries in the Asia Pacific is similar.
$H_0 : \psi_1 = \psi_3$ $H_A : \psi_1 \neq \psi_3$	0.4608	Accept Null Hypothesis, H_0. The innovative capacity in developed countries in the Asia Pacific region and in the other regions is similar.
$H_0 : \psi_2 = \psi_3$ $H_A : \psi_3 \neq \psi_3$	6.4303**	Reject Null Hypothesis, H_0. The innovative capacity in developed countries in the other regions is higher than in developing countries in the Asia Pacific region.
Model 3		
$H_0 : \delta_1 = \delta_2$ $H_A : \delta_1 \neq \delta_2$	2.8772***	Reject Null Hypothesis, H_0. The impact of the foundation condition on innovation in developed countries in the Asia Pacific is higher than that in developing countries in the Asia Pacific region.
$H_0 : \delta_1 = \delta_3$ $H_A : \delta_1 \neq \delta_3$	1.1277	Accept Null Hypothesis, H_0. The impact of the foundation condition on innovation in developed countries in the Asia Pacific region is similar to that in developed countries in the other regions.
$H_0 : \delta_2 = \delta_3$ $H_A : \delta_2 \neq \delta_3$	6.8454*	Reject Null Hypothesis, H_0. The impact of the foundation condition on innovation in developed countries in other regions is higher than that in developing countries in the Asia Pacific region.
Model 4		
$H_0 : \lambda_1 = \lambda_2$ $H_A : \lambda_1 \neq \lambda_2$	1.7736	Accept Null Hypothesis, H_0. The impact of the driver condition on innovation in developed countries in the Asia Pacific is similar to that in developing countries in the Asia Pacific region.
$H_0 : \lambda_1 = \lambda_3$ $H_A : \lambda_1 \neq \lambda_3$	2.6873***	Reject Null Hypothesis, H_0. The impact of the driver condition on innovation in developed in the Asia Pacific region is lower than that in developed countries from other regions.
$H_0 : \lambda_2 = \lambda_3$ $H_A : \lambda_2 \neq \lambda_3$	8.1521*	Reject Null Hypothesis, H_0. The impact of the driver condition on innovation in developed countries in the other regions is higher than in developing countries in the Asia Pacific region.
Model 5		
$H_0 : \xi_1 = \xi_2$ $H_A : \xi_1 \neq \xi_2$	3.3313***	Reject Null Hypothesis, H_0. The role of the foundation condition in enhancing the contribution of the driver condition to innovation in developed countries in the Asia Pacific region is higher than that in developing countries in the Asia Pacific region.
$H_0 : \xi_1 = \xi_3$ $H_A : \xi_1 \neq \xi_3$	1.8317	Accept Null Hypothesis, H_0. The role of foundation condition in enhancing the contribution of the driver condition to innovation in developed countries in the Asia Pacific region is similar to that of developed countries in the other regions.
$H_0 : \xi_2 = \xi_3$ $H_A : \xi_2 \neq \xi_3$	8.5401*	Reject Null Hypothesis, H_0. The role of the foundation condition in enhancing the contribution of the driver condition to innovation in developed countries in the other regions is higher than that in developing countries from the Asia Pacific region.

Note: The symbols *, **, and *** denote statistical significance at the 1%, 5%, and 10% significance levels, respectively.

BIBLIOGRAPHY

Academy of Finland and TEKES. (2006). *Finnsight 2015: The outlook for science technology and society*. OECD's Programme for International Student Assessment (PISA) website. Retrieved 23 October 2008 from http://www.pisa.oecd.org/pages/0,2987,en_32252351_32235731_1_1_1_1_1,00.html

Baily, M.N. (2002). The new economy: Post mortem or second wind. *Journal of Economic Perspectives*, *16*(3), 3–22.

Barro, R. (1990). Government spending in a simple model of endogenous growth. *Journal of Political Economy*, *98*(October), 103–26.

Becchetti, L., D. Bedoya, and L. Paganetto. (2003). ICT investment, productivity and efficiency: Evidence at firm level using a stochastic frontier approach. *Journal of Productivity Analysis*, *20*(2), 143–67.

Bozeman, B. and J.S. Dietz. (2001). Research policy trends in the United States: Civilian technology programs, defense technology and the deployment of the national laboratories. In P. Laredo and P. Mustar (Eds), *Research and innovation policies in the new global economy* (pp. 45–78). United Kingdom: Edward Elgar Publishing.

Cameron, G. (1996). *Catch-up and leapfrog between the USA and Japan*. Oxford: Nuffield College. Mimeo.

Criscuolo, C. and K. Waldron. (2003). *Computer network use and productivity use in the United Kingdom*. Centre for Research into Business Activity and Office of National Statistics, UK. Mimeo.

De Gregorio, C. (2002). Micro enterprises in Italy: Are ICTs an opportunity for growth and competitiveness? *Paper presented at the OECD workshop on ICT and Business Performance*. ISTAT, Rome, December.

Dosi, G., C. Freeman, R. Nelson, G. Silverberg, and L. Soete. (1988). *Technical change and economic theory.* London: Pinter.

Edquist, C. (1997). *Systems of innovation: Technologies, innovation and organization.* London: Pinter.

Freeman, C. (1987). *Technology policy and economic performance: Lessons from Japan.* London: Pinter.

Furman, J.L., M.E. Porter, and S. Stern. (2002). The determinants of national innovative capacity. *Research Policy*, *31*(6), 899–933.

Godin, B. (2006). The knowledge-based economy: Conceptual framework or buzzword? *Journal of Technology Transfer*, *31*, 17–30.

Greene, W.H. (2003). *Econometric Analysis* (5th ed.). New Jersey, USA: Prentice-Hall, Upper Saddle River.

Gurbaxani, V., N. Melville, and K.L. Kraemer. (1998). Disaggregating the return on investment to IT capital. In J.I. DeGross, R. Hirschheim, and M. Newman (Eds), *Proceedings of the Nineteenth International Conference on Information Systems* (pp. 376–80). Helsinki: ICIS.

Hof, R.D. (2005). The power of US: Mass collaboration on the Internet is shaking up business. *The Business Week*, (June), 53–62.

Im, Y. (2002). *ICT education to narrow digital divide in South Korea*. Retrieved 21 November 2008 from http://umpan1.un.org/intradoc/groups/public/documents/apcity/unpan011287.pdf

Kalam, A.P.J. (2003). Citizen Centric e-Governance: Technology and management policy. *Finance India*, *17*(4), 1273–77.

Kim, S.J. (2003). Information technology and its impact on economic growth and productivity in Korea. *International Economic Journal*, *17*(3), 55–75.

Kraemer, K. and J. Dedrick. (1993). *Payoffs from Investment in IT: Lessons from the Asia Pacific Region*. Irvine, CA: CRITO National IT Policy Publications.

Kumar, S. (2002). An empirical model to assess the impact of ICT, ICT literacy on productivity and economic growth: The case of USA. *Unpublished Bachelor of Business and Commerce Honours Thesis*. Monash University Malaysia.

Lau, L.J. and I. Tokutsu. (1992). The impact of computer technology on the aggregate productivity of the United States: An indirect approach. *Working Paper*. Stanford CA: Department of Economics, Stanford University. Mimeo.

Lucas, R.B. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(June), 2–32.

Lundvall, B.A. (1992). *National systems of innovation: Towards a theory of innovation and interactive learning*. London: Pinter.

Nair, M. (2007). The DNA of the new economy, *Economic Bulletin*, *8*, 27–59.

Nair, M., M. Kuppusamy, and R. Davison. (2005). A longitudinal study on the global digital divide problem: Strategies to close cross-country digital gap, *The Business Review Cambridge*, *4*(1), 315–26.

Nelson, R.R. (1981). Research on productivity growth and productivity differences: Dean ends and new departures. *Journal of Economic Literature*, *19*(3), 1029–106.

———. (1993). *National innovation systems: A comparative analysis*. New York: Oxford University Press.

Nelson, R.R. and S.G. Winter. (1977). In search of a useful theory of innovation. *Research Policy*, *6*, 36–76.

Porter, M. (1990). *The competitive advantage of nations*. New York: The Free Press.

Porter, M. and S. Stern. (2002). National Innovative Capacity. In M. Porter, J. Sachs, P. Cornelius, J. McArthur, and K. Schwab (Eds), *The Global Competitiveness Report 2001–2002* (pp. 102–18). World Economic Forum. New York: Oxford University Press.

Porter, M.E, J.D. Sachs, P.K. Cornelius, J.W. McArthur, and K. Schwab. (2002). *The Global Competitiveness Report 2001–2002*. World Economic Forum. New York: Oxford University Press.

Porter, M.E., K. Schwab, X. Salai-i-Martin, and A. Lopez-Claros. (2004). *The Global Competitiveness Report 2004–2005.* World Economic Forum. New York: Palgrave MacMillan.

Porter, M.E., X. Salai-i-Martin, and K. Schwab. (2007). *The Global Competitiveness Report 2007–2008.* World Economic Forum. New York: Palgrave MacMillan.

Rodrick, D., A. Subramanian, and F. Trebbi. (2002). Institutions rule: The primary of institutions over integration and geography in economic development. *IMF Working Paper, WP/01/189*. Washington, DC: International Monetary Fund.

Romer, P. (1986). Increasing returns and long run growth. *Journal of Political Economy*, *94*(5), 1002–37.

———. (1990). Endogenous technological change. *Journal of Political Economy*, *8*(5), 71–102.

Schumpeter, P. (1934). *The theory of economic development*. Cambridge: Harvard University Press.

———. (1942). *Capitalism, socialism and democracy*. New York: Harper & Brothers.

Sciadas, G. (2005*). From the digital divide to digital opportunities: Measuring infostates for development*. Montreal: Orbicom.

Timmer, M.P. and B. van Ark. (2005). Does information and communication technology drive EU-US productivity growth differentials? *Oxford Economic Papers*, *57*(4), 693–716.

Whinston, A.B. and S.Y. Choi. (2002). Summary of the US Team. In M. Kagami and M. Tsugi (Eds), *Digital Divide or Digital Jump: Beyond 'IT' Revolution*. Japan: Institute of Developing Economies (IDE), JETRO.

World Information Technology and Services Alliance (WITSA). (2006). *Digital Planet 2006*: *The Global Information Economy*. USA: WITSA.