

Can Information Technology Revive Economic Development in East Asia? The Role of Human and Technical Resource Policy

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ABSTRACT

Development of IT/e-business is a centerpiece of renewed economic growth in most countries of East Asia. This paper considers the challenges for policy focusing on the acquisition of knowledge and its utilization. While many countries in East Asia are well along the way toward upgraded production of IT related products, the softer aspects of IT and e-business are a greater challenge. They will call for policies that provide the needed infrastructure, and, particularly, they will pose a challenge in developing human capital.

JEL: O0, O1, O2, O3, O5

Keywords: East Asian development; Development policy; Knowledge; Human capital; Information technology (IT); E-business

I. INTRODUCTION

In the past 30 years, the developing countries of East Asia have shown remarkable economic growth. This is a record based largely on the performance of manufacturing; much of it for export markets, though high rates of domestic investment and modernization have also made important contributions. The 1997 financial crisis called into question the ability of these countries to compete effectively and to revive the growth process, though some, like China and South Korea, have continued to grow rapidly.

Today, the challenge facing East Asia is how to maintain or revitalize the growth “miracle”. Most countries envision the information technology revolution as a way to advance growth into the 21st century. Some of the developing countries in East Asia, like South Korea, Singapore, and Taiwan, have been successful in important branches of the IT industries, but others still lag far behind. This paper is concerned with how East Asia can cross the digital divide? Can the East Asian countries overcome technological barriers, acquiring the needed physical infrastructure and, most importantly, building the appropriate human capital? How should they reorient their policies?

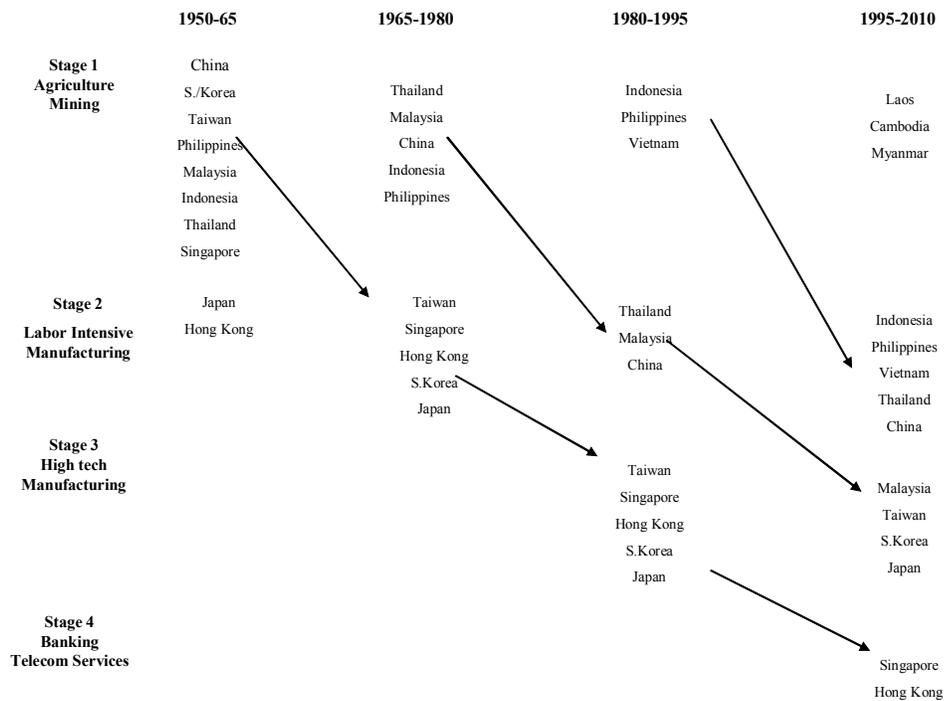
II. THE PROCESS OF EAST ASIAN DEVELOPMENT

Extending Vernon’s classic product cycle (Vernon, 1966), East Asian growth has been described as a growth ladder. (Chenery and Syrquin, 1989, and Adams, 1998). Beginning in the post-World War II years, as primary product producers, largely in primitive agriculture, these countries have been moving, one after another, up the technological scale, from simple labor-intensive assembly, to more advanced mechanical products and to sophisticated services. Behind these steps lie profound changes in competitiveness related to rising labor costs, growing availability of capital, and advanced technology.

The results of such a process in East Asia are summarized in Table 1. The table shows the changing situation of the East Asian countries from 1965 until the current fifteen-year period ending in 2010. The groupings are intended to describe the principal emphasis of each economy. No country’s activities fall exclusively into one category. A country may have some industries at higher stages and, perhaps, also some at lower ones. In the earliest period, 1950-1965, only Japan and Hong Kong were principally manufacturing economies. These countries were pioneers in what has been termed *export-led growth*. Other countries of East Asia were still primarily agricultural. In the next 15 years, Taiwan, Singapore, and South Korea developed important labor-intensive manufacturing industries. In the 1980s, Japan, Taiwan, Singapore, Hong Kong, and South Korea became producers of high tech products. A still more advanced stage of development involves high tech services. These include financial services, technical services, communications, and, importantly, regional headquarters and management of foreign direct investments. But note that in Asia only small largely urban entities have moved on to become primarily regional financial and communications centers.

Where does the IT/e-business economy belong on this scale? Principally in Stages 3 and 4 of this diagram, though assembly of consumer electronics is already an important Stage 2 activity. Manufacturing of advanced electronic equipment for computation and communication—chips, routers, steppers—are sophisticated Stage 3 activities. Financial and communications centers, computer programming, and the establishment of e-businesses falls into Stage 4, requiring computer network facilities, highly qualified workers, and, particularly, a cluster of related high tech firms providing each other with mutual support. These innovative activities have advanced most rapidly in an entrepreneurial environment, where venture capital encourages bright young technologists.

Table 1
The stages of the product cycle process



Today, Singapore and Hong Kong (China) are largely advanced service economies, communications, and financial centers with heavy emphasis on information technology and networking. Along with Taiwan, they have also become owners and managers of sizable direct investments in neighboring countries. Korea and Taiwan and, of course, Japan, are powerhouses in the production of high tech hardware. Other East Asian countries like Malaysia, China, and Thailand are at the edges of the IT revolution with substantial production of standardized electronic parts and assembly of consumer electronic equipment. Their most competitive industries still call for labor-intensive processes. Much of their high tech production activity is the result of foreign direct investment, some from Japan, the US, and Europe and some from Singapore, Taiwan and Korea. Much of the technology originates in the parent companies abroad. One should not underestimate the importance of the technological transfers, often a result of foreign direct investment, that make possible advancement on the development ladder.

III. IT/E-BUSINESS IN EAST ASIAN ECONOMIC DEVELOPMENT

The role of IT in the development of these economies has a number of alternative possibilities. Much depends on what dimension of IT is being considered.

With respect to production of hardware, in earlier stages of economic development, the focus is on manufacturing relatively simple mass production IT products: mobile telephones, memory chips, PCs and related products like monitors and printers. A large share of the world's production of these goods is already concentrated in East Asian countries, particularly in South Korea, Malaysia, and Taiwan. China, with its large potential domestic market and extremely low labor costs, is becoming a major producer. Management of these production operations is often in the hands of foreign capitalists and joint venture partners. Increasingly such FDI has been intra-regional, originating with firms in Taiwan, Hong Kong, and Singapore that have transferred much of the needed technical and management knowledge to neighboring areas of China and Malaysia.

As countries gain technological sophistication, they are able to produce more technically advanced IT products, like LCD displays, servers, manufacturing equipment, and telecom switches. In Asia, Japan has been a leader in such products. Other East Asian countries have specialized on some technologically advanced products with large markets, chip fabrication, for example. Custom contract manufacturing is becoming a pattern. But production of products at the technological frontier is not yet widely distributed in East Asia outside of Japan. Even the most advanced countries still lag behind the leading producers in the United States and in Europe.

With respect to software, the story is quite different, since software development and application call for very different capabilities. Software development remains largely in Western countries. It involves technical standards that have been set by early movers. And sometimes it uses proprietary algorithms that developers may not want to transfer to developing countries for fear of inadequate intellectual property protection. This kind of work calls for a high level of programming expertise typically available

only in regional technological clusters like Silicon Valley. Such skills are not yet a comparative advantage of East Asia, though routine programming is now being transferred into programming centers in Asia, for example, to Singapore and, recently to Shanghai in China.

The application of software to carry out e-business operations calls for computer equipment, rapid: Internet connections, and a population of users. It is difficult to convert business systems to electronic means particularly when the new approach is very costly and when traditional methods relying on cheap labor remain in use. Lau (2000) has argued that conversion to high tech and e-business management systems will be easier in Asia than in Western countries since there is often not a legacy of existing electronic systems. He calls it "creation without destruction".¹ But, in fact, it is extremely challenging to replace long-used paper-based and labor-intensive business systems with electronic paper-less methods though a long leap from the abacus to a touch computer screen is always a possibility. Installation and maintenance also remain serious challenges in regions where there is a shortage of experienced computer professionals, as in most of East Asia. For this reason, development experts have often talked about the use of less sophisticated *appropriate* technology (Pack, 1982). Only the most advanced cities in East Asia, like Singapore and Hong Kong, can hope to develop their economies principally around IT/e-business activities like communications and financial centers.

Consumer use of the Internet faces similar barriers. As we will note, except in Japan, Singapore, Taiwan, and South Korea, computers are not yet widely dispersed and access to the web remains difficult. Until this lack is remedied, it will be difficult to reach the majority of East Asian consumers over the Internet. This represents a serious barrier to B2C in the region. On the other hand, while users represent only a small fraction of the region's population, their number may be substantial.

IV. CROSSING THE DIGITAL DIVIDE

Most of the East Asian countries still have a long way to go to catch up with the most advanced IT economies. As is apparent in Table 2, much of East Asia, but not all, remains on the shady side of the digital divide. In comparison to the advanced countries of Europe and North America, computer ownership and use are still very limited in some countries, as is the availability of rapid broadband network service. The case of China is a good illustration. In view of China's huge population, the absolute number of Internet users is substantial (more than 20 million), but these represent a very small fraction of the potential population of users and few of them have high speed broadband service. In China, the Internet café is still the most popular way to access the worldwide web. Other countries vary. Singapore and Hong Kong are leaders with high computer density. They have developed Internet host sites comparable in numbers to many Western countries. South Korea and Taiwan have a high level of computer penetration and are world leaders in cellular telephones. On the other hand, the populous countries in East Asia, including Indonesia and Thailand, are not as far along in IT development. Popular awareness of the computer and of its potentials is still limited to an urban elite

and computer literacy is still low. Internet access is spreading but remains difficult in many areas outside big cities.

The disparity in IT development between various countries depends greatly on their stage of development. To some extent it may be simply a matter of time. Even in the advanced world, the spread of IT equipment and practice to business and to consumers has been recent. Developing countries where technology is less far along and labor is relatively inexpensive have been followers. In time, as part of the development process, many, but not all, aspects of IT are likely to progress in East Asia as well. Indeed, as we have noted, some countries have made tremendous steps in that direction and there have been some spectacular examples of “leapfrogging”, the overwhelmingly rapid development of cellular phone service, for example.

Table 2
Computer/internet statistics for East Asia

	Computers per 1,000 people (2000)	Internet Hosts per 10,000 people (2000)	Internet Users per 10,000 people (2000)
China	16	0.6	176
Hong Kong (China)	347	336.9	3,359
Indonesia	10	1.3	68
Malaysia	105	29.3	1,505
Philippines	20	2.58	266
Singapore	483	492.3	2,987
S. Korea	190	84.1	4,025
Taiwan	n.a.	n.a.	2,813
Thailand	24	10.5	266
Vietnam	9	.02	13
Japan	315	365.6	3,044
United States	585	2928.3	3,466

Source: World Bank, ADB

But the arguments in the opposite direction are at least equally strong. Much technical progress proceeds step by step. You must learn to walk before you can run. It is not often true that there is no existing business to displace. Indeed, often there are traditional systems of doing business that are well suited to local business culture. *Quanxi*, the network relationships that underlie Chinese business practice, may not fit well with the impersonality of e-mail communication.

There are significant barriers to the development of IT in some countries of East Asia. One cannot count on miracles. Physical infrastructure as well as human development barriers must be overcome, if IT is to become an engine of growth for the region. In the most populous countries, insufficient communications infrastructure and difficult accessibility of computer equipment still stand in the way of widespread computer use in business with other business (B2B) and with consumers (B2C). A physically wired network to the level of the consumer may not always be necessary, as the cellular telephone demonstrates. But an efficient Internet backbone and rapid access network connections are essential to gain the advantages of modern e-operations in business and government. Technological skills are also not yet sufficiently developed in some countries to make high tech manufacturing competitive, or, even, possible.

Acquisition of knowledge is an essential ingredient for IT-based development. Advanced engineering technology is central. But modern manufacturing and e-business also depend on less technical aspects of knowledge, for example, advanced management techniques: inventory controls, six sigma quality programs, supply chain operations, etc. How the factory floor is organized--whether the site is kept clean and neat, whether production is located sequentially, and how parts and supplies are handled--may make the difference between whether or not products are competitive and meet world market standards.

The requisite information may be acquired by *assimilation* or by *invention*.^{2,3} Enterprises not yet operating at the world technological frontier can improve total factor productivity quickly by adopting or adapting techniques already in use in more advanced countries elsewhere. There are a number of ways of acquiring foreign technology. Advanced capital goods frequently embody the latest technological wrinkles. Alliances or licensing agreements may provide patented technology, and managers and engineers may be sent abroad for training. As we have noted, technology transfer is one of the signal advantages of direct foreign investment or joint enterprises. The foreign investor sets up a production facility and transfers to it technical and management techniques used in his home country. Some fear, however, that such an approach will create foreign-owned enclaves, using techniques that are not transferred to indigenous operations. For this reason, many countries prefer to develop their own new technologies through R & D, experimentation, and experience. The farther a country's technology is from the technological frontier, the greater the difficulty of inventing its own production processes and the greater the advantage of technological assimilation.

Education is obviously a related issue. IT development and computer use require high tech programmers and network operators. Less intensive consumer computer applications may not call for the same high level of technical expertise, but they still require familiarity with the potentials of computers and, in many cases, an elementary knowledge of English. These can be acquired through training or through experience. Significant educational progress has been made in recent years. At the university level, in South Korea, 72 percent of the college age populations attend universities or technical institutes. However, in the most populous East Asian countries, the share of the college age population that gets tertiary education remains small. In China, for example, only 7 1/2 percent of college age persons are attending universities (Table 3). A

large fraction of Chinese students, however, are in engineering and may be gaining some IT-relevant training. In China, few public university programs have, yet, been adapted to computer applications. At lower levels of education, computer use is not available or just starting in many locations. However, private profit-making technical institutes are growing to provide computer-related instruction.

Finally, there is a need for technological clusters, geographic centers where there are lots of high tech enterprises, technicians, and suppliers with upward and downward linkages, like Silicon Valley in California or Austin, Texas. Some similar clusters have grown in developing countries, like Bangalore in India, and some are being fostered in industrial and research parks in Malaysia and Taiwan. In the end, they are a result, as well as the source, of successful learning and innovation in the IT field. Interaction and networking among high tech experts are important ingredients of IT advancement.

Table 3
Education in East Asia

	Tertiary Education Rate % of age group (1999)
China	7.5%
Hong Kong (China)	23.3%
Indonesia	11.3%
Malaysia	23.3%
Philippines	29.5%
Singapore	43.8%
S. Korea	71.7%
Thailand	31.9%
Japan	46.0%
United States	71.6%

Source: World Bank

V. THE ECONOMIC SETTING FOR IT AND PUBLIC POLICY

Ten years after the publication of the World Bank's seminal volume on *The East Asian Miracle* (World Bank, 1993) the role of public policy in economic development remains controversial. At the time, the World Bank concluded that "the fact that interventions were an element of some East Asian economies' success does not mean that they should be attempted everywhere...". In the meantime, public policies in the region, as elsewhere, have become somewhat less narrowly interventionist, in the sense of focus on promoting specific industries, and have turned to greater reliance on general non-industry-specific policies and market forces to advance development. The dispute between neoclassical economists whose strategy can best be summarized as simply to "let the market get prices right" and the industrial strategists, as Pack and Westphal

(1986) call them, who favor selective industrial promotion, has also become somewhat muted. This is because high technology IT/e-business activities pose special challenges that call for public intervention in some respects and that hinder it in others.

On one hand, favoring selective government policy intervention, public good considerations are very important with regard to IT and e-business. The introduction of new technology has important externality effects. As IT techniques become familiar, they become easier to apply. Programming expertise and specialized supplies become available. Network effects and externalities imply that the sum of benefits is bigger than would be the total value of separate individual parts. In other words, technical knowledge, that is so central to applications of IT, benefits the society beyond its benefit to the initial user. There are spillovers. Economic theory would suggest that private markets will not invest sufficiently in IT facilities, R & D, and education and will not employ socially optimal amounts of information technology on the basis of individual private profit expectations.

Moreover, there are important initial barriers, “*chicken and egg*” considerations. Large investments in communications infrastructure may not be justified at the start when there are few users. The advantages of the network come when it is fully operational, not when the first users get on line. In other words, unless initial inertia is overcome, market forces may not lead to the development of certain IT operations. Thus, a variety of arguments suggest that public initiatives to promote IT in the private as well as the public sector are necessary stimulants for rapid IT innovation and adoption.

On the other hand, public sector planning and decision-making may not deal well with the complexity of high tech and e-business endeavors. There have been many examples of publicly promoted high tech projects in developing countries that have gone wrong, that were not consistent with dynamic comparative advantage. This could happen because they were beyond the country’s technological capabilities or they could not be justified by profit and loss considerations, even in the long run. The complexity of the IT industries and the rapid technological changes in this field have frequently been a barrier to successful public sector intervention. Public IT plans are often guided by political considerations. They tend to be more rigid than the efforts of competitive private firms. As a result they may lag behind the newest technology and may support entrenched technical standards longer than is desirable.

The advantage of private sector initiatives is that they “let many flowers bloom” and that the failure of individual projects in the evolutionary selection process does not typically impose heavy and persistent burdens on the economy. One solution to these issues is to make public sector interventions broadly general, supporting science and technology and IT education rather than specific IT industries.

In any case, there is little disagreement that in the East Asian developing countries various development policy strategies have played an important role. Many of these have been macroeconomic but others have been more focused on microeconomic considerations, some general and others sector specific. They have included:⁴

- Policies for macroeconomic and balance of payments stabilization
- Policies aimed at optimal dynamic resource allocation

- Rapid capital accumulation and promotion of foreign direct investment inflows
- Agricultural development
- Export promotion and infant industry protection
- Institution building in the private as well as the public sector.

In particular, export promotion and, in some cases, domestic industry protection have played central roles. The issue is not whether such policies have been implemented, since they have been used widely to a greater or lesser degree (except for import protection in Singapore and Hong Kong). The question is whether they have been implemented vigorously with focus on particular sectors and whether this implementation has been successful.

With regard to South Korea and Taiwan, some scholars (Westphal, 2002, and Wade, 1990) place great emphasis on the role of government planning and intervention. These countries combined export promotion with import protection and other technology promoting measures as a basis for development of export industries. “In essence, technological learning was subsidized largely through import protection and disciplined through export incentives and planning. Import protection made possible the creation of export industries in advance of the point at which they would otherwise have become established, thus leading to precocious initiation of learning and accelerating the rate at which new export industries were established.” (Westphal, 2002, p. 39)

Most of the East Asian countries are putting into place plans to advance information technology. In this section, we will briefly summarize some of the current policy efforts at the country level and their background. These policies range widely and appear to be greatly dependent on the economic, cultural, and political setting.

- As we have noted, Singapore has had a long tradition of targeted intervention. It has long sought to attract foreign investment and has placed no barriers to transfer of technology. Westphal (2002) refers to it as “MNC-mediated industrialization”. To make up for Singapore’s lack of entrepreneurialism, many domestic enterprises involve substantial government ownership and control, using holding companies like Temasek. Early on, Singapore promoted exports and imposed no protective tariffs, deeming its home market too small for a domestically-oriented industrial base.

Singapore is by far the most advanced East Asian country in the promotion and implementation of the economy. It calls itself a “wired economy” and is providing high-speed Internet access to its entire population under Singapore’s IT2000 plan. Public authorities have also played a significant role in providing network services, forging alliances with international industry leaders, and establishing an appropriate policy and legal framework for free market competition. “Government intervention in the market has been successful because it has been accompanied by a unique civil service policy.....” (ITU, 2001, *The e-City: Singapore Internet Case Study*, p. 32)

Singapore is particularly distinguished in its IT educational programs at its many universities and other higher educational institutions. The Singaporean

Ministry of Education operates a unique primary and secondary education program, connecting all schools, offering computer training to teachers, and providing IT accounts to all students above 3rd grade.

- South Korea's export production is in the hands of highly concentrated horizontally and vertically diversified chaebols. These organizations are privately owned though they have had substantial government collaboration and support. Many of them have been able to gain international recognition for their products and brand names.

Korea has actively sought to develop indigenous technological capability, discouraging foreign investment in favor of domestic enterprises. Korea has one of the highest rates of mobile phone use in the world, extensive broadband connections, and a high level of education. However, this may not yet translate directly to business or consumer Internet applications. Surveys indicate that Korea's industries are still behind the world leaders. "Since they started as final assemblers of imported parts and components, many Korean industries are weak in terms of forward and backward linkage. This discourages innovation by user-producer interactions." (Lee *et al*, 2001) Many public policy decisions, for example, by the National Assembly's Science, Technology, Information and Telecommunication (STIT) Committee were long pending without resolution. (Chuong *et al*, 2002)

- In contrast to South Korea, Taiwan has emphasized small and medium size private enterprises located in technology parks. Taiwan has a tradition of facilitating the acquisition of technology through cooperation between government officials and industrial leaders. In contrast to Singapore, Taiwan has made important efforts to assimilate technology, to make the technology indigenous, supported and developed by local firms, even by firms under the direction of Taiwanese entrepreneurs returning from abroad. As in Hong Kong and Singapore, local investors have gone on to develop operations in China, in this way providing a transfer of technology in the outward direction. Statistics on computers and Internet use in Taiwan are more difficult to obtain than for other East Asian countries. The data available suggest that use of mobile phones and number of Internet users (per 10,000) falls only a little short of the highest in the East Asian region..
- Hong Kong has been very much a special case, with little or no technology strategy and an open market. But Hong Kong has also lagged behind in technological development shifting much of its manufacturing activity to neighboring areas of China, where low wages encourage labor intensive assembly operations. On the other hand, the public sector and private entrepreneurs have provided a high level of communications infrastructure that made possible the establishment of a financial and communications center. Whether such a center can continue to prosper in competition with other Chinese cities, now that Hong Kong is officially part of China, remains an unanswered question.
- China is not nearly as far along technologically as many other East Asian countries. A transition economy, China used a parallel system to continue (and

gradually phase out) its state enterprises along with its burgeoning market oriented enterprises. Foreign-owned and joint venture businesses dominate the export market and have been a source of great gains in productivity. An undervalued exchange rate has assured competitiveness in the world market as a whole and, in recent years, in comparison with other East Asian producers. With a huge domestic market potential and as a low cost producer, China offers great opportunities for electronic assembly operations, for cellular phones, computers, etc. China is, however, a very heterogeneous country with divisions of authority between provincial governments and the central administration that may stand in the way of effective technology policy. It has its “Golden Development Plan” which aims to achieve advances in science, technology, education and public administration. As part of this broad scheme, the Golden Bridge/Information Superhighway Project, Tsinghua University and a consortium of US Middle Western universities are setting up programs to train as many as 30,000 Chinese engineers, 100,000 computer professionals and many more government officials.

- Malaysia faces great disparities within the country and seeks to accommodate advanced high tech operations at the same time it wants to provide access in rural areas. Malaysia has carried out some highly sector-selective technology-based projects. It is creating a Multimedia Super Corridor and Cyberjaya, an intellectual industry city. The idea is to create a geographic cluster of high tech companies and their headquarters, research centers, and a multimedia university. Direct financial incentives and tax exemptions are provided for companies in the area that attain special status employing knowledge workers and transferring foreign technologies. The aim of these policies is clearly to advance, if not leapfrog, Malaysia’s technical competence in the IT fields.
- Thailand has had a long history of investment promotion through its Board of Investment (BOI). The Eastern Seaboard has been a referenced site for manufacturing and technology firms, though in recent years the BOI has sought to disperse such operations throughout the country. In Thailand, despite the fact that the National Information Technology Committee (NITC) has been operational since 1992, public policies toward Internet and technology development and educational development have lagged. Policies have been less aggressive and less focused than in the leading countries. Thailand continues to face a mismatch between demand and supply of qualified manpower. The State Communications Authority of Thailand (CAT) has maintained considerable control of Internet operations. Limited high speed access, lack of widespread competence in the English language, and cultural factors has been a barrier to the development of e-commerce.
- Philippines, one of the first countries to allow private telephone service, has numerous internet service providers but most are simply resellers. While there is much interest on the part of the government to promote IT, the private Philippine telecom market limits the government’s ability to develop IT infrastructure. The Philippines still lags far behind in terms of computer literacy and use.
- In an effort to advance technology, Indonesia was planning an aircraft industry, a field inconsistent with its technological capabilities.⁵ Indonesia has lagged

behind in Internet development as a result of low income and economic and political turmoil. The telecommunication/Internet sector in Indonesia remains dominated by government controlled telephone providers. More than half of Indonesian users access through internet cafes, locally known as Warnets.

- Vietnam's Internet penetration is growing but remains far behind other East Asian countries. The field continues to be state dominated and access remains tightly controlled. Laos and Cambodia, similarly, are latecomers hindered by low income and limited infrastructure.

VI. WHAT TO DO TO ADVANCE THE NEW ECONOMY IN EAST ASIA

It is not premature to make judgments about the success of public planning and support policies in East Asia. All of the East Asian countries have made spectacular progress. In some countries, active government support appears to have paid off "in spades". In others, the failure to implement effective policies may have been a barrier to still more rapid growth or to continuation of the growth trajectory. It is not clear that strategies that were effective at early stages of industrialization, that produced rapid expansion of export manufacturing, will serve as well for the next stage of development. With respect to Singapore, *The Economist* (11/30/02 p.56) writes "an awareness is sinking in among the island's ruling elite that a model that turned a swamp into metropolis may not work as well when it comes to turning the metropolis into a citadel of the 'knowledge economy'".

The likelihood that IT policies will be successful appears to depend greatly on the nature of the policy -- whether it is consistent with a country's comparative advantage, whether it is flexible or narrowly technical in focus, and whether it is concerned with broad questions of infrastructure and education. The setting in which the policies are applied, for example, the country's stage of development and its size, may also be important considerations.

What can the East Asian economies do to take advantage of the IT/e-business opportunities?

The continued promotion of hardware production for export markets is a logical step. As incomes rise and as labor becomes more expensive, it is necessary to turn toward more technically sophisticated products that call for higher levels of technology and more qualified workers. Much depends on the ability of these countries to acquire the technology and develop the manpower that are necessary for the more advanced and more profitable steps of the production chain. Foreign investment is a good source of capital and technology in these industries. But domestic capabilities must be also upgraded to enable indigenous firms to compete and to prevent an "enclave" phenomenon.

As production capabilities expand, the question of markets is likely to become more serious. Already a very large fraction of consumer electronics is produced in East Asia. As a result, manufacturing of electronic products in Asia has become cyclical reflecting the business cycle of the market in the United States and Europe. There is still room for expansion but as large countries like China become producers the export market may not be sufficient. This means that continued expansion will need to be

turned toward domestic markets in China and in other East Asian countries. Fortunately, East Asia itself provides growing market outlets.

Software and e-business activities fit less well with the region's comparative advantage. So far, only Singapore, South Korea, and Taiwan have the facilities and human capital that can support the softer aspects of IT and e-business. The development of these fields will require focused policy initiatives. Physical facilities are a matter of investment and many East Asian countries are moving rapidly to build Internet spines and related telecom facilities. Private businesses have been major movers in this respect in most countries, though government-owned or controlled firms still dominate in some countries, China, for example. Many of these public enterprises are showing a remarkable amount of entrepreneurial and innovational spirit. In any case, there is still much to be done to provide rapid Internet access widely for business and consumers, a constraint, particularly, for the lower income countries.

The real policy challenge will be to build human capital, to develop a population of technical experts, entrepreneurs, and a computer-literate population of users. It will not be possible to skip steps in this regard. Students must go through the grades of secondary school education before they can advance to tertiary institutions. Universities and technical schools must re-orient their instruction toward computerized procedures. Computer methods will be used when computers are available but computers are not likely to be made available until computer methods are widely used. It will take extensive planning and resources to create an environment that favors the development of IT/e-business economies in East Asia.

NOTES

1. His reference is to Joseph Schumpeter's classic discussion of competitive innovation as "creative destruction"; new more advanced products drive out the old.
2. Westphal (2002) elaborates on these terms and provides an extensive discussion of the role of knowledge acquisition in East Asian development.
3. Others have referred to assimilation of technology as *imitation* (Saito, 2000) but assimilation seems a more appropriate term since a good deal of adaptation to local economic and cultural conditions may be necessary.
4. Our list corresponds to that in Westphal (2002), but it could well represent the discipline's consensus.
5. At one point, half of Indonesia's engineers were involved in this project.

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