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Information Technology in Southeast Asia: Engine of Growth or Digital Divide?

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The widespread diffusion of the personal computer and the explosive growth of the Internet have moved information technology (IT)[1] into the mainstream of U.S. culture. People trade e-mail addresses, share favourite websites, and debate the merits of Internet stocks as casually as they might have argued over sports or automobiles in the past. Businesses look to IT to solve all manner of organizational problems and gain an edge over their competitors. And economists as respected as Alan Greenspan credit IT for helping sustain the non-inflationary growth of the U.S. economy, referring to it as the "new economy". There are dissenters, of course, who claim that IT accounts for too small a share of U.S. capital stock to explain the economy's strong performance, but their scepticism is largely ignored.

Outside the United States, however, countries and companies are looking at the issue of IT and economic performance with great concern.

Countries in Europe, Latin America, and especially Asia fear being left behind in an IT-driven global economy, which is increasingly being characterized, by a digital divide. Yet, they remember that the U.S. economy has invested heavily in IT for decades and still suffered anaemic productivity growth. In fact, the "productivity paradox" was coined to describe the paradox of high IT investment and low productivity growth in the United States. Non-U.S. companies likewise face the challenge of competing globally with U.S. companies that have restructured their operations around internal IT systems and are now using the Internet to build external networks that tie their entire supply chain together.

In order to develop strategies to respond to the challenges and opportunities of the early twenty-first century, both companies and countries need a good understanding of the impact of IT on economic growth, on corporate performance, and on the process of globalization. This is particularly true for the Asian region, which enters the new millennium in the wake of an unexpected economic crisis that has raised crucial questions about what countries and companies must do to return to growth and profitability. Three such questions are whether IT can play a role in that process, whether there is a growing digital divide between the Asian economies and others, and what policies and strategies are likely to achieve growth and bridge the digital divide.

1. Information Technology and Economic Growth

There is a consensus among economists that technology innovation and diffusion plays a critical role in stimulating economic growth and productivity. There are also good reasons to expect that investments in IT in particular will promote economic growth. Innovations from the IT industry are captured in easily replicated sets of instructions such as semiconductors and software code that can be used by millions of people at a low marginal cost. They also display a characteristic known as network externalities. For instance, one fax machine is useless, two fax machines have some value, but when millions of people have fax machines, the value of belonging to this network of users is amplified. Similarly, the widespread adoption of a particular set of technology standards, such as Internet protocols, should increase the payoffs from belonging to what is now a global network of users.

Indeed, the term "new economy" has been coined to mark the association of non-inflationary, sustained economic growth with high investment in IT and a restructuring of the economy due to the use of IT-led innovations such as enterprise systems, supply chain management, customer relationship management, the Internet, and e-commerce. "New economy" reflects the notion that the economy somehow works differently today than yesterday. A recent study by the Organization for Economic Co-operation and Development (OECD 2000) identified three characteristics that mark the new economy:

- higher multi-factor productivity growth due to more efficient business practices linked to the use of IT;
- economic expansion for a longer period without inflationary pressures emerging because IT puts downward pressure on inflation, while increased global competition keeps wage inflation in check;
- increasing returns to scale, network effects, and externalities from the use of IT in parts of the economy, which contributes to higher multi-factor productivity growth and fuels further economic growth in a virtuous circle.

The U.S. Department of Commerce's *Digital Economy 2000* report (2000) describes the new economy as follows:

> The new economy is being shaped not only by the development and diffusion of computer hardware and software, but also by much cheaper and rapidly increasing electronic connectivity. The Internet in particular is helping to level the playing field among large and small firms in business-to-business e-commerce: making it easier and cheaper for all businesses to transact business and exchange information. (P. v)
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> In conclusion, a growing body of evidence suggests that the U.S. economy has crossed into a new period of higher, sustainable economic growth and higher, sustainable productivity gains. These conditions are driven in part by a powerful combination of rapid technological innovation, sharply falling IT prices, and booming investment in IT goods and services across virtually all American industries. (P. viii)

1.1. The Productivity Paradox of IT

Not everyone is sanguine about the new economy or about the productivity impacts of IT. Sceptics have wielded data showing that

productivity gains from IT in the aggregate economy have been limited, despite the rapid improvement in the price-performance ratio of computers and heavy investment in IT. This argument was based in part on the fact that despite the fact that the United States invested heavily in IT during the 1970s and 1980s, productivity growth slowed during that period as compared with the earlier post-War years (Figure 2.1).

Economists such as Robert Solow (1987)[2] and industry analysts such as Steven Roach (1987) have juxtaposed this slowdown in productivity growth against the dramatic increases in IT spending over the same period and argued that IT investment has not resulted in the expected productivity improvements.

1.2. Firm- and Industry-Level Studies

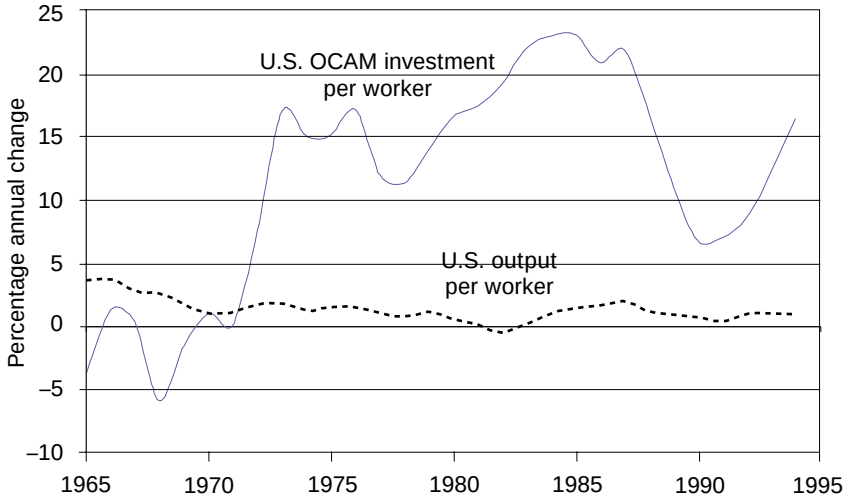
Studies of corporations as well as government agencies (for example, Brynjolfsson and Hitt 1996; Lehr and Lichtenberg 1997) have shown a high return on IT investment, with gross rates of return ranging from 50 per cent to over 100 per cent (when adjusted for the rapid depreciation of computer hardware, the net returns are more modest). It is believed that the returns are higher when the introduction of IT is associated with complementary organizational changes (Brynjolfsson and Hitt 1996).

Recent studies indicate that the contribution is growing in all IT-using sectors in the United States (Oliner and Sichel 2000; Council of Economic Advisors 2000). The evidence of sector gains for other OECD countries is more limited, and is believed to be due to a slower rate of adoption of IT, a lower level of investment in IT, and less-advanced statistical records, which fail to discern impacts that might be present.

Still, the fact that a certain set of companies (and the studies above focus mainly on large U.S. companies) or industry sectors show high returns to investment in IT does not mean that these gains are translated into productivity improvement at the national level. It might be that the impacts are mostly redistributional with the gains of some firms or industries coming at the expense of others as restructuring occurs in the national economy.

However, in a global economy, nations could benefit from IT investment just by making their firms more competitive against foreign

Figure 2.1
The Productivity Paradox of IT: Annual Change in Computing Investment and Productivity for the United States, 1965–94



Source: Dewan and Kraemer (1998, p. 57). OCAM is the Bureau of Economic Analysis' (BEA) "Office, Computing & Accounting Machinery".

firms. This would suggest a global zero-sum game, but with the potential for redistribution among nations. This prospect has serious implications for national policy because it means that countries can benefit by increasing their investments in IT, while countries that fail to do so will only fall further behind economically. So it is important to conduct country-level studies. If the results are consistent with the firm-level findings, this would then boost confidence that IT really does pay off in improved productivity.

1.3. Country-Level Studies

In order to draw meaningful conclusions about the impact of IT investment at the country level, it is necessary to look at multiple countries over time. We conducted the first analysis of IT investment across countries, using data from 1984 to 1990 for twelve Asia-Pacific countries (Kraemer and Dedrick 1994). We found a significant relationship between growth rates in IT investment and productivity growth at the

national level. However, the small sample made it impossible to control for other factors such as overall investment rates and initial level of development. The study did identify several factors that appear to drive IT investment. These include wealth (gross domestic product, or GDP, per capita), education levels, structure of the economy (share of employment in the service sector), and level of information infrastructure (telephone lines per 100 persons).

More recent multi-country studies by Dewan and Kraemer (1998, 2000) show that the returns on IT investment are positive for developed (industrialized) countries, but not significant for developing economies. The growth in IT capital stocks accounts for over 53 per cent of the average annual GDP growth and labour productivity growth (GDP per labour hour) in developed countries. Based on the economic and productivity growth over the 1985–93 period in these countries, IT contributed about 1.2 per cent of annual economic growth and annual labour productivity growth. Moreover, the contribution of IT is increasing over time in the developed countries (Dewan and Kraemer 2000), suggesting that this impact might be due to the cumulative stock of IT over time.[3] Recent single-country studies of the U.S. (Oliner and Sichel 2000; Jorgenson and Stiroh 2000) and OECD countries (Schreyer 2000) confirm these results.

A possible explanation for the substantial payoffs in developed countries is that new IT investments can take advantage of previous complementary investments in infrastructure, human capital, and information-oriented business processes to amplify the payoffs from IT. Accordingly, one explanation for the lack of significant returns on investments in poorer developing countries is the relative scarcity of infrastructure and other enabling investments. It might also be simply that IT investment levels are too small to have a measurable impact on GDP.[4]

1.4. New Cross-Country Research

In a more recent paper, we studied growth rates[5] in IT investment and labour productivity for forty-three countries from 1985 to 1995 (Kraemer and Dedrick 2001). We used a growth theory approach that let us include more countries and years than the earlier studies. With this sample, we

were able to control for growth in non-IT investment (that is, all other capital investments), along with other factors such as initial wealth (measured in GDP per capita) and labour force growth rates. The results of the analysis show the following:

- Growth (compound annual growth rate, CAGR) in IT investment per worker is significantly correlated with labour productivity growth, even when controlling for the other factors (Figure 2.2).
- Growth (CAGR) in non-IT investment per worker is likewise correlated with productivity growth, and the relationship is stronger than for IT spending.
- Initial GDP per capita and labour force growth were unrelated to productivity growth.

These findings are not surprising, since IT investment accounts for a small share of total investment in most countries (ranging from 2 to 20 per cent). While the role of IT in driving productivity might be greater in developed countries, as the study shows, the impacts of non-IT are much greater for the complete set of countries.[6]

2. IT and Productivity and the Digital Divide in Asian Countries

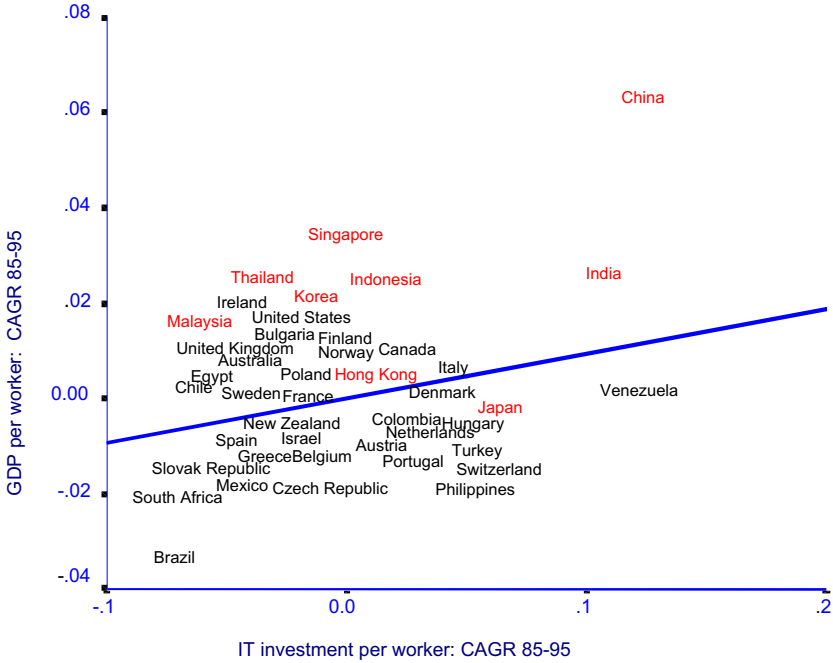
We have done new analyses that look specifically at the differences between Asian and non-Asian countries in terms of their use of IT and the related productivity gains. We also look at the differences in Internet readiness and e-commerce readiness as measures of the digital divide.

2.1. IT and Productivity

Surprisingly, we find dramatic differences in the two groups of countries on IT and productivity. When we measure the relationships between GDP per worker and IT and non-IT investment, we find that for non-Asian countries there is a positive payoff from investments in both IT and non-IT capital. But for Asian countries, the only positive correlation is found with non-IT investment. IT investment comes out with a negative correlation (Figures 2.3 and 2.4).[7]

In this analysis, each country together with the year (for example, Japan 1985, Japan 1986) is used as a data point, so that there are over

Figure 2.2
Growth in IT Spending and Productivity
(partial regression)



400 data points in the sample, providing strong support for the results.

It is important to note that the trend lines in Figure 2.3 are positive for both Asian and non-Asian countries when we look at non-IT investments. However, in Figure 2.4 the trend line is positive for non-Asian countries but negative for Asian countries when we look at IT investments. The negative slope is not as important as the fact that there is no positive correlation between IT spending and productivity in Asian countries. This is not explained simply by a higher prevalence of developing countries in the Asian sample. In proportionate terms, the two samples are roughly equivalent as the Asian sample included six developed and five developing countries compared with twenty developed and fifteen developing countries for the non-Asian sample. It is most likely that the explanation lies elsewhere, as will be indicated later.

Figure 2.3
Payoffs from Non-IT Investments, in Asian and Non-Asian Countries
(partial regression, scales show variance above or below predicted values)

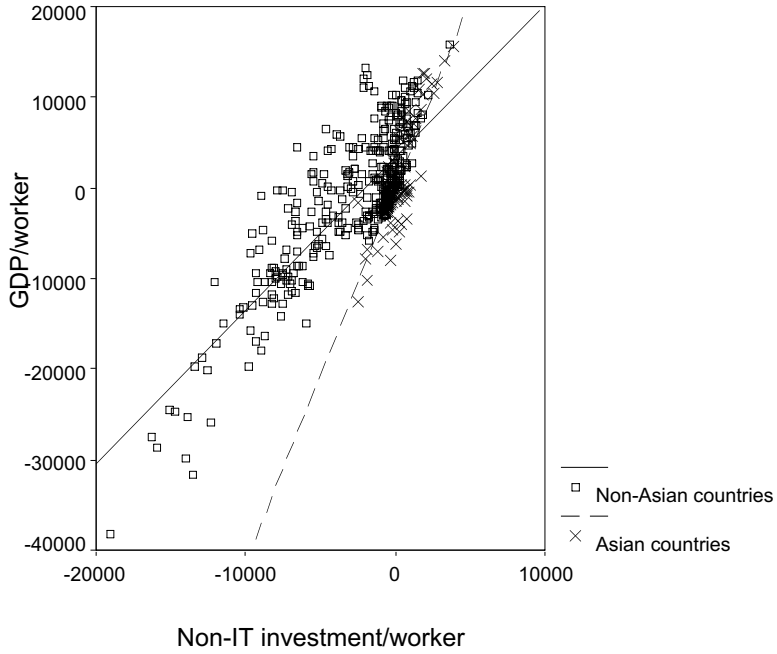
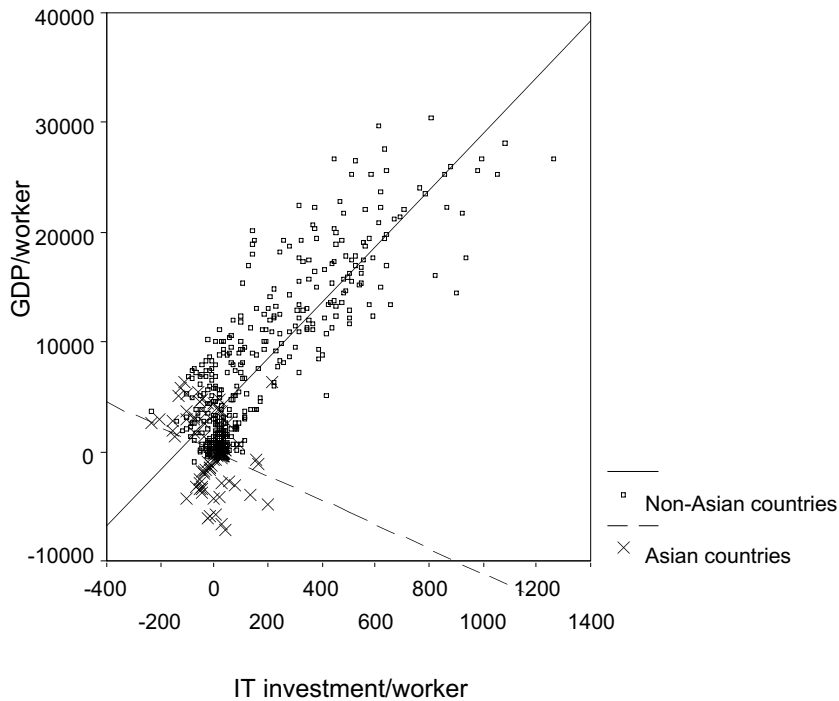


Figure 2.4
Payoffs from IT Investments, in Asian and Non-Asian Countries
(partial regression)



2.2. The Digital Divide

We also found dramatic differences in the two groups of countries on Internet readiness and e-commerce readiness. Taken together, they represent the extent to which a country is able to take advantage of the increasing returns and network effects of the new economy. "Internet readiness" is based on measures of connectivity (telephones per 1,000 persons, Internet hosts per 10,000 persons), access to the Internet (personal computers, or PCs, per 100 persons) and Internet use (Internet users per 1,000 persons). Table 2.1, columns 1 to 4, shows that the non-Asian economies are higher than the Asian economies on all measures of Internet readiness, and twice as high, or higher, on all measures except teledensity. Again, the Asian and non-Asian samples are well matched, even with the addition of Brunei and Vietnam in Table 2.1.

As might be expected, there is also a digital gap within the Asian economies, and the gap is extremely large. Countries that are uniformly high on Internet readiness include Japan, Hong Kong, Singapore, South Korea, and Taiwan. Those that are uniformly low include China, Indonesia, Thailand, India, Vietnam, and the Philippines. Interestingly, Malaysia and Brunei are between the two groups on all measures.

We also measure "e-commerce readiness" in the countries using the density of secure servers (secure servers per million population) in Asian and non-Asian countries (Table 2.1). While Internet readiness provides a measure of the extent to which a country provides an environment supportive of Internet applications such as e-commerce, the density of secure servers indicates the *actual readiness of a country to engage in e-commerce*. Secure servers are those configured to handle transactions such as payment by credit card and are critical to e-commerce operational transactions. As shown in the second last column of Table 2.1, there is also a large gap here between Asian and non-Asian countries. Excluding the United States, there are more than twice as many secure servers in the thirty-five non-Asian countries as in the eleven Asian countries in the analysis. Including the United States, there are more than eight times as many.

Perhaps most significant of all, when we compare Internet and e-commerce readiness between 1995 and 1999, as shown in Figure 2.5, we find that the gap between Asian and non-Asian countries is growing.

Table 2.1
Internet and E-Commerce Readiness, in Asian and Non-Asian Countries, 1998

Country	Internet readiness				E-commerce readiness	
	Teledensity (telephone lines per 1,000 persons)	Internet hosts per 10,000 persons	PCs per 1,000 persons	Internet users per 1,000 persons	Secure servers per 1,000,000 persons	IT investment as a % of GDP
Japan	502.6	133.64	271.88	77.44	3.39	2.28
Hong Kong	557.7	356.67	310.59	98.74	10.32	1.23
Singapore	562.0	259.84	343.27	140.04	21.18	2.84
Taiwan	524.4	142.75	178.46	75.31	1.85	1.16
South Korea	432.7	60.47	149.72	24.30	.82	1.49
Brunei	246.8	39.98	n.a.	31.75	n.a.	n.a.
Malaysia	201.6	30.21	78.21	12.42	1.08	1.70
China	69.6	0.84	7.01	1.27	.01	.96
Indonesia	27.0	1.97	10.61	0.52	.05	.26
Thailand	83.5	7.25	33.14	4.08	.10	.61
India	22.0	0.78	3.78	0.48	.01	.53
Philippines	37.0	3.00	16.26	2.41	.04	.79
Vietnam	25.8	0.00	6.45	.13	n.a.	.78
Asian average	253.3	79.72	117.45	36.07	3.53	1.22
Non-Asian average excluding USA*	385.9	247.42	197.36	82.20	8.63	2.17

* Non-Asian countries include Canada, United Kingdom, Australia, Spain, France, Brazil, Italy, Switzerland, Sweden, Netherlands, South Africa, Austria, Israel, New Zealand, Finland, Ireland, Norway, Belgium, Denmark, Russian Federation, Mexico, Portugal, Poland, Chile, Czech Republic, Hungary, Slovak Republic, Greece, Venezuela, Turkey, Columbia, Romania, Bulgaria, Egypt, Saudi Arabia.

Sources: ITU, *Yearbook of Statistics 2000* (Teledensity); AEA, *Cybernation 2.0* (PCs, Internet users); ITU, *Internet for Development 1999* (Internet hosts); http://www.netcraft.com (secure servers); International Data Corporation (IDC) (IT investment); World Bank, *World Development Indicators 2000* (GDP).

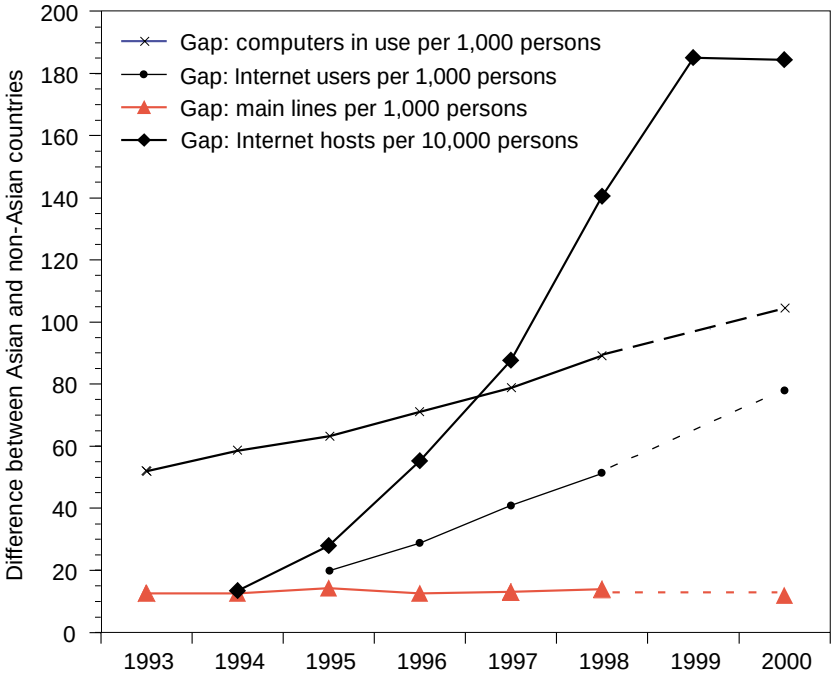
In other words, the Asian economies as a whole appear to be falling further behind rather than closing the gap with non-Asian economies. Of course, there are again very interesting and important differences within the Asian economies themselves. These differences are appropriately the subject of another analysis. The current analysis has been aimed at identifying digital disparities between the region and outside and identifying only major digital disparities within the region.

3. Interpretation of Findings

These findings suggest that, on average, Asian countries and companies are not using IT effectively to improve productivity or develop their economies, that there is a digital divide between Asian and non-Asian countries, and that the digital divide is growing.

How then do we interpret these findings? Since IT does have strong

Figure 2.5
Gap in Internet Readiness between Asian and Non-Asian Countries



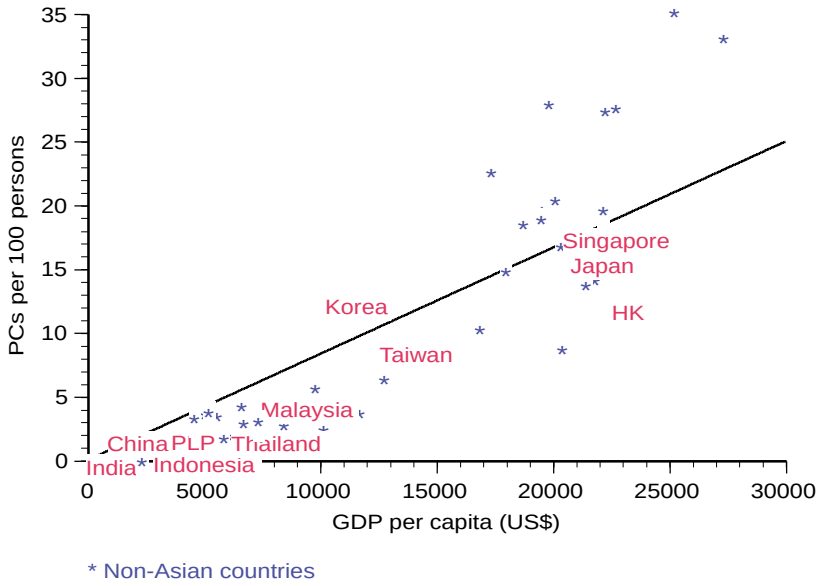
positive payoffs for non-Asian countries, and since the same technologies are available around the world, the problem is not that IT is inherently unproductive, or that Asian countries do not have access to the best technology. Although there might be other factors at work, our research in Asia (Dedrick and Kraemer 1998) suggests the following as key factors:

- *Cost of computing:* We do not have comparable cross-country data on the cost of hardware, software, or services, but we know that during much of the period in question (1985–95), prices varied considerably across countries. Japan, for instance, had PC prices at least twice the U.S. level, until Compaq started a price war in 1992, which was later escalated by Fujitsu. The same was true of Korea, where local PC makers were protected first by an import ban and then by control of distribution channels. If IT prices were higher on average for Asia, then investments in IT would have bought less computing power; thus the returns from that investment would likely have been lower.
- *Cost of telecommunications:* In addition to computer prices, the cost of telecommunications has been high. Most Asian countries had highly regulated telecommunications markets with little competition during the period, which would have increased the cost of building and using data networks. This would have discouraged the IT investments that are likely to have the highest return according to the concept of network economies. This conclusion is borne out by recent research showing that countries with lower telecommunications costs achieve higher IT and Internet penetration than those with higher costs (OECD 1999), and that highly networked companies achieve greater returns to IT investments than less networked companies (Gurbaxani, Melville, and Kraemer 1999).
- *Language:* The problems associated with handling ideographic characters (such as keyboarding, English language coding, displays) might have reduced the payoffs from using computers in several Asian countries. This problem might have been even more severe in the 1980s before more powerful processors and easy-to-use graphical interfaces made it easier to work with computers in Asian languages. It was only around 1993–94 that Windows became widely used in

Japan and other Asian markets. Before that time, users were forced to struggle with keyboard entry of arcane disk operating system (DOS) commands.

- *Low levels of IT use:* While it is true that technological progress tends to favour late adopters through better and cheaper technology *per se*, the same is not true with regard to technology use. There is clearly a learning process involved in using IT, both for individuals and organizations. The earlier a country starts using IT and the more it uses, the faster it is likely to start seeing results. Asian countries have lagged in adopting IT due to language barriers, organizational resistance, and in some cases, government policies that promoted computer production at the expense of use by raising trade barriers. Figure 2.6 shows that Asian countries have below-average levels of PC penetration relative to their income, as most of the Asian countries fall below the trend line. It might be that those countries failed to realize payoffs from their IT investments because they simply

Figure 2.6
PC Diffusion and GDP per Capita, in Asian and Non-Asian Countries



had not used the technology enough to gain the knowledge needed to achieve the potential benefits.

- *Industry structure:* The heaviest users of IT world-wide are the financial and service sectors, while the manufacturing sector usually lags. Asian countries have relatively high levels of manufacturing as a share of employment and economic output, and are thus more likely to improve productivity from investments in non-IT capital such as plant and equipment. However, manufacturing success depends increasingly on information activities such as planning and logistics,[8] which increases the importance of IT not only for firm efficiency and effectiveness, but also to allow oneself to be a player in global production networks. The U.S. and European countries that make up a large share of the non-Asian countries in our sample have much larger financial and services sectors, so they are more likely to be heavy users of IT. Also, U.S. companies in particular have adopted global production systems that are co-ordinated through extensive information networks and so-called enterprise systems.
- *Corporate management:* The management styles of Asian companies are often not well suited to taking advantage of the capabilities of computers and IT. Lifetime employment, prevalent in large Japanese companies as well as others in Asia, makes it difficult to use IT to replace workers. Hierarchical management structures and vertically integrated supply chains are often not amenable to the kinds of business process restructuring that is a necessary complement to effective IT use. Lack of trust in outsiders, and a dislike for paying for services in general can inhibit the use of a variety of consultants and IT service providers who might help companies use the technology better. Finally, top managers in most companies are not familiar with the technology and see computers as tools for secretaries or engineers; therefore they are less likely to think of IT as a solution to the various problems they face.

The finding that Asian countries are not enjoying the benefits of IT use is especially ironic considering the fact that a huge share of the world's computer hardware is produced in many of the very countries that were

included in this study. These countries have benefited from production of IT, but apparently not from use. This is different from the United States, where production and use have gone hand in hand, with a large, sophisticated user population putting pressure on producers to come up with better hardware and software. The only place in Asia where production and use have both flourished has been Singapore, where government policies have explicitly pushed both supply and demand. In the wake of the Asian financial crisis, these findings have important implications for both governments and companies in the region, including the many U.S. and European corporations with major investments in Asia.

4. Strategic Implications for Asia

The bottom line implication of these results is that Asian countries (governments) can benefit by promoting IT use and creating the environmental conditions needed to support effective use. Likewise, companies doing business in Asia can benefit by investing in IT to improve operational efficiency and to improve their position in the market. The first conclusion is especially important because most Asian countries' policies have promoted computer hardware production over use. However, our research shows that the economic benefits from IT use are likely to outweigh the benefits from production, which are limited to just one segment of the economy. The second conclusion is important to Asian companies that have been slow to adopt new information technologies and to reorganize their businesses to take advantage of the potential returns from IT.

The importance of IT use is being further amplified by the process of economic globalization, which puts a premium on using information and communications to create linkages to international markets and global production networks. Companies and countries that fail to develop the necessary capabilities risk being left out of the markets and production networks.

4.1. Globalization, IT Use, and Productivity

More and more countries see joining the global economy as a path to economic success. Countries that had previously pursued protectionist

strategies to nurture industrialization, such as China, Brazil, and India, have lowered barriers to trade and foreign investment, and are privatizing and deregulating important industry sectors. Even the shock of the Asian financial crisis has not caused a major retreat from global financial markets. Meanwhile, multinational corporations (MNCs) continue looking to developing countries for new markets and low-cost production sites, creating new opportunities for those countries to participate in the global economy.

The potential benefits of globalization for developing economies are great, including increased access to capital, markets, and technology. Countries such as Singapore, Taiwan, and Ireland have achieved rapid growth through outward-looking economic strategies, often in partnership with MNCs. However, the benefits are not automatic, and there are costs to liberalization as well. Domestic companies can be destroyed by foreign competition at home, as we have found to be the case with many Mexican and Brazilian PC companies after those markets were liberalized (Dedrick, Kraemer, and Palacios 2001; Botelho, Dedrick, Kraemer, and Tigre 1999). Also, MNCs may simply import goods to the local market without producing, exporting, or bringing in any technology. And if they do produce and export, they might only perform the lowest-value assembly work, creating jobs with very low pay and sometimes poor working conditions.

In order to benefit from globalization, and from foreign competition in the domestic market, countries need to establish competitive capabilities beyond cheap labour. These can take the form of educated workers, high-quality infrastructure, local R&D capabilities, and strong entrepreneurial skills. Information networks along with skilled knowledge workers make up the "soft" infrastructure that will be at least as important as physical infrastructure in the next century.

The key payoff from developing this soft infrastructure will be the ability to use IT productively. When markets are opened up, domestic companies face competition from MNCs that bring in the most advanced information systems. In order to compete, domestic firms can develop partnerships with those MNCs to gain access to their technology; they can work with leading information services providers in order to develop their own systems; or in some cases they might decide to outsource their

information systems altogether. Whatever strategy is used, staying competitive requires investments in IT to develop world-class information systems.

In addition to staying competitive in the domestic market, companies that make these investments are also setting the stage for competing in international markets. Time-to-market is becoming critical in many industries (for example, PCs, semiconductors, automobiles, fashion goods, and perishable foods), and these industries are moving quickly to integrate the entire supply chain electronically. Electronic data interchange was a first step, but now companies such as Dell Computer, Cisco Systems, Intel, and others are linking their design, procurement, manufacturing, logistics, and even marketing through Internet-based technologies. Companies and countries that hope to participate in these production networks will need sophisticated IT skills and good information infrastructures. Those that can develop the capabilities will benefit from globalization, while others will be left out.

4.2. Production versus Use

The foregoing analysis of payoffs from IT investment focuses on the *use* of IT as a productivity tool throughout the economy. There are also benefits at the national level from local *production* of computer hardware, software, and services. In fact the benefits from production are often more visible than those from use. They include jobs (usually lower-level jobs), creation of national capabilities, and participation in a dynamic, high-growth industry with strong export potential.

The value of IT production in the United States has recently been documented by the U.S. Department of Commerce (2000), which estimates that IT industries (computer hardware, software, and services, communications equipment and services) accounted for 8.3 per cent of the U.S. economy and nearly a third of GDP growth between 1995 and 1999. IT production also contributes to lower inflation rates, since a growing share of economic output is in an industry marked by rapidly falling prices. The report argues that actual inflation fell by an average of 0.5 percentage points a year from 1994 to 1998 due to the effect of the IT industry's declining prices. Finally, the IT industry, including telecommunications, employed 7.4 million workers in 1998 (6.1 per

cent of total employment), with an average annual wage more than 1.5 times that for all private employees.

Outside the United States, other countries have had equally impressive results from IT production. The IT industry is a major source of economic output, exports, and jobs in countries such as Japan, Taiwan, Singapore, Hong Kong, China, Korea, and Ireland, thanks mainly to opportunities created in the PC hardware industry beginning in the early 1980s (Dedrick and Kraemer 1998). Countries such as India, China, and the Philippines are also finding opportunities in the software industry thanks to large supplies of programmers. It is not surprising that policy-makers are attracted by the possibility of developing national computer industries, and that many developing countries (for example, Brazil, Mexico, Malaysia, Thailand, and China) have used various policy tools to encourage investment in IT production.

Creating a local IT industry is not a simple matter, however, especially for newcomers to the industry. While a number of new countries entered the industry during the PC revolution of the 1980s, other countries such as Brazil and Mexico had little success, and some earlier industry participants, including many European countries, were squeezed out. Even Japan and Korea have had limited success in computers (as opposed to components) outside their own markets.

If anything, the opportunities for newcomers are more limited today. Industry segments such as microprocessors, operating systems, routers, and packaged business applications are virtually closed off because the standards are set by the leading players in the IT industry, mainly U.S. companies such as Intel, Microsoft, and Cisco. Other industry segments such as dynamic random access memory (DRAM) and flat-panel displays require large capital investments, economies of scale, and specialized skills that few countries can hope to achieve. Moreover, many opportunities have already been pre-empted by earlier entrants such as Singapore, Korea, Taiwan, and Ireland, which have developed specialized skills and a strong supplier base. Some countries are offering expensive incentives to attract foreign investment in hardware production, but it is questionable whether they can catch up at this point. And even if they are successful in attracting foreign investment, the resulting industry is

likely to have limited value added and few opportunities for local companies to participate.

Finally, production benefits only one industry sector — the IT sector, while IT use can benefit all industry sectors. So if local production is promoted at the expense of domestic users, for example, through import barriers that raise prices, the bargain is probably a bad one for the economy as a whole. Given the choice between promoting production or use, we would argue for use, especially in countries that are not already part of the global production network of the computer industry.[9] Fortunately, the choice does not have to be so stark in most cases. In fact, there is a policy option that simultaneously encourages IT use while also creating opportunities to develop a local industry — that is, production close to use.

4.3. Production Close to Use

Most national policies to promote computer production have focused on hardware, which is the most tangible segment of the industry. However, the fastest-growing segments of the computer industry for over a decade have been software and services (Table 2.2). In the United States, employment in software and computer services industries nearly doubled from 850,000 in 1992 to 1.6 million in 1998. Over the same period, employment in those IT job categories that require the most education and offer the highest compensation, such as computer scientists, computer engineers, systems analysts, and computer programmers, increased by nearly 1 million or almost 80 per cent.

Even more dynamic is the burgeoning Internet sector, which has seen exponential growth rates for several years. These are the sectors that we refer to as "production close to use", because of the close interaction between the provider and end user of such software and services.

The software and services industries offer some specific advantages over hardware production. First, while some parts of the software industry are dominated by multinationals, there are still many opportunities to develop niche products without competing directly with Microsoft, Oracle, SAP, and the other large companies. These can be products developed for local markets that meet the needs of local language, culture,

Table 2.2
Computer Industry Growth Rates, 1987–97

Industry segment	CAGR (%)
Hardware	8.6
Software	14.0
Services	20.6

CAGR = Compound annual growth rate.

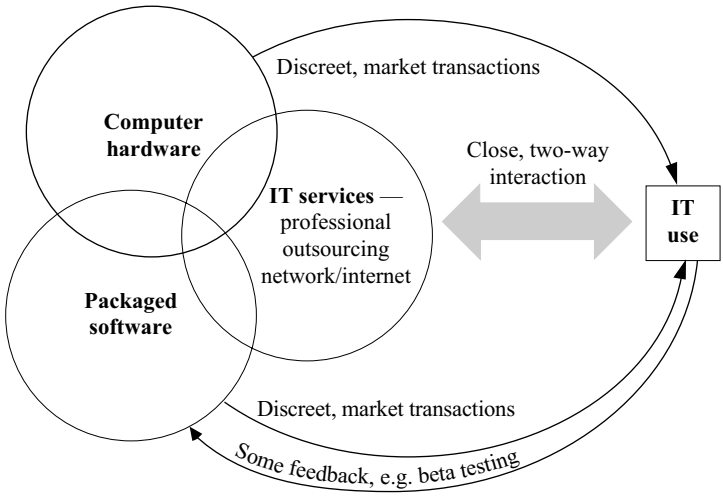
Source: McKinsey & Company (1998).

and business environments. The services business offers even more compelling opportunities, as services usually must be provided locally rather than being imported. They also require continuous interaction between local users and providers, and can benefit users as well as providers, helping countries realize the payoffs from IT use.

Figure 2.7 shows how information services such as systems integration, network integration, outsourcing, and Internet services can serve as a link between production and use. These linkages can help local users apply the technology more effectively and productively, helping to solve Asia's productivity paradox in IT use. They also can create new business and employment opportunities for local residents as local companies can start small and grow at a pace that is supportable by their own finances and capabilities. Developing local software, service, and Internet industries would also help diversify Asian IT industries away from the brutally competitive hardware industries in which, as one Asian executive stated, "we're all killing ourselves to make money for Microsoft and Intel" (Dedrick and Kraemer 1998, p. 261).

All of this does not mean that Asian countries will not continue to benefit from their role in the hardware industry. But even those countries should not be so focused on hardware that they ignore the great potential of software and services, and the multiplier effect of these sectors on improving IT use throughout the economy. Other countries that are just trying to enter the industry with limited resources to invest should look carefully at whether efforts to promote hardware production would have the same payoffs as promotion of IT use and production close to use.

Figure 2.7
Information Services as Link between Production and Use



5. Conclusions

There is good reason to believe that a new economy is taking shape in the United States as well as some other developed countries. The chief characteristic of the new economy is sustained economic and productivity growth. That economy is strongly shaped by the rapidly declining costs of IT and huge investments in IT, the Internet and other applications such as e-commerce, accompanied by firm and industry changes which leverage those investments.

Despite earlier concerns about the IT productivity paradox, there is now strong scientific evidence that IT investments do increase productivity for companies and countries on average. However, Asian countries have been slow to adopt IT, and have not enjoyed the benefits that other countries have realized. As a consequence, there is a gap between Asian and non-Asian economies in both Internet and e-commerce readiness — two central areas of IT application and increasing returns and positive network effects in the new economy.

This digital gap is partly due to uncontrollable factors such as

language, but is also due to development strategy, government policy, and corporate management issues. Government policies have raised the cost of computers and telecommunications and promoted hardware production at the expense of IT use. Corporate structures and practices have hampered IT use by making it difficult to restructure companies and reduce employment levels as new IT applications and opportunities to leverage IT are developed.

Companies doing business in Asia need to use IT and electronic commerce as tools to tie together their own supply networks and distribution channels. Asian-owned companies need to realize that their continued competitiveness will depend on revamping their own operations around IT, and integrating themselves into the information systems of their major customers. The Asian financial crisis is actually creating both the impetus and opportunity to do so, as companies are acutely aware of the need to change in order to survive. It is also opening the door for U.S. companies to enter markets in Asia that were previously closed, such as banking, insurance, transportation, and telecommunications. As these companies come to Asia, their Asian partners will gain access to the most advanced information systems, and their Asian competitors will be forced to improve their own IT systems and skills to compete. Companies that do not respond risk being driven out of business.

Asian governments are likewise looking for new ways to boost productivity and revive their economies. One option is to promote IT use and production close to use. Policies that improve communications and information infrastructure, remove barriers to use, and encourage investments in IT will help, as will efforts to promote the software, services, and Internet-related business sectors.

Most importantly, governments and businesses in Asia must change their perspective from one that values hardware over software and production over use. Until this change takes place, Asia is likely to fall behind the rest of the world in productivity growth and in tapping the business opportunities created by the rapid spread of the Internet and electronic commerce.

NOTES

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1. Information technology (IT) as used here includes computers, telecommunications, and management science techniques.
2. Solow (1987) remarks that "you can see the computer age everywhere but in the productivity statistics".
3. It is possible that this same effect is occurring now in some developing countries. However, comparable cross-country data for the period 1993–2000 are not yet available with which to do systematic analyses that would provide an indication of whether this is the case.
4. This does not mean that such impacts are not occurring. They might or might not be occurring. It means that the impacts are not measurable as yet.
5. Measured as compound annual growth rate (CAGR).
6. It is important to note that, although we use "IT investment", which is a flow variable and Dewan and Kraemer use "IT capital", which is a stock measure, the results from both analyses are mutually reinforcing. Also, the Dewan and Kraemer analysis is based on a production function model, which provides good evidence of causality.
7. We are aware of production function studies that show positive returns from IT investments at the firm level in Singapore and Korea. These studies do not contradict our country-level results as they are based on a different level of analysis, a sample of firms (usually larger ones), and show only average returns with some firms doing better than others. At the country level, the results can be different because all firms in the economy are included as is the public sector, and because the differences among firms can cancel each other out.
8. We mean this to include activities such as order management, forecasting, production planning, shop floor management, supply chain management, and enterprise resource management.
9. Clearly, this argument does not apply fully to countries that have found their niche and are already successfully engaged as part of global production networks. For example, as pointed out by a conference participant, Japan is very good at game technology, Taiwan at producing PCs, Singapore at disk drives and semiconductors, Korea at producing memory chips, and so on. We argue that these countries would benefit further from policies that promoted *both* production and use, and production close to use.

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