

# The Impact of Information and Communication Technologies on the Economic Competitiveness and Social Development of Taiwan

ARTHUR L. DAHL, International Environment Forum

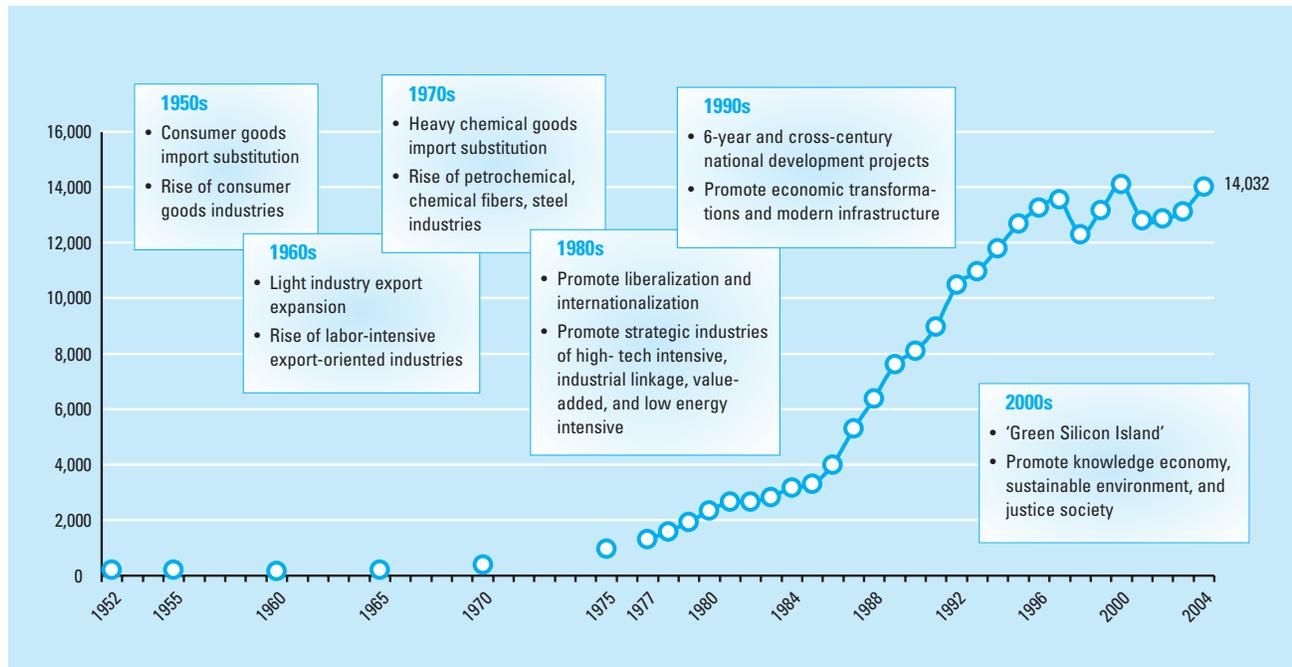
AUGUST LOPEZ-CLAROS, World Economic Forum

## Background on the development of the ICT sector

A half-century ago, Taiwan was a resource-poor underdeveloped tropical island. Through sustained good policies over the past few decades, it has lifted its population from poverty, joining the ranks of the most prosperous and competitive economies in the world. Unlike Korea, Thailand, Indonesia, Malaysia and Hong Kong, it was able to weather quite unharmed the Asian financial crisis in 1997. Today Taiwan is a technological powerhouse that ranks among the world's top producers of notebook personal computers, flat panel displays, modems, motherboards, and other electronic components and products. In 2004 it ranked fourth globally in the production value of its IT hardware.<sup>1</sup> It is also fifth in the World Economic Forum's 2005–2006 Global Competitiveness rankings, with a strong showing in the area of technology and innovation, ranking 3rd in the world in the technology index. The *2005–2006 Global Competitiveness Report* highlights Taiwan's exceptional strength in technology issues, including an impressive capacity for innovation, firm-level technology absorption, university/industry collaboration in research, and its pre-eminent position in the use of the latest technologies, from mobile telephones to personal computers and the Internet. This chapter explores some of the principal factors that have contributed to its success, which might well serve as a model for countries striving to improve their performance and competitiveness in information and communication technologies.

Taiwan's transition from a poor agricultural society into an increasingly sophisticated powerhouse of high-technology manufacturing and the world's leading producer of information and communication technology products is, without doubt, one of the most compelling development stories of the past half century. However, as with all other countries that wish to maintain a competitive edge, the authorities will have to remain vigilant. There is scope for further improvements in enhancing the quality of public institutions by increasing levels of transparency and openness. Taiwan should in coming years aim to reach the standards of the Nordic countries in this area. It has already matched their technological prowess. Now it must reach their levels of efficiency in public sector management.

In his case study on Taiwan in the 2004–2005 *Global Information Technology Report* (Lin, 2005), F.C. Lin traces the evolution of Taiwan's ICT industry through the first economic miracle of Taiwan's transformation from an agricultural to an industrial economy (1953–1986), and describes the second miracle of its industrial restructuring (1987–2000), when low technology industries were forced to relocate overseas and were replaced by technology-intensive industries, particularly in the Information Technology sector, as shown in Figure 1. In half a century, per capita GNP rose from US\$196 to US\$14,032.

**Figure 1: Taiwan GNP per capita income (US\$) and key historical developments, 1952–2004**

Source: Center for Economic Planning and Development, 2005b.

Lin attributes these successes to the following factors: strong government leadership in maintaining a high growth rate and a strong fiscal situation, manpower development with a high level of science and technology graduates, the coalescing of high-tech clusters following the model of Silicon Valley, the development of venture capital supporting high-tech small and medium enterprises, and a highly energetic private sector. He identifies the future challenges as breaking into the advanced industrial and research areas of application integration, technical innovation, and standards formulation as global competition reduces profit margins.

Today, everyone recognizes the economic challenge that mainland China represents for Taiwan. With the rapid growth of the economy in mainland China, there are increasing business ties between the mainland and Taiwan, despite as yet unresolved issues on the political front. Trade between the two is growing rapidly, and a large number of Taiwanese, perhaps up to a million, are now working in mainland China. There is a high level of investment as well, now estimated at US\$100 billion, as the mainland is the logical place for Taiwanese businesses to delocalize production that is no longer competitive in Taiwan, taking advantage of low land prices and cheap labor. These strengthening trade, economic and business links will undoubtedly serve to create the conditions for a peaceful, cooperative resolution of outstanding bilateral political issues.

Competition with the mainland is forcing Taiwan into another rapid transition as it searches for new areas of comparative advantage as a center for research and for corporate headquarters. Given Taiwan's relatively high cost of labor, land and services, it will need to maintain its engineering and management talent and flexible manufacturers (Mai, 2001), and invest more in research and in collaboration between industry, the research institutes, and universities, if it is to succeed in its next transition.

In addition to manufacturing them, Taiwan is already moving fast to adopt ICTs. The Institute for Information Industry (III) estimates that there were 8.92 million Internet users in Taiwan as of June 2004, with an Internet penetration rate of 39 percent, growing 2 percent the previous year, and showing signs of reaching saturation. About 12.2 million people, or 54 percent of Taiwan's population, were general Internet users—slightly more men (56 percent) than women (52 percent). As for age groups, 95 percent of people between 15 and 24 years, but less than 10 percent of people over 60 were Internet users. Geographically, Internet penetration was concentrated (over 60 percent) in the north, with 40–50 percent in other parts of Taiwan. (FIND, 2005)

### The Taiwanese comparative advantage

What has permitted a densely populated (628 persons/sq.km) island economy of only 36,000 square kilometers

(between Belgium and the Netherlands in size), and without significant resources, to become a world leader in some of the most advanced industrial technologies in only half a century? There is no single answer, but an interrelated set of factors, which, taken together, have given Taiwan a competitive edge. The sections below describe some of the most significant factors for success. Most of these are not unique to Taiwan, but could be applied by any country wanting to use high technology as a springboard to economic development. Ideology has not played a significant role, and both strong government intervention and a dynamic private sector have been important. Effective governance, good policies, imaginative institutional arrangements, and good macroeconomic management have provided a stable foundation. Adaptability and flexibility have been combined with long-term strategic planning. Major investments have been made in both human resources and infrastructure by government, businesses, and individual families. Most of the effort has come from Taiwan itself, rather than from outside donors or a former colonial power, and it has been widely shared by all parts of society. There is no reason why other small but highly motivated countries with nothing but human resources could not replicate the Taiwanese model and follow a similar path.

### Strong and coherent planning mechanisms

For many years, the government in Taiwan has had a clear strategic vision of the goals for its economy and society, regularly updated its vision through comprehensive planning processes, and supported it with planning mechanisms enjoying high-level political participation and support. Significant government financial resources pushed research and development processes forward until the technologies became commercially viable. The decision to focus on information and communication technologies as a future economic driver was taken in 1974, with the establishment of the Industrial Technology Research Institute (ITRI), and this vision has been developed systematically over the years.

Three major government structures play an important role in strategic planning relevant to high-tech industrial development: the Council for Economic Planning and Development (CEPD), responsible for planning for the economy as a whole; the Research, Development and Evaluation Commission (RDEC), which focuses on the public sector; and the National Science Council (NSC), which plans the development of science and technology.

### Council for Economic Planning and Development

This ministerial-level body formulates national development plans and policies, reviews proposals to the Cabinet, coordinates the economic and policymaking activities of related ministries and agencies, allocates public investment

funds, and supervises the implementation of development projects and programs. It has a staff of nearly 300, more than half with advanced degrees. With such a strong private sector, it is normal that the government listens to its views, both informally and through mechanisms such as the CEPD Advisory Council of business leaders.

In 2000, the CEPD set out to make Taiwan a green silicon island, and the latest Challenge 2008 National Development Plan was adopted in 2002. It acknowledges the increasing global competition and the magnetic effect of mainland China, and aims to develop a knowledge-based economy in Taiwan. With respect to ICT, it includes an e-Generation Manpower Cultivation Plan with online education, lifelong learning, English proficiency, and an internationalized college and living environment able to attract top talent globally. Its investment strategy is aimed at cultural and creative industry development, and international innovation and R&D, with a target for R&D spending to reach 3 percent of GDP within six years. Important research areas are bio-, nano-, chip-system, telecommunications, and hybrid technologies, as well as software design, optoelectronics, and environmental protection technology. The manufacturing industry is to be shifted to high value-added and low substitution products. Major investments in logistics, infrastructure and marketing services aim to make Taiwan into a desirable location for operations headquarters.

The e-Taiwan construction plan is intended to make it into Asia's most digitized economy and a model for the implementation of ICT, with broadband infrastructure targeted to reach six million households by 2008. Digital industries, such as entertainment, archiving, and digital learning will be supported, and e-government, e-commerce, e-traffic, e-society, and intelligent communications systems are being promoted. This process of learning-by-doing is intended to accelerate the conversion of innovation into practical applications.

### Research, Development and Evaluation Commission

The RDEC was established under the Cabinet in 1969 to effect innovation in public services. It drives government restructuring and reform, engages in policy innovation, policy research development, support and coordination for decision making, and promotes policy knowledge management. As the think tank for the Cabinet, it facilitates the coordinated functioning of the expertise of the academic, government, and business sectors, and communication between public and government agencies. It aims to establish a high-quality knowledge management system in government, improve government performance management, and promote e-Government.

### National Science Council

Since 1959, the NSC has been the highest government agency responsible for promoting the development of science and technology (S&T). It supports academic research, and has developed science parks as an essential component in Taiwan's economic development. It convenes S&T Strategy Planning Sessions every six months, and holds National S&T Conferences every four to five years for mid- and long-term planning. It reviews, controls, and evaluates all government S&T programs.

As part of the government reform program, there are plans to combine the above three strategic planning mechanisms into a single National Development Council represented in the cabinet by early 2006.

### The international human resources pool

The first impetus to Taiwan's development was the influx of government officials and other refugees from mainland China at the end of the civil war in 1949, bringing qualified manpower, but also facing the challenge of building a whole new national infrastructure from scratch. The early years were materially very difficult, and the emphasis was on military preparedness.

In the 1960s and 1970s, the brightest young Taiwanese went overseas for university and advanced studies, often to the United States, and since there were few career opportunities available in Taiwan, they stayed abroad and advanced in industry and academia. This brain drain seemed disadvantageous at the time, but, in fact, it allowed Taiwan to build a large pool of qualified and experienced people before its economy was ready to absorb them. From about 1985, they were offered incentives to return to Taiwan as entrepreneurs, to create startups in the science parks, or to take up research, academic, and management positions. These people not only brought their knowledge and experience back from places like Silicon Valley, but also their networks of contacts and working relationships with leading international companies. Most of the key people driving the successful ICT industry of today have followed this path, permitting the rapid acceleration of Taiwan to the top. This process has also allowed the rapid expansion of Taiwanese universities, from 15 in 1955 to 159 today, so that most of the required manpower for continuing expansion can now be educated at home. Other incentives are now being put in place to ensure that newly trained people can also acquire the international experience necessary in a globalizing world.

Taiwan also recognizes that recruitment today comes from a global labor pool, so it is making itself more welcoming to expatriate employees, establishing bilingual schools in science parks, providing signs and services in English as well as Chinese, and raising the general standard of the human environment, services, and cultural and recreational activities.

Figure 2 illustrates how Taiwan compares to other countries in selected areas, as a result of these intensive efforts.

### The structure of Taiwanese industry

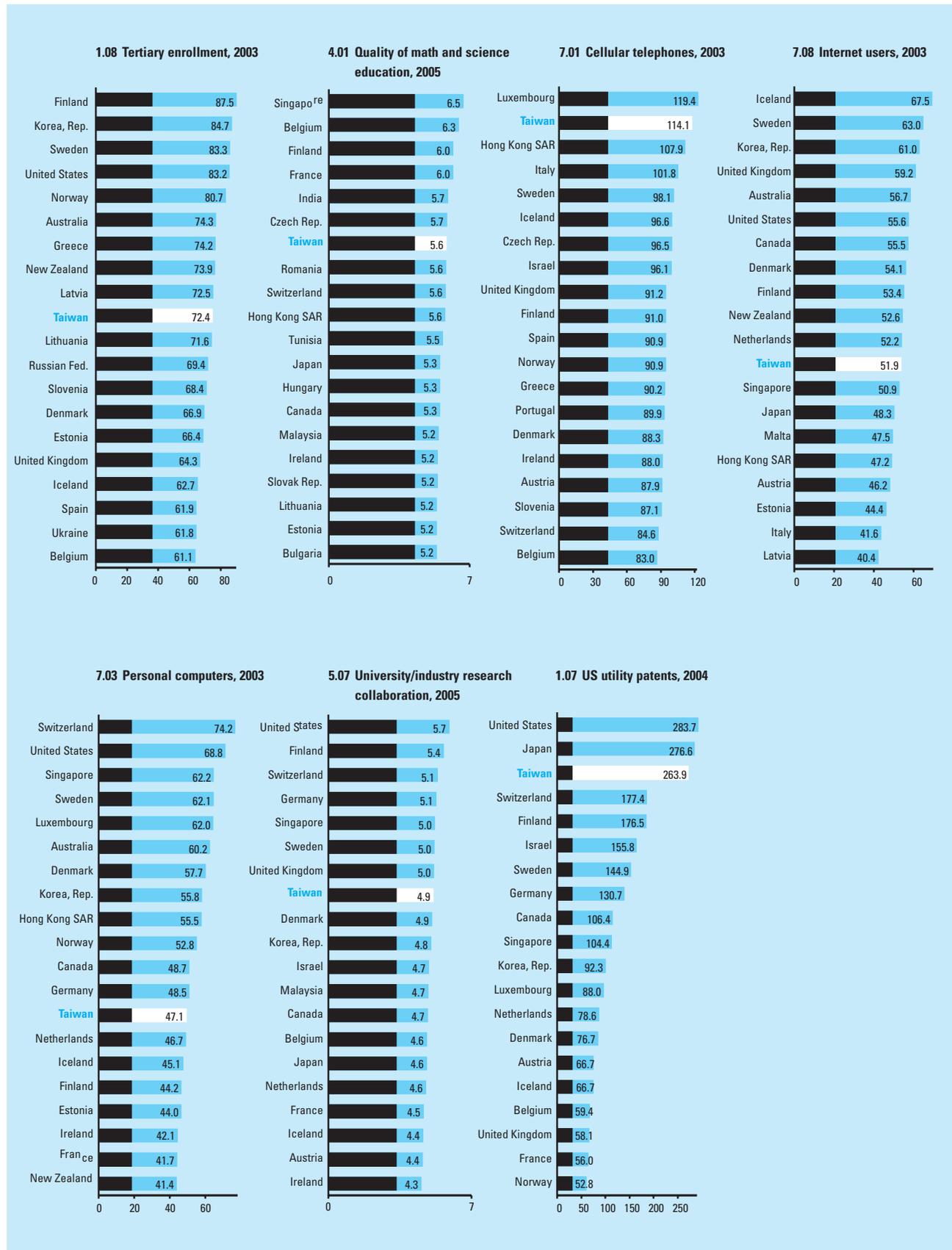
While advanced Asian countries have emphasized large corporate units, the Taiwanese economy is dominated by 97 percent small and medium enterprises (SMEs). While this might seem a disadvantage, the industry is structured in such a way that clusters of SMEs can service larger enterprises. The entrepreneurial spirit generated by Taiwan's difficult economic situation and lack of resources in earlier decades emphasized flexibility and cost-consciousness. Taiwanese companies are accustomed to turbulent times and constant change, and expect to have to change products every six months. This structure provides great flexibility and rapid response times, while allowing for a more human scale and stronger personal relationships within the companies.

### The special relationship to the United States

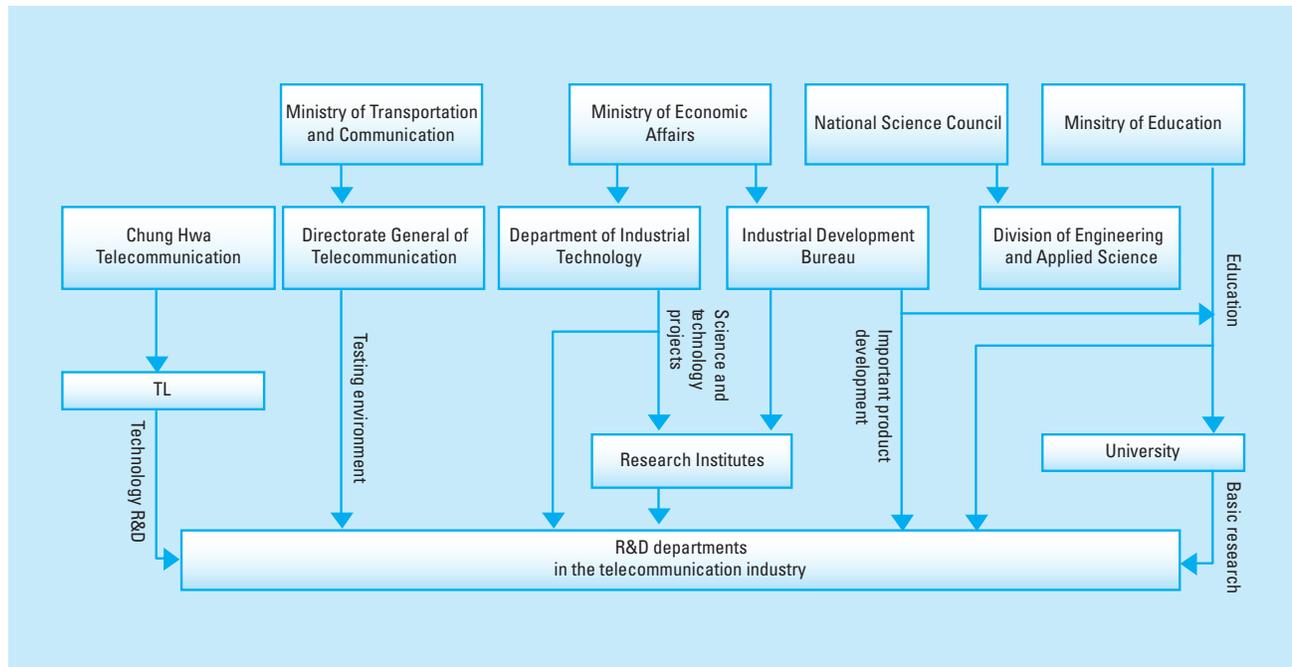
One particular comparative advantage has been the special place of Taiwan in the geopolitical relationships of the United States, keeping US frontiers open to Taiwanese students and immigrants. Lin (2005) has shown that the large pool of Taiwanese expatriates in the United States, developed through years of government encouragement for overseas studies, and often working in the leading high-tech industries and centers, has enabled Taiwan's own development. Incentives have been provided to lure back those with the technological and entrepreneurial experience necessary for Taiwan to stay near the forefront of innovation and business development. The personal relationships established across this human bridge provided the basis for the trust and long-term cooperation between Taiwanese and major international ICT players in creating and capturing new business opportunities. The brain drain is usually seen as a disadvantage for developing countries, but Taiwan has shown how it can be turned into an advantage in the global labor marketplace.

There is also a special economic relationship. Taiwan is America's eighth largest trading partner, and the fifth largest foreign market for American agricultural products, with US sales averaging almost US\$50 million per day, or about 25 percent more than to mainland China. Total two-way trade between the United States and Taiwan now exceeds US\$64 billion annually with reciprocal private investments also in the billions of dollars (Taipei Economic and Cultural Office, 2005).

Figure 2: Top 20 performers for selected variables



Note: The darker bar indicates the average across the 117 countries covered in the World Economic Forum's *Global Competitiveness Report 2005–2006*. Sources: World Economic Forum, 2005; International Telecommunication Union, 2004; US Patent and Trademark Office.

**Figure 3: Telecommunications program project structure**

Source: Adapted from Taiwan, 2005, National Science and Technology Program for Telecommunications.

## Mechanisms that connect ICT developments with economic growth and efficiency

### Integrated strategic planning

The role of the government in providing strategic leadership and long-term vision for Taiwan's development is exemplary. Just as the 19th century Meiji Restoration in Japan propelled its closed feudal society into the modern world, so has the government in Taiwan established the conditions and institutions necessary for each major step forward in its industrial development, first from a poor agricultural economy to a major producer of cheap goods, then, through stages of rising industrial efficiency and technological transformation, to the ICT powerhouse it is today. This process is continuing, as Taiwan aims to rise to the top of technological innovation and industrial leadership. The government's six-year Challenge 2008 National Development Plan is the latest example, with its focus on innovation, research and development, high value-added products, and making e-Taiwan Asia's most digitized, knowledge-based economy. Interestingly, this plan is not narrowly focused on ITC development, but includes making Taiwan attractive for operations headquarters establishment, top researchers and entrepreneurs through environmental improvement, community development, and cultural encouragement. It also aims to spread the benefits to all segments of the population including in the rural areas, thus ensuring social sustainability.

This overall planning is then supported by subsidiary layers of more specific planning in which government, the research community and the business sector all participate actively. For example, communications is a priority area for future industrial development. As illustrated in Figure 3, the National Science Council established a National Science and Technology Program for Telecommunications in 1998, in partnership with the relevant Ministries, to integrate resources from government, industry, academia, and research institutes, and to stimulate industrial advancement.

The telecommunications program, under a university-based principal investigator, supports research and development of key technologies, promotes the telecommunications industry, and trains the necessary talents through university degree programs, on-the-job training, and specialized education centers for optical communications, network applications, communication devices, broadband internet and wireless networks. The first phase, to 2003, was budgeted at US\$381 million, and focused on wireless communication and broadband Internet. The second five-year phase, budgeted at US\$416 million, incorporates the promotion of services and applications, and places the emphasis on increasing Taiwan's share in the communications industry, piloted by the Committee of Communication Industry Development under the Ministry of Economic Affairs. The goal is to create production value of US\$30 billion and a ranking in the top 10 countries by 2008.

There are similar plans to position Taiwan globally in System-on-Chip technology and other emerging areas. The next strategic goals identified by the government are the development of service industries and high-value-added activities in research and innovation.

The Taiwan government's Department of Industrial Technology has been vigorously promoting e-business, following a systematic strategic framework, which includes four main elements: policy, environment, applications and promotion (FIND, 2004). The goal is to establish a global logistics operation system based on a highly efficient e-supply chain framework. The strategy was launched in 2000 with three international supply chains linking leading international IT companies (IBM, HP and Compaq) with 42 Taiwan contract manufacturers, and 15 domestic e-supply chains between domestic IT manufacturers acer, MiTAC and ASUS and 3,955 of their upstream suppliers. In 2002–2003, cash flow services were added, with a network of e-payment and e-finance involving eight banks, 11 IT manufacturers and 4,900 suppliers. E-logistics was also developed to control inventories, track delivery, control warehousing, and organize customs and transportation. Engineering collaboration is being developed between clients, suppliers and technical/design partners, applying IT and workflow innovations to manage development cost and performance, engineering design changes, design data and projects, in order to shorten launch time, mass-produce new products, and achieve cross-industry synergies and competitiveness.

#### Institute for Information Industry

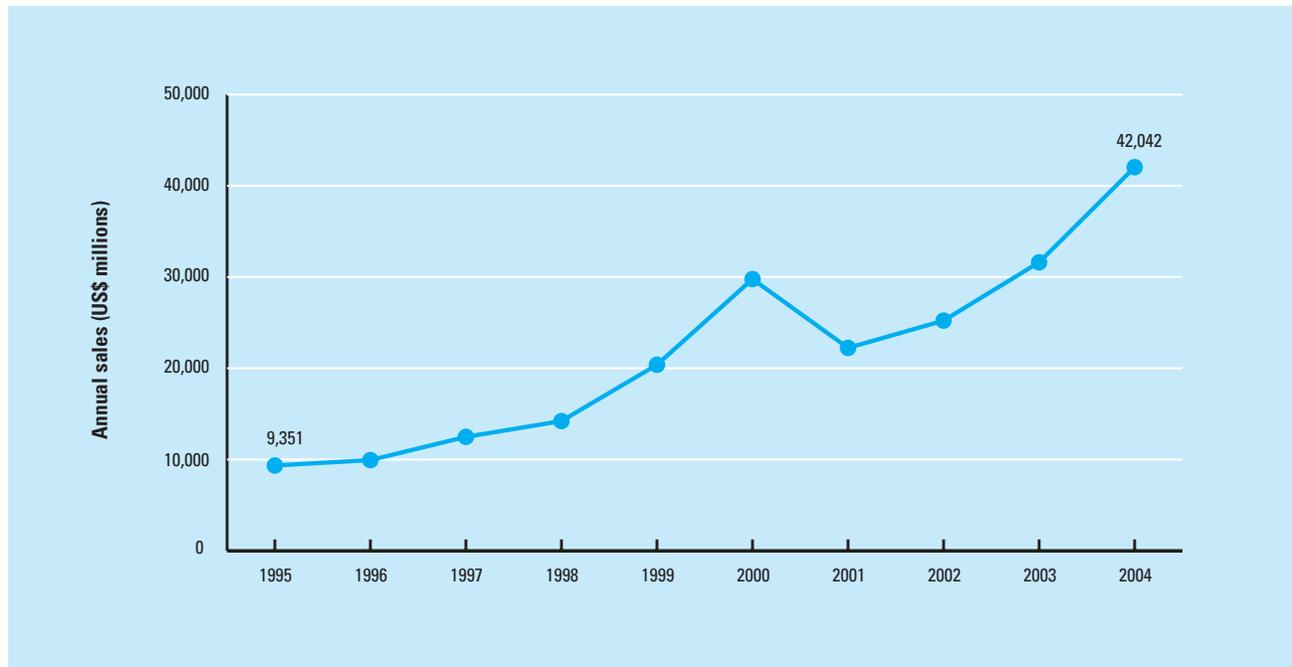
One key to Taiwan's success is a distinctive quasi-governmental structure at the heart of its ICT revolution. The Institute for Information Industry (III) was established in 1979 as a joint government-private sector think tank and management consultancy, to help promote the development of the ICT industry and deploy the information society. Funded by both government and the private sector, the III provides a neutral source of expertise independent of both partisan politics and individual corporate agendas. It is active in research and development, promotion of the ICT industry, and support and administration. The III Chairman is the science and technology adviser to the Prime Minister and President, and senior executives act as members of various government task forces. With a staff of more than 1,800 engineers, III runs project offices for the government, such as the National Information and Communication Initiative (NICI), e-Taiwan, Industrial S&T R/D, and offices in the Ministry of Economic Affairs. Since 1984, III also provides research for the government through its Market Intelligence Center and drafts laws through its Science and Technology Law Center. Presently, it aids Taiwan to become a world-class ICT leader, using ICT to increase productivity, raise

efficiency, improve quality of life in both the public and private sectors, and develop international collaborative projects with key industrial and academic partners and global offices in various important ICT centers. This unique institutional arrangement, with a large pool of highly talented people developing an integrated and strategic view of the IT sector and implementing it effectively both in government and the private sector helps to explain the coherence of the Taiwanese approach. The government, rather than expanding its bureaucracy, contracts government functions to III, making use of its human resources in a flexible and focused way.

The range of III functions is impressive. For industry promotion, it functions as a think tank, proposing government policies and providing market analyses, and staffing relevant advisory and promotional offices. In research and development, it works on software technology and incubates startups, develops concepts such as the integrated service model and the digital home, and generates consumer, communications, and computer technologies, including over 100 patent applications annually. In education, it has provided professional IT training to over 350,000 people in both the public and private sectors. For applications promotion, it has developed programs to address the digital divide, creating digital opportunity centers in remote areas and internationally for developing countries, and providing services to small and medium enterprises and disadvantaged and handicapped groups. It designs and manages projects to strengthen ICT infrastructure, including the planning of e-Taiwan, to extend broadband access to all households, and M-Taiwan, to provide mobile access through a combination of cellular telephone and WLAN networks. As manufacturing moves offshore, it moves the industry forward from tangible to intangible products, and aims to establish best practices in Taiwan as a model for the rest of the world.

#### The science park concept

Drawing inspiration from Silicon Valley and the advantages of physical clustering of research, industrial and academic activities, planning began in 1976 for the first science park in a former tea-growing area at Hsinchu, 70 km south of Taipei, with implementation beginning in 1980. Developed in three phases, covering 632 hectares, the Hsinchu Science Park today contains 385 companies (50 of foreign origin) with 115,000 employees. The government's investment of US\$1.7 billion in infrastructure has provided companies with rented facilities, reliable utilities, centralized customs, legal, and accounting services, convenient transport, schools including bilingual classes for expatriates, and adjacent housing with apartments for recently recruited staff. The science park is immediately adjacent to the Industrial Technology Research Institute and two universities.

**Figure 4: Annual sales of science parks, 1995–2004 (US\$ millions)**

Source: Taiwan, 2004a.

Everything is done to help incubate startups and facilitate the operations of companies in the park, including a five-year tax holiday. The government provides one-stop administrative services guaranteeing a response in three to five days. The standard facilities in modular units provide for business expansion, allowing companies several years to grow before they decide to build their own building on leased government land, shielding them from the high property costs in Taiwan. The science park screens applicants in relation to national priorities and for synergies with park activities. Other businesses trading with park occupants can locate themselves in adjacent communities. As companies outgrow the park and move out, the space is used for new arrivals and service activities.

The Hsinchu Science Park has emphasized semiconductors, but has significant industrial concentrations in integrated circuits, computers and peripherals, telecommunications, optoelectronics, precision machinery and biotechnology. Since it is now full, it is developing satellite parks in the region, including one emphasizing dual military-civilian applications and another for biomedical research and industries.

The government has now replicated the science park concept in other parts of Taiwan. The Central Taiwan Science Park emphasizes aviation, precision machinery and optoelectronics while the Southern Taiwan Science Park near Tainan focuses on optoelectronics. It allows a core company to settle on a large block of land with support-

ing companies clustered around it. Both are also paired with universities. Additional science-based parks are now planned, as well as thematic industrial parks for IC design, biomedical products and biotechnology, and even recycling technology.

The science parks have become an important element in the Taiwanese economy, generating US\$42 billion in sales in 2004 alone (Figure 4).

#### National Information Infrastructure

The National Information Infrastructure (NII) has been developed since 1994 under the responsibility of the inter-ministerial NII Steering Committee (STLC, 1996). The National Information and Communication Initiative (NICI) launched in 2001 is also overseen by a high-level inter-ministerial committee of the Executive Yuan. It aims to accelerate the development of the IT industry and e-commerce, improve the efficiency of government services, promote Internet usage and applications, and increase the competitiveness of Taiwan's IT industry. Today the principal government initiatives are e-Taiwan and M-Taiwan. In another illustration of close government-industry collaboration, the National Information Infrastructure Enterprise Promotion Association (NIIA) was established in 1996 to support government implementation of ICT applications and services, assist the private sector to provide ICT services to the public, strengthen links between government and private sector

visions and policies for science and technology, and collaborate with government to build a well-rounded environment for the ICT industry.

### Interaction of ICT and social and economic development

Taiwan has not only made a business of ICT, it has used these technologies for its own social and economic development. The interaction of the two sheds important light on Taiwan's success in this area.

#### The educational dimension

The high value placed on education in Chinese culture has been key to Taiwan's success, as has the government policy to build human resources, and welcome the thousands of Taiwanese who went overseas for educational opportunities they could not find at home. The IT revolution was launched with technologies licensed from international companies, using the talents of people educated abroad.

The first effort to build a research capacity focused on government-sponsored institutes. Thus, universities were not the original catalysts for innovation, as they were in the USA or Israel. The challenge for Taiwan has been and continues to be to build an educational system that can meet rapidly evolving manpower requirements and contribute to the research needs of the economy. The university system has expanded rapidly in recent years, but there is still a gap between academia and industry that will take time to fill. New industry technical colleges are now planned focusing on semi-conductors and digital content. However, the traditional Chinese educational approach at the primary and secondary level does not encourage the kind of innovative thinking necessary for success in scientific research and development, making the student transition to university more difficult. Efforts are now being made to address these problems.

With a work force mostly under thirty, there will be an enormous challenge in the years to come to retrain maturing workers as technologies, production processes and whole industries evolve. The educational system will need to emphasize lifelong learning, using ICTs as well as ongoing programs in the science centers and elsewhere. If Taiwan is to sustain its momentum, the educational system will need to become as flexible and entrepreneurial as industry.

#### The research dimension

From the earliest stages, the government has made heavy investments in research and technology development to create an enabling environment for rapid take-up of ICTs. The Department of Industrial Technology has funded many programs, but other ministries have also contributed. It has generally taken about 10 years of support for any one technology before commercial applications

become profitable enough for the private sector to take over, allowing public support to drop back to a low level so that strategic new areas can be developed. Of the total R&D expenditure of over US\$7.5 billion in 2003, US\$2.9 billion came from public sources and US\$4.7 billion from the private sector. The ratio of government R&D expenditure to that of the private sector has shifted from 49:51 in 1993 to 38:62 in 2003, while rising as a percentage of GDP from 1.75 percent to 2.45 percent over the same period. This strategy has been cost-effective in long-term economic returns, but it requires focused efforts and continuity in government support. Recognizing the importance of research to its future development plans, the government aims to increase combined public and private support for research and development to 3 percent of GDP by 2008 (see Figure 5).

The results of this research effort are apparent in various indicators of research productivity. In 2003, Taiwan ranked 18th in papers indexed in Science Citation Index, 10th in papers indexed in *Engineering Index*,<sup>2</sup> and 4th among all countries in US patents granted.

#### The human network

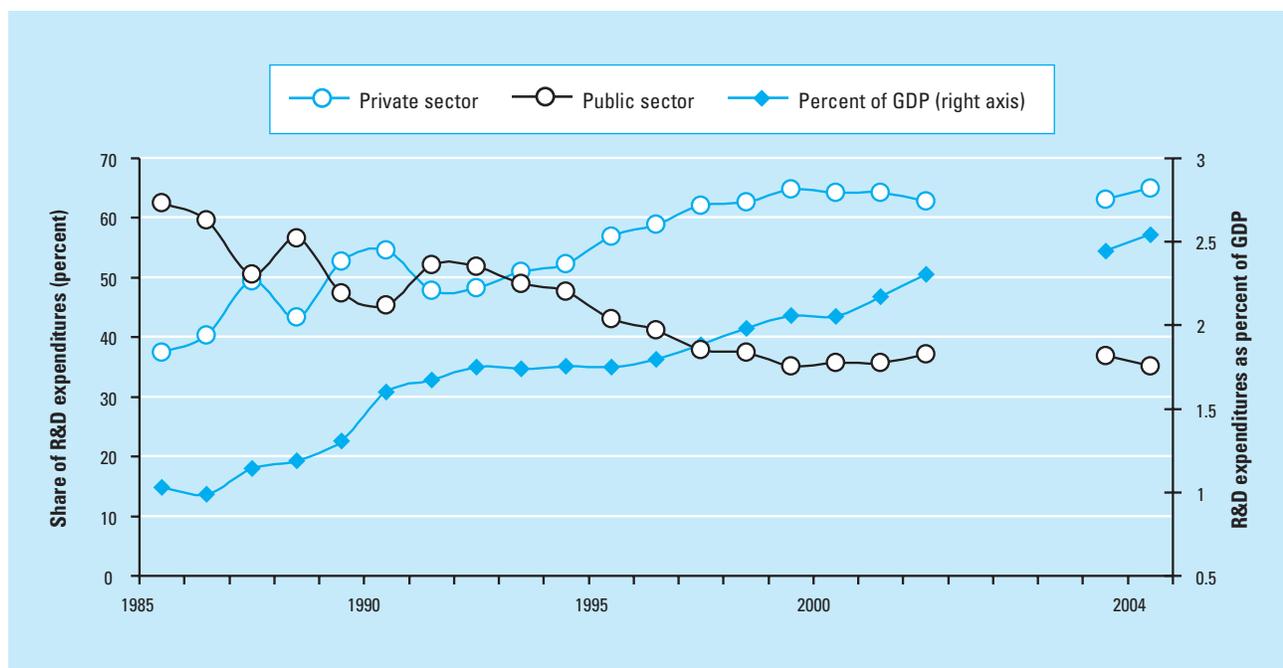
Taiwan's development was propelled in large part by its heavy investment in human resources, both through local science and technology education and through sending more than 50,000 students overseas for training. In addition, the large pool of expatriate Taiwanese needs to be considered as a significant economic and social asset.

The global information revolution and the rise of the Internet have made intense networking among widely spread social groups technically possible. The Taiwanese, as leaders in the ICT field, with their strong sense of family, and large expatriate population, are ideally placed to benefit from these networking possibilities. These informal networks, supplemented by overseas offices of various institutes and research centers, facilitate technology transfer, innovation and strong entrepreneurial relationships.

#### The cultural dimension

There are aspects of Chinese culture and the recent history of Taiwan which have jointly contributed to its success. The traditional Chinese family imposed a disciplined hierarchy, valued education, and encouraged entrepreneurship. In the difficult period after World War II and the end of the Chinese civil war, families often launched small scale business activities to survive. Even today, 30 percent of economic activity is in the unregulated informal economy, providing an alternative kind of safety net for those in difficulty. Since there was no social security, savings rates were high, averaging over 30 percent from 1975 through 1989, before declining to the still high 25–26 percent of recent years.<sup>3</sup> It was also normal to make sacrifices for

Figure 5: R&amp;D expenditure, 1985–2004



Source: Taiwan, 2004b.

children's education so that they could prepare for a better future.

Little is known about the effect of new horizontal forms of communications on traditional Chinese cultural hierarchies, particularly as they relate to age. As its economy matures, Taiwan will need to strengthen the social science dimension of its research and planning effort, if it is to manage the continuing rapid change expected in the years to come. Studies in Silicon Valley have shown how information technologies change family and community structure, and may either strengthen or undermine those structures, especially in areas that reach "technology saturation" (English-Lueck, 1998). Given the goal of an e-Taiwan, the effects of technology saturation and the ways technology and society interact must be considered carefully in order to ensure positive rather than negative social outcomes.

While Taiwan shows the best performance among developed economies for gender equality in ICTs, with less than two percentage points difference between men and women in Internet participation (World Internet Project, 2004), it does have a significant age gap. While the Internet reaches 95 percent of people between 15 and 24 years of age, this drops to less than 10 percent of people over 60 (FIND, 2005). There is also a noticeable digital divide between urban and rural areas, and with respect to indigenous peoples and the handicapped, a situation which is being addressed through new programs, such as the digital opportunity centers. Present government efforts

to spread ICTs to the rural areas and to all segments of the population should help to ensure that no one is left behind.

#### Taiwan as an ICT laboratory

The government plans to create an e-Taiwan with an e-Society envisaged and enriched through ICTs, an e-Industry integrated through ICTs and selling through e-commerce, an e-Government integrated and operated through ICTs, and e-Opportunities to close the digital divide by providing access and openness and reducing social inequalities. This will make Taiwan a test-bed for new technologies and applications and stimulate further innovation both to resolve whatever problems appear, and to explore new potentials.

It will be interesting to follow the social and cultural impact of such an intensively technological society. How far can ICT meet basic human needs? Are there negative effects which should be identified and addressed? Might there even be a reaction against such invasive technology, and movements to return to a simpler lifestyle and more direct human and community relationships? This may lead to defining the appropriate moderate level of technology that improves human well-being without becoming intrusive. Taiwan must expand its social science research capacity, in order to understand the human revolution that will accompany e-Taiwan, as this will also be essential to understanding and responding to international markets.

### Why is Taiwan considered an ICT powerhouse?

The success of Taiwan has been built systematically over decades as the economy has developed step by step, but with rapid and successful transitions. Contrary to the conventional wisdom that everything should be left to the private sector with the government only playing the role of detached and minimalist regulator, the government in Taiwan has played an extremely important role in its emergence as an ICT powerhouse, not only in terms of its indirect impact through the provision of good education and infrastructure, good macroeconomic policy, and so on, but also through quite direct interventions in the industry itself.

This suggests that selective and intelligent government intervention, aimed at facilitating the emergence of a strong private sector role in ICT can be productive and desirable. This has worked in Taiwan because the government has listened to the private sector and technical advice, and has created both consultative mechanisms among all parties to agree on common approaches, and institutions of the best technical experts to support both government and business. In Taiwan the public and private sectors collaborate so closely that the distinction is not easy to make. The structure of the private sector, consisting of many small and medium enterprises rather than a few dominant corporations, also facilitates government decisions in the interest of the whole economy and in the context of a globalizing world, rather than yielding to the self-interest of powerful local business lobbies. The resulting strategic, flexible, and adaptable approach to economic development is most appropriate to the rapidly evolving ICT industry.

For ICT, Taiwan has combined strong, yet responsive government planning, a heavy investment in human resources, a dynamic and flexible private sector, and strong research support, and focused this in well-organized and coherent clusters of science and industrial parks, supported by adequate infrastructure. A high savings rate and prudent government fiscal management have made it possible to finance the necessary development measures.

### Conclusion

The close collaboration of public and private sectors in some unique institutional mechanisms has allowed Taiwan's economy to go through several rapid industrial transitions and to position itself for the increasing competition ahead. For countries that may wish to follow this model, the following are some key lessons that should be widely applicable.

1. The role of good macroeconomic management to provide a foundation of stability: if the government is busy trying to put out fires on the macro side (public finances out of control, pressures on prices and the exchange rate, and so on), then it will not have the resources and energy to focus on such things as ICT development.
2. The role of education, training and skills development: human capital is clearly key to development in any technological area. This lesson is important for the developing world, where vast resources get allocated to what the International Monetary Fund calls "unproductive expenditures." A brain drain can be turned into an asset if good conditions attract those with technological and entrepreneurial experience back home again. Scarce human resources must also be employed flexibly, in order to advise government, train additional people, and support innovation in business.
3. Intelligent government intervention: creating the physical conditions for business development, providing incubator services, facilitating administrative procedures, supporting research, and generally being a supportive partner.
4. In an increasingly interdependent world economy, a more outward-looking orientation has become an essential element of successful development. In addition to the well-known gains from international trade, relative openness and strong links with the world economy impose on domestic producers the valuable discipline of international competition and provide opportunities for new exports. An open orientation can also attract much needed capital and expertise, thus enhancing the prospects for growth through increased efficiency. Greater integration with the world economy tends to enforce greater competitive discipline on producers for both domestic and international markets. It also serves as an important channel for absorbing technological advances from abroad, as is evident from the experience of many outward-oriented countries that have developed strong export sectors based on new manufacturing industries.
5. Credibility: a government that is able to deliver the increases in per capita income shown in Figure 1 has credibility with the private sector and will be listened to. In much of the developing world, widespread corruption and incompetence strongly mitigate against a constructive role for the government in the development process.
6. Long-term strategic vision combined with adaptive management: given a country's specific situation and

assets, government and business should identify where the economy and society should be in five or ten years, build consensus among all the partners on how to get there, and, while remaining ready to adapt to changing circumstances, focus resources on those objectives.

## Notes

- 1 Center for Economic Planning and Development (CEPD), 2005a, p. 18.
- 2 Ibid., p. 28.
- 3 CEPD, 2005b., p. 75.

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