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Published on: 24 Jan 1995 - Pacific Affairs

Topics: Newly industrialized country

Winter 1-1-1995

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Developing the Information Industry in Taiwan: Entrepreneurial State, Guerrilla Capitalists, and Accommodative Technologists[1]

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THE RAPID GROWTH of the East Asian newly industrialized countries (NICs) — South Korea, Taiwan, Hong Kong, and Singapore — during the 1960s and 1970s drew considerable academic interest and lively policy debates. By adopting export-led industrialization (ELI) development strategies, these NICs greatly benefitted from the remarkable expansion of world trade during the heyday of the Bretton Woods system, and rose to become major exporters of labor-intensive manufactured products (e.g., textiles and electronics).

However, starting from the early 1980s, these NICs gradually (and perhaps irreversibly) lost their traditional competitive advantage in labor-intensive products, and thus had to discover new sources of growth.[2] Key economic decision-makers reached the conclusion that to regain competitiveness in the world economy, the export-oriented economic structures of these NICs must be upgraded — that is, to become more technology- and skill-intensive. These NICs thus began to develop the so-called high-tech industries. In particular, information technology (IT) has been entrusted to play a central role in this new strategy.

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[1] An earlier version of this paper was presented at the 1994 Annual Meeting of the American Political Science Association.

[2] This shift was caused by pressures from three fronts: from *above* (rising protectionism in the developed countries whose markets had absorbed much of NICs' exports), from *below* (increasing challenges from second-tier NICs, such as Thailand, Malaysia, China, where labor costs are even lower), and from *within* (soaring real wages and wakening environmental consciousness).

The modern IT affects all sectors of the economy by providing both forward and backward linkages.[3] It plays a crucial part in accelerating indigenous technological advancement and industrial upgrading. However, it should be noted that the term "industrial upgrading" does not just mean creating new ("sunrise") industries; it also includes applying new techniques and methods in traditional (or even "sunset") industries so as to increase their efficiency and value-added. In fact, for the NICs, this latter prospect is more important, because such traditional export sectors as textiles, footwear, consumer electronics, and electric components are still very important, in terms of their shares of employment and export volume.

In addition to the economic appeal, IT has a political appeal. For many policy makers in the developing world concerned about their countries' standing in the world, developing IT offers an opportunity to close up on the advanced industrialized countries (AICs).[4] These economic and political motives of high-tech development will become evident when we consider the IT experience of one of the most successful NICs, Taiwan.

This paper discusses the origins, evolution, current status, and future challenges of Taiwan's information industry. The discussions are somewhat unconventional in two respects. First, I do not see IT as a detached "new" sector that can be easily implanted overnight without any links to the economy at large. On the contrary, I recognize and emphasize the connections between IT and conventional sectors: Taiwan's high-technology development was in fact an *outgrowth* of its previous successive development strategies. Second, I do not view the development of IT as a purely economic decision. Most key economic policies, high-technology included, are also political decisions, with political determinants and consequences.

The key findings of this paper are summarized here. The first point is that Taiwan's information industry was created on the solid foundation laid by the successful export-oriented electronics industry, and the cur-

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[3] Henry Nau, "National Policies for High Technology Development and Trade: An International and Comparative Assessment," in Francis W. Rushing and Caroles Ganz Brown, eds., *National Policies for Developing High Technology Industries: International Comparisons* (Boulder, CO: Westview, 1986), pp. 9–30; Richard R. Nelson, *High Technology Policies: A Five-Nation Comparison* (Washington, DC: American Enterprise Institute, 1984); and Rushing and Brown, *National Policies.*

[4] Walter Arnold, "Science and Technology Development in Taiwan and South Korea," *Asian Survey,* vol. 28 (1988), pp. 437–50; Mohan Munasinghe, ed., *Computers and Informatics in Developing Countries* (London: Butterworth, 1989); Carlota Perez, "Microelectronics, Long Waves and World Structural Change: New Perspectives for Developing Countries," *World Development,* vol. 13, no. 3(1985), pp. 441–63; Nathan Rosenberg, Ralph Landau, and David C. Mowery, eds., *Technology and the Wealth of Nations* (Stanford: Stanford University Press, 1992); Abdus Salam, *Notes on Science, Technology, and Science Education in the Development of the South* (Trieste, Italy: The Third World Academy of Sciences, 1989).

rent technology-intensive strategy is a natural extension of Taiwan's previous development strategies. The second point is that the role of the Taiwanese state in promoting high-technology industries has been very important. The state has played a positive entrepreneurial part in the inception of pivotal technologies and in the export vigor of Taiwan's information industry on the world scene. However, the large state role has not seemingly led to negative consequences commonly found in other countries. The third point is that Taiwan's small- and medium-sized informatics firms, or what I call "guerrilla capitalists," were arguably suited for *some* games (e.g., PCs and software) in this information technology race, due to their flexibility, agility, and assiduity. However, their small size becomes a serious disadvantage in *other* games (e.g., semiconductors); this is where the entrepreneurial state has stepped in. The fourth point is that acquisition of high-technology in Taiwan has followed an *accommodative* model, by maintaining close ties with the global technological market and by harnessing MNCs' investment with the country's macroeconomic development, rather than by asserting narrow economic nationalism and restricting the domestic market.

In sum, the contours of Taiwan's high-technology development have been shaped by a dynamic trio of entrepreneurial state, guerrilla capitalists, and accommodative technologists.

The first section discusses the linkages between Taiwan's IT development and its previous development strategies. The second section reviews the key policies of Taiwan's IT strategy. The third section examines the major institutions responsible for promoting IT in Taiwan. This paper concludes with a summary of the political economy of Taiwanese success in high-tech industries in light of relevant theories.

Information Technology: The Latest Development Strategy

Unlike other LDCs with rich natural resources and large domestic markets, Taiwan has no significant resources, except perhaps its human resources and high savings rates. These endowment-based characteristics have defined Taiwan's development strategies. Most scholars agree that a pool of educated, well-trained, disciplined, and inexpensive unskilled and semiskilled labor was the bedrock of Taiwan's successful labor-intensive ELI in the 1960s–70s. However, it is even more important to recognize that, for developing high-technology industries, Taiwan's exceptional combination of skilled labor (i.e., well-educated and, comparably speaking, inexpensive engineers and scientists) and savings — both human and financial capital — constitute a major advantage. Such reasoning was so evident among the decision makers that it could be judged as a policy "consensus" on development.

Summing up Taiwan's postwar economic development, Dr. Otto Lin, former president of Taiwan's Industrial Technology Research Institute, provided this review:

> Taiwan's development strategy in the 1950s was to focus on labor-intensive import-substituting industries in order to lay a stable foundation for economic growth; in the 60s it was to orient domestic industries toward export promotion in order to create jobs; in the 70s it was to launch heavy and capital-intensive industries in order to facilitate industries' upward vertical integration; and in the 80s it was to promote "strategic industries" and national key technologies in order to lead industries' upgrading and improve industries' structures.[5]

It is thus important to understand Taiwan's current high-technology development as a logical *extension* from its previous development sequences, rather than a *detached* new undertaking. And without the foundations laid by those successive strategies, IT could not have become a new viable source of growth and wealth for Taiwan. The following example of the relationship between IT and electronics will illustrate these points.

There existed close ties between IT and the electronics industry. In its formative years, IT had often been considered a part of the broad electronics industry, and grew out of the successful consumer electronics industry. Direct links existed between color TVs and color monitors, between integrated circuits (ICs) widely used in many consumer electronic products and computers, semiconductors and other components. Moreover, the technical expertise accumulated in the electronics industry was easily transferrable to the information industry. The information industry was not created in a total vacuum, as a result of a "visionary" technocrat's grandiose proposal. Rather, it was built on and expanded the previous successes of the electronics industry in terms of success in the market place and experience from learning. In addition, multinational corporations (MNCs) played a crucial formative role in Taiwan's electronics industry in the 1960s. More recently, however, they were also included in Taiwan's information drive, instead of being excluded. And broadly speaking, to maintain competitiveness in exports, which is the lifeline for an island economy like Taiwan, Taiwan must upgrade its products by moving gradually away from low-cost, labor-intensive commodities to high-value added, technology-intensive ones, and by concurrently increasing value-added mature products.

Two additional arguments further underscore the ties between IT and the established sectors. First, IT in Taiwan from the start has been des-

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[5] Otto Lin, "An Outlook for the Technology Industries of the 1990s," *Central Daily News* (in Chinese), 1 January 1990, my translation.

ignated as a "strategic industry" — that is, a crucial industry that can provide both *backward* linkages to the established sectors (e.g., textiles and consumer electronics) by improving their productivity and prolonging their life cycles, and *forward* linkages to the nascent as well as established sectors by enhancing their technological development and creating new sources of competitiveness.

Second, IT is entrusted with the task of correcting some of the negative externalities resulting from the previous growth-centered *cum* export-push strategy. These new emphases include (1) improving the quality of life, instead of pursuing single-minded growth; (2) seeking more balanced growth, which includes enriching the domestic market, instead of overweighing or over-depending on the foreign markets; (3) informationalizing the society, which will contribute to the empowerment of the citizenry — an essential element to democratic politics; and (4) salvaging the environment and overcoming infrastructural and transportation bottlenecks — both being sacrificial lambs for a long period of extraordinary rapid growth. These new tasks assigned to IT are precisely the types of adjustments that need to be made in Taiwan's metamorphosis into a mature industrial democracy. It is not an exaggeration to characterize IT as the bridge for Taiwan — connecting a Third-World stardom status to a First-World prestige.

Key decision-makers, industrialists, and intellectuals concerned with Taiwan's economic development long understood, and agreed on, the importance of informatics to their country's future. For instance, back in 1979, K. T. Li, a principal architect of Taiwan's economic development, stated, "[T]he development of the information industry is a worldwide trend, and Taiwan's economic future depends very much on our ability to catch up this trend."[6]

A virtual consensus on the need for continuous economic development existed in Taiwan among a network of experts like Li, forming an epistemic community.[7] This community, throughout successive phases of Taiwan's post-war development, has often enjoyed strong political sup-

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[6] K. T. Li, "Targets and Strategies for Developing the Information Industry in the Republic of China," cited in Denis Fred Simon and Chi Schive, "Taiwan," in Rushing and Brown, *National Policies*, p. 201.

[7] On the concept of epistemic community, see Emanuel Adler, *The Power of Ideology: The Quest for Technological Autonomy in Argentina and Brazil* (Berkeley: University of California Press, 1987); Peter M. Haas, "Introduction: Epistemic Communities and International Policy Coordination," *International Organization*, vol. 46, no. 1 (1992), pp. 1–36; John Kurt Jacobsen, "Much Ado About Ideas: The Cognitive Factor in Economic Policy," *World Politics*, vol. 47 (1995), pp. 283–310; Kathryn Sikkink, *Ideas and Institutions; Developmentalism in Brazil and Argentina* (Ithaca: Cornell University Press, 1991).

port (and autonomy) from the state, and has thus "embedded" many of its ideas in several key institutions, which perpetuates its political influence. The next two sections examine the most important policies and institutions responsible for promoting IT in Taiwan.

Key Policies of Taiwan's IT Development

1980 marked the inauguration of Taiwan's concerted IT strategy, as a ten-year IT development plan (see below) was approved. The late president Chiang Ching-kuo's personal plea served as a catalyst. He said:

> In recent years, by employing computers in improving management and technology, the U.S., Japan, and other [advanced industrialized] countries have gained rapid progress in production technology and significant increase in productivity. In order for our nation's technology to catch up [with that of the advanced industrialized countries], we must popularize computer education and application. The government, the educational community, and the industry must make an all-out collective effort to develop the computer and information industry, in order to upgrade our industries, and enhance the competitiveness of our nation's products in the world markets.[8]

Chiang's advocacy symbolizes a correct and timely perception of the advent of the information society. The microelectronics revolution and the arrival of the microcomputers lowered the entry barrier for select LDCs (mostly NICs) and offered them a rare opportunity to join the global technological race and to transform their economies and societies.[9]

In November 1984, Premier Yü Kuo-hwa pointed out the missions of Taiwan's "information industry strategy":

> (1) to promote effective utilization of computers in order to improve productivity and efficiency and add to living standards, (2) to open up the domestic market in order to spur the development of the information industry, and (3) to upgrade technology in the information industry and then to expand the domestic market into world export markets.[10]

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[8] Speech at a conference on finance and economics on 21 October 1980, cited from Institute for Information Industry (hereafter III), *Information Industry Yearbook, Taiwan, R.O.C., 1989* (in Chinese) (Taipei: III, 1989), p. i, my translation.

[9] As was well known only later, IBM's decision to use the "open architecture" for its PCs, which opened the Pandora's Box of compatible "clones" (as opposed to the proprietary technology used in its larger computers) and its late arrival (1981) in the PC market (already glutted with Apple and other vendors) provided that rare window of opportunity for the NICs studied here to jump into the technology race. It is also no wonder these NICs started their informatics forays roughly at this time. See Kenneth Flamm, *Creating the Computer: Government, Industry, and High Technology* (Washington, DC: Brookings, 1988), p. 98; and Tom Forester, *High-Tech Society: The Story of the Information Technology Revolution* (Cambridge: MIT Press, 1987), p. 206.

[10] Morris H. Crawford, *Programming the Invisible Hand: The Computerization of Korea and Taiwan* (Harvard University Center for Information Policy Research, 1986), p. 55.

These ideas about the importance of the information technology and the role played by the new information industry in Taiwan's economic transformation were codified in several important plans and embedded in several newly created institutions. The most important such plans were two ten-year plans for the information industry in Taiwan.[11]

The Ten-Year Plan, 1980–1989 ($10YP_1$)

Taiwan's first national plan for the information industry[12] had two central goals: (1) developing a new industry, and (2) promoting this industry for exports. To create a new industry, the plan called for promotion of computers around the island so as to foster a favorable environment for the development of the local information industry. To promote computers as an export industry, the plan emphasized accumulation and upgrading capabilities in information technology.

The $10YP_1$ called for the employment of four specific policies to achieve those twin goals: (1) nurturing the domestic market, by encouraging public and private enterprises to use computers; (2) manpower training, by fostering and training manpower for the information and computer industries, especially highly skilled experts; (3) introducing high technology, by improving the R&D environment, and establishing a comprehensive R&D system; and (4) improving the investment environment for the growth of the local information industry.

In essence, the information and computer industries were designated as "strategic industries," eligible for special government assistance. Some concrete measures of government assistance have included: (1) asking designated development funds and financial institutions to grant preferential loan services to computer-related strategic products, (2) empowering the Hsinchu Science-based Industrial Park to give preferences to applications for computer-related development and manufacturing activities, (3) including computer-related strategic products in the Statute for Encouragement of Investment as eligible for those special incentives ear-

[11] See Council for Economic Planning and Development (CEPD) (Republic of China), *Ten-Year Development Plan for the Information Industry in Taiwan, R.O.C. (1990–2000)* (in Chinese) (Taipei: CEPD, 1990); and *Ten-Year Development Plan for the Information Industry in Taiwan, R.O.C. (1980–1989)* (in Chinese) (1982). A related Ten-Year Long-Term Development for ROC's Science and Technology was promulgated in August 1986 to improve the general research and development (R&D) environment. In addition, there is an assortment of laws, regulations, decrees, and administrative measures concerning the information industry. They are collected in III, *Compendium of Information Industry-Related Laws and Regulations* (in Chinese) (Taipei: III, 1989).

[12] $10Y_1$ was drafted by III in 1980, at the request of the Council for Economic Planning and Development (CEPD), and approved by the cabinet in 1982. Its implementation began in 1982.

marked for "essential manufacturing activities," and (4) favorable government procurement of locally made computer-related strategic products.

The first ten years were the formative stage for Taiwan's information industry. In general, the implementation of this plan was successful, and the information industry began to take off. Through government promotion and the private sector's adjustment to the new incentive structure, this industry witnessed rapid growth, having become a major force in the nation's economy and export, and, meantime, contributed to heightened public awareness.

One way to evaluate the effectiveness of $10YP_1$ is to present a quantitative profile of Taiwan's information industry. Table 1 shows the evolution of Taiwan's information industry over time. Table 2 shows the extent of dominance by certain Taiwanese information products in the world markets. As we can see from these statistics, during $10YP_1$ Taiwan's information industry had transformed from an insignificant appendage to the electronics industry to an industry very important to Taiwan's economic vitality and export vigor.

But it also encountered some bottlenecks. Although in 1988 Taiwan became a major world producer of information products (with sales of over US$ 5 billion), it was hindered by its dependence on imported key components, its weak name-brand recognition and marketing channels, and its technological bottleneck above the microcomputer level. Furthermore, there was still an acute shortage of information industry manpower, although the R&D expenditure generally met the target.

Clearly, Taiwan's IT development needed a boost and reorientation. As a director at Taiwan's Institute for Information Industry (III) summed up, "The emphasis for the first ten years was on the *production* of information goods. The emphasis for the next ten years shall be on the *application* [of IT in various aspects of life]."[13] A planning official in Taiwan's Council for Economic Planning and Development (CEPD) also concurred, "[The information industry] in the first ten years focused on hardware production and exportation. In $10YP_2$, we shall actively promote software and the national market in order to create an information society."[14] This is the background for the second ten-year plan.

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[13] C. J. Cherng, Director, Promotion and Services Division, III, personal interview, 23 July 1990, Taipei.

[14] Chuang Shu Cheng, Senior Specialist, Department of Sectoral Planning, CEPD, personal interview, 19 July 1990, Taipei.

TABLE 1.
KEY INDICATORS OF TAIWAN'S INFORMATION INDUSTRY, 1978–1991

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Total output*	32	46	78	109	166	432	1,039	1,260	2,134	3,839	5,168	5,484	6,149	6,908
Growth rate (%)	–	43.8	69.6	39.7	52.3	260.2	240.5	21.3	69.4	80	34.6	6.1	12.1	12.3
As % of GNP	0.1	0.2	0.3	0.2	0.4	0.8	1.8	2.2	2.7	3.7	4.2	3.6	3.8	3.9
Ranking in all industries	–	–	–	–	–	–	–	–	23	18	13	10	9	9
Export value	–	–	–	–	–	–	–	1,220	2,063	3,701	4,999	5,244	5,873	6,546
Growth rate (%)	–	–	–	–	–	–	–	–	69.1	79.4	35.1	4.9	12	11.5
Export ratio (%)**	–	–	–	–	–	–	–	96.8	96.7	96.4	96.7	95.6	95.5	94.8
Share of total exports (%)	–	–	–	–	–	–	–	3.9	5.2	6.9	8.5	8.1	8.7	8.9
Ranking in all export industries	–	–	–	–	–	–	–	11	7	4	3	3	3	3
Share of global information product market (%)	–	–	–	–	–	–	–	1.0	1.5	2.4	3.1	3.0	3.0	3.1
Global ranking as producer of information products	–	–	–	–	–	–	–	9	7	7	6	6	7	7
Total manpower (1000)	0.9	1.3	2.2	3.1	4.7	12	29	30	38	50	66	80	–	–

Unit: US$ Million
Note: *Includes export value and domestic sales (retail prices)
**Export value / total output
Source: Compiled and calculated from III, *Information Industry Yearbook, Taiwan, R.O.C.*, 1992, 1991, 1990

TABLE 2.
TAIWAN'S TOP 10 INFORMATION PRODUCTS, 1994

Product	1994 Domestic Production	1994 Domestic + Overseas Production	% of World Market (Units)
Monitors	14,391	24,028	56%
Portable PCs	2,057	2,057	28%
Desktop PCs	3,090	3,090	8%
PC system board	11,529	17,545	80%
Power supplies	12,150	25,960	31%
Scanners	1,663	1,663	61%
Terminals	1,060	1,060	22%
Graphic cards	5,040	8,770	32%
Mice	22,052	29,800	80%
Key boards	7,068	22,800	52%
LAN cards	6,100	6,120	34%
Sound cards	1,986	1,986	11%

Unit: ,000
Source: III, *Retrospect and Prospects of the Information Industry, 1994–95* (in Chinese)

Ten-Year Plan, 1990–2000 ($10YP_2$)

This plan was drafted in 1990 based on the accomplishments and shortcomings of the $10YP_1$ and an evaluation of the development trends of the world's information technology. It symbolizes Taiwan's aspiration to become an "information Goliath."[15]

It seeks to accomplish four goals. The first is to popularize the utilization of information technology so as to increase productivity of the overall industrial structure and improve people's quality of life. As I argued earlier, this is the most important new *raison d'être* of IT, one different from that of the old mainstay of low-cost, low-wage, growth-centered projects. The second goal is to make Taiwan a major supplier of information products by developing crucial components and technology, upgrading product quality, and controlling marketing channels. The third goal is to achieve technological autonomy by expanding the scope and level of R&D investment through participation by both the government and the business. The second and third goals together present a difficult yet crucial task for Taiwan: to transform itself from a reliable OEM (original equipment manufacturer) contented with cut-throat profits earned from simple assembly to a technological leader reaping technological rents. And in a very crude sense, this is what distinguishes the First

[15] *Free China Journal*, 20 September 1990, p. 4, and 24 September 1990, p. 7.

World from the Third World. The fourth goal is to train a large pool of information manpower as a solid foundation of an information society by raising both the quality and quantity of manpower. This perhaps holds the key to the accomplishment of the previous two objectives. To sum up, $10YP_2$ identifies the following areas as priorities: computer application, IT output, R&D, and manpower training.

Several goals are noteworthy. The plan projects that Taiwan's share in the global IT market will rise from 1.9 percent in 1988 to 3.1 percent in 2000. As it turned out, however, this goal had already been met in 1991 (see table 1). In addition, the plan seeks to steadily raise the total R&D expenditures in industry revenues: from 3 percent in 1988 to 5 percent in 1995, and to 6.5 percent in 2000. By then, the private sector's investment in R&D will top that of the government by a four-to-one margin.

The most distinctive features of $10YP_2$ can be summarized as follows. First, although the plan still views the information industry as an important export leader, it further charges this industry with the task of dissemination of information and improvement of life quality of citizens. This is a marked departure from the previous "growth first, all for export" economic ideology. Second, the plan recognizes the maturation of hardware assembly, and instead stresses the development of indigenous R&D on key components and technologies. Third, more importantly, the plan views software as the future leading force for Taiwan's information industry, and designates special incentives to software (e.g., a software industrial park). Given Taiwan's comparative advantage in skilled labor (i.e., well-trained yet inexpensive scientists and engineers), this is a market niche Taiwan should focus on. In fact, it may not be an overstatement to say that strength in software (knowledge and technology defined as the ability to solve complex problems) is a new source of the wealth of nations.[16]

As explained earlier, the power of economic ideas rests in institutions. The next section examines these institutions.

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[16] Robert U. Ayres, "Technology: The Wealth of Nations," *Technological Forecasting and Social Change*, vol. 33 (1988), pp. 189–201; and Rosenberg, Landau, and Mowery, *Technology*. On issues related to the development of software by developing countries, see David O'Connor, "The Computer Industry in the Third World: Policy, Options, and Constraints," *World Development*, vol. 13, no. 2 (1985), pp. 311–32; Robert Schware, "Software Industry Strategies for Developing Countries: A 'Walking on Two Legs' Proposition," *World Development*, vol. 20, no. 2 (1992), pp. 143–64; "Software for Developing Countries: Major Issues in the 1990s," *Information Technology for Development*, vol. 5, no. 2 (1990), pp. 101–8; "Software Industry Development in the Third World: Policy Guidelines, Institutional Options, and Constraints," *World Development*, vol. 15, no. 10–11 (1987), pp. 1249–67.

Institutions Promoting IT Development in Taiwan

Figure 1 shows the major organizations promoting the information industry in Taiwan. The appendix of figure 1 lists the functions performed by these various institutions.

Figure 1 illustrates the identity of institutions and their participation in Taiwan's information industry. At the highest level, the Executive Yuan (cabinet) provides general policy guidance. Various cabinet bodies are involved in the tasks of planning, coordination, and monitoring. These include the National Science Council (NSC), the Ministry of Economic Affairs (MOEA), the Council for Economic Planning and Development (CEPD), and the Ministry of Communications (MOC). Three entities are of particular importance to Taiwan's information industry: the Hsinchu Science-based Industrial Park,[17] the Electronics Research and Service Organization of the Industrial Technology Research Institute, and the Institute for Information Industry.

Hsinchu Science-based Industrial Park (HSIP)

Often lauded as "Taiwan's Silicon Valley," HSIP, located 55 miles (90 km) south of Taipei in the booming technopolis of Hsinchu, was created in 1980 to spearhead Taiwan's high-technology development. By providing special incentives to advanced personnel and companies engaged in high-technology activities, HSIP encourages industrial technology research and innovation. It is appropriate to characterize HSIP as a "second-generation export processing zone" (EPZ), which defined Taiwan's successful ELI in the 1960s and early 70s. There are in fact some similarities between EPZ and HSIP, such as an assortment of incentives, export orientation, and labor-intensiveness. But the similarities are only superficial. In a nutshell, HSIP is an upgraded form of EPZ, with higher R&D emphasis, higher-caliber employees, and higher productivity.[18]

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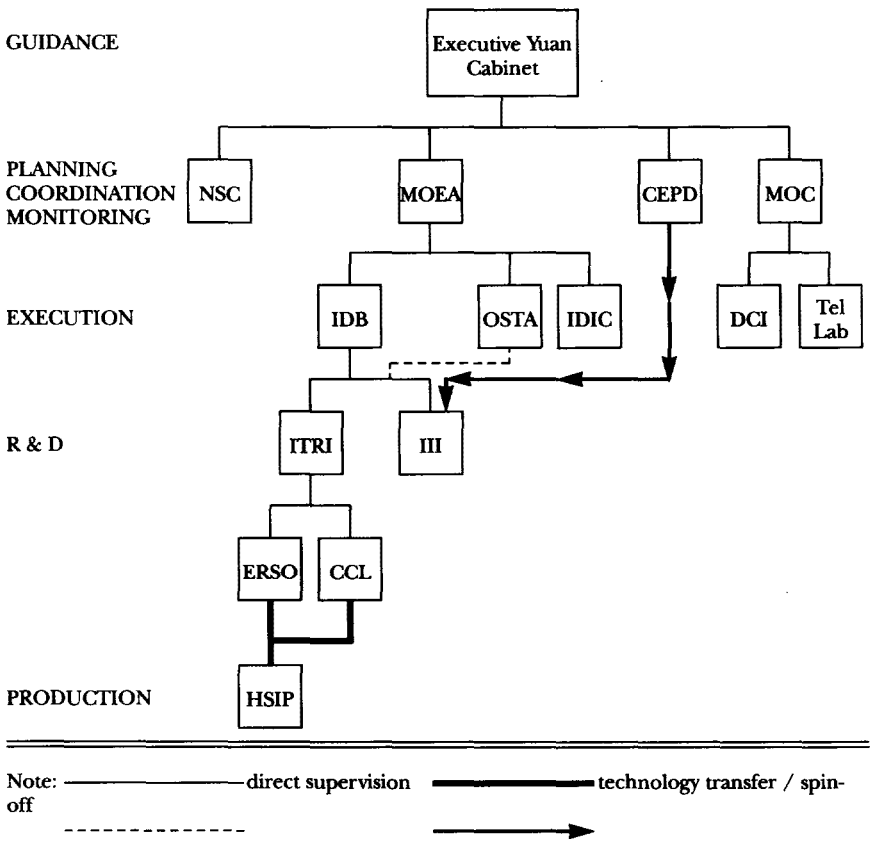
[17] HSIP was created under the NSC, symbolizing the R&D orientation of the park. In contrast, HSIP's predecessor, the much-touted export processing zones (EPZ) which defined Taiwan's success during ELI_1, were founded by the MOEA.

[18] A recent survey found that on average firms in HSIP spent 6 percent of revenues on R&D, whereas for the general manufacturing sector only 1 percent; nearly half (48 percent) of the HSIP's workers have college education or above, but for local manufacturers it is only 8 percent. Compiled from *Free China Journal*, 15 July 1994, p. 8.

FIGURE 1.
MAJOR ORGANIZATIONS PROMOTING THE INFORMATION INDUSTRY IN TAIWAN



APPENDIX TO FIGURE 1
NAMES AND FUNCTIONS OF ORGANIZATIONS PROMOTING THE INFORMATION INDUSTRY IN TAIWAN

1. Executive Yuan (Cabinet): its Research, Development and Evaluation Commission
   Functions: mapping out and fostering the establishment of an administrative information system and the development of the local information industry
2. NSC = National Science Council
   a. Electro-optics and Technology Committee (EOC)
      Functions:
      (1) Planning and promoting electro-optical science & technology and industrial development
      (2) Promoting (through exhibits, publications, and training) electro-optical science & technology and industry
      (3) Industry consultancy
   b. Science and Technology Information Center (STIC)

Functions:
(1) Collecting, analyzing, and processing computer information from both local and international sources
(2) Introducing valuable foreign data banks
(3) Establishing a national data bank for local science & technology periodicals, journals, and dissertations
(4) Increasing international cooperation and information exchange
(5) Establishing a national science & technology information network, and providing online consulting service

c. HSIP = Hsinchu Science-based Industrial Park
Functions:
(1) Stimulating industrial technology research and innovation
(2) Promoting high-technology development by providing special incentives
(3) Attracting advanced science & technology personnel
(4) Advancing industrial upgrading and creating new global competitive edge

3. MOEA = Ministry of Economic Affairs
a. IDB = Industrial Development Bureau: its Second Division (Electronics, Electrical, and Information Industries)
Functions:
(1) Promoting the development of the local information and electronic industries
(2) Evaluating the applications for computer investments by overseas Chinese and foreign nationals (to introduce new technologies)
(3) Executing the cabinet-approved plans regarding the development of the information and electronics industries
(4) Setting up projects and assistance measures for the information and electronics industries
(5) Managing loans earmarked for the strategic industries, including information, electronics, computer hardware and software, and communications equipment industries
(6) Executing the R & D projects jointly developed by MOEA, ITRI, and III

b. Production Automation Committee (PAC)
Functions: Executing and evaluating national industrial automation programs, and providing technical support to the automation industry

c. OSTA = Office of Science and Technology Advisors
Functions:
(1) Coordinating and facilitating measures for science & technology development under the Cabinet
(2) Evaluating and assisting science & technology research projects

d. Industrial Development and Investment Center
Functions:
(1) Promoting investment and technical cooperation projects by foreigners and overseas Chinese
(2) Promoting outward investment

4. CEPD = Council for Economic Planning and Development: its Sectoral Planning Department
Functions: Sectoral development planning for the information industry

5. MOC = Ministry of Communications
a. DCI = Data Communications Institute
Functions:
(1) Providing public information processing services (PIPS), including packet-switched public data network, electronic mail, and videotex
(2) Developing technologies related to digital communications
(3) Developing a large-scale information processing system

b. TelLab = Telecommunication Laboratories
Functions: Providing technical support to the Directorate-General of Telecommunications in such fields as network planning system technology, information technology, and circulating technology

6. ITRI = Industrial Technology Research Institute
a. ERSO = Electronics Research and Service Organization

Functions:
(1) Developing submicron (ULSI) production process technology
(2) Developing microelectronics technology
(3) Developing automation industrial technology
(4) Developing microwave and precision machinery technology
(5) Developing computer system technology
(6) Developing communication electronics technology
(7) Developing computer packaging technology
(8) Developing electronic product reliability technology

b. CCL = Computer and Communication Research Laboratories
Functions:
(1) Upgrading computer and communications technologies
(2) Developing digital electronic technology and advanced information technology
(3) Facilitating the development of computer, communications, and digital consumer electronics industries
(4) Promoting the application of system integration technology

c. Opto-electronics and Systems Laboratories
Functions:
(1) Establishing the complete and advanced technologies for computer peripherals
(2) Integrating multi-media technologies
(3) Establishing research centers for optical design, electro-optical components and technologies
(4) Establishing functional and passive components and technologies to support compu-ter and communication industries

d. Mechanical Industry Research Laboratories
Functions:
(1) R & D in the fields of precision machinery, thermal mechanics transportation, and automation
(2) Transfer of R & D results (both technologies and products) to the private sector

7. III = Institute for Information Industry
Functions:
(1) Assisting the government in mapping out short-, mid-, and long-term development plans for the information industry
(2) Assisting government agencies and state-run enterprises with the task of computerization
(3) Training the manpower of the information industry
(4) Studying and introducing advanced software technologies in order to upgrade local software design capabilities
(5) Fostering the development of local computer-related industries
(6) Promoting computer usage, and upgrading the level of computer application
(7) Providing market and technology intelligence
(8) Assisting in improving the environment for investment in the local information industry

Perhaps the greatest contribution of HSIP so far has been its role in technology transfer. This is seen in its increasing attractiveness to the returning expatriates. HSIP has to some extent reversed the brain drain.[19] Many firms in HSIP were founded by Chinese-American scientists and engineers, many in well-knit teams, who had obtained advanced degrees, and worked in positions of prominence in the U.S.[20]

However, the diffusion model is not the only *modus operandi* in HSIP. Several prominent and equally important industrialists rose from a completely different track, which I call an "indigenous path." The most prominent example is Stan Shih — "Taiwan's Bill Gates" — the shoestring entrepreneur who founded the Acer Corporation. Originating as an OEM for IBM, NEC, AT&T, etc., Acer has established its own name brand and risen to become the world's seventh largest computer manufacturer.[21]

The HSIP model is quite unique in two respects, based on a survey of science parks around the world, especially among the LDCs.[22] First, it combines both manufacturing and R&D. In fact, HSIP was built to create a synergy between the two.[23] Second, this park in recent years has become a magnet for returning Chinese-American scientists and engineers, causing a mini reversal of brain drain. Since there is an accumulated pool of

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[19] One publication reversed the term "brain drain" altogether, and call it Taiwan's "brain gain," *Business Week*, 7 December 1992, pp. 133–35.

[20] For a sketch of some of these individuals, see Vincent Wei-cheng Wang, *High Technology and Development Strategies in East Asia and Latin America*, Ph.D. diss., University of Chicago (1995), pp. 124–25.

[21] *Miami Herald*, 7 August 1995, p. 15.

[22] Kuniko Fujita, "The Technopolis: High Technology and Regional Development in Japan," *International Journal of Urban and Regional Research*, vol. 12, no. 4 (1988), pp. 566–94; John Michel Gibb, ed., *Science Parks and Innovation Centers: Their Economic and Social Impact* (Amsterdam: Elsevier Science Publishers B.V. for the Commission of the European Communities, 1985); Amy K. Glasmeier, "The Japanese Technopolis Programme: High-tech Development Strategy or Industrial Policy in Disguise?" *International Journal of Urban and Regional Research*, vol. 12, no. 2 (1988), pp. 268–84; C. S. P. Monck, R. B. Porter, P. Quintas, D. J. Storey with P. Wynarczyk, *Science Parks and the Growth of High Technology Firms* (London: Croom Helm, 1988); Organization for Economic Cooperation and Development (OECD), *Science Parks and Technology Complexes in Relation to Regional Development* (Paris: OECD, 1987); and Raymond W. Smilor, David V. Gibson, and George Kozmetsky, "Creating the Technopolis: High-Technology Development in Austin, Texas," *Journal of Business Venturing*, vol. 4 (1989), pp. 49–67.

[23] In contrast, South Korea's Dae Dok Science Town contains clusters of public research institutions, but no manufacturing facilities. Development of science parks in Latin America is virtually non-existent. The *maquiladora* (in-bond) factories along the U.S.-Mexican border mainly serve as offshore assemblers for U.S. firms. They are more like Taiwan's old EPZs. Brazil's Manaus Free Trade Zone has ironically become an odd import haven in a sea of domestic market protection. However, India has two important places for high-technology products: (1) Santa Cruz Electronics Export Processing Zone (SEEPZ) in Bombay and, more recently, (2) the southern city of Bangalore, both evidently inspired by Silicon Valley, and both having significantly cultivated India's software manpower and information exports.

such talents, Taiwan may be in a unique position with such human capital, which is a rare advantage for any LDC. In this regard, HSIP will continue to play a key role in transferring technology — via experienced scientists and engineers seeking to realize their entrepreneurial ambitions.

Industrial Technology Research Institute (ITRI)

The Industrial Development Bureau (IDB) under the Ministry of Economic Affairs (MOEA) is the government body involved in the daily administration of industrial development.[24] Under the supervision of MOEA and CEPD are two important organizations charged with R&D: ITRI and III. The Industrial Technology Research Institute (ITRI), established in 1974, was charged with R&D on hardware: computers, ICs, peripherals, semiconductors, and communication equipment. In 1974, ERSO (Electronics Research and Service Organization) was created under ITRI, and has since been involved in every generation of semiconductor development in Taiwan — from the IC (integrated circuits) project in the 1970s, to the VLSI (very large-scale integrated circuits) project in the 1980s, and to the submicron project of the 1990s. In fact, the establishment of ERSO was directly related to Taiwan's first IC project — through a licensing agreement with the American firm, RCA.[25]

In the early years, ITRI even played the role as an incubator and manufacturer. The United Microelectronics Corp. (UMC), one of Taiwan's largest and most successful IC houses, originated as a spinoff of ERSO.[26] There was also a high interchange of personnel between ERSO and the industry, or, more accurately, the exodus of ERSO employees to the private industry, because of the higher pay offered by industry. Exchange of personnel and expertise among ERSO, academia, and the industry is also quite common — in fact it was facilitated by geographic proximity and institutional support. Furthermore, joint research is actively encouraged, especially in Hsinchu. This may be necessary given Taiwan's industrial structure, which is dominated by small- and medium-sized firms. The dif-

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[24] Shih-chien Yang, director-general, IDB, personal interview, 30 July 1990, Taipei. The $10YP_1$ was mainly Yang's imprimatur when he worked at the CEPD, having recently returned to Taiwan with a Ph.D in engineering from Northwestern University. Yang's proposals were quickly endorsed by Li, who then recruited Yang as one of his key lieutenants. Yang is now a vice economics minister.

[25] For discussions on ERSO's roles in these projects, see Constance Squires Meaney, "State Policy and the Development of Taiwan's Semiconductor Industry," paper presented at the Conference on State Policy and Economic Development in Taiwan, R.O.C., Taipei, 4–5 December 1989; Sung Gul Hong, *The Politics of Industrial Leapfrogging: The Semiconductor Industry in Taiwan and South Korea*, Ph.D diss., Northwestern University (1992), pp. 81–90; and Wang, *High Technology*, pp. 157–68.

[26] Otto Lin, president, ITRI, personal interview, 14 September 1990, Hsinchu.

fusion effect of the ITRI/ERSO/RCA model was clearly felt in Taiwan's high-tech community. Over the years ERSO has trained numerous competent IC design and fabrication personnel, enabling Taiwan to become one of the few countries in the world that possesses credible IC design and fabrication capabilities.

As has been said earlier, the Taiwanese state has often stepped in to pick up the slack where the private sector is either insufficient or unwilling to move in. However, to create positive externalities in learning and cooperation within the industry, the government has in recent years tried to involve the private sector in joint R&D coordinated by the state (e.g., the five-year submicron technology development plan).

But in recent years, ITRI has concentrated on developing plausible industrial technologies and then transferring them for commercial production to interested and qualified private companies, usually in HSIP. By drawing an ample supply of capable technical manpower from the two nearby leading technology universities, Tsing-hua and Chiao-tung, and by feeding research results to the firms in HSIP, ITRI played a very positive role as a bridge between research and production, or as a conveyor belt between technology and commodity. Its focus on industrial and applied technology, as opposed to purely basic research, and its focus on D rather than R avoided many common mistakes found in other NICs.

Institute for Information Industry (III)

The III, established in 1979 at Li's behest, was charged with R&D on software, market intelligence, and dissemination of information technology. Jointly supported by the government, academic institutions, and private organizations, III's main mission is software development, including providing advice and guidance to the government and private organizations. In recent years, III has become the most important body for the training of the much needed information industry manpower. Moreover, its Market Intelligence Center (MIC) has provided market intelligence to both the public and private sectors.[27] Further, the government in recent years has requested III to inspect software and hardware for exports in compliance with intellectual property rights protection.[28]

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[27] Irving Ho, president, III, personal interview, 30 July 1990, Taipei; C. J. Cherng, personal interview, 23 July 1990, Taipei.

[28] *Foreign Broadcast Information Service: China-Daily Report* (hereafter *FBIS-CHI*), 18 May 1992, p. 70; 4 May 1992, p. 58; and 30 April 1992, p. 53.

III's most important task in recent years is the Software Engineering Environment Development (SEED) project. SEED's goal, according to Huang Wei-teh, III's vice president, is "to computerize everything possible (in Taiwan)." The SEED project, launched by III in 1988 with an investment of US$20 million, sought to provide an infrastructure for further development of the high value-added products and pollution-free software industry requiring very little labor or space. This is important because, as Huang asserts, "Taiwan produces 10 percent of total world output of personal computers, yet computer application in this country is [still] very limited." Software products made up about 10 percent of Taiwan's total information industry which was expected to spearhead future technological growth in the country.[29]

Naturally, other institutions such as OSTA, IDIC, DCI, and Tel Lab are also important. However, other noninstitutional features not shown on the chart are worth mentioning. The chiefs of ITRI, ERSO, and III (or Taiwan's industrialist-bureaucrat elites for that matter) had all been trained in top U.S. engineering schools, had worked for renowned U.S. companies and had reached prominent positions before they returned to Taiwan and began to experiment with their expertise. This is a more effective means of technology transfer[30] than the conventional one, which equates higher technology with novel "chic" products.

Several conclusions can be drawn from this discussion of the institutions promoting the information industry in Taiwan. First, the institutional arrangements of Taiwan's information industry reflect the widespread acceptance of the new economic ideology of enhancing national economy and quality of life through information technology. They also reflect key policy planners' view that the information industry holds a central place in Taiwan's new development strategy in light of the new challenges facing the nation.

Second, various institutional and legal infrastructures were created to facilitate the development of the information industry. Especially worth noting are the organic relationships among the government, public research labs, technology universities, and private businesses. The ITRI/III/HSIP model constitutes as much a bottom-up mode of industrial policy-making as the traditional and less effective top-down mode. The type of joint R&D is perhaps a harbinger of high-technology devel-

[29] *Free China Journal*, 2 July 1990, p. 7.

[30] Hsien-chee Fang, vice-chairman, III, and special advisor, ITRI, personal interview, 27 July 1990, Taipei. Dr. Fang left the Telecommunications Directorate in 1975 to become ITRI's president. In 1979, he became III's first president.

opment. The instrumental role of the state in initiating novel projects need not be denied. However, in order for a project to sustain itself and prosper, the private sector must be involved and take over through "spill-over" or "trickle-down" effects.

Third, not shown on the organizational chart is the enormous influence wielded by this particular high-technology epistemic community. The impact of such key figures as K. T. Li and Y. S. Sun (ex-premier and benefactor of the IC project) simply can not be underestimated. They did so much to chart Taiwan's high-technology expedition.

Conclusion: The Political Economy of Taiwanese Success in High-Tech Industries

We can now revisit the most salient elements of Taiwanese success in high-tech development: the entrepreneurial state, guerrilla capitalists, and the accommodative technologists.

Entrepreneurial State

The first factor in the discussion of patterns of high-technology development is the role of the state. The role of the state in creating high-technology industries, AICs and LDCs alike, is indispensable. This is because high-technology industries, as Tyson argues, possess the following characteristics: imperfect competition, strategic behavior, dynamic economies of scale, and technological externalities, hence providing a fertile breeding ground for interventionist policies. "Nearly everyone now concedes that competitive advantage in high-technology industries is *created* [emphasis added], not endowed by nature, and that governments the world over have earmarked them for special support."[31]

Although I agree with Li's argument that "depoliticization" (i.e., liberalization of the economy) was a key reason for Taiwan's "growth with equity" model in the last four decades,[32] I would argue that the new development strategy (technology-intensive ELI), which intends to overcome the bottlenecks encountered by continued labor-intensive ELI, actually necessitates a reinvolvement of the state in creating new comparative advantages. Nevertheless, this new active state role is defined by new democratic politics.

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[31] Laura D'Andrea Tyson, *Who's Bashing Whom? Trade Conflict in High-Technology Industries* (Washington, D.C.: Institute for International Economics, 1992), p. 9.

[32] K. T. Li, *The Evolution of Policy Behind Taiwan's Development Success* (New Haven: Yale University Press, 1988).

Specifically, the state in Taiwan has performed three essential tasks with regard to high technology development. The first is to provide guidance and sequence timing of projects. The second is to provide legal (e.g., statutes and laws) and institutional infrastructures (e.g., III, ITRI, HSIP). The third is to directly become the producer in some cases of market failures. The state wears the complementary hats of administrator and entrepreneur.

The question of why the Taiwanese state was able to play an important and positive role in the development of high-technology industries poses interesting theoretical puzzles. Although the state has assumed an increasingly important role as an entrepreneur in the production and distribution of goods and services, particularly in developing countries, earlier scholarship was often quite skeptical or uncertain about the state's entrepreneurial functions.[33] However, more recently several interesting studies have found positive functions for the state from the Taiwanese case (e.g., with regard to export expansion and the position of wage labor).[34] I would argue that in developing high-technology industries, state entrepreneurship in Taiwan was a necessary response to Taiwan's decentralized industrial structure, dominated by small- and medium-sized firms (to be elaborated upon later), limited technological resources and entrepreneurship, and the state's own developmental vision. It played a key role, and made some smart choices.

However, now it must work in a new political environment, which is subject to democratic scrutiny, and must acquire a new political style. The early "easy success" on hardware expansion has gradually given way to a more fundamental improvement of software, service, and application. This is because the elevation of national well-being requires "informationalization" of the society, to which this new approach is critical.

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[33] Raymond D. Duvall and John R. Freeman, "The Techno-Bureaucratic Elite and the Entrepreneurial State in Dependent Development," *American Political Science Review*, vol. 77 (1983), pp. 569–87; "The State and Dependent Capitalism," *International Studies Quarterly*, vol. 25 (1981), pp. 99–118.

[34] Steve Chan, Cal Clark, and David R. Davis, "State Entrepreneurship, Foreign Investment, Export Expansion, and Economic Growth," *Journal of Conflict Resolution*, vol. 34, no. 1 (1990), pp. 102–29; Cal Clark, "The Consequences of State Entrepreneurship: A Taiwan Case Study," *Pacific Focus*, vol. 2, no. 2 (1987), p. 77–94; and David R. Davis and Michael D. Ward, "The Entrepreneurial State: Evidence from Taiwan," *Comparative Political Studies*, vol. 23, no. 3 (1990), pp. 314–33.

In sum, the state in Taiwan is developmentally oriented,[35] committed to furthering economic growth and technological advancement. In the case of a high-tech industry such as IT, the state has done more than just correct market failures; it has also strived to created new sources of competitive advantage.

Guerrilla Capitalists

The second factor in the discussion of patterns of high-tech development is industrial structure. In this regard, Taiwan's decentralized (small- and medium-sized firms) structure has often been contrasted with Korea's centralized (*chaebol*) model. Table 3 compares South Korea's "bigness" and Taiwan's "smallness" models. Each model entails distinct strengths and weaknesses and each seems suitable for peculiar niches in the global high technology industries. Naturally, the contrasts between

TABLE 3.
THE KOREAN VS. THE TAIWANESE MODEL: BIG VS. SMALL

	The Korean Model	The Taiwanese Model
economy of scale	high	low
entrepreneurialism	low	high
response to market signals	slow	fast
technological development	cross subsidization of R&D	free-ride on state R&D
suitable products	standardized commodity products (e.g., DRAMs)	customized or design-intensive niche products (e.g., ASICs)
nature of agents' bargaining	powerful but corruptible (oligopoly)	democratic but fragmented (competition)
government-business relationship	from domination to symbiosis?	state leadership in some sectors, followership in others
suitable for industrial upgrading	better	worse?
key limitation	costly mistakes	size limitation

[35] See Chalmers Johnson, *MITI and the Japanese Miracle: The Growth of Industrial Policy* (Stanford: Stanford University Press, 1982); and "Political Institutions and Economic Performance: The Government-Business Relationship in Japan, South Korea, and Taiwan," in Frederic C. Deyo, ed., *The Political Economy of the New Asian Industrialism* (Ithaca, NY: Cornell University Press, 1987), pp. 136–64.

the two models are the results of domestic social, economic, and political variables but they indicate that there is "more than one road to Rome" for LDCs' high-technology development.

Conventional wisdom holds that the Korean model is better suited for IT. But actually the new information revolution could benefit Taiwan's decentralized industrial structure. Resembling the Silicon Valley model, this model's strengths lie in the cultivation of innovative and flexible small entrepreneurs who respond promptly to market trends. The small design houses can also take advantage of ample local engineering talents. Yet, smaller firms are hampered by their size, especially on projects that require massive and risky investments (e.g., memory chips). This is where market failures occur, and where the state has stepped in.

Calling Taiwan's decentralized strategy the "mushroom model," Yang Shih-chien, a key figure in $10YP_1$ and Li's apostle, draws a very illuminating contrast: "Taiwan envies Korea's and Japan's *points* (i.e., conglomerates), yet they admire our *surface* (i.e., thousands of 'mushrooms')."[36] This mushroom metaphor is quite catchy. The microelectronic revolution is that propitious technological rain, which nourishes thousands of mushrooms to thrive all over the high-tech green pasture. This is essentially how Silicon Valley (San Jose, California) got started, and how it was so different from Route 128 (near Boston).[37] In the Taiwanese context, it fortuitously blends well with the somewhat unflattering Chinese cultural propensity to "rather be the head of the chicken than be the tail of the cow" (i.e., to be one's own boss, no matter how small it is), which is said to have led to Taiwan's decentralized, small firm–dominated industrial structure. Because the electronic and computer industries from the very start received relatively modest state support, they had to become competitive in order to survive. The state's actions were largely limited to providing a good institutional and legal infrastructure and re-prioritizing incentive structures.[38]

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[36] Personal interview, 30 July 1990, Taipei.

[37] On the auspicious origins of Silicon Valley, see Everett M. Rogers and Judith K. Larsen, *Silicon Valley Fever: Growth of High-Technology Culture* (New York: Basic Books, 1984); Michael S. Malone, *The Big Score: The Billion-Dollar Story of Silicon Valley* (Garden City, NY: Doubleday, 1985); Ann Markusen, Peter Hall, and Amy Glasmeier, *High Tech America: The What, How, Where, and Why of the Sunrise Industries* (Boston: Allen & Unwin, 1986); and Forester, *High-Tech Society*. One interesting study, Anna Lee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge: Harvard University Press, 1994), draws the regional disparities of high-technology industries between Silicon Valley and Route 128.

[38] It should be pointed out that state intervention varies across the various sectors of the IT industry, ranging from low in computers and peripherals to high in semiconductors.

In contrast, the South Korean model of high-technology development can be characterized as an oligopolistic model. Vertically integrated and horizontally diversified into a wide array of industrial and financial sectors, these chaebol can achieve economy of scale and cross-subsidization. They can even take a long-term business perspective by employing predatory practices (e.g., dumping) to secure market shares. Their organization efficiency is fully realized in the manufacturing of commodity products suited for mass fabrication (e.g., memory chips). However, due to their growing size and bureaucratization, South Korean chaebol are often slower than their Taiwanese competitors in responding to changing market signals.[39] Also, the chaebol have made several costly mistakes in the past, because each was trying to outspend the others and together they sought to challenge the American and Japanese industry leaders head on.

Compared with the Korea, Inc. or the conglomerate model, Taiwan's information industry has pursued a "niche" strategy. This "mushroom" model is suitable for Taiwan, thanks to its small firms. It is more "democratic" in that it popularizes the information movement and proliferates high-caliber manpower. The niche strategy allows commercial agility and selective specialization. It will probably fare better against the neoprotectionist mood in the AICs (e.g., in the form of antidumping). These capitalists nimbly pursue business opportunities everywhere, and in their mind, no order is too small. They are guerrilla capitalists in the global commercial battle. Small can be beautiful; and selective can be competitive. This leads to the final point.

Accommodative Technologists

The third factor in the discussion of patterns of high-technology development is the choice of technology policy. The information industry is a very dynamic and fast moving industry, in which yesterday's winners and winning strategies can easily become tomorrow's losers. The crisis, failures, and restructuring of America's major computer companies (e.g., IBM, Digital, Wang, among others) give some indication of the challenges facing even the most successful Taiwanese companies. The debates over proprietary vs. "open" technologies, super vs. micro systems, centralized vs. decentralized models, and basic vs. commercial R&D all pose fundamental questions as to the appropriate choice of strategies in high-technology development.

[39] As a sarcastic journalist quipped, "If Taiwan is a ferocious cat, Korea is a newly born elephant." *Foreign Broadcast Information Service: Northeast Asia-Daily Report*, 12 March 1992, p. 24.

TABLE 4.
ASSERTIVE AND ACCOMMODATIVE INFORMATICS POLICIES — A STYLIZED COMPARISON

Characteristics	Assertive Model	Accommodative Model
basic orientation	import-substituting	export-oriented
market concentration	domestic	global
government support/protection:		
– import restrictions	high and widespread	low and selective
– market reserves	yes	no
– venture capital provision	yes	yes
– R & D	"in-house"/coordinative	mostly coordinative
– special incentives for "strategic industries"	yes	yes
– state-owned firms	prevalent	no
– government procurement favoring local firms	prevalent and explicit	infrequent and implicit
major objectives:	technological autonomy	efficiency/ competitiveness
	nationalism	industrial upgrading
development starts with	systems	peripherals
linkage direction	backward	forward
relationships with		
– existing industries	weak	strong (e.g., consumer electronics)
– user requirements	weak	strong
– export opportunities	weak	strong
price of products	high	low
quality of products	low	high
technological sophistication	high	low but increasing
sectoral emphasis	vertical (microeconomic)	horizontal (macroeconomic)
role of MNCs	marginal/excluded	important/involved
division of labor between MNCs and local firms	segmented markets (e.g., only local firms for PCs, but MNCs allowed in other segments)	organic cooperation at lower ends and moving up to higher ends
country cases	Brazil, Mexico, India, France	Taiwan, South Korea, (Japan)

Generally speaking, Taiwanese companies are not inventors, which define the "paradigms" of technological progress. Rather, most of them are learners, and a few of them are innovators. So the challenge for a successful NIC like Taiwan is how to transform itself from a copycat to a true inventor. On this point, we find an interesting divergence on *how* to accomplish this goal: Taiwan has adopted an "accommodative" strategy, whereas countries such as Brazil and India have adopted an "assertive" strategy. Table 4 summarizes these two models.[40]

As can be seen from this table, countries adopting accommodative high-tech strategy usually strive to incorporate high-tech industries in their overall macroeconomic adjustment. This is certainly true in the Taiwanese case. Furthermore, access to world markets and foreign technology also ensures the viability of the industry. By contrast, countries adopting the assertive strategy have sought to "break the shackles of the product cycle" by creating a "national" high-tech base, without regard to cost-benefit effectiveness.

The Taiwanese case shows that purely "national" technology, developed independent of world technological trends, is both undesirable and impossible. The very dynamic nature of IT industry calls for constant adaptation and learning. Taiwan's information industry in the early period emphasized and capitalized from hardware, thanks to the opportunities created by PC and microelectronics, and the ability to seize these opportunities. Over the years, through introduction, learning, and adaptation of foreign technologies, the industry has gradually moved up the technological ladder. It was not done by closing the borders. Rather, it was done through a dynamic division of labor between the state, MNCs, and local firms. In the years to come, this industry's emphasis will shift to software and application as part of a grass-root movement toward an information society. A change in attitudes toward information and the ability to use it may be a prerequisite for the upgrading of the society and economy. Acquisition of technology was done in an *accommodative* manner with a view to harnessing it with the nation's overall economic development. It was not done by asserting narrow economic nationalism and shutting off external trends.

In sum, the drama of Taiwan's information industry is played out by the dynamic trio of the entrepreneurial state, guerrilla capitalists, and accommodative technologists. The success of a NIC like Taiwan in developing high-tech offers optimism for the Third World: a nation's place in the international system is not ascribed, but acquired.

University of Miami, September 1995

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[40] See Vincent Wei-cheng Wang, "Models of High Technology Development in the East Asian and Latin American NICs," *Pacific Focus*, vol. 9, no. 2 (1994), pp. 5–42.