Chapter 7

The New Competitors: Industrial Strategies of Korea and Taiwan

CONTENTS

Figures

Tables

Chapter 7

The New Competitors: Industrial Strategies of Korea and Taiwan

INTRODUCTION AND SUMMARY

Ten years ago, the debates about competitiveness, industrial and trade policy, and America's role in the Pacific Basin centered almost exclusively on Japan. In the last decade, other East Asian countries have also increased their exports of manufactured goods. Most prominent are the so-called 'newly industrializing countries' or NICs: the Republic of Korea, the Republic of China, Hong Kong, and Singapore. From 1980 to 1988, the four NICs increased their share of U.S. manufactured imports from 13 to 18 Percent.[1]

This chapter is about the two larger East Asian NICs, the Republic of Korea and the Republic of China (hereafter Korea and Taiwan). In less than 30 years they have risen far up the competitive hierarchy of nations, becoming much more important world traders overall and contending in several capital- and technology-intensive industries. Taiwan became the world's 10th biggest exporter of manufactures in 1986, up from 28th in 1965. Korea was 13th, up from 33rd. As suppliers of manufactured goods to the U.S. market, they ranked 4th and 5th in 1989, up from 21st and 40th, respectively, in 1962.[2]

Korea and Taiwan remain relatively poor. Korea's per-capita income is comparable to Portugal's, and Taiwan has only recently crossed the World Bank's threshold for high-income countries.[3] Their overall role in the world economy must also be kept in perspective. Their combined gross domestic product (GDP) accounts for only 1.5 percent of world GDP, excluding the socialist countries, compared to Japan's 10.3 percent; their share of manufactured exports accounts for 4.9 percent of world manufactured exports, compared to Japan's 14.9 percent and 11.9 percent for the United States.[4]

Nonetheless, the ability of both Korea and Taiwan to move from the export of light, labor-intensive manufactures to competitive strength in higher technology industries remains impressive. For example, Korea is now the third largest producer of large capacity (VLSI) memory chips, after Japan and the United States. Taiwan is not far behind the world leaders in some kinds of semiconductor design, and has recently opened a state-of-the-art semiconductor fabrication facility for customized (ASIC) chips. Both have established important export niches in computers, peripherals, and add-ens.

Several other capital- or technology-intensive industries in both countries are competitive, including specialty steel and petrochemicals. Taiwan is the I0th largest machine tool producer in the world, with particular strength in numerically controlled machine tools at the lower precision end of the range. Korea may become the first new producer since the Japanese to break into the oligopolistic world car industry. Firms from both countries are entering alliances with multinationals from North America, Japan, and Europe to develop products for both world and Asian markets.

The Role of Industrial Policies: The Debate

Much of the literature about the economic prosperity of the East Asian NICs falls into one of several schools of thought. One argues that the main contributions of government in Japan, Korea, and Taiwan were to manage price incentives, particularly through the exchange rate and trade policy, to provide infrastructure and a favorable environment for investment, and to maintain macroeconomic stability. Writers in this school may grant that governments intervened to promote industrial development in Korea and Taiwan, but say these actions were hardly more responsible for the successes than the rooster is responsible for the dawn. They note that intervention in Korea and Taiwan was less pervasive than in most other developing countries, yet the outcomes were better.[5]

The second school sees government actions as more influential. In the strongest version, the state is the primary cause of rapid growth.[6] An alternative line of thinking focuses on the role of government in overcoming the problems of technology acquisition and adaptation.[7] Another argues that specific industrial policies can help gain entry into oligopolistic markets with high entry barriers, imperfect competition, and high returns.[8]

A more political view examines the way particular institutional arrangements affect the efficacy of

any state intervention. For example, some argue that public and private information-sharing in "policy networks" account for the high quality of government actions in Japan; these arguments apply to Korea and Taiwan as well.[9] Others concentrate on the political conditions that made for flexible markets in the NICs, such as weak labor movements and leftist parties, and strong, authoritarian leaderships.[10]

Summary of Findings

Korean and Taiwanese policies for industrial promotion did influence market incentives and market outcomes in a growth-promoting direction. If the measures these countries took were not always efficient in a purely economic sense, they were highly effective in promoting private sector growth. True, their effectiveness depends on price incentives and an ample supply of well-educated workers and energetic entrepreneurs. But these policies and conditions are a matter of industrial policy and government intervention.

The industrial and trade policies of Korea and Taiwan are similar in many respects. Both share a commitment to long-term planning, constructing broad visions of the direction that economic growth ought to take and the specific industries to be encouraged. Both have tied themselves closely to world markets, forcing their firms to compete in the world arena while nurturing them at home.

But, there are significant differences in the policies of the two countries. For example, in Taiwan the economy has been more open than in Korea, industrial policy has been less directive and interventionist, and the industrial structure less concentrated; at the same time, there is a greater reliance on public enterprises. These differences show that there is more than one viable approach to industrial promotion and more than one set of conditions under which it can work.

Until recently, Korea had a relatively protected home market. But protection aimed at assisting protected industries to become internationally competitive. Protection against selected imports was often coupled with offsetting incentives for export sale. For example, exporters could get permission and needed foreign exchange to import needed inputs (raw materials, components, and machinery), as could domestic suppliers who provided intermediate inputs to exporters. In the mid-1960s the export drive became a top priority, second only to national defense, with the President himself leading monthly government/industry Export Promotion Meetings. Korean policy forced firms to set their competitive sights to the world standard, but provided a domestic safe haven from the world's premier companies.

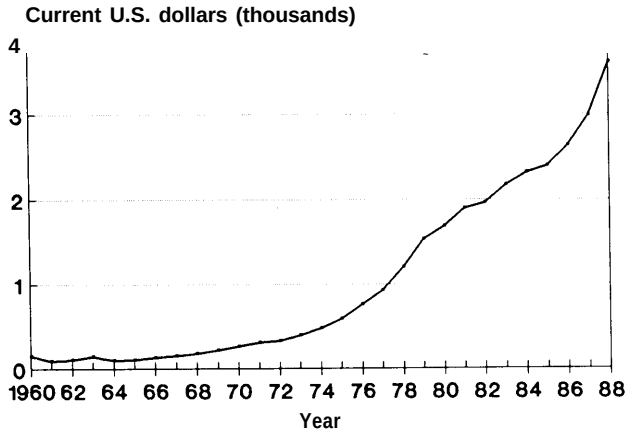
Table 7-l—Korea and Taiwan: Basic Economic Indicators, 1956-88 (annual averages)

	1956-60	1961-65	1966-70	1971-75	1976-80	1981-85	1986-88
Real GDP[a] growth							
Korea	3.3	6.5	12.7	9.0	7.6	7.6	10.5
Taiwan	6.7	10.1	10.0	7.8	10.7	6.7	10.3
Export growth							
Korea	12.9	39.6	32.0	32.5	15.3	12.6	18.0
Taiwan	27.9	25.8	27.2	29.2	29.3	11.6	12.6
Import growth							
Korea	1.4	6.3	33.8	10.8	14.9	9.2	12.5
Taiwan	23.7	16.2	22.7	33.8	25.9	2.7	21.2
Investment/GDP							
Korea	10.5	13.1	23.4	23.1	28.7	28.4	28.2
Taiwan	14.2	15,2	24.9	30.1	30.8	23.8	20.4
Exports/GDP							
Korea	7.4	6.0	10.4	23.8	39.3	39.9	40.3
Taiwan	10.2	16.9	25.0	41.7	50.9	53.9	59.0
Imports/GDP							
Korea	11.7	13.0	25.6	34.8	48.6	41.3	32.7
Taiwan	16.6	20.1	26.1	41.1	48.2	45.6	42.3

[a]GDP.gross domestic product

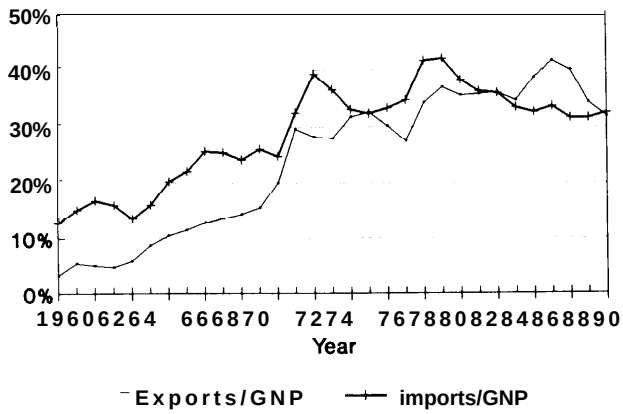
SOURCES: Taiwan Statistical Data Book; Directorate-General of Budget, Statistics and Accounting, Quarterly National Economic Trends; National Bureau of Statistics, Economic Planning Board, Korea Statistical Yearbook; Peter Petri, "Korea's Export Niche," *World Development*, vol. 16, No. 1, 1988, p. 48.

Figure 7-l—Per Capita Gross Domestic Product in Korea, 1960-88



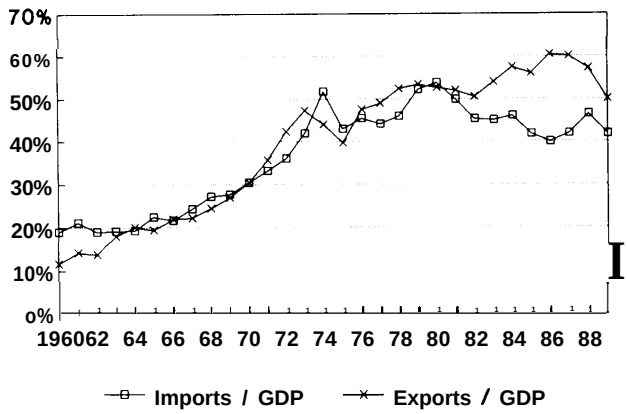
SOURCE: World Bank, *World Tables, 1989-90* (Washington, DC: World Bank, 1980) and International Monetary Fund, *International Financial Statistics,* various issues.

Figure 7-2—Korean Exports and Imports as Percent of GNP, 1960-90



SOURCE: World Bank, *World Tables, 1989-90* (Washington, DC: World Bank), July 1991; and International Monetary Fund, *International Financial Statistics,* (Washington, DC: International Monetary Fund, July 1991).

Figure 7-3—Taiwanese Exports and Imports as Percent of GDP, 1960-89



SOURCE: Republic of China, Council for Planning and Development, Taiwan Statistical Data Book, Taipei, Taiwan 1989.

In the 1980s both countries liberalized their economies, moving away from directive **industrial policies.** This meant not an **abandonment of industrial policy, but rather closer consultation and linkages** with the **private sector, support for private sector initiatives, and greater emphasis** on economywide policies such as manpower, infrastructure, and R&D. Technology policies became particularly important in the 1980s, as both countries sought to develop an indigenous technological base.

KOREA AND TAIWAN: INTERNATIONAL COMPETITIVE POSITION AND TRADING PATTERNS

Korea and Taiwan have maintained high growth rates since their transition to an outward-oriented strategy in the early 1960s (table 7-1 and figure 7-l). This performance has been led both by high rates of export growth, particularly in the 1960s and 1970s, and by high rates of import growth (figures 7-2 and 7-3). The openness of the economy—i.e., its exposure to international trade--can be measured by the ratio of exports and imports to gross domestic product (GDP). Both Korea and Taiwan have become more open in this sense, even if their trade policies have not always been fully liberal. Both countries have had high levels of domestic investment, though Taiwan's flagged somewhat in the 1980s.

Rapid growth accompanies impressive structural change (table 7-2). Taiwan had 30 percent of GDP in manufacturing by 1970; Korea took another decade to reach that level. Agriculture remained larger in Korea than in Taiwan, despite a plunge in agriculture's share of output over the 1970s and 1980s. Table 7-2 shows that finance, insurance, real estate and business services were more developed in Taiwan until 1980, when Korea's service sector took off.

***An* analysis of the export performance of the two** countries falls under two topics: the product compo-

Table 7-2—Korea and Taiwan: Changes in Industrial Structure, 1970-1988 (percentages of output by sector/GDP)

	1970		1975		1980		1985		1988	
	Korea	Taiwan	Korea	Taiwan	Korea	Taiwan	Korea	Taiwan	Korea	Taiwan
Gross domestic product	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture, forestry, fishing	26.8	15.5	24.9	12.7	16.3	7.7	12.8	5.8	10.8	5.0
Mining and quarrying	1.5	1.3	1.5	1.2	1.4			0.6	0.7	
Manufacturing	20.8	29.2	26.5	30.9	29.6	36.0	30.3	37.6	31.6	37.8
Electricity, gas, water	1.6	2.4	1.3	2.6	2.3	2.5	2.8	4.0	2.8	3.2
Construction	5.5	3.9	5.1	5.3	9.4	6.3	7.7	4.1	8.1	4.3
Wholesale and retail trade, restaurants, and hotels	18.2	14.5	19.4	13.2	18.0	13.1	12.2	13.8	12.3	14.3
Transport, storage, and communication	6.8	6.0	6.2	6.0	6.3	6.0	7.6	6.4	7.3	6.2
Finance, insurance, real estate, business services	3.0	9.8	3.4	10.5	4.8	12.7	11.8	13.8	13.2	15.7
Community, personal, and social services	7.5	3.0	6.9	3.9	8.1	4.0	4.1	4.7	4	4.8
Producers of government services	5.0	11.5	4.0	10.5	4.9	9.7	7.2	10.3	7	9.6
Producers of private non-profit institutions serving households	3.1	0.3	3.3	0.3	4.1	0.2	2.5	0.2	2.5	0.3
Domestic services of households		0.3		0.3		0.4		0.6		0.5
Less imputed bank service charge		2.2		3.0		4.8	2.8	5.1	3	5.4
Plus import duties		4.6		5.7		5.2	2.7	3.3	2.6	3.4

SOURCES: Directorate-General of Budget, Accounting and Statistics, Republic of China; Quarterly National Economic Trends, Taiwan Area, Republic of China; Bank of Korea, Economic Statistics Yearbook.

sition of exports, and the market or geographic composition of exports. To analyze the product composition of exports, we have calculated measures of "revealed comparative advantage" (RCA) for all export product groups from 1980 through 1986, the last year when data was available. The RCA index shows each country's share of world exports in a given product relative to that country's share of world exports of all manufactured products (making the denominator constant in all calculations). If this ratio is less than 1, the country's share in the product is less than the country's share of world trade. On the other hand, if the country has an RCA higher than 1 in a given product category, it reflects a larger market share than would be predicted on the basis of aggregate exports alone. The RCA index is a rough gauge of competitiveness; the higher the index, the larger the country's share in those markets.

Tables 7-3 and 7-4 divide the exports of the two countries into six groupings, first, on the basis of whether the RCA for the product is extremely high (over 4), high (1 to 4) or low (below 1); and, second, on the basis of whether it has risen or fallen between 1980 and 1986. We have also examined the technology intensity of these sectors, using a measure constructed on the basis of applied R&D expenditure. Though the data on R&D expenditure is dated and does not cover all sectors, it does provide indications. We have divided the products into those with high (***), intermediate (**), and low technology intensity (*).[11]

The tables show two other figures relevant to assessing the performance of Korea and Taiwan in the U.S. market. The first is aggregate exports in dollars. The second is an index, similar to the RCA, that measures the extent to which exports are concentrated on the U.S. market. A ranking of 1 indicates that the share of exports to the United States in the given product is equal to the share of exports to the United States in the country's total exports. A number higher than 1 indicates that Korea and Taiwan export a larger share of that product to the United States than they do of total exports, reflecting a dependence on the U.S. market and/or a competitive advantage vis-à-vis the United States.

The products with high and rising RCAs represent leading export sectors. What is surprising is the diversity of sectors represented. Korea has developed strong international competitiveness in the capital-intensive shipbuilding industry, a target of industrial policy in the late 1970s. Korea also shows strength in a range of consumer electronics products that are technology intensive, excelling in the more standardized segments. Yet Korea has also increased competitiveness in toys, games, and sporting goods, a low technology, tight-manufacturing sector that is typically labor-intensive.

Table 7-3-Korea: Revealed Comparative Advantage (1986 exports; other figures are ratios)

SITC Code and Product	RCA ratio	Technology intensity	Exports to U.S. (nearest $million)	Concentration in U.S.[b]
Rising RCA ratios				
Extremely *high RCAs (extremely competitive relative to other exports)*				
7528: Offline data processing equipment	24.5	••••	NA	NA
793: Ships and boats	7.4	••••	6	NA
894: Toys, games, and sporting goods	6.3	N A[c]	684	NA
762: Radios	6.0	•**	214	0.8
037: Preserved fish and shellfish	4.0	NA	41	0.4
High RCAs (advantaged relative to other exports)				
898: *Musical* instruments, recorded discs and tapes	3.9	NA	241	1.0
763: Sound recorders, VCRs	3.3	- *	358	1.2
775: Household electric appliances	3.1	•**	339	1.5
7643: TV, radio transmittal	2.1	•**	44	1.3
7641 : Telephones	2.1	•w	NA	NA
764: Telecommunications	1.7	•··	566	1.7
7781 : Batteries, etc.	1.3	•·	12	0.9
Low *RCAs (disadvantaged relative to other exports)*				
75: *Office* machinery, automatic data processing equipment (includes digital computers)	0.9	•··	515	1.3
655: Knitted fabric	0.8	•	4	NA
781 : Passenger oars	0.8	+··	799	1.5
334: Refined petroleum products	0.7	NA	38	0.2
792: Aircraft and parts	0.6	•··	15	NA
582: Plastics, condensed	0.6	•··	NA	NA
056: Vegetables, preserved	0.6	NA	11	NA
785: Motorcycles and bicycles	0.6	•··	16	NA
.744: Mechanical handling equipment and parts	0.5	NA	57	1.4
821 : Furniture	0.5	NA	54	1.2
881: Photo equipment	0.5	NA	18	NA
611 : Leather	0.3	NA	2	NA
74: General industrial machinery and parts	0.3	•	182	1.5
68: Nonferrous metals	0.2	·	14	NA
7783: Auto electronics	0.2	•·	9	8.2
784: Motor vehiclw parts	0.2	•·	56	1.1
Falling RCA ratios				
Extremely *high RCAs (extremely competitive relative to other exports)*				
831: Travel and hand bags	12.3	NA	331	1.3
85: Footwear	9.3	NA	1,489	1.8
653: Woven synthetic fabric	8.4	•	197	0.3
761 : Televisions	7.5	•··	442	1.4
786: Trailers and containers	6.2	NA	NA	NA
696: Cutlery	5.9	•·	66	1.1
84: Wearing apparel and accessories	5.4	NA	2,529	1.2
034: Fish, fresh	4.7	NA	73	0.4
693 Wire products, nonelectric	4.3	•	73	1.2
697: Household appliances of base metal	4.3	NA	95	1.0
7642: Microphones, loudspeakers, amplifiers	4.0	•**	45	2.3
High RCAs (advantaged relative to other exports)				
625: Rubber tires and tubes	3.5	NA	186	0.9
776: Transistors, valves, diodes, cathode tubes, semiconductors	3.5	NA	647	1.0
76: Telecommunications and sound recording and reproducing equipment	3.3	* *	1,580	1.3
661: Cement, lime, building products	3.2	•	12	NA
036: Shellfish. fresh	3.0	NA	24	NA

[a]Technology intensity is reported according to figures derived by C. Michael Aho and Howard F. Rosen, 1980, "Trends in Technology-Intensive Trade," U.S. Department of Labor, Bureau of International Labor Affairs, Economic Discussion Paper #9, pp. 49-52. The number of asterisks (from 1 to 3) corresponds to low. intermediate, and high levels of technology intensity. See text, footnote 11.

[b]Concentration ratios express the extent of export concentration in the United States relative to the world market. These ratios have been calculated in general only for products where U.S. 13SS imports exceed $35 million. Figures above one(10) indicate a concentration of exports in the United States relative to the world market; those below one indicate greater export concentration elsewhere relative to that in the U.S. market.

[c]NA=not applicable

Continued on next page

Table 7-3-Korea: Revealed Comparative Advantage (1986 exports; other figures are ratios)-Continued

SITC Code and Product		RCA ratio	Technology intensity	Exports to U.S. (nearest $million)	Concentration in U.S.[b]
651,652, 654,657:	Various textiles	2.9 to 2.1	•	118	<1
672:	iron and steeL primary forms	2.9	•	9	NA
666:	Pottery	2.5	•	56	1.5
694:	Nails, screws, bolts	2.5	•	111	1.9
673:	iron and steeL bars, rods, and shapes	2.4	*	39	0.2
771 :	Electric power machinery	2.0	•~~	29	NA
7782:	Electric lamps, bulbs	2.0	•~	46	1.9
674:	Iron and steel plates and sheets	1.8	•	262	1.1
884:	Optical goods	1.8	NA	59	1,4
678:	iron and steel tubes and pipe	1.6	NA	197	1.4
885:	Watches and clocks	1.5	•**	56	0.7
773:	Electricity distribution equipment	1.2	•~~	45	0.9
897:	Jewelry, articles of precious metal	1.2	NA	92	1.5
893:	Plastic articles, misc.	1.0	•*	100	1.3
Low *RCAs (disadvantaged relative to other exports)*					
791 :	Railway vehicles	0.9	•~	2	NA
778:	Electrical machinery, misc.	0.8	~~	164	1.6
699:	Base metal manufactures, misc.	0.8	•~	101	1.5
7512:	Calculating and accounting machines	0.8	~~~	44	5.4
635:	Wood manufactures, misc.	0.7	NA	9	NA
634:	Veneers, plywood	0.7	NA*	6	NA
663:	Mineral manufactures, misc.	0.6	***	8	NA
759:	Parts and accessories for 752	0.5		106	1.2
812:	Plumbing, heating, and lighting equipment	0.5	•~	19	NA
751 :	Office machines	0.4	•~~	46	2.2
695:	Hand and machine tools	0.4	•~	24	NA
64:	Paper products	0.4	NA	32	0.4
772:	Switchgear, circuits, and parts	0.4	•**	73	1,7
058:	Fruit, preserved	0.3	NA	7	NA
71:	Power generating machinery	0.3	•**	27	0.3
87:	Scientific and controlling instruments	0.3	•~~	56	1.0
724:	Textile and leather machines and parts	0.2	•~	6	NA
73:	Metal working machinery	0.15	•	17	NA
721 :	Agricultural machinery and parts.	0.05	•~	2	NA

SOURCES: United Nations, International Trade Statistics Yearbook; National Bureau of Statistics, Economic Planning Board, Korea Statistical Yearbook.

Taiwan shows a contrasting pattern. First, the range of products in which the country improved its competitiveness in the 1980s is greater, though with a lower average dollar value of exports in each category. This pattern reflects a' 'niche' strategy of specialization in products that are less technology- and capital-intensive than those in which Korea has excelled. For example, Taiwan improved its competitiveness in a number of apparel segments, while moving into standardized electronics products such as calculators and telephones that can be produced by small firms.

The third cluster, sectors with low but rising RCAs, represent those in which Korea and Taiwan are developing comparative advantage. In Korea, this list includes office machinery, computers, automobiles, and refined petroleum products, capital-intensive sectors targeted by the government in the last 15 years. Taiwan is competitive in steel, a sector **dominated by a state-owned** enterprise. Both countries show low but rising competitiveness in general industrial machinery.

The change out of light, labor-intensive manufactures is apparent in the next cluster of industries: sectors in which competitiveness was strong in the past, but is falling now. In Korea, decline in the competitiveness of steel and textile and apparel segments are noteworthy. Taiwan declined in some textile and apparel sectors, with a greater concentration of losses in light electronics, for which assembly operations were important for the country's development. The sources of this decline include rising labor costs, technological changes, and improvements in productivity that have moved production back to the advanced industrial states.

The final cell represents those sectors in which Korea and Taiwan are primarily importers rather

Table 7-4-Taiwan: Revealed Comparative Advantage (1986 exports; other figures are ratios)

SITC Code and Product	RCA ratio	Technology intensity	Exports to U.S. (nearest $million)	Concentration in U.S.[b]
Rising RCA ratios				
Extremely high RCAs (extremely competitive relative to other exports)				
894: Toys, games, and sporting goods	14.5	NAc	1,384	1.1
655: Knitted fabric:	12.9	•	5	NA
785: Motor- and bicycles	8.4	•–	244	0.7
697: Household appliances of base metal	7.4	•–	286	1.2
7512: Calculating and accounting machines	5.2	•––	82	1.1
846: Undergarments, knit	5.2	NA	386	1.6
821: Furniture	5.0	NA	990	1.6
694: Nails, screws, bolts	4.8	•*	207	1.5
847: Textile and clothing accessories	4.7	NA	48	0.5
7642: Microphones, loud-speakers, amplifiers	4.5	•**	133	1.5
812: Plumbing, heating, and lighting equipment	4.5	•–	292	1.8
036: Shellfish, fresh	4.2	NA	87	0.3
High RCAs (advantaged relative to other exports)				
7641: Tleephones	3.7	•–– *	NA	NA
657: Special yarns and textile fabric	3.5		66	0.4
771: Electric power machinery	3.5	•––	158	1.0
884: Optical goods	3.4	NA	123	1.2
7522: Digital computers	3.4	•**	NA	NA
695: Hand and machine tools	3.3	•–	220	1.1
844: Undergarments, nonknit	3.2	NA	226	2.4
775: Household electric appliances	3.0	•**	213	0.7
651: Textile yarn	2.9	•	11	NA
661: Cement, lime, building products	2.7	•	10	NA
699: Base metal manufactures, misc.	2.6	•–	405	1.4
7643: TV and radio transmission	2.3	•––	49	0.9
663: Mineral manufactures, misc.	2.3	•	9	NA
881: Photo equipment	2.2	NA	108	1.1
693: Wire products and grills nonelectric	2.1	•	11	NA
786: Trailers and containers	1.9	•*	NA	NA
75: Office machinery and automatic data processing equipment	1.9	•––	1,233	1.1
897: Jewelry, articles of precious metal	1.3	NA	121	1.4
772: Switchgear, circuits, and parts	1.2	•**	201	1.0
611: leather	1.1	NA	6	NA
Low RCAs (disadvantaged relative to other exports)				
673: Iron and steel bars, rods, and shapes	0.9	•	57	0.5
784: Motor vehicle parts	0.5	NA	205	0.8
74: General industrial machinery and parts	0.5	•	598	2.2
334: Refined petroleum products	0.4	NA	13	NA
721: Agricultural machinery and parts	0.4	•*	10	NA
674: Iron and steel plates, and sheets	0.4	•	23	0.4
87: Scientific and controlling instruments	0.3	•––	111	1.5
68: Non-ferrous metals	0.2	-	28	0.4
781: Passenger cars	0.01	•––	2	NA
792: Aircraft and parts	0.002	•––	4	NA
Falling RCA Ratios				
Extreme/y High RCAs (extremely competitive relative to other exports)				
831: Travel and hand bags	17.0	NA	523	1.1
8942: Toys and games	12.4	NA	787	1.1
85: Footwear	12.2	NA	2,101	1.4
635: Wood manufactures, misc.	8,5 -	NA	292	1.2

[a]Technology intensity is reported according to figures derived by C. Michael Aho and Howard F. Rosen, 1980, "Trends in *TAnology-intensive* Trade," U.S. Department of Labor, Bureau of International Labor Affairs, Economic Discussion Paper #9, pp. 49-52. The number of asterisks (from 1 to 3) corresponds to low, intermediate, and high levels of technology intensity. See text, footnote 11.

[b]Concentration ratios express the extent of export concentration in the United States relative to the world market. These ratios have been calculated in general only for products where U.S. 19S6 imports exceed $35 million. Figures above one (1.0) indicate a concentration of exports in the United States relative to the world market; those below one indicate greater export concentration elsewhere relative to that in the U.S. market.

[c]NA=not applicable

Continued on next page

Table 7-4-Taiwan: Revealed Comparative Advantage (1966 exports; other figures are ratios)--Continued

SITC Code and Product	RCA ratio	Technology intensity[a]	Exports to U.S. (nearest $million)	Concentration in U.S.[b]
845: *Other* outerwear, knit	6.8	NA	765	1.0
762: Radios	6.7	•**	264	0.6
893: Plastic articles, misc	6.4	•*	699	1.1
761 : Televisions	6.2	W*	445	1.2
056: Vegetables, preserved	5.3	NA	97	0.7
666: Pottery	5.0	•	238	2.3
842: Men's outerwear, nonknit	4.8	NA	296	0.8
High *RCAs (advantaged relative to other exports)*				
653: Woven Synthetic fabric	4.0	•	37	0.1
696: cutlery	3.9	•*	83	1.6
84: Waring apparel and accessories	3.8	NA	2,586	1.2
634: veneers, plywood	3.7	NA	139	0.9
034: Fish, fresh	3.4	NA	88	0.4
037: Preserved fish and shellfish	3.3	NA	83	0.8
76: Telecommunications and sound recording and reproducing equipment	3.0	•~	1,895	1.2
652: Woven cotton fabric	2.8	•	104	0.9
764 Telecommunications	2.5	•M	991	1.5
7782: Electric lamps, bulbs	1.9	•*	53	1.4
776: Transistors, valves, diodes, cathodb tubes, semiconductors	1.8	•~	318	0.7
724: Textile and leather machines and parts	1.5	•~	74	0.5
773: Electricity distribution equipment	1.4	***	307	3.6
778: Electrical machinery, Misc	1.3	•~	367	1.6
058: Fruit, preserved	1.2	NA	13	NA
625: Rubber tires and tubes	1.2	NA	94	1.0
685: Watches and clocks	1.2	•99	64	0.7
751 : Office machines	1.2	•~	99	1.2
73: Metal working machinery	1.1	•	154	0.9
Low RCAs (disadvantaged relative other exports)				
898: Musical instruments, recorded discs and tapes	0.9	NA	116	1.6
7781 : Batteries, etc.	0.8	•*	12	1.1
783: ships and boats	0.7	•~	137	1.4
7783: Auto electronics	0.7	**	9	1.6
759: Parts and accessories for 752	0.7	NA	420	2.9
654: other woven textile fabric	0.6	•	9	NA
678: iron and steel tubes, and pipe	0.6	•	89	1.3
763: Sound recorders, VCRs	0.5	•~	186	3.1
744: Mechanical handling equipment and parts	0.4	•	59	1.3
71: Power generating machinery	0.3	***	64	0.5
64: Paper products	0.3	NA	59	0.7
7518: Photocopy and thermocopy maOhbes	0.07	•**	12	2.7

SOURCES: United Nations, International Trade Statistics Yearbook,- Statistics of Trade, Republic of China.

than exporters. In line with~ their poorh resource endowments, these sectors include a number of raw materials-based products, particularly petrochemicals, and, in Taiwan, a range of capital goods

Both countries have developed and maintained competitivess in a diverse array of products ranging from technologically simple to complex. Korea shows a greater concentration in products with higher capital and technology intensity and greater scale economies, while Taiwan Shows greater product diversity. Korea's industrial policy has led to a handful of the largest firms dominating exports. Taiwan has, on average, smaller firms.

The pace of industria l adjustment out of declining sectors has been gradual; rising and falling sectors coexist over long periods Of time. In a number of product categories RCA's remain high While declining. Both countries continue to be competitive in traditional export products, such as footwear, even though comparative advantage is ending. This reflects their initial strong market positions in these sectors, and the ability of their firms to enhance productivity, increase investment, and adapt technoIogically to help offset increasing labor and other costs.

With technology transfer from industrialized nations to the NICs and the accumulation of physical

and human capital, the skill- and capital-intensity of NIC exports has increased. This places competitive pressure on the advanced industrial states. On the other hand, the NICs remain importers of a range of capital-, skill-, and technology-intensive goods. This suggests the likelihood of extensive two-way trade in highly differentiated products, a pattern that has characterized economic relations between Europe and the United States.[12]

Another area of concern is the geographic concentration of the two countries' exports. Tables 7-5 to **7-8 detail their exports and imports by** major markets; figures 7-4 and 7-5summarize the information graphically.

In the 1960s, Korea and Taiwan relied heavily on the U.S. market as the key to their export-oriented growth strategy. Following the first and second oil shocks, however, Korea aggressively diversified its exports. Korean construction firms pushed into the lucrative Middle East market, and exports of construction materials followed. Europe's share doubled between 1970 and 1975.

Table 7-5-Country Destination of Korean Exports, 1970-89 Major Trading Partners (US$ million)

	1970		1975		1980		1985		1989	
Asia:		33.9%		32.7%		26.1%		23.7%		33.2%
Australia	2.9	0.4%	63.0	1.2%	230.4	1.3%	368.8	1.2%	1,004.9	1.6%
Hong Kong	27.5	3.3%	181.9	3.6%	823.3	4.7%	1,565.5	5.2%	3,374.6	5.4%
Japan	234.3	28.1%	1,292.9	25.5%	3,039.4	17,4%	4,543.4	15.O%	13,456.8	21.6%
Singapore	11.0	1.3%	58.2	1.2%	266.3	1.570	490.1	1.6?40	1,532.4	2.5%
Taiwan	7.2	0.9%	62.8	1.2%	216.3	1.2%	196.1	0.7%	1,308.2	2.1%
Europe:		6.6%		12.7%		11.9Y0		8.4%		9.1%
France	1.5	0.2%	40.0	0.8%	291.2	1.7%	315.8	1.0%	894.0	1.4%
Germany	27.3	3.3%	312.2	6.1%	875.5	5.O%	979.3	3.2%	2,137.2	3.4%
Netherlands	13.5	1.6%	128.9	2.5%	349.5	2.0%	345.4	1.1%	755.8	1.2%
United Kingdom	13.0	1.6%	161.7	3.2%	572.5	3.3%	913.4	3.0%	1,861.3	3.0%
Middle East:		0.2%		2.5%		6.8%		3.9%		1.6%
Kuwait	1.5	0.2%	33.9	0.7%	249.1	1.470	205.6	0.7%	210.1	0.3%
Saudi Arabia	0.1	0.01%	91.1	1.8%	946.1	5.4%	968.7	3.2%	814.8	1.370
North America:		49.7%		34.1%		28.3%		39.6%		36.1%
Canada	19.5	2.3%	197.3	3.9%	343.4	2.O%	1,228.7	4.1%	1,882.3	3.O%
United States	395.1	47.370	1,536.2	30.2%	4,606.6	26.3%	10,754.1	35.5940	20,639.0	33.1%
World; country exports as share of world exports	835.1	90.3%	5,081.0	81.9%	17,504.9	73.2%	30,283.1	75.5%	62,377.1	80.0%

SOURCES: Bank of Korea, Economic Statistics Yearbook; Bank of Korea, Monthly Economic Statistics.

Table 7-6-Country Source of Korean Imports, 1970-89 Major Trading Partners (US$ million)

	1970		1975		1980		1985		1989	
Asia:		48.8%		42.7%		36.2%		37.5%		40.5%
Australia	13.7	0.7%	204.7	2.8%	680.0	3.1%	1,116.1	3.6%	2,243.0	3.6%
Hong Kong	19.7	1.0%	19.7	0.3%	98.2	0.4%	492.5	1.6%	581.7	0.9%
indonesia	19.8	1.0%	146.8	2.0%	484.5	2.2%	668.6	2.1%	1,135.2	1.8%
Japan	809.2	40.8%	2,433.6	33.5%	5,857.8	26.3%	7,560.4	24.3%	17,448.6	28.4%
Malaysia	57.7	2.9%	122.7	1.7%	471.6	2.1%	1,234.3	4.0%	1,503.4	2.4%
Singapore	13.5	0.7%	13.7	2.2%	161.2	0.7%	267.7	0.9%	640.8	1.0%
Taiwan	34.0	1.770	161.9	2.2%	313.3	1.4%	333.4	1.1%	1,328.4	2.2%
Europe:		7.7%		6.2%		5.1%		6.4%		7.2%
France	52.2	2.6%	137.3	1.9%	190.8	0.9%	442.3	1.4%	879.1	1.4%
Germany	67.2	3.4%	192.6	2.6%	636.6	2.9%	978.6	3.1%	2,623.5	4.3%
United Kingdom	32.7	1.6%	123.0	1.770	303.6	1.4%	565.8	1.8%	923.4	1.570
Middle East:		5.8%		15.9%		22.6%		3.7%		2.3%
Kuwait	30.6	1.5%	553.4	7.6%	1,753.2	7.9%	523.2	1.7%	381.7	0.6%
Saudi Arabia	84.6	4.3%	605.3	8.3%	3,288.4	14.8%	639.7	2.1%	1,041.8	1.770
North America:		30.6%		27.9%		23.6%		22.9%		28.6%
Canada	23.1	1.2%	150.1	2.1%	378.4	1.7%	630.2	2.O%	1,680.1	2.7%
United States	584.7	29.5%	1,881.1	25.9%	4,890.2	21.9%	6,489.3	20.8%	15,910.7	25.9%
World; country exports as share of total exports	1,983.9	92.9%	7,274.3	92.7%	22,291.7	87.5%	31,135.7	70.5%	61,464.7	78.6%

SOURCES: Bank of Korea, Economic Statistics Yearbook Bank of Kore~ Monthly Economic Statistics.

Table 7-7-Country Destination of Taiwanese Exports, 1970-89 Major Trading Partners (US$ million)

	1970		1975		1980		1985		1989	
Asia:		31.1%		28.5%		26.5%		26.4%		33.0%
Australia	20.4	1.4%	125.5	2.4%	539.3	2.7%	747.3	2.4%	1,531.9	2.3%
Hong Kong	135.8	9.2%	363.0	6.8%	1,550.6	7.8%	2,539.7	8.3%	7,013.9	10.6%
Japan	215.6	14.6%	694.2	13.1%	2,173.4	11.0%	3,460.9	11.3%	9,058.0	13.7%
Korea	27.8	1.9%	119.5	2.3%	266.5	1.4%	253.8	0.8%	1,131.3	1.7%
Singapore	35.9	2.4%	140.7	2.7%	545.1	2.8%	885.1	2.9%	1,970.0	3.0%
Thailand	25.1	1.7%	67.8	1.3%	176.2	0.9%	236.2	0.8%	1,103.2	1.7%
Europe:		6.0%		9.3%		9.2%.		5.5%		8.7%
France	3.1	0.2%	37.5	0.7%	265.6	1.3%	227.6	0.7%	1,084.9	1.6%
Germany	71.0	4.8%	316.2	6.0%	1,075.8	5.4%	805.4	2.6%	2,558.2	3.9%
United Kingdom	14.2	1.0%	137.8	2.6%	471.6	2.4%	650.0	2.1%	2,095.8	3.2%
North America:		41.5%		37.8%		36.5%		51.2%		38.9%
Canada	50.8	3.4%	181.6	3.4%	459.7	2.3%	944.8	3.1%	1,755.8	2.7%
United States	564.1	38.1%	1,822.7	34.3%	6,760.3	34.1%	14,773.3	48.1%	23,943.4	36.25
World;country exports as share of total exports	1,481.4	78.6%	5,308.7	75.5%	19,810.6	72.1%	30,725.6	83.1%	66,102.4	80.6%

SOURCE: Council for Economic Planning and Development, Taiwan Statistical Data Book.

Table 7-8-Country Source of Taiwanese Imports, 1970-89 Major Trading Partners (US $ million)

	1970		1975		1980		1985		1989	
Asia:		49.1%		36.0%		33.2%		35.5%		42.1%
Australia	47.9	3.1 %	159.5	2.7%	512.2	2.6%	800.6	4.0%	1.627.8	3.1%
Hong Kong	27.2	1.8%	74.7	1 .3%	249.9	1 .3%	319.6	1.6%	2,222.7	4.3%
Japan	652.7	42.8%	1,812.2	30.5%	5,353.2	27.1%	5,548.8	27.6%	16,016.6	30.7%
Korea	15.1	1 .0%	59.2	1 .0%	208.5	1 .1%	186.6	0.9%	1,239.0	2.4%
Singapore	5.3	0.4%	35.7	0.6%	221.7	1 .1%	275.8	1.4%	884.7	1 .7%
Europe:		5.8%		8.4%		5.1%		5.5%		6.7%
Germany	61.9	4.1 %	371.4	6.20/o	722.2	3.7%	846.1	4.2%	2,592.5	5.0%
United Kingdom	25.9	1.7%	127.4	2.1%	288.6	1 .5%	262.4	1.3%	926.5	1.8%
Middle East:		0.2%		3.8%		7.2%		6.8%		2.6%
Saudi Arabia	2.7	0.2%	228.3	3.8%	1,418.9	7.2%	1,361.0	6.8%	1,378.7	2.6%
North America:		25.0%		28.6%		24.9%		25.5%		24.9%
Canada	17.0	1 .1%	48.0	0.8%	248.9	1.370	368.9	1.8%	997.9	1 .9%
United States	363.8	23.9%	1,652.1	27.8%	4,673.4	23.7%	4,746.2	23.6%	11,984.1	23.0%
World; country exports as share of total exports	1,523.9	80.0%	5,951.6	76.8%	19,733.1	70.4%	20,102.0	73.2%	52,215.3	76.4%

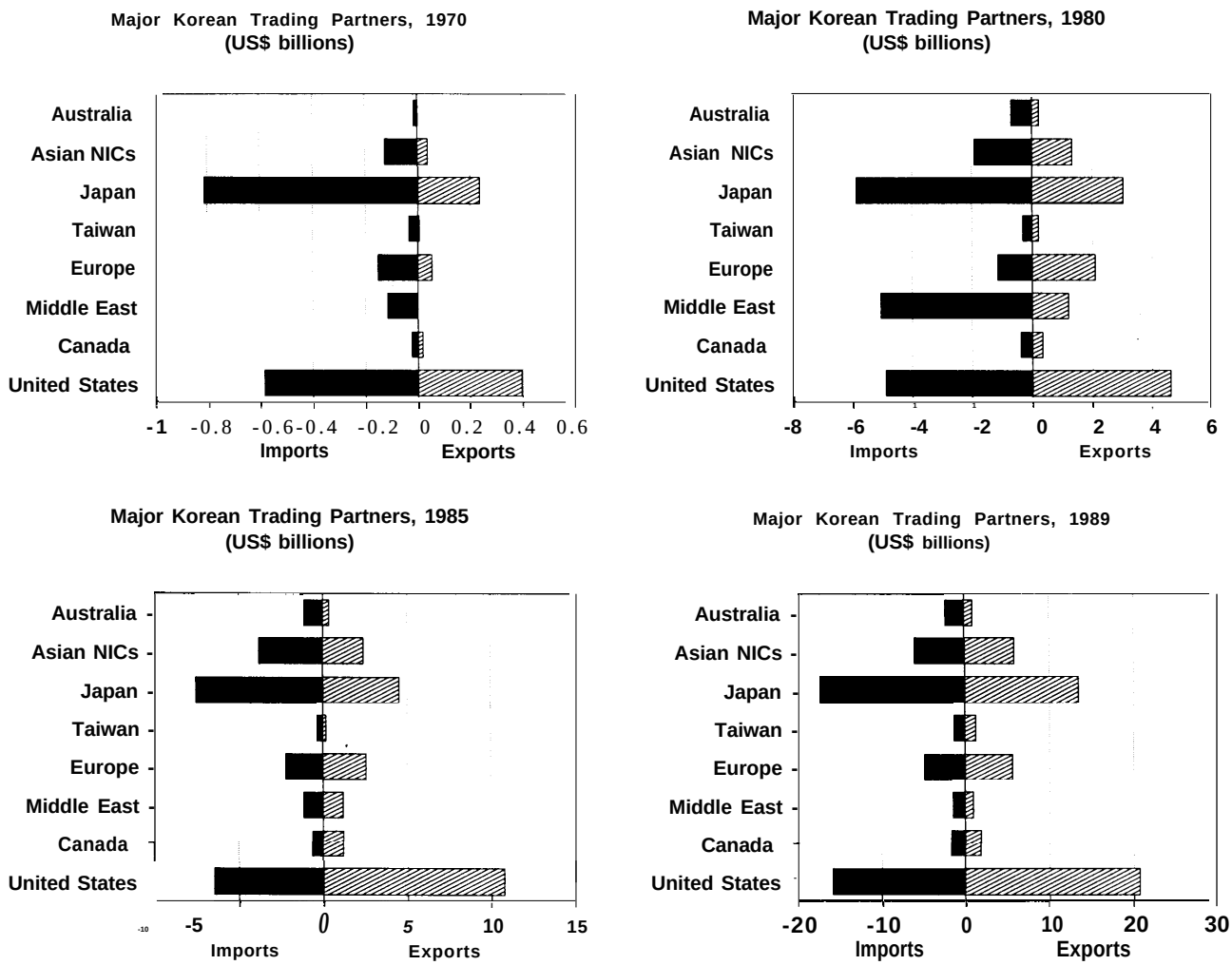
SOURCE: Monthly Statistic of Imports, Republic of China.

In the 1980s, the dependence on the **U.S. market fluctuated with economic conditions and exchange rates. The U.S. share of Korea's exports rose after the 1982** recession, and jumped dramatically, from 35 to 40 percent, after the sharp real depreciation of the Korean *won in* **1985-1986.** Thereafter, however, the U.S. share declined as the won rose, and has not approached its 1970 level. Korea's strategy of diversification holds true at the product level as well, **though footwear and automobiles still show a marked** concentration on the American market.

In Taiwan, dependence on the American market also increased over the **early 1980s, but the level was much higher, approaching 50 percent in 1985 before falling to around 40** percent in 1989, roughly the same as in 1970. Imports show a similar story, with **Korea diversifying away from the United States and Taiwan's share of imports staying constant over time.**

The data suggest a somewhat contradictory picture with regard to interdependence within East Asia. The NICs increased their trade with one another, though from a low base that reflects their competition in some product lines. Hong Kong's share in Taiwan's trade grew sharply over the late 1980s; an unknown portion of this trade is with the People's Republic of China. Both Korea and Taiwan increased their exports to Japan in the late 1980s, Korea more than Taiwan. Both countries have historically run deficits with Japan, their main source of imports. But Japan's share has fallen sharply since the peak in 1986 as a result of

Figure 7-4-Major Korean Trading Partners, 1970-89



NOTE: Europe includes Germany, France, United Kingdom, and the Netherlands. Asian NICs indude Singapore, Malaysia, Thailand, and Hong Kong. Midd!e East includes Saudi Arabia and Kuwait.

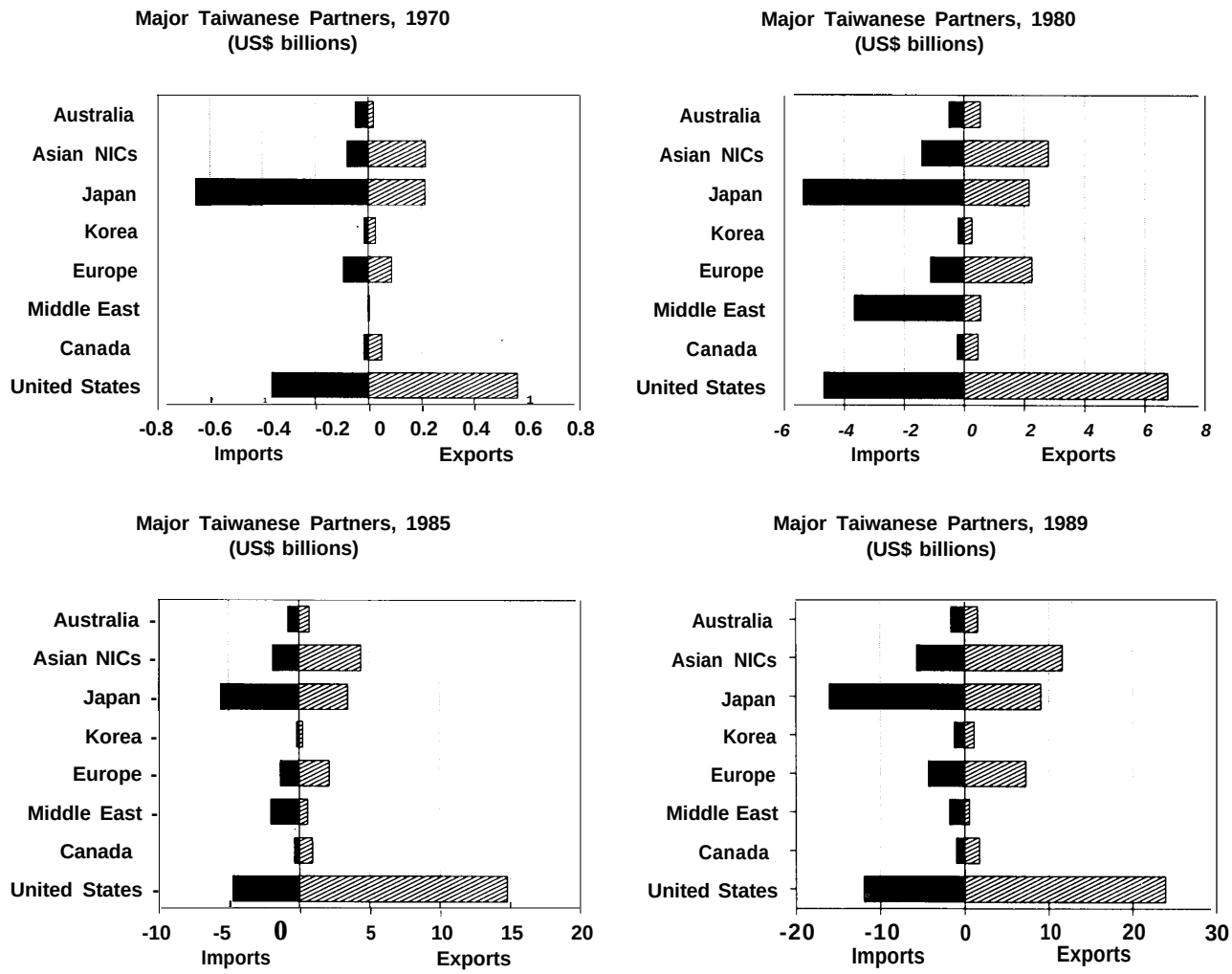
SOURCE: Bank of Korea, Economic Statistics Yearbook; Bank of Korea, Monthly Economic Statistics.

exchange rate **movements. Korea has been more successful in diversifying while Taiwan's trading patterns with Japan show greater constancy.**

The aggregate figures for Korea's and Taiwan's trade with Asia in the last two decades do not show any striking shift in shares going to or from Asia as a whole. This suggests that while there are changes in the NICs' trading patterns within Asia, there is no long-term movement toward greater reliance on Asian markets or the creation of an intra-Asian trading bloc centered on Japan.

This picture does not take into account the growing networks of foreign investment in the region, however. Analysis of such investments goes beyond the scope of this chapter, but it is important to note how they complicate the picture. First, some share of exports from Taiwan and Korea is coming from American and Japanese subsidiaries, usually as intrafirm trade. Table *7-9* suggests that American firms have played a relatively small and declining role in the exports of the two larger NICs. Japanese foreign direct investment, by contrast, increased dramatically in the mid-1980s following the appreciation of the yen. Total foreign direct investment in 1986 through 1988 was equal to the cumulative value of Japanese foreign investment from 1951 through **1985.**[13]

Figure 7-5-Major Taiwanese Trading Partners, 1970-89



NOTE: Europe includes Germany, France, United Kingdom, and the Netherlands. Asian NICs include Singapore, Malaysia, Thailand, and Hong Kong. Middle East indudes Saudi Arabia and Kuwait.

SOURCE: Republic of China, Monthly Statistics of Imports; Council for Economic Planning and Development, Taiwan Statistical Data Book.

Data comparable to that cited for the United States are not available on the trade behavior of Japanese affiliates, but information is available on the pattern of sales of all Japanese affiliates in the four East Asian NICs. Fifty-six percent of affiliates' sales of manufactures were to the local market, 15.1 percent were to Japan, 11.2 percent were to the rest of Asia, and 9.3 percent were to the United States, with the remainder split between Europe and other areas. This suggests that the primary purpose of Japanese foreign investment in these counties is to sell in the local markets.

Another complication concerns outward investment from Korea and Taiwan, particularly to Southeast Asia. Taiwanese firms have been particularly aggressive; for example, in 1986, they made three investments in Thailand with a total value of $5.8 million and no investments in Malaysia. In 1989, Taiwanese firms initiated 214 investments valued at $871 million in Thailand and 187 investments valued at $785 million in Malaysia.[14]

Again, data are not available on the trade behavior of Korean and Taiwanese firms and their affiliates in Southeast Asia, but it is likely that some of it is export-oriented. Overseas investment is often made in order to circumvent quantitative restrictions on exports, and to compensate for rising labor costs that reduces the profitability of traditional exports.

Table 7-9-Shares of U.S. Majority-Owned Foreign Affiliates in Total Exports of Manufactures, Selected Countries, 1977 and 1983 (percentages)

Host country	1977	1983
Korea	1.4	1.3
Taiwan	6.2	3.9
Hong Kong	8.1	5.6
Singapore	18.7	17.4

SOURCE: M. Blomstrom, 1. Kravis, and R. Lipsey, "Multinational Firms' and Manufactured Reports from Developing Countries," NBER Working Paper Series No. 2493, National Bureau of Economic Research, 19SS.

THE ROLE OF GOVERNMENT POLICY: KOREA

Korea's industrial strategy has moved through several stages. From the end of the Korean War to the early 1960s, the government emphasized reconstruction. Any industrial strategy was based on import substitution in light manufacturing industries. This effort involved extensive and frequently corrupt government intervention through import controls, multiple exchange rates, sale of state-owned enterprises, and influence over the allocation of crucial U.S. aid. Nonetheless, this was a time of rapid growth for Korean manufacturing.

Following a military coup in 1961, the government began a series of dramatic economic reforms that emphasized export expansion. It collapsed the multiple exchange rates into a single rate, devalued the *won,* and liberalized imports for exporters. The government provided additional subsidies through the financial and tax systems, while guiding investment in priority import-substituting industries, in some cases through state-owned enterprises (as in the steel industry).

Beginningin the late 1960s and accelerating after 1973, the government emphasized the development of heavy industry, including steel and nonferrous metals, chemicals and petrochemicals, machinery, automobiles, and shipbuilding. Exports were stressed as the ultimate criterion of success in these new industries, but greater weight was placed on import substitution. During this phase, the government expanded its role in the allocation of resources and in using financial, tax, and trade instruments. The government sought to guarantee that no company dominated any product market; key industries such as automobiles, shipbuilding, computers, and semiconductors typically had four or five main producers who competed intensely. The effect of this new heavy industry push was to encourage concentration of the industrial structure. Very large business groups, called *chaebol,* had priority access to credit and market opportunities, and gradually came to dominate the market.

In the early 1980s, the direction of policy changed again, due to inflation, the increased sophistication of the economy, crises generated by declining industries, and direct pressure from the United States to liberalize the economy. Critical to the change was the perception among influential technocrats that the government's extensive intervention in support of heavy industrialization had been mistaken, resulting in misallocation of resources and structural problems.

The new framework emphasized economywide measures, with the aim of reducing the government's role and making markets function more effectively. Between 1980 and 1983, banks were denationalized and targeted loans were cut back. Tariffs and quantitative restrictions, once formidable impediments to imports, have diminished since 1984. Anew Industrial Development Law, approved by the National Assembly at the end of 1985, focuses on improving industrial technology and productivity and building up Korea's innovation capacity. However, as a World Bank report notes:

> The legislation provides policymakers with a great deal of latitude with respect to policy implementation. . . . Thus, the degree of real intervention will be determined in pragmatic fashion as circumstances warrant.[15]

As this review suggests, the importance of different industrial policies has varied over time, with a period of extensive government intervention in the 1950s, followed by liberalization and more selective intervention in the 1960s. Government direction increased again during the heavy industry drive in the late 1970s. The more recent period has been one of more substantial liberalization. A stronger sense of these trends can be gotten by reviewing three major areas of policy: exchange rate, trade, and foreign investment policies; the role of the government in the provision of finance; and policies toward technology and R&D.

Exchange Rate and Trade Policies

When comparing the export perforrnance of Korea with that of other developing countries, there is widespread agreement that exchange rate policy

played a key role. A substantial devaluation was a key component in the transition to export-led growth in 1964-1965. Exchange rate policy thereafter was realistic, until an increase in domestic inflation led to overvaluation during the late 1970s. Following devaluation in 1980, the government returned to a stable, competitive exchange rate policy that pegged the *won* to a weighted average of currencies. When the dollar was rising strongly, the *won* depreciated relative to the dollar, as such a formula might suggest. After 1985, however, Korea experienced a period of significant real depreciation of the currency, even while the dollar was falling.[16] This change was largely responsible for the emergence of large bilateral surpluses between Korea and the United States in the late 1980s. Beginning in 1987, under pressure from the United States and the International Monetary Fund (IMF), Korea began to boost the value of its currency, a factor in the reversal of Korea's trade surpluses beginning in the second half of 1989 (by 1990, Korea had current account and merchandise trade deficits).

Korea's industrialization strategy has used both export incentives and import restrictions as policy instruments. The trade regime has been outward-looking on the export side and restrictive on the import side. Import restrictions have been aimed at directing the use of scarce foreign exchange and allowing infant industries to become internationally competitive. Although Korea ran a balance of trade deficit every year during the post war era up to 1986,[17] government controlled imports, giving approvals when a national interest test was met.[18]

Korea's lack of raw materials and the limited supply capacity of its domestic capital goods industries have constrained its industrial growth. Government policies emphasized export promotion in order to provide the money for the imports of raw materials and capital goods needed for faster growth. Further, the government's import restrictions favored domestic industries that could convert imports into exports, so as to permit still more imports of industrial inputs. Consumer goods were targeted for import controls and high tariffs. This allowed producers to charge higher prices on the domestic market and thereby absorb thinner export profit margins. This constituted an implicit consumption tax to promote exports, and accounts for periodic charges of dumping against Korean firms. In short, up to the balance of payments surpluses in 1986, Korea exported in order to import, and vice versa. Exports were a way to use unskilled labor in sophisticated industries.[19]

How protected has the Korean economy been? The economy received substantial protection over the 1960s, 1970s, and early 1980s, with protection falling markedly since then. Estimates of protection are subject to many errors, and the fact that different studies use different operational measures makes for difficulties in comparing results. The few studies available for Korea yield a sizable range of answers even for the same year. Moreover, the Korean trade system is complex; trade has been restricted in part through administrative and regulatory provisions that are neither transparent nor easily measured.

Studies suggest that patterns of protection followed the broad contours of industrial policy.[20] In 1968, the rate of effective protection for the economy as a whole was in the range of 9 to 21 percent, with the low estimate resulting from procedures that may bias the result downwards.[21] Transport, consumer durables, and machinery industries received rates of over 50 percent. Effective protection increased during the heavy industry drive of the 1970s, to the range of 24 to 34 percent by 1978. For manufacturing alone, one estimate gives an average of 49 percent.[22] Petrochemicals, steel, machinery, and shipbuilding received above average protection. Effective protection increased through 1982. One estimate gives a rate of 38 percent,[23] another study by the Asian Development Bank shows an overall tariff average of 33 percent for "the early 1980s."[24]

Although studies of effective protection rates are unavailable for the period since 1982, the liberalizing trend can be discerned in the ratio of import items that are classed as "automatically approved" (AA), as distinct from "restricted" or "prohibited." In 1981,75 percent of items were classtified as AA, accounting for 65 percent of imports by value. By 1984,85 percent of items, accounting for 72 percent of imports by value, were so classified. By 1986, the ratio had increased to 92 percent of items; the proportion by value probably exceeds 80 percent.

The liberalization of quantitative restrictions in the 1980s accompanied a phased reduction in legal tariffs, to an average of 20 percent for manufactured goods and 29 percent for agricultural goods (on an items basis) by 1986. By 1989, the average (nontrade-weighted) tariff rate came down to 13 percent, and was projected to fall further, to about 8 percent by 1993, comparable to average tariffs in Europe and

the United States.[25] Tariffs remain high on many kinds of agricultural produce.

It is difficult to draw conclusions about import liberalization. For example, until recently classification of an import as AA was a necessary but incomplete condition for unimpeded importation. The government could impose short-term penalty tariffs if items on the AA list were judged to harm important domestic industries. This system was dismantled only in the last 2 years. A recent World Bank report estimated that in 1986 as many as 25 percent of the AA import items were "potentially covered by one special law or another' that allowed ministries to regulate imports.[26] The report goes on to say that: "It is not known, of course, to what extent these administrative procedures lowered imports, e.g., when the relevant industry association or other body denied the importation of a commodity on the AA list.' '[27] On the other hand, the fact that an item is classified as "restricted" does not mean that it will be difficult to import.

Historically, the government has controlled foreign exchange in Korea. Earners of foreign exchange have been required to transfer it to one of several designated agencies, which in turn transfer it to the central bank. Private companies or citizens may retain only a small amount. The government formulates an annual Foreign Exchange Demand and Supply Plan. Little is known about how the plan is compiled or how conflicting demands on foreign exchange are reconciled. It is clear, though, that the Plan has binding force. Data on projected and actual foreign exchange spending show a close correlation year after year. Banks must limit the issue of foreign exchange for any import, even an AA import, when foreign exchange use runs beyond the limits of the Plan.[28] In effect, then, there have been two distinct hurdles in the import process: one to get the import license, the other to get the necessary foreign exchange. Despite a substantial import liberalization, scheduled to allow domestic industries time to adjust, a variety of administrative procedures still grant room for Korean officials to restrict imports.

Although until recently Korea had a relatively protectionist trade regime, several features differentiated it from the protective trade regimes of other developing countries. First, it was coupled with a realistic exchange rate policy so that biases in trade policy were not compounded by overvaluation. Then, protection was subordinate to a wider industrial strategy aimed at assisting protected industries to become internationally competitive.

Protection against selected imports dovetails with offsetting incentives for export sale. A crucial component of the transition to export-led growth in the mid-1960s was that all imports used as inputs into exports would be exempt from quantitative import restrictions. Raw material imports used for exports were also exempt from tariffs.[29] Capital goods used for export production were exempt from tariffs until the early 1970s. These became subject to tariffs as the government sought to deepen (diversify) the industrial structure into these products. Exports have also been exempt from indirect taxes such as harbor charges.

Duty free import of inputs for use in exports was available to 'indirect exporters,' domestically based suppliers that provided intermediate inputs to export producers or finished goods to a trading company that then exported them. Additional incentives came through import-export links, by means of which permission to import (and therefore the ability to reap high profits on the protected domestic market), was given to those with good export performance. The import of some very popular products was linked to export performance in closely related fields. Import rights for TV receivers, for example, were granted only to exporters of radios and electronic equipment. This not only gave a direct incentive to producers of electronic equipment to export, it also allowed them to protect their domestic market share by pricing imported items in a way that did not threaten their own production.[30]

Free-trade export-processing zones were key in attracting export-oriented foreign direct investment (FDI). The first free trade zone opened in 1971, with another eight added by 1985. But the zones have accounted for only around 10 percent of total FDI. They have probably been less important than the 218 "bonded' manufacturing plants (as of 1981), which can import without paying any duty but must export all their production.

Import liberalization for exporters conforms roughly to the market-oriented picture of Korea's growth. Other measures do not. Korea began giving concessional credit to exporters in the 1950s, enhancing the degree of concession and the ease of access to the credit after the transition to an export-oriented strategy in the mid- 1960s. Through the 1970s, automatic access to short-term export financing was

available to exporters at 6 to 12 percentage points below the commercial bank loan rate, constituting a large subsidy .31 Such loans ended in 1980. Medium- and long-term loans for investment in export production were also automatically available at concessional rates until 1980. Postshipment financing, export credit insurance, and export finance guarantees still exist.

The early incentives to export did not involve industrial targeting; companies profited from the incentives regardless of the product they exported. Export incentives became more targeted in the late 1970s with the heavy and chemical industry drive. Until 1973, tax incentives included a 50-percent reduction on business income tax on profits derived from exports. Subsequently, special depreciation allowances for capital equipment used in export production have been used instead. Various studies report that these direct export incentives have been reduced since the early 1970s, especially during the 1980s. In the early 1970s, the effective subsidy rate for exports averaged about 20 percent of the value of exports. It fell to about half that level by the end of the 1970s, and has declined further since.[32]

Overseas information and marketing services have helped expand Korean exports. Since 1962, the Korea Trade Promotion Corp. (KOTRA) has served as a nonprofit trade promotion arm of the Korean Government.[33] It was formed after careful study of JETRO, its Japanese counterpart, which provides much technical assistance in the early years. KOTRA maintains 77 offices around the world that provide information about Korean exporters and importers, the items they buy and sell, and the services they need and provide in foreign investment and construction work. It also arranges trade fairs and is a point of first call for foreign buyers. About 70 percent of its budget comes from government grants. Another organization with overlapping functions is the Korea Traders Association (KTA), a nonprofit private organization that includes all licensed exporters and importers as its members. There are also 30 or more industry-based exporters' associations.

To complement the work of KOTRA, the government launched a scheme to build up Korean general trading companies along the lines of their Japanese counterparts. Beginning in the early 1970s, those trading companies that met the stringent performance and size criteria for "general trading companies" received special privileges in terms of access to credit, retention of foreign exchange, and other assistance. They held the same leadership role on the trade side as the big conglomerates *(chaebol)* held in the heavy industry drive of the 1970s. By 1982, the 10 licensed general trading companies accounted for almost half of Korea's exports.[34]

From the mid-1960s onwards, the government elevated the export drive to the nation's number two priority, second only to national defense.

> Led by the president, and supported by the top economic ministers and the heads of the biggest firms, much of the country was wrapped in the fervor and enthusiasm surrounding the drive to develop through trade.[35]

The priority of exports was determined through a system of export targets and high-level export meetings. These helped to unify the array of export incentives and catalyze the reciprocal relationship between government and business. From 1965 on, upwards of 100 senior political leaders, bureaucrats, and business people met each month to discuss the export drive. The meetings were chaired by the President himself as a symbol of the government's commitment to exporting.

In addition, prizes were awarded once a year on Export Day. The prizes conveyed not just prestige, but also economic rewards, such as easier bank credit for nonexport projects.[36] In 1980, Export Day was renamed Trade Day, and prizes awarded for good performance in both exporting and importing.[37]

Development Financing and Foreign Direct Investment

Financial policy was an important component of export-promotion efforts. The Korean Government has used its control over the financial system for broader industrial policy purposes, however, discouraging business speculation and encouraging investment in "strategic" industries.[38]

Until the early 1980s, the government owned the commercial banks. The Ministry of Finance controlled the total supply of funds and interest rates through its agent, the central bank. The commercial banks allocated private funds under the guidance of the Ministry of Finance. The Minister of Finance, and sometimes even the President himself, appointed the chairman of each bank. Interest rates

were low for priority uses, including investment in government-designated industries and export finance. Subsidized loans, called "policy loans," constituted about half of total bank loans over the 1970s and carried nominal interest rates of around 10 to 15 percent; given inflation, real interest rates were close to or less than zero. Ordinary bank loans, on the other hand, carried nominal rates of 18 to 22 percent. These rates for ordinary loans were much less than rates on the unregulated and semi-legal curb market, which typically ranged from 30 to 40 percent a year or even higher. Estimates of the size of the curb market vary widely, from 10 to 40 percent of the financial sector.[39] Since denationalization, the volume of confessional lending has been greatly reduced, but remains important for a narrower set of strategic industries, including segments of electronics and computers.

Firms depended heavily on bank loans for their investments. Corporate debt/equity ratios over the 1970s were on the order of 310 to 380 percent, as compared to 50 to 90 percent in the United States and the United Kingdom.[40] This gave the government substantial leverage over individual companies. Not only could the government tempt them to enter priority fields by offering low cost or easily available credit; it could also cut off credit. This threat was serious, given the cost of alternative curb market credit and firms' inability to borrow internationally without government approval.

The government's direct influence over bank portfolios declined with the denationalization of the banks in the 1980s. The government maintains a role in financing its industrial policy objectives, however, through the Korea Development Bank and other schemes. The Korean Technology Advancement Corp. has served as a source of investment capital for the development of new products and processes generated by the Korean Advanced Institute of Science and Technology and other government research labs. The government also provides venture capital through the Korean Technology Development Corp., which makes funds available to the private sector for investment in specific R&D, technology acquisition, and other precommercial investment projects.

With domestic savings covering only 70 to 90 percent of domestic investment, Korea has depended on sizable inflows of foreign capital. This has taken the form of foreign borrowing, while foreign direct investment (FDI) has been kept low. As a proportion of total foreign loans and investment, total FDI flows amounted to only 3.2 percent in 1980. FDI flows have also been low as a proportion of gross fixed investment, lower than in Taiwan and much lower than in Indonesia, Malaysia, Singapore, the Philippines, and Thailand.[41] This reliance on foreign capital provided the government with an important tool Of industrial policy.

In 1983, however, the government revised the Foreign Capital Inducement Law to attract more FDI.[42] It anticipated that more FDI would bring more foreign technology. The new law is designed to reduce the number of restrictions on foreign investment, to accelerate the approval process, and to strengthen patent and copyright laws. Following these changes, the share of FDI in total capital inflows rose to 13.8 percent by 1988.[43] Meanwhile, the need for foreign borrowing declined as Korea moved from being a capital importing country to a capital exporter.

Technology Policies

Korea's technology policies fall into two stages of development. The frost stage covers the period from the mid-1960s to about 1980; the second stage covers the 1980s. The primary thrust of the frost stage was to obtain foreign technology and to master its use, while the secondary thrust was to develop Korea's own R&D capacity. In the second stage, the priorities were reversed.

The Korean Government paid careful attention to the way foreign technology was obtained. It discouraged FDI while encouraging licensing both as a more effective means of transfer and as involving less dilution of national control of production. The government screened licenses. It established advisory committees with representatives from industry, universities, and state laboratories, and it bargained with technology suppliers as a sole buyer, obtaining better deals than the firms could have negotiating on their own.

Almost 80 percent of licensing agreements are with Japanese or American firms. From 1962 to 1985, Japan was the source of 55 percent of the agreements, the United States, 23 percent. But the United States received a much larger share of total royalty payments, 42 percent against Japan's 30 percent, reflecting Korea's purchase of more sophis-

ticated and larger scale technology from the United States.[44]

Licensing agreements and FDI became more important in the 1980s as the government liberalized both. Efforts were made to tighten intellectual property protection, largely in response to persistent external pressure. The laws on patents and copyrights were comprehensively revised in 1987, and Korea has signed most international intellectual property rights treaties in recent years. This effort to liberalize transfers and tighten protection probably contributed to the increase in licensing agreements from 1982 to 1985. Most U.S. Government and business concerns with the laws themselves have been resolved, and the emphasis is now on enforcement, which many U.S. companies, especially in pharmaceuticals, claim is lax.[45]

During the first phase of technology policy, the development of Korea's own R&D capacity was a secondary goal. Nonetheless, early on the government began a long-term effort to increase Korea's R&D capacity. In 1966, the government created a major public industrial R&D laboratory, the Korea Institute for Science and Technology (KIST), followed by the Ministry of Science and Technology (MOST) in 1967.

As Korea moved closer to the technological frontier, it reversed earlier priorities by emphasizing the generation of new technological capabilities. In this second stage of technology policy, begun in the 1980s, the government intensified efforts to build a "national innovation system." A much higher proportion of R&D was carried out in private firms or consortia; government research organizations focused on generic technologies and/or on providing a bridge between university research labs and businesses. Previous restrictions governing technology transfer from abroad, such as limits on royalties, were liberalized.

Korea's centralized system for planning and implementing R&D policies is similar to those of Japan, Taiwan, France, and Germany, as opposed to the United States and the United Kingdom. The centralized system permits a clear-cut and long-term strategy for the development and commercialization of specific technologies and products. The system is dominated by MOST, which orchestrates a series of planning exercises with participation from other ministries and representatives of industries and research institutions. Science and technology plans are drawn up annually, with 5-year plans as well. In 1969 and 1986, 15-year plans attempted to determine key technologies over the long term and identify the potential for strengthening Korea's capability in them. The 1986 plan, published under the title "The Long Term Technology Forecast for the Year 2000," resulted from 2 years of discussion among some 500 experts in 8 subgroups.[46]

An important component of the institutional arrangements governing technology are nine government research institutes covering, among other fields, basic science, electronics, energy, and machinery (table 7-10). Over the 1980s, as private companies began to establish their own R&D labs, the national labs moved away from applied research and commercialization toward more basic technologies, often in collaboration with private firms.

The year 1980 marked the beginning of National Technology Promotion Conferences, held quarterly and presided over by the President. The conference brings together cabinet ministers, officials, representatives of industry, and members of research institutes, perhaps 250 in all.[47] This discussion forum represents a continuation of the approach applied earlier to exports through the Export Promotion Meetings, which were replaced by the National Technology Promotion Conference, indicating a shift in policy emphasis.[48]

Based on information and opinion expressed through these networks and fora, the "Year 2000" study set 25 activities as priority areas, within which projects should be chosen by government and business. Some of the 25 were leading sectors, while others were selected because they support the growth of leading sectors. The frost set includes computers, software, semiconductors, telecommunications, bioengineering, and fine chemistry; the second set includes design engineering, spare parts and materials, machine automation, and standards and measurements.

To implement such plans, the government has used a variety of policies, including manpower development, financial and tax incentives, and technology transfer. The government has sponsored a huge expansion of science and engineering places in schools and colleges. Enrollments in third-level engineering and science courses increased from 303,202 in 1980 to 494,925 in 1986, or 1.6 times.[49] Several hundred students in public research institutes, mainly in the Korean Advanced Institute of

Table 7-10-Korea: Major Government Research Institutes in 1985[a]

Name	Research fields	Expenditure ($millions)	Staff
Korea Advanced Institute of Science & Technology (KAIST)	Multidisciplinary	$102	1,628
Electronics and Telecommunications Research Institute (ETRI)	Semiconductors computers, telecommunications	$40	1,210
Korea Advanced Energy Research Institute (KAERI)	Atomic energy	$31	934
Korea Institute of Machinery and Metals (KIMM)	Machinery, metals, shipbuilding	$21	745

[a]Military labs are excluded.

NOTE: In 1968, KAIST had 1,429 people, of whom 293 had Ph.D.s and 636 had MA.s; KETRI had 1,258 people, of whom 47 had Ph.D.s and 840 had M.A.s.

SOURCE: Ministry of Science and Technology, *Introduction to Science and Technology, Republic of Korea* (Seoul: Ministry of Science and Technology, 1966); Yong-chan Park, 'The National System of Innovation in Korea, With an Introduction to the Semiconductor Industry" (University of Sussex, MSC thesis, 1987).

Science and Technology, have scholarships provided by private companies. These students normally move to the R&D laboratories of their sponsoring firms on graduation, providing the basis for continuing dialogue between researchers of private firms and the public institutions.

The government also sponsors an overseas study program, mostly for post-doctoral students. Between 1981 and 1985, 2,222 scientists and engineers were dispatched to the United States, Japan, and Europe for further study or work experience; the rate of dispatches scheduled to increase.[50] Another program creates a network among Korean scientists and engineers working abroad. Until recently the phenomenon of foreign-educated Koreans remaining abroad was seen as a "brain drain," with negative consequences for Korea's development. Now it is seen as constituting a "brain bank" of high-level human capital. Korean companies and government research organizations can target individuals with needed skills, either inducing them to return to Korea or leaving them *in situ* to do work of interest to those companies or organizations.

Further, the government has undertaken more targeted financial policy actions, providing direct support for R&D in the fields of electronics, mechanical engineering, chemistry, energy, and bioengineering. In 1986, 660 projects received direct support amounting to $56 million, with another $21 million in cofinancing from private fins. Several earmarked funds make loans for electronics, machinery, and textiles to support R&D investments totalling $100 million between 1981 and 1985.

More important is the "policy" loan window, or subsidized credit facility, of the commercial banks, described earlier. The Korea Industrial Bank and the Korean Bank for Small and Medium Enterprises channel money specifically for start-ups and for investment in R&D facilities, $130 million in 1985. Another mechanism is venture capital. By 1986, the government had sponsored four venture capital fins, with public or mixed public/private ownership.[51]

Through the 1970s and more intensively since the tax reform of 1981, the government has used tax credits and deductions to stimulate R&D. Some of the more important include:[52]

1. Tax deductions for technology development and manpower development; 10 percent of cost can be deducted from income tax.
2. Funds earmarked for R&D can be set aside in a reserve and deducted from taxable income, up to 1 percent of turnover or 20 percent of income. In high-technology industries, these ceilings are 1.5 percent of turnover or 30 percent of income.
3. Tax deduction or accelerated depreciation on investment cost of commercialization, either 6 percent of investment cost or 50 percent depreciation in frost year; or for locally made equipment, 10 percent of investment cost.

R&D expenditures increased rapidly, at an average annual rate of over 40 percent between 1980 and 1985 (in current *won), rising* from *0.58* percent of gross national product (GNP) in 1980 to 1.59 percent in 1985. A quarter of the total went to electronics in 1985. Two-thirds was spent by private industry,

one-quarter by government research institutes, and the remainder by universities.[53] The number of researchers also increased from 4.8 full-time equivalents per 10,000 population in 1980 to 9.1 in 1984. Again, a quarter of the total worked in electronics.

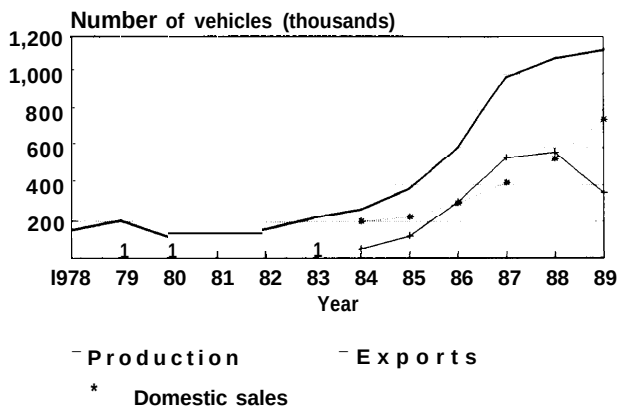
The build-up of private R&D has taken the form of business-level R&D labs and research associations among companies. The number of private R&D institutes rose from 37 in 1980 to 183 in 1985, nearly a fivefold increase. Of the private institutes, 27 percent were in electronics and 21 percent in machinery. The 183 institutes employed a total of 9,226 staff, of which 3,864 were in electronics. Their combined R&D expenditure came to $658 million in 1985. Four private "super institutes" spent more than $40 million each.[54] Following the Japanese model, the government also sponsored research associations among private firms. In 1985, 23 such associations were in operation, involving 286 firms. Seventy percent of the associations were in electronics alone. Most of the associations comprised a few large firms and many small and medium-sized firms.[55]

The government has also looked at the restructuring of industries in which Korea has acquired a leading international position but which now face decline. In textiles and clothing, a leading export industry, the government is helping to improve production technologies and assisting firms to move upmarket by emphasizing product design and quality. The Textile Modernization Fund, established in 1981 to provide loans for modernizing textile factories, had, by mid-1985, capital of approximately $30 million. The government has also supported R&D in textiles through the Korea Advanced Institute for Science and Technology (KANT), contributions to the Korea Federation of Textile Industries (KOFOTI), and tax exemptions for companies.[56]

Case Study: Automobiles

A greater sense of the interplay between government policy and industrial development is apparent through the detailed study of two industries: automobiles and semiconductors. The automobile industry is a highly concentrated, oligopolistic industry dominated by a handful of globally integrated firms. The industry is both capital- and technology-intensive, with important scale economies.

Figure 7-6-Korean Automobile Production



SOURCE: *Automotive News Market Data Book* (Detroit, MI: Automotive News, 1990).

The Korean automobile industry consists of 6 vehicle manufacturers and about 600 parts and components manufacturers. In 1988, it produced 1.1 million units, of which 577,000 (52 percent) were exported.[57] The automobile industry illustrates the successful use of joint ventures and licensing agreements with foreign corporations to produce for international markets, while building on such arrangements to produce an increasingly indigenous product. This process was assisted by government policy, which designated the industry as a "strategic export industry" and provided assistance, including export incentives, access to credit facilities, and protection of the domestic market.

However, the Korean auto industry still faces difficulties. Labor demands have increased costs, and provisional figures indicate that only 31 percent of the 1.13 million autos produced in 1989 were exported[58] (See figure 7-6). Some of this 40-percent decline from the previous year was due to sluggish American demand, and was offset by surging domestic demand and government prohibition of Japanese imports.[59] There are also structural problems, such as continuing dependence on foreign technology, the likely focus of future policy initiatives toward the industry.

In 1962, a public enterprise established the first Korean auto assembly plant in cooperation with Nissan. When the plant went into production, the government instituted tight import controls on finished vehicles, duty-free import of components, and tax exemptions for the producer. In 1965, the government transferred the assembler to a private

firm and approved a new technology agreement with Toyota. The government set a target of 50 percent domestic content in 5 years, rigorously enforced through control of access to foreign exchange. With heavy protection plus domestic content requirements in place, and with domestic components production growing fast, three more private firms were allowed to enter between 1965 and 1969 to fight for a market of less than 20,000 units a year.

The Heavy and Chemical Industry Plan of 1973 identified autos as a priority industry. In 1974, an industry-specific plan for automobiles was published covering the next 10 years. The objectives were to achieve a 90 percent domestic content for small passenger cars by the end of the 1970s and to turn the industry into a major exporter by the early 1980s.[60] The government stipulated the three primary producers, all *chaebol, the minimum size* of each producer, and the maximum size of car engines. It also required approval of all plans and precluded companies from changing their model within a set time.

Later requirements had the three producers set export targets for different markets, frost in Southeast Asia, then Latin America and the Middle East, peripheral Europe, Canada, and finally the United States. Companies were encouraged to set the export prices low, receiving various forms of compensation. The Hyundai Pony cost $3,700 to produce in 1979, sold domestically for $5,000, and sold abroad (free on board) at $2,200.[61] Firms received heavy export subsidies, particularly through access to credit, and were allowed to import a limited number of top-of-the-range models in kit form for lucrative domestic elite sale. The number of these imports was tied to export performance. Under these circumstances, the Korean producers invested heavily in anticipation of the export drive.[62]

In 1974, the government launched a complementary promotion plan for the parts and components industry. The plan required the three primary producers to meet a domestic content schedule and cooperate in the production of standardized parts and components. It further empowered the Ministry of Trade and Industry to select certain items and their assigned producers for special promotion, with a complete import ban once the item met the government's price and quality standards.

In 1980, following the second oil crisis and the rapid deterioration of domestic and world economic conditions, Chun Doo Hwan's government undertook a comprehensive rationalization of heavy and chemical industry sectors, including autos. The new regime decided that there was to be only one main auto producer, forcing one of the three "majors' to leave the business, a decision not reversed until 1984, It informed the other two that their rivalry in cars and power equipment was counterproductive, and asked them to concentrate on one line of business each. The Hyundai group got cars. The government reduced the automobile excise tax to stimulate domestic demand, halved the export targets, and greatly increased the volume of concessional credit. The investment drive resumed in 1982 as the economy recovered, with Hyundai Motor's debt to equity ratio soaring to 5:1. By 1986, the Hyundai Excel had become the best-selling new car import in U.S. history, following its earlier success in Canada. In 1988, Hyundai produced 650,000 cars, of which 63 percent were exported.

In 1987, Kia and Daewoo were allowed to reenter the passenger car business.[63] They will soon be joined by Ssang Yong Motors, a subsidiary of the Ssangyong *chaebol.*[64] Unlike Hyundai, which sells under its own name, Kia and Daewoo both sell their autos through foreign companies: Kia makes the Festiva for Ford Motors, and Daewoo the Lemans model for Pontiac. Similarly, Ssang Yong plans to transfer its present expertise in truck and jeep assembly to auto exports through a tie-up with Volvo.[65]

The automobile industry illustrates the range and multiplicity of arrangements between Korean and foreign producers. Hyundai is 10-percent owned by Mitsubishi and remains dependent on the Japanese company for its engines and designs. Its first export success, the Pony, was planned in Italy by a former designer for British Leyland. The Excel is a near-clone of the Mitsubishi Mirage, with Mitsubishi-made engine and transmission. Daewoo is in a 50-50 joint venture with General Motors to make a "world-class' subcompact car. Kia Motors, after a period of assembling Fiats and Peugeots in the late 1970s, has turned to Mazda of Japan for technical guidance and through Mazda (which is 24-percent Ford-owned) to Ford Motors for overseas sales networks and brand recognition. Mazda has a minority equity stake in Kia, and has supplied Kia with designs for two mid-sized cars. However, Mazda has grown reluctant to transfer key compo-

nent designs or grant the right to sell in Europe to its own future competitor.[66]

Korean automakers are reaching the limits of these partnerships. Foreign automakers are more reluctant to part with proprietary technology simply for a fee, and, for their part, hope to gain entry to the Korean market through their local partners. Consequently, the Koreans are turning to in-house R&D with the goal of bringing a wholly Korean-made car to market within the next few years. The Ministry of Trade and Industry estimates auto industry investment for 1990 alone to exceed $1.7 billion. Hyundai has announced plans to invest over $2.5 billion through 1992.[67] Because government plans call for doubling plant capacity by 1995,[&] however, the percentage of new investment funds going toward R&D is not clear. Kia is planning to market a sub-compact model for 1992 with an engine designed in-house. Hyundai has similar plans, but has conceded that its engine designs cannot match the performance of the Mitsubishi engines. Government policy towards auto production should therefore reduce the development costs of new, indigenous products through publicly funded or collaborative research programs and continued concessional credit.

Socializing the cost of investment will not spare Korea's automakers from labor demands. Following the announcement of a liberalization of politics in 1987, Korea's auto exporters have experienced production slow-downs and higher wage settlements. Relatively smooth labor relations at Kia show in productivity statistics: its employees produced 17.4 automobiles per person in 1989, a steady growth from 13.1 per person in 1983. But while Hyundai's productivity reached a peak of 21.8 units per person in 1987, the number fell to 19.8 in 1988 and 16.7 in 1989. Daewoo marked the lowest productivity with 10.0 units per person in 1989.[69] Ssang Yong has avoided most of these difficulties by offering competitive wage settlements (a 20-percent increase in 1988) and by being located away from the others' labor disputes.[70] Those disputes resulted in industry average wage increases of 21.8 percent in 1988 and 23.3 percent in 1989. Increases in 1990 are more moderate: 10 percent for Hyundai, 7 percent for Daewoo, and 7.3 percent for Kia.[71] Government plans to foster improved labor-management relations may include avoiding discussion above the company level, while resisting any attempts at cross-company organization.

Despite the booming domestic demand for autos, the Korean auto market is still highly protected. In response to intense U.S. pressure for general trade liberalization, the government announced an auto liberalization schedule in 1985, which permitted small car imports to begin in 1988 for the first time in over 25 years, but with a duty of 200 percent, to be lowered to 100 percent after 2 years. Japanese compact models remain the most heavily restricted. Imports of cars above 2,000 cc were liberalized in mid-1987, but by year end only 44 had been imported. In 1988, 396 foreign cars were imported, and 501 were sold in the first half of 1989.[72] These figures differ sharply from those of Taiwan, where automobile imports account for nearly 40 percent of domestic sales in a market less than half the size of Korea's. Korean dealers claim that bureaucratic delays and tariffs are not the primary deterrent to increased imports. Instead, they blame the National Tax Administration, whose investigations of foreign car buyers' finances have heightened social pressure not to flaunt wealth.[73] In any case, the government's ability to restrict imports despite the trend toward liberalization is obvious.

The government's ability to limit entry of new producers at home, and thereby protect economies of scale, is a key reason for the success of the Korean automobile industry in world export markets. This was a crucial component of the 1974 auto plan, and even when some opening of the market occurred in the 1980s, there was an effort to limit the number of entrants. Because companies in Korea must seek government approval for technology imports from foreign companies, they can be easily barred from technology-intensive sectors like automobile manufacture.[74] Samsung has tried to line up with Chrysler, but the government refused to allow Samsung to start an export-oriented car plant. More recently, the Ministry of Trade and Industry rejected a plan by Samsung to join with Nissan Diesel to produce large trucks, a possible prelude to Samsung's expansion into auto exports.[75] The Taiwanese Government was much less successful in restricting entry, and partly as a result the industry remains undeveloped there.

Case Study: Semiconductors

While Korea's electronics production is geared largely to exports, the domestic market also has expanded as per capita incomes have risen. In 1988, approximately 60 percent of electronics production was exported, 40 percent sold domestically.[76]

Growth accompanied a shift toward production and export of more sophisticated industrial electronics, with a declining share of output in consumer electronics.

Semiconductors are an important input to consumer and industrial electronics products; an indigenous technological capability is crucial in the ability to compete in linked industries such as computers and telecommunications. Semiconductor production or "fabrication" is capital-intensive, and some market segments also have large economies of scale. This is especially true in memory chips. Ability to innovate in the fabrication of chips at the rapidly moving technological frontier demands a high level of technological competence and large R&D expenditures. Production of more specialized custom or semi-customized chips demands ongoing design capabilities. Until recently, only firms in the United States, Japan, and Europe have had these capabilities.

Government policy toward the semiconductor industry in Korea moved through three main stages.[77] In the late 1960s, government policy encouraged foreign direct investment in semiconductors and standardized consumer electronics, despite an otherwise restrictive posture toward foreign direct investment. In the 1970s, the government attempted to lead the development of an indigenous semiconductor industry. This effort, not altogether successful, resulted in the establishment of an infrastructural base that would help Korea acquire its own R&D capabilities. But business interest was slight; the industry did not move much beyond the assembly stage.

In the 1980s, a number of the largest Korean firms became interested in acquiring semiconductor capabilities, particularly in the production of dynamic random access memories (DRAMs), the staple commodity of the semiconductor industry. At this point, government policy shifted to support the initiatives of these large national champions.

In the mid-1960s, the government encouraged foreign direct investment in semiconductors, mostly from U.S. companies such as Fairchild and Motorola. The aim was to increase Korea's exports rather than gain technology for Korean fins; there were no explicit government plans to develop the semiconductor industry. Some technology diffusion occurred, and two Korean firms subcontracted assembly of semiconductors. But the potential for technology transfer was limited because foreign firms located only labor-intensive assembly in Korea; moreover, there was little domestic demand for semiconductors.

In 1969, the government promulgated an Electronic Industry Promotion Law, designating the industry as a strategic export industry eligible for supports and incentives.[78] An 'Eight Year Electronics Industry Development Plan" identified three main policy actions to achieve the goal of an indigenous semiconductor capability. The first was to create mission-oriented research institutes, both public and private. The second was to expand advanced training capacity in electronics. The third was to encourage technology imports via licensing and consultants, to guarantee greater technology transfer than had occurred through foreign direct investment.

With the launch of the Heavy and Chemical Industry drive (which included the electronics sector), the new public Korea Institute of Electronics Technology (KIET) became the vanguard of these efforts.[79] Established in 1976, its charter gave it responsibility for planning and coordinating semiconductor R&D; importing, assimilating, and disseminating foreign technologies; providing technical assistance to Korean fins; and undertaking market research. KIET consulted closely with private fins. Three working groups--covering equipment, the work program, and the training program—each included representatives from industry, the government, and KIET.

Each of KIET's three divisions-semiconductor design, processes, and systems—were headed by a Korean with academic training and industry experience in the United States. In addition, a project development division kept abreast of marketing opportunities and foreign technologies. Monitoring foreign technologies was also central to the work of KIET's liaison office in California's Silicon Wiley. Established in 1978, the liaison office helped KIET obtain equipment and technology licenses, build contacts with U.S. semiconductor firms, and create a network among Korean researchers working in U.S. semiconductor companies. Through the network, KIET was able to help Korean firms identify particular individuals with skills or access, and either enlist their help while remaining *in situ* or repatriate them to work in Korea. KIET mounted training programs for Korean companies and admin-

istered a program to send Korean engineers and scientists abroad for experience in research institutes or companies. KIET took part in all technology transfer negotiations between Korean and foreign firms; in these negotiations, its Silicon Valley outpost and its project development division were especially important.

KIET opened Korea's first pilot wafer fabrication facility in a 1978 joint venture with a leading U.S. semiconductor firm, VLSI Technology. A year later it began building Korea's first full-scale commercial wafer fabrication facility to produce 16K DRAMs.

But most of the semiconductor industry in Korea was still concentrated at the assembly, packaging and testing stages, with little development of the more demanding segments of the industry. The few local firms that established fabrication facilities were dedicated to semiconductors at the commodity end of the market, mainly for use in consumer electronics. These companies were too small to undertake the huge investments needed to make standardized large-capacity chips, and lacked the design capability to produce customized chips.

Meanwhile, however, Korea's largest consumer electronics firms became interested in advanced semiconductor production because of their big in-house demand for semiconductors and a sense of vulnerability to manipulation by foreign semiconductor suppliers, particularly the Japanese. Between 1980 and 1990, five companies achieved the capability to fabricate state-of-the-art semiconductor devices, and three--samsung Electronics, Hyundai Electronic Industries, and Goldstar Electron-were involved in DRAM production. All three had links to large groups with substantial financial power, and were the national champions in the more sophisticated segments of the semiconductor industry in the 1980s.

The question was how to overcome the massive entry barriers to the more technology intensive segments of the market. The 1981 Basic Plan for Promotion of the Electronics Industry covered the period 1982-1986; in 1983, the Ministry of Commerce and Industry issued a report calling for accelerated development of semiconductors.[80] Despite the general move away from targeted policies, this plan included a wide range of fiscal and financial investment incentives for the main semiconductor firms.[81] The plan established an Electronics Support Fund, financed by public and private sector contributions to lend at preferential rates to firms engaged in priority activities. One of these was the establishment of R&D subsidiaries abroad. Infant-industry protection was also used. In 1984, the import of 185 electrical and electronics products was restricted, accounting for 37 percent of all electronic product categories. While direct financial subsidies and import protection were phased out over the decades, these measures still lowered the cost of entry into an extremely risky field.

The government also sought to restructure the industry using government procurement. A goal of the plan was to integrate upstream and downstream segments, maximizing economies of scale and technological spillovers. This was a conscious imitation of Japan, where semiconductor companies were divisions of larger electronics companies, which were, in turn, parts of conglomerates.

An important step was to use the government's tight control of telecommunications to aid the big Korean firms' entry into advanced semiconductors; indeed, the Korean Telecommunication Authority was one of the sponsors of large-scale integration in the early to mid- 1980s. The restructured telecommunications industry forced out some firms, with others assigned government-selected monopoly segments. Meanwhile, the government announced a multibillion dollar expansion and modernization of the country's telecommunications infrastructure, most of which would be guaranteed to the semiconductor champions. The three industry leaders entered joint ventures with multinational firms (ITT, AT&T, Northern Telecom), offering lucrative and risk-free telecommunications business in return for the transfer of specified telecommunications and semiconductor technology.

Computer policy also affected the development of semiconductors. The government first relied on obligatory public procurement of Korean-made machines. Then, in line with the Computer Industry Promotion Master Plan of 1984, it intensified the role of the national research labs, especially the Electronics and Telecommunications Research Institute (ETRI), in the acquisition of computer technology. It also imposed, until 1988, a complete ban on imports of microcomputers and gave software firms low interest loans for up to 90 percent of their R&D spending. The public sector expanded its use of microcomputers, and in 1986, the government announced domestic content guidelines for all mi-

crocomputers and peripherals, whether they were sold to the government or not.[82] Figure 7-7 summarizes the growth of the Korean computer production and exports.

It appears, though, that the driving force in Korea's push into semiconductors was industry. Firms drew on both government support and their own substantial financial capabilities to jump directly into the high-volume memory market. In 1983, Samsung, the early leader in the field, acquired DRAM production technology from Micron Co. of the United States.[83] The company went from greenfield sites to operating plants for 64K DRAM chips in only 8 months in 1984, half the time it took in the United States and two-thirds of the time in Japan.[84]

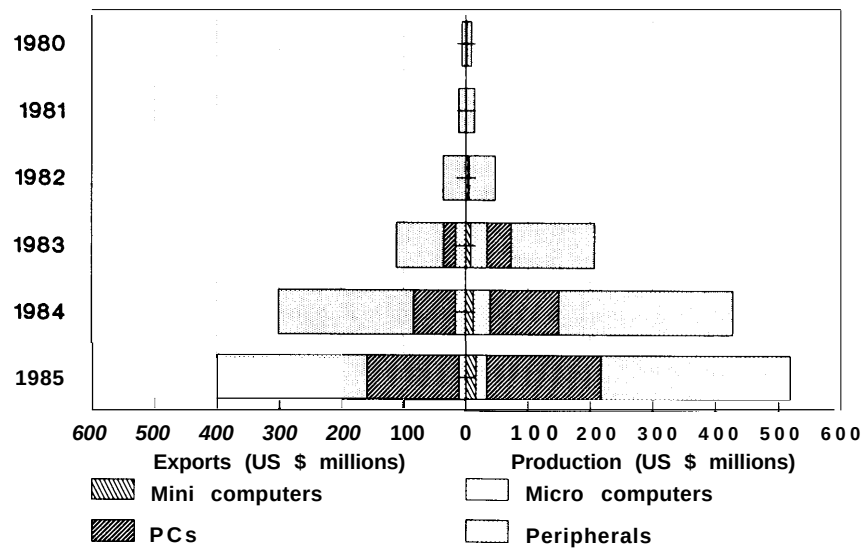
This strategy had substantial risks, however, since commodity memory chips are subject to notorious price fluctuations; just as Samsung entered the 64K DRAM market, prices fell dramatically and the company was forced to absorb large losses. Nonetheless, because of its size and diversified structure, the company persevered, moving quickly from 64K DRAMs to 256K DRAMs to the mass manufacturing of the 1M DRAM by the late 1980s. The company introduced engineering samples of 4 megabit DRAMs in late 1988, only 6 to 9 months behind the Japanese leaders.[85]

The investment needed for this achievement, and the attendant risk, show in the high debt/equity ratio of the firm that manages Samsung Group's semiconductor interests: nearly 7 to 1 in mid-1987. Since much of the debt was in the form of bank loans, and since the government still influenced the banking system after denationalization, this figure suggests government support for Samsung's strategy. The financing terms were generous, and Samsung cross-subsidized from other profitable parts of the group. In 1985, Samsung Semiconductor contributed 2.5 percent to the group's sales and made one-third of the group's investment.[86] Samsung's in-house R&D institute had more than 600 researchers and a budget of over $40 million in 1986. Its Silicon Wiley outpost had a staff of 213 employees.

The strategies of the other two major producers differed from Samsung in their precise product mix. Nonetheless, the three companies' strategies had several factors in common:

- secure technology through licensing or joint-venture arrangements;
- make massive investments in commodity chip production; and
- establish an American presence in Silicon Valley both for the acquisition of technology and to facilitate marketing.

Figure 7-7—Korean Computer Industry Exports and Production by Product



SOURCE: Stephan Haggard, David Lane, Robert Wade; and Robert Neff and Laoemi Nakarmi, "In Korea, All Circuits are Go," *Business Week*, No. 3168, July 9, 1990, pp. 69, 71.

Hyundai got its initial production technology from Vitalec, an American firm. In early 1983, Hyundai announced an ambitious development plan that included a $450 million, 5-year investment program and the establishment of a subsidiary in Silicon Valley capitalized at $5 million. In 1985, the firm began making 256K DRAMs, bypassing production of 64K DRAMs altogether.[87]

Goldstar had a longer-established presence in electronics and technology agreements with Western Electric and Honeywell. Goldstar devoted more attention to diversifying its production among a number of semiconductor devices. Nonetheless, it also tried to jump ahead of Samsung by securing technology for the 256K DRAM from AT&T and in 1989 concluded a highly publicized deal with Hitachi that gave it the technology for the 1M DRAM.[88]

The scale of South Korean investment in semiconductors was huge. The national champions committed more than $1.2 billion to semiconductors for 1983 to 1986, five times more than the combined investment of Taiwan's four major semiconductor projects for 1984 to 1987-1988.

As business took the lead, the role of government policy changed. KIET, having pioneered medium-scale semiconductor technology, found that by 1984 the *chaebol* had superior fabrication facilities and were rapidly expanding their in-house R&D capacity. Rather than attempt to guide the entry into successive stages of DRAM fabrication, KIET left this to the fins. It sold most of its fabrication facilities to one of the *chaebol,* changed its name to the Electronics and Telecommunications Research Institute (ETRI), and initiated parallel basic research efforts in semiconductors, computers, and telecommunications. This is not to say that ETRI, as the national R&D laboratory, has been eclipsed. Its staff numbered 1,200 in 1985, with a budget of over $40 million.[89]

By the time the 64K DRAMs were produced, the product cycle had already passed the phase of high scarcity. World demand for semiconductors slumped; aggressive pricing by the Japanese lowered the price still further. From 1985 to 1987, Korea's VLSI facilities operated at only 30 percent of capacity or less much of the time, with the price well below cost of production. Yet the government did not pour in fresh money. It was reluctant to commit itself to assisting another high-risk, capital-intensive industry in difficulty, having just finished the restructuring of the heavy and chemical industries in the 1970s. The popular impression that Korean firms have made it to the world semiconductor frontier without government help probably is due to this refusal to help the troubled fins, combined with anxiety to conceal government help for fear of retaliation from the United States and Japan on grounds of "unfair competition."

By 1986, the government decided to get more involved again. As Korea's capacity to innovate in the production of standard chips became manifest, it became increasingly difficult for companies to access foreign technologies. The government was concerned about the royalties that Korean firms were paying. Moreover, the government was planning a national computer network costing several hundreds of millions, for which most contracts would be steered to Korean companies. Joint development of advanced chips would be a giant step in that direction, especially because large-capacity memory chips are considered the "technology driver" for several kinds of advanced semiconductors integral to such a system.

In conjunction with ETRI, the government coordinated the leading firms to form a Japanese-style R&D consortium to develop the 4 megabit memory chip. A board of ETRI-sponsored experts allocated money from a joint government-business research fund to support projects proposed by research teams from member firms. Those teams whose engineering samples met govemment-specified standards had to repay much less on government loans than those whose samples failed. This performance-based cooperation resulted in increased R&D competition among member firms. By 1990, 18 collaborative research projects were underway through the consortium arrangement, with total R&D expenses estimated at $250 million.[90]

When world prices of memory chips started to rise in 1988, the conglomerates, which had been prepared to wait until the 1990s, began to earn big profits on semiconductors. By 1990, Korea was the world's third largest fabricator of DRAMs after Japan and the United States.

Several conclusions can be drawn from this analysis of the development of the Korean semiconductor industry. Direct government efforts to lead the industry in the absence of strong private sector interest do not appear to have been effective in the

short run, but they probably did have long-term effects.

The industry took off with the entry of the large *chaebol.* A variety of market forces made such a move imperative, including their own internal demand for chips. Their entry had extensive government backing and followed closely a new government plan that included both direct financial support and fiscal incentives to investment in R&D and training. The growth of the *chaebol was* partly an outgrowth of government policy during the heavy and chemical industry drive of the 1970s, when the electronics sector was targeted for support. The three technological leaders in the 1980s benefited from the incentive policies of the 1970s, and through their entry into consumer and industrial electronics developed their appetite for in-house production of chips.

Korea's industrial strategy and structure in semiconductors has some limitations. While the *chaebol* have made large investments in the production of commodity chips, policy has neglected the development of the small and medium-sized firms that played an important role in technological innovation in the United States and Taiwan. Moreover, by concentrating on standardized chip production, the Korean industry is vulnerable to price fluctuations and low profitability, though it is perhaps better able to withstand them, compared with most semiconductor firms in the United States, due to the integration of the largest Korean producers. We return to some of these issues when discussing Taiwan's strategy toward the industry.

THE ROLE OF GOVERNMENT POLICY: TAIWAN

Taiwan's industrial strategy has moved through stages similar to Korea's.[91] From 1945 until the late 1950s, the emphasis was on import substitution to develop light manufacturing industries. Around 1960, some of the import-substitution controls were dismantled, and export promotion measures intensified, resulting in a rapid expansion of manufactured exports. In the early 1970s, the government intensified efforts to upgrade the industrial sector and develop heavy industries, and in the 1980s, the emphasis shifted to technological improvement.

Despite these similarities, there are important differences between the two countries in both industrial strategy and structure. First, Taiwan's state-owned enterprises spearheaded the move into heavy industries such as steel, cement, aluminum, and petrochemicals. Averaged over the 1970s, public enterprise's share of industrial production was 22.5 percent, and 30 to 35 percent of gross fixed capital formation was undertaken by public enterprises.[92] (By 1988, public enterprise's share of industrial production had fallen to 18.1 percent.) These figures put Taiwan in the top decile of noncommunist countries in terms of the size of their state-owned enterprise sector. This is an interesting paradox, given that Taiwan is generally viewed as having a market-oriented economy. The Kuomintang (KNIT), arriving at the end of World War II, brought with them a strong socialist element that pervaded the Taiwanese Government for many years. The more numerous native Taiwanese are responsible for much of the country's recent business growth. The two factions have not always seen eye-to-eye.

A second difference is that the government has not explicitly promoted the concentration of the industrial structure as a component of its development strategy. Small and medium-sized firms have played a much greater role in Taiwan than in Korea. For example, in 1981 Korea had 10 firms listed in *Fortune's 500* biggest industrial firms outside the United States, while Taiwan had only 2. Hyundai, Korea's largest private business group, had annual sales of $8 billion in 1983 and employed 137,000 people; Formosa Plastics Group, Taiwan's biggest private group, had annual sales of $1.6 billion and 31,200 employees.[93]

The small size of Taiwan's firms should not be exaggerated; over time, industrial concentration has increased. Almost half of manufacturing production in 1971 and 1981 came from firma with more than 500 employees, and firms with less than 20 employees accounted for only 12 percent of manufactured output in 1971 and 9 percent in 1981.[94] Nonetheless, there is a notable difference in industrial structure between the two counties that had important implications for business strategy. Small firms are more likely to seek out quick-entry niches in export markets rather than attempt to produce standardized, high-volume items with high scale economies.

The role of foreign capital was also different in Korea and Taiwan. Taiwan has been more open to foreign direct investment than Korea. Foreign direct investment has played a larger role in both capital

formation and investment, and has been an explicit component of the country's technology strategy .95 Meanwhile, savings in Taiwan have consistently outstripped investment.

A final difference has to do with the range of instruments of industrial policy. Taiwan has had a more market-oriented strategy than Korea, with the government playing a less directive role in the economy. For example, protection has been lower and targeted credit policies have played a smaller role in Taiwan than in Korea. The government has devoted more attention to the provision of infrastructure and to arms-length incentives, such as fiscal incentives, that are less discretionary.

The government recently gave up some of the more direct techniques it employed in the past. The country is going through a period of substantial economic liberalization. Nonetheless, the government has by no means relinquished its role in guiding the evolution of the industrial structure through supportive policies, and in the 1980s accelerated its interest in enhancing the country's indigenous technological capabilities.

Exchange Rate and Trade Policies

Trade has played an even larger role in Taiwan's economy than in Korea's. Imports plus exports have been over half of GNP since 1970, and over 80 percent of GNP since 1976. Moreover, Taiwan has run balance of payments *surpluses in every year since 1970,* with only three exceptions—1974, 1975, and 1980-when imports surged in connection with the two oil shocks. Taiwan now has the second largest foreign exchange reserves in the world after Japan, and by far the biggest per capita.

These surpluses are largely attributable to exchange rate policy. The unification and devaluation of the exchange rate in the late 1950s was a key component of the country's export-oriented growth strategy. Unlike Korea, where macroeconomic policy has undergone several inflationary cycles, fiscal and monetary policy in Taiwan has been extremely conservative, allowing the government to hold to a fixed exchange rate policy. Because of its export success, and perhaps because of political pressure from the large export sector, the government was reluctant to allow the exchange rate to appreciate in the first half of the 1980s. Another reason for the country's pursuit of surpluses is more political. The government is preoccupied with Taiwan's vulnerability to pressure from mainland China, and considers large foreign exchange reserves a hedge against disruption of the island's normal trade flows.

The Central Bank intervened continually by buying foreign exchange, thus keeping the New Taiwan dollar ($NT) undervalued. In 1986, however, the government recognized the problems associated with the strong $NT, including inflationary pressures at home, and has slowly allowed the currency to appreciate. In 1989, the country undertook a major liberalization of its foreign exchange market, including floating the New Taiwan dollar. These actions reduced the bilateral surplus with the United States.

While less protectionist than Korea, the government has restricted imports. One reason was that tariff charges remained the single most important item of government revenue until the early 1980s. Ministry of Finance officials, worried about revenue, have resisted lowering tariffs. Even in the mid-1980s, customs duty accounted for 17 percent of tax revenue, second only to income tax at 19 percent.[96] Yet industrial policy was a motivation for protection as well, suggested by the fact that these restrictions were maintained even as foreign exchange reserves ballooned in the early 1980s. Legal tariffs, which averaged over 60 percent in 1969, remained as high as 30 percent in 1986, with large differentials across sectors.[97]

Total tariff revenue as a percent of total imports, however, was only 9 percent in 1984, the difference being accounted for by exemptions on imports used as inputs to exports. This drawback system was one of the most power-lid export incentives at the government's disposal. Exporters enjoyed a free-trade regime; nonexporters, including consumers, paid higher prices for restrictive trade policies.

In terms of quantitative restrictions on imports, 80 percent of items on the import schedule had no restrictions as of 1984, which appeared to reflect a fairly liberal regime. However, the 20 percent of items with restrictions accounted for over *half* of Taiwan's imports that year. Twenty-nine percent by value had to be approved by a domestic agent, whether the producer of a domestic substitute (e.g., steel, cement), or from a government bureau, such as the Industrial Development Bureau of the Ministry of Economic Affairs. Another 21 percent were limited by who could import them; some could be imported only by publicly owned trading compa-

nies, others only by the end-user. Only 4 percent were limited by origin in 1984; origin restrictions, especially from Japan and Korea, were much more important in the past.[98]

Since the mid- 1980s, however, a dramatic liberalization of imports has occurred, matching an earlier run-down of export promotion assistance. The average tariff in 1986 was 28.2 percent. In August 1987, tariffs were lowered on several thousand items, reducing the average tariff level to just over 20 percent. The level dropped further in 1988 to 13 percent and in 1989 to 10.3 percent, with a target for 1992 of of only 7 percent, equivalent to or even lower than in the advanced industrial states.[99] Protection of agricultural goods remains high; indeed, if it were not for higher agricultural tariffs, Taiwan's trade regime would approach complete free trade. Tariffs on agricultural products in 1989 were 24.2 percent, scheduled to decline to 20 percent by 1992. As in Korea, liberalization of agricultural imports has been a heated political issue.

Taiwan also revamped its system of nontariff controls. By March 1989, 98 percent of all product categories were freely importable, with restrictions remaining on articles related to national security and health. While tariffs have come down and quantitative restrictions have been reduced, the duty-drawback scheme, which allowed exporters to import inputs for export products at duty-free prices, is being dismantled. Other restrictive measures, such as harbor fees, have been dropped as well.

Development Financing and Foreign Direct Investment

Until the second half of the 1980s, Taiwan had an even higher investment ratio than Korea. Gross investment averaged 28.4 percent of GNP between 1965 and 1980, compared with Korea's 26.5 percent. And in contrast to Korea, Taiwan's investment has been financed with domestic savings. Between 1965 and 1980, the share of domestic savings in GNP was 28.7 percent, slightly more than the share of investment. Over the 1980s, the gap between domestic savings and investment widened; Taiwan became a net creditor.

The government controls Taiwan's formal financial markets. But whereas Korea denationalized the commercial banks between 1980 and 1983, they remain largely government-owned in Taiwan.[100] The government closely regulates lending and borrowing, and appoints senior staff. The banks, in turn, have historically dominated the financial system, with nonbank financial institutions accounting for only 5 percent of the assets of Taiwan's major financial institutions in 1980.[101] The curb market has supplied some 30 percent of the total volume of loans processed through the financial system over the 1970s, at rates 50 to 100 percent higher than bank loan rates.[102] Taiwan's firms depend on credit more than equity for financing. The ratio of corporate sector debt to equity was between 160 to 180 percent between 1971 and 1980, less than Korea's but in the same order of magnitude.

With companies dependent on bank loans and government controlling the banks, the government coordinated industrial investment by means of credit allocation. In the 1960s, the Ministry of Finance gave each bank lists of 6 to 12 industries for priority attention. During the 1970s, the banks themselves participated in drawing up the lists. The banks have taken pride in achieving compliance with the lists.[103]

Nevertheless, the government has relied on discretionary credit allocation less than the Korean Government, the difference perhaps reflecting Taiwan's greater use of public enterprises. Since the mid-1970s, government direction of commercial banks' credit allocation has declined. The government instead has relied more heavily on special industrial policy banks, notably the Bank of Communications.

The Bank of Communications was the lead bank for infrastructure financing until 1979, when it was designated a development bank. Its functions were to extend confessional loans and credit guarantees to capital-intensive industries, take equity positions in new firms in high-technology industries, and advise customers on how to improve management and innovation. Following a 1982 ruling, 40 percent of new deposits in the postal savings scheme are to be redeposited with the Bank of Communications, thus opening a major new source of funds.

Foreign direct investment accounted for only 8 percent of total investment in manufacturing during the 1970s. In electronics and machinery during the 1970s, foreign direct investment accounted for roughly 50 percent and 25 percent of investment, respectively. But over the 1970s and 1980s, the Taiwanese Government imposed export requirements and/or domestic content requirements on most foreign investors. Local content requirements

have helped build linkages between foreign owned and domestically' owned plants, and have aided technology transfer as Taiwanese employees of foreign firms move to locally owned firms or start their own companies.

As for outward investment, prior to the mid-1980s the government carefully screened such investment for its consistency with national development objectives. Since the mid-1980s, however, under the pressure of huge foreign exchange reserves and rising domestic wages, restraints have been cut sharply. Outflow has begun to cheaper labor sites, such as Thailand and the Chinese mainland, while outflow to North America continues.[104]

Technology Policies

The Government of Taiwan has taken a direct responsibility for accelerating technology development and application in industry.[105] Instead of one preeminent coordinator, such as Korea's MOST, this function is dispersed among artly competing agencies in Taiwan. This may reflect the problems posed to technology policy by the country's decentralized industrial structure and the preponderance of small firms in the economy.

The nearest counterpart to Korea's MOST is the National Science Council, which reports directly to the cabinet (Executive Yuan) but does not have ministerial status. It publishes a series of National Science and Technology Development Plans. Its tasks include guiding, coordinating, and evaluating all government R&D efforts, including specific research projects and manpower development. Inside the government, the National Science Council is not preeminent in matters of science and technology, however; several other organizations vie for influence over science and technology policy, including the Council for Economic Planning and Development, the Industrial Development Bureau of the Ministry of Economic Affairs, and the Industrial Technology Research Institute (ITRI). Established in 1973, ITRI is divided into six institutes, one each for electronics, machinery, chemical engineering, energy and mining, industrial materials, and standards and measurement. By 1990, ITRI had a budget of $270 million and a staff of over 5,000. ITRI is concerned only with civilian technologies; another agency with a much bigger staff covers military technologies. (See also table 7-11 summarizing the four largest Taiwanese Government research institutes.)

The single most influential body on technology policy as a whole is probably the Science and Technology Advisory Group (STAG). With only a small administrative budget, it was until recently headed by K. T. Li, a man of immense personal influence resulting from several decades of experience in government. As Minister Without Portfolio with special responsibility for science and technology, he created STAG in 1979 to coordinate the various science and technology initiatives undertaken by these other organizations.[106] Backed by a small secretariat, he worked with a council of about 10 foreign advisors, all of them experts in some area of science and technology and all experienced in business or administration. Almost all were American citizens. STAG assesses the relevance of world technology developments for Taiwan and evaluates proposals for technology initiatives from Taiwan.

Table 7-n-Taiwan: Major Government Research Institutes in 1990[a]

Name	Research fields	Expenditure ($millions)	Staff
Industrial Technology Research Institute	Electronics, machinery, Chemical engineering, standards & measures, industrial materials, energy & mining,	$270	5,087
Institute for Information Industry	Software technology, products, marketing, training	$50	730
Development Center for Biotechnology	Biotechnology, applied ohemistry, biochemistry, immunology	$25	328
Food Industry Research and Development Institute	Food technology, products, processing equipment, training	$12	302

[a]See table 10 for Korean Major Government Research Institutes.

SOURCE: Coordination Council for North American Affairs, Office in U. S.A., Science Division, Republic of China, personal communication, Aug. 12, 1991.

Taiwan lacks an equivalent of Korea's high-level National Technology Promotion Conference. Korea's "Long Term Technology Forecast for the Year 2000" (1986) resulted from 2 years of discussions among some 500 experts in 8 working groups. Taiwan's National Science and Technology Development Plan for 1986 to 1995 was preceded by week long conferences in 1982 and 1986, and was attended by some 400 participants, of whom only about 15 percent were from private firms. Moreover, they came as individuals rather than as representatives of industrial associations.

The government has long emphasized education. Universal primary enrollment (98 percent) was achieved in 1970 and secondary enrollment reached 80 percent of the age group in 1980. The enrollment ratio is much lower at the tertiary level, only 14 percent for men and 12 percent for women in 1985.[107] Above the junior high school level, institutions are divided into those that are academically or vocationally oriented. Since the mid-1960s a dramatic change in enrollments has occurred in favor of the vocational. Forty percent of secondary school enrollments were vocational in 1963, 66 in 1980, and 69 in 1986. This preponderance in favor of vocationally oriented institutions is exceptional compared to most other countries. At the tertiary level, 55 percent of students are in vocationally oriented colleges, 45 percent in academic universities.[108]

Taiwan's junior colleges (ages 18 to 20 or 21) have graduated over 20,000 engineering students a year through the 1980s, while its universities have graduated over 10,000 bachelor-level engineers a year. The figure for bachelor-level engineers is 70 percent more than the corresponding per capita figure for the United States, and is close to Korea's (per capita).[109] The presence of a large stock of engineers has been important for allowing national control over decisions about foreign technologies and for mastering the use of those technologies. Great care is taken to ensure the practical orientation of engineering training, especially from the vocational schools, and each school has arrangements with local firms to take students as part-time workers throughout the school year.

These shifts in enrollments reflect demand, the fact that engineers are paid on average 20 percent more than arts graduates of the same age, and the fact that an engineering qualification is a fast track to management positions.[110] However, these changes also reflect direct controls. From 1966 onwards, a series of Manpower Development Plans have guided Taiwan's education expansion, and the results have corresponded closely to targets in terms of expansion of different subjects, the balance between public and private schooling, and overall rates of expansion.

Some targets went strongly *against social* demand. For example, the government lowered the allowable rate of expansion of places in tertiary institutions from 5 percent in the Fourth Manpower Development Plan (1972-1976) to 3 percent in the Fifth (1977-198 1). The slowdown was effected both by spending controls and by reducing the pass rate in the national tertiary level entrance examination. Intended to avoid unemployment among the highly educated, the result has been to exacerbate shortages of scientific and engineering manpower. The constraint on the expansion of academic secondary schools and universities also runs against social demand, because academic secondary schools are the principal route to universities and university degrees (including engineering) that yield higher rates of return and prestige.

In 1975, there were 2,301 students studying abroad, most under government auspices. By 1986, this number had risen to 7,016, over 90 percent of whom were in the United States. But a majority of students who study abroad do not return to Taiwan. Of the one in five of Taiwan's graduates in engineering, science, medicine and agriculture who go abroad for further study, only about 20 percent returned during 1976 to 1986. In 1983, the government launched a program to encourage students and others with technical skills to return. The program included keeping in touch with thousands of potential recruits. Many returnees work initially at ITRI. The National Science Council also administers a program to bring Taiwanese and other Chinese engineers and scientists in the West to Taiwan for short assignments. Some 3,200 people came under this program between 1970 and 1980.

The government has also developed a series of targeted incentives, including special funds to lend either for technologically advanced machinery or R&D activities. The most important of these is the Strategic Industry Fund. Established in 1982, it had a capitalization of $500 million by 1983 and could be used for:

1. Purchase of domestically produced machinery, with an interest rate 2 points less than the average of the minimum and maximum long-term rates for commercial bank loans (this average was 10 percent in 1983).
2. Purchase of new machinery, from any source, by producers of specified products within the "strategic' industries of machinery, automobile parts, electrical machinery, and electronics and information. The list of eligible products contains 135 items. The interest rate is two points less than the minimum of the long-term rates.
3. Special cases to be decided by the planning agency, especially for the introduction of labor-saving equipment in any sector. Again, loans are at preferential rates. The existence of special cases indicates that the government retains significant discretion to decide what is strategic.

The pay-back period is a maximum of 8 years, with a 2-year grace period. The collateral is the value of the machinery itself. Compared with the normal terms of Taiwan banks, loans from the Strategic Industry Fund are highly confessional. Other special-purpose funds include the Sine-American Fund for Economic and Social Development, established in 1965, and The Development Fund; both are available for discretionary channeling of funds into targeted sectors.

The Statute for Encouragement of Investment, first promulgated in 1960 and revised many times since, gives tax incentives for technological upgrading and R&D activities. It combines two approaches to industrial promotion. One is to make the incentives available to many industries but stipulate stringent performance criteria so that only a few firms in each industry will be eligible. The other approach is to target the incentives on a narrow range of "strategic' industries, and make them easily available to firms within these industries. The compromise in Taiwan is to have a broad range of industries eligible, with a high proportion of items eligible from the strategic industries of machinery and electronics and information, and relatively few items eligible from such well-established industries as textiles.

The incentives include the tax holiday, accelerated depreciation, investment tax credit, duty-free import of capital goods, and reduced business tax rate. Several other schemes bolster these incentives. R&D spending is encouraged by a 20-percent tax credit for firms with yearly R&D spending above their maximum in the previous 5 years, provided this brings their spending above a certain minimum. Businesses in specified high-technology industries can defer income taxes and face a maximum income tax rate of 20 percent of annual taxable income, provided they also meet the R&D minimum. These same firms can retain profits of up to two times their paid-in capital; they are eligible for up to 50-percent government grants for R&D expenditures, and also for government purchase of equity.

Companies in machinery and electronics and information are eligible for government cost sharing of up to 50 percent for putting in approved manufacturing or financial systems, and, since 1984, for loans at almost 3 percentage points less than the average of the minimum and maximum long-term rates. To encourage technology transfer from abroad, the government allows technical know-how or patent rights to be supplied as part of an equity share (up to 25 percent), and exempts foreign enterprises from taxes on income gained through furnishing approved patents.

A particularly innovative scheme for promoting local R&D was the development of the Hsinchu Science-based Industry Park in 1980. Modeled on the Stanford Science Park, it attracts foreign and domestic high technology firms, mostly in informatics, precision instruments, new materials, and biotechnology. The object is to lift some of the risks faced by participating firms, and thereby induce enough companies to locate there to generate positive spillovers ("externalities") among them. Investors are allowed 5 years of tax holiday within the first 9 years, a 22-percent ceiling on corporate income tax, below-market land rents, exemptions for various import and export fees, and low-cost loans and government equity of up to 49 percent of total investment. The companies also benefit from close proximity to the ITRI institutes. One hundred firms are now operating in the Park, near its capacity.

Other technology upgrading programs include:

- an industrial extension service;
- intensive quality control efforts;
- the fostering of venture capital firms; and
- initial steps to increase the protection accorded to intellectual property rights.[111]

There is talk of making Taiwan the Switzerland of Asia, with high-quality products from relatively small-scale firms.

What are the effects of this system of technology policy? Compared to their Korean counterparts, Taiwan's public research and service organizations are less closely connected to private firms, which have not made nearly as large an investment in their own R&D facilities. Critics often say that the public labs have been unsuccessful in developing new products, which is attributed to their poor communications with private firms and problems of the incentives in public sector research. But public labs carry out a major training function and encourage their younger staff to spin off their own companies to commercialize new products. This has been a major incentive for luring back Taiwanese professionals living abroad. A Taiwanese researcher at IBM, for example, may be offered the position as chief of a research team at one of the public labs, with more responsibility and command over budget than at IBM, plus the prospect of developing his own company to bring to market the products developed in the lab. The popular charge of poor communications between labs and firms presumably relates to well-established companies, rather than these spinoffs. However, this incentive mechanism disrupts the work in publicly funded technology programs when key staff leave.

Indicators of R&D inputs must be used cautiously, for different countries use different definitions. By official figures, Taiwan spent 1.06 percent of GNP on nonmilitary R&D in 1985, less than Korea's 1.59 percent. About half of Taiwan's spending is classed as coming from the public sector, but when government grants to certain nonprofit organizations are included, the figure rises to 60 percent. Private domestic and foreign firms account for the rest. This is perhaps three times more than the public sector's share in Korea, attributable to the presence of larger firms in Korea. In terms of numbers of researchers per 10,000 people, on ahead count rather than full-time equivalency basis, Taiwan has about 14, compared with Korea's 11.

Case Study: Automobiles

Taiwan's automobile industry is far from breaking into the world market.[112] Like Korea, Taiwan designated the automobile industry as a strategic sector, But in 1988, in contrast to Korea's output of over 1 million units, Taiwan produced only 275,725 motor vehicles.[113] A case study of the industry therefore illuminates differences between Korean and Taiwanese industrial policies and structures. The Taiwanese Government was more reluctant to push into heavy, capital-intensive sectors and support the development of large national champions. This reticence was partly the result of the inability of the Taiwanese Government to restrict the entrance of new producers, policy incoherence derived from bureaucratic wrangling, and more fragmented business-government relations than in Korea.

In the absence of larger firms capable of achieving the required scale economies and with a smaller domestic market, the prospects for automobile exports appeared dim. Taiwan thus turned to state-owned enterprise to promote auto exports. When this effort failed, they sought an industrial strategy that relied on trade liberalization, encouragement of foreign direct investment, and the development of an export-oriented parts industry. This strategy appears to be yielding better results.

At the end of the 1960s, the automotive industries of Taiwan and Korea looked much alike. Starting in 1958 with an assembly plant in cooperation with Nissan (the joint venture partner in Korea's first plant 4 years later), by the late 1960s Taiwan had four assemblers struggling for a share of less than 20,000 units a year. Each had Japanese participation. Industry complaints about the inadequacy of Japanese technology transfer were never quite taken to heart, however, and government promotional measures were limited to domestic content requirements and import controls.[114] Over the 1970s, Taiwan's auto policy drifted. The state's organizational and financial capabilities were heavily committed to other projects aimed at boosting the competitiveness of existing export sectors. The 1974 oil crisis made matters worse by dampening expectations about the industry.

The government split on policy for the automobile industry. Some officials saw it as a future major exporter, some accorded it a central role in Taiwan's defense strategy, others doubted that domestic demand could ever be sufficient—given a population half the size of Korea's—to provide the base for an export drive. The latter group thought the emphasis should be on development of an automobile parts industry, which might later support internationally competitive assemblers.

Another reason for policy drift was that domestic car prices above international levels did not harm the economy's overall international competitiveness as high prices on intermediate goods would have. This predisposed the government to the development of intermediate inputs. As a result of these drifting policies, auto production became less efficient. The government did nothing to stop new entrants, and in 1979 the six assemblers each produced an average of only 18,000 compacts, sedans, and light trucks. The resulting rattletraps were sold on the domestic market only.

In 1978, spurred by news of Korea's big push into automobiles, the government announced a proposal to encourage the establishment of a large-scale automobile plant with an annual capacity of 200,000 compact cars, mainly for export. The strategy was to induce a foreign car maker of world standing to enter a joint venture with a domestic enterprise, and thereby obtain technology not only for assembling but also for upgrading the capability of the auto components suppliers. Only Toyota and Nissan submitted investment applications.

To underscore that the Big Auto Plant was aimed at the world rather than the local market, the Ministry of Economic Affairs stipulated that the foreign joint venture partner could not hold more than 45 percent of the equity and would have to export 50 percent of production. Several months later, after receiving the Japanese applications, the government stated its intention to retain control over the enterprise by announcing that the state-owned China Steel Corp., rather than any existing automaker, would be the foreign partner's working counterpart. China Steel's chairman, Zhao Yaodong, was appointed head of a "Big Auto Plant preparatory committee," and Taiwan's automotive industry association played no role in the formulation of policy. Seven domestic private ths, none in automobiles, split a 30-percent equity share in the venture. Other local firms would subcontract to the plant.

In 1982, Toyota was chosen as joint-venture partner. In July 1983, however, disagreements emerged between Toyota and the Ministry of Economic Affairs (MEA). The government now insisted on a 90-percent local content, and substantial transfer of production technology, despite Toyota's protestations that these **should be goals** rather than fixed targets. It planned to prevent Toyota from taking **profits from the venture if it failed to meet a strict timetable for achieving these** conditions. Toyota argued that the conditions would be impossible to meet.

A 1984 cabinet reshuffling brought to the fore officials who had been wary of the Big Auto Plant plan. Zhao Yaodong was removed as Minister of Economic Affairs. The new government favored the development of Taiwan's auto parts industry into an integrated production system. K. H. Yu, a powerful man with easy access to the president, was inclined to retain domestic industry protection and provide greater support for private domestic and foreign firms. The new Minister of Economic Affairs first announced that the joint venture would remain contingent on Toyota's compliance with the conditions already laid down, but then the government signaled that should the joint venture fail, Taiwan would proceed with an alternate plan to develop the parts industry. In September 1984, when no convergence between Toyota and the MEA was evident, the Toyota-China Steel joint venture was canceled.

Other Japanese automakers showed an interest in Taiwan. Glad to seize at a second chance, the Taiwan Government acted to restructure the domestic industry. Chastened by the Big Auto Plant failure, the new Automobile Industry Development Plan of 1985 reversed several basic policies. It proposed to lower tariffs and domestic content requirements on finished cars, limiting import bans to small Japanese cars and quotas to Korean cars. The new plan removed the 45-percent foreign equity ceiling, allowing 100-percent foreign ownership in export-only car and components production. It imposed export ratios and technology transfer requirements case by case. To ease pressure from Washington over Taiwan's perennial trade surplus with the United States, the plan also included gradual tariff reductions from 65 to 30 percent and the market's opening to all car imports by 1993.[115] Hence, the government gave up its earlier emphasis on domestic content and national control in order to maximize an export orientation. While it favored a consolidation of the industry by means of mergers or exits, it did not try to force this consolidation.

The domestic assemblers began to show signs of life. They planned export-oriented expansion, established a joint design engineering center to develop the island's first domestically designed model, and, in the case of a joint venture with Ford, announced

that the Taiwan subsidiary would be integrated into its global supply network. The firms chose to strengthen their links with Japanese companies and explore new relationships with other foreign producers (table 7-12). Honda, Nissan, Mitsubishi, and Toyota now have large equity stakes in Taiwanese companies. All plan to make Taiwan a major site for parts and components in the 1990s. Toyota and Nissan may export compact models, partly in hope that Taiwan will provide a fast track into the China market.

Foreign automakers also see a new market in Taiwan. Rising consumer income and the appreciation of the New Taiwan dollar since 1985 has spurred domestic demand for foreign automobiles. Growth in demand has aided domestic car makers too, but they face difficulties given the high scale economies required to be profitable and the currency appreciation. Foreign-made car sales rose to 136,000 in 1988 (38 percent of the market) from 33,000 (13 percent) in 1986. In May 1989, imports passed local car sales for the first time.[116] With 9 car companies and their foreign tie-ups saturating a market of 20 million people, a major shake-out should occur in the next several years.

This case illustrates some of the difficulties in devising and applying industrial policy. Protection alone did not foster the development of a competitive industry, and in fact encouraged a proliferation of inefficient entrants. The state-led joint venture with a foreign producer also failed, but the reasons appear to have been political as well as economic; this strategy attempted to bypass domestic automakers altogether. The current strategy centers on the use of market liberalization to force a restructuring of the industry through foreign participation, with the expectation that the parts industry will provide a number of niches independent of final assembly. Two things should be noted about this strategy, however. First, no less than the state-led strategy, it rests on independence from domestic producers. Second, it is likely to result in an industry restructuring that could probably demand further government intervention.

Case Study: Semiconductors

Electronics became Taiwan's biggest export category in 1983, surpassing textiles and apparel. In 1988, it accounted for 21.5 percent of exports.[117] The industry is dominated by foreign fins, mostly from

Table 7-1 2—Taiwan Auto Industry External Sources of Capital and Technology

Taiwan automaker	Foreign tie-ups	Nature of linkage
China Auto Corp . . .	Citroen	Technology
	Mitsubishi	Technology
Ford Liu Ho	Ford	70% equity-ownership
	Mazda	Technology
Kuo Zui	Hino	Technology
	Toyota	22% equity-ownership
Prince Motor	Suzuki	Technology
San Yang	Honda	13.5%equity-ownership
		Technology
San Fu	Fuji Heavy Industry (Subaru)[a]	Technology
	Renault	
Ta Ching	Fuji Heavy Industry (Subaru)[a]	Technology
	Nissan	
Yu Tian	Daihatsu	Technology
	Peugeot	Technology
Yue Loong	Nissan	25%. equity
		Technology

[a]In late 1990, Nissan acquired a substantial share of Subaru from Fuji Heavy Industries.

SOURCE: Jonathan Moore, "TrafficJam," FarEastern *Economic Review,* June 21,1990, pp. 76-78; Walter Arnold, "Bureaucratic Politics, State Capacity, and Taiwan's Automobile Industrial Policy," *Modem China, vol. 15, No. 2,* April 1989, p. 209.

the United States, which account for more than two-thirds of production. About two-thirds of total production is exported, primarily to the United States. Over a quarter of electronics imports come from the United States, and over half come from Japan.[118] In consumer electronics, Taiwan's domestically owned firms adopted the strategy of moving into the price-sensitive low end of the consumer market left behind as the Japanese moved into more highly differentiated consumer and industrial electronics. In component production, Taiwan specialized in production of standardized components and the assembly of semiconductors. Firms began to differentiate their products and attempted to enter the more advanced end of the consumer, industrial, and component markets.

However, the small Taiwanese firms have been handicapped in reaping economies of scale. The contrast is with the Korean *chaebol,* whose size and diversity gives them advantages in input purchase, international marketing, and the ability to cross-subsidize. Therefore, in Taiwan, the role of the government has been more important in building up technological mastery of microelectronics. And whereas the *chaebol* moved into large volume

production of standardized chips, Taiwan concentrated on small runs of specialized chips.

The original stage of Taiwan's involvement in semiconductors was based on offshore assembly operations; if anything, Taiwan was even more liberal in encouraging the entry of these fins. Yet this strategy was initially motivated by interest in exporting rather than in developing an indigenous electronics base. The foreign firms constituted a relatively insulated enclave, with many initially located in export-processing zones.

In 1974, Taiwanese Government officials made serious plans to acquire semiconductor design and production capability.[119] They established the publicly owned Electronic Research and Service Organization (ERSO), under the Industrial Technology Research Institute (ITRI). ERSO was, first, to verify the possibility of "leapfrogging" directly into integrated circuit production, bypassing transistor fabrication, and, second, to be a catalyst in securing private sector interest. ERSO would then recruit a foreign partner to setup a demonstration plant, with the aim of transferring the technology to a domestic private firm and commercializing it. In 1976, ERSO opened the country's first model shop for wafer fabrication, and a year later it signed a technology transfer agreement with RCA in integrated circuit design. By the second half of 1978, ERSO was in production, with competitive costs and accelerating sales.

The aim of this venture was not simply production, however, but the development of an indigenous semiconductor industry through internal technology transfer, i.e., from ERSO to a local company. Finding no companies to take over the entire operation, in 1979 the government established a joint venture with a group of firms called United Microelectronics Corporation (UMC). UMC was a subsidiary of ERSO, with a 45-percent equity share split among five private local fins. Drawing on RCA ties and ERSO manpower and technical expertise, UMC built a state-of-the-art production facility in 1982 to fabricate customized chips. UMC made agreements with three Silicon Valley design firms owned by Chinese-Americans, which opened branches in the Hsinchu Science Park. These joint ventures soon produced advanced chip designs.

ERSO also introduced critical technologies, such as mass production capabilities. ERSO established a Common Design Service Center, which spread design technology to the private sector and provide consulting and training in computers and design tools. A number of design houses profited from the effective subsidy in ERSO's generous Iicensing agreements.

By the late 1970s, government officials envisaged an integrated information industry linking semiconductors, computers, computer software, and telecommunications. An information industry task force, headed by two senior cabinet ministers, was responsible directly to the Premier himself, thus indicating the high priority attached to the industry. The Information Industry Development Plan for 1980 to 1989 spelled out a comprehensive approach to promoting the information industry.

Industry leadership came from public research organizations and their public enterprise offshoots. ERSO was responsible for guiding the development of new core technologies and products, and for training microelectronics engineers, some of whom would then move to private industry. After demonstrating the capacity for integrated circuit (IC) production, ERSO emphasized capacity in application-specific integrated circuits (ASICs). Design strength in custom-tailored chips was essential, ERSO argued, both to provide a source of innovation across the information industry, from data processing to consumer electronics to telecommunications, and also to differentiate Taiwan from Korea, which was then competing against U.S. and Japanese firms in high-volume memory chips. As the private sector developed a commercial interest in semiconductors, ERSO altered its role, focusing greater attention on basic research. In 1989, it established a laboratory for developing technology to produce submicron line widths on chips; in 1990, it split its operations into two parts, one devoted to further semiconductor research, the other emphasizing systems technology.[120]

By 1986, however, Taiwanese firms still lacked the capacity to make VLSI chips in commercial quantities. Fearing that the time for collecting high returns on advanced chip designs would soon run out, UMC and its partners sold the designs to one Korean and two Japanese companies. This dismayed senior government policymakers, concerned that the lack of a domestic integrated circuit industry could hamper their efforts in linked industries. The government thus redoubled its efforts to find a multina-

tional company able to fabricate VLSI chips in Taiwan.

Philips, a Dutch company with many long-established factories in Taiwan, agreed to start a foundry in late 1986.[121] The project was a joint venture of the government (48.3 percent), Philips (27.5 percent), and several domestic private firms. The government contributed almost half the $153 million startup cost. The new company, Taiwan Semiconductor Manufacturing Corp., makes chips to order rather than designing and marketing its own, reducing the risk that it will steal proprietary knowledge.

The company claimed that its technology as of mid-1988 was only 9 months behind that of the major U.S. firms like Texas Instruments and Intel, whom it includes among its nine big U.S. customers. By mid-1988, it was making 10,000 6-inch wafers a month. U.S. industry analysts consider it state-of-the-art, and its cost per wafer is estimated to be below that of the best U.S. merchant facilities. A second $220 million plant was scheduled for completion in 1991, with a capacity of 30,000 6-inch wafers a month and capable of 1 micron line widths.

But government leadership was not the whole story. In 1988, the country saw the emergence of the frost chip makers not funded by the government: Hualon, Winbond, and Advanced Microelectronic.[122] Hualon and Winbond invested $360 million to build two state-of-the-art fabrication facilities for DRAMs and ASICs. Market imperatives drove the larger Taiwanese end-users to form alliances in order to guarantee needed output. In 1989, Texas Instruments announced a *$250* million joint venture to make advanced semiconductors, providing its partner, the Taiwanese computer company Acer, with an assured supply of chips. During the 1988 shortage of one megabit memory chips, Acer was unable to meet demand for its computers because of the scarcity of chips, while several of its competitors were less affected because they made their own chips. The new plant came on stream in mid-1991, and makes 4 megabit DRAMs.[123]

In addition to the chip foundries and the Texas Instruments-Acer joint venture, Taiwan's smaller semiconductor firms design and produce large quantities of "yeoman" chips, of good quality, low price, and fast delivery, for consumer electronics products. The island has the biggest pool of chip design talent in Asia outside of Japan. Many of the design houses are staffed by ERSO-trained engineers.

The proliferation of smaller firms is visible in related segments of the electronics industry, including personal computers, peripherals and add-ens, accounting for nearly 7 percent of Taiwan's exports in 1987, up from near zero in 1980.[124,125] Taiwan has over 100 computer manufacturers, compared to fewer than 60 in Korea. They do everything from clone-making to add-on graphics and communication cards, Chinese-character computer systems, software packages, and the development of systems integration through multi-user workstations. The imitation lag between introduction of a new personal computer product in the United States and the launch of a machine with similar functions by Taiwan's computer makers is down to 6 to 9 months, sometimes less.[126]

Acer, the leading firm, had 4,800 employees as of 1987, 15 percent of them in R&D. In that year it spent $10 million, 3 percent of revenue, on R&D.[127] It ships just over 3 percent of the world's IBM-compatible personal computers, while its share of the more powerful machines based on Intel's 386 microprocessor is around 6 percent.[128] Its clone of IBM's PS/2 30 model appeared in mid-1988, followed in early 1989 with two more products based on models at the PS/2 range but with superior performance characteristics. For the latter especially, a reputation for product reliability is crucial for market success, because a malfunction in one unit can put a whole network of users out of action. Acer and Mitac, Taiwan's second main firm, took a license under IBM's personal computer patents on a running royalties basis. IBM also obtained a substantial up-front fee plus the right to license Acer and Mitac patents on the same basis.

ERSO continues to take a leading role in computers. For example, it has provided the domestic makers with an IBM compatible basic input-output system to strengthen their hand in warding off IBM lawsuits. Over the first half of the 1980s, it dedicated major research projects to some 20 information products, including a microcomputer local area network system, a dot-matrix printer, and a 32-bit microprocessor. With the Industrial Development Bureau, it identifies firms to commercialize the products once it has mastered the technology. In 1987, ERSO had a staff of 1,700 and a budget of just under $100 million.[129]

In the software industry the state has a large presence through both ERSO and the publicly owned Information Industry Institute (III). The III has evolved into a profit-making public enterprise, taking up nearly every major software project in the public sector instead of channeling demand to the private sector. Its competence is signaled by agreements with top U.S. computer firms to help commercialize in-house products for the Asian market. Two examples are a Chinese input-output system developed by III and licensed to IBM, and a joint venture with Hewlett Packard to develop software for the Asian market.[130] Much of the other commercialization sponsored by the institute has been undertaken by its own subsidiary.

In contrast to the automobile sector, Taiwan has a successful industrial policy in semiconductors and electronics that exploits its strength in low-cost engineering capabilities.[131] Initially, the government led production, and used its facilities to train personnel and transfer technology. ERSO then entered into joint ventures with local and foreign partners to develop key segments of the industry, still using it facilities for internal technology transfer with the goal of close integration among the different industry components. More recently, ERSO has concentrated its efforts in new products and more basic research. The policy aim was to move the industry towards higher technology products and to reduce dependence on foreign sources for key components and raw materials.

KOREA AND TAIWAN: SIMILARITIES AND DIFFERENCES

Many of the similarities between Korean and Taiwanese industrial policies are striking, but the differences are also significant, showing that there is more than one viable approach to industrial promotion.

Korean and Taiwanese Government leaders share a presumption that the state should promote industrial development and national prosperity. Both countries have been committed to the development of a strong private sector and have used an array of policy tools, including protection and financial incentives, to promote that goal.

Both countries issue detailed plans and quantitative targets for investment and output for particular industries. Yet this East Asian planning style has tied itself closely to world markets; in this, it is fundamentally different from the import-substituting strategy pursued by most Latin American countries and India, or the centralized planning of the Eastern European countries. The two countries' emphasis on exports forces firms to operate in environments outside government control, and acts as a check on policy.

Korea and Taiwan see no inconsistency in making a commitment both to markets and to State assistance to industry. The State helps companies become more competitive internationally, not only by infrastructure investment and macroeconomic stability, but also by intervention at sectoral and even firm levels. One of the driving themes of this intervention has been to reduce the vulnerability of their industrial sectors to cut-offs from foreign, especially Japanese, suppliers. Recent efforts in semiconductors were motivated partly by this concern, as were earlier investments in industries such as steel and petrochemicals.

Finally, both governments share a commitment to long-term planning. This planning does not mean detailed quantitative targets for investment and output for particular industries. Rather, it means broad visions of the directions that economic growth ought to take and the specific industries that ought to be encouraged. It is striking that the current successes in semiconductors and computers, for example, are the fruits of government promotional programs begun in the early to mid- 1970s.

Korea and Taiwan are also distinct from each other in important ways. The Korean Government encouraged the growth of large private business groups to spearhead Korean industrialization. Particularly in the late 1970s, during the heavy and chemical industry push, it guided their investments by means of subsidized credit through the state-owned banking system, controlling their access to foreign exchange, protecting the domestic market, and offering investment tax incentives. This system was cemented by a strong government ' 'persuasion" and durable social ties between business and government leaders. As the business groups have become more central in the economy, the government has constructed elaborate consultative mechanisms through which policy formation occurs.

Korea discouraged direct foreign investment except in electronics. Most technology came through

either licensing or more informal means of transfer—e.g., returning students. Public R&D organizations contributed to the build-up of an indigenous R&D capability, but over the 1980s private fins, encouraged by the government, established their own R&D facilities.

This pattern of industrial policy accounts for both strengths and weaknesses of Korea's industrial development strategy. The development of large national champions has made the country particularly strong in the development of large-scale and capital-intensive production; this is reflected in the country's success in autos and DRAMs. Korea's weaknesses have been in flexibility and design. The policy challenge for the future, therefore, will lie in building a more flexible industrial structure, probably through the promotion of small and medium-sized firms.

The Taiwanese Government, on the other hand, has not encouraged the growth of large business groups. It has relied on public enterprises, often allied with multinational companies, to undertake big pushes into new fields. The efficiency of these investments is due to the unique nature of the political system; in contrast to other developing countries, state-owned enterprises have not enjoyed easy or unlimited access to public finance. As the semiconductor case shows, public enterprises change the distribution of profit opportunities in the downstream sectors and induce new patterns of investment. Taiwan also relies on public R&D organizations, partly because of the inability of small firms to sustain their own R&D.

Consultative mechanisms of the Korean type are lacking, however. Relations between the government and private firms are characterized by distance and even a certain degree of mutual suspicion, perhaps reflecting the ethnic split between mainlanders, who until recently have dominated top positions in the ruling KMT, and native Taiwanese. This distance was visible in the failed effort to center an auto strategy on a state-owned enterprise and the subsequent government liberalization of the domestic market; the contrast with Korea in this regard is striking.

The government has made it easy to start a business or enter a new industry and has been more welcoming of direct foreign investment than Korea. Foreign investment is, however, under export and/or domestic content requirements to check its domination of the domestic market and increase its links to domestic industries. Arms-length incentives and the ease of doing business have encouraged a dynamic small and medium-sized industry sector, not only in light, labor-intensive manufacturing, but also in dynamic, high-technology segments; this can be seen in the semiconductor case.

This combination of strategy and structure explains Taiwan's pattern of competitiveness. Less able to rely on direct government support and protection than Korean fins, and unable to finance operations of similar scale, Taiwanese firms are more likely to adopt a niche strategy, relying on indigenous design capability and flexibility to enter more specialized product lines. This shows in both the development of the custom and semi-custom end of the semiconductor market and in the rapid development of the automobile parts industry.

The differences in strategy between Korea and Taiwan also reflect the difference in industry structure. A strategy of targeting resources at a few large firms could be viable, although we have seen that this strategy also had some important costs. With Taiwan's many small and medium-sized firms, its strategy of creating opportunities for downstream entry through publicly owned upstream industries seems appropriate.

Differences in industry structure were partly the result of government policy. Taiwan's political leaders and senior officials were steeped in an official ideology that had strong socialist components. The native Taiwanese, who had been ruled by the Japanese for 50 years up to 1945, were in a four to one majority and played a large role in the development of the private sector; they regarded the KMT Government as something of an alien force. Hence both sides, government and business, tended to view each other with suspicion. In Korea, by contrast, technocrats and political leaders shared a strong nationalism. Indeed, the sense of wounded pride induced by Korea's 45 years of Japanese rule in a previously unified kingdom with unchanged boundaries for 1,000 years helped to foster the notion of the South Korean people as a single team against the rest of the world. The perception of an underlying fusion of interests helped sustain a relatively well-developed policy network between the economic bureaucracy and private companies. Through these relations of reciprocity, the business groups emerged as Korea's national champions.

Korea's strategy is much closer to the Japanese than is the Taiwanese. Korea's *chaebol* were built with the Japanese *keiretsu* as the prototype, although the *chaebol* were barred from owning banks. Korea's industrial structure resembles Japan's more than does Taiwan's. The government's instruments of industrial steerage were similar too, particularly the use of selective credit, protection, foreign direct investment controls, and export promotion. But Japan relied on public ownership less than Korea.

Industrial policy in the two countries now faces two major challenges. The first is political liberalization. In the past, strategy in both countries has been formulated with little input from interest groups other than business, and in Taiwan, even business input was limited. Democratization will now open up new channels for a host of other actors, including labor and the legislature. This will put new pressure on the coherence of industrial policy initiatives.

The second challenge is economic liberalization. In response to past failures, external pressures, and the need to be closely integrated with rapidly changing technology markets, both countries have begun to open their markets to foreign competition and reduced the government's directive role. As we have argued, however, this is not likely to mean a repositioning of the government's role rather than its demise, with greater attention focused on technology policy and collaborative ventures with the private sector.

1 U.S. Department of Commerce, International Trade Administration, Office of Trade and Investment Analysis, *U.S. Foreign Trade Highlights,* July 1989, table V1OB, pp. 126-128.

2 World Bank, *World Development Report 1988 (New* York, *NY:* Oxford University Press, 1988); Council for Economic Planning and Development, *Taiwan Statistical Data Book 1987* (Taipei, Taiwan: Executive Yuan, 1987); United Nations Statistical Office, Department of Economic Affairs, *Commodity Trade Statistics (New York, NY:* United Nations, 1987); U.S. Department of Commerce, International Trade Administration ibid.

3 See World Bank, *World Development Report 1990 (New* York, NY: Oxford University Press, 1990), table 1, pp. 178-179.

4 Figures are for 1986, from World Bank, *World Development Report 1988 (New* York, *NY:* Oxford University Press, 1988); Council for Economicalarming and Development, op. cit. Japan's share of world gross domestic product (GDP) is for 1985, from *The World in Figures* (London: Hodder and Stoughton, 1987).

5 See, for example, Anne Krueger, *The Development of the Foreign Sector and Aid* (Cambridge, MA: Harvard University Press, 1979) and the contributions to *World Development vol. 16, No.* 1, 1988, a special issue on Korea.

6 See Alice Amsden, *Asia's Next Giant (New* York, NY: Cambridge University Press,1989).

7 The most coherent statements of the case for selective industrial policies are Howard Pack and Larry E. Westphal, "Industrial Strategy and Technological Change: Theory vs. Reality," *Journal of Development Economics* vol. 22, 1986, pp. 87-128; Larry Westphal, "Industrial Policy in an Export-Propelled Economy: Lessons from South Korea's Experience," *Journal of Economic Perspectives* vol. 4, No. 3, summer 1990, pp. 41-59.

8 See Paul Krugman, "Targeted Industrial Policies: Theory and Evidence,' in *Industrial Change and Public Policy (Kansas* City: Federal Reserve Bank of Kansas City, 1983).

9 Forareviewofthe debate onJapaneseindustrial policy, see Greg Noble, "The Japanese Industrial Policy Debate," in Stephan Haggard and Chung-in Moon, *Pacific Dynamics: The International Politics of Industrial Change* (Boulder, CO: Westview Press, 1989).

10 See Stephan Haggard, *Pathways from the Periphery: The Politics of Growth in the Newly Industrializing Countries* (Ithaca, NY: Cornell University Press, 1990).

11 Technology intensity is based on the ratio of applied R&D expenditures as a share of shipments, as calculated by C. Michael Aho and Howard F. Rosen using data from the mid 1970s. This ratio ranged from 0.22 for special textile fabrics and related products to 13.4 for telecommunications apparatus, with an average of 2.19. We divided the industries into three categories. High-technology products are those that are above the sample average. Intermediate-technology products have ratios from 1 to 2; low-technology products have ratios below 1. For a full discussion of the methodology, see Aho and Rosen, Department of Labor, Bureau of International Labor Affairs, *Trends in Technology-Intensive Trade,* Economic Discussion Paper 9, October 1980.

12 See H. Don, B. H. Gunasekera, "Intraindustry Specialization in Production and Trade in Newly Industrializing Countries: A Conceptual Framework and Some Empirical Evidence from East Asia,'' *World Development vol. 17,* no. 8, 1989, pp. 1279-1287.

13 Shujiro Urata, "The Rapid Globalisation of Japanese Firms in the 1980s: An Analysis of Activities of Japanese Firms in Asia," paper prepared for OECD Meeting of Experts on Globalisation andRegionalisation of the World Economy, June 20-21, 1990. The following data on the export behavior of Japanese firms is also from Urata.

14 Jonathan Moore, "The Upstart Taipans,'' *Far Eastern Economic ReviewVol. 148, No. 16,* Apr. 19, 1990, p. 84.

15 Danny Leipziger, *Korea: Managing the Industrial Transition,* vol. 1 (Washington DC: World Bank, 1986), p. 106.

16 The major study of Korea's recent exchange rate policy is Bela Balassa and John Williamson *Adjusting to Success: Balance of Payments Policy in the East Asian NICs,* 2d ed. (Washington DC: Institute for International Economics, April 1990).

17 Bank of Korea, "Balance of Payments, Foreign Trade and Foreign Exchange," *Economic Statistics Yearbook 1987* (Seoul, Korea: Bank of Korea, 1987); and Bank of Korea, "Summary of Exports and Imports," *Economic Statitistics Yearbook 1982 (See@* Korea: Bank of Korea, 1982).

18 Leipziger, op. cit., vol. 1, op. cit.

19 Richard Luedde-Neurath, *Import* Controls *andExport On"ented Development:* A *Reassessment of the South Korean Case* (Boulder, CO: Westview Press, 1986).

20 The following data is reported in "Trade Liberalization" chapter three in Leipziger, op. cit., vol. 1. See also Luedde-Neurath, ibid.; Robert Wade, "The Rise of East Asian Trading Nations-How They Managed Their Trade" (mimeo, World Bank Trade Policy Division, Country Economics Department, 1988); and Robert Wade, *Governing the Market: Economic Theory and the Role of Government* in *East Asian Industrialization* (Lawrenceville, NJ: Princeton University Press, 1990).

21 The low estimate comes from Larry Westphal and K. S. Kim, "Industrial Policy and Development,'' World Bank Staff Working Paper No. 263 (Washington DC: World Bank, 1977). The high estimate comes from K. S. Kim, "Long-term Variation of Nominal and Effective

Rates of Protection" (Seoul: Korea Development Institute, 1982). On the question of possible calculational bias, see Robert Wade, Governing *the Market,* ibid., Chapter Ten.

22 Young Soogil, "Trade Policy Reform in Korea: Background and Prospect," mimeo (Seoul Korea Development Institute, 1984).

23 Young Soogil and Yoo Jungho, "The Basic Role of Industrial Policy and a Reform Proposal for the Protection Regime in Korea," (Seoul: Korea Development Institute, 1982).

24 See Balassa and Williamson, op. cit., p. 46.

25 Office of the United States Trade Representative, *National Trade Estimate Report on Foreign Trade Barriers (Washington DC: Office* of the U. S.T.R., 1989), p. 115; and ibid., 1986, p. 165.

26 Leipziger, op. cit., vol. 1, p. 65.

27 *Ibid.,* p. 65.

28 See Luedde-Neurath, op. cit.

29 Since 1975 the tariff has had to be paid and then claimed back against evidence of quantities used for exports.

30 See Luedde-Neurath, and Yung Whee Rhee, ''A Framework for Export Policy and Administration: The East Asian Experience," World Bank Industry and Finance Series No. 10 (Washington DC: World Bank, no date).

31 Leroy Jones and 11 SaKong, *Government, Business, and Entrepreneurship in Economic Development: The Korean Case (Cambr*idge, MA: Harvard University Press for Harvard University Council on East Asian Studies, 1980); David C. Cole and Yung Chul Park, *FinancialDevelopment in Korea, 1945-1978* (Cambridge, MA: Harvard University Press for Harvard University Council on East Asian Studies, 1983).

32 Leipziger, vol. 1, p. 75.

33 Robert Wade, "The Rise of East Asian Trading Nations," op. cit.

34 Yung Whee Rhee, Bruce Ross-Larson, and Garry Pursell, *Korea's Competitive Edge: Managing the Entry into World Markets* (Baltimore, MD: Johns Hopkins University Press for the World Bank, 1984), table B-8.

35 Ibid., p. 16.

36 Jones and SaKong, op. cit.; R. Wade, *Irrigation and Agricultural Policies in South Korea* (Boulder, CO: Westview Press, 1982), pp. 86-88, 112.

37 Phone interview with Hee-Boum Lee, Korean Science Attache, Aug. 2, 1989.

38 Jones and SaKong, op. cit.

39 Tibor Scitovsky gives the high estimate in'' Economic Development in Taiwan and South Korea," *Food Research Institute Studies* vol. 19, No. 3,1985, p. 253; Korea Exchange Bank, *Monthly Review* vol. 16, No. 7, July 1982, gives "miscellaneous" loans (which include curb market loans) as 17 percent in 1979, 23 percent in 1980, and 8 percent in 1981. See also Cole and Park, op. cit., chapter 4; and Robert Wade, "East Asian Financial Systems as a Challenge to Economics: Lessons from Taiwan,'' *California Management Review,* vol. 27, No. 4, summer 1985, pp. 106-127.

40 Scitovsky, ibid. The Korean figure is probably biased upwards by inflation and by certain features of the rules of accounting for depreciation. One estimate of the "real" Korean figure puts it at more like 160 to 180. See World Bank, *Korea's Development in a Global Context* (Washington, DC: World Bank, 1984), p. 238, note 8.

41 Thomas G. Parry, "The Role of Foreign Capital in East Asian Industrialization, Growth and Development" in Helen Hughes (ed.), *Achieving Industrialization in East Asia (New* York, NY: Cambridge University Press, 1988). Parry shows that capital flow information is statistically weak, with different statistical organizations such as the OECD and the IMF giving very different figures for the same variable.

42 Luedde-Neurath, op. cit.

43 Korean Embassy, Financial Attache, from Ministry of Finance announcement.

44 Ministry of Science and Technology, *Annual Statistics on Science and Technology, Republic of Korea* (Seoul: Ministry of Science and Technology, 1986).

45 R.M. Gadbow and T. Richards (eds.), *Intellectual Property Rights: Global Consensus, Global Competition* (Boulder, CO: Westview Press, 1988), p. 298; Far Eastern Economic Review, "Patent drugs abuse,'' *Far Eastern Economic Review,* vol. 140, No. 25, June 30, 1988, pp. 48-49. The U.S. Trade Representative announced the formation of a task force to look into Korea's patent system, explaining, "I am concerned that there is a lack of patent enforcement in Korea," International Trade Reporter, June 15, 1988, p. 883.

46 Ministry of Science and Technology, 'Umg-term Science and Technology Forecast for the Year 2000,' in Korean (Seoul: Ministry of Science and Technology, 1986).

47 Yong-chanPark, "TheNationalSystem of Innovation in Korea, with an Introduction to the Semiconductor Industry," (University of Sussex, MSC thesis, 1987).

48 Phone interview with Hee-Boum Lee, Science Attache Korean Embassy, interview with OTA staff, Aug. 2, 1989.

49 UNESCO, *Statistical Yearbook* (Paris: 1988), pp. 3-325. See also Ministry of Education, *Statistical Yearbook of Education (Seoul: 1985).*

50 Ministry of Science and Technology, *Introduction to Science and Technology* (Seoul: 1986).

51 Yung-chan Park, op. cit.

52 Ministry of Science and Technology, *Annual Statistics on Science and Technology,* op. cit.

53 Ministry of Science and Technology, *Introduction to Science and Technology,* op. cit.

54 *Ibid.*

55 Korea Industrial Research Institute, *Industrial Technology White Paper, 1986, in* Korean, cited in Yong-chan Park, "The National System of Innovation,'' op. cit.

56 Leipziger, op. cit., vol. 2, pp. 33-36.

57 Lee Byung-Jong, "HomewardBound,' 'BusinessKorea,F ebruary 1989, p. 34.

58 Mark Clifford, "The Engine Is Straining," *Far Eastern Economic Review,* Jan. 18, 1990, p. 35.

59 *Ibid.,* p. 36.

60 Nam Choong Woo, director of the Korean Ministry of Trade and Industry's transportation-machinery division claimed that though the official rate is 90 percent localization, the real rate is closer to 50 percent. The gap is ascribed to skew in the measurement of localization success. Mark Clifford, "The Engine Is Straining," op. cit., p. 38.

6 1 Chu Yun-han, "Authoritarian Regimes Under Stress: The Political Economy of Adjustment in the East Asian NICS,' (University of Minnesota, PhD. thesis, 1987), p. 205.

62 *Automotive News,* Feb. 22, 1988.

63 Mark Clifford, "Local Anesthetic," *Far Eastern Economic Review,* vol. *45, No, 33,* Aug. 17, 1989, p. 63.

64 ''Ssang Yong Motors Takes on (Korea's) Big Three,"*Business Asia,* Sept. 18, 1989, p. 308.

65 *Ibid.,* p. 309.

66 Sohn Jie-Ae, ''Letting It All Ride on the Automobile," *Business Korea,* July 1990, pp. 25-27; Clifford, "The Engine Is Straining," op. cit., p. 36.

67 Clifford, "The Engine Is Straining,'' op. cit., p. 35.

68 Clifford, "The Engine Is Straining," op. cit.

69 Sohn Jie-Ae, op. cit., p. 28.

70 "Ssang Yong Motors Takes On (Korea's) Big Three," op. cit., p. 309.

71 Sohn Jie-Ae, op. cit., p. 28.

72 Clifford, "Local Anesthetic," op. cit., p. 63.

73 Ron McMillan, "Still Stuck in Neutral.. .," *Asian Business,* July *1988, pp. 59-60.*

74 Therefore, it is not clear that the plan was not rejected simply to preserve the economic rents gained by KAMA members from restricted entry. Gregory Noble (in a 1988 Harvard dissertation "Between Competition and Cooperation: Collective Action in the Industrial Policy of Japan and Taiwan,") has shown how dominant producers in Japan's steel minimill industry were able to persuade government to shutdown (unsuccessfully, as it turned out) "maverick" mills.

75 "South Korea Rejects Samsung's Plan To Make Large Trucks with Nissan," *Asian Wall Street Journal,* Aug. 17-18, 1990, p. 3.

76 Electronics Industries Association of Korea, *Electronic Industry of Korea 1989,* table 2B.

77 For an overview of the industry, see Byung-Moon Byun and Byung-Hun Ahn, "Growth of the Korean Semiconductor Industry and Its Competitive Strategy in the World Market," *Technovation* September 1989, pp. 635-656; Yong-chan Park, op. cit.

78 See Leipziger, op. cit., vol. 2; and Selected *Topics and Case Studies* (Washington, DC: The World Bank, 1987), pp. 202 ff.

79 Chu Yun-han, op. cit.

80 Anthony Rowley, "The Birth of a Multi-National," *Far Eastern Economic Review,* vol. 120, No. 14, Apr. 7, 1983, p. 56.

81 For details of this arrangement, see Leipziger, op. cit., vol. 2, pp. 203-204.

82 Chu, op. cit.

83 Fora corporate profile, *see Electronic Business* June 25, 1990, pp. 34-38.

84 Andrew Tanzer, "Korea Chips Away," *Forbes,* vol. 135, Feb. 25, 1985, p. 44.

85 *Electronics Weekly,* "Korea Hot on Tails of Leaders in Chip Race", June 1, 1988, p. 3.

86 Samsung Semiconductor and Telecommunication, *Retrospect for the Last Ten Years of Samsung Semiconductors and Telecommunication, in* Korean, 1987.

87 *Electronic Business* Feb. 6, 1990, pp. 25-32.

88 For corporate pro files, see *Far Eastern Economic Review, Nov. 19,1987,* pp. 80-82; *Electronic Business Aug. 20,1990,* pp. 67-9. On the tie-up with Hitachi, see "Thanks for the Memories," *Far Eastern Economic Review, vol. 145 No. 34,* Aug. 24, 1989, pp. 50-51.

89 Ministry of Science and Technology, *Annual Statistics on Science and Technology, 1986.*

90 Byun and Ahn, op. cit., p. 647.

91 For overviews of Taiwan's industrial policy, see Robert Wade, *Governing the Market,* op. cit.; Thomas Gold, *The Taiwan Miracle (Armonk, NY:* M.E. Sharpe, 1987); Walter Galenson, ed. *Economic Growth and Structural Change in Taiwan* (Ithaca, NY: Cornell University Press, 1979).

92 Council for Economic Planning and Development, *Taiwan Statistical Data Book 1988* (Taipei, Taiwan: Executive Yuan, 1988).

93 R. Myers, 1986, "The economic development of the Republic of China on Taiwan, 1965-1981", in L. Lau, op. cit.

94 Directorate-General of Budget, Accounting and Statistics (DGBAS), Republic of China, *Fourth and Sixth Censuses of Commerce and Industry.*

95 Chi Schive, The Foreign Factor: *The Multinational Corporation's Contribution to the Economic Modernization of the Republic of China* (Stanford, CA: Hoover Institution Press, 1990).

96 Taiwan Statistical Data Book 1986, op. cit., table 8-6. Total tax revenue includes revenue from the wine and tobacco monopoly.

97 Tu, C. H. and Wang, W. T., "Trade Liberalization in the Republic of China on Taiwan, and the Economic Effects of Tariff Reductions", paper to the Joint Conference on the Industrial Policies of the ROC and the ROK, (Seoul: Korea Development Institute, 1988).

98 S. C. Tsiang and Wen Lang Chen, "Developments towards Trade Liberalization in Taiwan," paper to the 1984 Joint Conference on the Industrial Policies of the ROC and the ROK (Taipei: Chung-hua Institute for Economic Research, 1985).

99 Board of Foreign Trade, "Tariff Reduction of the Republic of China on Taiwan", (Taipei: Ministry of Economic Affairs, 1988); Balassa and Williamson, *Adjusting to Success,* op. cit., p. *83.*

100 Of the 15 commercial banks, 4 are private. But the biggest (International Commercial Bank of China) is only nominally private, having been privatized in the wake of UN derecognition to allow Taiwan to have a bank with overseas branches while avoiding the diplomatic problems of government-owned banks. The other three private banks are tiny.

101 Ching-ing Hou Liang and Michael T. Skully, "Financial Institutions and Markets in Taiwan," in Michael T. Skully, cd., *Financial Institutions and Markets in the Far East (New* York, *NY:* St. Martin's Press, 1982), p. 174.

102 Sam P. S. Ho, "Small-scale Enterprises in Korea and Taiwan," World Bank Staff Working Paper #384, (Washington, DC: World Bank, 1980). The image of a street market is misleading, for most curb market credit takes the form of supplier's credits from big firms to small firms.

103 Nicholas Riegg, "TheRole of Fiscal and Monetary Policies in Taiwan's Economic Development" PhD thesis, University of Connecticut, 1978; also Taiwan's Bank of Communications, *Annual Report, various years.* Riegg, *citing* a Bank of Taiwan source, says that "up to 75 percent of loans flowed to the targeted industries" (1978:95). The Bank of Communications reporta comment proudly on the bank's success in financing its designated target industries. The 1973 report, to take just one example, gives figures to show that over haJf of the bank's total loans went to its six target industries.

104 In 1988, for example, Formosa Plastics undertook a $150 million expansion at one of its four U.S. petrochemical plants.

105 It began to do so quite early. In 1959, at a time when 76 percent of Taiwan's exports were still agricultural or processed agricultural products (mostly rice and sugar), the government promulgated the "National Guidelines for Long Range Scientific Development" and formed the "Council on Long Range Scientific Development", since renamed the National Science Council.

106 Phone interview with George Liu, North American Coordination Council Science Attache, June 30, 1989.

107 Jennie Hay Woo, "Education and Industrial Growth in Taiwan: A Case of Planning," Harvard Institute of International Development EEPA Discussion Paper #18, 1988.

108 Specifically, theproportion of tertiary students in engineering expanded from 24.6 percent in 1955-56 to 30.3 percent in 1975-76 to 32.8 percent in 1985-86. Natural sciences and medicine rose from 10.1 percent in 1955-56 to 14.6 percent in 1985-86. So as of 1985-86, a little less than half of Taiwan's tertiary students were studying engineering, natural sciences or medicine. Humanities and fine arts fell from 15.8 percent in 1955-56 to 9.1 percent in 1985-86. Law fell from 6.8 percent to 1.2 percent.

109 Ministry of Science and Technology, *Science and Technology Annual, 1984,* p. *227.*

110 National Youth Commission position, cited in Woo, "Education and Industrial Growth in Taiwan," op. cit., table 8.

111 Taiwan has a reputation as a producer of pirated products. During the 1980s, however, the government committed itself to increase the level of intellectual property protection. Since 1985, the government has overhauled its intellectual property laws, creating strong domestic pressure for retrenchment. Partly as a consequence, implementation of the new laws has been lax, and pirating activity continues. There is, however, a trend towards tighter enforcement. R.M. Gadbaw and T. Richards (eds.), 1988, *Intellectual Property Rights: Global Consensus, Global Conflict?* (Boulder, CO: Westview Press), ch. 10.

112 For an overview, see Walter Arnold, "Bureaucratic Politics, State Capacity, and Taiwan's Automobile Industrial Policy," *Modern China* vol. 15, No. 2, April 1989, pp. 178-214, from which this section draws extensively.

113 Council for Economic Planning and Development, *Taiwan Statistical Data Book 1989* (Taipei, Taiwan: Executive Yuan, 1989), p. 94.

114 A 1971 report on the state of the industry characterized technology transferred from several Japanese companies and General Motors as "inadequate," and proposed a more purposeful import-substitution role for policy. The government's response was a higher auto import tariff and a superficial package of fiscal measures aimed at stimulating domestic demand. Walter Arnold, "Bureaucratic Politics, State Capacity, and Taiwan's Automobile Industrial Policy," *Modern China* vol. 15, No., April 1989, pp. 185-186.

115 "Taiwan's Auto Industry Faces Hard Times Amid Booming Sales," *Business Asia,* Jan. 30, 1989, p. 35.

116 "Foreign Automakers Capitalize on Taiwan's Relaxed Import Code," *Business Asia,* Sept. 11, 1989, p. 300.

117 Ministry of Economic Affairs, Taiwan Board of Foreign Trade, *Foreign Trade Development of the Republic of* China, 1989, p. 2.

118 "Country report: Taiwan," *AEU: Journal of the Asia Electronics Union,* April and May 1986.

119 Foranoverviewof tbeindustry, see Se-Hwa Wu, "TheCourse of Taiwan's Integrated Circuit Industry Development" paper presented at the conference on Taiwan Enterprises in Global Perspective, Columbia University, New York, NY, Sept. 15, 1990.

120 *Far Eastern Economic Review* Aug. 2, 1990, p. 54.

121 *Electronic Business,* Jan. 15, 1988, pp. 85-7.

122 *Electronic Business,* Sept. 4, 1989, p. 79.

123 Bob Johnstone, "Chipping In: Taiwan Computer Firm in Tie-up witb US Chipmaker," *Far Eastern Economic Review, May 25, 1989,* p. 82. No information is given on help tbat Acer may have gotten from the Taiwan Government.

124 Electronics Research and Service Organization% "ROC and ROK Comparative Development of the Information Industry" (Taipei, Taiwan: Electronics Research and Service Organization 1987).

125 Note that these exports are quite import intensive; imports of inputs for personal computer components account for as much as half of the value of component exports. Chi Schive, forthcoming, "The next stage of industrialization in Taiwan and Korea," in G. Gereffi and D. Wyman, *Manufactured Miracles: Patterns of Industrialization in Latin America and East Asia* (Lawrenceville, NJ: Princeton University Press).

126 K. T. Li, "Technology Development and Cooperation among NICS in the Western Paci.tic," industry *of Free China,* vol. 68, No. 3, September 1987, pp. 1-12.

127 IBM official, personal communication, July 1989.

128 Johnstone, "Chipping In," op. cit., p. 82.

129 Science and Technology Advisory Group, personal communication. Eighteen percent of the staff were engaged in administrative support.

130 Chu Yun-han, "AuthontarianRegimesu nderStress," op. cit., p. 2,27.

131 In addition to the efforts of the public research and service organizations described above, other forms of state assistance are available to makers of electronics products. Tax incentives, loans on concessionary terms, and other privileges have been targeted on electronics; protection, however, has not.