THE KOREAN SEMICONDUCTOR INDUSTRY: HISTORICAL OVERVIEW AND PROSPECTS FOR FUTURE DEVELOPMENT

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1. INTRODUCTION

We live in a world undergoing an information revolution. As the world becomes smaller and smaller through the development of information networks including the internet, the ownership of cutting-edge information and communication technologies is rapidly becoming a factor of primary importance in both gaining, and maintaining a position in the forefront of the international political economy.

The semiconductor industry has been termed 'the crude oil of the information era', a graphic symbolization of the importance of semiconductor devices as an essential component of information and communications equipment. An increasing proportion of contemporary manufactured products, from consumer electronics to industrial robots, from consumer durables to smart missiles, without their silicone 'brains' would be useless. This implies that in the future the semiconductor industry will increasingly serve in a bed-rock capacity, being the basis for the development of virtually all other high-technology industries. Furthermore, it is clear that a wide variety of semiconductors with varying levels of technological complexity are required to meet the demand for not just high-technology goods but also increasingly mundane consumer goods such as VCRs and calculators which rely on semiconductors as well.

The semiconductor industry being characterized by varying levels of required technology, afforded opportunities for some developing countries, especially Korea, to overcome the high entrance barriers of the industry. South Korea has been particularly successful in making a name in the world semiconductor market while

many American and European semiconductor manufacturers, since the 1970s, have disappeared without trace.

Starting from scratch, the Korean semiconductor industry was fostered in the mid 1960s through the assembly of labour-intensive, low technology semiconductor devices for multi-national companies (MNCs) from advanced countries, particularly the United States of America and Japan. However, despite this rather inauspicious start, by 1995 three Korean semiconductor firms (Samsung Electronics, LG Electronics and Hyundai Electronics) came to be ranked amongst the world's fifteen top semiconductor producers. Currently, the Korean semiconductor industry is dominated by Samsung Electronics and Hyundai Electronics following the merger of LG Semiconductor with Hyundai in 1998.

From the very beginning of its semiconductor 'leapfrogging' phase which began in 1983, Korea has placed heavy emphasis on the mass production of memory chips. As of 1996, Korea controlled around 40% of the world DRAM market, allowing Korea a share of the world DRAM market equal to that enjoyed by its Japanese competitors. Korea possesses world-class DRAM production and process technologies. Samsung Electronics, for instance, announced at the end of June 1999 the successful development of the world's first 1 Gb DDR SDRAM (Double Data Rate Synchronous Dynamic Random Access Memory) at a press conference held at its US-based production complex, Samsung Austin Semiconductor.

These achievements are a clear warning to developed countries of the prospect of Korea becoming a world-beater in cutting-edge technologies in the

coming information era. It is therefore astonishing to note progress made by Korea's semiconductor industry, from a scratch starter to a world beater in less than fifteen years. How has Korea managed to develop its semiconductor industry so successfully in such a short period of time? What are the historical precedents which allowed Korean firms such an advantage over international competitors? What effect did the recent financial turmoil have on the industry, and what are the future prospects in the wake of the economic crisis? It is the aim of this paper, using broad sources of information, to firstly outline the historical background, recent economic and political factors in an effort to provide answers to these questions.

2. STATE INDUCEMENT OF FOREIGN CAPITAL (1965-72)

In the early 1960s semiconductor producers from the United States were seeking skilled and relatively cheap labour in foreign countries. South Korea was an ideal place for this purpose because of its highly skilled human resources, low wages, and peaceful environment ensured by the authoritarian government. The first foreign investment in the Korean semiconductor industry was made by the U.S. firm Komy, in December 1965. Although the size of investment was relatively small, this was the first important step in developing a domestic semiconductor manufacturing industry.

The first sizeable investment was made by Fairchild in 1969. At that time, it was one of the largest semiconductor firms in the United States. Fairchild set two preconditions: 100% ownership and free access to the domestic market. It was almost impossible for the Korean government to satisfy these conditions due to existing legislation on foreign investment .

The Fairchild conditions were discussed and reviewed by the Economic Planning Board of Korea (EPB). The EPB decided to use its right to amend the legislation governing foreign investment with the view to attract more foreign capital and technologies in the future. Large foreign investment was crucial for the government-devised plan to promote the domestic electronics industry. We can see from this fact, that even laws and regulations were changed in order to create favourable conditions for implementation of a government strategy to induce foreign investment. As it was planned, many US semiconductor and electronics firms arrived in Korea attracted by Fairchild's success and established joint ventures as well as exclusively owned firms (see table 2.1). Following the example of Toshiba in 1969, Japanese companies joined this trend as well. (Hong 1997, 82-83)

Table 2.1 - Foreign Investment in Korean Semiconductor Firms (1965-1973)

Approval Date by the EPB	Name of Firm	Foreign Investor	Country	Investment Amount ($1000)	Foreign Ownership (%)	Location
12.1965	KOMG	KOMG	USA	76	25	Seoul
4.1966	Semikor	Fairchild	USA	2250	100	Seoul
7.1966	Signetics	Signetics	USA	1750	100	Seoul
12.1966	Korea-Micro	KMI	USA	224	49	Seoul
3.1967	Motorola	Motorola	USA	8000	100	Seoul
7.1968	IMEC	Komy	USA	1210	100	Seoul
1.1969	Minsong	Han-American	USA	145	35	Seoul
7.1969	Toshiba	Toshiba	Japan	1400	70	Kumi
9.1969	Samsung-Sanyo	Sanyo + Sumitomo	Japan	1500	40 + 10	Seoul
3.1970	Taehan	AMI	USA	2264	100	Seoul
3.1970	Electrovoice	EV	USA	50	50	Kumi
7.1970	Varadyne	Varadyne	USA	294	49	Kumi
7.1970	Korea IC	Tesco	USA	700	50	Kumi
12.1970	Toko	Toko	Japan	390	100	MAFEZ
9.1971	KTK	Toko	Japan		100	MAFEZ
7.1972	Rohm	Rohm	Japan		95	Seoul
11.1972	Tokyo Silicon	Sanyo	Japan	1624	100	MAFEZ
5.1973	Sanken	Sanken	Japan	700	100	MAFEZ

Sources: Soh Changrok, September 1997

The creation of an electronics industrial complex was amongst the most important objectives of the Electronics Industry Promotion Law. President Park was personally involved in this issue. The Kumi Electronics Industrial complex was officially opened in April 1970. The complex was granted numerous privileges and government support in the form of infrastructure and facilities development. (Park, et al 1987)

Masan Free Export Zone (MAFEZ) was established together with the Kumi Industrial Complex, following the instructions of the Korean government. The main purpose of MAFEZ was to attract Japanese investment. The port of Masan in the southern part of Korea was especially selected because of its geographical proximity to Japan. As it was forethought by the government, Japanese capital dominated in MAFEZ, and in 1974 it accounted for more than 90% in terms of number of foreign companies as well as in terms of the size of total investment. (Lee Changrok 1974, 1212-1257)

MAFEZ serves as an example of the government's desire to attract as much foreign investment as possible. At the same time, it shows the great dependence of Korean economy on imported capital. MAFEZ made clear the state attitude towards foreign capital. The government evidently favoured joint ventures over to 100% foreign owned enterprises. (Soh 1997, 221)

The Foreign Capital Inducement Law was enacted in 1969, providing different types of incentives for foreign investment such as five year tax holidays, duty-free imports of capital goods and raw materials, and 50 per cent income tax reduction. It is worth noting that the Foreign Capital Inducement Law did not have detailed instructions regarding foreign investment, stating that the process of foreign direct investment should be regulated by the Economic Planning Board and the related ministries, including the Ministry of Trade and Industry. (Yoon 1989, 50)

The Korean government continuously promoted the electronics industry even during the periods of massive foreign investment inflow. The government's dedication to developing the electronics industry was announced by President Park in

the 1967 ‘ State of the Nation Address’ . Professor Wan-Hee Kim of the Department of Electrical Engineering at Columbia University was invited by the Ministry of Trade and Industry in an effort to help promote the Korean electronics industry. Mr. Kim prepared a report on the issue and submitted it to the president Park in September 1967. The Scientific and Economic Council also prepared recommendations in March 1967. Both recommendation packages, one by the Economic and Scientific Council and the other by the MTI were almost identical and included the following points:

- adoption of systematic industrial policies including the enactment of the Electronics Industry Promotion Law;
- export promotion;
- long-term policies for the education of technical personnel;
- encouraging the *chaebol* to enter the electronics sector;
- various tax incentives;
- the establishment of the Electronics Industry Promotion Fund.

(EIAK 1989, 56-61)

These recommendations where again aimed at attracting foreign investment and export promotion. In order for the industry to become more competitive in the international market, the government tried to induce large conglomerates to enter the electronics sector. Two *chaebol,* Taehan Electric Wire and Samsung, entered the electronics industry in 1968 and 1969 respectively. One of the most important milestones in the government’ s vigorous efforts to promote the industry was the enactment of the Electronics Industry Promotion Law in 1969. At the same time, The

'Eight-Year plan for the Electronics Industry Promotion (1969-76)' was prepared by the Ministry of Trade. This plan consisted of the following three main points:

1) developing 95 major products;

2) exporting $400 million by 1976;

3) establishment of the 14 billion won Promotion Fund.

(EIAK 1989, 76-82)

As a result of the these government efforts, the Korean semiconductor industry grew rapidly reaching 5% of total exports by 1973. The share of private investment into the electronics industry sharply increased in response to the government's promotion strategy. The number of firms in the electronics sector in 1968 numbered 120 (115 domestic, 3 exclusively foreign subsidiaries, and 2 joint ventures). (EIAK 1989, 40) It is obvious from this fact that despite of various incentives by the Korean government to attract foreign investment into the electronics industry, the government policies did not bring the desired results due to negative attitude towards 100% foreign owned enterprises, and constraints in accessing the domestic market. The situation in the semiconductor industry was quite different from that described above, as foreign capital and investment were crucial for the development of this industry. (Hong 1997, 85)

As a part of the plan to promote the domestic electronics industry, The Korea Electronics Industry Cooperatives (KEIC) were formed in 1967 by private producers, under the patronage from the Ministry of Trade and Industry. The KEIC was created in order to establish an effective communication channel between MTI and the industry as a whole, rather than with individual producers. (EIAK, 1989, 86-90)

Although big conglomerates at that time were not involved in the manufacturing of semiconductors, the entry of Samsung into the electronics industry in 1969 was an important occurrence for the long-term development of the industry. Based on its early entry, Samsung managed first to capture the leading position in the Korean semiconductor industry, and later, in the world market. Other companies involved in producing electronics strongly opposed the entry of Samsung. All 59 members of the Electronics Industry Cooperative Association unified in an effort to prevent the state's approval of Samsung's joint projects with Sanyo and NEC. They were afraid that Samsung, already superior in many terms, would drive them out of the domestic market. Responding to the efforts of existing firms, the government placed two preconditions on Samsung' s joint projects:

1) The entire production was to be exported.

2) Items to be produced were restricted.

(EIAK, 1981)

Samsung's entry into the electronics industry illustrates well the relationships existing at that time between the state and private manufacturers. Under pressure from the opposition, the government placed certain constraints on the company although it actually approved Samsung' s initiative. In March 1971, both of the restrictions were abolished.

Summarizing the above it could be said that:

The creation of the Korean semiconductor industry was initiated as a result of state efforts to attract foreign investment, and due to the willingness of American and Japanese companies to develop off-shore production of semiconductor devices.

Based on the outward looking industrialization strategy, the state was providing various incentives to attract foreign capital. The number of foreign subsidiaries involved in semiconductor manufacturing was increased substantially due to the enactment of the Foreign Capital Inducement Law in 1969. It should be noted, however, that none of these companies represent major semiconductor manufacturers firms, today.

Despite of the early entry of Samsung into the electronics industry, semiconductors started to play an important role in the operations of the company only after the mid-70s, when Samsung absorbed Korea Semiconductor Inc. In general, we could say that at this stage the state was reasonably successful in the promotion of exports and attracting foreign capital.

3. HCI PROMOTION PERIOD (1973 - 1979)

Due to the high levels of export dependency of the Korean economy, the world economic downturn of the 1970s, the dismantling of Bretton Woods system, as well as the announcement of the Nixon doctrine were quite detrimental. The first Oil Shock of 1973 worsened the situation further. The policy of the United States government to withdraw a portion of their troops from the Korea, as well as the uncertainty brought about by the Nixon doctrine pushed the Korean government to accelerate the implementation of heavy and chemical industrialization. Unlike Japan and Taiwan, Korean government undertook a sharp expansionary economic strategy. In the 1973 ' State of the Nation Address' heavy and chemical industry development was announced by the Korean president as the new direction for economic development.

The main principles embodied in the Heavy and Chemical Industrialization were stated as follows:

1) six strategic industries shall be intensively promoted;
2) production shall be geared toward export except a small portion of import substituting domestic consumption goods; and
3) manufacturing facilities shall be built on a large, internationally competitive scale

Taking into account its high export potential, the electronics industry was selected for promotion under the heavy and chemical industrialization program. The electronics industry during that period grew rapidly and was focused mainly on the production and export of consumer electronics. Rapid development of the electronics

industry brought about an increase in demand for semiconductors. The majority of the domestic demand for semiconductors at that time was met by the Japanese producers. As Korean consumer electronics were becoming more competitive in the world market, Korean electronics producers frequently experienced shortages in supply of semiconductors from Japan. This situation was usually becoming more acute during the periods of market boom.

Most semiconductor related projects were heavily dependent on both foreign capital and technologies which were not easy to obtain. This fact created constraints for Korean companies in exploiting opportunities offered by the latest semiconductor developments. Overcoming this structural dependence on imports was one of the main objectives of the Korean government when promoting the electronics industry under heavy and chemical industrialization plan. In 1975 the Economic Planning Board further simplified regulations governing foreign investment to create a favourable environment for inducement of foreign participation in the technology sector. A six-year plan was prepared by the Ministry of Trade and Industry to promote local production of six electronic components, including memory devices and silicon wafers.

The economic boom of the 1970s began to decline in Korea from the mid 1980s. Taking into account the relatively low technological level of the semiconductor industry in Korea, most of the above-mentioned projects depended on the acquisition of foreign technologies. It was extremely difficult to obtain such large quantities of modern technology as foreign (and especially Japanese) firms were quite reluctant to transfer it to Korean chipmakers. Despite government plans to attract as

much foreign investment as possible into the semiconductor industry, it did not allow more than 50% equity share by the foreign firms, with the result that the level of foreign investment in Korea changed little.

Despite the vigorous efforts of government and the private sector in developing domestic semiconductor manufacturing capability there were no significant changes in the Korean semiconductor industry barring the entry of Samsung and Goldstar. Priority was placed on the promotion of the heavy and chemical industries and on the strengthening of country's export potential. As long as the exports of electronics were growing, the government did not expend large amounts of effort in promoting the semiconductor industry despite its original plan to do so. A major portion of already limited resources were being channeled to the heavy and chemical industries making further investments into the domestic electronics industry impossible. The promotion fund, initially planned to be instituted by 1969 upon enactment of the Electronics Industry Promotion Law, was not created until 1979 (EIAK 1989, 174).

"*Though the state in this period could be viewed as truly capitalist developmental state shown in its very strong push for heavy and chemical industrialization, the achievements in the semiconductor industry were considerably low. Unlike the Taiwanese state during the same period, the Korean state did not launch any significant research projects or the construction of semiconductor facilities, though these were planned as part of heavy and chemical industrialization. The entry of Samsung and Goldstar in the semiconductor business was a real breakthrough. These two semiconductor firms, however, largely remained as simple assemblers, rather than independent manufacturers. Thus what was actually*

achieved in the semiconductor industry during the second phase was not only far from the original plans but also not directly linked to the subsequent development in Korea" (Hong 1997, 94).

During the 1970s foreign companies continued to constitute the bulk of domestic manufacture and export of Korean made semiconductors. The growth (46.6% average annual growth rate during 1971-79) of the electronics industry was based mainly on consumer electronics rather than on production of components and semiconductor devices. As it was mentioned before, the rapid growth of the electronics sector increased demand for semiconductors and led to the inducement of large conglomerates such as Samsung and Goldstar into the semiconductor industry. Since the beginning of 1980s Korean *chaebol* specializing in electronics production started to invest heavily in the semiconductor business, and thus, this period is considered to be a true start of Korean semiconductor industry.

4. THE TECHNOLOGY LEAPFROGGING EFFECT (1980-87)

Starting from the end of the 1970s, the Korean economy was in recession and its GNP growth declined to 2.5% per year from an average of 9.9% from 1962 to 1978. In 1980 the Korean economy growth rate of -4.9% was Korea's first experience of negative growth since 1962. Inflation rates increased to 26.4% in the same year. Trade deficits rose from $1.8 billion in 1978 to $4.4 in 1979 (World Bank 1980). Part of the reason for this decline in economic performance may be attributed to external factors, such as the second Oil Shock in 1979, and rising international interest rates. Internal factors included the political instability that concluded with the assassination of President Park in October 1979, (Lee 1980, 63-67) and the tremendous over-capacity of, and inflation caused by, the heavy and chemical industrialization. (KDI 1981; Haggard and Moon 1990, Woo 1991, 178-82).

In April 1979, President Park's government announced the Comprehensive Measures for Economic Stabilization (CMES) that differed greatly from the previous expansionary economic strategy pursued by the government. The main components of the CMES were the following:

1. "*emphasis on comparative advantage rather than industrial targeting and import substitution;*
2. *transition toward an economy led by the private sector;*
3. *a general reduction of state intervention and wider play for market forces;*
4. *emphasis on social development;*
5. *vigorous pursuit of macroeconomic stabilization"* (Haggard and Moon 1990, 219).

In May 1980, Major General Chun Doo-Whan seized the power in the country by means of military coup and immediately set about reshuffling the heavy

and chemical industries. Those in charge of the creation of CMES continued their work during the Fifth Republic (1981-87). This gave a new direction to the industrial policies of the 1980s. Two main objectives were to be reached under the new industrial policy of the government; liberalization and stabilization. 'Indicative planning' was to replace active state intervention under these changing conditions.

The new direction of the government policy was also influenced by the increasing pressure from the developed countries for liberalization of the Korean market. In response to this pressure in the beginning of 1980s the Korean government had to introduce new trade and finance liberalization programs. (Yoffie 1983; Odell 1985; Hong 1988).

The Electronics Industry Law was amended in 1981 and a new, long-term promotion plan for the Electronics Industry was announced by the Ministry of Trade and Industry. Comparing to previous state devised plans, this plan was less authoritarian in its tone and basically represented the government guideline for the further promotion of the Electronics Industry.

In the meantime, by 1986 Samsung's memory business appeared to be becoming quite successful. This fact had a great resonance within the Korean government and private circles, as it was a clear sign of Korea's future competitive advantage in high-tech industries.

"A major difference between the policy measures adopted in this period and the previous ones lies not in the content, but in the nature and process of developing

semiconductor policies. In sharp contrast to the promotion efforts up until the 1970s, the programs in the 1980s were 'indicative' in nature, meaning that the state simply drew the guidelines rather than actively pushing the policy targets specified in those plans. In addition, most of these policies were demanded by the private sector rather than directly initiated by the state. In many cases, the state simply endorsed the private projects already set in motion" (Hong 1997, 96).

One of the biggest differences between mid 1980s and the preceding period is that in mid 1980s private businesses took the initiative both in terms of investment and production. The role of the government in promoting the semiconductor industry has declined to the degree where some private manufacturers called upon the government to intervene in the sector (Soh 1997, 234).

In 1981 Samsung Electronics devised a plan to invest some $13 million in semiconductor mass production facilities. Between 1981 and 1982 Samsung created a semiconductor research center. In 1982, the former Chairman Lee Byung-chull, and the founder of the Samsung Group announced that Samsung's future strategy will be largely focused on the semiconductor business.

There were several reasons for Samsung to specialize in the production of DRAM. First of all, DRAM is the most widely used semiconductor device and consequently has the biggest market share. Secondly, DRAM requires relatively simple technology allowing its mass production. At the end of 1983 Samsung developed the 64K DRAM. This was a big technological advancement followed by many other achievements. In October 1984, Samsung developed a 256K DRAM,

followed by a 64K SRAM in 1985, a 1M DRAM in 1986, a 256K SRAM in 1986, a 4 M DRAM and a 1M SRAM in 1988, a 16 M DRAM in 1990, a 64M DRAM in 1992, and a 256M DRAM in 1995. Although the initial technology for production of these devices was borrowed from abroad we can clearly see that Samsung's developments within the semiconductor industry have been astonishing.

Korean semiconductor manufacturers started to increase their foreign operations and become more internationalized through alliances with foreign companies. By 1985, all three leading Korean semiconductor producing conglomerates (Samsung, LG, and Hyundai) established operations in "Silicon Valley" in the United States with investments totaling $1 billion. The main purpose of such investments was the acquisition of modern technology, staff training and coordination of business with overseas partners. (Business Korea, 1985)

As mentioned above, Korean semiconductor manufacturers were heavily dependent upon foreign technologies. Therefore, initially between 9% to 23% of total investment was channeled to the production facilities rather than research and development. For example, between 1982 and 1986, 53 technology transfer contracts were signed, from which 48 were related to wafer fabrication. (Park et al. 1987, 281). The United States provided 36 out of the total 53 (68%) transfers. Japan was the second main source transferring 13 technologies. Import of similar technologies by large Korean semiconductor producers indicates the fact of growing competition among them as well as lack of government coordination in regards to the imports of semiconductor related technologies from abroad.

In 1985 Korean semiconductor producers were severely affected by a volatile character of the world semiconductor market. The demand and price of memory devices declined significantly. This forced most of Korean semiconductor companies to amend their aggressive investment plans.

"Samsung, however, continued its push for the more advanced memory chips and accelerated the development of more sophisticated DRAMs, though it was the most severely hit by the price drop. Goldstar took a moderate step, and focused its production for in-house consumption and the long-term OEM production for Hitachi. Hyundai had to close down its pilot production facility in Silicon Valley, but continued investments because it had considerable in-house demand from its automobile firm. Daewoo also had to scale down its semiconductor project drastically. When the market recovered in 1986, Daewoo was far behind in the semiconductor business and never came back to the leading position, Samsung, LG and Hyundai continued their business, and by 1986, the combined sales of these firms accounted for more than 90 per cent of Korean wafer fabrication" (Hong 1997, 103).

Nonetheless, during that period South Korea along with other East Asian nations significantly improved its ranking following the regional pattern of rapid economic development (see Table 4.1)

Table 4.1 GNP per capita levels and country rankings (US$, current prices) 1962 and 1986

1962	**Comparable**[b]	**1986**	**Comparable**

	Rank[a/] amount	economies	Rank/ Amount	Economies
Taiwan	85/ 170	Zaire Congo, PR	38/ 3,580	Greece Malta
South Korea	99/ 110	Sudan Mauritania	44/ 2.,372	Surinam Argentina
Hong Kong	40/ 450	Spain Malta	28/ 6,906	Saudi Arabia Israel
Singapore	38/ 490	Greece Spain	25/ 7,411	New Zealand Bahamas

Notes:

a- Ranking out of 129 countries

b- Comparable refers to countries immediately above and below the four dragons in the World Bank Atlas listing.

Source: (Hobday M., 1995, p.15)

If we look at the sources of investment into the Korean semiconductor industry we will observe the following picture: only 20% of the investment was financed by the industry itself before 1986. The remaining 80% came in the form of loans from domestic and foreign financial markets. Foreign borrowing accounted for almost 32% of investments made until 1986 (Park et al. 1987, 278). Consequently, about 48% of the required investment was provided by the domestic financial market where the state still played a dominant role. For example, some semiconductor R&D related projects received funding under government sponsored programs for Special Research Projects.

Summarizing the above, it could be said that after 1983 large conglomerates have taken the initiative in expanding production as well as R&D related activities within the semiconductor industry in Korea. The difference between government directed development of the semiconductor industry in 1970s and private sector led

reinforcement of the sector is evident. During this period *chaebol* participated actively in the strengthening of the semiconductor industry not due to the incentives offered by the government, but because of the importance of the industry itself for the future of these groups.

5. FROM IMITATION TO INNOVATION (1988 - 1996)

1987 was marked in the history of Korea as another period of political transition. Roh Tae-woo, a retired military general and a close friend of President

Chung became the next president of Korea representing Democratic Justice Party. There was also growing pressure for democratization from different strata of society including the labour unions, the opposition political parties, church and students. The atmosphere was generally tense and further exacerbated by labour unrest and student demonstrations.

Increasing demands from the United States for the liberalization of trade after 1988, import restriction by advanced countries as well as the appreciation of the national currency, put Korean businessmen and politicians in a difficult situation. Starting from the mid 1980s, Korea opened its wine, tobacco and insurance markets and made an effort toward liberalizing the banking sector. Under pressure from the United States, Korea was also forced to appreciate its currency from ₩890 per dollar in 1986, to about ₩720 in early 1991. The main reason for this appreciation was to reduce bilateral trade deficits ($9.9 billion in 1988) between Korea and the United States.

All of the aforementioned changes resulted in decreased competitiveness of Korean exports in the world market. For example, the annual growth rate of electronics exports decreased from 35.4% in 1988 to just 9.5% in 1989 (Hong 1997, 105).

During this period the *chaebol* gained more and more independence. The state could no longer disregard private sector opinion *"given the dominant economic position of the chaebol, and taking into account that their performance was a crucial factor contributing to the government's political legitimacy".* (Soh 1997, 234).

Since 1988 there was an ever-increasing pressure for more equitable wealth distribution. Huge profits earned by the *chaebol* were considered by a majority of the public to be unfair. During that period government was frequently blamed for facilitating the expansion of *chaebol.* As most of the Korean semiconductor industry was owned by large conglomerates such as Samsung, LG and Hyundai, it became very difficult for the government to continue to promote it.

There was also an external constraint in the form of US giant electronics manufacturers. Following Vernon's product life cycle theory (Vernon 1966, 1971), US MNCs scattered their production facilities in different countries to increase their competitiveness in the world markets, and transferred relatively simple technologies. Based on these technologies, countries like Korea developed quite sophisticated technologies able to threaten even US semiconductor manufacturers. U.S companies already had unpleasant experiences with the Japanese leapfrogging and were undertaking protective measures against transfer of technologies able to undermine their competitive advantage in the semiconductor sector.

Because of the increasing pressure from the United States, Korea had to comply with the international norms for intellectual property right protection that absolutely prohibits reverse engineering by semiconductor firms. Since then, Korean semiconductor firms have had to deal with numerous lawsuits, mostly by US semiconductor companies accusing Korean producers of being in violation of patent rights. The Uruguay Round and the resulting World Trade Organization (WTO) have

also increased restraints on the Korean government with regard to promoting particular industries.

The state-private partnership in formulating and implementing science and technology related policies has significantly increased during that time under the pressure of the aforementioned constraints. At the same time, the state's reduced ability to promote the semiconductor industry was counterbalanced by the growth and increased strength of *chaebol*.

Despite of the fact that the private research capabilities were increasing rapidly during 1980s, still most of the advanced technologies were purchased from abroad. Before 1993 R&D investment from private sources was around 14% of total revenues, and it decreased to less than 10% afterwards. This does not mean that R&D spending has decreased, on the contrary, the absolute amount of investment by private companies in research and development in the early 1990s increased significantly.

In 1990 around US$650 million were spent by Samsung on R&D (30% increase comparing to the previous year). Still this amount was smaller than of Japanese Matsushita and Sony who spent US$2.3 billion and US$1.1 billion respectively. (*Asian Business*, October 1990, pp. 28-29).

Table 5.1 points out the smaller size of Korean electronics companies comparing to Japanese ones. For example Samsung's electronics operations are approximately 25% of Sony's operations. Nevertheless the sales were frequently larger comparing to the majority of European and US companies (except IBM). Even

during the global economic recession in 1992 were quite profitable, while many Japanese, European and US companies suffered from heavy losses (Hobday 1995, p.72).

Table 5.1 - Sales of Electronics by South Korean and Japanese conglomerates; 1991 and 1992 (trillion Won, US$ billions)

	1991		**1992**		**1992 net profits**	
	Trillion Won	**Billion US$**	**Trillion Won**	**Billion US$**	**Trillion Won**	**Billion US$**
Korean firms						
Samsung	6.0	7.9	6.1	7.8	0.72	92
Goldstar	3.8	5.0	3.8	4.8	0.27	34
Daewoo	1.6	2.1	1.7	2.2	0.17	22
Japanese Firms						
Fujitsu	-	29.0	-	30.0	-	0
NEC	-	31.5	-	29.0	-	-100
Sony	-	32.0	-	32.5	-	210
Toshiba	-	39.0	-	39.0	-	200

Source: (Hobday 1995, p.73)

We should also pay attention to the improved organizational capacity of the *chaebol* involved in the semiconductor industry. Utilizing their worldwide presence and marketing networks, planning and coordination departments of the *chaebol* were able to efficiently gather information about the semiconductor market including future market size, strategies of rival companies and related government policies in different counties.

Despite of the fact that the Korean semiconductor manufacturers attained success in production of memory devices, many structural imbalances still remained unchanged. For instance, according to 1995 figures, the share of memory products in total semiconductor production was around 91% and only the remaining 9% was devoted to non-memory devices. Such concentrated production patterns may be explained by the shortage of advanced technology and by insufficient development of related industries involved in production of materials and equipment.

Imbalances of the production structure led to the imbalances in the export/import pattern. For example, around 90% of Korean semiconductor production was exported, whereas, almost 70% of domestic semiconductor demand (mainly for devices of relatively high sophistication) has been met by imports (see table 5.2 and 5.3) (Hong 1997, 113).

Table 5.2 - Domestic Market Sizes and Imports of Semiconductors, (1991-96 $million, %)

Year	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Markets (A)	2,320	2,570	3,080	3,500	4,399	5,300
Markets (B)	1,879	2,107	2,402	2,660	3,035	3,604
B/A (%)	81	82	78	76	69	68

Notes: Estimated figures after 1995 Source: KSIA (1996), p.14.

Table 5.3 - Domestic Demands, Production, and Imports of Equipment and Materials, (1990-95, $million)

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**

Equipment						
Demand	717	904	874	1,392	1,977	2,174
Production	53	75	94	107	171	391
Import	664	829	780	1,285	1,806	1,783
Materials						
Demand	508	591	714	946	1,314	1,872
Production	160	193	239	347	553	876
Import	348	398	475	599	761	996

Notes : Estimated figures after 1995 Source : KSIA (1996), pp.18-24.

To overcome such weaknesses, Korean companies were trying to devise various globalization policies. After 1993, the Korean government strongly pushed for creating industrial alliances with foreign and especially the U.S. semiconductor companies. One of the reasons for forming such alliances was to press jointly for the opening of markets in Japan as well as challenging Japan with technological achievements. As the United States were competitive in cutting the edge technology, it was thought to combine this advantage with Korea's manufacturing strength and highly skilled labour force to counterbalance the structural weaknesses outlined above. (Kim Wan-Soo, April 1996, 15).

Newly industrialized economies have a slightly different pattern of specialization comparing to the advanced economies. Catch-up hypothesis *(Abramowitz, 1990)* argues that a relatively low income economies may be able to advance faster than the ones with high income levels since they have an opportunity to utilize technological innovations developed by the latter. (OECD, 1999, p.30). When we look at figures for Korea (see Annex 1), a number of differences are

obvious. Intensity of Korea's R&D as well as the number of scientific and technical articles per unit of GDP is quite low in comparison to other advanced nations. In general Korea's innovative activity appears to be lower comparing to the advanced countries and the transfer and adoption of foreign technology still plays an important role.

Summarizing the aforesaid, we could say that during this phase the private sector has been the major driving force of the semiconductor industry in Korea. Smart decisions taken by Korean private businessmen were the main factors in Korea's leapfrogging in the semiconductor industry. At the same time, it should be noted that such decisions were supported by the government, which at that time was still in control of the country's banking sector.

6. THE ECONOMIC CRISIS OF 1997 AND FUTURE PROSPECTS

6.1 The Economic Crisis of 1997

South Korea has transformed itself from the position of being one of the world's poorest countries at the end of WWII into the eleventh largest economy in the world by 1998. It has developed several industries including automobiles, shipbuilding, and semiconductors. The semiconductor industry has become especially synonymous with this economic expansion as it saw South Korea build a dominant position in the memory market. But, in 1996, the collapse of prices within the world DRAM market seemed to predict the imminent demise of Korea's economic boom years.

Korean manufacturers have historically experienced large increases in their market shares of DRAM. According to 1995 and 1996 statistics, the three major Korean manufacturers enjoyed at that time more than 30 percent of total semiconductor production. Although the entire market share was less than that of Japan, Korea was establishing its position in the market. From 1993 to 1995, the DRAM market reached its climax with profitability being high. Under such circumstances, Korean manufacturers invested heavily in order to rapidly expand their production capacity in an effort to increase their market share in this highly lucrative market. However, as a result of such hasty expansion in DRAM production capacity and improvement of production process, toward the end of 1995, the supply of DRAM came to exceed market demand. New production capacity was downscaled continuously, but the problem of overproduction was never effectively addressed throughout 1996 or 1997. As a direct consequence the market price of DRAM dropped. Although Korean manufacturers continued to improve production capabilities and strove to win further market share of DRAM, since 1996, both

earnings and profits were decreasing continuously. Finally, under bitter market competition, semiconductor manufacturers started to incur losses in 1997.

Due to the expansion of its economy, South Korea has suffered from a situation of chronic excess capacity, not only in the semiconductor industry but also in automobiles and other products. Companies that could not make adequate returns on their heavy investments began to default on loan repayments, consequently, foreign investors lost confidence. Finally, the Won came under attack ending Korea's years of market boom.

Like Japan, South Korea's banks became over-burdened with bad debts during Korea's rapid economic expansion and many of the bank's assets were held in the form of stocks or real estate rather than in hard currency. Nevertheless, there are some significant differences between South Korea and Japan. Japan had very small amount of foreign debt, especially in dollars. On the contrary, while Japan was running large trade surpluses in years when the economy was booming, it was able to amass significant holdings of foreign currency. In comparison with Japan, Korea had a very large level of foreign debt and relatively low foreign capital reserves.

Many of Korea's banking institutions may be classed as "merchant" banks. They differ greatly from the kind of merchant banks which may be found in the United States. U.S merchant banks specialize primarily in loans to businesses, whereas, the Korean "merchant" banks specialize in short-term loans. Many of these banks were established in 1972 in an effort by Korean government to draw money from Korea's illegal 'curb' money markets to legitimate banking institutions within

government control. Many of these "merchant" banks took on short-term loans from international money markets to lend to their customers, taking advantage of favourable exchange rates. The problem occurred when the customers started to default. The merchant banks had insufficient reserves to pay back their offshore loans. At the same time, there was an unusual problem with credit checking, "cronyism" and other related issues in many Asian countries.

For several weeks during 1997, the South Korean government tried to survive without requesting help from the IMF. But finally, in December, an agreement was reached for $57 billion dollars of IMF loans to be paid to Korea. The won was depreciated by 40.0% against the U.S. dollar, and Korea finally had to face the reality of its situation. The IMF stand-by agreement included clauses that stipulated that the government must let banks fail rather than bailing them out, and financial markets must be thrown open to foreign investment. Other significant weaknesses brought to public attention by the crisis included unbelievably high debt/equity ratios, massive foreign borrowing and the lack of discipline within the financial sector.

"Since the typhoon of the International Monetary Fund hit the South Korean Peninsula, the semiconductor industry in Korea has been among the most seriously affected industries. As a result, the export of Korean semiconductors in 1998 fell to $13.5 billion, 5% lower than the same period in 1997" (H.Y. Kim, 1999).

Due to the terms and requests of the IMF stand-by agreement, the Korean government had to suppress funding to the semiconductor and automobile industries. As a result, Hyundai Electronics refused to make a planned investment in Scotland,

UK and LG Semiconductor postponed indefinitely a similar investment project in Wales, UK.

As a next step, the government, influenced by the IMF, pushed Hyundai Semiconductor to merge quickly with LG Semiconductor. This merger in-turn delayed investment into a new facility for the development and production of 256 Mb DRAM, until the merger was complete.

Hyundai and LG negotiations regarding the terms and conditions of this merger proved to be time consuming. In the meantime, at the end of 1998, Samsung announced that it was going to complete its ninth fabrication facility for 64 Mb DRAM by the first half of 1999. This would allow Samsung to keep its status of being number one producer in the world memory device market.

The final decision regarding the merger of Hyundai Semiconductor with LG Semiconductor was taken at the end of 1998. According to U.S. consulting firm, Arthur D. Little, Hyundai was given the controlling stake of the merger. As a result of this merger Hyundai becomes the second largest company in the world DRAM market. By means of this merger, the Korean government and the industry authority assert that up to $2.5 billion of duplicated investment on R&D, royalties and expenses for patents may be saved.

The financial crisis of 1997 caused the worst recession in Korea since the postwar era and had a devastating impact on the economy of the country. Real GDP fell from 5% to 10% before crisis to -5.8% in 1998. Unemployment increased from

pre-crisis levels of 2% to 6.8% in 1998 and 8.1% in March 1999. (Joon-Ho Hahm, Frederic S. Mishkin, 1999).

6.2 The Post Crisis Economic Rebound

Avoiding years of decline and depression, the crisis affected economies of East and South-East Asia are revealing a striking ability to recover rapidly to the surprise of international spectators. The semiconductor industry is showing a similar tendency toward recovery in response to the improving business environment. The Korean Semiconductor Industry Association (KSIA) estimates that total semiconductor exports in 1999, including those by assembly and packaging firms, will reach $18.2 billion, an 11% increase compared to 1998. (H.Y. Kim, 1999).

When the crisis started, foreign investors and businessmen working in East Asia thought they were the unluckiest people on the planet. One day they benefited from an economic miracle and the next they fell into a financial crisis, as capricious foreign capital fled the currency and stock markets, for no obvious reason.

The same foreigners, it emerged, thought in reality they were inefficiently managed economies with an element of cronyism. Nevertheless, fortune appears to be returning to them and the capital is flooding back in. It seems now that affected by the crisis economies of East and South-East Asia are capable of making rapid recoveries. Next, probably, will come a gaggle of books and articles promulgating a new economic miracle.

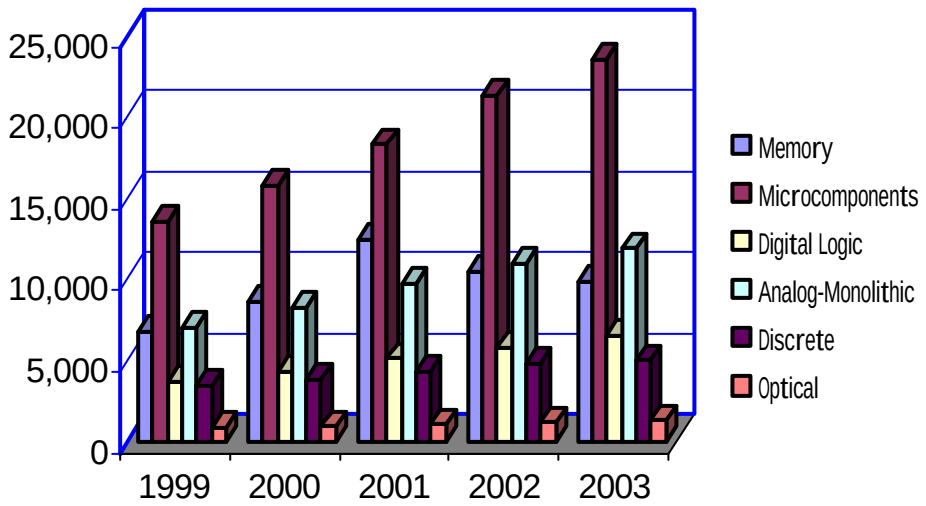
In South Korea, for instance, the recovery has been exceptional. Private economists are forecasting 5 - 8% GDP growth this year. Thailand and Malaysia are also rebounding quickly. Even Indonesia, which has experienced a 20% drop in GDP, is expected to return to expansion at the end of 1999. (The Economist, 08/21/99)

Although a relatively quick recovery was forecasted by many economists, its speed and magnitude has surprised even the optimists. Looking at the change in sentiment in the stock markets we can see that over one year after the crisis those in Thailand and Malaysia have almost doubled. The major indexes in Seoul and Singapore are now above the pre-crisis levels.

Responding to the signs of recovery, consumer spending is growing everywhere throughout the Asia. As domestic demand increases, so do exports (See Graph # 1) within the region. Now, export volumes are soaring. The even more speedy recovery of imports is actually decreasing current-account surpluses, but the process itself shows us that a recovery of East Asian economies has actually started.

6.3 Asia/Pacific Semiconductor Market, Revenue Forecast, 1999-2003, Millions of Dollars

Graph 1.

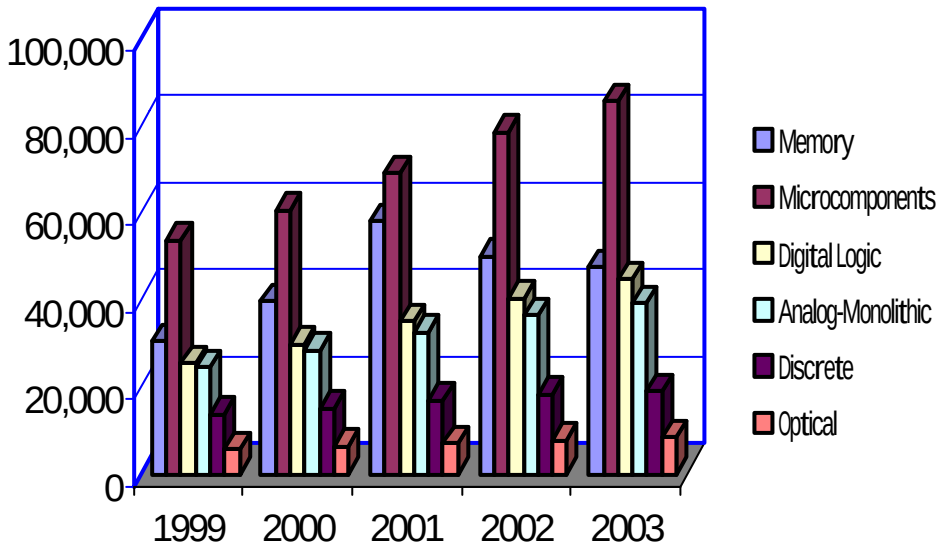


Asia/Pacific semiconductor consumption started gradual recovery during at the end of 1998. It is expected to have positive growth in 1999 due to increased production of electronic equipment.

According to Dataquest, the semiconductor revenue in Asia/Pacific will increase by 14 percent in 1999 and total $35 billion. This follows a 4 percent decline for 1998. Long-term regional revenue will grow at a 13 percent CAGR (Compounded Annual Growth Rate) and reach $58 billion by 2003 (Graph 1).

Semiconductor consumption will be based on a stable growth of data processing and communications applications. Micro components and memory products will achieve the highest regional growth rates. Communications equipment will also contribute to the rapid Asia/Pacific semiconductor growth. This application will support the demand growth for ASICs, DSPs, ASSPs, and analog ICs (Dataquest, Spring 1999).

6.4 Worldwide Semiconductor Market, Revenue Forecast, 1999-2003, Millions of Dollars



Graph 2.

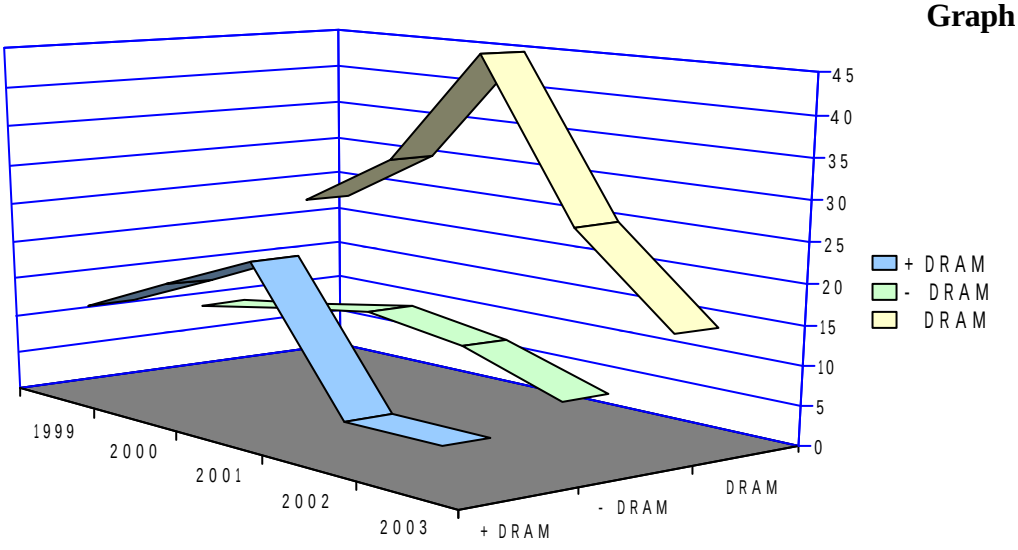
Dataquest forecasts that worldwide semiconductor revenue will grow by 12.6 percent in 1999, totaling $153 billion following a 7.5 percent reduction in 1998. By 2003 (Graph 2), worldwide semiconductor revenue is predicted to reach $244 billion, which is a 12.4 percent compound annual growth rate for the five-year period 1998-2003.

Growth is estimated to speed up in the year 2000, but is expected not to exceed 20 percent, due to continued weakness in DRAM pricing through at least the first half of the year. While economic conditions in Japan continue to be inert, the worst of the economic crisis in the Asia/Pacific region appears to have been overcome. Demand in the Asia/Pacific region is expected to partially decrease in 1999, but is forecasted to hasten considerably in 2000. (Dataquest, Spring 1999).

After analyzing the worldwide semiconductor market revenue and growth rate for 1999-2003, I feel it is pertinent to examine the semiconductor forecast for the same time period including and excluding DRAM (see graph 3).

6.5 Semiconductor Forecast: With and Without DRAM 1999-2003

Graph 3.



This Graph provides a somewhat different forecast. It shows the worldwide semiconductor market growth rates for 1998 through 2003 for total semiconductor, DRAM, and non-DRAM semiconductor (that is, total semiconductor, excluding DRAM). The graph shows a somewhat more stable and flattering long-term semiconductor market growth rate prediction when DRAM are excluded. It also highlights the more volatile growth rate forecasted for DRAM (Dataquest, Spring 1999).

The information we may attain from this graph is important in helping us to understand the difficulties in predicting Korea's semiconductor market trends. The forecast is complicated by the high share of DRAM in total semiconductor production.

6.6 Creation of World Semiconductor Council

One of the important developments in 1999 is the creation by the world's major semiconductor manufacturing nations of an organization aimed at lowering trade and investment barriers against hi-tech commodities.

In a joint statement issued at European headquarters in Belgium, the new organization, called the "World Semiconductor Council," (WSC) announced its main objectives as being "to implement market principles in creating barrier-free trade in semiconductors by minimizing government intervention and discrimination". The WSC stated that it "condemns dumping" and appealed to the governments undertake effective anti-dumping measures in compliance with the rules and regulations of the General Agreement on Trade and Tariffs (GATT).

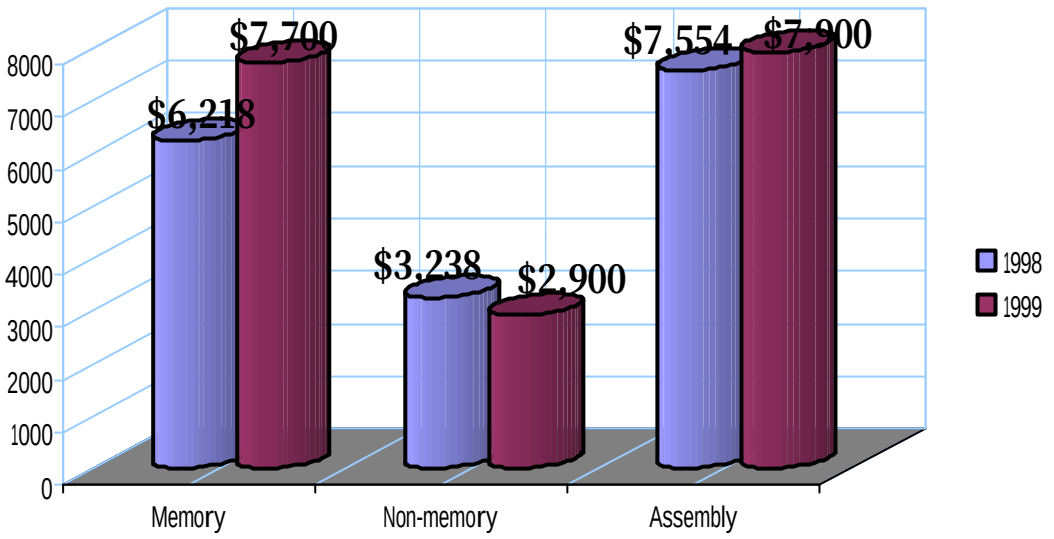
"The competitiveness of companies and their products, not the intervention of government and authorities, should be the principal determinant of industrial success and trade," the statement said.

According to the statement by the Korea's Ministry of Commerce, Industry and Energy the council will consist of representatives from Korea, the United States the European Union, Japan and Taiwan. The meetings of the council will be held annually with the aim to discuss the semiconductor related government policies in the participating states.

"Until now, international semiconductor meetings focused on regulatory measures aimed at opening up the Japanese market," the ministry statement said. "But the new system follows independent agreements made at the private sector levels between the United States, Japan the European Union and Korea."

The founding members of the WSC are the Electronic Industries Association of Japan, the U.S. Semiconductor Industry Association, the European Electronic Component Manufacturers Association and the Korea Semiconductor Industry Association (Korea Herald, 06/11/1999).

6.7 Korean Semiconductor Market, Revenue Forecast by Korean Semiconductor Industry Association (KSIA) 1998-1999 (Millions of Dollars)



The semiconductor industry in Korea has been seriously affected by the East Asian Financial Crisis of 1997. Even prior to the crisis, the semiconductor industry had been influenced by the price drop in the world memory market.

As mentioned above, the export of Korean semiconductors in 1998 reached $13.5 billion, 5% lower than the same period in 1997. Nevertheless, the Korean Semiconductor Industry Association (KSIA) forecasts that the total exports in 1999, including those by assembly and packaging firms, will total around $18.2 billion, an 11% increase compared to 1998 (H.Y. Kim, 1999).

Due to the decline in the semiconductor industry and the fall-out from the IMF sanctions, equipment and materials industries in Korea experienced a serious slowdown in 1998. There was virtually no new investments made by semiconductor

manufacturers in Korea in 1998 except the investment made by Samsung at the end of the year.

"Samsung Electronics is restructuring its business around sophisticated, value - added areas such as computer central processor units (CPU), application specific integrated circuits (ASICs), and next generation wireless communications and multimedia semiconductor products. Samsung is also planning to invest $1.2 billion to expand the company's monthly production capacity of non-memory products. With the expanded capacity, Samsung has projected sales of system LSI chips will increase by at least 44% per annum, from $1.2 billion in 1999 to $1.8 billion in 2000, and further to $2.5 billion by 2001. At the same time Samsung plans to structure its business around 'system-on-chip' devices, microprocessors, and Alpha CPU, as well as on its mobile communications, multimedia and network products" (Kim Chang Soo, 1999)

For the Korean semiconductor industry the future looks bright. WSTS forecasts that the memory market in 1999 will expand by 13% to $14.6 billion, by 26% to $18.4 billion in 2000 and by 28% to $23.7 billion in 2001. The supply is going to be supported by an estimated 13% to 16% annual growth of a market for personal computers, as well as by the rapidly growing internet and communication applications. (H.Y. Kim, 1999)

The September 1999 earthquake in Taiwan will strengthen the position of Korean semiconductor and LCD manufacturers in the world market. According to the Korea Information Society Development Institute (KISDI), the price rise in computer

parts is unavoidable due to interruptions in supply of Taiwanese semiconductors and circuit boards. The price of DRAM was rising even before the earthquake with Dataquest predicting a 0.4% oversupply. However, after the natural disaster in Taiwan the world market is going to experience around 5% shortage of memory devices. The price of TFT/LCD, one of the strategic products for Korean semiconductor producers is also expected to rise due to the damage to Taiwanese production lines. It will be also beneficial to the Korean semiconductor companies if the Japanese industries' strategy to hinder the growth of Korean semiconductor companies through establishing subsidiaries in Taiwan will fail. (Korea Herald, 14/10/1999)

Worldwide, the beginning of 1999 could be considered as a turning point in the semiconductor industry after troublesome 1998. According to Dataquest, analog, discrete, and optical semiconductor suppliers and distributors reported raising demand and relative price stability. Early second quarter Dataquest reports show raising demand for the majority of semiconductor products. DRAM price reductions that began in the second quarter caused an insignificant growth decline in the second quarter of 1999. The aforementioned price reductions caused concern throughout the semiconductor industry over revenue expectations for the second half of 1999. Nevertheless, world semiconductor industry continues to experience a return to growth in the third quarter of 1999 with a strong fourth quarter forecast. (Dataquest, Spring 1999)

7. POSITIVE SIDES OF THE CRISIS AND IT' S LESSONS

Although in the short term Korea's economy was badly damaged, in the long run, it will be able to recover, and build a more solid structure due to the following reasons:

- Korea has adopted restructuring measures towards *chaebol.*
- Future investment plans will be prepared more carefully.
- The Korean monetary system is facing a rearrangement.
- Financing for Korean manufacturers will not be as easy as before.
- In terms of semiconductors, the country will focus on the domestic production processes and materials especially for logic devices.

Another positive outcome of the IMF crisis is that most of Japanese DRAM manufacturers have already decided to drop the production of memory devices, as U.S. manufacturers did in the past due to low profitability and intensive competition caused by the excess supply. There was an opinion that Korean DRAM manufacturers will face the same problems within five years because of strong challenges from the Taiwan semiconductor industry. However, due to the IMF, Korean manufacturers are restructuring themselves and are becoming more competitive.

It could be said that the IMF provided the Korean semiconductor industry with an opportunity to prolong the enjoyment of its leading position in the world memory market.

In order to ensure healthy economic environment and stability of the Asian economies the following lessons should be learned from the crisis of 1997:

- Reforms aimed at allowing market forces to operate freely must be implemented. Investment, production and export should not be subsidized or assisted by the state but should instead be governed by market forces.

- Asian economies should not try to achieve economic recovery only through exports. Subsidies to exports as well government designed export targets will only further aggravate the existing problems. Government directed lending to certain companies has already caused over-capacity in several industries, including semiconductors.

- Any new financing for industry must be commercially feasible and not government instructed. Loans to businesses must be entirely market-based and not be below a benchmark rate based on the individual credit-worthiness of a borrower. Companies that cannot operate in the free market environment must be restructured or sold.

Decisive actions are to be taken to improve the quality and transparency of corporate balance sheets through the adoption of international accounting standards. The accounting system used should be clear enough to allow effective monitoring of the financial performance of a company.

8. CONCLUSION

As we observed previously, the role of the state in the development process of the Korean semiconductor industry has changed with time. The Korean government which put a lot of efforts into the promotion of heavy and chemical industrialization in the 1970s was not in a position to offer similar incentives during the take-off of the domestic semiconductor industry in the beginning of 1980s. This was caused by structural constraints (discussed in Chapter 5) both in Korea and abroad. Because of these changes in business and political environment, private firms decided to enter the risky semiconductor business. In the following development of the industry, the government and *chaebol* cooperated actively in elaborating and implementing the semiconductor related policies.

We can say that the existing economic structure in Korea was not favourable to innovation in the semiconductor industry. Partly this is because of the nature of Korean industrialization that was focused on imitation rather than innovation. From the very beginning it happened to be based on foreign designs and borrowed technologies. At the same time, it was overstressing the importance of the economies of scale. In this regard we can recall Alice Amsden stating (Amsden 1989) that that learning is a new mode of industrialization for the late industrializing countries.

The main question is if Korea is able to change from imitator to innovator. Starting from the 1970s, the Korean economical structure was very well suited to the learner's requirements and mentality. Eventually, a special set of conditions is

essential for innovation mechanism to start working. The institutional arrangements that facilitated Korea's rapid late industrialization based on foreign technologies are now starting to have negative influence on the advancement of domestic technological knowledge. (Soh 1997, 259)

Samsung's example clearly illustrates that Korea is gradually becoming an innovator in the semiconductor industry. Although skeptics claimed that it lacked the technological capability to enter and remain competitive in the semiconductor business, Samsung Electronics has, in only a decade, transformed itself from a mere producer of discrete devices to the renowned leader in the world memory market. (Kim Linsu 1997)

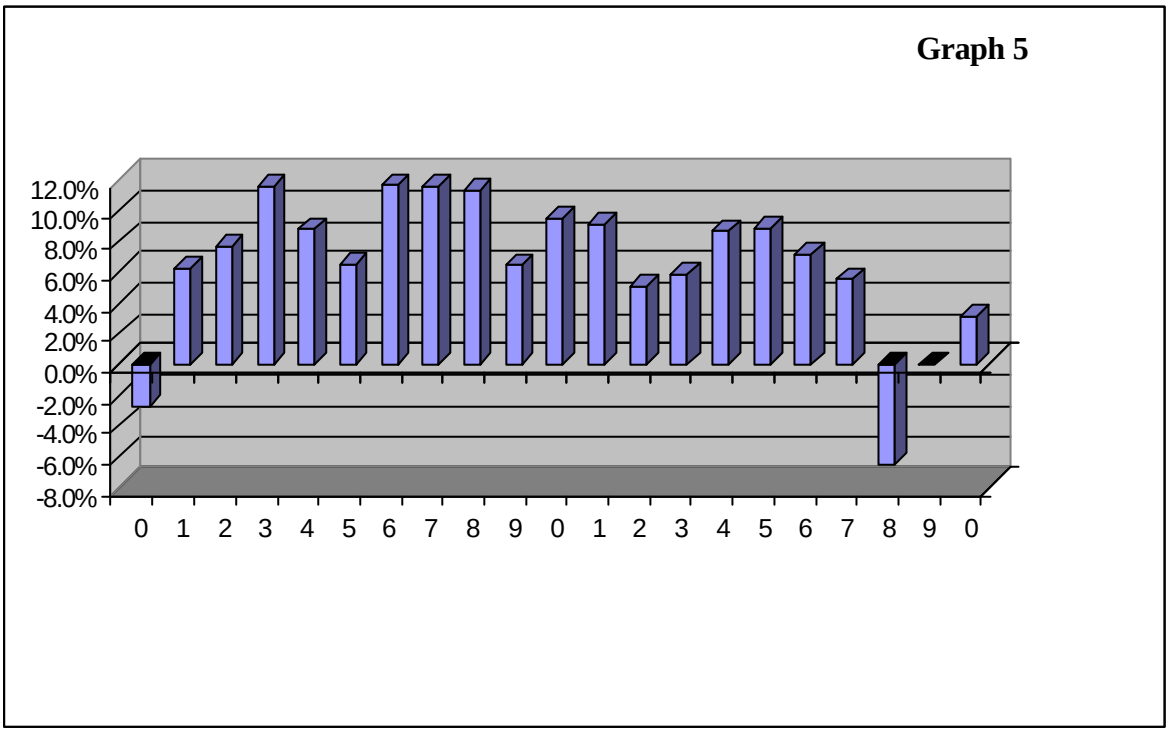
Recent developments in Korea indicate major changes in the national environment. The strong authoritarian bureaucracy of the previous years has been gradually loosing its power, while private businessmen have started to realize the necessity to restructure their companies. Still and all, a switch from one system to another is a quite complicated task to carry out.

South Korea's admission to the OECD in 1996 concluded 35 years of rapid economic development. The strong fundamentals conducive to this rise were - export oriented industrialization, high rates of savings, and investment as well as highly skilled and educated labour force. One year later, in 1997, the uncompromising financial crisis sweeping over entire Asia region has damaged the Korean economy significantly.

"Tthe South Korean economy has been shaken to its very core and the ability to recover to the prosperous levels of the past decades will require more structural reform. With the rest of Asia recovering and with the re-emergence of the several key semiconductor markets, conditions in South Korea are improving. However, long-term growth depends directly on the government's ability to implement economic reforms that will bolster the financial sector, improve corporate management practices and further open the once closed economy to more foreign investment".(Cahners In-Stat Group 1999)

Graph 5 shows South Korea's GDP rates/forecast according to Cahners In-Stat Group

Graph 5

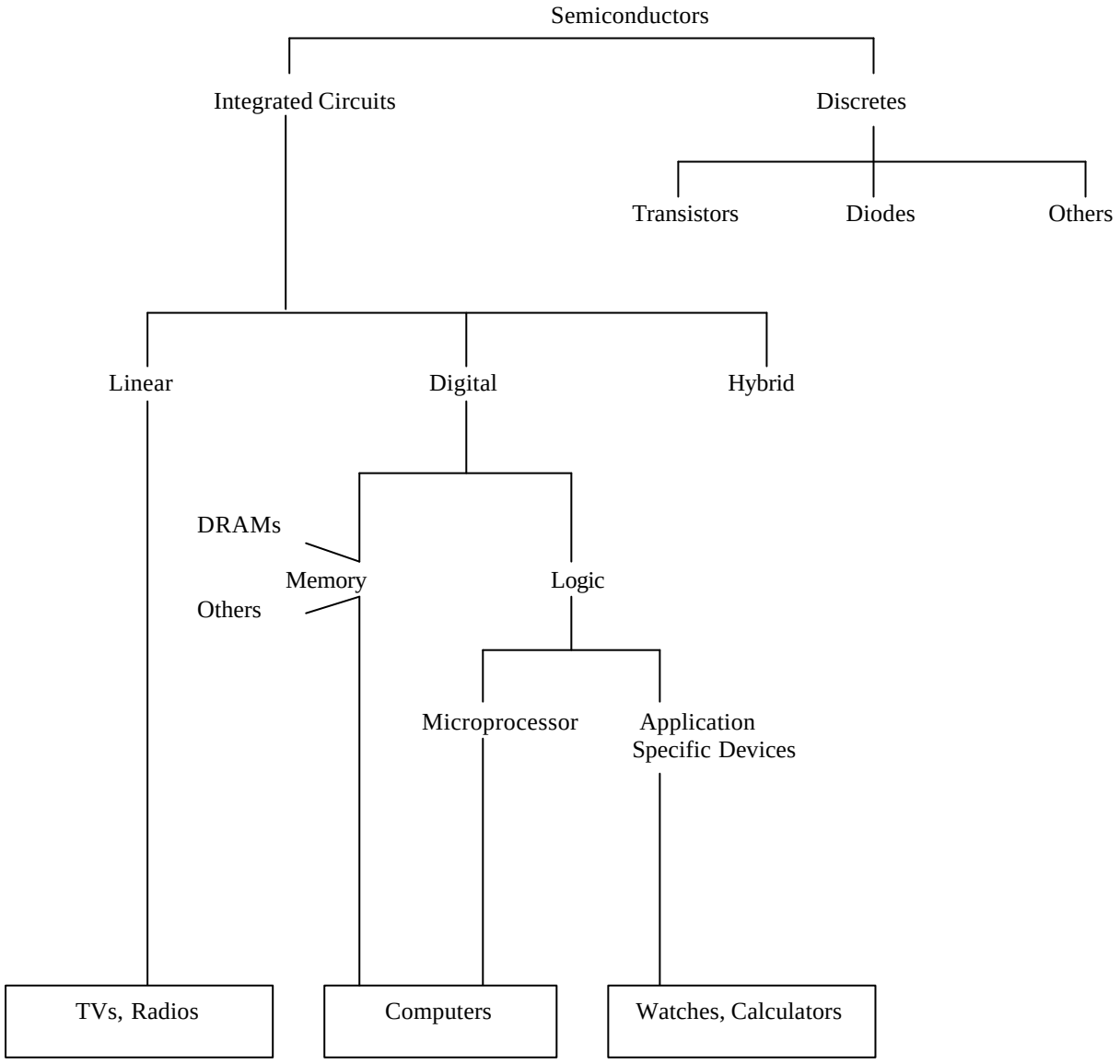


South Korea: Real GDP Growth (Annual % Change)
Source: 1999 Cahners In-Stat Group – S19903SF

Many of East Asian countries consider the on-going recovery as a return to the phenomenal growth rates they enjoyed in early 1990s (see annexes No.2 and No.3). Eventually such speedy growth will be much harder to achieve now than it was in the past. Asian economies are more developed now than they were in the beginning of their developmental take-off. They will retain the advantages of youth for many years yet, but growth will depend less on injecting more people and capital, and more on something rather harder - raising productivity. That demands comprehensive reforms. If Asian governments will find themselves unable to implement their promised reforms, they will fail to lay the groundwork for more efficient use of capital and for faster growth in productivity not only in the semiconductor industry but across the entire economies of their respective countries.

Annex I

Semiconductor Classification by Device



Representative End-Users

Source: Soh Changrok, September 1997

Annex II Income and Technological Performance in OECD countries, 1995[1]

Country	Income level, 1996	Indicators of scientific and technological performance							
	GDP per head of population as a % of OECD average	Gross Domestic Expenditure On R&D as a % of GDP 1995	Researchers per 10,000 labour force 1995	Scientific and technical articles per unit of GDP 1995[2]	Government financed R&D as a % of GDP 1995	Government financing of R&D as a % of total R&D, 1995	Business expenditure on R&D as a % of business GDP, 1995	Technological strength per US$ of R&D 1995[3]	Technological intensity, 1995[4]
United States	140	2.6	74	20	0.9	34.6	2.1	410	10.4
Norway	128	1.7	73	21	0.8	43.5	1.4	..	..
Switzerland	126	2.7	46	37	0.8	28.4	2.2	..	..
Japan	121	2.8	83	15	0.6	20.9	2.2	354	10.6
Iceland	118	1.5	72	23	0.9	62.9	0.8	..	..
Denmark	117	1.8	57	31	0.7	39.2	1.7	87	1.6
Canada	114	1.7	53	25	0.6	33.7	1.4	203	3.3
Belgium	112	1.6	53	20	0.5	26.4	1.4	111	1.8
Austria	111	1.5	34	18	0.8	47.6	1.1	125	1.9
Australia	107	1.6	64	24	0.8	47.5	0.9	..	..
Germany	107	2.3	58	21	0.8	37	1.9	215	5.0
Netherlands	106	2.0	46	31	0.9	42.1	1.3	170	3.5
France	103	2.3	60	20	1.0	42.3	1.9	115	2.7
Italy	102	1.1	33	13	0.5	46.2	0.8	101	1.0
Sweden	100	3.6	68	41	1.0	33	3.9	147	5.3
United Kingdom	98	2.1	52	29	0.7	33.3	1.8	160	3.2
Finland	96	2.3	61	35	0.9	35.1	2.2	114	2.7
Ireland	92	1.4	59	16	0.3	22.6	1.4	69	1.0
New Zealand	88	1.0	35	29	0.6	52.3	0.3	..	..
Spain	77	0.9	30	16	0.4	43.6	0.5	21	0.2
Korea	72	2.7	48	5	..	19	2.3	25	0.7
Portugal	70	0.6	24	7	0.4	65.2	0.2	8	0.0
Greece	67	0.5	20	16	0.2	46.9	0.2	..	..
Czech Republic	64	1.2	23	15	0.4	35.5	0.9	..	..
Hungary	47	0.8	26	20	0.4	47.9	0.4	115	0.7
Mexico	36	0.3	6	2	0.2	66.2	0.1	15	0.0
Poland	35	0.7	29	17	..	64.7	0.4	..	..
Turkey	30	0.4	7	4	0.2	64.5	0.1	..	..

1. Or latest available year.
2. Scientific and technological articles per billion of US$ of GDP. See National Science Foundation (1988).
3. Technological strength is determined by multiplying the number of patents with an index of their impact. This index measures how frequently a country's recent patents are cited by all of a current year' s patents. The patents refer those granted at the US Patent Office. Data are from CHI research.
4. Technology intensity compares the technological strength of a country with its GDP expressed in PPP$. See *OECD, Science, Technology and Industry Outlook 1998* for details. *Source:* OECD calculations on the basis of the MSTI database. CHI Research, National Science Foundation (1998), and OECD, *Science, Technology and Industry Outlook 1998*.

Annex III

Average annual rates of growth of real GNP (selected years).

Country/group	1960-69	1970-79	1980-88	1988	1991	1992	1993[a]	1994	1995	1996	1997	1998
Four NIEs												
Hong Kong	10.0	9.4	8.0	10.5	3.9	5.2	5.6	12.9	6.1	10.8	11.7	-4.8
South Korea	7.7	9.5	8.7	15.9	8.4	5.5	6.3	14.4	19.7	6.4	-8.7	9.5
Singapore	8.9	9.5	7.0	10.0	6.7	5.6	6.5	22.4	19.7	10.6	2.1	6.0
Taiwan	9.5	10.2	7.5	9.5	7.0	6.7	n/a	8.1	7.9	4.6	4.0	0.1
ASEAN-4												
Indonesia	3.4	7.8	5.8	7.5	7.0	5.5	6.0	12.0	14.1	12.4	-5.3	3.0
Malaysia	6.5	8.1	5.3	6.6	8.6	8.5	8.0	14.1	19.2	13.8	-1.0	0.2
Philippines	3.0	6.3	1.6	6.4	0.0	3.3	1.5	18.5	15.6	12.2	-1.2	7.8
Thailand	8.3	7.4	5.6	7.1	7.9	7.5	7.8	15.2	16.7	7.7	-14.9	7.7
Other Asia												
China	2.9	7.5	9.2	10.2	4.6	12.0	10.0	-8.7	30.0	17.3	10.1	-1.7
Developed												
Canada	5.7	4.7	3.1	4.3	-0.2	0.3	2.8	-1.1	4.9	4.9	2.7	-1.6
Japan	10.9	5.2	5.3	5.1	3.1	0.9	2.4	9.7	9.6	-10.6	-8.7	14.8
United States	4.1	2.8	2.6	3.6	0.4	2.2	2.5	5.8	4.7	5.1	5.8	-3.7

a – official 1992 estimates

Updated from Michael Hobday, 1995, p.14. (Source for all economies 1994-1998 - APEC Secretariat Web-site: www.apecsec.org.sg/member/gdp.html)

Annex IV **APEC Economies' GDP figures (1989 – 1998)**

Current Price GDP (US$ billion)	1989 (a)	1990 (a)	1991 (a)	1992 (a)	1993 (b)	1994 (b)	1995 (b)	1996 (b)	1997 (b)	1998 (b)
Australia	292	296	283	300	285	327	353	395	394	394
Brunei Darussalam	3.5	3.6	3.7	3.7	4	4	5	5	5	5
Canada	575	574	561	564	553	547	574	602	618	608
Chile	29	30	32	35	44	51	65	69	77	77
China	356	370	399	452	599	547	711	834	918	902
Hong Kong, China	69	72	75	79	116	131	139	154	172	163.8
Indonesia	99	106	113	121	158	177	202	227	215	221.5
Japan	2817	2952	3079	3120	4275	4689	5137	4595	4193	4812.1
Korea	232	254	277	291	333	381	456	485	443	485.2
Malaysia	39	43	47	50	64	73	87	99	98	98.2
Mexico	234	244	253	260	403	421	286	329	403	348.6
New Zealand	44	44	43	43	44	51	60	66	65	59.5
Papua New Guinea	3	3	4	4	5	5	5	5	5	4.2
Peru	n.a.	n.a.	n.a.	n.a.	41	50	59	61	65	63.7
Philippines	43	44	44	44	54	64	74	83	82	88.4
Russian	n.a.	n.a.	n.a.	n.a.	173	279	348	434	450	394.9
Singapore	34	37	39	41	58	71	85	94	96	101.8
Chinese Taipei	153	161	173	183	223	241	260	272	283	283.4
Thailand	73	80	93	100	125	144	168	181	154	165.8
USA	5478	5522	5458	5637	6553	6936	7265	7636	8080	7783
Vietnam	n.a.	n.a.	n.a	n.a.	13	16	20	23	26	24

(a) figures are expressed in 1990 prices and exchange rates
(b) figures are expressed in 1997 prices and exchange rates
Source: The APEC Region Trade and Investment, http://www.apecsec.org.sg/member/gdp.html

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List of Acronyms

ASICs	Application Specific Integrated Circuits
ASSPs	Application Specific Standard Products
APEC	Asia Pacific Economic Cooperation
CAGR	Compounded Annual Growth Rate
CMES	Comprehensive Measures for Economic Stabilization
CPU	Central Processing Unit
DRAM	Dynamic Random Access Memory
DSP	Digital Speech Products
EIAK	Electronics Industry Association of Korea
EPB	Economic Planning Board
GATT	General Agreement on Trade and Tariffs
GDP	Gross Domestic Product
HCI	Heavy and Chemical Industries
IC	Integrated Circuit
IMF	International Monetary Fund
KDI	Korea Development Institute
KEIC	Korea Electronics Industry Cooperatives
KSIA	Korea Semiconductor Industry Association
LCD	Liquid Crystal Display
LSI	Large Scale Integration
MAFEZ	Masan Free Export Zone
MNC	Multinational Corporation
MTI	Ministry of Trade and Industry
OECD	Organization for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
R&D	Research and Development
SRAM	Static Random Access Memory
WSC	World Semiconductor Council
WSTS	World Semiconductor Trade Statistics
WTO	World Trade Organization