The Origin of Korean Industrialisation Strategy
−Early History of Korea's Catch-Up Industrialisation−

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1. Introduction

The Korean electronics industry can be traced back to 1959 when Gold Star (the predecessor of LG Electronics) successfully started its first commercial radio sets production.[1] This was only six years after the end of the Korean War (1950-1953) in which Korea suffered devastating damage. Although the beginning was to imitate Japanese radio sets by reverse engineering, Korea now has some of the leading electronics companies in the world such as LG and Samsung. This paper aims to elucidate the industrial development process that has made such a dramatic transformation possible.

The Korean Electronics Industry has grown to become a global player in the 90s, although not without having gone through some business fluctuations. There are some questions to be addressed. How was such fast growth possible? What kind of strategy has been taken? What were the major factors of their success? To address these questions, it is required to analyse the production mechanism, the Government's policy and, the global and domestic business environments. These analytical discussions will be undertaken in the following parts of this paper.

2. Early Development Process of Korean Electronics Industry

The first serious attempt to commercially produce consumer electronics was made by a small venture business, Gold Star in 1959. This attempt involved two important factors. First, Gold Star employed an experienced German engineer to supervise the entire process. Second, reverse engineering was introduced to imitate foreign radio products.[2]

The initial stage of commercial production of vacuum tube radios by assembling imported parts and components usually involves 1) working out of various circuits, 2) identification of components used, and 3) figuring out how to assemble those parts and components. For this process, GOLD STAR needed to employ the experienced foreign engineer.

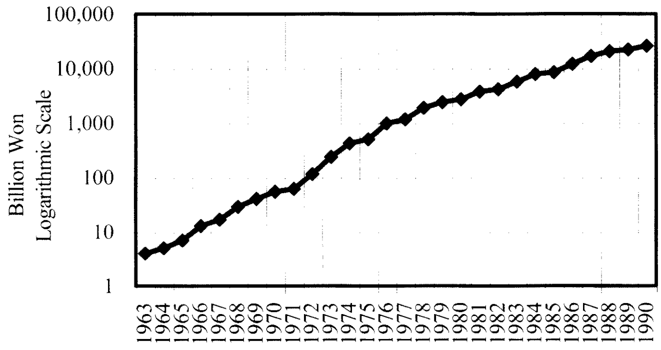
The Park Chung Hee Administration, which came to power in October 1963, originally started at the Coup d'etat on 16 May 1961. The Park administration introduced several domestic industry protection measures. A typical measure in line with this import substitution policy of the new administration was the Act of Ban on Imported Goods Sales in 1961. This Act prohibited the import and sales of those electronics components for radios which could be domestically produced. Supported by this highly protective measure, commercial production of radio receivers and other electronics components such as resistors, capacitors and speakers was started, although the actual size and technology employed in these production activities were very small and remained at a primitive level.[3]

After a modest start of the commercial production of radios, Gold Star began to produce black and white television sets in 1966. Therefore, 1966 is now considered as the real birth date of the modern Korean electronic industry. However, Korea was still suffering from a serious shortage of capital and a large number of unemployed. Linsu Kim wrote "However, growth (of electronics industry) was slow until late 1969, when the government designated electronics a strategic export industry."[4]

The Korean government, in the middle of the cold war, was facing serious political and security challenges. On one hand, military and political threat from the north was the issue of very existence of the regime. Because of this, the government was urged to transform the country to an industrialised nation. On the other hand, the government was aware that they had to make a choice if they should follow the American style laissez-faire economic system or Japanese government intervention system. There still remained strong anti-Japan sentiment among the entire population. However, as Matsumoto pointed out, there also remained a wide range of legal and administrative systems established by Japan. The Korean Civil Code, for example, started as a translation of Japanese civil code, and continued to be used for more than ten tears in Korea before independence. Public administration system was in the same situation. Because of these reasons, the Korean government choose the Japanese model.[5]

The Government first designated of the electronics industry as the Nation's strategic export industry. Subsequently, it enacted the Electronic Industry Promotion Act in 1969 which created the electronics promotion fund for preferential financial support, the Korean electronic industry accelerated its growth in the 70s.

Fig. 4.1 Korean Electrical Machinery Industry's Production



Source : East Asian Long Term Economic Statistics Vol. 5, K. Kawabata

In the framework of this act, preferential financial support was not open for everybody but only for some selected business groups. The government intended to establish the Korean version of "Zaibatsu" or conglomerates. Such Korean business groups are now known as "Chaebols". Each of those selected business groups established electrical machineries manufacturing companies. Supported by those preferential financing, they aimed at the overseas market.

As shown in Fig. 4.1, the Korean electrical machineries industry showed an exponential growth. In the decade from 1970 to 1979, the industry became 44 times larger. Even taking the small start into consideration, this growth should be considered as a rare successful case for a developing country.

In addition to the preferential financing, the Park Administration undertook 1) a series of structural reformation measures to promote exports, and 2) specific measures to promote the electronics industry as the champion of industrial development of Korea.[6] The first group of measures were the rationalisation of foreign exchange rate and the liberalisation of bank loan interest rates.

Under the Syngman Rhee administration (1948-1960), the official foreign exchange rate was set at 18 Won against 1 US Dollar, while the prevailing market rate was around 55 Won for the US Dollar. This foreign exchange policy that artificially overvalued Won against US dollar not only benefited importers, but also seriously discouraged exporting industries. At the same time, the bank loan interest rate was tightly controlled by the government and kept at a very low level. Keeping an interest rate much lower than natural level decided by the market brought about a few outcomes simultaneously.

The low interest loan was provided selectively to those privileged business groups in the American development aid related industries, the sugar, flour milling, and textile industries. Those privileged business groups also could enjoy artificially overvalued foreign exchange rate. Because of these, only those politically well-connected business groups could expand their business, while a large number of small and medium firms were effectively disregarded. In fact, many of these privileged business groups successfully accumulated their capital and grew to become large conglomerates, the "Chaebols." Secondly, those labour intensive industries such as footwear and garment that had potential competitiveness in the global market were discouraged and could not get any chance for development.[7]

In contrast with the predecessor, the Park Administration undertook rationalisation of foreign exchange and interest rate. The Korean Won's exchange rate was decided at much lower rate which is closer to the black market rate. The interest rate was set at much closer to the market prevailing level. This first group of reformation naturally triggered structural changes of the Korean Industry. The lower exchange rate substantially improved the Korean made products' price competitiveness in the international market. The lower and rationalised interest rate made the bank loan more accessible to those small and unprivileged manufacturers. The labour intensive industry such as small textile and footwear manufacturers which had an export potential could gather more investment and export their products more competitive price than before.

The second group of specific measures to promote exports industries include preferential financing, direct subsidies, reduction or wavier of corporate tax, and reduction or wavier of capital goods imports for export activities. These first and second groups of measures were introduced in the mid and late 60s. These efforts by the Government resulted in a fast growth of exports in the 70s.

3. The Production Mechanism of the Korean Electronics Industry

3.1 Basic Conceptual Models

The electronics Industry, as a part of the manufacturing industry has several outstanding features in comparison with process industries such as the chemical and steel industries. The first of these features is that final products of the electronics industry consist of many different components produced by many different producers.

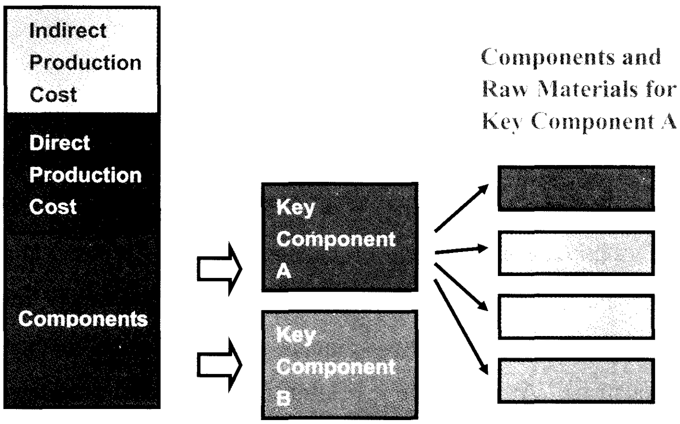
In the case of consumer electronics products such as colour televisions (CTVs), stereo sets and

Table 4.1 Growth of the Electronics Industry of Korea (US$ Million)

	1968	1970	1975	1980	1985	1990	1994
Production							
Consumer Products	12.9	30.4	270.0	1,148	2,669	10,141	12,621
Industrial Products	6.7	17.4	93.6	364	1,518	6,345	9,892
Total	19.6	47.8	363.6	1,512	4,187	16,486	22,513
Exports							
Consumer Products	0.1	9.0	198.3	1,020	1,752	5,727	7,319
Industrial Products	3.6	0.4	35.8	169	783	3,481	5,807
Total	3.7	9.4	234.1	1,189	2,535	9,208	13,126

Source : Linsu Kim, Imitation to Innovation, Harvard Business School Press, 1997
Korea Development Bank, Korean Industry in the World, 1994

Fig. 4.2 Electronics Products and Components



video cassette recorders, a final product consists of 1,000-2,000 components. Starting from a large number of capacitors and resistors, they are varied to structural components largely made by plastic injection mould, electronic circuits made of those passive components (capacitors, resistors and others), and others.

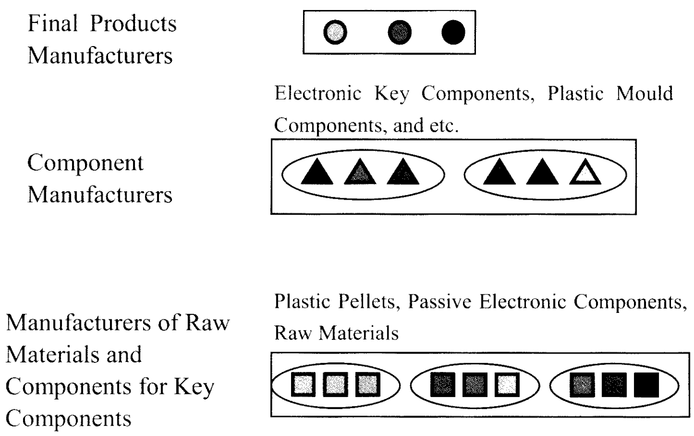
A large part of these components are not produced by a final product manufacturer but by specialised component manufacturers, although some key components may be produced by the final product manufacturer as its core competence. A final product manufacturer of consumer electronics usually has over 100 component suppliers as business partners.

The production cost structure of the final product manufacturer, therefore, consists of component cost, direct production cost and indirect production cost. In fact, 70 to 90% of the production cost is taken up by the component cost. The final product manufacturer's cost competitiveness is decided by both its own productivity improvement efforts and the component manufacturers' price competitiveness. This implies that a continuous decline of production cost observed as a result of dynamic economy of scale or learning effect in the final product manufacturer is, in fact, composition of a dynamic economy of scale at both the final product manufacturing level and the component production level as shown in Fig. 3.2 of chapter 3 of this study.

Unless an improvement in productivity is achieved by the component manufacturers, a final product manufacturer can not attain price competitiveness in the market. A final product manufacturer that purchases components from those component manufacturers who have already achieved dynamic economy of scale will have stronger price competitiveness. In other words, any final product manufacturer that has no access to those competitive component manufacturers can not have price competitiveness in the market. This is the dilemma of a developing nation that does not have an established supporting industry.

This paper analyses how the Korean

Fig. 4.3 Multi-Layered Industrial Structure of Electronics Industry



Electronics Industry has responded to the fact that there was an absence of established component manufacturers at the early stage of their development.

3.2 Final Products and Components Production

As pointed out before, Gold Star started its B&W television production in 1966. However, a large part of activities in the Korean Electronics Industry was borne by foreign capital joint ventures' electronic components assembly and exports by using relative low cost labour. These joint venture firms were mostly partial relocation of labour intensive part of production process. A typical example was the assembly of ICs. In the late 60s and 70s, many American semiconductor manufacturers tried to reduce production cost by relocating their labour intensive and not technology intensive assembly parts of their production process. These joint ventures indeed contributed to foreign currency earning for Korea. However, as Korean wage level went up, they relocated again those assembly facilities further to a third country where labour cost was lower. To this extent, these joint ventures did not necessarily make any substantial contribution to industrial development of Korea.

The government was fully aware of a need for the nation to foster its own industrial base. However, it took a decade to see concrete result from such efforts. Electronics manufacturers supported by domestic capital started to play an important role in the 1970s.(8) After the mid 70s, the consumer electronics industry has showed fast growth through a steep increase of their exports.

In the ten years from 1973 to 1982, television receivers' production has grown by 7.5 times. This is equivalent to 22.3% annual growth. A large part of this fast growth can be explained by the remarkable increase of exports, particularly to the US. In 1975, Korean exports of consumer electronics products had reached nearly 200 million US$. The share of exports in consumer electronics production was exceptionally high at 73.4%, while Japanese counterparts' export ratio of CTVs was stable around 20% during the period.(9)

During this period, there was not serious competition with Japanese manufacturers. The Korean manufacturers' main export items were low-end B&W televisions while Japanese manufacturers focused on CTV exports. On top of this, Japanese manufacturers faced a few challenges. First, they had to overcome sharp yen appreciation triggered by the Nixon shock in 1971. Secondly, tension around the US-Japan trade conflict on CTV was heightened because of increasing Japanese CTV share in the US market. Because these, Japanese manufacturers were left with no choice but to shift their products to higher value added products and, at the same time, to establish their production bases in the US.(10)

In the case of Samsung Electronic, which began B&W TV production six years after Gold Star in 1972, started to export only one year later in 1973. Colour Television production was started in 1974 by Gold Star and soon followed by Samsung. They began exports of colour television (CTVs)

Table 4.2 Production of Consumer Electronics Products and Components in Korea

	Television Receivers	B/W TV Receivers	Colour TV Receivers	VCR	CRT
1973	816,369	816,369	-		n.a.
1974	1,163,960	1,163,960	-		n.a.
1975	1,225,176	1,182,081	43,095		1,313,097
1976	2,290,622	2,235,562	55,060		2,224,745
1977	2,990,141	2,893,467	96,674		3,514,215
1978	4,826,477	4,242,401	584,076		5,536,531
1979	5,867,321	5,445,118	422,203		6,961,703
1980	6,819,002	5,863,232	955,770		8,925,483
1981	7,548,348	5,302,008	2,246,340		9,845,533
1982	6,112,027	3,922,478	2,189,549	50,000	6,227,737
1983	7,641,135	3,925,233	3,715,902	151,000	n.a.
1984	9,730,113	5,424,752	4,305,361	342,000	n.a.
1985	7,849,145	4,061,983	3,787,162	1,329,000	n.a.
1986	11,799,393	5,636,055	6,163,338	3,657,000	n.a.
1987	14,921,752	6,237,606	8,684,146	5,836,000	n.a.
1988	14,820,499	4,389,292	10,431,207	8,683,000	n.a.

Source : Economic Statistics Yearbook of Korea, Economic Research Institute of Korea, '80, '84, '90

by the end of 1977.[11]

Although it has been said that Japanese industrial development has been achieved by fast export growth, its export share has never been as high as Korea. Therefore, it can be fairly stated that the Korean electronics industry's growth was one of the frontrunners of the export driven industrial development model which was followed by other developing countries such as Thailand and Malaysia.

Consumer electronics consist of many components. Among those components, the ones that shape the essential characteristics of final products are called "key components." In the case of television receivers, Cathode Ray Tune (CRT), Fly Buck Transformers (FBT), Deflection Yokes (DY) and Tuners are considered as key components. CRT is the most important component as it transforms electronic signals to pictures on the screen. FBT is used to impose a high voltage to accelerate electron beam emitted from an electron gun attached to a CRT. DY controls the electron beam to precisely impinge upon particular points of the CRT surface. A tuner adjusts the reception frequency to receive a particular channel.

Among these components, a CRT for colour television is one of the most expensive components and, according to the international trade statistics of Japan, cost approximately 12,000 yen (nominal fob price) in 1980 on average. In contrast, tuners cost relatively much less, approximately 1,300 yen in the same year.

Looking at the table above, one immediately notices that domestic production of CRTs for television receivers was almost the same volume with the domestic production of television sets, at least during the period between '75-'82. This implies that Korea's indigenisation of CRT, one of the key components, was almost completely achieved by the early stages of industrialisation. According to the Institute of Developing

Economies in Japan. Korea's indigenisation of components for black and white television receivers (B&W TV) for exports in 1979 reached 95%, while that for colour televisions (CTV) in the same year remained as low as 34%.[12]

This makes for an odd contradiction with a claim by many researchers saying that the Korean industry had a heavy dependency on the supply of foreign technology, raw materials, capital goods and components.[13] Many researchers on Korean industrial development have pointed out that this high dependency on the foreign supply of components and raw materials has been the prime cause of the fragility of Korean industrial development.

In fact, a simple consideration of the definition of indigenisation and some careful observation on statistical facts can easily clear up this puzzle. In the first place, key components consist of many types. It is often the case that the definition of indigenisation depends on the place of final assembly of those components.

Table 4.3 CRT (1988) (1,000 units, $1,000)

Components	Demand in Korea		Total Imports	
	Units	Value	Units	Value
Colour CRT	12,522	901,594	112	8,440
B&W CRT	8,060	57,355	-	-
CRT for Monitors	5,382	83,421	107	1,658
Total	25,964	1,042,360	219	10,098

Source : Korea Economic and Industrial Data Handbook '88-'89

In the case of Colour CRT, only 112 thousand units were imported in 1988 while the domestic demand for colour CRTs was 12.5 million. According to these statistics, the indigenisation rate of colour CRT reached 99.1% if the rest of demand was filled by domestically made colour CRTs. However, if we take a look at the import figure of components for CRT, we observe a completely different scenario.

Table 4.4 Components and Raw Materials for CRT (1988) (US$1,000)

	Unit	Demand (x 1,000)	Total Imports	
			Unit	Value
Getter	pc	124,352	124,352	13,056
Antenna Spring	pc	19,360	19,360	6,776
Frit Glass	kg	987	987	2,961
Phosphor	kg	213	213	254
Graphite	kg	384	384	690

Source : Korea Economic and Industrial Data Handbook '88-'89

Components and raw materials for CRT were completely dependent on foreign supplies in 1988. Taking the 1979 description by the Institute of Developing Economies (IDE) into consideration, it is fair to say that the Korean electronics industry's indigenisation of CRT at the final assembly phase succeeded at an early stage. Nevertheless, the supply of those CRT components depended on foreign sources. The source of 96% of components for consumer electronics was Japan, according to the IDE. [14]

Exactly the same thing can be said about FBT and DY.

Table 4.5 DY and FBT (1988) (1,000 units, $1,000)

Components	Demand in Korea		Total Imports	
	Units	Value	Units	Value
DY	25,964	39,608	707	2,208
FBT	25,964	52,706	707	4,126

Source : Korea Economic and Industrial Data Handbook '88-'89

The share of foreign supplies of DY and FBT was only 2.7% in 1988. On the other hand, the supply of raw materials and components for these key components also totally depended on foreign supply.

Table 4.6 Components and Raw Materials (1988)

(1,000 units, $1,000)

	Unit	Demand (x 1,000)	Total Imports	
			Unit	Value
Epoxy Resin	kg	2,446	2,446	8,707
Insulation Paper	pc	125,151	125,151	7,595
Silicon Grease	kg	6	6	203
Noryl	kg	472	472	1,699

Source : Korea Economic and Industrial Data Handbook '88-'89

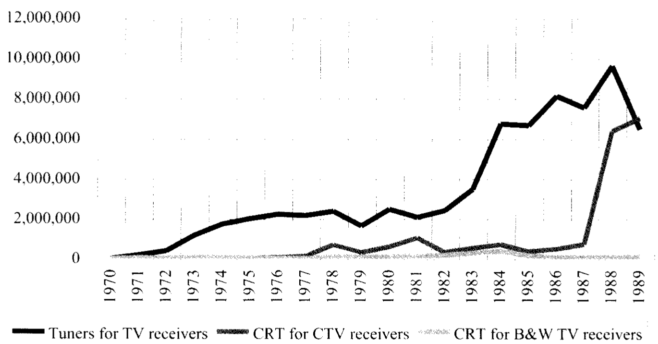
Taking an example of DY production, the final assembly process involves winding coils by using specialised machines and tools, and bundling of coils among others. It can be said that the Korean electronics industry has acquired the specialised machines and know-how of the final assembly of DY and FBT.

If we take a look at the situation from the other side, namely the Japanese export of key components for TVs, we can find an interesting aspect. Japan's export of tuners for TVs was increased from the beginning of the 70s and stayed around 2 million sets a year throughout the late 70s and the early 80s.

While Korean TV production increases from 2.3 million in 1976 to 6.8 million in 1980, Japan's export of TV tuners stayed at almost the same level of 2 million a year. Therefore, it should be natural to consider that the gap between domestic demand and imports of TV tuners from Japan was filled by domestically produced TV tuners.

Based on the above observation, we may categorise the indigenisation phases into 1) indigenisation at the final assembly level, and 2) indigenisation of components and raw materials. For convenience, we may define the terms of indigenisation as; a) complete indigenisation (100% domestically done), b) high indigenisation (more than 75%), and c) incomplete indigenisation (less than 75%). We can summarise our observation of the indigenisation of key components by the

Fig. 4.4 Japan's TV Key Components Exports to Korea



Source : Japan Trade Statistics Monthly, Ministry of Finance

Korean electronics industry at the early stage (the 70s-the 80s). This summary, indeed, rectifies the contradiction of two observations by precedent research works. Namely, a higher degree of indigenisation at the final assembly level of key components is consistent with IDE observation. At the same time, a very high dependency on imports of components and raw materials for key components supports propositions by many researchers' claims.(15)

Table 4.7 Indigenisation of Key Components

Key Components	Final Assembly	Components & Raw Materials
CRT	Indigenised	All Imported
DY	Highly indigenised	All Imported
FBT	Highly indigenised	All Imported
Tuners	Incompletely indigenised	Incompletely indigenised

Now, there appears to be further question as to why this has happened. The Korean electronics industry might have indigenised everything. Is this high dependency on imports of components and raw materials a serious disadvantage for the industry?

4. Catch-Up Strategy and External Factors

To answer these questions, the following points may be considered for further analysis.

1) How did Korean Government policy shape this scenario of industrial development?
2) Did private company strategy play an important role?
3) How was business and technological environment surrounding the Korean electronics industry?

In the following part of this paper, further discussion takes place to address these questions.

4.1 Government Policy

The Korean government's industrial policy on the electronics industry in the 60s was a mixture of import substitution, and the promotion of export-oriented foreign investment. As pointed out by IDE, real growth of indigenous capital activities had not been apparent until the 70s. [IDE, 1981] Since then, President Park Chung Hee and his successors focused on a few targets.

1) Export promotion
2) Promotion of leading companies of Chaebols
3) Protection of indigenous capital

For these purposes, the government a) designated leading indigenous exporters, b) provided preferential financing schemes to these designated exporters, c) restricted new entry into the market even by domestic capital, d) facilitated high import tariff barriers to protect domestic market, e) provided the leading exporters with tax incentives and import duty exemptions, f) prescribed simplified customs procedures specially for the leading exporters, g) actively promoted export oriented foreign direct investment to free trade zone, and h) supported technology imports particularly into the strategic export oriented industry. Hasegawa and others have pointed out that "Companies that met or exceeded the Ministry of Commerce and Industry's (MCI) set export targets received more favours, while sanctions and tax investigations faced those that failed to meet their quotas."(16)

Korean exports drastically increased in the late 70s and the 80s, although its export drive was sometimes criticised as dumping. Korea consequently earned trade surplus with many of its trading partners with exception of Japan. For Korea, the Japanese consumer electronics industry was a front runner of the industry, the primary supplier of components and technology, and a serious competitive threat. Because of its high dependency on Japanese made components and capital goods imports, whenever Korean exports increased, their trade deficit with Japan was inevitably widened.

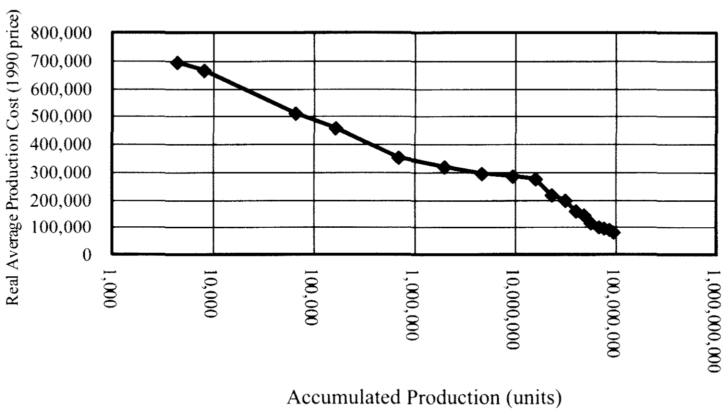
In 1978, a new trade policy entitled "Source Diversification System for Specific Imports" was introduced to restrict imports from Japan. In the first year, 261 categories of products including motor vehicles and colour televisions were practically banned from being imported from Japan. In 1981, because of a domestic business slow down, the number of restricted categories was increased to 924. Although the number of restricted categories of imports has been gradually decreased, the trade restriction system on imports from Japan remained until 1999.

The consumer electronics industry was one of the industries which was most seriously affected by this policy. Japanese consumer electronics manufacturers could not export many of Japanese made consumer electronics products while they exported a large amount of components and raw materials, as well as technology.

4.2 Dynamic Economy of Scale in Final Products and Components

We have seen that the Korean consumer electronics industry has been benchmarking the Japanese counterpart for its development process. It imported a large percentage of raw materials and components, and also technology from its Japanese counterpart. Therefore, it is a natural supposition that the Korean industry's competitiveness was, to a certain extend, decided by the productivity improvement of its Japanese counterpart. In this regard, it is worthwhile to observe how much dynamic economy of scale or learning effect prevailed in the Japanese consumer electronics industry.

Fig. 4.5 Colour Television : Real Average Production Cost



Source : Machinery Statistics Yearbook, Ministry of International Trade and Industry (MITI) (Japan), each year

Reliable time series data of colour television production, shipment and inventory data in terms of volume (unit) and value (Yen) have been available since 1962.[17] Taking annual data of production volume and value, we can calculate the average production cost per unit. By using GDP deflator, we can deflate the nominal average production cost per unit to obtain a "real average production cost". Fig. 4.5 is the relationship between Real Average Production Cost and Accumulated Production Volume for Japanese CTV production since 1962 to 1979.

Fig. 4.5 shows a typical learning curve where production cost decline as accumulated production volume increases. Shintaku made a detailed discussion on Japan's CTV shipment data for the same period and concluded that a structural change in production technology took place around 1970.[18] He pointed out that the introduction of transistors and ICs into CTV since 1970 accelerated the pace of reduction in production cost further. In fact, we can observe a clear bending at the production volume of 16 million units which is corresponding to the year of 1970.

Taking Shintaku's proposition, we can conduct a non-linear regression analysis to estimate how much learning effect affected production cost in Japan. For this purpose, we define that "Leaning Effect" discussed here as a measure of how much cost reduction takes place while accumulated production volume is doubled. The following table is a comparison of Learning Effect during the two periods in Japan.

Table 4.8 CTV Production Learning Effect

Period	1962-1969	1970-1979
Learning Effect	8.2%	37.9%

In the early phase ('62-'69), Japan's CTV production cost was reduced by 8.2% while accumulated production volume was doubled. Since 1970, the pace of cost reduction was drastically accelerated to 37.9%. This figure of learning effect was even higher than that of the semiconductor industry. Shintaku pointed out that this acceleration of production cost reduction was achieved by 1) cost reduction of transistors and ICs themselves, 2) introduction of IC made substantial reduction the number of electronic components required, 3) introduction of transistors and ICs made circuit board auto-insertion possible and drastically improved final assembly productivity.[19]

It should be true that one of the major contributors to this drastic acceleration of cost reduction was the introduction of transistors and ICs. In particular, the auto-insertion machine significantly reduced production cost at the final assembly stage. Sony developed the first transistor based B&W TVs in 1960. Since then, each manufacturer drastically accelerated introduction of transistors and then ICs into televisions throughout the 60s. By the early 70s, most of CTVs produced by leading Japanese manufacturers became "full-transistors" products using only transistors and ICs, not vacuum tubes.

However, we must not forget that the share of key components such as CRT, FBT, DY and tuners is a large part of the total cost of components. The cost reduction effect of transistors and ICs affected less than half of the total cost for components. Therefore, it was not possible to achieve such high speed cost reduction without strong learning effects on these key components.

To measure learning effect on those key components, let us observe the learning curve in the same way we have observed on CTV production. Statistical data of production and shipment of those key components are available for CRTs and tuners, but not for FBT and DY. Because we have to analyse components cost for final assembly, we must use real average shipment price rather than production cost. However, only production unit and value data are available for tuners. Hence, we have to deal with real average production cost for tuners and real average shipment price for CRTs.

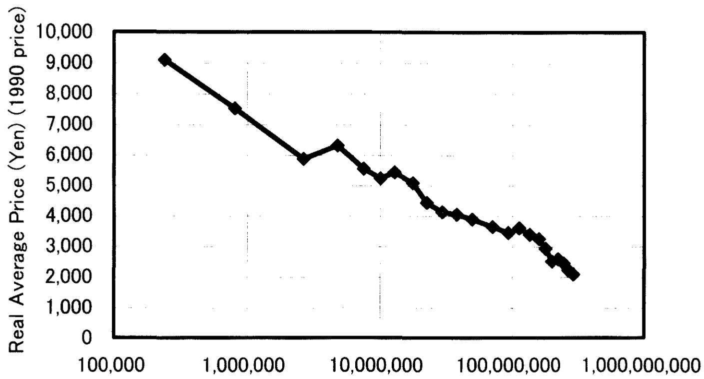
Fig. 4.6 is the relationship between real average shipment prices and an accumulated shipment volume of colour CRTs. The machinery statistics yearbook did not carry value data (in Yen) for either production or shipment from 1968 to 1974. Based on the data covering 1965-1967 and 1975-1979, we obtain 19.8% for learning effect. The same procedure was applied to tuners and the value of 12.6% learning effect was obtained. We might notice an interesting difference between CTV learning curve and those of key components.

1) In the case of CTV production, real average production cost (1990 price) was decreased from 456,366 yen in 1964 to 83,174 in 1979. The 1979 real average production cost was 1/5.5 of the 1965 price. On the other hand, the real average shipment price of tuner was only 1/2.1 of the 1965 price. The learning effect was stronger for CTV final assembly, while not so much for some key components.
2) The CTV learning curve shows a bending due to technological innovation in production. However, such bending in the learning curve was not observed for CRTs and tuners.

Fig. 4.6 Colour CRT : Real Average Shipment Price & Accumulated Shipment Volume

Source : Machinery Statistics Yearbook, Ministry of International Trade and Industry (MITI) (Japan), each year

Fig. 4.7 Tuners for Television : Real Average Production Cost



Source : Machinery Statistics Yearbook, Ministry of International Trade and Industry (MITI) (Japan), each year

Let us summarise the results of learning effect estimation.

Table 4.9 CTV Key Components Learning Effect

	CRT	Tuner
Learning Effect	19.8%	12.6%

Table 4.10 CTV Other Components Learning Effect

Period	1962-1969	1970-1979
Learning Effect	6.7%	40.4%

Based on these observations, we may reach the following propositions;

a) Old vacuum tube CTV sets production achieved a relatively lower learning effect. The major part of cost reduction in vacuum tube CTV sets was achieved chiefly by learning effect on key components, particularly Colour CRTs.

b) After the introduction of transistors and ICs into CTV, learning effect on CTV production was drastically strengthened. A sharp drop in the price of semiconductors, a substantial reduction of required components by the introduction of ICs, and the transformation of production from manual assembly to mechanised assembly by auto-insertion machine reflected upon the very high value of the learning effect, which played the dominant role in production cost reduction after 1970.

This technological innovation in Japan had a considerable impact on the catch-up strategy of the Korean consumer electronics industry.

4.3 Korea's Catch-Up Strategy

As has been referred to, Korea started commercial production of Black and White Television Sets in 1966 and Colour Televisions Sets in 1974. The Korean consumer electronics industry lagged behind by more than ten years its Japanese counterpart. When Korea started its CTV production in 1974, the Japanese consumer electronics industry produced 7.3 million units. The accumulated production of CTV in Japan had already reached 47.3 million units. Furthermore, a technological innovation that took place in

Japan accelerated the pace of the learning effect by nearly five times.

For the Korean consumer industry, its Japanese counterpart must have seemed far ahead. At the beginning of their commercial television production, what kind of strategic options were possible? To answer this question, we need to address three principal factors;

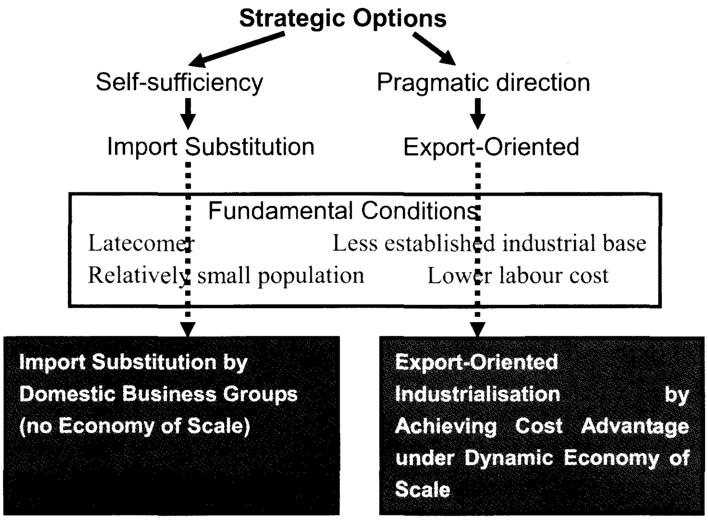
1) Domestic market oriented (import substitution) or export oriented?
2) Assembly concentration or full-set industrialisation (both component and final products industries)?
3) Industrialisation by indigenous capital or foreign capital?

These factors are not independent of each other. If one hopes to promote export oriented industrialisation, one has to achieve international competitiveness. If dynamic economy of scale prevails, the domestic market might be too small. The question whether industrialisation by indigenous capital or foreign capital should be chosen is not only a business issue but a policy issue as well.

If Korea took an import substitution strategy, its consumer electronics industry would primarily have to concentrate on its domestic market. Its population was 34.7 million and GDP per capita was US$540 in 1974. Its CTV domestic market has grown in parallel with Korea's economic growth throughout the late 70s and the 80s. However, it was 1988 when CTV domestic market reached the size of 2 million units a year, while Japanese market was over 9.5 million units a year. As long as learning effect prevails in the industry, it was obviously not possible for the Korean consumer electronics industry to take off without exports.

It was also a strategic choice whether Korea should take a full-set strategy where both final products and component industries are promoted or an assembly-oriented strategy. To analyse this choice, let us do a simple simulation. Based on the

Fig. 4.8 Korea's Strategy Decision



findings on the CTV production learning effect, let us assume that the Korean consumer electronics industry only used domestic components and raw materials, and achieved the same learning effect of 8.2% with its Japanese counterpart for the first five years of CTV production, from 1975 to 1979. At the end of 1979, its production cost would be reduced from 100% in 1975 to 66.1% in 1979 due to learning effect. However, its Japanese counterpart which had started CTV production twelve years before Korea reduced its production cost to 12.0% in comparison with its first year of production in 1962. If Korea had chosen a full-set strategy, production cost would have been five times more expensive than its competitor.

The Korean government promoted indigenisation of components and raw materials because of its widening trade imbalance with Japan. However, the Korean industry indigenised components and raw materials at a much slower pace than the government expected. Namely, the Korean industry chose the best way to strengthen its international competitiveness by making the best of its Japanese counterpart's learning effect. On average, labour cost in Korea for electrical machinery industry was 15-19% of Japanese labour cost in the 70s. Together with components and raw materials from Japan, the Korean consumer electronics industry benefited from lower labour cost of a high quality and hardworking work force.

Spence proposed a theory of forward pricing.[20] According to him, if a manufacturer has some information on learning effect, the manufacturer would offer competitive price based on marginal cost at the end of a planning horizon even at the very beginning of production. If a manufacturer knows that an average production cost declines over the time, the manufacturer would set a price for its product very low to attract a larger demand. The Korean industry knew that the average production cost declines over time, because it could closely observe what had happened to the Japanese counterpart. On the basis of this observation, the Korean industry could guess how much average cost decline it could expect for its production system. Therefore, the Korean industry could implement this “forward pricing” where they offered much lower price than Japanese from the very beginning.

5. Inference and Implications to a developing country

There are a few things that many developing countries can learn from the Korean experience. The first is the strategic approach taken by the Korean government for industrialisation. The Korean government since the Park administration set the strategic target, export driven industrialisation. For this target, the government rationalised the financial system and foreign exchange rate to promote exports. It also facilitated the promotion scheme to encourage the designated strategic industries of the country.

The second issue which many developing countries may find useful is that pragmatism. Although there still remained strong anti-Japanese sentiment, the Korean industry and government took a pragmatic approach to purchase many components from the Japanese component manufacturers. They also introduced a wide range of technology and know-how from the Japanese industry. Although Korea suffered from chronic trade deficits with Japan, the empirical findings of this chapter confirmed that the Korean pragmatic choice to import Japanese made components accelerated the Korean catch-up process.

It has been pointed out by many researchers and many preceding studies that the development of the Korean consumer electronics industry has had fundamental and structural fragility and weaknesses because of its high dependency on foreign technology and, component and raw materials. Indeed, this high dependency did not change for a few decades since the early 60s. However, its choice to use Japanese made components rather than to persist in all-Korean made components was the best and only possible way for Korea to catch-up with Japan.

Because Korea could start from the middle of the learning curve by using Japanese components and raw materials, Korea could reduce production cost much faster than doing everything from the very beginning. In addition, using the dynamic economy of scale that was achieved by its Japanese counterpart made it possible for the Korean industry to foresee the future cost reduction. Such expectation on the future cost reduction of the Korean industry based on observation of the Japanese dynamic economy of scale made it possible for the Korean industry to commit itself in forward pricing. This is another reason for competitive pricing by the Korean electronics industry.

Even now, a few developing countries impose a strict and progressive demand for indigenisation of components and raw materials on foreign owned subsidiaries. If a foreign owned subsidiary can not satisfy a certain level of indigenisation, a heavy import duty is imposed on the component imports. The host country government expects such indigenisation requirement encourage components and raw materials local production in the developing country. It is indeed very convenient for the government if the indigenisation requirement promises components and raw materials local production as well as an increase of tax revenue. However, such heavy penalty on foreign owned subsidiary for not satisfying indigenisation requirements often triggers the counterproductive vicious cycle. In other words, protection of one sector of an industry inevitably invites demands for protection from other sectors of the industry.

The discussion in this paper found out that acceleration of industrialisation process under the dynamic economy of scale is possible only by using foreign cost competitiveness. The Korean industry succeeded in using Japanese component industry's cost competitiveness. Therefore, if those developing countries with small domestic market persist in "self sufficiency" in industrialisation, it would be very difficult for them to attain industrialisation within a short period.

The third lesson that many developing country may find it worthwhile to learn is benchmarking. Being located next to Japan, the industrial rival, may be considered as a negative factor for Korea. Nevertheless, the Korean industry closely observed success and failure of its Japanese counterpart. The Korean industry benefited from successful business experience of the Japanese industry. At the same time, the Korean industry could avoid those mistakes that its Japanese counterpart had made.

<Notes>

(1) [Kubota et. al. 1990] 3p.
(2) [Linsu Kim 1997] 134p. Kim explains development process of the Korean electronics industry in detail in his book. He argues that the Korean electronics industry has started imitation of Japanese counterparts' products but has quickly acquired various technological know how through its development process to create innovative products.
(3) [Kubota et. al. 1990] 3p.
(4) [Linsu Kim 1997] 133p.
(5) [Matsumoto 2001] 26-27p.
(6) [Linsu Kim, 1997] 133p., [Watanabe, 1996] 63p. Watanabe gives detailed analyses on this Korea's drastic change under the Park administration from import substitution policy to export oriented policy in his book.
(7) [Watanabe, 1996] 42p.
(8) [IDE, 1981] 94p.
(9) [Linsu Kim 1997] 136p.
(10) [EIAJ, 1998] 45p., [Shintaku, 1994] 44p.
(11) [Kubota et. al. 1990] 88p.
(12) [IDE 1981] 106p.
(13) [Hattori 2001] 43p., [Watanabe 1982] 180-187p., [Watanabe 1996] 180-185p.
(14) [IDE 1981]
(15) [IDE 1981] 105-107p.
(16) [Hasegawa et. al. 1997] 463-464p.
(17) [MITI]
(18) [Shintaku 1994] 54p. and 84-87p.
(19) [Shintaku 1994] 64-69p.
(20) [Spence, 1981]

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<Appendix>

Estimation of Learning Curve for CTVs and Components

1. Outline of Estimation Methodology

The machinery statistics yearbook provides quantity and value of machineries production in Japan. For the electronics industry, categories for CTV, B&W TV and some key components are available. However, FBTs, for instance, are counted only as transformers. It is, therefore, impossible to differentiate FBTs out from many other transformers.

In this study, regression analysis and estimation focused only on those products and key components that can unmistakably be differentiated from the others. Only those key components satisfy these conditions are CRTs and tuners.

Original data taken from the machinery statistics yearbook were firstly examined from continuity point of view on classification. Then average shipping price (ex-factory price) was calculated by using quantity data.

In this process, changes in composition of various sized CRTs were disregarded for simplicity. This "nominal" average shipping price was deflated by the GDP deflator taken from the GDP statistics of Japan (GDP deflator based on 68SNA where base year was set at 1990). The estimation of learning curve was conducted on the "real" average shipping price and the accumulated production.

2. Estimation Results

ACC : Accumulated Production (unit)

AVRP : Real Average Production Cost (yen)

AVRS : Real Average Shipment Price (yen)

a) Colour Television Sets Production Cost

$$\ln(AVRP) = 14.502 - 0.124 \ln(ACC) + 9.475\ Dummy$$

(175.783) (-19.211) (19.060)

① 0.563 Dummy ln(ACC)

(-19.796)

$R^2 = 0.966$ $\bar{R}^2 = 0.995$ D.W. = 1.680

Dummy : 0 (1962-1969), 1 (1970-1979)

b) Colour CRT

$$Ln(AVRS) = 15.402 - 0.318 \ln(ACC)$$

(11.741) (-3.934)

$R^2 = 0.756$ $\bar{R}^2 = 0.707$ D.W. = 1.964

c) Tuner

$$Ln(AVRP) = 11.667 - 0.195 \ln(ACC)$$

(56.821) (-16.568)

$R^2 = 0.929$ $\bar{R}^2 = 0.926$ D.W. = 0.411

d) Other Components (other factors)

$$\ln(AVRP) = 13.935 - 0.101 \ln(ACC) + 10.870\ Dummy$$

(40.866) (- 4.231) (12.980)

② 0.647 Dummy ln(ACC)

(- 13.104)

$R^2 = 0.986$ $\bar{R}^2 = 0.982$ D.W. = 1.658

Dummy : 0 (1962-1969), 1 (1970-1979)