3. Industrial Diversification and Technological Upgrading since 1980

The Korean economy is considered to have entered the progressive phase of development since the early 1980s. Accompanied by a series of reform measures and changes in strategies, its industrial structure has seen dramatic transformation. Now, Korea is recognized as one of the most successfully industrialised countries with some of the best high-technology industries. A study of the Korean development pattern in this phase suggests that technological upgrading in tandem with industrial requirements is the major factor underlining the success. At the same time it has also faced several hardships and taken steps to correct the failures.

This chapter presents a comprehensive analysis of the contribution of high technology in the industrial and overall economic progress of Korea. To this end, it first discusses the characteristics of the government's economic and industrial planning since the 1980s. Further, technology policies and strategies adopted by the government are elaborated in detail. Focus is placed on explaining how the private firms have been able to accumulate industrial technology capabilities.

As a case study, the chapter takes into account the telecom sector (mobile phone industry) to study its technology acquisition process. In the final part, it assesses the contribution of technology to the total trade by analyzing the technology structure of the manufactured exports and Korea's competitiveness in the world. The chapter is divided into five sections.
3.1 ECONOMIC REFORMS AND CHANGES INDUSTRIAL STRUCTURE

3.1.1 Entering the Market Liberalisation Phase: The 1980s

The previous chapter has already noted the fact that the export growth rate began to slow down after 1976 resulting in economic downturn. In fact, Korean economy was in a vulnerable condition during the phase 1979-1982. In desperation to quickly achieve the "target of exports" (assumingly high), the policy makers overlooked the repercussions of high inflation and current account deficit. In a sense, the state was not able to measure the impact of such instability at the domestic front and thus neglected taking precautionary measures. A brief discussion is presented here to understand the causes of such slowdown and measures taken by the government to overcome it.

A number of factors including excessive state-intervention, heavy investment in HCI and the worldwide recession following the second oil shock were responsible for Korea's economic recession. In its objective to rapidly expand the industrial facilities, the state miscalculated the domestic potential for investment. It is true that state intervention in this aspect was necessary in the face of resource crunch and that it played a greater role in making certain provisions for financing the firms. With the financial support of the government, the firms focused on fulfilling the export-targets that were assigned to them. Such aggressive expansion beyond normal capacity required heavy investment, which was to be met by borrowing loans from foreign countries in the absence of adequate domestic savings.¹

Moreover, the large-scale import of raw materials, parts and machinery, needed for expansion of the Heavy and Chemical Industries (HCIs) along with the relatively heavy import intensity of Korea's traditional exports, further widened

the trade deficit. The state tried to keep the surmounting deficit under control by borrowing money as debts as a result of which Korea's medium and long-term external debt kept on mounting.\(^2\) In addition, the second oil shock, that virtually derailed economic growth worldwide, aggravated Korea's already spiraling balance-of-payment deficit. It also led to increased protectionism in the industrialised world. Besides, the crop failure of 1980s and challenges from other developing countries in labor-intensive products' export were other serious setbacks for Korea.

The political situation following the assassination of President Park delayed the response from government to address the problems. The new administration drafted a CMES (Comprehensive Measures for Economic Stabilization) package and began its implementation in 1980. The CMES focussed on:

(i) emphasising comparative advantage rather than industrial targeting and import substitution,

(ii) making transition towards an economy where market forces were to be the determinants of growth with less state-intervention,

(iii) promoting private sectors in a way so as to let them play the lead role in economic take-off,

(iv) paying greater attention to social sector development, and

(v) pursuing macro economic stabilization programme for price stability and structural adjustment.\(^3\)

The CMES was formulated to give a new direction to the economy through sweeping reforms in the policy directives. Also steps were taken to devaluate the

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\(^2\) Also see Richard M. Auty, *Economic Development and Industrial Policy: Korea, Brazil, Mexico, India and China*, (London, New York: Mansell, 1994), pp. 124-142. As noted here, after the initiation of HCl Korea's external debt rose from $ 3.9 billion to $ 8.0 billion between 1973 and 1976. This continued to increase steadily in 1977 and 1978 by about $ 2 billion annually in nominal terms. The 1979 deflation further pushed external debt up to $ 22.9 billion.

currency and freeze the salary levels of employees during the period 1979-1981. Accordingly, the Fifth Five-Year Plan (1982-86) targeted on price stabilization and structural adjustment rather than on growth maximization, but the core strategy of export-oriented industrialization continued. This indicated a major shift in policy approach of the government.

Compelled by both external and internal factors, the government had no option but to adhere to the process of trade liberalization whereby the future course and direction of the industries would be regulated by the market. The market would create conditions for expansion of industries instead of the state. As per the new pattern, the focus of the industrial policy shifted from an industry specific to a functional approach. The government would provide support in the forms of tax incentive and preferential credit allocation on the basis of business activity rather than providing directly to the officially selected strategic industries. It would serve more general functions such as R&D investments, automation, energy saving and pollution control.

After the corrective measures were put into practice the Korean economy achieved stability in 1983. Though the growth rate slowed down for the period of 1984-85 due to economic slowdown in the industrialised countries, the duration was too small to have larger effect and the economy was already on the road of structural transformation by implementing the Fifth Plan. The Sixth Plan was announced with the broad objective of developing an international network of production in high-tech industries to increase the volume of exports. By doing so the government wanted to realise a surplus in balance-of-payments, reduction in foreign debt and strengthening of a market-based economic system.


In sum, the objectives of the Fifth and Sixth Plans were to raise the efficiency and strengthen the international competitiveness of the Korean firms by promoting a free enterprise market system. It may be said that the government’s policy direction began to be determined by an increasingly competitive global economic environment. The process of opening-up the domestic market for foreign enterprises was deepened to inject the spirit of competition among the domestic industries. Further liberalisation in finance, imports and foreign exchange regimes took place to support this strategy.\(^6\)

Such economic reforms in the early 1980s were accompanied simultaneously by industrial restructuring measures. To this effect, the Fair Trade Law (the MRFTA) was introduced in 1980 with the objectives of ensuring fair trade by eliminating the bottlenecks and preparing the ground for a competitive industrial environment in the domestic sphere. Cognizant of the negative effect of building up of over capacity in the HCIs with the help of the borrowed money, it was quite logical for the government to first initiate an appropriate check-and-balance mechanism against the malpractice of the chaebol.

So the major part of the regulatory framework in MRFTA was concentrated on curbing the unnecessary diversification and expansion of the Chaebol. Armed with certain provisions for dealing with the abuse of market dominant position, anti-competitive business organization, undue collaborative activities, unfair trade practices, restraints on competition by trade associations and so on, the enactment of MRFTA was certainly a bold step forward in consonance with the changes in the international trade dynamics.\(^7\)

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Also see, B.N. Song, n.6, p. 116. As stated in Article no.1 of the Law (MRFTA), “This Law shall be aimed at encouraging fair and free competition and thereby stimulating creative business activities and protecting consumers as well as promoting a balanced development of the national economy”. 

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<table>
<thead>
<tr>
<th>Plan Period</th>
<th>Broad Objectives</th>
<th>Avg. Economic Growth Rate</th>
<th>Avg. Export Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th Five Year Plan 1982–1986</td>
<td>Implement economic stabilization programme. Begin the process of market liberalization. Reduce government intervention. Encourage private sector to play the lead role. Curb chaebol’s excess diversification</td>
<td>8.6 (7.5)</td>
<td>11.3</td>
</tr>
<tr>
<td>6th Five Year Plan 1987–1991</td>
<td>Continue stabilization measure. Deepen market liberalization. Modify industrial structure towards advanced technology. Adapt to international business principles.</td>
<td>10.0 (7.3)</td>
<td>19.5</td>
</tr>
<tr>
<td>7th Five Year Plan 1992–1996</td>
<td>Globalize the economy. Focus on knowledge-intensive industries. Boost FDI Implement measures to curb the monopoly of chaebol. Promotion of SMEs Abolition of the EPB.</td>
<td>7.0 (7.5)</td>
<td>10.8</td>
</tr>
<tr>
<td>1997–2001</td>
<td>Restructure the corporate sector. Reform the financial sector. Curb unnecessary expansion of chaebol and promote SMEs.</td>
<td>4.5</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Source: The economic objectives are compiled from various books on the topic. The figures are calculated from National Statistical Office, *Annual Statistical Reports*, (various issues) and Korea Development Institute, *Major Indicators of Korean Economy*, (various issues). The figures in parentheses indicate the target growth rate.

A new agency, the Fair Trade Commission, was set up in 1981 to monitor the implementation of the MRFTA. The number of designated strategic industries to get the benefit of preferential tax treatment was reduced from eleven before
1974 to six in 1981. Instead of the strategic industries, the tax treatments were provided to the firms in high technology-intensive area. The top 30 chaebol were dealt with a more restrictive credit policy and directed to restrict their sectoral diversification around three or fewer core areas.

Besides, a new Industry Development Law came into effect in 1986 replacing the seven existing industry-specific promotion laws. The most important feature of this law was its emphasis on productivity growth rather than export capacity expansion. Under the new law strict scrutiny measures were applied to select industries for government assistance. Accordingly, only two broad categories of industries (instead of the strategic industries) were entitled for government support,

(i) sectors where it became difficult to attain international competitiveness despite a comparative advantage for the Korean economy, and

(ii) structurally inefficient declining industries in which Korea was gradually loosing competitiveness with three-year government intervention in this category.

While at the economic front the policies were strongly implemented, at the industrial front negligence was clearly visible. The privatization and deregulation policies initiated in 1987 and 1988 respectively were only partially implemented. Clear signs of contradiction between the government’s projection of promoting a competitive market mechanism and facilitating the growth of key chaebol could be seen when the government divested a major part of its financial

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8 Haeran Lim, n. 5, p. 87. During the period 1981-1996 the MRFTA was amended five times in 1986, 1990, 1992, 1994 and 1995 and several new provisions were included to make the MRFTA more result-oriented.

The deregulation policy that was actually meant for findings out the incompetent industries and for seeking an optimal solution of deregulation, in turn created many industries, which remained exempted from Competition Law.
resources on the four key chaebol for their expansion. Thus the government persisted with its reliance on the chaebol for realising export targets and maintaining competitiveness, as no other alternative seemed viable.

Barring these limitations, the industrial policies in the 1980s at least responded in some sense to the market signals by bringing moderate if not transparent changes in the industrial structure. For the first time, the need for developing the SMEs in order to improve equity and efficiency and to reduce the unemployment problem was felt at large. Being encouraged and financially supported, the SMEs were seen as producers and suppliers of the parts and components required in the large industries.

In addition to the continued expansion of major technology intensive industries such as advanced consumer electronics products, automobiles, iron & steel, shipbuilding, fine chemical and processing equipment etc., the promotion of IT sector was given priority. As a result, the major chaebol began to diversify their business activities towards the semiconductor chip and computer equipment manufacturing process.

With effective implementation of such measures Korea became capable in substantially increasing its exports and posted a GNP growth of over 11 per cent for three consecutive years from 1986. But by the end of the decade, the growth rate again slowed down. On the one hand, Korean industries were rapidly moving towards the high-tech structure. While on the other, they were also losing comparative advantage in cheap labour due to labour unrest for hike in wages, which disrupted manufacturing activities.

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13 Haeran Kim, n.5, p.101. In the mid-eighties, the government introduced measures such as Yeoshingwanli (loan management) policy and promoted subcontracting relationship between the large enterprises and SMEs.
14 Ibid. Korea became a trade surplus nation for the first time in its history of trade and economic development as a result of such growth in GNP.
Table 3.2: **Industrial and Technology Policies since 1980s**

<table>
<thead>
<tr>
<th>Subject</th>
<th>1980s</th>
<th>Since 1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Policies and Objectives</td>
<td>- Concentration on growth of Technology-Intensive Industries</td>
<td>- Shift towards Knowledge-Intensive Industries</td>
</tr>
<tr>
<td></td>
<td>- Rationalization of HCI Plan</td>
<td>- Strengthening International Competitiveness of Industries</td>
</tr>
<tr>
<td></td>
<td>- Improvement in Industrial Productivity</td>
<td>- Promotion of Industries on Priority basis</td>
</tr>
<tr>
<td></td>
<td>- Promotion of Small and Medium Enterprises</td>
<td>- Corporate Restructuring through downsizing the Chaebol and Promotion of SMEs</td>
</tr>
<tr>
<td></td>
<td>- Relaxation on the Entry of Foreign Companies</td>
<td></td>
</tr>
<tr>
<td>Major Industries and Export Items</td>
<td>- Electronics such as Microwave Ovens, Sound Recording equipment, Steel, Ship, Light Passenger Cars</td>
<td>- Microelectronics such as Semiconductor, Computer Peripherals, Telecom Equipment, Automobiles</td>
</tr>
<tr>
<td>Technology Policies and Institutional Mechanism</td>
<td>- Emphasis on Internalization of Imported Technologies</td>
<td>- Building up Indigenous Capabilities</td>
</tr>
<tr>
<td></td>
<td>- Enhancement of R&amp;D and Encouragement of Private Sector R&amp;D</td>
<td>- Adoption of Innovation-based Strategies</td>
</tr>
<tr>
<td></td>
<td>- Announcement and Implementation of Major R&amp;D Programmes</td>
<td>- Intensification of R&amp;D and Implementation of R&amp;D Programmes in Next-generation Technologies</td>
</tr>
<tr>
<td></td>
<td>- Continued expansion of Technical and Engineering Education</td>
<td>- Promotion and Expansion of Technology Parks</td>
</tr>
<tr>
<td></td>
<td>- Focus on Cooperative Industrial Research Project</td>
<td>- Creation of Innovation Clusters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Focus on Establishing National Innovation System</td>
</tr>
<tr>
<td>Technology Accumulation Strategies of Firms</td>
<td>- Technology Acquisition through Joint Venture and OEM Arrangement with Leading Foreign Firms</td>
<td>- Increasing Investment in in-house R&amp;D and setting up Research Outposts abroad</td>
</tr>
<tr>
<td></td>
<td>- Engagement in own R&amp;D</td>
<td>- Strategic Alliances and Global Networking with Foreign MNCs to access Cutting-edge Technologies</td>
</tr>
<tr>
<td></td>
<td>- Minor Improvement in Existing Technologies through Learning-by-research</td>
<td>- Emphasis on Creative designs through Innovation</td>
</tr>
<tr>
<td>Source: Prepared from various sources.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.1.2 **Transition to Globalisation: The 1990s to the Present**

The slow-down of growth in 1989 and the recurrence of trade deficit in 1990 again pointed out the inherent weaknesses in the economy and called for further reforms. The absence of a strong labour policy and the failure to deregulate the economy were strongly criticized for the loss of competitiveness by the chaebol.\(^{15}\) In 199, the situation was quite different. The dynamics of U.S. trade relations with Korea and Japan began to change. Both were forced to hasten the process of market liberalization thus loosing the leverage of protectionism for competitive U.S. industries.

Most important of all, the process of globalization gained momentum in the developing countries in the early 1990s and became the core element of trade policy in almost all countries. This urged the need for a reorientation of the Korean economy. The stiffening competition among nations and across firms to survive in the global market had become a cause for concern and thus been assigned high priority in the overall development strategy in Korea also. Such circumstances forced the government to once again shift its policy on chaebol from regulation to liberalization in order to enable them to compete freely in the global market. For instance, the existing Anti-Trust and Fair Trade restrictions on the credit controls to the thirty largest firms were waived off with some reservations.\(^{16}\) As a result of the domestic markets' opening up for imports, the Korean firms, which formerly competed for exports, began to compete for imports and for attracting foreign capital.

The Seventh Five-Year Plan was carried out with a major concern to accelerate the pace of trade liberalization. But it is felt that discussions on this plan would not be of much use as it was suspended in less than two years. In its place the leadership announced a New Five-Year Plan (1993-1997) with modifications.

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\(^{15}\) Tat Yan Kong, n.12, pp. 150-151.

\(^{16}\) Linsu Kim, n.9, p. 35.

'Restrictions on the credit controls of the thirty largest chaebol were lifted, provided that their firms reduced internal ownership to less than 20 percent, raised capital to asset ratio above 20 percent, and offered more than 60 percent of its share to the public.'
The New Plan focussed on the importance of financial, administrative and budgetary reforms that were essential for assuring Korea a place in the list of advanced industrial powers by 1997. Moreover, it also reflected a shift in focus and laid special emphasis on the need to develop the initiative and creativity of the private sector and further reduce the intervention of the government on economic development process.

This plan was followed immediately by the announcement of the "Korean Economy for the 21st Century: Vision and Development Strategy" covering the period 1994-2020 with four major objectives:

"an advanced economy, with innovative spirit and vitality; a welfare state with a high level of culture and good quality of life; a world economic centre contributing to a global society; and a peaceful, prosperous state for all Koreans."

To realize these objectives, the government laid emphasis on improvement of the domestic environment for inward investment and facilitation of outward direct investment. The financial markets were further liberalised and economic regulations were framed in consistence with international standards. Various restrictions on foreign borrowings were lifted.

The government-business (chaebol) relationship, which was on a smooth track after the reversal of policy in the early 1990s, once again appeared to be under scrutiny. Under the provision of the new plan, the chaebol once again were required to restructure their organizations. The Fair Trade Commission announced that the top ten chaebol would be required to select three core businesses and designate the companies that would specialize in those sectors,
while the next twenty would have to choose two core businesses. In addition, the promotion of SMEs was seen as essential for long-term economic prosperity.

But by then, as the chaebol had become economically powerful, they sought the removal of excessive state control, which they thought, had impeded their competitiveness by limiting their access to foreign capital. They were capable enough to borrow directly from the international sources to fund their ambitions expansion plans.

Coming to the industrial structure, the challenges from transnational corporations, TNCs, of the advanced nations provoked the Korean industries to maximize their efficiency by taking advantage of the opportunities for globalise production. The major high-tech sector emphasized since the 1990s are semiconductor, telecom (mobile phone), fiber optics, automobiles, nuclear energy, aerospace, biotechnology and fine chemical and processing equipment.

The effect of these policy changes on the growth of the economy could be felt in the first five years of 1990s. The average GNP growth rate was 7.6 percent with the lowest of 5 percent in 1992 and 5.8 percent in 1993. Encouraged by such trends, the administration moved in the direction of joining the club of OECD, which was believed to be a formal recognition of the advancement of Korean economy. Many of the domestic barriers to meeting OECD requirements had gradually been removed and Korea finally was accepted as a member of the OECD in 1996.

Just one year later, the situation began to worsen leading the economy to fall into the trap of the financial crisis of 1997. The impact of the crisis (that

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Also see, Brian Bridges, *Korea After the Crash: The Politics of Economic Recovery*, (London, New York: Routledge, 2001), p. 16. However, the new government’s (Kim Young Sam) decision to abandon the centralized planning and coordination framework by forcing the Economic planning Board to merge with Ministry of Finance into a new super ministry (Ministry of Finance and Economy) in some ways allowed the chaebol to have greater freedom to invest and borrow where they liked.

20 Tat Yan Kong, n.12, p. 154.

21 Figures are taken from *Korea Annual 1997*, (Seoul: Yonhap News Agency, 1997), p. 233 and the average is calculated.
engulfed not only Korea but also many other Southeast Asian emerging economies) was severe and perhaps the greatest setback since the Korean War. In attempts to find out what went wrong with the policies and strategies of the Korean economy, the number of studies has been increasing since then. A brief survey of literature suggests that the crisis stemmed from the heavy short-term borrowing by the firms, which in turn increased the total external debt to an all-time high level of US$ 104.7 billion. Although during the period 1991-1995 the overall growth was not altogether discouraging, it could not compensate for the mounting debt. However, there were many long-term factors like loss of competition in exports and some policy mistakes.

To overcome the crisis Korea did not have any alternative but to seek the help of the IMF (International Monetary Fund). The IMF and the government reached a final agreement on 3 December 1997 on positive counter measures along with a US$ 57 billion bailout. This was followed by the inauguration of the new government with Kim Dae Jung as President. Under the IMF guidelines, the government started implementing a series of policy reforms to create a truly free market system. The reform agenda included the restructuring of the financial sector, determination of the value of currency by the market, restructuring government agencies related to economic affairs, reduction in the extent of chaebol business areas, the forced reduction of the chaebol’s debt-capital ratio to 200 percent of capital, the dissolution of the chaebol’s planning and coordination.

22 Thailand, Indonesia and Korea were the most severely affected economies. While Thailand was the first to be affected by the crisis and Korea was its culmination point.
24 The financial crisis is still a contentious issue among the scholars of development economics. The literature is voluminous on the causes of the crisis and the steps taken after in the affected countries. However, it is not the focus of this study to explore and discuss in detail about the crisis. The objective of the study in this regard is to examine whether technology could possibly have been a factor behind it. This point will be elaborated in the analysis part. For more on the various facets of the crisis see, Sung-Hee Jwa, A New Paradigm for Korea’s Economic Development, (Hampshire, New York: Palgrave, 2001), pp. 174-211. Frank J. Richter (eds.), The East Asian Development Model: Economic Growth, Institutional failure and the Aftermath of the Crisis, (Great Britain: Macmillan, 2000), pp. 169-197. World Bank, East Asia: The Road to Recovery, (Washington D.C., 1998), pp. 1-17.
offices and the establishment of a tripartite coalition between labor, management and the government. 25

These policy reforms are still in operation and the Korean economy has witnessed steady improvement since 1999. The export growth is also regaining confidence. To note, an overwhelming expansion of IT industries mainly the semiconductor, telecom equipment and digital electronics devices has become clearly visible since the crisis. With these revivals the economy is expected to gradually look up in the near future.

3.2 DIRECTIONS OF TECHNOLOGY POLICY

The transition of the Korean industries into the mature phase from the early 1980s demanded an altogether different approach to the strengthening technological capabilities. The Korean industries were opened to world-class competition in production efficiency following the pursuance of consistent economic liberalisation and market openings. At this stage the industries could no longer rely on imported technology and cheap domestic labor force to compete in the international market. In the backdrop of the advanced countries' refusal to transfer core technology, it became crucial for Korea to make a 'blueprint' for its own indigenous technological development.

Development of creative and innovative technological capabilities was seen as: (i) an underlying force for its export growth in coming decades, (ii) a means to have competitive advantage over others and (iii) a requisite to help Korea become an advanced industrial society. For this, the most essential prerequisite was the development of an indigenous base for R&D, which required strong commitment from the government. Such R&D structure further would be capable to perform simultaneously the dual task of (i) mission-specific diffusion of imported technologies through improvement in learning mechanism and (ii)

25 For explanations see, Dongyoul Shin, "The Dual Sources of the South Korean Economic Crisis", in F. J. Richter (eds.), n. 23, pp. 189-195. The detail of these policy prescriptions is also provided in Sung Hee Jwa, n. 23, pp. 196-200.
carrying out research for new product development as well as to make minor improvement with creative inputs in the product.26

It may be said that R&D became the ultimate source of technological development and the whole debate of technology policy in this phase is centred on R&D. To put it in other words, the government's intention of giving direction to the technology development pattern at this stage is largely reflected in its R&D programmes and policies.

3.2.1 Modes of Technology Transfer

A change in the government's approach towards import of technology can be noticed in this phase. The sources of technology import were diversified. Recognising the importance of FDI as a key channel for importing technology, the policy framework devised mechanism to attract FDI. Moreover, in its attempt to induce more sophisticated complex foreign technologies, the government reversed its policy on foreign technology licensing. Although other forms of technology transfer such as capital goods import and turnkey plants still continue to some extent, it is safe to say that FDI, FL and OEM have become the three major channels for foreign technology acquisition since the early 1980s. The government has taken several measures to promote FDI and FL modes among the local business firms.

As a first step in this regard, the foreign licensing policy was completely relaxed and liberalized substantially in this phase. For examples, in 1984 the approval system was converted into a notification system under which industries were relieved from seeking government approval for technology import. Acquisition of disembodied technology was preferred to embodied technology

thus marking a shift from the earlier policy. In 1986, the government allowed the importation of trademarks and reduced tax deductions on royalty payments.\(^{27}\)

At the same time, Foreign Direct Investment regulations were also eased thereby facilitating the flow of technologies from foreign firms, although in some cases the regulation remained, as it was before, for example, in consumer durable. To improve the domestic environment for foreign investment the government revised the Foreign Capital Inducement Act in 1983. A new guideline for FDI containing a ‘negative list system’ was introduced under the provision of which 71 of the 520 manufacturing industries were prevented from access to FDI.\(^{28}\) However, the number of FDI eligible sectors increased over time.

Various incentives and facilities were also offered to allow foreign suppliers, a greater ownership control without which it would have been difficult for firms to obtain advanced foreign technology. The impact of FDI liberalization and FL relaxation could be discerned from the dramatic increases in investments. For instance, the total FDI increased from US$ 720.6 million during 1977-81 to 3433.2 million during 1987-89 and FL investment rose from US$ 451.4 million to 2130.3 million over the same period, i.e., in both cases approximately a five-fold increase was observed.\(^{29}\)

Despite such increase in FDI, it was observed that at the end of 1980s Korea still was lagging behind many other emerging industrializing nations. The reasons for it as pointed out by the foreign firms were bureaucratic hassles and increasing cost of production due to high labour wages, labour disputes etc. In response to these complaints, further steps were taken to gradually do away with the constraints and reduce red tapism. Export, local content and technology transfer requirements were abolished in 1989. The government introduced the prompt approval system, tax exemption measures and other incentives to


\(^{28}\) Ibid.

\(^{29}\) Linsu Kim and Carl J. Dahlman, n. 26, p. 443, Table 1.
encourage foreign investment in strategic high-technology sectors. Full foreign ownership was permitted in a large range of business categories.30

A new five-year Foreign Investment Liberalization Plan came into effect in 1996 with recommendations for opening up of restricted business categories to FDI in several phases from 1997 to 2000. Friendly mergers and acquisitions by foreigners were also allowed to some extent. After the crisis the government has taken more steps to completely liberalize technology-related FDI realising its vital importance for strengthening the competitiveness of the firms as well as sustainable development of the economy.31

The proportion of Korea’s industrial sub sectors open to foreign investment rose from 66 per cent in 1984 to 90.6 percent by 1994. The cases of technology transfer through licensing increased from 247 in 1981 to 707 in 1993 except for slight drops during the recession period in Korea.32 As of 1998, more than 97 percent of Korea’s industries were open to foreign investors, while only 22 industries out of 1128 were fully or partially restricted to FDI because of national security and cultural concerns.33

To help firms diffuse the transferred technologies, a technology transfer centre was set up in the mid-1980s. This centre guided the industries with information regarding the various alternative technologies available abroad, the suppliers of such technologies and gave assistance to the firms in preparing contractual documents to procure the required technologies. The government also set up three technical information centres for collection and dissemination of

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30 Francois Nicolas, “A Case of Government-led Integration into the World Economy”, in F.Sachwald (ed.), Going Multinational: The Korean Experience of Direct Investment, (London, New York: Routledge, 2001), p. 29. This approval system enabled the Ministry of Finance to approve foreign investment applications without consultation with related ministries and certain categories of FDI projects were exempted from government screening. Also ‘one stop service stations’ were established to provide solution in this regard.

31 Ibid., pp. 32-37.


33 Francois Nicolas, n. 30, p. 36.
technical information. 34 These centres helped a significant number of private firms with their services. The already established public R&D institutes also served as transfer agents by undertaking joint research with industries, providing them guidelines to identify relevant foreign technology and helping them to negotiate technology transfer.

3.2.2 National R&D Programmes in the Formation Stage (1980s)

A number of R&D programmes have been introduced since the early 1980s with a view to enhance the national technological capabilities (TC) in general, and TC of the private sector in particular. Amendment of the Technology Development Promotion Law in 1981 facilitated various tool to promote private R&D with a view to strengthening the firms’ absorptive, learning and generating technological capacity.

The National R&D programme initiated by the MOST in 1982 focusing primarily on the future problems was considered as the first major public sector R&D programme in Korea. After five years, another major R&D programme, ‘Industrial Base Technology Development Projects (IBTDP)’, in the existing technology areas was launched by the Ministry of Commerce, Industry and Energy (MOCIE) in 1987. In the formation stage i.e. in the 1980s, these two programmes emphasized on the development of technologies required for the local production of major products and materials by absorbing and improving the imported technologies effectively. In this regard, the programmes gave priority to proposals that involved the private enterprises. 35 Also, other ministries began to

34 Linsu Kim and So-Mi Seong, n.32, p. 403. In addition, a national network of technical extension services began to appear with the active involvement of the National Industrial Technology Institute, eleven Regional Industrial Technology Institutes and the Small and Medium Industry Promotion Corporation. The Korea Academy of Industrial Technology together with other GRIs and industry specific R&D institutes under trade associations formed the crux of R&D networks.

establish their own R&D programmes in order to solve the problems in the areas under their purview.

These programmes have been continuing their operations in high technology intensive areas since the 1980s. The targeted new technology areas, which came under the NRP scheme included: localization of machinery parts and components, new material development, semiconductor design, development of computer machinery, biotechnology and basic research in universities. Under the provisions of IBTDP, the MOCIE's task was to identify important R&D projects in industrial firms and offer subsidy to research organizations (GRIs, PSRIs and University Research Institutes) to undertake such projects. The NRP and IBTDP were assigned the task to develop core technologies where Korea enjoyed potential advantages.36

Various incentives, which had both direct and indirect bearing on the development of private R&D, were provided to the technology-intensive sectors. These incentives included: subsidies for research expenses (designated R&D project expenses); tax incentives like reduced tariffs on import of R&D equipment and supplies; deduction of non-capital R&D expenditures; exemption of real estate tax, special consumption taxes and value-added taxes for R&D related activities; offering preferential loans for corporate R&D (setting up new laboratories) by state-controlled banks and public funds; and promotion of exchange of ideas and cooperation among R&D personnel.37 Besides, other tax incentives were also provided to reduce the cost of imported technology, promote

36 Linsu Kim and So-Mi Seong, n. 32, p. 405.
'There exists certain difference in the concerned ministries' identification of the high-tech industries. The MOST has designated ten areas as high-tech in nature, namely, information technology (IT), mechatronics, new material, biotechnology, fine chemical & processing, new energy, aerospace & oceanology. 21st century transportation, medical & environmental and other basic core industries. On the other hand, the MOCIE identifies eight areas as high-tech in nature, namely, microelectronics, mechatronics, new materials, fine chemicals, biotechnology, aircraft and any other industry designated by Presidential decree.
small scale sectors in high-technology activities, reduce the cost of introducing new capitals and encourage venture capital and venture investment.

For augmenting the effectiveness of these R&D programmes the institutional arrangement have been strengthened. For example as mentioned in the previous chapter the two pioneering institutes of KIST and KAIS were merged into the Korea Advanced Institute of Science and Technology (KAIST) in 1981 but were again separated. To make the existing research facilities more result-oriented, the equipment and manpower of the 16 state-supported research institutes were consolidated into nine institutes under the purview of the MOST.38 To provide financial support for the development of new and existing technologies, products and processes, Korea Technology Development Corporation came into being in 1981 by the joint effort of government, business and World Bank. The KTDC has been providing venture capital for high-technology related projects undertaken by the private firms.

The seriousness of the government toward the promotion of S&T began to be reflected sharply with the constitution of a quarterly high-level Conference for Promotion of Science and Technology in 1982. The Conference under the Chairmanship of the President himself included financial institutions, research institutes and academia. Since its inception, meetings have been taking place regularly to discuss critical issues pertaining to Science and Technology. To cite one example, in the conference of 1983 the Minister for S&T appealed to the private sector to catch up with advanced nations, encouraged the key industrial firms to set up outposts in the advanced nations for quick absorption of technology abroad and to conduct joint research with foreign companies in domestic circle.39

Including KAIST these are: the Institutes for Advanced Energy Research, Electrotechnology and Telecommunication Research, Standard Research and Ginseng and Tobacco Research; and, the Institutes of Energy and Resources, Machinery and Metals, Electronics Technology and Chemical Technology.
39 Ibid.
The ever-increasing demand for highly trained engineers and researchers to carry out the research activities following the establishment and expansion of R&D institutes put pressure on the government to emphasise qualitative technical education. These scientists and engineers had to act as vehicles for diffusing new technologies, its management and organizational practices. New institutes like science high schools, the Korean Institute of Technology and vocational training colleges were established. Universities were provided with grants to start industry-oriented research activities and the enrolment ratios in higher education increased over 70 per cent within six years between 1980 and 1986.\(^{40}\) The Korea Science and Engineering Foundation, KOSEF, began its overseas programme to support Korean scientists and engineers to study abroad in high technology field.

3.2.3 R&D Programmes in the Innovation Stage (since 1990)

The rapid transition of Korea towards a knowledge-based economy since the early 1990s has demanded a truly innovation-based approach to making R&D strategy. Aware of Korea’s weakness in core technologies despite a series of R&D initiatives, the government has been putting renewed emphasis on qualitative R&D. The R&D policies at this stage have focused on the complicated task of helping the firms to become able to generate its own technology and create its own product, process and market-leading innovative techniques. In other words, the philosophy of innovation has been deeply incorporated into the national development policies.

The government has stressed on several key aspects of R&D with special emphasis on international cooperation in order to expedite the process of harnessing innovative capabilities. The major policy goals include: (1) expansion of scientific and technical education in universities, government and private institutes; (2) emphasis on joint-research among government, private and university research centres; (3) establishment of a scientific and technological

\(^{40}\) Kim and Dahlman, n. 26, p. 446.
information system; (4) promotion of regional S&T activities; (5) increasing the R&D investment to 5 percent of the total budget and (6) nurturing a science-oriented Korean society.

The commitment of Korea to leapfrog technically is best displayed in its announcement of the Highly Advanced National R&D Project or HAN project in 1992, which has been continuing since then. The primary aim of this project was to raise the standard of Korea in selected core technologies to that of the G-7 nations by 2001. For that a limited number of high-technology projects were identified. The HAN project consisted of two project groups.

The first one, i.e., the Product-oriented Technology Development Project (PTDP) focuses on technologies for specific products in which Korea has potential to compete with the advanced countries by the early 21st century. The

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<th>Table 3.3: Changes in the National R&amp;D Programme by Stage</th>
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<tr>
<td><strong>Formation stage (1982-1984)</strong>: Internalization of foreign technologies</td>
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<tr>
<td><strong>Take-off stage (1985-1990)</strong>: Development of core technologies</td>
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<tr>
<td><strong>Maturing stage (since 1991)</strong>: Creative and future-oriented research</td>
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<tr>
<th>Planning</th>
<th>NRDP objective</th>
<th>NRDP objective</th>
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<tr>
<td>No planning: bottom-up</td>
<td>Internalization of foreign technologies</td>
<td>Development of core technologies</td>
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<tr>
<td>Based on loose long term plan</td>
<td>Creative and future-oriented research</td>
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<th>Main actors</th>
<th>NRDP objective</th>
<th>NRDP objective</th>
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<tr>
<td>Government R&amp;D institutes (GRI)</td>
<td>Internalization of foreign technologies</td>
<td>Development of core technologies</td>
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<tr>
<td>Main: GRI, Minor: Universities and industries</td>
<td>Creative and future-oriented research</td>
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<tr>
<td>GRI with increased role of universities and industries</td>
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targeted products are new agrochemicals, ISDN (Integrated Services Digital Network using the ATM digital switching system), High Density TV (HDTV), ASIC, flat panel displays, biomedical, micromachines, next generation vehicles and express railways. The second one, i.e., the Base (or Fundamental) Technology Development Project (BTDP) focuses on core technologies that are indispensable
for continued economic growth and high quality of life. Under this category, technologies pertaining to next-generation semiconductors, advanced materials, advanced manufacturing systems, new functional biomaterials, environment, new energy, next generation nuclear reactors, advanced superconductor TOKAMAK and human sensibility ergonomics are included. A total of US$ 3.2 billion was spent for the Han project between 1992 and 2001. These projects involve all relevant ministries as well as government enterprises and private corporations. The projects' success in the initial years could be seen from the development of quilon-based antibiotics, liver disease treatment medication and HDTV. The government decided to continue these projects after its initial success.

More recently in 1997, the 'Creative Research Initiative' (CRI) programme was initiated to strengthen the national potential for technological competitiveness through creative basic research. Accordingly, small number of promising young scientists and engineers are being identified and provided with research grants for pursuing advanced research in frontier technologies.

Moreover, the government launched a long-term strategic initiative, the 'Long-term Vision for Science and Technology Development toward 2025' (Vision 2025) in 1999. This plan has been providing guidelines to the S&T development process in order to make Korea an advanced and prosperous economy. Its major features include; (i) shifting the innovation system from government-initiated to private-sector-initiated, (ii) improving the effectiveness of national R&D investment, (iii) aligning the R&D system to a global network. (iv)

43 Ibid.
from a supply expansion policy to an efficient utilization policy and (v) meeting the challenges of the information and biotechnology revolution.

**R&D investment pattern.** The total investment in R&D has been consistently growing up. As shown in Table 3.4, the total R&D expenditure increased from 1,237.1 billion won in 1985 to 16,110.5 billion won in 2001. The most remarkable thing to observe is the gradual decline in the government’s share in the period. Its share in the total R&D investment declined from 64 percent in 1980 to 25 percent in 1985 and 19 percent in 1995.

### Table 3.4: R&D Expenditure and Structure of Korea, 1985-2001

(Unit: W Billion Won, %)

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<tr>
<td>R&amp;D expenditure</td>
<td>1,237.1</td>
<td>3,349.9</td>
<td>9,440.6</td>
<td>16,110.5</td>
</tr>
<tr>
<td>- Government &amp; public(G)</td>
<td>306.8</td>
<td>651.0</td>
<td>1,779.5</td>
<td>4,187.4</td>
</tr>
<tr>
<td>- Private sector (P)</td>
<td>930.3</td>
<td>2,698.9</td>
<td>7,661.0</td>
<td>11,923.1</td>
</tr>
<tr>
<td>- Ratio(G:P)</td>
<td>25.75</td>
<td>19.81</td>
<td>19.81</td>
<td>26.74</td>
</tr>
<tr>
<td>R&amp;D/GNP (%)</td>
<td>1.58</td>
<td>1.95</td>
<td>2.50</td>
<td>2.96</td>
</tr>
<tr>
<td>- R&amp;D Exp. of Mfg. Sector</td>
<td>688.6</td>
<td>2,134.7</td>
<td>4,854.1*</td>
<td>---</td>
</tr>
<tr>
<td>- Per cent of sales of Mfg. Sec.</td>
<td>1.51</td>
<td>1.96</td>
<td>2.55*</td>
<td>2.37</td>
</tr>
<tr>
<td>No. of Researchers/10,000 Pop.</td>
<td>10.1</td>
<td>16.4</td>
<td>22.3</td>
<td>28.8</td>
</tr>
<tr>
<td>No. of corporate R&amp;D Centres</td>
<td>183</td>
<td>966</td>
<td>1,980</td>
<td>6,337a</td>
</tr>
</tbody>
</table>


Note: * - figures of 1994, a - quoted as companies in the report.

However, its share has increased to 26 per cent in 2001 due to cut in R&D budget of the corporate sector following the crisis. The number of established corporate R&D centres rose from 183 in 1985 to 1,980 in 1995 and 6,337 in 1998. This shows the inclination of the corporate sector toward getting involved in R&D.

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44 MOST, n.41, pp.14-15. for detail on this plan see, MOST, *Vision 2025: Korea's Long Term Plan for*
especially after the crisis. The ratio of R&D expenditure to GNP (R&D/GNP) increased from 1.58 percent in 1985 to 2.96 percent in 2001. By any account such ratio is higher than that of many developed countries.\textsuperscript{45}

University and institution-based research network has expanded considerably and are conducting full-scale research on cutting-edge technologies. A few universities have been transformed into research oriented graduate schools. In addition, Science Research Centers (SRCs) and Engineering Research Centers (ERCs)) have been established and promoted in the nation’s leading universities. The SRCs and ERCs are focusing on innovative research in basic science and new technologies.\textsuperscript{46} Students graduating from these institutes are being regularly sent abroad for advanced training. Also the promotion of research at GRIs has been continuing.

3.3 ACCUMULATION OF TECHNOLOGICAL CAPABILITIES

As noted, unlike the earlier phase, R&D has become the major source of accumulating technological capabilities since the 1980s. After introducing the above-mentioned programmes, it became essential for the government as well as the private enterprises to see its effectiveness in developing products that would meet the international standard. To this effect the government gave priority to cooperative research among the three major organizations under the framework of the national innovation system as discussed below.

3.3.1 Developing Cooperative Research And A National Innovation System: The Government’s Strategy

Development of an advanced national innovation system has become essential in the wake of intensifying competition among enterprises for market leadership. This largely depends on how faster an enterprise penetrates the market

\textsuperscript{45} For instance, the ratio of R&D to GDP in Germany was 2.52 % in 2001, in UK 1.86 % and in France 2.15 % in 2000.

\textsuperscript{46} MOST, n. 41, p. 20.
with advanced designs and products than others. Like many other industrialised nations, where NIS is a proven case of success for leading the market, Korea has also acknowledged the significance of establishing a national system of innovation since the late-1980s. However, considering cooperative research as an essential component of NIS, it can be said that the process began soon after Korea entered the progressive phase of industrialization.

As a first step in this direction, cooperative R&D began to be promoted in 1982 with the introduction of Industrial Research Association (IRA) system.\(^{47}\) Many specific consortia were formed on product basis. Incentives were provided to the participants of IRA most of which were consolidated in electronics and telecom sector. These consortia had the objective of pursuing research on advanced technology and creating the seeds for next generation technology. A study on cooperative R&D in Japan and Korea puts the number of R&D consortia existed in Korea between 1982 and 1997 at 190 with electronics and machinery industries accounting for 75 per cent of the total consortia budget from 1993 to 1997. Out of the 190 consortia, 78 consortia had only two participants. The participants in all the consortia during 1982-1997 totaled to 349 including participants from 25 universities and National Research Institutes.\(^{48}\) However, these consortia could not help Korean firms much to develop innovative technology because of the firms' hesitation to share knowledge for the fear of loosing out to emerging competitors in current and future market. Instead, the consortia were focussed on developing applied technology.

**Expanding the Research Network**

To promote research cooperation and to build close links among firms, academia and public institutes, the NRP and IBTDP brought in projects on target

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\(^{48}\) Ibid. The electronics and machinery accounted for 55% of Korean R&D expenditure between 1993 and 1997. It showed that compared to Japan and US, Korean R&D efforts were more concentrated in a smaller number of industries.
technologies, which were to be undertaken jointly. The universities witnessed rapid increase in enrollment in the technology related faculties and produced a large number of skilled engineers and technicians who could be absorbed in industries. Funded by the government, these universities and institutions provided R&D oriented training to the students and drew response from industries to jointly undertake projects. Some industries also at the same time planned to provide funds to recognized universities.

However, during the 1980s majority of the Korean universities did not have sufficient facilities and incentives to participate in these activities successfully. It was only the government that promoted university–industry cooperation by opening its National Research Programmes to universities. The strengthening of university-industry relation is reflected in the increase in the number of joint research undertaken by SRCs and ERCs with industry from 24 cases involving 34 firms in 1990 to 415 cases involving 338 firms in 1994. In recent years, several leading universities such as Seoul National, Yonsei and Korea have established science parks in their campuses and tied up with chaebol for research activities.49

The industry-university relationship has also led to the emergence of some technology-based venture firms. KAIST and several leading universities served as incubators to such venture firms. For instance, Medison, a firm spun-off from KAIST, became a leading producer of ultrasonic scanner, accounting for 25 per cent of the global market in portable models in the early 1990s and has rapidly diversified into other technology-intensive businesses like bio-energy medical equipment and medical information system. The success of Medison in developing such technology could be largely attributed to its engineering research at the KAIST laboratory.

Apart from the two major programmes of NRP and IBTDP, the government also introduced the Industrial Generic Technology Development

49 Linsu Kim and Gihong Yi, n.42, pp.177-178.
Project to solve the problems in technology-related activities faced by the industries and to strengthen the relation between the three players. To identify urgent R&D projects in firms and to support universities and GRIs for conducting projects jointly with private firms, the Ministry of Trade, Industry and Energy has been conducting survey each year and providing financial assistance to the institutes.  

**Development of Innovation Clusters**

One of the most effective means to develop innovative capabilities has been the establishment of science and industrial parks across the industrial belts and concentration of R&D institutes in these parks. Since the early 1990s, the government has established several innovation clusters in order to transform the institutes as knowledge producers and transmitters for the Korean industries. The most prominent of these is the Daedeuk Science Valley, which became operational in 1992. It offers a wide range of R&D related tax incentives both to local and foreign firms in high technology areas, mainly information technology and biotechnology. As of now, there are 105 organizations in the town, including 9 government agencies, 30 government-supported institutes, 25 industrial research laboratories, 37 venture companies and 4 schools of higher education, the KAIST and the Chungnam National University being added to the list recently. Since its establishment, these R&D cluster in Daedeuk has been engaged in transforming research results into tradable commodities and services through spin-off companies.

Following the pattern of Daedeuk, a number of similar parks have been set up around different high-tech industrial region. These include:

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50 Ibid., pp. 174 - 175.
51 MOST, n. 41, p. 30. It took almost two decades for the government to construct the district. The Daedeok valley is considered as the Silicon Valley of Korea.
(i) Pusan Science and Industrial Park (2001) with 8,215 firms, 8 government and 141 private research labs and 26 universities in its surrounding in Pusan region where mechatronics industries are located;

(ii) Changin Science Park (2001) around Kangung region for micro-electronics production units with 155 firms, 4 government and 2 private institutes and 2 universities in its surrounding;

(iii) Ochang Science Park (2001) around Chongju region of information technology and medical instruments production units with 380 firms, 7 government and 18 private institutes and 5 universities in its surrounding;

(iv) Kyongbuk Techno Park (2000) in the Kyongsang region, where there are production units of textiles and design new materials, with 820 firms, 10 government and 31 private R&D Labs and 5 universities located in its surrounding.  

In tandem, the government has also focused on establishing Regional Research Centres (RRCs) with a university as the central agent. The RRCs are entrusted with conducting research pertaining to regional development involving the local firms, universities and research institutes in order to enhance the technological capabilities of all the regions. The government established 37 RRCs between 1995 and 1999 and by the end of 1999, 104 universities had participated in the RRCs. These R&D clusters have tended to emerge as innovation clusters but are facing some obstacles such as regional imbalance between R&D functions and production functions, imbalances in government investment, lack of participation of local governments, lack of coordination in the central government and the over-concentration of business activities in one or two region.  

Such efforts to promote cooperation among GRIs, PRIs (private research institutes) and URIs (university research institutes) in R&D so as to generate

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53 Ibid. See Table 2, p. 315, for more information on regional and industrial parks located in Korea. It should be noted that most of the firms located around the parks and region are small and medium enterprises. Their greater participation in the R&D clusters shows their inclination toward designing and production of new equipment and components with advanced technology.

54 Ibid.
creativity have produced limited but noteworthy results considering Korea's late entry to R&D. For example, a low-density electronics switching system has been developed and commercialized successfully by joint research between a public R&D institute and four private firms. Similarly, the same public R&D institute in cooperation with three semiconductor producers completed the designing of a 4-mega byte Dynamic Random Access Memory (DRAM), a key component for computer machinery production.55

4.3.2 Private Sector's Technology Accumulation Strategy

It is evident from the above discussion that private enterprises have gained significant benefits from their involvement in cooperative research as the major players. Moreover, all the R&D programmes of the government aim at fostering the private enterprises' research capabilities. Apart from this, what is of equal importance is the several other measures pursued by the firms to acquire technological mastery in their specific fields of operation.

As already noted, the industrial structure of Korea has become more and more technology intensive following the policy changes in the early 1980s. Particularly, the rapid growth of knowledge industries in recent years has shortened the life cycle of the products. To sustain the increasing competition in the international market at this stage it became essential for the Korean firms to upgrade their own internal and learning capabilities in order to reach the technological frontier. The firms are continuously increasing their investments in R&D.

Being aware of the reluctance of foreign firms to transfer technology, the firms at this stage have adopted different strategies. These include partnership with foreign venture capital, engagement in cross licensing, OEM arrangement and joint product development with transnational corporations. Also, the

conventional modes of technology imports through capital goods and licensing agreement are said to have continued. However, the two most significant modes adopted by the firms are reverse engineering and outward direct investments by establishing research outposts in industrialised countries.

Recognizing the talents of Korean scientists, and engineers settled abroad mainly in the US having sound technical knowledge to solve challenging jobs, the firms offered them attractive salary and packages in order to get them back into their fold.56 As a result the number of Korean-Americans joining the Korean firms has increased consistently. The government and industries have also identified and recruited qualified personnel from abroad capable of transferring new technologies. These practices have helped Korean engineers to learn the production techniques in new technologies used in advanced nations.

The major chaebol have set up their research outposts and are expanding networks in industrialised nations to capitalize on the sophisticated technologies. For example, LG Electronics developed a network of R&D Laboratories in Tokyo, Sunnyvale in California, Chicago, Germany, Ireland; Samsung set up its R&D centres such as San Jose Research Institute and Image Quest Technology in Silicon Valley and in Maryland, Boston, Tokyo, Osaka, Sendia in Japan, London, Frankfurt, Moscow to name the prominent ones; Daewoo Electronics had twelve R&D centres in eight countries; and Hyundai had outposts in San Jose, Frankfurt, Singapore and Taipei as of late 1990s. The success of these firms in gaining access to state-of-the-art technologies can be gauged from the following few examples.

The LG Technology Operation in Sunnyvale acquired the capability of designing the latest personal computers, display terminals and high-resolution monitors, while its North American Laboratory in Chicago concentrated on

producing HDTV, digital VCR and telecom equipment.\textsuperscript{57} Samsung's Californian research team was responsible for developing the circuit and process design for 256K DRAM chips.

Simultaneously, these R&D institutes have also been engaged in forging strategic alliances with parent companies of advanced countries' for technology exchange and joint market. An increased number of Korean companies have also set up business linkages with overseas companies for raw materials, parts, half-finished products, services, machinery equipment and other production facilities. These companies have also emphasized on globalizing R&D through mergers and acquisitions. Hyundai's success in acquiring full ownership of Axil computer in Santa Clara, California for computer development; its stake in Laserbyte corp. in Sunnyvale, California to obtain magneto optical disk drive technology; in Metaflow in La Jolla, California to develop SPARC compatible microprocessor; in image Quest, San Jose, California to develop flat panel display; and in Maxtore, San Jose to develop hard disk drive could be attributed to its R&D networks set up abroad.\textsuperscript{58}

Not to be left far behind, the government has also in recent years sought international cooperation in R&D by providing subsidies for joint research programmes. To this effect contracts have been signed between research institutes and foreign universities and institutes. For instance, the government Electronics and Technology Research Institute (ETRI) had teamed up with Stanford University for the joint development of an operating system for an indigenous multimedia work station and this technology later on to be transferred to LG, Samsung and Daewoo for commercialization.


\textsuperscript{58} Ibid. Also see Linsu Kim and So-Mi Seong, n.32, pp.411-415. Simultaneously, the chaebol's investment in R&D also began to increase. For example, in 1989 alone, Samsung spent $ 900 million, Hyundai and LG spent $ 600 million each, and Daewoo spent $ 300 million in R&D.
The chaebol have also established such collaborative industry-academia association for joint research. For example, LG Electronics has tied up with thirty-two foreign universities for cooperative R&D with an investment of $10 million. It has also entered into alliance with Motorola, Phillips and Xerox to develop new technologies. Samsung, in the past, was involved in joint projects in the semiconductors and LCDs with foreign universities.\textsuperscript{59}

Although in the consumer electronics sector too, the firms have relied on strategic alliances, joint venture partnership and in-house R&D for learning and innovation, the OEM arrangement appears to have the most prominent one until the mid-1990s. Under OEM, the buyer, i.e. the TNCs provided training to engineers, helped in selecting equipment and supplied materials. The firms learned and mastered much of the production and design know-how by strenuous in-house efforts, trial-and-error investment and on-the-job training within OEM arrangement with Japanese and US firms. According to Hobday, OEM accounted for some 70 percent to 80 percent of Korea's total electronics exports in 1990 and the largest three chaebol relied on OEM for 63 percent of their exports.\textsuperscript{60} However, in the later stage the significance of OEM began to decline with strategic alliances and joint product development taking lead as alternative source of technology acquisition.

The Korean firms' engagement in OEM in consumer electronics has been extensively discussed in a few studies.\textsuperscript{61} An example of an SME may be cited here. The emergence of Kocom or Korea Communication Incorporated in the

\textsuperscript{59} Aradhana Aggarwal, n. 55.

\textsuperscript{60} This paragraph draws heavily from M. Hobday, *Innovation in East Asia: The Challenge to Japan*, (Cheltenham: Edward Elgar, 1995), p. 67.

Also see, Roger van Hoesel, *New Multinational Enterprises from Korea and Taiwan*, (London, New York: Routledge, 1999). The author provides case studies of Samsung and LG Electronics and analyses their technology acquisition mainly through OEM. It notes that in 1993 Samsung had about 160 OEM contracts with buyers from USA, Germany, Japan and France while LG had about 120 OEM contracts with companies USA, Canada, Japan and Germany. For detail, see pp. 165-176.

\textsuperscript{61} For instance Jin W. Cyn, *Technology Transfer and International Production: The Development of the Electronics Industry in Korea*, (Cheltenham: Edward Elgar, 2002), pp. 173-269. This study presents a comprehensive analyses of OEM strategy followed by major Korean firms such as Daewoo, Samsung, Hyundai, Anam, KEC, Kocom, LG etc. Also see, M. Hobday, n.58.
1980s is a case in point. Beginning with manufacturing of chime doorbells and door-inter-phones, the firm looked forward to developing of video inter-phone. Kocom at first tried to develop the products through imitation and reverse engineering but was not successful. It ultimately decided to take the route of OEM. It entered an OEM arrangement with Japan’s Sharp Inc., which proved a turning point for its videophone technology.

By 1990, it was able to design its own products. Under OEM, Kocom improved its engineering capability through learning from Sharp’s trial-and-error process and developed technical standards using Sharp’s high standard as a model. The learning involved here was general and not specific technology-oriented. On an average engineers from the OEM buyer spent about thirty days or more in a single training-session with KOCOM’s R&D team. At the same time, it did not neglect improving its own R&D in order to reduce dependency on OEM. Later on, KOCOM decided to enter the digital still camera industry on OEM basis and provided the product to Japan’s Nikon, Toshiba etc. In this manner, Kocom became capable of exporting its products, either as own brands or OEM to over 70 countries. It has an annual average growth of over 20 percent since the late 1980s.

However, most of the SMEs faced difficulties in acquiring innovative capabilities due to inadequate support from the government. This was revealed from a survey conducted by the Korea Federation of Small Businesses in 1997. The most serious bottlenecks for the SMEs in their innovation activities, as the survey found, was lack of R&D personnel and technicians (28.5%), followed by financing difficulties (26.1%). The third significant bottleneck was lack of R&D facilities and equipment (16.8%).

63 Ibid. Also see, Jin W. Cyhn, n.59, pp. 230-234.
It is true that the major chaebol have in recent years been able to occupy a certain place in consumer electronics segment. But given the trends of the new markets with new designed products, it seems that they lag far behind. To build up an overseas marketing, distribution and service network, the three major chaebol, Samsung, Daewoo and LG have made huge investments. Also, the export market in consumer electronics goods has seen changes. The chaebol are now concentrating more on expanding their market in developing regions like China and India where they face relatively less competitive environment. Anyway, considering the time factor, it could be said that Korean electronics firms have achieved commendable success in gaining access to the advanced electronics technology in comparison to many other developing nations.

3.4 TECHNOLOGY ACQUISITION IN THE MOBILE TELECOMMUNICATION SECTOR

3.4.1 Background

The performance of the mobile telecom industry in less than two decades since its inception is noteworthy. This industry now enjoys the status of the second most important individual high technology export item in Korea after semiconductor and is expected to take the top position very soon. The first mobile communication service started in Korea in 1984 based on imported analogue technology. But the breakthrough was made in the mid-1990s when Korea became the first country in the world to develop the CDMA-based (Code Division Multiple Access) technology for commercial purpose.65 The development of

65 Kun Mo Chung and Kong Rae Lee, “Mid-entry Technology Strategy: The Korean Experience with CDMA”, R&D Management, (29, 4, 1999), p. 358. The CDMA-based cellular communication system is recognized as a second-generation digital technology. It is embedded with features such as better user capacity, high quality of voice and service, enhanced resistance to noise and interference, higher degree of privacy and above all higher speed data transmission capabilities. This technology was first innovated by a small US venture company, Qualcomm, in the early 1990s and immediately applied for some military purposes but was not developed for commercial application.
CDMA is considered as the most notable technological accomplishment. Particularly interesting to note is the fact that development and commercialization of CDMA-based mobile communication system in Korea is the best example of joint research between GRI and corporate sector R&D.

Unlike the other high technology intensive sectors, which have been developed solely as export-oriented industries, the primary reason for selecting CDMA technology was the government's desire to improve the domestic communication network. Prior to the decision of adopting CDMA, a state-owned company, KMT (Korea Mobile Telecom Co.), provided the mobile telecom service. As the analogue system was prevalent in the US, the company decided to feed up the market with the same system. KMT did not have the capacity to produce the equipment and hence it imported most of the equipment from Motorola and AT&T. Moreover, the local firms involved in telecom business imported mobile handsets and supplied them in the Korean market. For instance, Hyundai and Samsung imported handsets from Novotel, Canada and Toshiba, Japan respectively.⁶⁶

3.4.2 Development of CDMA Technology

Aware of the growing consumer demand and increasing presence of foreign companies, the government implemented a programme to develop an original mobile telecom system in 1989. The task of conducting and supervising the programme was assigned to the leading government-sponsored Electronics and Technology Research Institute (ETRI). Despite the high risk of uncertainty and domestic firms' strong reservations, the ETRI decided to go ahead with CDMA technology.

After giving a final thought to adopt such technology, ETRI decided to approach Qualcomm, a small US firm and the original developer of CDMA, for licensing the technology. Qualcomm accepted the offer and an agreement was
signed in 1991. As per the terms of the agreement, Qualcomm had to design the whole CDMA system, the development of base system and the basic design of handsets. ETRI’s task was to develop the switching and base stations as well as to participate in the manufacturing of the handsets. Both also agreed to allow participation of the Korean firms in the project.

In the first phase, ETRI conducted research to understand system definitions and the basic concepts of CDMA. In the next stage it conducted high level design of network and mobile cellular phone. By 1994 it gained sufficient capability on design network and mastered the fundamental techniques. During the period 1989-1993, its engineering and technical staffs were sent in batches to the technology provider, Qualcomm. Its technical team learned about the complex technological elements and acquired the problem solving capacity from Qualcomm. Besides, ETRI’s past experience of successfully developing the TDX switches helped a lot to carry out R&D activities efficiently and more accurately. The joint research was completed in 1993 and ETRI finally approved it for commercialization.

3.4.3 Cooperative Research With Private Firms

The commercialisation of any technology depends largely on the participation of the private firms. In this regard, ETRI sought cooperation form private firms and four designated manufacturers, three chaebol - Samsung, Hyundai and LG, and one medium-sized company, Maxson, gave their consent to jointly undertake the project with ETRI. The project required the firms to manufacture prototypes, design of the cellular sets and commercialise them. On

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67 Ibid., p. 173.
68 K.M. Chung and K.R.Lee, n. 63, p. 359-360. ETRI’s total research budget for this project was US$1,69,50,000.
69 Most of the research efforts required for obtaining technical solution in the CDMA process was almost similar to that involved in TDX project and therefore ETRI’s accumulated knowledge in developing TDX reduced the burden to a great extent.
the other hand, ETRI took the responsibility for providing the system designs such as base station, central control station and mobile telephone exchange.  

Another agreement was signed between Qualcomm and Korean firms in August 1993 under which Qualcomm would provide technical consultations. According to the agreement, the Korean firms would manufacture the handsets and the wireless equipment. They agreed to pay royalties to the Qualcomm towards service charge as it had the intellectual property rights in CDMA technology. However, the firms were restrained from paying royalties on equipment such as switching system.  

The working of Samsung in developing and commercialising CDMA may be briefly mentioned. Samsung invested heavily in this sector with a view to capture domestic market and also to export to the international market. Like others, it entered technical agreement with Qualcomm. In the initial years, many engineers from Samsung were dispatched to Qualcomm for training. They learned the design technology related to various functions of CDMA devices through ‘user interface’ method. Qualcomm also taught Samsung about various customer preferences and how to cater to the markets in the area of design. Besides, its own advantage of being a leader in semiconductor enabled the firm to adapt the technology. It has also invested heavily in in-house R&D for CDMA mobile phone unit. By 1998 Samsung invested around US$ 120 million in R&D.  

Samsung’s success on this front can be seen from its increasing volume of export of CDMA handsets. Its total sales amounted to over US$ 3 billion with

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Also see, H. Lee and S.Y. Han, n. 65, pp. 172-173.  
The whole project was completed in eight years including initial joint research with Qualcomm and the total expense was US$ 110 million. The manpower involved in the R&D was 1,042 man-years.  
71 K. Lee and C. Lim, “Technological Regimes, Catching up and Leapfrogging: Findings from the Korean Industries”, Research Policy, (30, 2001), pp. 459-483. The period fixed for royalty payments is thirteen years for local sales and fifteen years for exports. The amount of royalty paid by the Korean companies is thought to have equivalent to 5.25 percent of sales revenue per mobile phone unit, in addition to the fees paid for technology licensing.  
72 This paragraph draws from Jin W. Cyhn, n. 61, pp. 200-201.
export accounting for 45 percent in 1998. It controls about 25 percent of the US market and 17 percent of the world market. It has recently struck a deal with Sprint Co. of US to supply a total of US$ 3 billion worth of 2.5 generation CDMA 2000-1X mobile handsets.\(^{73}\) However, it is also paying heavy royalties to Qualcomm. In 2002, it ranked 4\(^{th}\) in worldwide market share after Nokia, Ericsson and Motorola.\(^{74}\)

The localisation ratio in the mobile phone until 1997 was only 30 per cent and most of the core parts including MSM chips were imported. But following the indigenous development of MSM chips by ETRI in 1997 and Samsung’s declaration to produce the chips on its own, the Korean firms have significantly reduced their dependency on foreign firms. However, the actual value added in the locally manufactured handsets amounts to 40-50 per cent. They have successfully developed CDMA 2000-1X service, which is regarded as 2.5 generation technology.\(^{75}\) Considering the market potential of the service as very high, Samsung and LG have been pouring billions of won into the new business.

3.4.4 Export Account

Korea has more than 50 per cent share in the global CDMA phone market. According to a report of the MOCIE, the exports of domestically manufactured handsets are expected to surpass US$ 10 billion mark. A senior official of the Ministry also indicated that mobile phones would be included as the nation’s fourth highest volume export items among manufactured products after semiconductor, automobiles and computers.\(^{76}\) Moreover, the Ministry of Information and Communication (MIC) has unveiled an ambitious export

\(^{73}\) Economic Report, (Seoul: February, 2002), p. 53

\(^{74}\) Economic Report, (Seoul: May 2002), p. 56. LG is ranked 10\(^{th}\) in terms of worldwide share in mobile phones. Other mid-sized Korean mobile phone makers are also making inroads in the Chinese and European markets relying on manufacturing technologies derived from their own original development manufacturing (ODM).

\(^{75}\) Business Korea, (Seoul: June, 2001), pp. 54-55. CDMA 2000-1X provides data speed greater than 100 kilobytes per second, two to three times faster than before, and allows users to surf web sites through their handsets.

projection by setting an annual target of US$ 35 billion for mobile communication and handset system.

The export of CDMA handsets from Korea is concentrated in a few pockets, as many countries have not yet adopted the system. The Korean firms are engaged in inducing other countries to adopt CDMA technology as their mobile phone service standard. The government is also promoting projects to build a pan-Pacific CDMA belt. So far, 47 countries or 130 operators, including the two giant emerging markets China and India, have selected CDMA technology for their mobile phone network. Remarkably, most of the CDMA handsets offered by telecom operators in India (like Reliance and Tata) are supplied by Korean companies, Samsung and LG. Influenced by the growing popularity of Korean made CDMA sets, leading foreign firms such as Nokia and Motorola have established their research centres in Korea. 77

3.5 ANALYSIS AND ASSESSMENT

3.5.1 Structure of Production

The industrial structure has seen remarkable transformation since the early 1980s. The government has emphasized more on qualitative expansion of the production structure by implementing measure towards promotion of manufacturing and service industries, which are high technology-intensive in nature.

As shown in Table 3.5, the share of agriculture, forestry and fisheries sector in the total GDP went down from 12.6 per cent in 1985 to 4.7 in 2000 while that of manufacturing sector has increased from 29.2 per cent to 31.3 per cent. The service sector, which includes the knowledge-intensive industries, has also registered an increase of about 6 per cent in its share over the period. This indicates that by 1985, manufacturing and service sector had already gained

prominence and hence their growth during the recent period is marginal. The graph for construction sector is fluctuating in nature.

Taken separately, the growth rate of GDP and the IT sector’s contribution to the total GDP over the last decade is impressive. This sector has developed at a rate three times faster than the overall economy since the mid-1990s, thanks to the extraordinary export performance of semiconductor, mobile phones and computer equipment. Even at a time when the nation’s GDP shrank by 6 per cent following the crisis in 1998, this industry surprisingly recorded growth of 16.7 per cent. The IT sector’s contribution to the GDP growth witnessed a ten fold increase in 10 years from 4.5 per cent in 1990 to an all time high of 46.8 per cent in 2000, but declined to 31.7 per cent in 2001 due to world wide slump in IT demand. Moreover, it accounted for 16.1 per cent of total value added in 2000 which was the highest among OECD nations. 

Table 3.5: **Industrial Structure (at current prices)** (in %)

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, forestry, fisheries</td>
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<tr>
<td>Mining and manufacturing</td>
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<td>29.6</td>
<td>29.8</td>
<td>31.6</td>
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<tr>
<td>Manufacturing</td>
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<td>28.8</td>
<td>29.4</td>
<td>31.3</td>
</tr>
<tr>
<td>Electricity, gas, water</td>
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<td>2.1</td>
<td>2.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Construction</td>
<td>7.5</td>
<td>11.4</td>
<td>11.3</td>
<td>8.0</td>
</tr>
<tr>
<td>Services a</td>
<td>37.2</td>
<td>39.0</td>
<td>41.0</td>
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<tr>
<td>Producers of govt. services b</td>
<td>9.2</td>
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<tr>
<td><strong>Gross Domestic Product</strong></td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Source:** National Statistical Office, *Statistical Handbook of Korea 2002*, p. 36.

a Includes wholesale & retail trade, restaurants & hotels, transport & storage, communications, finance & insurance, real estate, business services, social & personal services, import duties and deducted imputed bank service charges.

b Includes producers of non-profit services to households and domestic services to households.

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During the period 1982–1996 (see Table 3.1) the economy grew at an average annual rate of 8.55 per cent while the same for export was 13.8 per cent. The highest growth rate witnessed in both the economy and exports was in the Sixth Five-Year plan. The effect of the financial crisis has resulted in a sluggish performance of the economy since 1998. But the slow down particularly since 2000 can be largely attributed to the global recession. Almost all nations have been badly affected and one cannot attribute it to reduction in export due to lack of competency solely. However, Korea has been fast recovering from the crisis and is said to have overcome most of the structural barriers at least to a manageable level.

3.5.2 Composition And Technology Intensity Of Exports

As shown in Table 3.6, the share of low-technology intensive products as a whole in the total export declined from 48.7 per cent in 1985 to 22.5 per cent in 1995 and 16.9 per cent in 2000. The share of medium technology intensive products increased from 21.7 per cent in 1985 to 31.3 per cent in 1995 but slightly declined to 29.2 per cent in 2000. In the same period the share of high technology intensive products went up from 14.4 per cent to 32.9 per cent and 38.4 per cent respectively. Based on the calculations, Korea’s share in world exports of manufactures raised from 1.5 per cent in 1985 to 2.5 percent in 2000. Of particular note, Korean high technology products increased its contribution to the world exports from 1.8 per cent in 1985 to 4.2 per cent in 2000 while medium technology intensive products accounted for 2.5 per cent in 2000. This proves that the magnitude of Korean exports is the largest in high technology products.

The study further examines (see Table 3.7) the individual contribution of the three technological categories. For this purpose, it selects two best products from low technology and medium technology intensive products and three from high-technology and knowledge intensive products based on the standard
Table 3.6: Korea’s Competitiveness in the World Market, 1985-2000

<table>
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<tr>
<th></th>
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<tr>
<td>I. Market Shares</td>
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<td>0.5</td>
<td>0.3</td>
<td>0.4</td>
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<td>0.8</td>
<td>1.2</td>
<td>2.0</td>
</tr>
<tr>
<td>3. Manuf. not based on Nat. Res. c</td>
<td>2.3</td>
<td>2.6</td>
<td>2.9</td>
<td>3.2</td>
</tr>
<tr>
<td>Low Technology d</td>
<td>5.0</td>
<td>4.7</td>
<td>3.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Medium Technology e</td>
<td>1.1</td>
<td>1.6</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>High Technology f</td>
<td>1.8</td>
<td>2.5</td>
<td>3.8</td>
<td>4.2</td>
</tr>
<tr>
<td>4. Others</td>
<td>0.5</td>
<td>0.7</td>
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<td>II. Export Structure</td>
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<td>1. Primary products a</td>
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<td>3.2</td>
<td>1.9</td>
<td>1.7</td>
</tr>
<tr>
<td>2. Manufactured based on Natural Resources b</td>
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<td>12.0</td>
</tr>
<tr>
<td>3. Manuf. not based on Nat. Res. c</td>
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<td>88.0</td>
<td>86.7</td>
<td>84.4</td>
</tr>
<tr>
<td>Low Technology d</td>
<td>48.7</td>
<td>41.7</td>
<td>22.5</td>
<td>16.9</td>
</tr>
<tr>
<td>Medium Technology e</td>
<td>21.7</td>
<td>25.9</td>
<td>31.3</td>
<td>29.2</td>
</tr>
<tr>
<td>High Technology f</td>
<td>14.4</td>
<td>20.5</td>
<td>32.9</td>
<td>38.4</td>
</tr>
<tr>
<td>4. Others</td>
<td>1.1</td>
<td>1.3</td>
<td>2.2</td>
<td>1.8</td>
</tr>
</tbody>
</table>


a Contains 45 basic products that are simple to process.
b Contains 65 items: 35 agriculture/forestry groups and 30 others.
c Contains 120 groups representing the sum of low, medium and high technology.
d Contains 44 items: 20 groups from the textile and garment category, plus 24 others (paper products, glass and steel, jewellery).
e Contains 58 items: 5 groups from the automotive industry, 22 from the processing industry and 31 from engineering industry.
f Contains 18 items: 11 group from electronics, plus 7 others (pharmaceuticals, turbines, aircraft, and optical and measuring instrument.)
classification (mentioned in the analysis part of Chapter 2). The result shows significant fundamental changes in the total trade composition.

In the low-tech intensive (LTI) category, the share of iron and steel products in the total exports reduced from 8.6 per cent in 1982 to 4.8 per cent in 1994 and to 3.8 per cent in 2000. The share of textiles, yarn fabrics etc. also went down from 10.2 per cent in 1982 to 7.3 per cent in 2000. In the medium-tech intensive (MTI) segment, the picture is mixed. While the share of road vehicles in total exports rose from 1.9 per cent in 1982 to 8.9 per cent in 2000; that of transport equipment decreased from 13.5 per cent to 5.1 per cent in the corresponding years.

As expected, the figure for high-tech intensive (HTI) segment is encouraging. In this category, office and data processing equipment increased its share in total exports from 0.5 per cent in 1982 to 11.3 per cent in 2000. Similarly, telecom, sound recording and reproducing equipment’s share rose from 5.0 per cent to 8.3 per cent. The share of electronics products also registered a dramatic increase from 5.2 per cent 1982 to 18.4 per cent in 2000. Here a surprising trend to observe is that the financial crisis had hardly any negative effect on the account of this sector’s export. In fact, following the crisis, the office and data processing equipment witnessed the highest rate of increase. Taken together the three groups contributed for approximately 38 per cent of the total export. This confirms the fact that high-technology intensive products dominate the export structure of Korean industries.

Table 3.8 shows the ranking and per cent share of the top ten products. In 1990, textile clothing was the top export item with a share of 11 per cent while semiconductor was in the second position. But in 2000, semiconductor became the top export item followed by computer and software and automobiles. Petrochemicals and ship also were two major export items together accounting for 10 per cent of the total exports.
Table 3.7: Technology Intensity of Korea's Exports, 1982-2000

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<td>Low-tech. Intensive</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Iron &amp; Steel</td>
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<tr>
<td>Export (% share in total)</td>
<td>8.6</td>
<td>5.6</td>
<td>5.5</td>
<td>4.8</td>
<td>5.4</td>
<td>3.8</td>
</tr>
<tr>
<td>CAI*</td>
<td>17.9</td>
<td>4.6</td>
<td>2.4</td>
<td>1.2</td>
<td>8.6</td>
<td>1.9</td>
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<tr>
<td>Textile, yarn fabrics (^a)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export (% share in total)</td>
<td>10.2</td>
<td>9.2</td>
<td>9.3</td>
<td>11.1</td>
<td>8.5</td>
<td>7.3</td>
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<tr>
<td>CAI</td>
<td>26.2</td>
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<td>18.5</td>
<td>20.2</td>
<td>22.1</td>
<td>18.4</td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>Road vehicles (^b)</td>
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<tr>
<td>Export (% share in total)</td>
<td>1.9</td>
<td>5.2</td>
<td>5.1</td>
<td>6.9</td>
<td>8.8</td>
<td>8.9</td>
</tr>
<tr>
<td>CAI</td>
<td>3.7</td>
<td>13.3</td>
<td>11.0</td>
<td>14.1</td>
<td>29.1</td>
<td>27.8</td>
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<tr>
<td>Transport equipment (^c)</td>
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<td></td>
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<tr>
<td>Export (% share in total)</td>
<td>13.4</td>
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<td>4.6</td>
<td>5.4</td>
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<td>5.1</td>
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<tr>
<td>CAI</td>
<td>27.0</td>
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<td>5.6</td>
<td>6.9</td>
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<tr>
<td>Office &amp; auto data processing machine</td>
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</tr>
<tr>
<td>Export (% share in total)</td>
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<tr>
<td>CAI</td>
<td>-1.6</td>
<td>1.2</td>
<td>4.4</td>
<td>3.0</td>
<td>7.1</td>
<td>23.0</td>
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<tr>
<td>Telecom, sound recording &amp; reproducing equipment</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export (% share in total)</td>
<td>5.0</td>
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<td>9.6</td>
<td>8.5</td>
<td>5.2</td>
<td>8.3</td>
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<tr>
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<td>21.7</td>
<td>15.7</td>
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<td>Electrical machinery, apparatus &amp; appliances (^d)</td>
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<td>18.8</td>
<td>18.5</td>
<td>18.4</td>
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<tr>
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<td>-5.0</td>
<td>5.9</td>
<td>21.6</td>
<td>3.4</td>
<td>3.9</td>
</tr>
</tbody>
</table>


Notes: \(^a\) Includes made-up articles and related products.
\(^b\) Includes cars, motor cycles, parts and road motor vehicles.
\(^c\) Includes railway vehicles, ships, boats, air crafts and parts.
\(^d\) Includes parts, non-elec. counterparts and household type equipment.
*Denotes comparative advantage indicator.
Table 3.8: Top Ten Exports of Korea (1990 & 2000) (Unit: Share in per cent).

<table>
<thead>
<tr>
<th>Item</th>
<th>Share</th>
<th>Item</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clothing</td>
<td>11.6</td>
<td>Semiconductors</td>
<td>15.0</td>
</tr>
<tr>
<td>Semiconductors</td>
<td>7.0</td>
<td>Computer and software</td>
<td>8.5</td>
</tr>
<tr>
<td>Leather</td>
<td>4.6</td>
<td>Automobiles</td>
<td>7.6</td>
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<tr>
<td>Ship</td>
<td>4.3</td>
<td>Fiber textile</td>
<td>5.9</td>
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<tr>
<td>Image facility</td>
<td>4.0</td>
<td>Petrochemicals</td>
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<td>Steel board</td>
<td>3.7</td>
<td>Ship</td>
<td>4.6</td>
</tr>
<tr>
<td>Fiber textile</td>
<td>3.6</td>
<td>Wireless communication</td>
<td>4.5</td>
</tr>
<tr>
<td>Computer</td>
<td>3.3</td>
<td>Steel board</td>
<td>2.8</td>
</tr>
<tr>
<td>Sound facility</td>
<td>2.9</td>
<td>Clothing</td>
<td>2.3</td>
</tr>
<tr>
<td>Automobiles</td>
<td>2.9</td>
<td>Electron tube</td>
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<tr>
<td>Total top ten exports</td>
<td>47.9</td>
<td>Total exports</td>
<td>100.0</td>
</tr>
</tbody>
</table>


Note: The per cent share is calculated taking total exports amount of 1990 and 2000.

3.5.3 Comparative Advantage and International Competitiveness of Korean Industries

To see the trade specialization pattern of the three categories (presented in Table 3.7), the comparative advantage of each product group is calculated using the formula provided by Lafay, which is mentioned below.79

CAI (Comparative Advantage Indicator ‘f') = \[
\frac{1000}{Y} \frac{2 (X_M - X_Mi)}{X + M}
\]

79 For explanations see, Gerard Lafay, The Measurement of Revealed Comparative Advantages, in M.G.Dagenais and P.A.Muel (eds.), International Trade Modelling, (London: Chapman & Hall, 1992), pp. 209-220. The comparative advantage is derived from a variety of factors including choice of segments best suited to the macroeconomic factors of production and lower relative costs through innovation in the production process (new forms of specialization) at microeconomic level. Productivity growth is central to
where $Y$ is the total gross domestic product for the year concerned, $X$ and $M$ represent the total exports and imports respectively and $X_i$ and $M_i$ refer to the export and import volume of the individual product.

Both the products in the LTI category lost their comparative advantage with iron & steel by a greater margin from 17.9 in 1982 to 1.9 in 2000. The textile products and transport equipment (MTI) displayed marginal decline over the period from 26.2 to 18.4 and from 27.0 to 15.0 respectively. Gain in terms of comparative advantage was much higher for road vehicle (MTI category) i.e., from 3.7 in 1982 to 27.8 in 2000 and for office and autodata processing (HTI) i.e., from -1.6 to 23.0 in the corresponding years. Telecom etc. also gained comparative advantage. However, a disturbing trend was noticed in case of electrical machinery etc. This group witnessed remarkable gain as a comparative advantage class i.e., from 0.6 in 1982 to 21.6 in 1994 but started rapidly losing its advantage soon after. Its CAI was only 3.9 in 2000.

Korean industries have in recent years become the market leaders in a number of high-technology intensive products. In the semiconductor (DRAM) market, Samsung has consistently maintained its number one position for the last several years (will be discussed in detail in chapter V). Hyundai is also not far behind in DRAM production. For instance, it ranked second in 1999 in the world after Samsung. Korea also ranks as the top LCD (liquid crystal display) producer with Samsung Electronics and LG/Phillips together accounting for more than 35 per cent share in the international market. As already mentioned, Korea has also emerged as the undisputed leader in world CDMA cellular phone market. It also secured second position in the production of CD-ROM drives, VCRs and CRTs (cathode ray tubes) in 1999 and has maintained that position since then. Not lagging back, its shipbuilding industry is world-renowned receiving around 40 per cent of all the orders issued globally. Besides, Korea is also the world’s sixth

determining the comparative advantage of a firm. Note that if $\gamma$ moves in the negative territory (-), the product (or industry) is said to have comparative disadvantage.
largest automaker and steel producer\textsuperscript{80} (with POSCO recently ranked as the most efficient firm).

Furthermore, a look at the rankings of IMD and Global Competitiveness Reports reveals many advantages and disadvantages of Korea as listed in Table 3.9. For example, the IMD Report ranks Korea at 3\textsuperscript{rd} and 14\textsuperscript{th} in terms of patents right and overall productivity growth respectively. On the other hand, the Global Competitiveness Report puts Korea in 6\textsuperscript{th} and 9\textsuperscript{th} position in terms of innovation and overall technology index. It also classifies Korea as a core innovator for its better capacities to innovate and win global markets in technologically advanced products.\textsuperscript{81}

The Human Development Report 2001 measures the technological progress of nations taking into account the technology achievement index of each country. Here, Korea, with an overall score of 0.666 is placed fifth among the 72 countries worldwide and is recognized as a technological leader. In terms of patents granted to residents (per million people in 1998) Korea came second only to Japan. According to reports, the high-and-medium technology exports constituted 66.7 per cent of the total goods exports from Korea in 1999.\textsuperscript{82}

The effectiveness of R&D in generating innovative capabilities is usually reflected in the patents right granted to the nationalities in general. In this regard also Korea has performed considerably well. In another sense, the R&D efforts of Korean industries have resulted in remarkable rise in terms of patent rights. Over the period 1982-1996 Korea ranked seventh in terms of the accumulated number of US patents.\textsuperscript{83} The OECD calculations based on the data from the US Patent and

\textsuperscript{80} This paragraph is summarized from KOTRA, \textit{Korea Trade and Investment (KT&I).} (Seoul: Vol.18, No.5, 2000), pp. 40-46.
\textsuperscript{81} Also included as core innovators are the other three East Asian economies of Singapore, Taiwan and Hong Kong along with the other advanced and industrialised nations from across the continents.
\textsuperscript{82} United Nations Development Programme, \textit{Human Development Report 2001}, p.48. The Technological Achievement Index focuses on four dimensions of technological capacity that are important for reaping the benefits of the network age. These are creation of technology, diffusion of recent innovations, diffusion of old innovations and human skills.
\textsuperscript{83} S.C. Chung, n.34, pp.149-150.
Trademark Office (USPTO) suggest that over the period 1992-1999, Korea ranked first in biotechnology patents right and third in information technology.\textsuperscript{84}

Table 3.9: Korea's Position in Global Competitiveness Index

<table>
<thead>
<tr>
<th>Indices</th>
<th>Rank</th>
<th>Indices</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Exports of Goods &amp; commercial services</td>
<td>13</td>
<td>1. Growth Competitiveness</td>
<td>23</td>
</tr>
<tr>
<td>2. Total Exp. on R&amp;D as % of GDP</td>
<td>7</td>
<td>2. Sophistication of Company Operation &amp; Strategy</td>
<td>26</td>
</tr>
<tr>
<td>3. High-tech Exports as % of Mfd. Exports</td>
<td>6</td>
<td>3. Quality of Business Environment</td>
<td>30</td>
</tr>
<tr>
<td>4. Patents granted to Residents</td>
<td>3</td>
<td>4. Technology Index</td>
<td>9</td>
</tr>
<tr>
<td>5. Overall Productivity Real Growth</td>
<td>14</td>
<td>5. Innovation Subindex</td>
<td>6</td>
</tr>
<tr>
<td>6. Achievement in Higher Education</td>
<td>6</td>
<td>6. Macroeconomic Environment</td>
<td>8</td>
</tr>
</tbody>
</table>


Note: The IMD Report is prepared annually taking into account four broad competitiveness factors, namely, economic performance, government efficiency, business efficiency and infrastructure. It provides extensive coverage of 49 countries.

The Global Competitiveness Report takes into account 11 main factors including aggregate performance, Information Technology, Business Environment, Innovation and Diffusion. In the above-mentioned report it has covered 75 nations.

Both the reports use hard data and survey data in order to determine the rankings.

Table 3.10: Foreign Technology Payments by Fields (selected sectors) and by Nations (US and Japan)

(Unit: $ million and cases)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>113.6</td>
<td>451.4</td>
<td>3,273.5</td>
<td>7,191.0</td>
<td>12,496.6</td>
</tr>
<tr>
<td></td>
<td>(752)</td>
<td>(1,225)</td>
<td>(4,229)</td>
<td>(3,227)</td>
<td>(602)</td>
</tr>
<tr>
<td>Electronics</td>
<td>12.8</td>
<td>47.5</td>
<td>1,146.0</td>
<td>3,668.2</td>
<td>6,888.3</td>
</tr>
<tr>
<td>Machinery</td>
<td>14.6</td>
<td>89.3</td>
<td>633.3</td>
<td>1,486.3</td>
<td>2,439.8</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>5.1</td>
<td>11.2</td>
<td>122.2</td>
<td>141.5</td>
<td>47.2</td>
</tr>
<tr>
<td>Communication</td>
<td>5.0</td>
<td>18.7</td>
<td>62.3</td>
<td>89.0</td>
<td>153.3</td>
</tr>
<tr>
<td>Share of</td>
<td>29.7</td>
<td>159.3</td>
<td>1,588.3</td>
<td>3,663.8</td>
<td>7,399.6</td>
</tr>
<tr>
<td>United States</td>
<td>(164)</td>
<td>(302)</td>
<td>(1,139)</td>
<td>(1,052)</td>
<td>(286)</td>
</tr>
<tr>
<td>Share of</td>
<td>63.7</td>
<td>139.8</td>
<td>993.7</td>
<td>2,426.7</td>
<td>2,781.5</td>
</tr>
<tr>
<td>Japan</td>
<td>(494)</td>
<td>(638)</td>
<td>(2,078)</td>
<td>(1,320)</td>
<td>(119)</td>
</tr>
</tbody>
</table>


The discussion above reaffirms that Korea has made remarkable progress in building its indigenous capability through continuous upgradation of its R&D. However, a serious matter of concern is that it has also become more dependent on imported technology. This is evident from the ever-increasing expenditure on foreign licensing, technical consultation and capital goods with electronics sector accounting for more than 50 per cent since 1990 (Table 3.10). In total, while the number of cases of technology transfer have considerably decreased since the 1990, the amount paid toward these have increased almost by twofold.
3.5.4 **Linking Technology with the Crisis**

As long as the Korean economy grew almost unhindered until the crisis, there was hardly any doubt or question raised over the technological dimension of industrial growth. As it is known, Korea plunged into the crisis because of its incapacity to reduce the ever-increasing short-term foreign debts and close the huge gap in trade deficits. For instance, the balance of payment in trade declined from $7.6 billion in surplus in 1987 to $20.6 billion in deficit while its foreign debt increased from $31.7 billion in 1990 to $156 billion in 1997.\(^{85}\) As already mentioned, studies on the causes of such huge deficit and borrowing have pointed out various responsible factors. Among these, eroding competitiveness of the Korean firms (chaebol) was one of the external factors. It may seem surprising though that the Korean companies failed to keep up their consistent high performance after having seen the whole process of remarkable transformation in the country. But there are certainly some evidence which their troubles can be attributed to.

The chaebol began to lose their competitiveness in low-technology intensive (including some mid-technology intensive) products in the international market due to rapid increase in labor costs from the mid-1980s. At the same time, China and other Southeast Asian nations were rapidly emerging as competitors in the same traditional sectors where Korea was enjoying an advantage. This necessitated the chaebol to diversify their industrial activities into high-tech technology intensive industries where they would compete with firms from advanced regions.

It is true that the chaebol responded positively by expanding their networks towards high-tech industries. But at the same time, aware of the greater risk and uncertainty in this sector, they invested their limited resources in unproductive activities such as real estate and property business rather than spending it for

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R&D. In other words, instead of focusing investments on turning out high value-added commodities and developing more sophisticated production technologies, the chaebol emphasised on buying real estate and pouring money into stock market. Apart from these, the massive trade blitz unleashed by the US on Korea and Korea’s early entry into OECD forced it to adopt a more liberal stance towards foreign capital and finance. All these factors also exposed the inability of the government to prevent market failures.86

To boost their investment in the newly diversified ventures, the chaebol lobbied the government to open up the financial markets. The opening up of the financial markets helped the chaebol inside the country and their foreign branches to borrow capital from foreign firms. In fact, in absence of any monitoring mechanism of the government, borrowings by the foreign branches’ increased rapidly.87 So when the foreign investors withdrew on seeing the crisis slowly spiraling to other economies starting with Thailand, most chaebol began to face serious liquidity problem.

On the other hand, following the declining export trends in the two advanced markets of the US and Japan since the late 1980s, many chaebol began to relocate their production facilities and redirect their exports in the developing regions of China and other Southeast Asian countries.88 This could be explained in one sense as due to the lack of sufficient innovative capabilities of the Korean firms to remain competitive in these advanced nations in their existent products. For example, although in semiconductor markets, the chaebol had a stronghold, they also began to face price competitiveness from Taiwanese firms for the same quality. In the run-up to the crisis many nations in the region started reducing their

88 Sung-Hee Jwa. n. 24, p. 186.
import volume. This affected the exports from Korea to this region, which in turn resulted in deterioration in the balance of payment structure.

Moreover, it is seen that close to 40 per cent of the Korean exports was accounted for its electronics product. Such narrow specialization in a single area led to over capacity problems. This was because success of many firms in this sector encouraged others to invest heavily and take risk in electronics sector. Being supported by the government many firms entered new high technology sectors before acquiring the necessary technical expertise. This ultimately resulted in heavy reliance on imported inputs and technology and below normal operations of the firms. These firms could easily borrow money from abroad following the financial market opening and invest it for such purposes that proved non-profitable thus adding more to the already increasing trade deficits.

Putting it differently, as can be observed from Table 3.7, in the electrical machinery category, Korean industries have started losing their comparative advantage since the mid-1990s. Even if this sector’s export volume was increasing, the total surplus trade account in this particular sector was decreasing from 1985 onwards except in two years, 1994 and 1995. It happened so because of increase in import volume of electronics items. So, contrary to expectations, exports by the electronics sector could not reduce the overall trade deficit significantly.

Looking from another angle, the Korean industrial structure in reality was highly unbalanced. Despite the government’s resolve to strengthen the technological capacity of SMEs, much remained merely on paper. The strong alliance of the government and the chaebol hindered the growth of SMEs. Often the chaebol preferred to import small parts and components from foreign firms at a higher price, which further reduced their profit margin and added to the

deficits.\textsuperscript{90} Had the SMEs been provided with incentives like the chaebol to upgrade their capabilities, they would have supplied these items at lower prices. Unfortunately, instead of regulating, the government often came to the rescue of chaebol irrespective of their unproductive activities.

Therefore, it can be said that to a certain degree lack of competitiveness mainly due to inadequate attention paid to innovation-oriented R&D, undesired diversification of the Korean companies and above all, an unbalanced industrial structure attributed to the worsening financial position of Korea finally leading to the crisis.

\textsuperscript{90} Nicola Bullard and others, n. 86. The authors here point out that most of the machine parts in industrial plants continued to be imported from Japan which is partially true.