COMMISSION
OF THE EUROPEAN
COMMUNITIES

SCIENCE
RESEARCH AND
DEVELOPMENT

MONITOR - SAST ACTIVITY
STRATEGIC ANALYSIS IN SCIENCE AND TECHNOLOGY

THE NEEDS AND POSSIBILITIES FOR COOPERATION BETWEEN SELECTED ADVANCED DEVELOPING COUNTRIES AND THE COMMUNITY IN THE FIELD OF SCIENCE AND TECHNOLOGY

(Sast Project N° 1)

COUNTRY REPORT ON THE REPUBLIC OF KOREA

by
Michael Hobday, Sussex Research Associates Ltd

January 1991

EUR 14141 EN

MONITOR - SAST ACTIVITY
STRATEGIC ANALYSIS IN SCIENCE AND TECHNOLOGY

THE NEEDS AND POSSIBILITIES FOR COOPERATION BETWEEN SELECTED ADVANCED DEVELOPING COUNTRIES AND THE COMMUNITY IN THE FIELD OF SCIENCE AND TECHNOLOGY

(Sast Project N°1)

COUNTRY REPORT ON THE REPUBLIC OF KOREA

by
Michael Hobday, Sussex Research Associates Ltd

January 1991

Published by the
COMMISSION OF THE EUROPEAN COMMUNITIES

Directorate-General
Telecommunications, Information Industries and Innovation

L-2920 LUXEMBOURG

Catalogue number : CD-NA-14141-EN-C

FOREWORD

This report has been prepared for the Strategic Analysis in Science and Technology Unit (SAST) of the Directorate-General for Science, Research and Development of the Commission of the European Communities. SAST activities are part of the MONITOR Programme which aims to identify new directions and priorities for Community research and technological development (RTD) policy and to help show more clearly the relationship between RTD policy and other Community policies.

For questions already identified as of interest for the development of Community policy, SAST projects provide an investigation of the perspectives opened up by science and technology. SAST projects thus serve as an input to the process of policy formulation. In the case of the SAST project to which this report contributes, "The needs and possibilities for cooperation between selected advanced developing countries and the Community in the field of science and technology", the context of policy questions includes the evolving economic relations between the Community and these countries, the interest to the Community of promoting international cooperation in science and technology with various types of countries, and the Community's role in European science and technology.

This report is one of a set of country studies carried out for the project. The set comprises the Republic of Korea, Thailand, other ASEAN countries, the People's Republic of China, India, Brazil and Mexico. An overall strategic review will also be available in 1992.

It should be borne in mind in reading the country studies that the fieldwork on which they are based was carried out almost entirely in the country concerned. The points of view of European industrialists/researchers/policy makers were not explicitly sought for this part of the project. (They will be sought as part of the work for the overall strategic review.)

SAST presents this report as a stimulus to reflection and debate within the European Community on the best strategies to adopt towards a group of increasingly important countries. It must be stressed, however, that the orientation and content of reports prepared for SAST cannot be taken as indicating the considered opinion of policy advisors within the Commission services.

NOTE

Korea *is used in this report as a synonym for the* ***Republic of Korea***

TABLE OF CONTENTS

PART II : DECISION BASE ANALYSIS

II.1. THE ECONOMY

II.2. THE S&T SYSTEM

ANNEXES

LIST OF TABLES (with page references)

RERERENCES

INTRODUCTION AND READERS' GUIDE

Objectives and structure of the report

This report presents an analysis of the workings of the S&T system in Korea. It also suggests areas for possible future EC-Korean collaboration in S&T.

The results of the study are divided into two main sections:

Part I: Strategy review

- I.1. The status of S&T in Korea
- I.2. Implications for European-Korean collaboration

Part II: Decision base

- II.1. The economy
- II.2. The S&T system

Part I presents the findings of research conducted in Korea. It illustrates the current problems facing Korean industry, the need for industry to diversify its main international sources of technology (currently Japan and the US) and the desire on the part of Korean industry and government to co-operate with Europe.

Part I also assesses: the technological problems facing small and medium enterprises; the poor state of the academic sector in S&T; and the striking importance of government research laboratories in Korea.

Part I shows that Europe is viewed as a major new source of S&T for Korea. It assesses how Europe might benefit from a deepening S&T relationship with Korea in the future and highlights important obstacles to co-operation, both in relation to Korean market liberalisation and the practicalities of S&T co-operation.

Part II provides detailed statistical information on the Korean S&T system and shows how S&T has evolved in relation to Korean industry.

Four Annexes are attached. Annex 1 presents details of Korean institutions concerned with S&T. Annexes 2, 3 and 4 provide brief case studies of three industries: telecommunications, semiconductors and high definition television. The case studies illustrate how Japanese and US firms are collaborating with Korean firms in high technology ventures.

Barriers to co-operation

From the perspective of many EC officials, prior to extensive collaboration in S&T, progress needs to be made on the Korean side regarding the ongoing and significant difficulties over intellectual property rights (IPR), preferential treatment of the US, market liberalisation and access to capital within Korea.

Barriers confronting European businesses within Korea are central to any discussions within the EC over extending the remit of S&T collaboration with Korea. Until these barriers are overcome it is unlikely that the potential for positive and mutually beneficial collaboration with Korea will be exploited to the full.

Parameters of the study

As a first step in evaluating the potential for future EC-Korean S&T co-operation, the main focus of the study is the Korean economy and the views of the Korean S&T community. The study analyses why the Korean Government and industry is looking outwards to Europe at this time and why Korea is keen to reduce its technological reliance on Japan.

The study is based largely on the views of Korean officials. It is also based on a detailed empirical analysis of the workings of the Korean S&T system and Korea's S&T standing within the international context.

Prior to any EC policy decisions on S&T co-operation, further study needs to be conducted on: (a) European industry's needs and possibilities for S&T co-operation; and (b) the relationship between European strengths, weaknesses, opportunities and threats in S&T and those of Korea.

At the present time, the IPR and market liberalisation issues tend to dominate EC discussions over co-operation with Korea. The present study attempts to show that if the current obstacles could be overcome, substantial benefits could be gained by both parties. It also puts forward recommendations for S&T co-operation with Korea, based on interviews conducted in Korea.

Research methods

The report is largely based upon a series of interviews conducted in Korea by two SRA members during June and July 1990. A total of 51 interviews were carried out at 41 separate institutions. Interviews took place with senior government officials, R&D directors of large firms, leading academic observers, directors and researchers within government research institutes.

For reasons of practicality, the interviewee sample was drawn from S&T professionals and practicioners within Korea. Keenness to collaborate with the EC may, in part, have reflected the bias of the sample.

Care was taken to obtain the views of middle and lower managers as well as ministers, ex-ministers and chief executive officers of large firms. Interviews also took place with various committees and task forces analysing EC-Korean S&T relations. For cross-checking purposes, a small number of foreign firms operating within Korea were consulted, as were S&T experts from the British and French Embassies, the British Council and the EC Delegation in Seoul.

A small number of interviews were also carried out with EC officials in Brussels. Information in written form was also received from the EC and incorporated into the final report. Most EC interviewees highlighted the barriers to S&T and industrial co-operation mentioned above.

Enthusiasm for co-operation within Korea

From the Korean side, there was a great deal of enthusiasm for establishing strong Korean-EC S&T collaboration. This enthusiasm was based on current perceptions of the Korean need to:

- reduce its S&T dependence on Japan and the US;
- compete within the EC market;
- acquire and upgrade local S&T capabilities;
- improve the status of small and medium sized firms;
- to improve project evaluation skills in S&T.

As the report shows, many of these needs materialised during the latter half of the 1980s.

The strong interest in this EC research project reflected the desire on the part of many senior industrialists and government officials to rapidly expand cooperation with the EC.

Most Korean interviewees were keen to embrace the principle of mutual benefit in EC-Korean S&T collaboration. Many made suggestions as to how this principle could be made operational in future S&T collaborations.

SRA hope that the contacts made during this work will be useful for any follow up activities, whether in Korea or in the EC.

The status of "S&T" and "R&D" in Korea

This report uses the terms S&T and R&D in the conventional way. S&T refers to concrete fields of scientific and technological activity, such as solid state physics (science) and semiconductor development (technology). R&D (and engineering) refers to the activities needed to advance S&T (and industry).

It is important to emphasise that most of Korea's S&T activity is in the field of technology (product and process), rather than science. Similarly, most of Korea's R&D effort can be described as development (advanced and not so advanced) and engineering rather then basic or applied research.

Within Korean universities, research institutes and firms there is little "science" or "basic research" in the conventional sense of these terms.

Over the past 30 years or so Korean R&D has been developed to meet the perceived (often future) needs of the industry and economy. Much of the applied research and engineering capacity within Korea has been promoted by government through the Ministry of Science and Technology (MOST) in large, government funded research institutes and not in universities, as is often the case in other countries.

Very recently (since the mid-1980s) firms have begun to integrate backwards from manufacturing and engineering into R&D, to reduce their dependence on foreign sources and to support their moves into higher value-added goods and services. In most areas basic research and theoretical science is not yet on Korea's agenda of priorities.

EXECUTIVE SUMMARY

Objectives and background

As a first step in evaluating the potential for science and technology (S&T) co-operation between the EC and South Korea (hereafter, Korea), this report presents an analysis of the workings of the S&T system in Korea.

The study is based on a detailed analysis of: (a) the S&T and industrial systems in Korea; and (b) the views of a sample of 51 key Korean S&T officials from industry and government. The views of relevant Commission officials were also received at various stages during the research.

The study shows that Korea is currently looking outwards to Europe, at this time, in an effort to reduce its traditional technological reliance on Japan and, to some extent, the US.

Prior to any Commission policy decisions on S&T co-operation, further study needs to be conducted on: (a) the needs and possibilities for S&T co-operation from the perspective of European industry; and (b) the extent to which European strengths, weaknesses, opportunities and threats in S&T are complementary to those of Korea.

Barriers to co-operation

From the perspective of many EC officials, prior to extensive collaboration in S&T, progress needs to be made on the Korean side regarding the ongoing and significant difficulties over: intellectual property right (IPR) protection, preferential treatment of the US, market liberalisation and access to capital within Korea (hereafter "barriers").

Barriers confronting European businesses within Korea are central to discussions within the Commission over extending the remit of S&T collaboration with Korea.

Until these barriers are overcome it is unlikely that the potential for positive and mutually beneficial collaboration with Korea can be exploited to the full.

These difficulties can only be resolved through negotiation between the relevant EC and Korean agencies and such political pressure which may be applied by the EC.

The status of S&T in Korea

Korea has traditionally had close economic and technological links with the US and Japan, but relatively few links with Europe. During the 1960s and 1970s Korea benefited a great deal from fairly liberal flows of technology from both the US and Japan.

Most of Korea's S&T activity is in the field of technology (product and process), rather than science. Similarly, most of Korea's R&D effort can be described as development (advanced and not so advanced) and engineering rather then basic or applied research.

Within Korean universities, research institutes and firms there is little "science" or "basic research" in the conventional sense of these terms.

Over the past 30 years or so Korean S&T has developed to meet the perceived (often future) needs of industry and the economy, often via the Government through the Ministry of Science and Technology (MOST) in large, government funded research institutes and not in universities, as is often the case in other countries.

Korea's need to strengthen its S&T base

A stronger S&T capability is needed to enable Korea to shift into higher value-added, technology-intensive goods and services. This adjustment is vital to enable Korea to continue on its path of modernisation into the next century.

Korea can no longer rely on low value-added, labour-intensive exports to sustain its growth. Since the mid-1980s, wage costs have risen substantially, the Won has appreciated, some Korean goods have become less competitive on world markets and export growth has begun to slow.

More recently (since the late-1980s) firms have begun to integrate backwards from manufacturing and engineering into R&D, to reduce their dependence on traditional Japanese and US sources and to support their moves into higher value-added goods and services.

Firms and government agencies are making large investments in S&T in order to deepen the technological "roots" of the economy and to build up alternative international sources of technology. The EC is seen as the "first best" option outside Japan and the US.

Korea's desire to reduce its technological dependence on Japan

The major Korean conglomerates (the Chaebol) have succeeded in competing with Japanese firms in several high technology sectors. In response, some Japanese firms have begun to restrict the transfer of technology in many key areas of components, software, capital goods and machinery.

Korean strategists are agreed on the need to reduce their technological dependence upon Japan. This will require a substantial upgrading of the domestic S&T base. Collaboration with willing international partners is viewed as an important aspect of this process.

Strained relations with the US

The US has played a major role in forcing Korea to liberalise its internal markets and to adhere to international standards over IPR. This has caused tension between the US and Korea. Preferential treatment of the US in relation to the EC has also acted to increase the current problems between Korea and the EC Commission.

However, as the Annexes show, US firms are continuing to co-operate with Korean companies in areas such as information technology. IPR and other difficulties appear to be resolved at the level of the firm.

Korean desire for co-operation with the EC

A strong desire for co-operation with the EC was expressed by many senior Korean industrialists and other S&T officials. This desire stems from current scientific, technological and industrial needs.

The S&T infrastructure in Korea is weak and out of step with Korea's industrial power. S&T investments have been oriented towards the short-term needs of the industrial sector. Universities have been underfunded and poorly equipped.

Koreans believe that a large increase in S&T links with the EC could help remedy some of these problems. The EC is viewed as a major potential new source of S&T, as well as an important market opportunity for the future.

Korean industry is also willing to explore the possibilities of matching European technological competences with Korean needs and vice versa.

The impasse over S&T co-operation

EC Commission officials are reluctant to broaden S&T co-operation due to the difficulties discussed above. EC-Korean S&T co-operation is therefore at an impasse. Koreans are willing to collaborate, but the Commission is worried about the dangers of one-way technology transfer and insufficient IPR protection.

The potential advantages of S&T co-operation suggest that the current impasse could be damaging to the long-term technological and economic interests of both parties.

Potential benefits for the EC

As a major Pacific Basin economy, Korea is a potential partner for European firms attempting to gain a "window" to the Pacific Basin regional network of markets, low cost components and low cost labour (particularly in neighbouring economies in which Korea has interests).

Through strategic partnerships or jointly-owned ventures in certain areas, it might also be possible for EC firms to gain access to Korean expertise in mass-manufacturing process technology in sectors such as consumer electronics. This could be exchanged, say, for European expertise in R&D and standards technology.

Very few European firms are involved in such ventures when compared with Japanese and US companies.

S&T co-operation at the pre-competitive level, could increase the number of near-to-market collaborations, building up valuable personal contacts and an improved cultural understanding between both parties.

From the Commission perspective, such strategies assume that IPR and other problems can be resolved.

However, as the case studies for electronics show, major ventures between Japanese, US and Korean firms are continuing, despite the tightening of technology transfers to Korea. The S&T impasse could mean that both Europe and Korea miss the opportunity presented by Korea's current restructuring, and that the EC presence in Korea falls further behind that of Japan and the US.

Other collaboration barriers

Some Korean's expressed general concerns over their perceptions of protectionism within Europe. The idea of "fortress Europe" is strong within some Korean circles.

Many Koreans expressed a preference for the more familiar Japanese and US technology sources. In several high technology sectors European technology is ranked second or third after that of the US and Japan.

Also, many Korean officials are not sure whether they are permitted to participate in EC programmes, nor under which circumstances they should deal with the EC, as opposed to individual nation states. These barriers would also need to be addressed prior to extensive co-operation.

Specific opportunities for S&T co-operation

Korean academics feel that at the basic S&T level there are now major opportunities for co-operation with Korean universities and government funded research institutes.

Similarly, industrialists believe there is scope for exploring mutually beneficial collaboration in near-to-market technology areas.

A range of S&T fields in which Korea is keen to collaborate is identified in section 1.2.11 of the report. These include nuclear power and waste management, energy conservation technology, offshore oil development, information technology, biotechnology, oceanology and medical research.

Next steps

In spite of the position of the Commission on IPR and other barriers, the Korean President recently signed agreements on S&T co-operation with EC member states, notably France and the UK (in 1989). In France, for example, a programme of co-operation between the CNRS and Korean R&D laboratories has begun.

Also in near-to-market areas, the French Government has reached agreement on joint ventures in construction, industrial plant and natural resources.

Given that co-operation is proceeding between member states and individual firms, assessment needs to be made of:

(a) the needs and opportunities for S&T collaboration from the perspective of EC industry;

(b) subsidiarity - what, if any, is the proper role of the EC in S&T co-operation with Korea, in relation to member states.

Above all, major efforts need to be made to resolve IPR and other difficulties at the appropriate political levels by both parties, as the current impasse rules out any major, wide-ranging EC-Korean initiatives on S&T co-operation.

PART I : STRATEGIC REVIEW

I.1. - THE STATUS OF S&T IN KOREA

I.2. - IMPLICATIONS FOR EUROPEAN-KOREAN COLLABORATION

I.1. THE STATUS OF S&T IN KOREA

I.1.1. TIGHTENING UP OF INTERNATIONAL S&T FLOWS

- S&T links have been strongest with Japan and the US

Korea has traditionally had a close relationship in S&T with the US and Japan, but relatively few links with Europe. During the 1960s and 1970s Korea benefited from fairly liberal flows of technology from both the US and Japan.

US flows of S&T originated in government to government co-operative relations. For instance, the US under President Johnson was largely responsible for the formation of Korea's first and foremost government S&T establishment (the Korean Institute for Science and Technology, KIST, established in 1966). Government relations led to strong firm to firm relations and private sector co-operation in technology.

In contrast, Japanese relations began as commercial, firm to firm links. Korean firms manufactured industrial products under licence from Japanese companies. These interactions involved technology flows from Japan and led to more formal government to government relations in S&T. In recent years Japan has supplied much of the industrial technology which enabled the large Korean firms to compete successfully in world markets.

Recent collaborations with Japan include the agreement to involve Korea in Japan's Human Frontiers Programme (a cross-sectoral national programme covering environmental issues and quality of life). Korea and Japan have also agreed to collaborate in new materials, nuclear power and several other areas (although Korean newspaper reports are sceptical of the benefits, given Japan's new reluctance to transfer technology to Korea).

For many industries Japan has been the leading supplier of strategic technology inputs for Korea. Links between the two economies are very close. Many Korean directors and engineers speak Japanese and are familiar with the Japanese system of conducting business and licencing technology.

- Japan has begun to restrict technology transfer

As Korea has become a major competitor, Japan has become more reluctant to transfer technology in many key areas of components, software, capital goods and machinery. Within Korea there is a common view that Japanese firms have formed a consensus (implicitly at least) not to supply strategic technology inputs to Korea. Many observers within Korea believe this effort to have become very effective in the latter half of the 1980s. Some Korean's believe they are experiencing the "tail end" of technology transfer from Japan. Koreans claim that in some cases, the large Japanese conglomerates have begun not only to restrict technology flows to Korean competitors, but also to pressurise their own high technology suppliers to restrict transfer of strategic technology inputs.

Japan has not totally "dried up" as a source of technology. Some analysts in Korea believe that informal channels of technology transfer may still operate effectively and that competition within Japan to sell machinery and technology will undermine any attempts to restrict technology flows. However, there can be little doubt that formal channels of Japanese-Korean technology transfer do not function as smoothly as before.

- Relations with the US have also become strained

Like Japan, the US has become a less constant and reliable source of technology. The US has played a major role in forcing Korea to liberalise its internal markets, to adhere to international standards over intellectual property rights and patent protection, to cease dumping products on international markets (an accusation Korea strenuously denies) and to reduce Korea's large balance of payments surplus with the US.

Korean observers hope that the recent government efforts to demonstrate adherence to intellectual property rules and patent law well reduce some of the tension between the US and Korea. Korea has also recently become a net importer of goods and services. Korean officials hope that these factors, plus the efforts to liberalise local markets, will lead to improved technology transfer relations with the US overall.

- **Potentially, the EC is an attractive new source of technology**

The recent disputes with the US and Japan have exposed an important technological weakness in the Korean economy. Korean observers believe that to overcome Japanese and US efforts to restrict technology transfer, it is necessary to diversify their technological sources and to reduce their overall dependence on international suppliers of technology.

The EC is seen by many in government and industry as an important alternative (if potential) source of technology. The attractiveness of direct access to the EC market also indicates that the EC is a 'first best' regional option for expanding technological sources beyond the traditional ones. As discussed below, methods of technological acquisition include direct foreign investment, jointly owned ventures in Europe (and East Asia), collaboration with academic institutions, and strategic partnerships between Korean and EC firms.

There is also a strong current interest in Eastern Europe and especially the USSR. Eastern Europe is viewed as having a strong science base, complementing Korea's powerful production and marketing capabilities. This complementary match could work to the benefit of both parties. In March 1990 a 21 member Soviet delegation met with Korean officials to discuss S&T collaboration. The Soviet Union has requested assistance from Korea to convert military plant to civilian purposes. The Soviet Union has offered Korea a reported 786 proprietary technologies, of which 325 are "available for commercial use" (Korean Economic Journal, 11 June 1990).

However, the current fascination with the Soviet Union and Eastern Europe may be short lived. Korean firms are learning of the financial and economic difficulties of dealing with the Soviet Union. For instance, Korean firms are facing problems in obtaining hard currency payments for goods and services sold.

I.1.2. THE WORSENING ECONOMIC ENVIRONMENT

During the 1970s and the early part of the 1980s, the domestic and international economic environment was undoubtedly favourable to Korea's export-led growth strategy. The Won remained low against the appreciating Japanese Yen and the Dollar (leading to technology licencing by Japanese firms, as well as export competitiveness vis a vis Japan and the US). Labour costs were relatively low. Labour unrest was not a major problem. US and

Japanese technology flows were fairly liberal. Local interest rates were low. The large conglomerates enjoyed considerable support from the Korean Government. Also, there was relatively little competition from low wage East Asian economies (e.g. Thailand). Inflation was low. Industrial growth was extremely rapid. Local markets were effectively protected from foreign competition. The balance of trade was generally strong and positive.

In the latter part of the 1980s the position changed considerably. Korea began to suffer from:

- increasing protectionism from Japan and the US
- the liberalisation of internal markets
- the need to adhere to international IPR standards
- rapidly growing importation of consumer goods
- a shift to a balance of trade deficit for the first time
- a slow down in export growth
- the rise of double digit inflation
- severe labour unrest
- rising labour costs leading to
- competition from low cost East Asian economies
- recent Yen depreciation
- an appreciating Won.

These problems have dented Korean confidence in their economic success. In a sense, the difficulties being experienced are the growing pains of an extremely successful economy. Korea is now confronted with the need to restructure its economy, industry and technology to cope with the problems of success.

- The Korean economy is confronting a series of transitions

(a) from export led growth to domestic demand
(b) from a low wage to a "medium" wage economy
(c) from low to high(er) value-added production
(d) from assimilative to innovative technological behaviour
(e) from central direction to increased reliance on market mechanisms
(f) from mass produced low margin products to technology intensive goods and services.

A large part of the adjustment which needs to be made depends on the continued technological upgrading of the economy. This process of technological adjustment will involve: the large Korean conglomerates; small and medium sized firms; the government R&D institutes; and the Korean university system. It will also involve a restructuring of Korea's international S&T relations with the US, Japan and the EC. The rest of this section focusses on these issues.

I.1.3. TECHNOLOGICAL DEEPENING AND DIVERSIFICATION : STRATEGIES FOR THE 1990S

- A consensus is reached on technology strategies

Two sets of technology strategies are being pursued to achieve the restructuring of the industrial sector. These can be termed technological deepening and technological diversification. Both strategies are an attempt: (a) to overcome the restrictions on international technology transfer to Korea; and (b) to promote local product and process innovation. Deepening refers to indigenous efforts to improve the industrial R&D base. Diversification refers to effort to diversify sources of technology beyond the US and Japan.

These strategies involve government, industry and academia in new R&D activities. There is a broad measure of consensus among the different groups on the main objectives for Korea in the 1990s, as well as the methods by which the objectives are to be achieved. A successful backward integration into S&T by industry is generally viewed as a critically important facet of Korea's overall industrial restructuring. In the 1990s, the economy is to move from growth based on cheap labour to growth based on high technology.

The leading Chaebol are committed to a large increase in R&D expenditure and effort, as is the Korean Government through the Ministry of Science and Technology and the Ministry of Trade and Industry. For the first time in Korea, a major attempt is being made to strengthen the university base in S&T. Thirteen centres of excellence (science and engineering research centres) were financed in 1989 by the Ministry of Science and Technology in key areas such as artificial intelligence, new materials, bio-technology and semiconductor physics. One hundred such centres are planned by the year 2000 (see academic section below). Most of the government research institutes are now in the process of moving away from industry-related R&D towards more generic, advanced research (orientated towards industry needs). As large firms set up their own R&D laboratories, the government R&D units are searching for a new role for themselves.

As already noted, Japan and the US have begun to restrict flows of technology to Korea. This is leading Korean firms into a diversification of international technology sources. The attractiveness of direct access to the EC market also suggests that the EC is a 'first best' regional option for Korea's search for new sources of technology.

I.1.4. INDUSTRIAL RESTRUCTURING: A SHIFT TO "FLEXIBLE CONGLOMERATION"

- In the 1970s the emphasis was on low cost labour

Up to the end of the 1970s Korea's 30 or so large conglomerates deployed their highly motivated, low skilled labour in mass production industries: first, through low-margin, high-volume, light industries such as textiles; then in the 1970s, the heavy industries of steel, construction and shipbuilding; in the 1980s the dynamic sectors have been the more capital and technology-intensive sectors such as consumer electronics, computers and electronic components.

Prior to the 1980s, the Chaebol aimed at relatively stable, low price/low profit margin, large scale markets. Industrial organisation was based on fairly rigid, hierarchical line management systems. As much of the technology was acquired under licence from overseas, the firms made little investment in R&D (especially basic and applied research) or science.

The prevailing industrial structure is widely viewed as immature and unwieldy. Management styles have to change to meet the demands of the 1990s.

- Now the economy needs more R&D and higher value-added production

Korea is now facing an ongoing structural adjustment from cost-based competitive advantage (based primarily on cheap labour) to technology based competitive advantage, centred on higher value-added products, higher skilled labour and professional management.

A vital component of this strategy is a greater corporate commitment to R&D. The conglomerates have increased their spending on R&D but many feel that higher levels of investment are needed. There is strong political pressure as well as economic pressure for the Chaebol to increase R&D expenditures. The evidence suggests that they are responding positively.

There is also a pressing need for greater management and organisation flexibility to assess and respond to market needs. This in turn requires less hierarchy, more decentralised management systems and delegation of strategic decision making to the industry operating units.

On these general issues there is widespread agreement across industry, government, and the academic sector. This consensus was arrived at only very recently (1989-1990).

- The conglomerates intend to become more flexible

The transition faced by the conglomerates can be characterised as a shift from the mass production (or "Fordist" after Henry Ford) paradigm to a more flexible, technology intensive and market responsive paradigm. It is important to remember that this shift is occurring in steady incremental, if painful, steps and not a once-and-for-all adjustment. For instance, in rapidly changing areas such as consumer electronics the transition has already begun. However, it is a costly and difficult learning process for industry.

Organisational hierarchies remain too bureaucratic and sluggish to respond to rapidly changing high technology markets. In his analysis of the Korean position, Michael Porter (a leading management theorist) recommends that the Chaebol break up and divest themselves of their many industrial enterprises in order to become market leaders in relatively few sophisticated, high technology markets (see Korea Business World, March 1988 pp9-10). Porter argues (a) conglomeration works well in an economy where little first class management exists and the driving need is to raise capital and add value and (b) at this stage the Korean economy will not develop if the conglomerates remain the engine of development.

- But they intend to remain conglomerates

However, the general view within Korea is that the conglomerates will not divest or break up into more flexible, specialised industrial units. Rather, the history of the industry and the nature of the firms (and their owners) suggest that the firms will attempt to achieve a

form of "flexible conglomeration": large conglomerates with technology-deep, flexible, market responsive operating units. Korean executives hope that this new organisational form will be characterised by:

(a) the advantages of flexible management styles:

- decentralised management
- independent profit/cost units focussing on specialist sectors
- customer-responsive marketing
- higher value-added, niche product markets
- capture of software and service markets
- backed by in-house R&D and innovation

(b) combined with the advantages of conglomeration:

- large financial economies of scale
- global marketing outlets
- the financial and technology capacity to overcome large barriers to entry in new markets
- ability to withstand short term market downturns and financial loss in specific sectors (e.g. in semiconductors)
- the ability to cross-subsidise new areas from high profit-making industries (e.g. Samsung's subsidy of semiconductors from its telecommunications operations).

Whether the Chaebol manage to achieve this combination of advantages remains to be seen. However, the Porter argument probably underestimates the potential for decentralisation within the Chaebol. It also misjudges the likely pattern of Korean industrial development, which may well follow (in some respects) the "Japanese route" of large multi-product, multi-technology corporations, rather than the more typical US model of focused, relatively concentrated corporate structures. The Chaebol will continue to expand but there will probably be a lower rate of diversification in the future.

If successful, the Chaebol will reap the advantages of technology deepening. The greater technological autonomy generated will lead to less reliance on overseas suppliers for strategic inputs. The ability to generate new product designs and process technologies will enable the large firms to become market leaders rather than followers. The successful technological transition of the Chaebol is therefore central to Korea's overall economic strategy.

- Changes, to date, reveal a mixed picture

Evidence of corporate efforts to change is plentiful, ranging from Goldstar's new CU (Cultural Unit) organisation to Samsung's massive investment in R&D near Taedok Science City (see Part 3). Overall, private as well as public R&D spending has increased substantially and plans exist to increase still further the ratio of R&D spend to GDP. (However, it should be noted that corporate R&D figures include items such as manpower and engineering costs, not normally classified as R&D in the West. This practice enables firms to claim tax relief on R&D spending and other benefits).

In making the changes, Samsung and more recently Goldstar are seen as leaders. Some conglomerates are relatively slow to change (e.g. Daewoo), preferring to rely on more traditional market-driven management and R&D. Daewoo still spends roughly 70% of its

R&D budget on short-term product/process needs (information from interview, June 1990).

The Chaebol are still, to some extent, led by first generation entrepreneurs (often family members) who excelled in the "mass production" paradigm. The second generation directors understand modern management techniques and see their role as "co-ordinators rather than dictators", as one interviewee put it.

The leading Chaebol have embraced the new corporate philosophies with enthusiasm. Goldstar, for instance, has recently undergone two major restructurings. The new Cultural Unit approach was the result of an in-depth Mackinsey consultancy project carried out in 1988. Executives are encouraging intra corporate entrepreneurship (called "intrapreneurship") to overcome rigidities and to continually renovate organisational structures and practices.

Even with strong management commitment, such major structural changes are very difficult to carry out. Old practices are difficult to change and the Chaebol are extremely large (Samsung for instance has around 150,000 employees).

I.1.5. STRENGTHS AND WEAKNESS OF A SELECTION OF KOREAN INDUSTRIES

During the 1970s and 1980s Korea developed significant strengths in a number of high technology and capital intensive industries. The electrical and electronics sector is an area of comparative overall strength, accounting for 21% of total exports in 1988 and around 36% of total corporate R&D spending.

As Annex 2 shows, in the electronics components field Korea is strong in mass produced standard semiconductors (e.g. discrete products and 256K and 1 megabit DRAMs), but weak in application specific integrated circuits (ASICs), computer-aided design systems, factory automation, capital goods and material inputs.

In telecommunications (Annex 3), Korea is strong in telephones handsets, small rural exchanges, private branch exchanges, facsimilie machines, optical transmission and digital microwave. In contrast, Korean producers are weak in advanced systems such as large scale public switches, ASICs for public exchanges, high performance video phones and laser technology.

In consumer electronics Korea is very competent in colour TVs, hi fi, VCR and camcorders but lags several years behind the market leaders in Japan, the US and Europe in high definition television (HDTV) (see Annex 4). In conventional colour TVs, Korea's main strengths lie in mass manufacturing, scale intensive operations. However, even here Korea is fairly weak in digital circuitry (design and manufacture) and computer integrated manufacturing. In terms of assembly (e.g. chip insertion and automatic soldering) Korea is almost on par with Japanese market leaders. In HDTV areas such as display production technology, projectors, integrated circuitry (e.g. decoders, signal processors and converters) and flat panel antennae, Korean companies are far behind the world technology frontier.

In mature, light industries such as apparel and clothing and footware, Korea is a world leader. Apparel and clothing accounted for 14.3% of total Korean exports in 1988, while footware accounted for 6.3% of exports.

In heavy industries such as shipbuilding, iron and steel and passenger vehicles Korea is a major exporter (these items accounted for 2.9%, 5.0% and 5.5% of exports in 1988, respectively). During the late 1970s and early 1980s Korea built up impressive capabilities in petrochemicals, basic machinery, fine chemicals and primary metals.

Fine chemicals are typically high value-added, technology intensive and resource efficient. Fine chemicals accounted for around 60% of total value added in chemicals in 1986. This compares well with the US and Japan but poorly with the EC. Conversely, Korea is a major importer of intermediate raw materials and weak in several industries related to chemicals.

In advanced manufacturing systems and factory automation, Korean industry has been slow to adopt and manufacture products. However, the industry is active at the lower end of the factory automation spectrum (e.g. numerically controlled machine tools, fixed sequence robots and automated materials handling systems). Korean production of programmable logic controllers (PLCs) is growing rapidly, accounting for around 30% of the domestic market in 1988. Production of PLCs is mostly through joint ventures with Japanese and US firms.

Robotics have taken off very quickly in the last five years. Production is mainly in relatively simple discrete units for high volume sectors such as automobiles and electrical components. Japan accounts for roughly 70% of total robots used in Korea, the US 20% and Korea 10%. As in most other markets the EC lags behind, accounting for roughly 2% of robots used.

Aerospace is emerging as a new export industry. The Chaebol have set themselves the task of becoming major manufacturers of aircraft over the next decade or so. Exports are estimated to have risen from $21m in 1988 to around $850mn in 1989 to $2bn in 1990 (EIU, 1990). Much of this activity was in defence related contracts.

I.1.6. THE POSITION OF SMALL AND MEDIUM SCALE ENTERPRISES (SMEs)

- Small and medium firms have lagged behind the Chaebol

Most analysts in Korea believe that industry suffers from a severe weakness in the area of small and medium enterprises (SMEs). This is a result of the economy's almost exclusive reliance on the Chaebol. For mobilising resources and entering mass production industries the Chaebol proved extremely effective. However, rather than working with local firms, the Chaebol licenced in foreign technology. In contrast to Japan, small and medium firms have not grown up in parallel with the conglomerates.

The SMEs which exist are few in number (relative to the support needed for the large firms) and technologically unsophisticated. SMEs have traditionally played a sub-contracting role for the large firms, providing low cost, mature technology inputs to industry. In Korea, SMEs tend not to be technology suppliers, innovators or specialist producers of capital goods and materials.

- There is widespread agreement on the need for upgrading SMEs

To achieve the transition to higher value-added industry, the economy needs a large number of new technology-based SMEs. This is a widespread view, held by leading economists, the large firms themselves and government ministries such as MOST and MTI.

The leading Chaebol (e.g. Samsung and Goldstar) now recognise the importance of nurturing SMEs in high technology areas. SMEs are needed to support the large firms with capital equipment, materials, fine machinery parts, components and software. In craft-based, "human-orientated" technologies (e.g. software applications) suited to small size, low overheads and market agility, SMEs have clear advantages over the Chaebol. Increasingly, the large firms intend to become systems integrators, supported by SME suppliers of components, sub-systems and other technology inputs.

A strong base of SMEs will reduce the large firms' dependence on competitors (particularly Japanese firms) for technology, enable Korea to establish a custom software sector for the electronics industry, provide a local source of vital automobile parts and, in general, build the technological 'roots' to enable the large firms to move into high technology markets.

In 1986 the Ministry of Trade and Industry launched a national campaign to enhance the productivity of SMEs through the KPC (Korean Productivity Centre) and the SMIPC (Small and Medium Industry Promotion Corporation). Like KAITECH, these institutions began very recently. KPC provides consultancy, industrial automation support, re-education, engineering services and other productivity-enhancing programmes for SMEs.

- SME development poses major difficulties

Nurturing technology-based SMEs in Korea is an extremely difficult task. Korea lacks the US and European tradition of venture capital start-ups. The economy also lacks the Japanese tradition of large firm sponsorship of vital small companies. Entrepreneurship has been confined to the Chaebol where spin-offs are few and far between.

To make matters worse, government support for SMEs faces severe difficulties. The government machinery is familiar with supporting large firms, not SMEs. Also, government SME programmes may "backfire". The need for careful evaluation of government spending may dampen such entrepreneural spirit which does exist and add bureaucratic interference to the problems faced by small companies. The need to evaluate specific support projects, the danger of slowing down SME progress and the difficulties of actually creating the environment for SMEs to flourish are problems currently facing Korea.

In order to acquire capabilities to promote SMEs Koreans are looking towards the EC and other regions. For instance, under the Korean-French Industrial Co-operation programme, the Korean Small and Medium Industry Promotion Corporation has formed a joint venture with the French Association for the Promotion of Industrial Development (APRODI). In the SME area there may well be more scope for EC-Korean collaboration.

I.1.7. S&T IN THE ACADEMIC SECTOR

- University R&D facilities are poorly developed in Korea

To date, the academic sector in general and the university sector in particular have made relatively little contribution to the S&T system in Korea. It is true to say that there are few distinctive S&T competences in the Korean academic sector. University S&T research has suffered from a lack of government financial support and a lack of priority from the Ministry of Education. Instead, the government has focused its R&D resources on the large research institutes which exist outside the academic sector. (These are sponsored by the Ministry of Science and Technology rather than the Ministry of Education).

Within Korea, many argue that (traditionally) there has been little commitment to S&T on the part of most universities. Universities have been centres for teaching rather than research. Consequently, the university sector is not well adapted to the needs of high technology industry. According to this view, an alternative research institute structure was necessary to overcome the unwillingness of universities to embrace industrially-related R&D.

Universities have been a source of manpower rather than a contributor to the S&T needs of the economy. In this sense, the weakness of the university sector resembles that of Japan. However, within Japan several of the top universities (e.g. Kyoto) boast world class scientific and engineering groups. Korea does not yet boast such capabilities. Most would agree that universities suffer from a serious lack of R&D funds and poor equipment and facilities.

Korea has relied heavily on overseas universities, particularly the US, for training and PhD supervision. There are now many Koreans in government research laboratories and academia who have PhDs from US universities. Japan and Western Europe have also provided a channel for this type of training.

- Links with industry are poor

Firms complain that despite the numbers of college graduates from Korean universities (often 10 applicants for each engineering job) the quality of applicants is very low and substantial further training is needed in basic engineering. Industry also claims that such work that is carried out is remote from the needs of industry and driven by the need to publish. Universities, in general, are not at the stage of operating research laboratories.

There appears to be very little systematic university-firm collaboration in Korea. However, there are some exceptions. In the areas of process modelling and flat panel displays, for instance, universities perform very useful functions for industry.

There are some pockets of excellence in academia, but these are few in number and confined to small groups. In general, work carried out would not be classified as scientific or basic research, or even exploratory technological research. Work tends to be applied research rather than basic science.

- University S&T groups are soon to be strengthened

As part of the Korean Government's S&T strategy, there is now a strong commitment to improve the university position. Very recently the Ministry of Science and Technology has

established a plan to strengthen university R&D activities. In 1989 13 centres of excellence in science and engineering research (called SRCs and ERCs) were set up in:

- topology and geometry
- theoretical physics
- semiconductor physics
- organic chemistry
- molecular microbiology
- plant molecular biology and gene manipulation
- advanced fluid engineering
- artificial intelligence
- sensor technology
- spacecraft research
- thin film fabrication and crystal growing for advanced materials
- biotechnology process engineering
- animal resources.

The centres, at present, amount to small groups selected according to reputation and ability to work with industry. The SRCs and ERCs are funded by the Ministry of Science and Technology, although they operate within the academic sector (usually funded by the Ministry of Education). If successful, the centres will mark a turning point in the fortunes of universities in the field of S&T.

A total of 100 SRCs and ERCs are planned by the year 2000. Their mandate will be to develop technology in collaboration with firms, the government research institutes and other universities. The centres are being encouraged to form links with leading international research groups. For instance, the 13 centres above have formed a co-operative venture with counterpart laboratories of the CNRS in France (agreed during President Roh Tae Woo's state visit to France in December 1989). It is hoped that Korean firms will contribute financially to the centres. In some cases firms have already given financial support.

I.1.8. GOVERNMENT FUNDED R&D INSTITUTES (GFIs)

- In Korea GFIs are an alternative to the universities

KIST (Korean Institute of Science and Technology) the first GFI was established in 1966 under a new Ministry of Science and Technology, which had a remit to build up the S&T infrastructure of the Korean economy. The mission of KIST was to generate a base for Korea in S&T and to provide vital services to industry. KIST became the first Korean S&T institute to attract back engineers and scientists from the US and other countries.

Ten or so GFIs were set up during the 1970s. Their aim was to create critical mass in a wide range of technologies vital for industrial progress. There are now 22 GFIs (see Part 3). The Ministry of S&T supports many of the GFIs. However, other ministries are also actively involved in funding and deciding research agendas. For instance, the Ministry of Communications is involved with the Electronics and Telecommunications Research Institute; the Ministry of Energy and Resources are closely linked to the Korean Atomic Energy Research Institute and so on.

Architects of the GFI system in Korea argue that they needed to set up the GFIs to circumvent the university establishment. They argue that Universities in Korea saw themselves as "time honoured institutions" with little regard for industry or commerce.

Undoubtedly, the GFIs took a lead role in S&T in the 1970s. There are significant and impressive cases of GFI-industry collaboration leading to high technology market entry. Among the most well known are the semiconductor DRAM project and the TDX telecommunications exchange project, both sponsored by the Ministry of S&T under the Electronic and Telecommunications Research Institute.

Given their aim of supporting industry, the GFIs have worked mainly in the field of applied (advanced and not so advanced) research rather than basic research or science.

- Some criticise the GFIs for lacking industry relevance

Organisations such as KIST carried out consultancy for industry from the early stages. However, many in industry and ministries other than the Ministry of Science and Technology claim that KIST and other GFIs have not linked well with industry. Nor, they argue, have GFIs played a major role in supporting the Chaebol in their industrial activities. This has led the government to encourage more GFI-industry collaboration in S&T since the early 1980s. For instance, the Ministry of Trade and Industry has recently set up its own major R&D institute (the Korean Advanced Institute of Technology) specifically to bridge the gap between S&T and industrial needs.

Links between some GFIs and industry were certainly poor to begin with. In part this was because of the non-industrial research orientation of many of the GFIs. GFI personnel tended to be drawn from the academic sector and judgement on project success (and promotion) was often based on publications rather than industry relevance.

There may be other reasons for a lack of synergy between many of the GFIs and the large conglomerates in the past. First, because firms were mostly involved in licencing technology from abroad, rather than generating technology locally and fostering local sources, there may have been a lack of demand from industry during the 1970s and early 1980s. The outward orientation of the Chaebol (at least to some extent) may have left the GFIs working in an industrial vacuum.

Second, as the large firms set up their own research laboratories, they may be inclined to belittle the efforts of "rivals". To some extent industrial criticism of the GFIs may be a version of the "not invented here" syndrome.

In the latter half of the 1980s, firm-GFI links have improved. This is due, in part, to firms' attempts to source technology locally. Also, the new R&D laboratories of firms have more in common with the GFIs (despite rivalry) than they had with production units, prior to the major R&D investments of firms. In the future more interaction with industry is expected as the Chaebol's R&D programmes develop.

- But few would question the importance of the GFIs to Korean S&T

Despite criticisms of lacking industry relevance, few would argue that the GFIs have not played a critically important part in the S&T development of Korea. They have provided the economy with a research base to build upon in the future and the personnel to support R&D projects both in industry and outside. Organisations such as KIST began a "reverse brain drain" attracting back many leading scientists and engineers to Korea, particularly

from the US. For instance, the President of the Korean Aerospace Institute (created in 1989) was hired back from the US.

By helping to fill the S&T vaccuum left by the Chaebol and the universities, the GFIs have proved extremely valuable to Korea. The GFIs gathered and disseminated technical information. They created a substantial pool of concentrated R&D and engineering resources.

Now the economy is poised to deepen its R&D base, the need for domestic research capabilities is becoming increasingly important to industry. For the domestic S&T base, the GFIs are likely to become still more important in the future.

- As industry invests, GFIs are searching for a new role

As firms move into the applied R&D area, the GFIs are finding it necessary to review their objectives. In the future, tasks closely related to industry such as applied product and process development and technological trouble shooting will increasingly be performed by firms. R&D activities which are on the critical path of industrial development will be integrated into the infrastructure of the conglomerates.

The GFIs can be expected to shift gradually away from R&D directly related to industrial innovation into more generic, basic and experimental R&D. In order to move into more basic research, the older GFIs will face a difficult adjustment process. The management, evaluation and execution of basic research requires different skills than that required of industrial R&D. For instance, outputs cannot be evaluated simply in terms of products, processes and prototypes. The time scales involved in basic research are often much longer than those relevant to applied work. Project managers used to dealing in the world of industry related research may find their skills less relevant to generic work. The same problem applies to engineers.

The likelihood is that as the overall base of R&D expands, there will be room for the existing GFI activities as well as the new research. Rather than displacing the base of applied R&D, new generic research projects will be added to the portfolios of GFI groups, softening the adjustment process. However, it is likely that some groups will find their own work redundant as industry moves into the R&D domain.

I.1.9. S&T DECISION-MAKING IN KOREA

- The Ministry of Science and Technology

The Ministry of Science and Technology (MOST) has been the main decision making body in S&T for the past 20 years or so. MOST provides the funding for many of the GFIs and takes a active part in the direction of their work.

Although MOST is a key S&T institution within Korea, MOST has been too weak politically to achieve its objectives alone. Strong support for S&T over the past 20 years or so has been given by successive Presidents of Korea.

- The Ministry of Trade and Industry

The Ministry of Trade and Industry (MTI) is a more powerful ministry than MOST. The MTI have recently taken a strong interest in technology. As the MTI's role of industrial targetting and import protection has diminished during the 1980s, the Ministry has become more active in promoting high technology and providing pre-competitive R&D support for large and small firms. The MTI, for instance, recently set up its own research and teaching body to promote the development of industrial technology (see above).

There is rivalry between MOST and MTI, particularly as the MTI shifts into the domain of industrial technology support and bridge building between S&T and industry.

- The Economic Planning Board

The Economic Planning Board (EPB) sits above the MTI, MOST and other ministries including the Ministry of Finance. It decides upon and allocates budgets and is extremely powerful in many fields, including technology and economy. (The Minister in charge of the EPB is also the deputy Prime Minister).

- S&T at the presidential and ministerial levels

Any high-level discussions on EC collaboration in S&T should begin with MOST but also take place with other ministries such as MTI and the EPB. Presidential advisers should be involved where appropriate.

In addition, ministries with special responsibilities (e.g. Communications, Energy and Environment) should be closely involved with any projects which include their areas. Typically, they allocate budgets for the research institutes in their fields and have a strong influence on policy direction.

The President is involved in S&T through the Presidential Blue House. Major policy decisions which affect S&T are taken by presidential advisers or presidential secretaries. The Economic Adviser is a key person in the area of S&T.

- Special S&T committees

There are a number of committees and task forces concerned with international collaboration in S&T. Between them, they have direct access to several ministers and the President of Korea.

Among the most important is the First International Committee on International Co-operation, connected to the Department of International Co-operation of KOSEF (Korea Science and Engineering Foundation). This committee was set up in 1989. It has a number of high level individuals working on various aspects of EC-Korean collaboration in S&T. The committee is due to report by the end of October 1990.

MOST have a task force working on EC-Korean collaboration. This was formed in February 1990. It has 12 groups, one of which is solely concerned with S&T. This was organised by the EPB and will report to the Prime Minister.

The Presidential Commission on the 21st Century, established in June 1989 (due to finish in May 1994) has direct access to the President. One of its four major concerns is the

development of Korean S&T. The Commission will advise on energy, IT, environment, international links and many other S&T issues.

Members of the various S&T committees interviewed during this study were open and frank (often very positive) about the prospects for EC-Korean collaboration. They are a good source of information and will be influential in future EC-Korean S&T links.

I.2. IMPLICATIONS FOR EUROPEAN-KOREAN COLLABORATION

I.2.1. BARRIERS TO COLLABORATION

Serious barriers to collaboration must be addressed prior to fruitful long-term relations in S&T between Korea and the Community. From the Community perspective (e.g. DGI), although limited collaboration could bring benefits in some specific cases, wide ranging co-operation in S&T runs the danger of one-way technology transfer to Korea combined with insufficient IPR protection.

Three specific areas of EC concern are: (1) the protection of IPR rights; (2) restrictions on foreign investment; and (3) access to Korean markets.

As far as IPR is concerned, discrimination against the Community vis-a-vis the US is a matter of considerable concern. To date, negotiations with the Korean authorities have failed to reach a conclusion satisfactory to the EC. Transitional arrangements in favour of the US seriously disadvantage Community interests in sectors such as pharmaceuticals, cosmetics, agrochemicals, semiconductors, printed materials, computer software and sound recordings and other sectors requiring protection of patents or copyrights.

Regarding foreign investment, more than twenty percent of industrial categories remain prohibited or restricted. Community investors also face serious financial problems due to limits on the transfer of equity capital, local loan facilities and Won funding. In joint ventures, foreign partners risk being unable to subscribe to their equity share whenever capital has to be increased. This can occur as a result of Korean legislation concerning the public issue of shares and/or administrative pressures. Also, Korean land acquisition requirements and complex and detailed tax investigations into foreign investors act as barriers to foreign investment.

Regarding access to Korean markets, high import duties, quantitative restrictions, tax disrimination against imported products, protectionist safety standards and delays in customs clearance are among the difficulties faced by EC companies. From the perspective of some EC officials, the problems facing Community firms' cast doubt on the willingness of the Korean authorities to really open the domestic market to foreign goods and services' (Communication from Directorate-General I, 21 November 90, Number 132383).

Accordingly, many EC officials are reluctant to encourage wide-ranging S&T co-operation. In areas such as semiconductors and pharmaceuticals, increased co-operation in S&T could run the risk of one-way technology transfer from the EC to Korea. Except in specific cases of clear and unequivocal net benefit to the community, the principle of mutual benefit may well be unattainable, particularly in near-to-market co-operation.

I.2.2. THE IMPASSE OVER EC-KOREAN S&T CO-OPERATION

At the present time there is an impasse in the issue of EC-Korean S&T co-operation. Many Koreans wish to collaborate, but the EC is unwilling given the dangers of collaboration. Only in specific areas of clear and unequivocal net benefit to the EC, is the EC keen to collaborate in S&T. However, this criterion rules out many of the close-to-market sectors

in which Korea is keen to co-operate and already boasts strong capabilities: consumer electronics, telecommunications, semiconductors and so on (see Annexes 2, 3 and 4). In these areas uncertainty and risk prevail and the problems of IPR and market access loom large.

The position of the Commission in near-to-market technology areas is understandable. However, it casts doubt on Commission's willingness to co-operate with Korea in pre-competitive S&T and areas such as high definition TV standards (see Annex 4).

The danger of this impasse is that co-operation will continue between Korean firms and S&T agencies and their counterparts in Japan and the US, leaving the EC at a disadvantage. In addition, Korea will continue to form agreements with individual EC member states and European firms, as is currently the Korean practise, regardless of the Community position on IPR and market access (see sections II.2.3.2 and Annexes 2, 3 and 4).

In so far as the Commission could play a role in stimulating Korean-EC links, the impasse suggests that the S&T "boat" is likely to be missed (see section I.2.11 below). As a consequence, Europe is unlikely to improve its position vis a vis Japan and the US in Korea, despite the current Korean desire to seek additional international sources of S&T.

I.2.3. THE POTENTIAL BENEFITS OF LONG-TERM "COMPLEMENTARY COLLABORATION" IN S&T

In the light of the ongoing liberalisation problems, it is unlikely that extensive S&T collaboration will proceed in the short-term. This is unfortunate for both parties, as the potential benefits of wide-ranging co-operation could be considerable both to Korea and to the Community.

Korea is set for a major expansion of its S&T base in the 1990s. If problems of market liberalisation can be overcome and European investors are able to secure IPR protection and market access, then it may be possible for EC-Korean co-operation in S&T to work to the benefit of both parties through the principle of complementary collaboration.

During discussions with Korean officials, the following arguments for complementary collaboration were put forward.

- Collaboration could benefit EC and Korean firms

Korea now boasts significant strengths in manufacturing process and product technology, yet is weak in vital areas of basic and applied research. Conversely, in some areas the EC is relatively weak in manufacturing and product technology, but strong in basic and applied research. It follows that with careful matching, both parties could benefit from each other in S&T co-operation.

For instance, in exchange for advanced process or standards technology a Korean producer could transfer leading-edge manufacturing technology to a European firm. This could take place in a joint R&D venture, a strategic partnership arrangement or in a jointly owned company. Decisions could then be made as to how the joint Korean-European venture might address both European, Korean, South East Asian, US and other markets.

According to some Korean industrialists, this type of collaboration on the basis of complementary technological strengths and weaknesses could work to the long-term economic benefit of both parties.

- Collaboration could open up new markets

Through strategic partnerships, EC firms could enable Korean companies to compete more effectively in Europe from within EC national boundaries. Korean firms would gain access to large and growing EC markets (and technology). Europe could gain from increased employment and, in the longer term, the integration of Korean multinationals into the industrial infrastructure of the EC.

Similarly, strategic partnerships within Korea could enable EC firms to access the large and rapidly growing Korean market, more effectively than direct foreign investment. In addition, a foothold in Korea could enable access to other Pacific Basin markets. A strong local presence in the Pacific Basin region is a pre-requisite for continued competitive success, particularly in high technology sectors.

Korea is a major competitor within the Pacific Basin and has experience of manufacturing and producing high technology goods within East Asia as a whole. Korea could provide a window by which EC firms could access the East Asian market, East Asian manufacturing and product technology, low cost components and low cost labour. Although wage costs have risen in Korea, they remain substantially lower than EC wage costs. In addition, Korean firms have considerable experience in accessing low cost labour in neighbouring economies such as China.

Korea's S&T strengths and weaknesses and its current need to adjust suggest it could be a "natural partner" for the EC within the Pacific Basin region.

Limited versions of such complementary collaborations already exist on the part of European firms. For instance, the UK microcomputer maker AMSTRAD manufactures personal computers within Korea for sale mainly within the EC market. Ericsson of Sweden has formed a successful manufacturing joint venture with OPC in telecommunications. Similarly, Hewlett Packard of the US has formed a strategic partnership with Samsung in computing technology.

If IPR and market access problems can be overcome, then in order to access the Pacific Basin market the EC may wish to promote such ventures in the future.

Although other major economies within South East Asia may also desire to collaborate with the EC, few outside Japan boast such well developed manufacturing, product and global marketing capabilities.

- Collaboration could benefit academic research

During the study, an idea for exploration was put forward by a senior representative of the academic sector. He noted that some European universities currently suffer from financial constraints and an ageing population of researchers. In some S&T fields it is difficult for experienced, senior project leaders to recruit young able post-doctoral researchers.

In Korea the situation is reversed in many areas. There are very few world class research laboratories with senior project leaders. Conversely, Korea boasts a large population of young, inexperienced but highly enthusiastic researchers.

A possible model of complementary collaboration would be for groups of Korean researchers to engage in research work within European universities, funded from the Korean side. This would alleviate problems faced by both parties and could facilitate good technology links and personal contacts which could benefit both parties in the long-run.

I.2.4. WHY SHOULD KOREA COLLABORATE ?

Undoubtedly, the EC is a promising source of (a) technology and (b) new markets for Korean firms. At the present time Korea is at the preliminary stages of diversifying its international sources of technology. The EC is seen as a 'first best' option for collaboration outside US and Japan. Indeed, Korea has a pressing need to expand its S&T sources, as the difficulties with Japan and the US demonstrate.

The EC science and research base is viewed as being very strong overall. In some areas (e.g. telecommunications and pharmaceuticals) EC industrial technology is leading edge. EC collaborative programmes have stimulated a great deal of interest from Korea (in electronics, energy and so on). EC programmes such as ESPRIT I and II and RACE have placed Europe on the technological map and made the region very attractive to Korea as a source of S&T.

The EC may have lessons to offer Korea in many areas. These include:

- basic S&T capabilities in many specific fields
- setting up and running basic research laboratories
- project level technology assessment and evaluation methods
- effective policies for small and medium enterprises
- energy use and conservation
- information technology standards (e.g. software and HDTV)
- senior project management experience at the academic level.

However, as noted earlier, in areas such as telecommunications there are major difficulties over access to Korean markets for EC firms. Also, as far as pharmaceuticals are concerned, there is discriminatory treatment in the field of intellectual property protection.

1.2.5. WHY SHOULD THE EC COLLABORATE ?

If the trade, right of establishment and IPR difficulties could be resolved, then there could be attractive benefits for the EC in relation to extending S&T and industrial collaboration with Korea.

Summarising the potential benefits for EC collaboration:

- Korea could provide a "window of opportunity" for the EC in the Pacific Basin, providing EC firms with access to:
  - East Asian markets
  - low cost labour (particularly in neighbouring economies in which Korean firms have investments)
  - low cost components

- Korea boasts very significant manufacturing capabilities which could possibly be transferred to EC firms in exchange for R&D and standards technology

- the EC needs to compete in the Pacific Basin and the US to remain competitive in the 1990s - Korea could be an appropriate collaboration partner

- S&T collaboration at the academic level could benefit European universities, through the infusion of project funds and young researchers

- S&T co-operation at the pre-competitive level (academic, industry and government research laboratory) would serve to improve relations between both groups and set up valuable personal contacts vital for future co-operation.

Some of the above arguments were put forward by Korean interviewees as reasons for the EC to consider wide-ranging S&T co-operation. The potential appears to be substantial and certainly warrants detailed exploration.

I.2.6. DANGERS OF THE "HOLLOW" CORPORATION VERSUS LEARNING FROM COMPETITORS

Forward-looking EC firms such as Thomson of France, believe that learning from competitors is essential to enter new markets such as advanced consumer electronics. In the case of video cassette recorders, for instance, Thomson had no capability in the early 1980s. The company began by distributing Japanese products. It then entered into technology transfer agreements with the Japanese firm JVC.

Following this, Thomsom was able to build up its own in-house production capacity. By 1990 Thomson had become a globally respected supplier of video cassette recorders, with a 50-50 venture with JVC in Berlin and a plant in Singapore. The Singapore plant has the capacity to produce one million sets per annum based on Thomson's proprietary technology.

As the President of Thomson argues, a learning strategy towards South East Asian and other market leaders is vital for firms wishing to catch up in areas such as consumer electronics. Thomson's strategy has relevance to Korean collaboration. Where Korean firms are market leaders (e.g. in some areas of consumer electronics), then collaboration in technology arrangements could benefit European firms.

Thomson's view also has relevance to EC concerns expressed to SRA about the prospect of production shifting outside national and/or firm boundaries (sometimes called the 'hollowing' of the corporation). Thomson believes that a flexible, global strategy is essential for firms wishing to remain at the forefront of consumer electronics, semiconductors and other high technology areas. As Gomez of Thomson puts it:

'We must have an organisation that can install and move the links of the business chain to any part of the world. Ten years ago, that meant moving assembly and production to low-cost areas such as Malaysia and Taiwan. Now it also means moving marketing and R&D to places like Singapore. Years from now, the wisest decision might be to bring production plants back to Europe and move the headquarters wherever the brightest, most hardworking people are.'

(Interview: Harvard Business Review May-June 1990, p135)

In this interpretation of modern industrial "best practice", the location of production outside national boundaries or outside the innovating firm does not reflect a hollowing of the corporation. On the contrary, the firm is constantly adjusting to competitive requirements across the value-added chain through from research to production to marketing. As such, the firm is constantly learning and augmenting its core capabilities which, in turn, is vital for long-term growth, profitability and survival.

The need for firms such as Thomson is therefore to develop the organisational capabilities and flexibility to meet global technology and market requirements, from where it is most appropriate to do so. In this context, Korean firms have demonstrated a formidable capability in several market areas, to the point where Japan has begun to restrict flows of technology. It is conceivable therefore that European firms could benefit from selective engagement in collaborative ventures with Korean companies.

I.2.7. ADDITIONAL BARRIERS TO CO-OPERATION

- Close ties with Japan

In addition to the barriers discussed in section I.2.1, further barriers mitigate against co-operation. Important structural barriers noted by Korean officials included the close, traditional links which Korea enjoys with Japan and the US. Most Koreans are relatively unfamiliar with European culture, business methods, non-English languages and so on.

Despite the current reluctance of Japan to transfer strategic technologies, Japan is still viewed as the primary source of technology.

If the EC attempted to strengthen S&T relations with Korea, EC firms would probably face a stepping up of competition from Japan, especially if EC-Korean relations prove successful. Japan would seek to retain its hegemony over technology transfer to Korea.

The regional proximity of Japan puts Europe at a disadvantage, as do the long standing links between the two countries. In part, these factors explain the relatively weak presence of European firms within Korea.

Also, Japanese individuals and firms are likely to continue to supply Korea with technology through informal sources of technology (e.g. retired Japanese engineers and so-called "moonlighters" from large Japanese firms who fly from Japan to Korea during weekends to provide technical assistance).

- Strong links with the US

Similarly, the US continues with close technology and business ties and benefits from a greater familiarity with Korean technology and business practices. Many leading researchers and managers in Korea have been trained in US universities (and US firms in some cases) and retain close personal connections with the US. Political ties with the US are also strong.

- Perceptions of European technology strengths and weaknesses

In certain technology areas some Koreans view the EC in second or third place behind Japan and the US. In several core electronics fields (for instance, computing, software and semiconductors) the EC tends to be ranked second or third after Japan and the US.

- The "transparency problem"

A final difficulty cited by many senior Korean officials is the "transparency problem". The transparency problem refers to the lack of visibility on the part of Koreans of the EC's rules, procedures and contact points for collaboration. First, there is a low degree of awareness and understanding in Korea of the "EC" entity, as opposed to individual European countries. Second, there is little understanding of the objectives and nature of EC S&T programmes. Koreans are not sure:

(a) if they are allowed to collaborate in EC programmes
(b) in which circumstances it is appropriate to collaborate with the EC, as opposed to individual nation states
(c) which procedures to follow to apply for programme entry
(d) which departments, groups or individuals within the EC to communicate with on issues of collaboration.

- Other difficulties

Other problems mentioned by Korean interviewees included:

- the difficulties of some Korean firms in starting up factories within the EC
- the relatively high cost of European labour
- Korean difficulties in assessing technological capabilities in European universities, government laboratories and firms
- poorly developed bargaining skills on both sides.

I.2.8. MEASURES TO IMPROVE S&T EC-KOREA CO-OPERATION

From an EC perspective, wide-ranging EC-Korean S&T co-operation can only proceed with a resolution, or satisfactory progress towards a resolution of the market access, capital and IPR problems discussed in section I.2.1. Such progress can only be achieved through negotiation between the appropriate EC and Korean agencies and relevant political pressures which may be applied by the EC.

If satisfactory progress towards IPR and other difficulties can be reached, then to enable wide-ranging S&T co-operation additional measures would need to be taken to resolve the "second order", structural, cultural and communication difficulties discussed in section I.2.7.

During the Korean field research, S&T practitioners put forward the following ideas for overcoming the second order difficulties:

- ministerial level agreement or statement of S&T intent
- Korean-EC working parties from industry, academia and government laboratories could be set up to

- identify specific EC-Korean projects for collaboration
- EC-Korean government level supporting mechanisms for collaboration
- dissemination of information on collaboration procedures and
- schemes to assist firms and universities to collaborate.

From the Korean perspective, prior to these actions, decisions would need to be taken by the Commission on: (a) whether Korean firms, government institutes and universities are eligible to participate in EC programmes; (b) whether Korean firms operating within Europe (or within Korea) may engage in EC programmes; (c) which activities should be discharged by the Commission as opposed to EC member states.

I.2.9. THE ROLE OF "NON-THREATENING" PROJECTS

It may be decided by the Commission, that despite EC concerns over market liberalisation and so on, some limited co-operation in "non-threatening" areas of S&T could be to the unequivocal benefit of EC companies and S&T agencies.

For instance, both parties stand to gain from collaboration in environmental, health and energy issues. Co-operation in high definition television (HDTV) standards could also benefit the EC by widening the potential market for the European HDTVs (although the prospects for co-operation appear poor from the Korean perspective, see section I.2.11).

If such collaborations were successful they could build up improved links between the EC and Korea and lead to a stronger presence of EC enterprise in Korea in the future.

I.2.10. KOREAN SUGGESTIONS FOR S&T CO-OPERATION

Korean officials suggested many specific fields for collaboration with the EC during the interview programme:

- energy; nuclear power - nuclear waste management - fuel cycle technology - nuclear safety - alternative energy source (water/ocean)
- energy conservation technology (distributed heating, cold generators)
- offshore oil development - gas combustion technology - natural gas liquification - technology for submerged cables - clean coal technology - new and renewable resources
- biotechnology
- oceanology
- environment, pollution (air and water) e.g. acid rain
- medical research
- housing/construction
- information technology (e.g.semiconductors, software and HDTV)
- policy research for each of the above.

Detailed recommendations on specific areas of collaboration and methods of collaboration need to be built up carefully and take fully into account EC concerns over market access, IPR and other difficulties.

In addition, the views and requirements of EC industry need to be assessed prior to any decisions. Where areas are considered to be of mutual benefit, then S&T co-operation could begin via: exchanges of information, the establishment of EC-Korean communication channels in S&T, exchanges of engineers and scientists and so on.

Assuming some progress towards the resolution of IPR and other difficulties in the future, it may be possible to establish a national scheme within Korea to agree terms and conditions of collaboration with the EC. Within an agreed EC-Korean S&T procedure, collaboration could occur more easily between firms, research laboratories and universities. Such a procedure might also promote mutually beneficial co-operation in the private sector, independent of EC programmes.

I.2.11. DANGERS OF "MISSING THE BOAT": LESSONS FROM THE CASE STUDIES

At the present time the EC is a distant third after Japan and the US in terms of Korean activity in science, technology, industry, trade and investment. Given Korea's current needs and the EC's competences in S&T, there is a major new opportunity for the EC to strengthen its S&T and industrial links with Korea.

However, the current impasse over market access, IPR and other matters threatens to prevent such links from being developed with the support of the Community. In so far as the Community could assist firms and EC S&T agencies in co-operating with Korea, this implies that the S&T "boat" may be missed.

The case study material in Annexes 2, 3 and 4, lend some support to the view that Japan and the US will continue to strengthen their positions in Korea, relative to the EC, despite the tightening up of technology transfer on the part of Japanese companies.

I.2.12. HIGH DEFINITION TELEVISION (HDTV) STANDARDS (ANNEX 4)

Major decisions are currently being taken by Korean companies regarding HDTV. Opportunities could exist for European firms to share standards technology with Korean firms and benefit from Korea's competences in the mass manufacture of TV sets. For example, one or more European firms could form a jointly-owned venture with a major Korean manufacturer - an idea suggested by a Korean Chaebol during the field research.

However, the view in Korea that the EC is not "generous" with its technology or its markets (e.g. Jun and Kim, 1989) may lead to Korea adopting the Japanese or US standard, rather than the EC one. Korean firms have not yet ruled out any particular standard, but most of the running has been made by Japan and the US, rather than the EC.

From the Commission's point of view, the constant emphasis on IPR and market access problems, coupled with the negative perspective by some Koreans over EC "generosity", could work against a possible EC-Korean link up.

I.2.13. TELECOMMUNICATIONS (ANNEX 3)

Apart from Alcatel of France, most EC firms are not major players in the Korean telecommunications market. As Korea attempts to upgrade its telecommunications network, it is likely that some liberalisation of services will take place, particularly in the areas of business communications, value-added networks and mobile communications. Korea may have to purchase leading edge technology and equipment which they cannot produce locally.

Several European firms could potentially supply equipment and technology under joint venture arrangements. Currently, Alcatel is the main EC firm engaged in technology transfer to Korea. US and Japanese firms are keen to increase their activities within Korea (as is Ericsson of Sweden).

IPR and market access problems do not appear to act as barriers to technology transfer to Korea in near-to-market technology activities such as telecommunications. Problems appear to be resolved by the firms engaged in joint ventures with Korean companies.

I.2.14. SEMICONDUCTORS (ANNEX 2)

In semiconductors, as in other areas of electronics, Korea is able to access world class technology, mainly through partnerships with Japanese and US companies. The major 1989 Goldstar-Hitachi venture in one megabit DRAM technology shows that even under the current climate of Japanese suspicion of Korean companies, some Japanese firms believe there are significant commercial advantages to be gained from co-operation with Korea.

In more complex areas, such as application specific integrated circuits (ASICs), Korean firms are managing to access design, materials and capital goods technology from joint ventures with US, Japanese and in some cases, European firms.

I.2.15. GENERAL LESSONS IN ELECTRONICS

Despite Korea's record on market access, IPR and so on, Korean firms appear to be accessing leading edge electronics technology from the Japanese and US market leaders and, in some cases, European firms. The motivation on the part of foreign companies is commercial. Korea is a large and expanding market for technology, components, consultancy services and so on. IPR and other problems appear to be resolved at the firm level, within partnerships.

The weak presence of EC firms within Korea appears to be a result of strong historical and cultural links with Japanese and US firms, rather than IPR and market access problems. If the current impasse over IPR deters commercial ventures between EC and Korean companies, this will add to Japanese and US advantage in Korea.

PART II : DECISION BASE

II.1. - THE ECONOMY

II.2. - THE S&T SYSTEM

II.1. THE ECONOMY

This section provides data on some of the most important features of the Korean economy, beginning with the transformation from an agricultural to an industrial economy, and then focusing on structural changes and challenges facing Korea in the 1980s. Major points of interest include: Korea's economic performance during the 1980s, the 1989 slowdown in growth, trends in outward and inward investment, the activities of the Chaebol, moves towards liberalisation, and sectoral and regional trading patterns.

II.1.1. HISTORY: THE TRANSFORMATION OF THE KOREAN ECONOMY

- Korea's industrial take-off began in the 1960s

Table 1 outlines the evolution of Korea's industrial development, from the early import-substitution of light industries in the 1960s, to the development of heavy industries in the 1970s. During the 1980s the emphasis has moved onto technology-intensive sectors.

The corresponding strategies for S&T are also outlined in Table 1. Here the emphasis shifted from promoting foreign technology imports in the 1960s, to supporting industrial-related research in the 1970s, to building successful national R&D projects in high technology in the 1980s.

- Korea was rapidly transformed from an agricultural to a manufacturing economy

Up until the early 1960s, Korea was essentially an agricultural economy. As Table 2 shows, since the 1960s the share of manufacturing in GDP increased from 13.5% to 31.6%. Conversely, the share of agriculture, forestry and fisheries fell from 38.7% to 10.8%. Social overhead expenditures increased steadily to support Korea's industrialisation.

Government policies were implemented through successive Five Year Plans which began in the early 1960s. During the 1960s, Korean policies supported industries such as cement, oil refining and fertilisers. The government took a leading part in building up basic infrastructures such as roads, railways and electricity.

During the 1970s, policies gave support to export promotion development of labour intensive light industries such as textiles, plywood and footware.

TABLE 1 : Transformation of the Korean economy 1960s to 1990s

Period	Industrialisation	Science & Technology
1960s	Develop import-substituting industry	Strengthen S&T education
	Expand export-oriented light industries	Deepen S&T infrastructure
	Support producer goods industries	Promote foreign technology importation
1970s	Expand heavy and chemical industries	Expand technical training
	Shift emphasis from inward capital flow to technology import	Improve institutional mechanisms for adapting imported technology
	Strengthen export-oriented industry competitiveness	Promote research applicable to industrial needs
1980s	Transform industrial structure to one of comparative advantage	Develop and acquire top-level scientists and engineers
	Expand technology-intensive industry	Perform national R&D projects more efficiently
	Encourage manpower development & improve productivity	Promote industries' technology development
1990s	Adjust industrial structure and improve productivity	Develop basic science, high technology and social welfare technology
	Promote balanced development	Expand science and technology resources and promote efficiency

Source : Ministry of Science and Technology (1990) p15

TABLE 2 : Industrial structure 1960s to 1980s (Unit : % of GDP)

	1961	1971	1981	1988
Economic field				
Agriculture, forestry and fisheries	38.7	27.0	18.0	10.8
Mining and manufacturing	15.4	22.3	30.9	32.4
(manufacturing)	13.5	21.0	29.5	31.6
Social overhead capital	9.1	13.3	16.5	20.4
Other services	36.8	37.3	34.6	36.4

Source : Economic Planning Board, cited in Ministry of Science and Technology (1990) p12

- Like other economies, Korea has faced economic difficulties

It would be wrong to suggest that Korea made an effortless transition from lower to higher "stages of production". For instance, in 1979 and 1980 the economy faced major difficulties with the increase in oil prices and the worldwide recession. In 1980, these problems, coupled with an extremely poor rice harvest, forced the economy into a year of negative growth. A slow recovery began in 1981, but until 1984 the economy still suffered from the recession.

Inflation also bedevilled the economy from time to time. In 1981 the inflation rate reached 21.3% (Ministry of Science and Technology, 1990, p9). The rate fell back to 7.3% in 1982 and continued to fall to around 2-3% until 1985. In late 1987 inflation reached more than 8% (see Table 3). Some estimates put the current rate of inflation at around 12% per annum (e.g. Financial Times, May 16, 1990, piii).

- The 1980s witnessed a major shift from light to heavy industry

Since the mid 1970s and into the 1980s, a series of large scale investment projects were undertaken in the steel, shipbuilding, petrochemical and machinery industries. These resulted in a declining share of light industry in GDP and an increase in areas such as machinery, primary metals and chemicals.

TABLE 3 : Origins of GDP (1982 and 1988) - % of total at market prices

	1982	1988
Agriculture, forestry, fishing	14.6	10.8
Mining and quarrying	1.5	0.7
Manufacturing	28.3	31.6
Electricity, gas, water	2.2	2.8
Construction	8.0	8.1
Trade, restaurants, hotels	13.1	12.3
Transport, storage, communications	8.7	7.3
Financial, business services	8.4	13.2
Government services	8.0	7.9
GDP at factor, cost, including others	100.0	100.0

Source : Elaboration of data in EIU (1989) and EIU (1990)

Table 3 compares the main components of GDP for 1982 and 1988. It emphasises the increasing importance of manufacturing as well as financial and business services, the latter having overtaken agriculture as a source of GDP.

II.1.2. ECONOMIC PERFORMANCE IN THE 1980s

- Since 1985 growth has been extremely rapid

Korea is nearing the end of its third decade of sustained economic growth. In the very recent period, rates of growth, exports and income per capita have exceeded those of almost all other countries. During the period 1986 to 1988, economic growth averaged around 12.6% per year. Export volumes grew at an astonishing 16.5% per annum.

Measured in terms of GNP per capita, income nearly doubled from US $2,194 in 1986 to $4,040 in 1988, raising Korea from low to middle income status in the world economy. After 1985 the current account deficit was transformed into a sustained and heavy surplus.

- Growth was facilitated by the "three lows"

Growth during the 1980s was the result of Korea's ability to exploit a favourable economic environment. Three frequently cited factors in Korea's 1980s' growth are: the low value of the currency; the low level of international oil prices; and low interest rates.

However, under similar conditions most other economies failed to achieve growth rates approaching those of Korea. Much of the Korean success in GNP growth and exports was based on the aggressive risk-taking strategies of the large conglomerates which dominate the economy, coupled with the low wage rates paid to workers.

TABLE 4 : Macroeconomic indicators 1985 to 1990

	1985	1986	1987	1988	1989	1990*
GDP current Won'000bn	80.8	93.4	108.0	125.3	138.1	147.1
Real GDP growth %	6.9	12.4	11.8	11.3	5.5	6.5**
Consumer price infl. %	2.5	2.3	3.0	7.1	5.2	6.8
Exports FOB $bn	30.3	34.7	47.3	60.7	62.3	64.0
Imports CIF $bn	31.1	31.6	41.0	51.8	61.3	63.2
Current account bal $bn	-0.9	4.7	9.9	14.2	5.1	1.0
Reserves excl gold $bn	7.7	8.0	9.2	20.8	22.5	-
Total extrnl debt $bn	46.7	44.5	35.5	31.1	29.4	-
Exch. rate (av) W/$	868.5	881.5	822.6	731.5	671.5	-

(March 1 1990 exchange rate : Won 697 per US Dollar)
* based on projection made in mid January 1990
** refers to GNP not GDP (GNP calculation is slightly higher than GDP)
Sources : EIU (1990)
Financial Times, May 16, 1990

II.1.3. THE SLOW DOWN IN KOREAN GROWTH

- Growth slowed dramatically in 1989

As Table 4 shows, growth slowed down dramatically in 1989. GNP grew at less than half the rate of the previous three years. Estimates for 1990 show a similar performance to 1989. The rapid growth of exports of 36% (1986 to 1987) and 28% (1987 to 1988) fell to just 3% (1988 to 1989). Export growth is projected to stay at roughly 3% in 1990 (measured in dollar value). In volume terms exports actually fell by 7% in 1989, compared with a growth of 15% in 1988.

The slow down in export growth forced the current account surplus down from $14.2bn in 1988 to $5.1bn in 1989 (a fall from 11% of GNP to 3.6% of GNP).

- Reasons for slow growth include the appreciation of the Won

The steady appreciation of the Won against the US dollar and the Yen has reduced the competitiveness of Korean export goods. As the Won appreciated against the Yen, competition from Japan intensified. (Korean firms now compete with Japanese firms in more than 50% of their product exports). The aggregate competitive loss against Japan in the past two years amounted to 36% (through the exchange rate) and a further 20% or more through wage costs (Financial Times, May 16, 1990, pvii).

- As well as industrial disputes

TABLE 5 : Incidence of labour disputes

	Number of strikes	Average duration
1987	3749	5.4 days
1988	1873	13.0 days
1989	1616	18.00 days

Source : Ministry of Labour (cited in Financial Times, May 16, 1990)

Widespread labour unrest produced significant disruptions in industrial output in 1988 and 1989. Hyundai union leaders (among others) were imprisoned during the strikes. Riot police clashed with workers in several industries, ranging from the shipbuilding industry to the state-run broadcasting network.

The Korean Labour Institute calculates that production valued at Won 7,409bn (roughly $10.6bn) was lost due to strikes in 1988 and 1989. The Ministry of Labour cites labour disputes as both a cause of inflation and a reason for the loss in export competitiveness. The Ministry of Labour claims that labour disputes led to wage increases of 20% in 1989 and a loss of seven million working days, amounting to an economic cost of $6.5bn (nearly 4% of GNP). (Financial Times, May 16, 1990).

- And inflation

Inflation has returned to Korea as a serious economic problem. In 1990 inflation was forecast to reach double figures - its highest level since 1981 (Financial Times, July 17, 1990, p4).

Since 1987, unit labour costs (taking into account productivity gains, currency changes and wage increases) in Korea increased by 43% between mid-1988 and mid-1989 - more rapidly than in any other Asian economy.

From 1986 to 1989 unit labour costs in dollar terms rose by 100%, ending Korea's low-cost wage status (Financial Times, November 27, 1989, pi).

The causes of inflation appear to be: (a) wage increases of more than 20% per annum since late 1987; (b) recent land speculation (e.g. land prices rose by 33% in 1989); and (c) property rents and property prices (both increased by 15% in 1989).

- Key export sectors have suffered, but increased domestic demand has compensated

Wage inflation, labour unrest and the appreciating Won have led to a declining performance of several key export sectors such as automobiles, steel, textiles and electronics in 1989 and 1990.

Motor vehicles exports fell by 40% in 1989 from 576,000 to 347,000 (a fall of 200,000 for Hyundai alone) due to exchange rate adjustments, labour costs and strikes (EIU, 1990, p23). Strong growth in the domestic market compensated for the export losses (a 45.8% growth in 1989 to 763,308 vehicles). In 1990, Korean car producers expected to sell two thirds of their output on the domestic market (exports were around 60% of production in 1989).

In electronics, 1989 production increased by 10% over 1988, but exports increased by only 6.1% (compared with 40% in 1988). To compensate for this, domestic sales of consumer electronics increased by 25% in 1989, while industrial electronics sold in the domestic market rose by 42% in 1989.

Increased domestic consumption, itself partly the result of wage increases over the past two years, softened the impact of falling export growth. Without the strong expansion of domestic consumption overall industrial output would have suffered far more severely.

- Competition from low wage economies has also affected exports

Labour-intensive industries such as apparel and textiles are suffering from a long-term structural decline, as lower cost developing countries undercut Korean exports. In textiles (the economy's largest employer and one of its largest export items), Korean exports rose by 9.2% to $15.4m in 1989, roughly half of the increase of the previous year.

In the steel industry it is expected that imports will soon exceed exports, as the stronger Won has led consumers to look towards lower cost foreign products.

- But some sectors are sustaining a good performance

Some sectors are continuing to improve their export position. These include shipbuilding, footware and auto parts - the latter due to strong exports of cars during the period 1987

and 1988. Orders for more complex ships have kept order books healthy, especially in the early part of 1990 (EIU, 1990, p24).

II.1.4. THE KOREAN "CRISIS" IN CONTEXT

It should be pointed out that Korea's 1989 growth (greater than 6%) is much higher than that achieved by most other economies, developed or developing. The so-called Korean "crisis", frequently reported in the Korean media, exists only in relation to Korea's strong economic performance of the post-1985 period. Compared with most other economies, Korea remains healthy and the outlook for continued development is good.

As a report from the International Monetary Fund puts it: "The present difficulties should not be allowed to overshadow the impressive expansion, unequalled elsewhere in the world, that has been achieved by Korea's dynamic economy since 1985. As a result of its accomplishments the Korean economy is in a strong position to face the challenges that lie ahead" (cited in Financial Times, November 27, 1989, pi).

Indeed, very recent reports from the Korean Development Institute have revised growth figures for 1990 almost back to levels of the boom years of 1987 and 1988. The consensus for 1990 growth was between 8% and 9% in July 1990. Wage demands were forecast to slow to 10% or so in 1990, compared with 20% in 1989, while the number of industrial disputes also fell significantly in the first quarter of 1990. In 1990, demand continued to shift to the domestic economy, with construction and consumer goods consumption leading the growth.

Although Korea's economic difficulties may not be intractable, as discussed below, Korea needs to make significant structural adjustments both in economic matters and in science and technology, to meet the new economic circumstances of the economy. Among the most pressing problems are the long-term appreciation of the Won, higher wage rates, increasing interest rates, and the need to upgrade the quality and technology of Korean manufactured goods.

II.1.5. FOREIGN (INWARD) INVESTMENT TRENDS

Table 6 presents foreign investment trends by major country for the periods 1962 to 1989 and 1987 to 1989. The table demonstrates a large acceleration in the rate of direct foreign investment in the three year period 1987 to 1989. Around 46% of total accumulated investment in Korea occurred during these three years.

Table 6 also illustrates the dominance of Japanese inward investment throughout Korea's industrialisation period. After Japan, the US is the next major investor. European countries come a very distant third, with West Germany and the UK slightly increasing their share of total investments in the last three years.

TABLE 6 - Foreign investment trends by country. On approval basis, $'OOOs

	1987		1988		1989*	
	projs	value	projs	value	projs	value
US	93	255,140	104	284,401	72	262,843
Japan	207	493,899	177	696,244	99	383,035
West Germany	10	41,493	15	74,040	17	36,574
UK	6	48,329	8	21,781	7	39,191

	Totals 1962-1989			Totals 1987-1989		
	projs	value	%**	projs	value	%
US	692	1,874,946	32.9	269	802,384	30.4
Japan	1,876	3,425,295	60.2	483	1573,178	59.7
West Germany	93	215,855	3.8	42	152,107	5.8
UK	45	174,650	3.1	21	109,301	4.1
Totals	5,690,746	100.0	2,636,970	100.0		

* January to September

** percentage of cited countries by value

Source : Elaborated from Ministry of Finance data (cited in Financial Times, November 27, 1989 piv)

As Tables 7 shows, inward investment in manufacturing has outstripped that of all other sectors. Investment during the period 1987 to 1989 amounts to nearly 50% of total foreign investment over the last three decades. During the last three years, foreign investment in manufacturing has continued to proceed more rapidly than other sectors, with services, hotels, electronics and chemicals following in second, third, fourth and fifth place by value.

Major European companies that have invested in Korea include: Philips, Valeo, LM Ericsson, ICI, Alcatel, Volvo and Saab. Large European companies are increasingly looking to Korea as a valuable market in its own right. Also, Korea is sometimes viewed as a base for exporting to other Pacific Basin economies.

The growth of the domestic automotive industry is an example of Korean success attracting foreign investment. For instance, Valeo, a major European producer of automotive components, formed a joint venture with the Korean clutch maker Pyeong Hwa in order to supply Hyundai, Dywoo and Kia. This occurred as a result of current and future Korean automotive industry prospects.

In 1989 the automotive sector attracted a large number of foreign investors. They began supplying the conglomerates with high technology designs, parts and components. To some extent, Korean firms encouraged European and US investment to reduce their technological dependence upon Japan. Hyundai, for example, encouraged its Korean suppliers to form joint ventures with US and European firms to reduce its dependence on Mitsubishi of Japan for vital inputs.

TABLE 7 : Foreign investment trends by sector. On approval basis, $ '000

	1987		1988		1989*		%*.
	projs	value	projs	value	projs	value	
Agri-fish	1	2,747	1	9,847	1	2,158	0.03
Mftng	323	779,345	273	738,174	143	568,198	35.65
Chemicals	45	153,401	44	237,471	22	145,408	9.63
Machinery	48	87,645	62	64,972	29	70,082	3.81
Electronics	80	212,157	55	269,884	29	90,637	9.79
Transport eqpt	31	119,532	12	43,138	11	142,890	5.22
Services	35	277,158	65	533,065	94	293,560	18.87
Hotels	8	248,877	5	418,902	2	96,669	13.07
Financial	1	16,080	7	89,767	3	111,006	3.71

Totals 1962-1989				Totals 1987-1989		
	projs	value	%**	projs	value	%*.
Agri-fish	80	35,165	0.03	3	14,752	0.03
Mftng	2,450	4,406,413	36.59	739	2,085,717	35.65
Chemicals	308	991,146	8.23	111	563,280	9.63
Machinery	407	396,182	3.29	139	222,699	3.81
Electronics	547	1,099,862	9.13	164	572,678	9.79
Transport eqpt	113	643,299	5.34	54	305,560	5.22
Services	419	2,385,956	19.81	194	1,103,783	18.87
Hotels	76	1,696,191	14.09	15	764,448	13.07
Financial	33	387,692	3.22	11	216,953	3.71
Totals		12,041,906			5,849,770	

. 1989 figures for January to September

** percentage of products cited by value

Source : Elaborated from Ministry of Finance data (cited in Financial Times, November 27, 1989 piv)

II.1.6. OUTWARD INVESTMENT BY KOREAN CONGLOMERATES

- Outward investment has accelerated rapidly since 1985

Outward investment rose from an accumulated level of only $476m in 1985 to $1.1bn in 1988. In February 1990, cumulative outward investment stood at over $2bn. According to the Bank of Korea, South Korean foreign investment rose by 93% in 1989. In this year the BOK approved 369 projects, together worth $927m.

Most of the recent investments are small in terms of initial spend with some notable exceptions, such as Hyundai's automotive plant investment in Canada. The size of investments is expected to grow as companies move on from pilot plants to full scale production and local upstream and downstream investments.

Only very recently have the Chaebol begun to formulate cogent international investment strategies. Among the Chaebol, Samsung probably boasts the most advanced foreign

investment programme. Samsung plans to increase its overseas electronics production from 5% in 1989 to 25%-30% by 1992. The Financial Times quotes a senior Samsung official: "First you start exporting then you establish sales companies, then a production base and then a global marketing system. Four stages. We are in between the second and third stage" (November 27, 1989, pvi).

Restrictions on outward investment were lifted as Korea's trade balance and foreign exchange reserves strengthened in the post-1985 period. Prior to this, most outward investment was limited to securing raw materials and establishing sales offices.

Rapid wage rises have also encouraged the Chaebol to relocate overseas. To circumvent relatively high local wage costs, labour-intensive industries have begun to relocate abroad, especially in low-wage South Asian countries.

Firms wish to locate production facilities closer to final markets in the US and Europe. This is seen as a mechanism of overcoming trade friction and a way of meeting technical demands of these regions.

- The EC accounts for a very low share of outward investment

North America accounts for 43% of Korea's accumulated outward investment since 1968 (Financial Times, May 16, 1990 pvi). In the last two or three years, South East Asia (notably Indionesia, Malaysia and Thailand) has attracted investment because of low wage costs and growing market opportunities. To date, the EC only accounts for 4% of the accumulated total.

Korean firms are aware of the importance of the European Community market. Each have investment strategies toward the EC. Table 8 provides details of electronics investments in the EC and neighbouring countries for 1989.

Not all firms have begun investing in the EC or neighbouring countries. Hyundai, for instance, has decided not to expand within Europe ahead of 1992. Instead, Hyundai intends to form partnerships with European firms to market products globally.

- Most firms now have operations abroad

The Chaebol have invested in subsidiaries across the world. Goldstar, for instance, has operations throughout East Asia and North America, including joint ventures and wholly owned plants in the US, Mexico, West Germany, the UK, Italy, Egypt, Thailand, the Philippines and Indonesia. Samsung Electronics has ten plants abroad and has recently opened up a telecommunications and TV factory in Hungary (Financial Times, May 16, 1990, pvi and pvii). In 1987 Samsung opted for a major UK production base within Europe to produce video recorders and microwave ovens (TV manufacture is concentrated in Portugal). In 1988, Hyundai Motors opened up a C$400m car assembly plant in Canada.

Within Europe, Goldstar's main consumer electronics facilities are located in West Germany. However, the firm has stated that it is attracted to the UK because of relatively low unit labour costs, availability of skilled workers, and regional support for investment. Goldstar established a £14m site in the north of England to produce microwave ovens.

TABLE 8 : Korean foreign direct investment in electronics in the EC and neighbouring countries, 1989

Firm	Country	Year of establishment	Ownership	Main products
Goldstar	West Germany	1986	100 %	CTV, VTR
	England	1989	100 %	MWO
	Turkey	1987	25 %	MWO
Samsung	Portugal	1982	55 %	CTV
Electronics	England	1987	100 %	VTR, MWO
	Spain	1989	90 %	VTR
	Hungary	1990	40 %	CTV
	England	1989	-	CTV
Daewoo	France	1988	51 %	MWO
Electronics	Hungary	1989	51 %	MWO
	England	1989	100 %	VTR
Philco	Greece	1987	40 %	PCB
Saehan Media	Northern Ireland	1987	100 %	Video tape

Source : company data, cited in Jun and Kim (1990) p65

II.1.7. INDUSTRIAL CONCENTRATION: THE CHAEBOL

- The Chaebol are the main instruments of Korea's industrialisation

The Chaebol are large, multi-industry conglomerates. They have continued to dominate the Korean economy throughout its development. The most recent data available (1988) show that the top 30 Chaebol were equivalent to 94% of GNP. Although double counting of sales between and within business groups distorts this percentage upwards, it is clear that a large proportion of Korea's industrial output is concentrated in the Chaebol. Within the economy as a whole, the leading 30 firms employ around 18% of Korea's total workforce and account for 37% of total sales.

The Chaebol have been the main instruments of Korea's economic growth. They have enjoyed substantial government subsidies, preferential treatment and various forms of support. Much of their diversification has been through government directed loans.

As Table 9 shows, the Chaebol are highly diversified, extremely large firms. Rather than divest or specialise, the groups are intending to further diversify their activities (e.g. Samsung intends to enter the car industry; two other groups are set to enter

petrochemicals). This makes modern management techniques, technology deepening and specialisation difficult to achieve. However, as discussed in Part I.1.4, the leading firms are attempting to modernise their approach and decentralise their decision making.

TABLE 9 : Leading Chaebol and their Major Activities, 1988 (Won Billions)

	Sales	Net profit	Main activities
Samsung	21,248	293.5	Electronics, aerospace, textiles, food, insurance, advertising
Hyundai	19,030	236.0	Construction, automobiles, shipbuilding, electronics, heavy machinery, insurance
Goldstar	15,602	204.8	Electronics, semiconductors, oil and petrochemicals, trading, insurance, advertising
Daewoo	10,401	115.8	Electronics, machinery, autos, shipbuilding, aerospace, financial services
Sunkyong	6,388	102.0	Oil refining, petrochemicals
Sangyong	4,316	135.0	Cement, autos, machinery, trading, financial services

Source : Bank of Korea, cited in Financial Times, May 16, 1990 pvii

- Recently the Chaebol have come in for criticism

The Chaebol are often accused of failing to make adequate long term investments in R&D, modern production facilities and product developments, especially during the post-1985 boom years. In the car industry, for instance, Korean producers spent around 3% of sales on R&D, whereas their Japanese competitors (already boasting leading-edge technology) spent more than 5% of turnover on R&D.

As Part II.2 shows, corporate R&D investments in Korea are fairly low by international standards, but increasing. Overall, the ratio of R&D investment to GNP rose to 1.9% in 1987 from 0.9% in 1982. The government target for 1991 is 3%, but this may not be achieved (Financial Times, May 16, 1990 pvii).

Low investments in R&D may, in part, be due to high debt ratios (often in excess of 300%). However, many argue that the Chaebol concentrated on short-term profit making, rather than long-term technology investments during the growth years. Instead of restructuring for the future, it is argued that they were more concerned with, for example, profiteering through land speculation (e.g. Financial Times, May 16 1990, pvii).

The unpopularity of the Chaebol in the period 1988 to 1989 led the government to restrict credit limits and cross holdings of equity between the group affiliates. In 1990 the slowdown in growth strengthened the Chaebol's position and resulted in the removal of some of the restrictions placed upon them.

In the main, the conglomerates are still run by their founder families. They are often politically well connected, sometimes cautious and traditional in their management

approach. Transition to second generation management has been made to some extent by some firms (e.g. Samsung, Goldstar and Sangyong). In others, old traditions continue.

- Hyundai, for example, has been slow to change

Hyundai is probably the least committed to fundamental changes of direction and management style. Hyundai, the second largest Chaebol, is still largely directed by the 75 year old founder of the company. Despite the company's size (a turnover of $18bn in 1988, boasting 175,000 employees and 25 subsidiaries) the Chairman's management style is autocratic and individualistic. Hyundai's management take a confrontational approach to industrial relations.

Hyundai, unlike Samsung and Goldstar, plans no fundamental change in direction; but like the other Chaebol, Hyundai is committed to improved quality, higher value-added, more strategic partnerships and heavier investments in R&D. However, there are no plans to narrow down on core businesses. Hyundai intends to remain in traditional areas such as shipbuilding, automobiles, and plant and machinery. The company intends to continue to diversify into new areas such as industrial electronics, mechatronics, semiconductors and consumer electronics.

- Leading firms are making huge efforts to adjust

The need for change among the leading firms has led to efforts to improve product design capabilities, reduce dependence on OEM sales, and to adopt modern business management techniques. Firms such as Samsung and Goldstar have stepped up investments in R&D in order to shift into higher value-added production and to reduce dependence on Japanese suppliers of technology.

II.1.8. PROGRESS TOWARDS ECONOMIC LIBERALISATION

- Tariffs and import restrictions

In 1989 nearly all industrial products were officially exempt from import restrictions, although a wide range of non-tariff barriers remain. On the other hand, there were heavy import barriers on agricultural goods. Generally, tariffs remain higher than those in the OECD economies. However, levels of import tariffs have fallen from 24% in 1983 to 18% in 1988 and 11% in 1989. In 1993 tariffs will be reduced to 8%, a level similar to those of most developed economies (Financial Times, May 16, 1990 piii).

In October 1989 Korea reached an agreement in the GATT to eliminate, by 1997, existing quantitative restrictions on balance of payments grounds. These restrictions concerned mainly agricultural products. However, import bans or strict import vetinary and phytosanitary regulation apply to numerous agricultural products which may otherwise by considered "liberalised". In other cases, progressive market liberalisation may be nullified or heavily impaired by market regulation arrangements, including heavy subsidisation of local farm products (Communication from DGI, 21 November 90, Number 132383).

- Falling exports have led to pressures for a return to protectionism

The fall-off in export growth in 1989 led to arguments within Korea that liberalisation of import markets would lead to severe balance of payments difficulties. A new cabinet

(installed in March 1990) introduced some export promotion measures in an effort to revive exports, reminiscent of the export promotion policies of the 1970s.

Government officials denied that the economy would return to the 1970s' policies of import restrictions, closed markets and export subsidies. The US has partially succeeded in persuading Korea to open its markets to competition and to revalue the Won against the dollar. Given the dependence of Korea on the US market for its exports (around 28.9% of the total in 1989), Korea is more likely to take US interests into account when adopting liberalisation measures.

- Foreign investment

As of 1989, 79% of the sectors in Korea's standard industrial classification were open to foreign equity investment, and about 61% of the service areas were open to foreign investment. Foreign investments may be subject to "performance requirements" in a national treatment basis, and to local equity participation requirements. Land acquisition and exploitation of land and other resources remain restricted.

Foreign exchange and Won funding restrictions severely limit financing projects by foreign companies and are additional barriers to foreign investment.

- Financial markets

A liberalisation plan was announced in 1988. According to this plan the financial markets would be progressively opened to foreign competition but only after 1992 would direct foreign investment in the stock market be possible. However, previous promises (e.g. the commitment in 1981 to open stock markets by 1987) were not fulfilled and semi-official reports are now pointing out that the opening of Korean capital markets under Uruguay Round initiatives could constitute a serious threat for the survival of the sector (Communication from DGI, 21 november 90, Number 132383).

There are three main elements in the de-regulation of Korean financial markets (see Financial Times, May 16, 1990 pii for details):

(1) Exchange rates - prior to 1989, the authorities were frequently accused of maintaining the Won at artificially low levels. Banks are now permitted to set their own rates within certain bands. However, the government still strongly influences the exchange rate through the "middle market exchange rate system" introduced in March 1990. This mechanism enables the Bank of Korea to exercise power over the day to day exchange rate.

(2) Financial markets - the Korean stock market (now the tenth largest in the world) was capitalised at roughly $140bn in 1989 (it was expected to exceed $200bn by 1992, the date set for liberalisation). Although foreign investors were prohibited from investing directly in the Korean stock market, in 1990 a number of investment trusts for foreign investors were introduced. Korean firms were also allowed to issue convertible bonds overseas, with the implication that foreigners will eventually become direct holders of equities. In 1990 the government, for the first time, allowed shares of a major Korean company (Samsung) to be held by foreign investors. Most observers see these moves as the beginning of a controlled and gradual liberalisation of the stock market. It is likely, however, that restrictions on foreigners will remain for some time, especially on bond and money markets.

(3) Banking practices (including interest rate controls). Some de-regulation of banking began in 1988 when ceilings on some lending and deposit rates were lifted. However, further liberalisation, especially on deposits, would be needed to allow interest rate competition between banks.

II.1.9. TRADE TRENDS: EXPORTS AND IMPORTS

As Table 10 shows, Korea is heavily dependent on the US and Japan for both exports and imports. The EC region as a whole is also important for Korean exports (13.8% of the total) and imports (11%) of the total. West Germany is the largest importer of Korean goods within the EC, accounting for 3.9% of the total in 1988 (EIU, 1990). The UK is the second largest EC importer, accounting for 3.2% of total Korean exports in 1988.

TABLE 10 : Shares of trade by region 1988

	Exports	Imports
North America	38.1 %	26.9 %
Japan	19.8 %	30.7 %
EC	13.8 %	11.0 %
Hong Kong and Singapore	8.1 %	2.2 %
Rest of world	20.2 %	29.2 %

Source : Financial Times, May 16, 1989, piv

Turning to sectoral trends, clothing and apparel continue to be important items, but they no longer dominate exports (see Table 11). However, electronics-related goods (as defined in Table 11) constituted 20.8% of total Korean exports in 1988, larger than any other closely related group of products.

Table 11 illustrates the dynamism of Korea in the electronics industries. Samsung and Goldstar are planning to enter the world camcorder market, which may add significantly to the electronics export figures ($300m for Samsung alone). Samsung is now using its own brand name in an attempt to register the firm as a leading supplier of quality goods. Other major export items include passenger cars, footware, textiles, iron and steel.

Data in Table 12 show that the Korean economy remains highly dependent on imports of raw materials, chemicals and petroleum. Despite advances in electronics and related industries, Korea is a major importer of electronic components.

TABLE 11 : Selected major export items ($m), 1988

		% of total
Apparel and clothing	8,695	14.3
Passenger cars	3,336	5.5
Footware	3,801	6.3
Textile fabrics	2,766	4.6
Iron and steel	3,049	5.0
Electronics related of which :	12,644	20.8
Transistors, chips etc	3,856	6.4
Office machines	2,574	4.2
Telecomms equipments	1,598	2.6
TV receivers	1,421	2.3
Gramaphones, speakers etc	1,766	2.9
Radios	1,429	2.4
Toys	1,023	1.7
Ships and floating structures	1,760	2.9
Total including others	60,696	100.0

Source : Elaborated from EIU (1990)

TABLE 12 : Selected major imports items, 1988 ($m)

		% of total
Raw materials	7,742	14.9
Chemicals	6,283	12.1
Petroleum and products	3,837	7.4
Electronic components etc.	3,591	6.9
Iron and steel	2,082	4.0
Aircraft	1,445	2.8
Scientific instruments etc.	1,367	2.6
Telecomms equipment	1,065	2.1
Total incl. others	51,811	

Source : EIU (1990)

II.1.10. THE KOREAN ECONOMY IN THE INTERNATIONAL CONTEXT

To complete this section, it is interesting to view the Korean economy within the world context. Table 13 presents comparative technological indicators for Korea, the US, Japan and Taiwan. The Korean economy is small compared with the major economies of the world. Korea is less than 6% of the size of the Japanese economy and less than 4% of the US economy in terms of GNP.

Korean per capita GNP is $4,000 per year, compared with $23,300 for Japan and $18,500 for the US. Despite Korea's economic success, per capita incomes remain very low by OECD standards. Indeed, Korea's per capita GNP is below that of it nearest rival, Taiwan. Overall, Korean GNP is higher than Taiwan's because of a larger population.

TABLE 13 : Comparative economic indicators, 1988

	Korea	Taiwan	Japan	US
GNP ($bn) (current prices)	169.2	119.7	2859.7	4863.1
Per capita income ($'000) (current prices)	4.0	6.0	23.3	18.5
Real GNP growth 1979-88 (%)	7.0	8.1	4.0	2.5
Average annual inflation 1978-88 (consumer price index, %)	9.3	5.0	2.6	6.1
Unemployment rate (%)	2.5	1.7	2.5	6.2
Domestic savings rate (%)	37.7	36.3	33.7	13.8
Population (m)	42.0	19.9	122.3	243.8
Average annual growth of population 1979-88 (%)	1.3	1.6	0.7	1.0

Source : Korea Economic Planning Board (cited in Financial Times, November 27 1989 pii)

II.2. THE S&T SYSTEM

- Introduction

This section analyses the S&T structures and spending in Korea. It is divided into three parts:

II.2.1: S&T planning and institutions
II.2.2: R&D spending patterns and comparisons
II.2.3: International co-operation and future plans.

The analysis covers the Korean Government Funded Institutes, Taedok Science Town, industrial R&D laboratories and the status of university S&T. Korea's spending on R&D is compared with that of other countries, as is government support for R&D. The opening up of Korea to international S&T co-operation is reviewed. Barriers to collaboration from the perspectives of Korea and the EC are also highlighted.

For follow up purposes, Annex 1 lists a selection of major Korean S&T related ministries, institutions and their functions.

II.2.1. S&T PLANNING AND INSTITUTIONS

II.2.1.1. The planning mechanism for science and technology

- Early objectives for S&T

The early development pattern chosen by South Korea centred on the acquisition and absorption of technology. Shortages of skilled manpower and an inadequate research infrastructure hindered early development and limited the technological options open to companies.

Joint ventures and OEM agreements were the main source of technology transfer during the 1970s and 1980s. Licensing agreements increased in importance as Korea improved its ability to absorb novel technologies.

- The nature of the planning system

On the face of it, the planning of S&T policy is fairly centralised and well co-ordinated in Korea. Long-term S&T policy, strategies and annual plans are drawn up by the Ministry of Science and Technology (MOST) with extensive participation from other ministries such as the Ministry of Trade and Industry (MTI), the Economic Planning Board (EPB) and the Ministry of Communications (MOC).

Park (1988) cites three important characteristics of the planning system in Korea:

(a) a high level commitment and frequent involvement of the President and ministers in the S&T planning process

(b) the informal mode of continuous consultation between individual ministries, industrial associations, industrialists, the government funded research institutes (GFIs) and universities

(c) targetting of policies on well-defined, key areas of medium- to long-term importance, enabling the concentration of scarce investment and technological resources.

Kim (1990), by contrast, argues that the institutional system has not been a runaway success: "Korea has never had a strong ministry like MITI [of Japan] for co-ordinating national systems for promoting industrial R&D" (p5). Kim stresses the conflict between ministries concerned with S&T and the difficulties of co-ordinating R&D in Korea.

- Conflict between MOST and other ministries affects S&T policy

MOST, established in 1967, was set up to formulate long-term policies on R&D and co-ordinate the various R&D activities of the other ministries. However, MOST's formal role of high-level planning and co-ordination tended to be ignored by other more powerful ministries during the 1960s and 1970s.

Several important ministries are involved in S&T decision making (see Annex 1). The ministries tend to work within a "pecking order" in terms of power, resources and regulatory power.

Although MOST has had formal responsibility for S&T policy and planning, other more powerful ministries (e.g. Trade and Industry, Economic Planning, Communications and Energy) have had a significant say in the direction of Korea's S&T.

- Other factors influence S&T policy

Since the take-over of civilian government in 1987 and moves towards political democratisation, MOST has attempted to push its territorial claim over Korean S&T. However, these moves have coincided with other important factors which will shape the future direction of Korean S&T policy. These factors include:

(a) international political pressures over trade and IPR, to force Korea to re-examine its intervention with respect to near-to-market activities (this could include technology support)

(b) a government shift from direction and support of commercial activities towards more indirect contribution through: pre-competitive basic and applied research; the upgrading of research institutions and personnel; and improved co-ordination across ministries. MTI, for instance, intends to increase its technology support to industry

(c) the initiation of several high technology development plans by various ministries, including EPB, MTI and MOST, to take Korea into the 1990s (see 2.14 below).

II.2.1.2. Government funded R&D institutes (GFIs)

- GFIs have substituted for university R&D

Government funded R&D institutes have played a vital role in Korea's high technology development (probably unique among developing countries). In contrast to other industrialising economies, Korean S&T investments have occurred outside the university system in large institutes dedicated to support the industrial development of the economy.

Architects of the GFI system in Korea argue that they needed to set up the GFIs to circumvent the university establishment. They argue that universities in Korea saw themselves as "time honoured institutions" with little regard for industry or commerce.

GFIs took a lead role in Korea's technology development in the late 1960s and throughout the 1970s and 1980s. Indeed, they have received over 90% of research funding awarded by the government.

During the 1980s there have been impressive cases of GFI-industry collaboration, leading to high technology market entry. Among the most well known are the semiconductor DRAM project and the TDX telecommunications exchange project, both sponsored by the MOST under the Electronic and Telecommunications Research Institute.

- The GFI model began with KIST

The GFI system began with the establishment of the Korea Institute of Science and Technology (KIST) in 1966. KIST was set up as a multi-disciplinary research institute. It had several ambitious goals: to absorb foreign technologies into Korea; to assist with their commercialisation; to create a climate for R&D activity in industry; and to modify and adapt advanced technologies.

Following KIST's establishment and the diversification of Korea's industrial base, further specialist GFIs were created. During the 1970s, roughly ten institutes were established in fields such as machinery, electronics and telecommunications. Several of the GFIs are closely linked to related ministries. These include the Ministry of Communications and the Ministry of Energy and Resources. The Ministry of S&T provides supports to several of the GFIs.

Various re-organisations and funding changes have occurred within the GFI system (see Kim, 1989). For example, the Korea Institute of Electronics Technology was merged with the Korea Electrotechnology and Telecommunications Research Institute to form ETRI. The early development of telecommunications was funded by MOST. Later this responsibility was taken over by the Ministry of Communications.

TABLE 14 : Technology development targets of selected GFIs for the 1990s

Institutes	Principal coverage	R&D target
Korean Institute of Science and Technology (KIST)	new material	- new material needed for next generation of hi-tech industry
	environment	- elimination of pollution-generating factors
	mechatronics	- CIM technology and intelligent robots
	housing	- mass production of housing
System Engineering Research Institute (SERI)	software	- supercomputers, systems software - artifical intelligence - automated software development
Genetic Engineering Research Centre (GERC)	biotechnology medicine	- basic bio-tech for agriculture, environment, health, medicine
Korea Atomic Energy Research Institute (KAERI)	nuclear resource	- own design atomic reactor - radioactive waste mngt. - use of radiation
Korea Institute of Energy and Resources (KIER)	new energy	- energy battery technology - solar energy - hydrogen energy
Korea Standards Research Institute (KSRI)	metrics standards	- basic metrology - electromagnetic measures - scientific instruments
Korea Institute of Machinery and Metals (KIMM)	leading edge machinery & materials	- magnetic guided train system - aerospace materials - factory automation
Electronics and Telecommunications Research Institute (ETRI)	semiconductors computing communication	- advanced IC design - central processing units - ISDN, satellite communications

(continued overleaf...)

TABLE 14 : Technology development targets of selected GFIs for the 1990s (continued)

Institutes	Principal coverage	R&D target
Institute of Space Science and Astronomy	astronomy space science	- propagate conditions for Korean Space Industry
Korea Research Institute for Chemical Technology (KRICT)	chemistry	- new materials - polymers - weaponry - anti-pollutants
Korea Ginseng and Tobacco Research Institute (KGTRI)	botanical	- industrialisation of new natural medicines - production of botanical raw for medicine using biotechnology
Korea Electric Technology Research Institute (KERI)	electric technology	- electricity supply technology - high speed metro - superconductive applications
Korean Aerospace Research Institute (KARI)	aerospace	- aircraft systems - satellites and rockets
Korean Research Institute of Ships and Ocean Technology (KRISO)	ships ocean	- ship design and CSDP - submarine robotics - ocean pollution protection
Korean Ocean Research and Development Institute (KORDI)	ocean	- mineral resource development - ocean observation systems - South Pole resource exploration

Source : Kyung (1990)

- GFIs provide the backbone of Korean S&T

Some of the GFIs began as testing bodies, checking that products met nationally agreed requirements. Many were concerned with new product development - a role that industry was failing to perform during the late 1960s and 1970s. Some of the former MTI research institutes, such as the Energy and Resources and Chemical Technology Institute, were transferred to MOST.

Although new specialist institutes spun off from KIST, KIST has remained central to Korean S&T development. Currently, KIST has three main centres (bio-engineering centre; systems engineering and ocean research).

Table 14 lists 15 of the major GFIs currently operating within Korea and provides details of their principal R&D interests. Currently, many of the GFIs are attempting to shift away from applied R&D into more generic, basic and experimental R&D. This will be a major challenge to the GFIs and it is an area where collaboration with Europe may benefit Korean S&T. Europe has significant experience in many of the basic technology areas Korea is now attempting to enter.

As Part I argued, within Korea the GFIs are sometimes criticised for lacking industry relevance. However, there can be no doubt that the GFIs have provided Korea with a

technological "backbone". Without them, in all probability, this national S&T resource would not otherwise exist.

As industry integrates backwards into R&D, the likelihood is that the GFIs will prove to be a vital resource for industry, not only in basic and applied S&T, but also in terms of human resource supply, training, consultancy, international S&T monitoring and so on. Given the weakness of the university system in Korean S&T, the importance of the GFIs to Korean S&T overall is without question.

II.2.1.3. Formation of hi-tech "valleys" - Taedok Science Town

- Taedok began with grand plans

The government established two R&D centres: one in Seoul and the other in Taedok Science Town (in Taejon City), 170 kilometres (or two and a half hours) south of Seoul. Seoul Science Park began with three R&D institutes and three economic centres. Taedok Science Town is Korea's largest R&D complex.

Plans for Taedok Science Town began in 1973. The town was eventually integrated into Taejon City in 1983. Taedok's aim was to attract clusters of GFIs and private laboratories to Taejon. This called for a science area of 27.6 square kilometres with living quarters, cultural areas, educational institutes and production centres. The idea was for a self-sufficient science town with 50,000 people by the mid-1980s. (Since then, the aim has been scaled down considerably).

By 1990, there were eleven GFIs (four in basic research, three in energy and four others), three private institutes (Ssanyong Research Centre, Lucky Central Research Institute and Hangyang Research Institute), and four higher education units (Chungham University, Chungham College of Computer Science, KAIST and KIT). (Electronics Korea, May, 1990, Vol 3, No 7). Eleven out of Korea's total of 22 GFIs are now located in Taedok. However, there are still nine GFIs located within Seoul, despite efforts to attract them to Taedok.

- Recent moves have provided a stimulus to Taedok

Three GFIs, the Korean Advanced Institute for Science and Technology (KAIST), the Systems Engineering Research Institute and the Genetic Engineering Centre moved to Taedok in 1990, providing a stimulus to the town. As a result, Taedok boasts around 9,000 employees, including 1,087 PhD researchers, equivalent to 70% of all PhDs in Korean GFIs.

Efforts have been made to link education and training with R&D in Taedok, particularly with the relocation of KAIST (a graduate school of science) to the town. The Korean Institute of Technology (KIT) for undergraduates was also set up in Taedok in 1984.

Taejon City decided to support Taedok by investing Won 1bn in 1990 to encourage the production of high technology products on the edge of the complex.

MOST forecast that by the early 1990s, Taedok will host about 50 R&D institutes. Several corporations have plans to build R&D units in the town.

- Much of the plan has yet to be realised

Institutional co-operation was expected to enliven R&D activities but, to date, there has been little networking among the institutes. There are one or two notable exceptions: for instance ETRI has co-operated well with the Korean Standards Research Institute (KSRI) in the telecommunications exchange project (TDX-1).

Much of the "grand plan" has yet to be realised. The original idea was for a self-sufficient science town with 50,000 people by the mid-1980s. However, relatively few private R&D laboratories have moved to Taedok since 1979 and the original aims have been scaled down considerably. Even GFIs have preferred to remain in Seoul, attracted by the concentration of economic and academic activities in the capital. For instance, although the KAIST educational establishment moved to Taedok, the research arm, KIST, remained in Seoul. Some argue that the Chaebol are purchasing land in Taedok, primarily as a means of land speculation (Electronics Korea, May, 1990, Vol.3, No. 7 p38).

As Kim (1989) notes, there are some signs that corporate R&D centres are clustering regionally around related interests. For example, most of the semiconductor and biotechnology laboratories are located in Seoul, telecommunications centres tend to be in the electronics industrial zone near Kumi, and new material institutes are near Pohang - where the Pohang Steel Corporation has its steel headquarters and its own research-oriented private university.

II.2.1.4. Private research laboratories

- Private R&D laboratories began in the 1970s

During the 1970s, private research institutes were established in the chemical, pharmaceutical, food and textile industries. As Bloom (1989) points out, significant private R&D in the electronics sector dates back to 1975, when Goldstar set up its Central Research Laboratory. During the 1980s, private R&D laboratories began to proliferate. Many of these laboratories are extremely small.

The Chaebol dominate both in terms of quantity and quality of research, as Table 15 illustrates. Out of a total of 7,873 staff employed in institutes of more than 100 staff in 1988, 6,347 (or 81%) were employed by the four leading Chaebol: Samsung (31%), Daewoo (18%), Lucky (16%) and Hyundai (15%) (see Table 15).

- Some R&D laboratories are not yet effective

Bloom (1989) argues that the organisation of R&D within the corporate sector is not yet wholly effective. Firms have modern equipment and first rate staff, but have yet to learn how to manage research and researchers. Bloom suggests that there is a tendency for research directors to treat staff as though they were production engineers, and for the research to be conducted within an unduely structured and hierarchical environment.

- Corporate R&D covers electronics, metals, machinery and chemicals

The main thrust of corporate R&D is in electrical and electronics technology, including semiconductors and telecommunications. Other major fields covered include machinery and

metals, chemicals and textiles. Metals and machinery includes areas such as iron and steel making technology and advanced materials.

- The Government has sponsored corporate R&D

As Kim (1989) illustrates, the Korean Government has used three mechanisms to subsidise corporate R&D: direct subsidy; preferential financing; and tax incentives.

Preferential financing through state-controlled banks and public funds has been the most important mechanism for stimulating corporate R&D. In 1987, for instance, preferential funding accounted for 94.3% of total state-funded corporate R&D activities. In contrast, direct R&D subsidy accounted for only 4% and venture capital around 2% of publically funded corporate R&D (Kim, 1989, p13).

TABLE 15 : Major private institutes in Korea (more than 100 staff), 1988

Group/firm Institution	No. of Staff *	R&D field
Hyundai	[1143]	
- Automobile RI **	863	Machinery and metals
- Heavy Industry RI	155	ibid
- Electronic RI	125	Electrical and electronics
Samsung	[2475]	
- Aviation RI	207	Machinery and metals
- Heavy industry RI	130	ibid
- Semiconductor & Communications RI	1074	Electrical and electronics
- Electronics RI	770	ibid
- Electron Devices RI	186	ibid
- Electricity RI	108	ibid
Lucky	[1299]	
- Central RI	528	ibid
- Semiconductor RI	328	ibid
- Electricity Technology RI	139	ibid
- Communications RI	121	ibid
- Lucky Central RI	183	Chemicals
Daewoo	[1430]	
- Heavy Industry Ri	404	Machinery and metals
- Automobile technology RI	238	ibid
- Shipbuilding and Marine equipment RI	172	ibid
- Communications RI	164	Electrical and electronics
- Electronics RI	452	ibid

(continued overleaf...)

TABLE 15 : Major private institutes in Korea (more than 100 staff), 1988 (continued)

Group/firm Institution	No. of Staff *	R&D field
Others	[1526]	
Kia industry RI	358	Machinery and metals
Pohang Steel Mill RI	141	ibid
Korea Electricity and telecommunications RI	218	Electrical and electronics
Tong Yang Precision Central RI	126	ibid
Daeyoung Electronics Industry RI	122	ibid
Hankuk Tyre RI	124	Chemicals
Korea Explosives RI	121	ibid
Pacific Technical RI	102	ibid
Tong Yang Nylon Central RI	108	Textiles
Kolon Technical RI	106	ibid

* figures in brackets = total staff February 1988
** RI = Research Institute
Source : Korea Business World, April 1988 (amended)

Two schemes for direct subsidy were introduced in the 1980s: the National R&D Projects (NRP); and the Industrial Base Technology Development Projects (IBTDP).

NRP is administered by MOST and is concerned with "new" (to Korea at least) technology areas, involving market externalities to justify government support (usually areas with a high risk of failure and/or wide economic and social benefits). New technology areas include machinery parts and components; new materials development; semiconductor design; super-minicomputer development; energy conservation technology; and biotechnology development. (Investment in NRPs are detailed in Kim, 1989, p11, Table 2).

IBTDPs are administered by MTI. MTI conducts surveys annually to identify "urgent" R&D projects in industrial firms and provides subsidies to research organisations (GFIs, universities and firms). In 1989, 174 technologies were identified and 146 projects funded, costing around $17.2m (Kim, 1989, p10). Although carefully targetted, such financial sums are small in comparison to support projects in many OECD economies.

- Venture capital is weak in Korea

Venture capital has been slow to develop within Korea. The government has introduced a number of small schemes to promote venture capital, however, it is not yet a major source of R&D funding.

- Tax incentives for large firms are important

Tax incentives have been a major indirect mechanism for promoting corporate R&D. As Kim (1989) shows, there are five categories of relevant incentives: (a) reduced tariffs on import of R&D equipment and supplies; (b) deduction of annual capital R&D expenditure and personnel development costs from taxable income; (c) accelerated depreciation on industrial R&D facilities; (d) exemption from real estate tax on R&D establishments; (e) a tax reduction scheme which enables firms to set aside, annually, up to 30% of profits before tax to be used for R&D.

II.2.1.5. Universities and the educational system

- Basic education in Korea is extremely effective

The importance of education in successive Korean Governments' modernisation plans is discussed in detail by MOST (1989), Kim (1989) and various others. Investment in education grew from 2.5% of the government's budget in 1951 to 22% in 1987. In Korea, the government only provides one third of total education expenditure. The rest is borne by parents and the private sector.

By the mid-1970s, the illiteracy rate had become so insignificant it was no longer measured. By 1987, 98.8% of all children were receiving education up to the age of 14. Attendance at college and university grew from around 10% of the population in 1970 to over 25% in 1987.

Local education and overseas training are powerful forms of status and social advance in Korean society. In 1988 there were 1.4m students in Korean higher education institutes and another 50,000 students overseas (Korea Business World, December, 1989).

Korea has consistently surpassed other NICs such as Argentina, Brazil, India and Mexico by almost all indices of basic educational attainment. As recently as May 1990, the Financial Times cited the US Department of Education statistics to show the average mathematics proficiency of 13 year-olds in Korea was substantially better than their counterparts around the world:

TABLE 16 : Mathematics proficiency of 13 year-olds in Korea and other countries

South Korea	567.8
Canada	529.0
Spain	511.7
UK	509.9
Ireland	504.3
US	473.9

level 300 = simple addition and substraction
level 400 = basic operations to solve simple problems
level 500 = intermediate level skills to solve two step problems
level 600 = measurement and geometry solving complex problems
level 700 = more advanced mathematical concepts

Source : US Department of Education (cited in Financial Times, May 4, 1990)

- But S&T training lags behind general education

Despite advances in general education, according to a variety of sources (MOST 1990; Kim 1989; Bloom 1989) Korea has yet to develop a comparable stock of highly trained scientists and engineers. The government plans to increase the number of scientists and engineers from 11 per 10,000 population in 1986 to 30 by the year 2,000. This would bring Korea up to the 1988 level of Japan. (MOST data, cited in the Korea Newsreview, February 3, 1990 p15).

- There are plans to strengthen graduate S&T courses

There is a strong commitment to expand graduate programmes in S&T to meet future needs. The proportion of science graduates is to be increased from 40% to about 60% (the present level of arts and social science graduates) by the year 2,000. Critics argue that it will take a great deal of effort to reform the old style teaching-oriented approach of the educational system. This may explain the continued emphasis on research-oriented teaching institutions, such as KAIST and KAITECH, within Korea.

II.2.2. R&D SPENDING PATTERNS AND COMPARISONS

II.2.2.1. The scale of S&T in the international context

- Korean investment is low by international standards

According to MOST, Korea now stands thirteenth in the world's technology league in terms of technological investment and R&D manpower (see Table 17). At the present time, in comparison with the G7 averages on R&D investment expenditure and patenting activity, Korea is well behind the technology leaders.

TABLE 17 : International comparisons of R&D indicators

	R&D investment ($bn)	R&D manpower total		Per 10,000 pop.	Patents reg.		Technology trade $mn
United States	118.7	806,000		33	70,800	(86)	10,710
Japan (87)	62.3	418,000		34	102,600	(86)	5,270
West Germany	31.6	143,000	(85)	24	50,600	(86)	2,900
France (87)	20.0	105,000	(86)	19	35,500	(86)	2,300
Britain (86)	12.9	90,000	(85)	16	17,500		2,270
Italy (86)	7.5	64,000		11	47,900	(85)	-
Canada (86)	4.9	75,000		30	-		-
G7 average	36.8	243,000		-	541,500		4,690
Korea (88)	3.2	57,000		14	5,300		773
Korea (2001)	39.82	150,000		30	?		?

Source : MOST (cited in the Korea Newsreview, February 3, 1990 p15)

- But there are plans to catch up

In a plan announced by President Roh Tae-woo in a new year's conference (in 1990) Korea aims to be on par with the G7 nations by the end of the 1990s, both in terms of S&T capability and spend. The government is committed to provide the necessary support for R&D activities in universities as well as private firms.

According to the plan, Korea's technology investment will reach $39.8bn by 2001, equivalent to 5% of GNP. By 2001 the plan forecasts a total of 150,000 S&T personnel. Thirty of every 10,000 workers are to be engaged in R&D programmes (Table 17). Areas in which Korea expects to reach the international frontier in basic R&D include semiconductors, computers, chemistry and new materials.

- R&D spending has grown very rapidly

Table 18 illustrates the increase in Korea's R&D activities over the period 1971 to 1987. Albeit from a low base, R&D spending by government and the private sector rose very rapidly from Won 10.7bn ($28.6m) in 1971 to Won 1,878bn ($2.37bn) in 1987. MOST's recent survey (1990a) puts the 1988 figure at $3.2bn.

II.2.2.2. Patterns of spending on domestic R&D

TABLE 18 : Major R&D indicators in Korea : Historical trends
Won billion (current prices)

	1971	1976	1981	1987
Research expenditure				
- gov't funds	10.7	60.9	293.1	1,878.0
- private funds	7.3	39.2	121.7	383.0
- gov't:private ratio	68/32	64/36	42/58	20/80
GNP	3,376	13,881	45,126	97,532
R&D/GNP	0.32	0.44	0.65	1.93
Numbers of researchers	5,320	11,661	20,718	52,783
- gov't & GFIs	2,477	3,592	5,065	9,184
- universities	1,918	4,811	8,488	17,495
- private	925	3,258	7,165	26,104
- R&D exp/researcher	4,306	5,223	14,149	35,580
- researcher/1,000 pop.	0.08	0.33	0.54	1.27
Number of corporate R&D laboratories	1	12	65	455

Note : figures do not include research assistants, technicians and other supporting personnel
Source : MOST Science and Technology Annals, various years, compiled by Kim (1989)p7

Despite Korea's very rapid growth, R&D spending grew faster than GNP, rising from 0.32% of GNP in 1971 to 2.01% in 1988. Data from the EPB put the current ratio of R&D:GNP at 2.6% in 1989 (the government target being 4.0% GNP by 1996). Even at current prices these changes demonstrate a very substantial increase in R&D spending.

As Kim (1989) points out, the acceleration in R&D expenditure during the early 1980s was due to the shift away from the promotion of light/mature industries to heavy and technology-based industries. R&D spending has continued to accelerate as Korean firms diversify into higher technology industries.

TABLE 19 : National project R&D investment
Unit = Won billion (current prices)

	1982	1983	1984	1985	1986	1987
Public and industrial projects						
Projects with public leadership	8.2	13.9	16.1	17.3	27.1	28.2
Public R&D institute-industry joint projects	4.6	6.7	4.5	8.1	15.1	18.1
matched by private sector	5.0	12.6	9.0	13.2	46.1	49.5
Number of projects	66	106	106	186	296	370
Number of corporations involved	86	131	134	212	240	250
International joint projects	-	-	-	1.6	2.3	2.9
Basic research	-	1.0	0.9	1.5	5.0	5.0
Technical assistance to SMEs	0.4	0.4	0.5	1.0	1.5	N/A
R&D evaluation projects	-	-	-	0.5	0.6	0.8
Total national project spend	13.3	22.0	22.0	30.0	51.7	55.0

Source : Science and Technology Annals, 1988. Compiled by Kim (1989) p11

- The private sector shoulders most of the R&D burden

As Table 18 shows, the private sector has steadily taken on more responsibility for the country's R&D efforts. This is largely due to the gradual technological upgrading of the Chaebol and their diversification into technologically intensive areas. In 1971, the public sector accounted for 68% of R&D expenditure. This fell to only 20% in 1987.

- R&D laboratories have proliferated

A large rise in corporate R&D laboratories is registered in Table 18, from only one in 1971 to 455 in 1987. Many of these units are extremely small (more than 70% employed less

than 30 researchers in 1987; a further 20% employed 30 to 100 researchers). However, the large firm institutes are growing in importance. Twenty-nine institutes with more than 100 engineers in 1987 employed around 8,000 researchers. Samsung, the leading R&D spender, boasted an R&D staff of around 2,475 in 1988; Hyundai's R&D staff was roughly 1,143 and Lucky-Goldstar's was 1,299 (Korea Business World, April, 1988).

More recent data from the Korean Industrial Research Institute record a total of 604 R&D laboratories for 1988. KIRI state that 264 of the institutes are run by conglomerates, while 340 are run by small and medium size firms.

It is not possible to comment in detail on the activities of these corporate "R&D laboratories". There is some indication that the figures may be inflated due to preferential treatment by the government for R&D spending by firms. However, there can be no doubt that corporate commitment to applied research has increased, especially on the part of the Chaebol.

- Government wishes to increase its participation

Very recent data indicate that the government wishes to broaden its role in R&D and increase its share of R&D spending. Park Un Suh, Director General of MTI (cited in Far Eastern Economic Review, April 1990, p142), for instance, states that the government's R&D spending is expected to rise from 20% to around 30% by 1994. (This compares with a 50% to 60% share of government R&D spend for the US, France and West Germany).

GFIs have taken on the main burden of advanced R&D in Korea. Kim (1989) notes that GFIs have also been major instruments for national projects. For instance, they have received over 90% of research grants awarded by government in "new" technology areas.

As discussed earlier (section II.2.1.5), little progress has been made in building up a strong basic research capability in the university sector. There are very few R&D facilities at Korean universities. Personal computers are fairly unusual and sophisticated data processing equipment is extremely uncommon in universities. Sung Ki Soo, head of the Systems Engineering Research Institute, argues that Korea's Education Ministry imposes a "deadening egalitarianism which condemns all universities to the same shabby level of facilities" (Far Eastern Economic Review, April 1990, p142).

Although the number of universities now exceeds 100 (and despite the fact that university R&D expenditure has risen from Won 572m in 1971 to Won 198bn in 1987) universities still only account for around 6% of R&D expenditure. As a supply of personnel, universities are undoubtedly important. They account for over 30% of Korea's R&D manpower and 75% of PhD-level personnel in S&T.

II.2.2.3. Government support for R&D projects

Table 19 gives a profile of the government's commitment to national R&D projects. Spending increased from Won 13.3bn ($17.7m) in 1982 to Won 55.0bn ($69.4m) in 1987. The government's subsidy to the private sector in these projects more than quadrupled during this period.

However, Korean national project spending is low by OECD standards. Indeed, it is dwarfed by single national programmes and projects such as the UK Alvey Programme

($500m over five years) and the US Sematech venture ($1.5bn for semiconductors alone, over a five year period).

Also, spending on international joint projects remains low, as does basic research expenditure. Technical assistance to SMEs is thin, despite the strong expressed commitment to building up Korea's base of small and medium firms.

TABLE 20 : Supply and distribution of total R&D, 1988
Unit = Won millions, current prices

By source :			
Government	17.71 %	637.6	Won million
Private	82.27 %	2,961.7	
Foreign	0.02 %	0.7	
By executor :			
GFI	20.50 %	738.0	Won million
Higher ed	9.92 %	357.1	
Company	69.58 %	2,504.9	
By character of R&D :			
Basic	15.56 %	560.2	Won million
Applied	19.81 %	713.2	
Development	64.63 %	2,326.7	
	100.0 %	3,600.0	

Source : MOST (1990a)

TABLE 21 : Supply and distribution of total R&D by character of R&D 1985 to 1988

	1985	1986	1987	1988
Basic research (share in %)				
GFIs	15.7	19.8	19.9	19.7
Universities	65.3	66.5	77.2	72.8
Companies	9.4	7.4	5.6	6.2
Applied research (share in %)				
GFIs	42.0	28.1	27.8	36.8
Universities	28.0	27.8	17.9	20.4
Companies	24.4	26.1	16.8	14.7
Development (share %)				
GFIs	42.3	52.1	52.3	43.5
Universities	6.6	5.8	4.9	6.8
Companies	66.2	66.5	77.5	79.1

Source : MOST (1990a)

II.2.2.4. The focus and sourcing of recent Korean R&D spending

Table 20 illustrates the trends in Korean R&D activity by source and distribution of total R&D spending for 1988. The data confirm that R&D is mainly privately funded and executed in Korea. Relatively little spending is allocated to higher education as compared with GFIs. Funding tends to be allocated to developmental, rather than basic or applied research.

Table 21 shows the relative contribution of firms, GFIs and universities to total R&D spend for the period 1985 to 1988. Universities have increased their contribution to basic research and moved away from applied work, but not to any substantial degree. GFIs have shifted slightly towards basic research since 1985, at the expense of applied work. Firms have increased their contribution to developmental work at the expense of basic and applied research.

II.2.2.5. Corporate R&D by sector

During the 1980s, Korean industry allocated around 5% to 6% of sales to R&D, with the Chaebol spending slightly more overall. In the electronics industry the average was 3.81% of sales. According to data from the Korean Industrial Research Institute, in 1988 R&D spending across industry increased by 26.7% to reach Won 1,486 trillion (approximately $2.25bn) (Korea Business World, December, 1989, p61).

Table 22 shows R&D investment by Korean firms, by sector, for 1987. Electrical/electronic is by far the largest single sector, accounting for 36% of corporate spending. Transportation comes a poor second at 16%, with machinery at 11% and chemicals at 10%.

TABLE 22 : Korean private R&D expenditures by sector, 1987

Electrical/electronics	36 %
Transportation	16 %
Machinery	11 %
Metal products	3 %
Chemical products	10 %
Textiles	4 %
Other	20 %
Total	100 %

Source : Science and Technology Yearbook 1987 (cited in Korea Business World, 1989, p61)

The Korean Institute for Economics and Technology forecast a substantial rise in corporate commitment by the year 2000. KIET forecast that total corporate R&D spend will increase from Won 585bn in 1990 to Won 2,628bn in the year 2000 (a rise from 6% to 8% of sales) (Korea Business World, December, 1989, p61).

II.2.3. INTERNATIONAL CO-OPERATION AND FUTURE PLANS

II.2.3.1. Foreign technology acquisition - historical trends

- Early policies were very restrictive

Historically, Korea has relied on foreign technology acquisition for industrial development. As Kim (1989) argues, in the early years of industrialisation technology was non-critical and the mature technologies concerned were relatively easily absorbed through mechanisms such as reverse engineering. During this stage, policies for direct foreign investment and foreign licensing were very restrictive.

During the 1980s, as technology has become a critical factor in Korea's competitiveness, the government gradually liberalised its policies towards direct foreign investment and foreign licensing in order to enable an inflow of technology.

- Licensing and direct investment took off in the 1980s

Table 23 presents a variety of indicators of technology transfer to Korea. DFI and FL took off in the 1980s with the liberalisation of government policy. As Kim (1989) points out, over 48% of total DFI and 67% of royalty payments in FL since 1962 occurred in the last five year period recorded (1982 to 1986).

- Japan and the US dominate technology transfer

Table 23 shows that Japan has taken the lead in DFI, while the US has remained ahead of Japan in terms of FL and technical consultancy. There has been a substantial shift away from Japan and the US since 1982, as far as capital goods imports are concerned, with "others" accounting for 62% of imports over the period 1982 to 1986.

- Capital goods imports have been the main channel of transfer

Table 23 suggests that imports of capital goods have been the principal source of technology transfer to Korea over the past three decades. Korea remains a heavy importer of capital goods and in some areas is still dependent on overseas contractors for large scale projects (e.g. in the nuclear and train industries). However, in many areas Korea now boasts substantial domestic capability.

- Informal technology acquisition has also been important

A flow of foreign-educated scientists and research personnel has played an important role in the development of Korea's research capabilities. Since 1968, the government has encouraged Korean scientists and engineers working overseas to return. To date, 1,500 personnel have been repatriated, including several key individuals. MOST forecasts that another 2,000 will have been induced back by the year 2000.

TABLE 23 : Foreign technology transfer to Korea. Unit : $ million, current prices

	67-71	72-76	77-81	82-86	Total
1. Direct Foreign Investment (DFI)					
Japan	90	627	301	875	1,901
US	95	135	235	582	1,072
All others	34	117	184	310	659
Total	219	879	720	1,767	3,632
2. Foreign Licensing (FL)					
Japan	5	59	140	324	527
US	8	21	159	603	792
All others	4	17	152	259	431
Total	17	97	451	1,186	1,750
3. Technical Consultancy					
Japan	12	8	21	89	130
US	3	6	17	159	185
All others	2	5	17	84	108
Total	17	19	55	332	423
4. Capital Goods Imports					
Japan	1,292	4,423	14,269	20,986	41,118
US	472	1,973	6,219	12,394	21,133
All others	777	2,445	7,490	53,338	64,143
Total	2,541	8,841	27,978	86,718	126,394

Source : Ministry of Finance for DFI and FL
MOST for technical consultancy data
Korean Society for the advancement of machinery Industry for capital goods data
Compiled by Kim (1989) p23

Consultants from both the US and Europe have made a valuable contribution to Korean industry. Also, Korean companies have pursued a policy of recruiting retired (and increasingly non-retired) employees of Japanese companies to act as consultants and impart valuable product and process information.

This cadre of experts has provided a source of fresh knowledge about state-of-the-art technologies. In some cases, they have made a direct managerial and business input, as with researchers from the US Du Pont laboratories.

TABLE 24 : KOSEF's co-operation with Foreign Agencies

Agency	Date of Exchange/ Memoranda of Uniderstanding	Programmes
National Science Foundation	24.5.77	Co-operative Research (CR) Joint Seminars (JS) Exchange of Scientists (ES)
Deutsche Forschungsgemeinschaft	4.7.77	CR, JS, ES
Centre National de la Recherche Scientifique	28.7.78	CR, JS, ES
Japan Society for Promotion of Science Foundation	24.5.77	CR, JS, ES
Academy of Science Research and Technology Egypt	31.5.79	ES
Alexander von Humboldt Foundation	1.9.82	ES
Royal Society of London	22.4.83	ES
Royal Swedish Academy of Engineering	23.11.84	ES
Fellowship of Engineering	23.11.88	ES
National Research Council	26.1.89	CR, JS, ES

Source : KOSEF (1990)

II.2.3.2. Examples of international R&D co-operation

- Institutions and government support foreign R&D collaboration

The Korean Science and Engineering Foundation (KOSEF), established in 1977, is partly responsible for building up the scientific infrastructure of Korea. KOSEF provides funds for the academic sector and boasts a series of co-operation programmes with international S&T agencies. Its total budget allocation for 1989 (including Government Support Fund) was Won 34,975m (roughly $51m). KOSEF's main co-operation programmes are outlined in Table 24.

Korea is following a general policy of expanding its presence in key foreign science parks. To date, seven GFIs and 19 corporate subsidiaries have established units within foreign science parks as part of Korea's development of an international R&D network.

According to MOST (1990a), Won 2bn (around $3m dollars) are to be allocated to a project to assist co-operation with technologically advanced countries over the seven year period 1990 to 1996. Co-operation is to be promoted in the fields of welfare technologies such as basic science, environment, traffic and aeronautics, ocean exploration and high speed trains.

- Collaboration has begun within some EC member states

Within the EC, ministerial talks on S&T were planned with: the UK (March 1990); France (June 1990); and West Germany (July 1990). In the US, the MOST report (1990a) suggests that Korea is currently re-negotiating a co-operative S&T agreement which expired in 1988. With Japan, Korea is hoping to set up a joint-committee on basic science and an evaluation centre for new materials. (President Roh visited Japan in May 1990 for talks on trade and S&T).

The UK exports chemicals, plant and machinery, and scientific instruments to Korea. Korea has strong ties with UK firms such as GEC, British Aerospace and Barclays Bank. In S&T, the UK has formal arrangements with 18 Korean Universities and more are being discussed. The Korean Institute of Technology, for instance, collaborates with Imperial College in London. The UK was involved in the setting up of Ulsan Institute of Technology (now the University of Ulsan) and the Pohang Institute of S&T.

In November 1989 President Roh Tae-woo met Mrs. Thatcher. The two leaders agreed to promote joint ventures in the fields of IT, energy, industrial waste processing, robotics, construction and anti-pollution technologies by combining UK technology with Korean skills and enterprise. President Roh expressed a commitment to the protection of IPR and trade and investment liberalisation.

In November 1989 President Roh Tae-woo, on a state visit to France, agreed with President Mitterand on the transfer of French high technology in the fields of aerospace and genetic engineering. The two Presidents also agreed to promote joint ventures in construction, industrial plant and natural resources.

A programme of co-operation has begun between the CNRS of France and KOSEF, enabling the new Korean university centres of excellence to co-operate with their counterpart laboratories at the CNRS (Korea Newsreview, December 2, 1989, p4-5).

- S&T collaboration may take place with North Korea and China

With North Korea, the government is identifying various foreign policy initiatives, including S&T ministerial talks and exchanges of scientists and technologists. The possibility of North/South co-operation follows on from a number of commercial ventures between Chaebol (notably the Lucky Group) and North Korean interests.

Korea has established a number of agreements with China on joint ventures in high technology R&D (Korea Business World, March, 1990) in areas such as semiconductors (notably application-specific integrated circuits).

- Korea has links with Sweden

With Sweden, Korea has strong trade and technical relations with large firms such as Ericsson and Saab-Scania. A Swedish-Korean Trade Council was recently created to oversee trade and S&T relations between the two countries. In 1982 the Korean Telecommunications Authority selected Ericsson to install its AXE switching system in Korea. Ericsson then formed a joint venture with Korea's Oriental Precision Company, which gave birth to Otelco in 1983 (a producer of telecommunications equipment) (Korean Business World, January 1989, p48).

By 1988 one million AXE exchange lines had been manufactured in Korea and installed by Otelco. Ericsson transferred switching technology to Otelco in a major telecommunications venture, which required some 400 man months in overseas training for Koreans and 1000 man months of Swedish expert assistance. Deals with Swedish firms also cover truck and aircraft manufacture (Korea Business World, June 1988, p51).

- The US is a major S&T partner

As discussed in Part I, the US has a long tradition of collaboration in S&T at all levels with Korea. The US Government was instrumental in establishing and funding KIST in 1966. More recently, the National Academy of Science conducted a feasibility study which led to the formation of the Korean Science and Engineering Foundation (KOSEF) in 1977.

The US has many operations and joint ventures in Korea covering a wide range of technical areas. Firms such as IBM, DEC and Hewlett Packard compete for market share within Korea. Samsung's founder, Lee Byung-choll, visited the US in 1976 and met David Packard and William Hewlett. This meeting led to a major joint venture between Samsung and Hewlett Packard (Korea Business World, January 1989, p48).

- So is Japan

Japan has been one of the main sources of technology to Korea. Cases of technology transfer increased 20% to 30% per annum since the early 1970s, when they reached a peak of 307 cases in 1987. This declined to 180 cases in 1989. According to Korean observers, this recent decline reflects the reluctance of Japan to transfer technology in areas where Korea is now competing with Japan. Sensitive technology areas include: automobiles, colour TVs, semiconductors and VTRs (Korean Times, 2 June, 1990).

President Roh Tae-woo attempted to rebuild S&T links with Japan on a state visit in 1990. During the visit, the two countries agreed to launch a joint high technology R&D venture and to dispatch 1,000 Korean trainees to Japan for vocational training over a five year period (Korean Economic Journal, 11 June, 1990).

- Eastern Europe is widely discussed

R&D collaboration with Eastern Europe is expected to continue with several countries, most notably Hungary. The first ministerial talks between the two countries were held in Seoul in May 1990.

Five million dollars over a five year period are to be allocated to establish a joint Eastern Europen-Korean research co-operation centre. Korea has already participated in technology exchange projects on space and aeronautics, communications satellites, basic science and ocean exploration with the USSR. Korea intends to promote more ministerial talks and to reach agreements with the Soviet Science Academy.

The USSR has requested help from Korea to convert military plants over to civilian purposes. Korean firms are also proposing to import advanced technology from the USSR because of technology restrictions from other countries (Korea Newsreview, 31 March, 1990, p13). A 21 member Soviet delegation visited Seoul in March 1990 to discuss Korean-Soviet economic co-operation.

The USSR offered Korea 786 technologies for appraisal, half of which are said by MOST to be "available for commercial use immediately or within five years" (Korea Economic Journal, 11 June, 1990).

Although at the present time the USSR appears an attractive source of technology to Korea, it may be that the appeal is short lived. Among the problems faced by Korean firms in the USSR are poor infrastructure, shortages of raw materials, restrictions on profit remittances and conversion of the rouble into hard currencies. Differences in cultural and business practice have also proved significant in some cases.

II.2.3.3. Barriers to collaboration: intellectual property, tariffs, trade and foreign investment

- Tariff rates

Historically, Korea has used its developing country status to control direct foreign investment and to limit participation by outsiders in local markets.

Under severe US pressure Korea made unilateral concessions to the US, lowering its tariff rates for a range of items mostly of interest to the US (Communication from DG1, 21 November 90, Number 132383). More generally, as Table 25 shows, Korea has gradually reduced its tariffs from 1982 to 1988 on manufactured goods and agricultural products.

In 1987 the Korean EPB and the Ministry of Finance began an import liberalisation drive. They lowered import duties on 436 commodities in March 1988 and put in place a plan to progressively lower the basic tariff rate from 20% to an average of 10% to 15% (Korea Business World, March, 1988).

However, Korean tariffs remain higher than those of developed countries. The official policy is to reduce tariffs to to approximately those of developed countries. Table 26 shows the planned tariff cuts for industrial and agricultural imports which have recently been postponed for one year.

TABLE 25 : Average Korean tariff reduction trend

Year	82-83	84	85	86	87	88
Total	23.7	21.9	21.3	19.9	19.3	18.1
Manufac-tured goods	22.6	20.6	20.3	18.7	18.2	16.9
Agricultural products	31.4	29.6	28.8	27.1	26.4	25.2

Source : Ministry of Finance (cited in Korea Business World, March 1988 p36)

- "Super 301"

Korea's tax and duty structure has caused widespread concern in the US and Europe. According to outside traders, "layer upon layer" of Korean duties and taxes have priced foreign goods out of the Korean market (Korean Business World, March, 1988).

In 1989, Korea faced being identified as an unfair trader by the US. However, in 1990 the Bush administration decided to leave Korea off the "Super 301" list of unfair traders (Electronics Korea, June 1990, Volume 3, No. 8). This was partly due to a sharp reduction in the US trade deficit with Korea (by $2.6bn to $6.3bn in 1989), combined with an overall US merchandise export growth of 20% to Korea in 1989.

Also, the steady appreciation of the Won during the period 1985 to 1989 led Korea's removal from the US list of "currency manipulators" in 1989 (for the first time).

- Unilateral concessions to the US

Under severe US pressure, Korea made unilateral concessions to the US, lowering its 1983 tariff rates in 1987 across more than 200 items of interest to the US. More generally, as Table 25 shows, Korea has gradually reduced its tariffs since 1982 to 1983 in manufactured goods and agricultural products.

Although tariffs remain higher than those of the OECD economies, import tariff rates have fallen from 24% in 1983 to 18% in 1988 and 11% in 1989. In 1993 tariffs will be reduced to 8%, a level similar to those of most developed economies (Financial Times, May 16, 1990 piii).

TABLE 26 : Planned five-year tariff cuts

	1988	1989	1990	1992*	1993	1994
Average rates for total imports	18.1	12.6	11.2	9.5	8.1	7.1
Industrial products	16.9	11.5	9.9	8.4	6.9	6.1
Agricultural products	25.2	18.8	18.1	15.4	14.7	12.4

* originally 1991, now postponed for one year (see text)
Source : Ministry of Finance (cited in Korea Business World, July 1988 p71)

- Further tariff cuts are planned

There can be little doubt that the tariff position has improved markedly in recent years. However, some US officials are still concerned that significant trade barriers existed in 1990. Critics remain cynical about the sincerity of the Korean government to meet its liberalisation targets. This cynicism is due not just to the high standard import tariffs on many goods, but to a combination of tariffs, cumulative taxes and invisible trade barriers.

The EC has continued to press for tariff reduction. The EC has argued that Korea's strong balance of payments surplus is inconsistent with remaining import restrictions (CEC 1989). Further liberalisation measures were promised by Korea during consultations between Korea and the EC in July 1989 to take effect after 1991. In some areas, e.g. cars, the EC have welcomed reductions in import tax (CEC 1989).

- Non tariff barriers

In the case of Korea, market opening depends more on the highly effective non-tariff measures than on the protection provided by tariff rates. In this area and despite some improvements, the situation is disappointing. Internal taxation, labelling requirements, safety and technical regulations, customs procedures, and trade-related financing restrictions are used by the Korean administration as instruments to deter imports, especially those of consumer goods (Communication from DGI, 21 November 90, Number 132383).

- IPR problems have caused friction with the EC

In response to increasing international pressure and after fairly difficult bilateral negotiations with the US, the Koreans enacted, in 1987, new laws on intellectual property which were, broadly speaking, consistent with currently accepted standards.

In their general application, the new laws apply only prospectively (i.e. they do not create any new protection in respect of those matters, particularly copyrights and patents, which were in being prior to the date of the new legislation and were not protected previously). However, the US, using the threat of action under trade legislation, negotiated additional transitional measures which benefit only US nationals.

The EC made it clear that it could not accept such discrimination and asked for identical treatment to that given to the Americans. After discussions with the Korean authorities the EC failed to reach a satisfactory solution to this matter (Communication from DG1, 21 November 90, Number 132383).

Since then, the issue has been the continuing focus of Community concern in contacts with the Korean side. The Koreans are basically still offering far less, both in terms of duration of protection and number of products covered, than they have granted to the US.

- IPR conflicts have eased with the US

In response to measures taken by the government, Korea was downgraded in 1989 from the "priority watch list" to the less significant "watch list" of IPR suspected violators by the US administration.

Although the conflict with the US has eased, IPR and trade issues remain high on the agenda of bilateral US-Korean discussions and the GATT negotiations. Specific problems remain which could also prove to be a source of difficulty for future Korean-EC collaboration in S&T.

- Foreign investment

Direct foreign investment in Korea has continued to increase through the 1980s due to rapid industrial growth, an improving investment climate and an attractive domestic market. Many sectors are now open to investment from abroad. The legal environment and general business conditions are still matters of concern for foreign investors. (See Parts II.1.8 and II.1.9 for details).

- Korean complaints against the EC

Korea, in its turn, has registered a series of problems with the EC regarding protectionism and unfair practise. They include specific complaints concerning:

- anti-dumping measures on VCRs
- an EC decision on Hyundai (sub judice in 1989)
- local content regulations (refuted by the EC)
- lack of transparency on the part of Korean inward investors in the EC
- residual import restraints of France (to be removed in 1992)
- import restrictions on Korean cars (some member states).

Source: CEC (1989)

Korean officials and analysts accuse the EC of increasing protectionism (see Jun and Kim, 1990 p63-64). Protectionist measures include quotas on Korean colour TVs, the raising of domestic content requirements (ranging from 40% to 45%) for local production units, a block on knocked-down assembly kits from Korea and other anti-dumping measures. EC officials deny these charges (verbal communication from DGI, 8 November 90).

Table 27 provides a listing of current Korean trade disputes with the EC and the US.

- Impact on future EC-Korean S&T collaboration

Although there is a long-term trend towards improved IPR protection, market liberalisation and so on, severe short-term difficulties dominate the focus of EC relations with Korea. There can be no doubt, that from the Commission perspective, current problems pose a stumbling block to collaboration between the EC and Korea in S&T.

TABLE 27 : Major trade disputes in progress with the EC and the US

Country	Product	Filing date
US	CTV	May. 1983
	CPT	Nov. 1986
	Key phone system	Dec. 1989
	Cellular phone	April 1989
EC	CTV	Aug. 1987
	CDP	Jan. 1987
	Video tape	Sept. 1987
	Audio tape	Jan. 1989
	VCR	Sept. 1986/Feb. 1989
	MW oven	Sept. 1988
	CPT	Feb. 1988

Source : MTI data cited in Jun and Kim (1990) p64

The longer-term improvements achieved by Korea can not be denied. However, problems still remain and these need to be resolved to enable EC-Korean S&T co-operation to proceed.

II.2.3.4. Policy plans and strategies for the 1990s - MOST

In the last year or so, three of the main organisations concerned with S&T (MOST, EPB and MTI) have formulated future plans for S&T. These are summarised below.

The future goals of MOST are spelled out in its annual report and occasional papers. For the 1990s, MOST is concerned to:

(a) improve co-operation and co-ordination between various government bodies

(b) give top priority to Korean participation in international joint R&D projects

(c) establish further science parks to stimulate technological innovation on a regional basis

(d) continue increasing the quality and quantity of the S&T workforce

(e) improve the morale of S&T workers.

Three areas to be targetted to meet both the social and economic needs of Korea: high technology; basic technology; and welfare technology. The government aims to become a developed economy by the year 2000. The long range S&T plan is central to that goal.

TABLE 28 : MOST's Framework Programme : 1990 to 1993

Technology area	Four year budget*
Information technology	$ 5,000 million
Mechatronics	-
New materials	$ 150 million
Chemicals	$ 155 million
Biotechnology	$ 90 million
Aerospace	$ 450 million
Nuclear energy	-

* approximate budgets 1990 - 1993
Source : MOST (1990a) p2

MOST have outlined a framework programme for the execution of their high technology plans. This will run from 1990 and 1996. MOST is to contribute to the projected budget of around Won 9,740bn (approximately $14.2bn). The plan is for $4.2bn to be supplied by government and $10bn by the private sector (MOST 1990a p1).

The proposed programme would be developed through a collaboration between the EPB, MTI and MOST. To date, there is no firm indication that this programme has been accepted formally, but the plans do parallel others put forward by the EPB and the MTI. They also demonstrate the overall commitment to S&T in Korea.

MOST's framework programme would cover the seven fields shown in Table 28. Some of the key technology targets included in the programme are as follows:

- VLSI and ASIC capabilities: 16M DRAM by 1991; 64M DRAM by 1993
- intelligent, networking computers
- enabling information technologies: semiconductors; software techniques (IKBS and automated software development)
- optical and optoelectronics activities.

- MOST is to support 100 university centres of excellence in basic research

As far as promoting basic technology is concerned, MOST wish to target and fund a new cadre of "superior" R&D institutes, selected on the basis of region and R&D field. It is proposed that 30 institutes are to be selected in 1990. The target is 100 dedicated centres of excellence by 2001. According to interviews carried out (see Part 1), these centres are to be located within the academic sector. Thirteen such centres have already been established.

TABLE 29 : Promoting basic technology : "superior" R&D institutes

Region	Field
Seoul area	new materials, polymer micro-organism, medical engineering
Central region	AI, sensor engineering, bio-processing
South West	semiconductors, catalyst engineering, environment
South East	factury automation, aerospace, ocean

Source : MOST (1990a) p3

The promotion of welfare technology is a relatively new departure for Korea and the policy outline is very thin. Four areas of activity are mentioned in the MOST document (1990a):

- water purification
- health and medical technologies
- housing technology
- automatic signal processing.

MOST has also put forward a strategy outline for: (a) the R&D workforce; (b) commercialisation of R&D results; and (c) international collaboration.

(a) Plans for the R&D workforce

The government accepts that Korea's R&D workforce is still relatively underdeveloped (public and private) and that problems of quality are likely to be compounded by a major shortfall in personnel (estimated at 200,000 by 2001) as the S&T policies take shape over the next decade.

The government therefore plans to:

- increase the proportion of science students to social scientists from the present level of 49% to 55% by 1993
- enable graduate students to get the opportunity to participate in GFI programmes
- provide tax concessions on high technology educational infrastructure and equipment
- take a more pro-active role in re-educating private sector S&T personnel in GFIs
- provide conditional exemption from military service for researchers
- intensify repatriation of Korean nationals from overseas
- extend the recruitment of non-Korean national scientists and technologists.

(b) Plans for the commercialisation of R&D results

The government intends to strengthen design, production and engineering capabilities through a number of measures including:

- the setting up of engineering R&D centres
- reducing the private sector risks involved in the commercialisation of innovative high technology products and processes (how this is to be achieved is not discussed)
- the setting up of funds to ensure that finance is available for personnel, technology or information associated with the
- commercialisation of public sector innovations.

II.2.3.5. The EPB's "ultra modern technology industry promotion programme"

In parallel to MOST's programme in S&T, the EPB announced in February 1990 the first phase of a seven year "ultra modern technology industry promotion programme".

The EPB called for an increase in investment in high technology industries to 4% of the nation's GNP, from the current level of 2.6%. This would place Korea among the top international spenders (in terms of GNP percentages: US R&D spend accounted for 2.8% in 1986, while Japan's spending amounted to 2.5%). If the goal is met, Korea's total investment in technology over the seven year period 1990 to 1996 will be roughly Won 38 trillion.

Of the projected Won 38 trillion, the EPB plan estimates that 70% will be accounted for by private industry and the remainder from government sources. Table 29 contains targets outlined by the EPB.

TABLE 30 : Technologies expected to be developed

Fields	R&D sectors	Expenditure * (1990 to 1996)
Information industry	- intelligent computer - HDTV - Ga-As ultra speed ICs - laser optics	10-15
Mechatronics	- intelligent robotics - ultra precision machine tools - CIM	5-7
New materials	- fine ceramics - high-polymics - metals and semiconductor material	4-5
Biotechnologies	- non polluting genetic pesticide	2-3
Precision chemistry (incl. genetic eng.)	- new substances - functional chemicals	2-3
New energy	- energy saving gas turbine	3-4
Aeronautics, space, ocean	- wind force - power plant	3-4
Public welfare technology	- high-technology medical instruments, prevention of environmental pollution	1-2
Total		30-43

Source : EPB (1990)
* Expenditure in Won Trillions

Some reports on the EPB plan also included computer design and production for shipbuilding, cost Won 150bn; and a super-speed magnetic-guided train ("Maglev system") cost Won 330bn.

According to the EPB plan, Korea intends to capture 1/5 of the world's intelligent computer market by the year 2000 (a market valued at $120bn). Korea is also to become a major exporter of computer software for intelligent computers. This ambitious plan also speaks of overtaking Japan as the number one shipbuilding nation by the year 2001 and of capturing $4bn of the world's chip market by 1995.

The plan expects other government bodies such as the Ministries of Defence, Communications, Health and Agriculture, Forestry and Fishery to contribute to the scheme.

TABLE 31 : MTI Technology programmes (by sector in Won billions)

	1990-1994			1995-2000		
	Facility investment	R&D	total	Facility investment	R&D	total
Micro-electronics	68.2	47.8	116.0	-	-	-
Mechatronics	4.8	1.0	5.8	13.7	2.8	16.5
Aerospace	4.0	3.6	7.5			
New Materials	37.4	25.7	62.1	120.10	59.8	179.9
Fine chemicals	24.0	10.4	34.3	39.6	25.0	64.5
Bio-technology	-	4.2	-	-	-	-
Laser	-	20.5	-	-	-	
Total spend : Won 511.3 bn						

Source : Ministry of Trade and Industry (cited in Far Eastern Economic Review, 28 September 1989 p142)

II.2.3.6. MTI's technology plans

The MTI has also announced a number of technology programmes intended to promote the development of so-called key bottleneck technologies. A special fund was set up in 1987 with initial funding of Won 10bn ($15.04m) to support SMEs. This is expected to broaden to include the Chaebol in 1990.

The fund subsidises projects up to 40% to 80% in areas such as heat treatment, printing, lithography and moulding. The scheme was felt to have been successful and in 1989 MTI increased the fund to Won 24bn and extended eligibility to large companies. For instance, MTI is now committed to allocate Won 80m to a three year 16 megabit DRAM project involving Samsung, Hyundai and Goldstar (Far Eastern Economic Review, 28 September, 1989).

The MTI has recently put forward a five year technology development project to develop seven key technology areas. The five year project includes microelectronics (e.g. semiconductors), machine tools and robotics (including mechatronics), aerospace (including the FX fighter and the HX helicopter), new materials (metals ceramics and polymers), fine chemicals, lasers and biotechnology. Forecast expenditures for each of these areas are presented in Table 31.

II.2.3.7. Information Industry Programme

In May 1990 the Korean Economic Journal (May 7, 1990) reported that the government intended to foster the IT industry with a large infusion of public funds. The draft plans include setting up a telecommunications college to train information specialists and an expansion of standards research. Construction of teleports and new media cities will be promoted, as will SMEs in areas such as office and factory automation.

The draft also calls for a restructuring of the regulatory environment for information. Bi-directional cable TV services are to begin in 1992, HDTV services in the mid-1990s and an independent satellite service by 1996.

R&D projects include super-conducting optical memory circuits, intelligent computers, ISDN (integrated services digital network), VANs (value added networks) and data base services.

Total spending is expected to reach Won 5.2 trillion by the year 2000. The large bulk of the funding is to be from the government (Won 5.0 trillion). The remaining Won 200 billion is to be raised from private sources. In May 1990 the plans had been through public hearings and were expected to be finalised by the government in June 1990.

ANNEXES

ANNEX 1 : MAJOR KOREAN S&T (AND RELATED) MINISTRIES, INSTITUTIONS AND THEIR FUNCTIONS

1. Economic Planning Board (EPB)

Overall economic performance and policy
- forthcoming 7th 5 year development plan
- long-term perspective plan

Industrial performance and policy
- leading growth sectors
- role of SMEs
- structural adjustment

Technology transfer
- import of foreign technologies (foreign direct investment, license contracts etc)
- role of the US and Japan (compared to Europe)
- steering mechanisms for the import of technology
- restrictive clauses etc
- export of technology

2. Ministry of Science and Technology (MOST)

Main features of S&T policy and strategy
- legal and administrative infrastructure
- institutional infrastructure
- main actor in S&T policy and co-ordination
- major overall and sectoral targets
- medium- and long-term technology development plans
- long term plan of Science and Technology towards the year 2000
- links between industrial and S&T policy
- incentive systems for promoting private R&D and innovation, with special reference to SMEs

R&D activities (R&D expenditure and manpower)
- growth, sectoral structure and main areas of R&D activities
- R&D activities of public research institutes, universities and industrial enterprises, with special reference to SMEs
- links between public and private research activities (co-operation and co-ordination)
- important R&D programmes at the national and sectoral level
- effectiveness and success of public research activities (transfer of research results to the industrial sector)
- basic research

International S&T co-operation (R&D and training)
- co-operation with the US and Japan
- co-operation with other industrialised countries, especially with Europe
- potential fields for strengthening the co-operation with Europe

3. Korea Development Institute (KDI)

- industrial sector focus
- medium- and long-term development policy and strategy,
- sectoral priorities
- present and future structural adjustment problems
- main growth constraints and problem areas
- strong economic and technological dependence on Japan and the US
- monopolistic and oligopolistic market structures
- environmental problems
- social tensions
- potential fields for co-operation with Europe

4. Ministry of Trade and Industry (MTI)

Foreign trade
- growth and structure of foreign trade
- US and Japan as trading partners
- export performance, especially high technology goods
- trade policy (formal and informal trade restrictions)

Industry
- industrial performance (at the sectoral level)
- medium- and long-term targets
- sectoral priorities
- incentive system with special reference to SMEs
- monopolistic and oligopolistic market structures and related policies

Intellectual property rights
- patent and copyright law

5. Ministry of Communications/Electronics and Telecommunications Research Institute (ETRI)

- establishing an important microelectronics sector
- transfer of technology from abroad (US and Japan)
- foreign technology transfer problems
- public procurement programmes as incentives for local industry
- medium- and long-term technology targets
- major research programmes in the field of electronics and telecommunications
- co-operation and co-ordination between public research institutes and private R&D units
- R&D co-operation with foreign countries

6. Ministry of Energy and Resources/Korea Advanced Energy Research Institute (KAERI)/Korea Institute of Energy Resources (KIER)

- problems and policies in the energy sector
- nuclear energy for the medium- and long-term
- nuclear safety standards and waste treatment
- transfer of technology from abroad
- major research programmes in the field of nuclear energy
- R&D co-operation with foreign countries

7. Ministry of Agriculture, Forestry and Fisheries

- problems and policy in the agricultural sector
- major research programmes (e.g. biotechnology)
- S&T co-operation with foreign countries

8. Ministry of Health and Social Affairs

- problems and policy in the health sector
- major research programmes (e.g. bio-technology)
- S&T co-operation with foreign countries

9. Ministry of Education

- basic education
- undergraduate training
- manpower formation in S&T (mainly in natural and technical sciences)
- medium- and long-run targets

10. Korea Advanced Institute of Science and Technology (KAIST)/Korea Institute of Technology (KIT)

- training of highly qualified R&D personnel
- R&D links with the industrial sector
- overcoming bottlenecks in the supply of R&D personnel
- manpower formation in S&T
- medium- and long-run targets

11. Ministry of Environment

- environmental problems (water pollution, air pollution, waste etc.)
- environmental policy
- major research programmes in the field of environment
- S&T co-operation with foreign countries

12. Korea Standards Research Institute (KSRI)

- policy in the field of industrial standards
- adoption of international standards
- development of national standards
- co-operation in the field of standards development with foreign countries

13. Korea Institute of Science and Technology (KIST)

Including:
- Environmental Engineering & Science Laboratory (Department of KIST)
- Center for Science and Technology Policy (CSTP)
- Genetic Engineering Center (GEC, affiliated to KIST)

Areas covered:
- S&T policy
- environmental problems
- health problems
- biotechnology
- S&T co-operation with foreign institutes

ANNEX 2 : SEMICONDUCTOR CASE STUDY

Following Byun and Ahn (1989) the development of the Korean semiconductor industry can be divided into four stages:

1. The embryonic stage (1965 to 1973)

The origin of the Korean semiconductor industry began in 1965 with a Korean-US joint venture (KOMG) to assemble transistors. Other foreign semiconductor firms were encouraged to set up offshore plants and begin assembly of discrete devices in the 1960s. US companies included Signetics, Fairchild and Motorola.

These offshore plants gave Korean individuals direct experience of semiconductor assembly. Korean industrialists gained their first insight into the workings of the world semiconductor industry. During the late 1960s two domestic firms began the assembly of discrete devices.

2. The transitional stage (1974 to 1982)

In 1974 a firm founded by a domestic investor and a Korean-American technical expert began producing large scale integration (LSI) watch chips. The technical expert provided local Korean technicians with design and wafer fabrication capabilities which were not directly accessible within offshore assembly operations.

In 1979 a major household electronic appliance manufacturer linked up with AT&T to begin wafer fabrication of LSIs. Production during the 1970s and early 1980s concentrated on components for household appliances such as televisions, hi-fi and calculators.

During the late 1970s, domestic firms did not actively conduct R&D or promote technology transfer from the international producers. Mass production and new product development capabilities were outside of the scope of Korean firms. They lacked the financial, technological and marketing capabilities needed to become an international player. Other more lucrative opportunities open to Korean industrialists and financiers were much lower risk then semiconductors.

The government, however, had began to realise the strategic importance of semiconductor technology. It founded a technical graduate school and assigned one of the universities to specialise in electronic engineering. The government also set up ETRI (see Annex 1)

3. The expansion and take-off stage (1983 to 1987)

Byun and Ahn (1989) argue that the semiconductor industry, which had been relatively passive since its inception, was divided into two parts around 1983 when Samsung Electronics produced its first 64K DRAM.

The two major groupings were (a) Samsung and Hyundai and (b) Goldstar. The groups chose very different paths. Samsung began major investments in manufacturing and product development, while Goldstar was content to continue as before. Hyundai (which had already amassed an industrial fortune through construction, shipbuilding and automotive interests) began a programme to construct large-scale plants for the mass production of memory devices.

In the four year period 1982 to 1986, Korean electronics companies invested about $1bn in facilities and around $180m in R&D, unprecedented sums by Korean standards.

During 1985 the international market for 64K DRAMs levelled out. In addition, Japanese firm were (allegedly) dumping 64K devices onto the market as they moved up to 256K DRAMs. Korean industry had to endure heavy losses during this period. The increasing rate of technological development also threatened Korean firms' future profitability. Shortened product life cycles meant that firms had to graduate quickly to new generation products.

In addition to falling prices and weak demand in 1985, nearly all of Korea's chip makers were accused of infringement of patent rights. They also had major problems with quality control, marketing and establishing an acceptable international brand image.

After 1986 the world DRAM market recovered to the benefit of Korean firms. Korean firms also benefitted from the imposition, by the US, of restrictions on imports of Japanese chips, in response to dumping. This had the effect of creating chip shortages and raising prices.

The Korean Government made significant efforts to promote the industry through support for R&D (direct and indirect), financing, marketing and manpower training.

Several private research institutes specialising in R&D for leading edge semiconductor technology were also established, as were "outpost" operations in Silicon Valley (e.g. Samsung Semiconductor USA). The US operations aimed to gather new technical information and develop new products using US technical expertise.

These organisations apparently played a critical role in overcoming the shortage of high quality technical expertise.

Changed business attitudes led to an impressive upgrading of the Korean semiconductor industry, resulting in remarkable growth in production (for details see Byun and Ahn, 1989, Table 4, p645). Exports grew from around $600m in 1982 to $1.36bn in 1986 and to $2.8bn in 1988 (growth for the first nine months of 1989 was around 25%).

Samsung became the 13th largest semiconductor manufacturer in the world in 1989, with semiconductor sales of $1.3bn (this was made up largely of high volume, low margin DRAMs).

As well as the growth in production and export volumes, Korean industry achieved remarkable progress in technological accumulation. While the 64K DRAM, developed in 1983, depended almost exclusively on foreign technology, the one and four megabit DRAMS required a considerable technological input from domestic chip makers.

4. Self-supportive stage (1988 onwards)

By 1990, Korean industry had the capacity to mass produce one megabit DRAMs, one megabit ROMs and 256 kilobit SRAMs. In 1989 Samsung produced in the order of five million one megabit DRAMs per month. The company planned to be one of the first in the world to mass produce four megabit DRAMs in the mid-1990s. The four megabit project was a collaborative development effort within Korea involving ETRI, Samsung, Goldstar, Hyundai and the MTI. Collaborative work also began on the 16 megabit DRAM.

- The Goldstar-Hitachi venture

Goldstar, for a long period, trailed behind Korea's memory manufacturers. Instead the company concentrated on producing smaller volumes of lower risk products such as logic devices.

However, in 1989 Goldstar signed a major agreement to access the technology and manufacturing expertise for Hitachi's one megabit DRAM. Hitachi hopes to benefit from a secure production source and from freeing up its own resources for more lucrative activities. Goldstar hopes to gain fabrication capacity, technical assistance, chip design advice and so on. Goldstar Electron, the group's newly formed chip division expects to invest $2.2bn in a new wafer fabrication facility at Chungju by 1997 (Far Eastern Economic Review, 24 August 1989).

- ASICs

By 1990 Korean firms were poised to enter the more complex area of application specific integrated circuits (ASICs) via a mix of domestic firms and joint ventures with US, Japanese and European firms. The Korean firm Anam, which boasts one of the largest memory assembly plants in the world, formed a joint venture with VLSI Technology of the US to develop ASICs. Goldstar set up a dedicated ASIC department at its R&D institute and plans to expand the share of ASICs in its semiconductor range from 8% in 1989 to 25% by 1992.

- Skill shortages

The most difficult problem faced by domestic firms in the late 1980s was the shortage of high level skills for product development. Imported technology from foreign competitors became increasingly problematic. The Japanese, in particular, attempted to reduce transfers to the Korean "upstarts". However, the large scale Hitachi-Goldstar partnership illustrates that, despite concerted efforts, there are commercial pressures on Japanese firms to form joint ventures with Korean companies and to supply technology to them.

Korean firms have tended to collaborate with other firms and research organisations to develop new products. In return they offer a long-term investment commitment and the promise of high quality, high volume production.

TABLE 32 : Recent international technology transfer agreements in the Korean semiconductor industry

Samsung Group	
Intel	1 megabit EPROM; DRAMs; & SRAMs
Texas Instruments	semiconductors *
Unysis	semiconductors *
Sharp	CMOS
DITTI (FRG)	BiCMOS
Exel	semiconductors *
Lucky-Goldstar Group	
United Microtek (USA)	1M DRAM & SRAM; ACMOS TTL IC
Advanced Micro-Devices	64K DRAM
LSI Logic	gate arrays
Zilog	16-bit NMOS mcps
Hitachi	1 M DRAM
Hyundai Group	
TI	64K & 256K DRAMs
INMOS	256K DRAM
MOS Electronics	1M DRAM
LSI Logic	gate arrays
Alto Corp (Japan)	semiconductors *
Daewoo Group	
Zymos	MOS IC

* area unspecified
Source : Derived from Bloom (1989)

- The role of the government

The government played a critical role as mediator in collaborative efforts in promoting chip developments. It also provided subsidies for R&D and other incentives (see Part II). With the participating firms, the government established a joint R&D fund, then research teams proposed research plans. Next, a committee composed of technical experts (from government, research institutes and companies), under the supervision of ETRI, evaluated and selected research projects. Amounts allocated to individual teams were adjusted according to the committee's continuing evaluation of research progress. In this way, relatively small sums resulted in greater interest in R&D, and significantly improved

domestic R&D capabilities. The joint development of the 16 megabit DRAM between Samsung, Goldstar, Hyundai and the MTI is a case in point.

- Assessment of Korean technological capabilities

According to Bloom (1989), most R&D has been directed towards the indigenous production of products first appearing overseas, with relatively little emphasis on indigenous design. This position may have changed somewhat with the domestic design effort attached to the one, four and sixteen megabit DRAMs.

Korean firms lag behind the Japanese and US leaders in terms of:

- wafer size (one generation behind)
- new materials (especially areas such as Ga-As, HEMT, JJs
- CAD and CAE workstations and software, including cell libraries for ASICs
- VLSI masks (except Samsung) are supplied by Japan and US
- line widths (one generation behind leaders, e.g. 1.5 micron DRAMs)
- fabrication and other capital equipment (import dependent on the US and Japan)
- factory automation selective (little CIM or CIM research)

Source: Jun and Kim, 1989, p41 (data from ETRI internal reports)

On the positive side, Korean firms are moving swiftly to build up capabilities in these areas. Also, Korea is up with the world leaders in terms of assembly, productivity and testing.

Korean firms still lag behind their competitors in terms of establishing international marketing networks and international brand awareness. In house R&D capabilities are weak. Korean industry has yet to offer creative new products to the market. However, current efforts to develop ASICs and other complex chips suggest this stage is not too far off in the future.

Industrial concentration and scale of enterprise will remain the linchpin of Korean chip efforts. In electronics overall the four Chaebol control around 60% of production, 40% of all foreign technology agreements and 80% of all research activity (Bloom, 1989).

- Future challenges

Korean companies believe they must localise manufacturing equipment and materials. Most are imported from the US and Japan. Major equipment is typically controlled by leading semiconductor manufacturers and sometimes witheld for competitive reasons. Recently, Korea has established some joint ventures for materials, leadframe equipment, bonding wire, wafers, chemicals and glass.

To improve their market prospects, firms are aware of the need to offer proprietary designs based on in-house design capabilities.

Korean firms depend on foreign markets for more than 90% of their total production volume. Industry wishes to increase the domestic share of consumption to reduce its vulnerability to future worldwide recessions.

- Implications for the EC

Despite EC concerns over problems of market access, IPR and so on, Korean firms appear to be accessing leading edge technology from the Japanese and US market leaders. The motivation on the part of foreign companies is commercial. Korea is a large and expanding market for technology, components, consultancy services and so on. IPR and other problems appear to be resolved at the firm level, within partnerships. Also, Commission concerns expressed to SRA over "breeding a competitor" appear to be misplaced - a formidable competitor already exists.

At the individual firm level, there may be opportunities for some EC firms to form joint ventures with Korean companies, given the efforts by Japan to restrict transfers of capital goods and design technologies. In this event it is not clear that the Commission would have a role to play. Problems and opportunities would need to be resolved by the firms involved on a case by case basis, as is currently the practice. Any logistical support as might be deemed necessary or desirable could be provided by the embassy representing the national government of the European firm, rather than the Commission.

ANNEX 3 : TELECOMMUNICATIONS CASE STUDY

- The key role of telecommunications

The telecommunications sector embodies technology necessary for the country to meet a number of national objectives laid down in Korean industrial and economic objectives for the 1990s. These include:

- consolidation of the information technology industry
- infrastructure for the modern information economy
- reduction of dependence on foreign technology in key sectors
- increasing shares of the market in both the developed and developing countries.

At the present time, Korea is weak in a number of key enabling technologies. In the past, major aspects of Korean telecommunications, including hardware, software and services have been protected from overseas interests. As Korea attempts to upgrade its infrastructure and improve its capabilities, opportunities in the domestic market are likely to increase.

- Orientation of the telecommunications sector

As Jun and Kim (1989) shows in detail, telecommunications is the only major sector of the Korean electronics industry which has not been export orientated. Unlike consumer electronics, computers and semiconductors, the telecommunications sector was developed to satisfy internal infrastructural needs. Exceptions include some terminal products, mobile handsets and, in 1989, the sale of a small number of digital public exchange systems to the Philippines, Pakistan and other countries.

Unlike other Korean electronics sectors, domestic demand far exceeds foreign demand. The public sector is by far the biggest customer for switching systems, networking technologies and terminals.

Growth of the telecommunications industry has been slow in comparison to other electronics sectors. Production of the Ericsson AXE digital exchange technology began under licence in 1983. This has now been localised and developed into the TDX-1, which has formed the basis for rural digitalisation. In some regions (e.g. Seoul and Pusan) the government, through the Korea Telecom Authority (KTA) has installed AT&T and Alcatel switches.

- Government objectives

Although the industry is currently small, the government is determined to promote its full transition into an internationally competitive industry. The government is also committed to a modern telecommunications infrastructure with a targeted 70% penetration of voice communications, ISDN in the main conurbations and extensive private networks and VANs by the turn of the century. Although the government is likely to continue its policy of import substitution as Korean suppliers improve their capabilities, upgrading the network

is likely to require increased international co-operation both in services and in equipment and technology.

- International collaboration

Monopsony purchasing power has allowed the government to insist that foreign firms seek joint ventures with the Chaebol in order to bid for public sector orders. Consequently, a number of international co-operative technological ventures have developed with major foreign producers, mostly US and Japanese.

In areas such as exchange and transmission equipment exports are beginning. These are based mainly on foreign technology licencing and joint ventures arrangements.

- Industrial structure

The telecommunications sector is highly concentrated and dominated by three Chaebol: Samsung, Goldstar and Daewoo. These three firms boast an extensive product range (switching, transmission and terminals) as well as vertical integration into components.

Hyundai has niche market capabilities in telephone and mobile terminal equipment. The company's strategy is to build up market share in sectors such as private exchanges, transmission equipment and TV satellite dishes.

Another important player is OPC (Oriental Precision Corporation) which has a joint venture between a number of Korean companies and the Swedish firm LM Ericsson. Ericsson has been actively involved in the development, production and marketing of the TDX-1 public exchange (10,100 to 20,000 line capacity). It has also begun to transfer technology for its more advanced replacement, the TDX-10 (100,000 line capacity). This exchange has performance characteristics equivalent to some of the most advanced in the world. The first systems are due for installation in Korea in 1993.

As in most countries, market domination by the entrenched market leaders and government purchasing policy act as barriers to direct entry by foreign competitors. However, as Table 33 shows, many international companies have found access to the Korean market via joint ventures.

- The service sector

The Korean Government monopolises the supply of telephone services through the KTA and data communications through DACOM (the Data Communications Corporation).

The government has made a public commitment to liberalise services gradually over the next few years. The VAN market is to be opened up in the early 1990s. According to some domestic and overseas residents, the current quality of service provision and technical support is very poor.

The government sees integration, speed and intelligence as the key elements of future systems. The R&D efforts of both the KTA and Ministry of Communications have been predominantly geared towards ISDN. According to Jun and Kim (1989) Korea has made major strides towards the development of indigenous time division digital switching, semiconductor inputs, optical communications and ISDN software.

TABLE 33 : Technical affiliations of the Korean telecommunications industry, 1988

	Public exchanges company model	Private exchanges company model	
Goldstar	AT&T 5ESS	NEC	NEAX-2400
Samsung	Alcatel S1240	Rolm	CBX
Daewoo		NTT	SL-1
OPC/Otelco	Ericsson AXE10	Ericsson	MD-110
Hyundai		Fujitsu	ABCS

Source : Jun and Kim (1989) p46, original data from MTI

- Assessment of technological capabilities

A full listing of Korean technological capabilities and weakness is provided by Jun and Kim (1989) p48. To summarise some of their main findings, Korea lags behind the market leaders in terms of:

- broadband ISDN exchange R&D
- ASICs for public exchanges
- design and software automation for exchanges
- network integration into LAN equipment
- voice, data and video integrated exchanges (private)
- broadband transmission
- optical subscriber systems
- protocol conversion
- digital microwave
- satellite system design
- mobile system design and production
- VLSI for mobile communications
- high performance teletex design
- videotex standards
- high performance videophone

In several cases (e.g. optical transmission, digital microwave, and facsimilie) Korea is only one generation behind the world leaders. In fields such as narrowband ISDN, hardware design for public exchanges, private exchanges for voice and data, satellite operation and maintenance and teletex manufacturing, Korea is on par with the world leaders.

- Efforts to improve capabilities

In areas such as data capture and switching Korea lacks asynchronous technologies, broadband, ASICs and BiCMOS technology. Systems design and communications software capabilities are only just beginning to emerge. A major R&D joint ventures between Samsung, Goldstar, Daewoo and Otelco is attempting to rectify current weaknesses in these areas. These efforts are coordinated by ETRI and supported by the links with AT&T, Alcatel and Ericsson.

In transmission technology Korean firms are weak in optical materials and optoelectronics (lasers, repeaters etc.) and again VLSI components, systems design and production capabilities. Optical transmission is another focus for R&D. This has been encouraged by Korea's link into the trans-Pacific submarine optical fibre system between the South Island, Hong Kong, Japan and through to the States.

KTA and ETRI are active in the development of junction lasers, wavelength division mutliplexing and new optical fibre materials. KAIST and the Korean Fibre Optic Communication Company along with the German HHI group have been central to Korea's development of optical fibre technological capability.

The Koreans have accumulated some design and production capabilities for single mode terminals, such as telephone sets and mobile handsets and facsimilie machines. In terminals Korean firms' main weaknesses lie in standards and high performance design. The move towards more intelligent, high performance terminals such as the G4 fax and videophones is dependent upon new design capabilities, new media services and ASIC components.

- ISDN and digitalisation

ISDN has been the overall medium-term goal which has set the Korean telecommunications research agenda. The Koreans expect to have a comprehensive functional public integrated services digital network by the end of the decade.

Digitalisation of the telecommunications system is being driven by the Ministry of Communications and KTA. While Korea has design and production capabilities for the passive and structural elements of telecommunications systems, firms remain weak in the largest (and fastest growing) elements: complex semiconductors and software.

R&D is being applied to the "domestification" of volume components such as network terminating equipment, optical transmitters and receivers as well as ASIC design technology for switching systems.

- International co-operation

Korea is a member of the International Telecommunications Union (ITU) and the Asia Pacific Telecommunication (APT) organisation. It is an associate member of INTELSAT (the international satellite organisation) and is collaborating with the International Maritime Satellite Organisation. On international standards, ETRI is participating in CCITT and ISO standards work.

According to one report, by the end of 1988, KTA had established bilateral technology co-operation agreements with eight organisations from five countries. Another two co-operative agreements are due to commence in 1990. These will be with the French and Spanish Telecommunications authorities for assistance with the 1992 Olympics in Barcelona.

ETRI has developed a number of accords with international research institutes, notably: HHI (W. Germany), AT&T and BCR in the US, Northern Telecom in Canada, Alcatel NV in the Netherlands and Ericsson of Sweden. ETRI has also had talks or contact with SRI in the US, the UK Alvey programme, NTT in Japan and CNET and INRIA in France (among others). ETRI is also engaged in a semiconductor materials development project with Tokyo University.

- Important telecommunications-related institutions include:

  - Ministry of Communication
  - Korea Telecommunication Authority (KTA)
  - Data Communications Corporation of Korea (DACOM)
  - Korea Telecommunication Industry Cooperative
  - Korea Information Industry Association (Seoul)
  - KTA Research Centre (Seoul)
  - System Engineering Research Institute (Seoul)
  - ETRI (Choong Nam)
  - Dongyang Electronics (Otelco R&D Centre)
  - MAXON Technology Institute
  - Goldstar Electronic R&D Laboratory
  - Samsung Semiconductor and Telecommunications R&D Centre

- Implications for EC-Korean co-operation

EC firms are poorly represented in the Korean telecommunications field. It is likely that, in the future, some liberalisation of network services will take place as Korea attempts to upgrade its telecommunications infrastructure, particularly in the areas of business communications, VANs and mobile communications. This could provide opportunities for European market leaders to gain access to the Korean market.

In the area of equipment, Korean firms are faced with the need to access world class technology. Several European firms could potentially supply this under joint venture arrangements. Currently, Alcatel is the main EC firm engaged in technology transfer to Korea. Japan and US have strong traditional links in the telecommunications field. Some are keen to increase their activities within Korea (as is Ericsson of Sweden).

IPR and market access problems do not appear to act as barriers to technology transfer to Korea in near-to-market technology activities such as telecommunications. Problems appear to be resolved by the firms engaged in joint ventures with Korean companies.

ANNEX 4 : HIGH-DEFINITION TELEVISION (HDTV)

- The importance of TV to Korean electronics

Consumer electronics accounts for roughly 40% of total Korean electronics exports and production. Within the electronics sector, colour TV has been the single largest export item until 1988 when VCR took the lead in terms of export sales. In 1988 colour TV exports amounted to $517m (3.9m sets) (Jun and Kim 1989).

TV has been the "cash cow" of the Korean electronics industry. Korea is today one of the largest colour TV producers in the world. Within Korea, Samsung, Goldstar and Daewoo account for around 98% of total colour TV output.

However, Korea's international marketing capabilities are weak in relation to production capacity. Fifty to sixty percent of Korea's TV output is made under OEM arrangements and sold under foreign buyers' own brand names. In addition, Korean firms invariably occupy the low end of the market where prices and profit margins are low.

- Government commitment to HDTV

Although late in starting, Korea is now fully committed to the next generation of TVs, the HDTV. The MTI announced in March 1990, plans for an HDTV export industry by 1993. A consortium of private companies, the nation's broadcasting corporation and several R&D institutes committed a total of $150m over the period 1990 to 1994.

Work will be directed at developing HDTV reception, transmission, industrial applications and telecommunications. However, MTI admits that Korea is several years behind the market leaders in Japan, the US and Europe.

- Assessment of Korean technological capabilities

In conventional colour TV Korea's main strengths lie in mass-manufacturing scale-intensive operations. According to Jun and Kim (1989), Korea is relatively weak in research and development (most areas) and digital circuitry (design and manufacture) and computer integrated manufacturing. In terms of assembly (e.g. chip insertion and automatic soldering) Korea is almost on par with Japanese market leaders.

In HDTV their technological capability is far weaker than in colour TV. In areas such as display production technology, HDTV projectors, integrated circuitry (e.g. decoders, signal processors and converters) and flat panel antennae, Korean companies are far behind the world technology frontier.

The danger for Korea is that the market will shift to HDTV, leaving Korean industry with a large technology gap to close. Korean strategists are also concerned over their acute dependence on Japan.

- Korean strategies towards hardware technology

Korean industry tends to see the importance of HDTV in the longer term. In the short-run, companies are most concerned with improving the resolution of picture tubes for traditional colour TVs. This market is still expected to be substantial for some time to come. Also, enhanced picture tube technology will help prepare Korean firms for HDTV entry.

- Korean strategies towards HDTV standards

One of the most important decisions facing Korean producers is deciding on which standard to follow: Japan's MUSE; the EC's MAC or the forthcoming US ACTV standard. According to Jun and Kim's analysis (1989) Japan offers technological superiority, the US the largest market. In contrast, the EC is seen as "not generous in both the entry barriers of technology and market" (p80). Jun and Kim see the EC standard as a third choice, despite its possible advantage in terms of the large number of countries working on the MAC standard.

Jun and Kim argue that Korean industry will eventually vote for the US system for three reasons: (1) the US system allows the continued use of traditional TV sets; (2) Korean firms expect more in the way of technology transfer from US firms than their Japanese and European counterparts; (3) recent partnerships with Japanese firms have proved difficult in areas where Korea is a major competitor.

Jun and Kim may be premature in their assessment. Japan and Korea have already begun a joint programme. In exchange for permission from the Korean Telecommunications Authority to transmit MUSE coverage of the closing ceremonies of the Olympic Games in Seoul in 1988, NHK agreed to transfer some aspects of MUSE technology to Samsung and Goldstar. Each of the two companies despatched a dozen engineers to Japan in order to receive training on MUSE decoder systems and, according to some sources, prototype circuit diagrams of the decoder. The engineers returned to Japan for further assistance in callibrating the decoder's digital code in 1990.

Some Korean sources say that the transfer from Japan was in fact limited. They argue that the main MUSE requirement is in the broadcast and transmission technologies, rather than the decoder.

Korean firms believe that the international competition in standards could go either way. For example, they believe that the US could adopt a MUSE or MAC format. Alternatively, Japan and the EC may adopt a version of the US standard. Korean firm are therefore keeping their options open.

- Investment strategies

In addition to the problems of chosing a standard, the joint Korean investments noted above are miniscule in comparison to the EC, Japanese and US investments. Because of the uncertainty over future standards, Korean industry believes that for the time being it will have to spread its investments across all three systems. The major forward investments will come from industry rather than the government.

Korean companies appear to be developing experimental HDTV sets based on the MUSE standard. This is likely to be followed by R&D efforts on the EC and US standards.

According to the Electronic Industries Association of Korea, Samsung, Goldstar and Daewoo aim to accumulate mass production capabilities by 1993 and to supply the Japanese, US and EC markets in 1994 or 1995.

- Corporate activities

Samsung has stepped up its efforts to develop HDTV display screens, devices for treating HDTV signals and semiconductor inputs. Its new R&D centre has projects aimed at mastering key technologies and devices for the MUSE system and the EC's MAC system. Samsung is expected to follow this up with work on the US standard as and when results are forthcoming.

Goldstar recently established an HDTV development council. Its own programme of technology development is similar to that of Samsung's. According to one engineer, Goldstar is making a strong effort to develop customised chips for use in MUSE technology.

In contrast to Goldstar and Samsung, Daewoo will not benefit from the link with NHK. Nevertheless, spurred on by the normal Chaebol rivalry, Daewoo is determined to invest enough in R&D to maintain parity with its Korean competitors.

- Implications for the EC

At the present time, major strategic decisions are being taken by Korean companies. Opportunities could exist for European firms to share standards technology with Korean firms. European firms could benefit from Korea's demonstrated capabilities in mass manufacture of television sets. It is conceivable that one or more European firms could form a jointly owned venture with a major Korean manufacturer. (This was, in fact, suggested during the field research).

However, there is a view in Korea that the EC is not "generous" with its technology or its market (e.g. Jun and Kim, 1989). Korean firms appear to be adopting a wait-and-see approach, not ruling out any particular standard. Most of the effort to pursuade Koreans to adopt a standard appears to have been made by Japan, rather than the EC. From the Commission's point of view, the linking of general IPR and market access problems to EC-Korean collaboration issues, coupled with the negative perspective by some Korean's over EC "generosity", could result in an impasse in EC-Korean HDTV co-operation. Given Korea's strong capacity in the TV production field, this could be damaging to EC economic interests.

LIST OF TABLES
(with page references)

REFERENCES

Bloom, M. D. H. (1989): Technological Change and the Electronics Sector: Perspectives and Policy Options for the Republic of Korea, Report Prepared for OECD Development Centre Research Project on: Technological Change and the Electronics Sector: Perspectives and Policy Options for Newly Industrialising Countries, draft report

CEC (1989): Agreed Summary of Conclusions Reached on Main Bilateral Issues Discussed at the High Level Consultations Between the Commission of the European Communities and the Repulic of Korea, held in Brussels, from 4 to 7 July 1989

CEC (1990): Information received from the Commission of the European Communities

EIU (1989): South Korea, No 1 1989, Economist Intelligence Unit Country Report

EIU (1990): South Korea, No 1 1990, Economist Intelligence Unit Country Report

Electronics Korea, Various Issues

Financial Times, Various Issues

Far Eastern Economic Review, Various Issues

EPB (1990): Economic Planning Board, Ministry of Trade and Industry and Ministry of Science and Technology, February, Seven Year Programme for the Development of High Technology and Industry (1990 to 1996)

Jun, Y. W. and Kim, S. G. (1990): The Korean Electronics Industry - Current Status, Perspectives and Policy Options, Report Prepared for OECD Development Centre Research Project on: Technological Change and the Electronics Sector: Perspectives and Policy Options for Newly Industrialising Countries, Draft Report

Kim, L. (1989): Korea's National System for Industrial Innovation, A Paper Prepared for the National Technical System Conference at the University of Limburg in Maastricht, the Netherlands, November 3-4. First Draft

Korea Business World, Various Issues

Korea Newsreview, Various Issues

Korean Economic Journal, Various Issues

KOSEF (1990): Korean Science and Engineering Foundation, Annual Report

Kyung, S. H. (1990): Review of the Role of Government Funded R&D Institutes for the 1990s, Presented at a Symposium entitled, R&D Trends of Advanced Countries and Our Direction,February 1990

Lee J., Bae Zong-tae and Choi Dong-kyu (1988): "Technology development processes: A model for a developing country with a global perspective", R&D Management Vol.18 No.3, pp235-250, July

MOST (1990): Introduction to Science and Technology, Ministry of Science and Technology

MOST (1990a): Policy Direction in the 1990s, A Report of the Ministry of Science and Technology, February.