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Models for National Technology and Innovation Capacity Development in Turkey

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Models for National Technology and Innovation Capacity Development in Turkey

Project	Models and Strategies for National Technology and Innovation Capacity Development in Turkey
Prepared for	The Government of Turkey
Prepared by	Korea Development Institute (KDI)
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Korea KNOWLEDGE SHARING PROGRAM

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Knowledge Sharing Program

Models for National Technology and Innovation Capacity Development in Turkey

May 2009

MINISTRY OF STRATEGY AND FINANCE

KDI Korea Development Institute

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Preface

In the 21st century, knowledge is the key factor in determining a country's level of socio-economic development. From this recognition, the Knowledge Sharing Program (KSP) was launched in 2004 by the Ministry of Strategy and Finance (MOSF) of the Republic of Korea and the Korea Development Institute (KDI). The KSP is designed to contribute to the socio-economic development of the targeted development partnership country by sharing Korea's development experience and knowledge. The most distinguishing characteristic of the KSP is that it is demand-driven and participation-oriented. The program analyzes the problems from the partnership country's perspective and provides policy implications that can be practically implemented in the environment of the partnership country. For Turkey, the Knowledge Sharing Program was initially launched in 2005 between KDI and the State Planning Organization of Turkey on the topic “A Way Forward for the Turkish Economy: Lessons from Korean Experiences.”

Upon the successful implementation of the program, MOSF and KDI have decided to further strengthen the relationship by implementing a second project with the Technology Development Foundation of Turkey (TTGV) on the topic “Models for National Technology and Innovation Capacity Development.” Under the main topic mentioned, experts from both countries worked on four sub-topics which are: 1) Development Strategy and National Innovation System; 2) University-Industry Linkages; 3) Technology, Entrepreneurship and Incubation; 4) Industrial Upgrading with Cluster Approach. This second project is unique in that the experiences of both Korea and Turkey are compared and discussed in sequence, thereby drawing out valuable policy implications and lessons for both countries.

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I would like to take this opportunity to express my gratitude to the project manager Dr. Joonghae Suh and the project consultants including Dr. Byung Su Kang, Dr. Joon Mo Yang, and Dr. Chai Sung Lim for all their work in successfully completing the KSP with Turkey. My sincere thanks also goes to the Turkish counterparts, Professor Erol Taymaz, Mr. Mahmut Kiper, Mr. Serdar Demir, Ms. Deniz Bayhan, Mr. Atilla Hakan Ozdemir, Ms. Tulay Altay, Ms. Pelin Durtas and Mr. Altan Kucukcinar. I would also like to thank Mr. Ayanoglu, Head of Department at General Directorate of Social Sectors and Coordination at SPO, who actively supported the project. Lastly, I would also like to thank the members of the Office for Development Cooperation (ODECO) of KDI for their dedication and contribution to the project.

Upon this occasion of publishing the findings of the KSP with Turkey, I have a strong belief that the program findings will be of great value for both Korea and Turkey and I sincerely hope that through this Knowledge Sharing Program, the Turkish government and relevant line ministry personals could benefit from the Korea's experience. I also hope our final report, which sets out national technology and innovation capacity development strategies from various perspectives, could be used as a catalyst in bringing the Turkish economy one-step further to development. The policy recommendations in this report, however, are based on the Korean experiences and are solely the opinions and recommendations of the authors.

Oh-Seok Hyun
President
Korea Development Institute

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Introduction

1. Stages of the Knowledge Sharing Program with Turkey

The Ministry of Strategy and Finance (MOSF) of Republic of Korea, in collaboration with the Korea Development Institute (KDI), has been implementing the Knowledge Sharing Program (KSP) with selected development partnership countries since 2004 with the overarching goal to assist in enhancing national competitiveness and the institutional restructuring efforts of partnership countries by sharing Korea's development experience. KSP is not intended to offer any definitive solution or recipe for specific economic development, but to analyze economic problems of a country from the demand side and to provide practical and useful references based on Korea's similar cases and experiences.

The initial KSP with Turkey began in 2005. From May 2005 to April 2006, KDI and State Planning Organization (SPO) of Republic of Turkey jointly implemented the Knowledge Sharing Program on the topic "A Way Forward for the Turkish Economy : Lessons from Korean Experiences." Upon the successful implementation of the program, the State Planning Organization officially requested a follow-up program on the topic "Models for National Technology and Innovation Capacity Development," which was written by the Technology Development Foundation of Turkey (TTGV). Based on such a request, the Ministry of Strategy and Finance, the sponsoring organization for KSP, and KDI selected Turkey as its development partnership country for 2008. As the first step of the KSP, KDI composed a group of four experts and carried out a Pilot Study in June. In October 2008, experts from both countries agreed upon four sub-topics and they are as follows:

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Four Sub-topics:

- Development Strategy and National Innovation System
- University-Industry Linkages
- Technology, Entrepreneurship and Incubation
- Industrial Upgrading with Cluster Approach

In January 2009, in order to discuss and coordinate contents of research and consultation in progress, ten Turkish experts visited Korea to hold an Interim Reporting & Policy Practitioners' Workshop. At the Interim Reporting Workshop, the experts from both countries actively exchanged their views on four project areas. From January 13th to 15th, the Turkish delegates visited diverse organizations to have a look at the first-hand experiences of Korea in dealing with its R&D and science and technology policies. The delegates were able to hear about university-industry cooperation at Hanyang University Education Research Industry Cluster. They also visited Daedeok Innopolis, Daejeon Technopark, two spin-off companies, LG Chemical Research Institute and KAIST. On January 15th, the delegation met with the mayor of Asan City and were able to discuss cooperation between local governments of two countries in the near future. Also, they visited Hyundai Motors Asan plant, where they could closely observe the actual process of automatic car assembling done by the robots. On the last day, the delegates heard about the incumbent president's science and technology policies at the Ministry of Education, Science and Technology, Korea's R&D evaluation and planning system at the Korea Institute of Technology Evaluation and Planning, and R&D management and support system to SMEs at the Korea Industrial Technology Association.

As the final stage of the KSP on "Models for National Technology and Innovation Capacity Development," a Dissemination Seminar was held on March 12th, 2009 at Divan Hotel Moment, Ankara, Turkey. Over 100 people from 26 different Turkish organizations participated in the Seminar, showing a great interest to the findings of the KSP between Korea and Turkey. Mr. Ayanoglu, Head of Department at General Directorate of Social Sectors and Coordination in State Planning Organization (SPO) delivered the Opening remarks, particularly mentioning the successful outcome of the program between two countries. Following the Opening remarks, H.E. Chang-yeop Kim, the Ambassador of Korea to Turkey, delivered Congratulatory remarks, commemorating the second successful KSP implemented with the Turkish government. Mr. Cakmakci, Assistant Secretary General of TTGV, delivered Welcoming remarks as the last speaker of the Opening Session.

Session I was chaired by Dr. Cemil Arikan, Director of Research and Graduate Policy at Sabanci University and project findings on "Development Strategy and National Innovation System" of two countries were delivered by Dr. Suh of KDI and Dr. Taymaz of METU. Then Session II was chaired by Dr. Mustafa Colakoglu, Vice President of KOSGEB, and presented by Dr. Lim of Konkuk University, Ms. Akarsoy and Ms. Durtas of TTGV on the topic, "Cluster

Approaches to Upgrading Industrial Structure." Session III dealt with the topic, "University-Industry Linkages" of two countries, chaired by Dr. Canan Cilingir, former Vice President of METU and presented by Dr. Yang of Yonsei University, Mr. Kiper and Mr. Demir of TTGV. Lastly, Dr. Kang of Chungnam National University, Ms. Bayhan and Mr. Ozdemir of TTGV compared "Technology, Entrepreneurship and Incubation" of two countries in Session IV, which was chaired by Dr. Bayram Mecit, Vice President of KOSGEB.

Participants engaged in active discussions in each session, showing a great interest in how two countries developed differently in the four areas under the main topic, "Models for National Technology and Innovation Capacity Development." The Seminar provided the participants with the opportunity to learn and compare different development experiences and perspectives of two countries and the Korean experts sincerely hoped that the project findings could be utilized in the policy-making process of the Turkish government.

2. Summary of Policy Recommendations

2.1. Development Strategy and National Innovation System

Korea has made enormous development in science and technology over the past four decades. By making continuous and massive investments in human resource development and R&D, Korea succeeded in building up a unique innovation system on a barren land. The factors that have influenced the Korean Innovation System (KIS) the most are (1) outward-looking development strategy, (2) industry-targeting development policy, (3) large-firm oriented industrial policy, (4) human resources, (5) government-led S&T infrastructure building, and so on. Lessons from Korea's such experiences are: First, human resource is the key to science and technology development and thus to economic growth; Second, nothing can better motivate private businesses to invest in technology development than market competition.

As for Turkey, the main strength of its innovation system is the fact that almost all institutions necessary for a well-functioning NIS exist in Turkey. There are some weak institutions and links, but the institutional set-up is almost ready. Moreover, there are a good mix of policies and programs that encourage the supply of R&D. In Turkey, existing R&D support schemes are all supply-side policies, i.e., they attempt to increase the supply of R&D by reducing its cost (direct subsidies, tax deductions for R&D personnel, etc.). However, the impact of supply side policies is likely to be limited. There seems to be a need for complementary demand-side policies (most importantly, the use of public procurement to demand higher quality/new products, and enforcing and regulating quality standards and technical requirements). In addition, acquisition of new machinery (embodied technology) seems to be the main form of technology upgrading in Turkey. However, firms, especially small and medium-sized ones, do not have sufficient knowledge about new technologies, and are not able to effectively operate modern machinery and equipment. Technology transfer and diffusion policies would be helpful to increase productivity and to enhance competitiveness. Two options for the Tukish industry are: One, enhancing the competitiveness of domestic firms by reducing their costs, first and foremost, by cutting real wages, and lowering taxes and subsidizing inputs (for example, energy), which was tried many times before and proved to be unsuitable; Two, requiring firms to move towards high value added products and activities by developing technological competence and being innovative. The tale of automobile and consumer electronics industries is the evidence for the fact that imitation of foreign technology is not any more sufficient for sustained growth.

2.2. University and Industry Linkages

In Korea, private sector has been leading the ecosystem of technology development, which is gaining its self-sustaining momentum. Now Korea has entered into a new phase of development in the globalized world economy. Korea is experimenting on the transformation of universities in a way that they can be more directly involved in the innovation and technology development process.

The Korean experiences proposed three propositions as the followings:

- Proposition 1: There is no jumping process from low technology to high technology
- Proposition 2: There is always a gap between business need and professors' incentives
- Proposition 3: The success of the projects depends on the implementation, and the successful implementation depends on thorough evaluations.

Proposition 1 suggests that the policy horizon should be long and the strategies should be prepared according to the current situation by step-by-step approaches. Proposition 2 explains why the Korean government used the government funded research institutes rather than universities. Universities and industrial linkages in the ecosystem of technology development are exogenous, and not sustainable without the government support and therefore, proposition 3 remains important. Building the self-sustaining ecosystem is a difficult task. The system led by the private sector may lack in a long term vision. In this respect, the government is expected to provide longer term R&D investments such as R&D expenditure on basic science and investment for the future industrial transition.

In Turkey, for the last 10 years, several attempts on UIL related mechanisms have been initiated by several public and private organizations. Since, the lack of a systematic approach to monitoring and evaluating of the innovation programmes is a significant weakness of the Turkish governance system. In order to overcome this challenge, it is also required to have a national scientific knowledge-base generated in long term by universities and public R&D laboratories. Universities should have their research policies and priorities. Each university should make their roadmaps and design and establish its systems and mechanisms accordingly. Since universities should be the pioneers, especially at the beginning phase of UIL, they should prepare their policies, declare them and then negotiate for funding for thier overall goals and targets. In addition, Turkey should reshape its procurement policy in a way domestic firms and universities are motivated for R&D co-operation with some incentives. Also, enactment of better laws and legislation to enable hybrid institutional structure in which measures like “Triple Helix” model of university-industry-government interaction similar to USAMP is required.

2.3. Technology, Entrepreneurship, and Incubation

With reference to the Korean experience of Daeduck Technopolis, there are important findings which are important to the future development of local high-tech centers. First, there are the role of a high-grade university, the location of a variety of research facilities, and the attractiveness of the area to highly-qualified workers and entrepreneurs as a place to live and work together. Second, there is the need to create business incubators and technological and financial support mechanism to maximize the opportunities for technology transfer between academic and research facilities and private firms. Third, there is the need for local government initiatives to reinforce technology-led economic development in Turkey. Fourth, Daeduck Technopolis has shown that technological spin-offs and firm creation are of more importance than the relocation of basic research establishments to ensure successful regional economic development and local industrial progress. In addition, in order to foster the regional economy via commercialization of Technopolis research results, more designated linking programs combining the sectors should be developed. Considering high entrepreneurship in METU in Turkey, Turkey would rather accelerate professors and researchers’ technology commercialization by developing a strong linking mechanism in advance than waiting for the establishment of new business. As a linking mechanism, Technology Commercialization Center is very important.

In the case of Turkey, the survey results and other related papers show that incubators in Turkey play an important role in supporting technology based entrepreneurship but still technoparks/incubators are not very effective or do not seem to have strong pull affect for academicians for start-up business. Also as it is stated, there are many agencies providing various services to entrepreneurs or start-ups but the service network or co-operation is not effectively utilized and well-developed to obtain the maximum added-value. Furthermore there is also a necessity to support enterprises through convenient advisory and training activities from establishment to development and growth phase. In Turkey, there is no strategical national plan for the information or software technologies. There is a need for attracting other technologies to have cross-sectoral R&D. There is also a need of public financing to stimulate the development of the venture capital industry and early stage funding. Incubators and technoparks should be constucted as a regional strategy for the effective technology transfer and linking mechanisms. Policy makers should evaluate the available support programmes, better understand entrepreneur's current situation and the barriers for start-up, their growth and development, in order to form appropriate policy mechanisms to support enterprise development.

2.4. Industrial Upgrading with Cluster Approach

In Korea, the root of the successful development of the automobile component industry goes back to the national plan for developing the automobile industry in Korea. Af for the Korean automobile component industry, the expansion of the successful automobile makers' growth and the strategic plan and policy drive at national and local level has been important factors for the successful industrial growth. From the experience of Korea, in order to achieve the dynamic growth of the automobile component in Marmara automotive cluster, the government needs to have the strategic plan for upgrading the automobile component industry and allocating resources for supporting the plan. These plans need to be supported by the central government. In the case of Turkey, automobile component industry is likely to return benefits to Turkey higher than the investment made by Turkish government. With the strong automobile component industry, Turkey can keep or expand the number of employees working in the automobile manufacturers and component manufacturers and get taxes out of the employees and the companies in the automobile industry. If the Turkish government does not succeed in enhancing the competitiveness of the automobile component industry, then the automobile makers in Turkey would find it increasingly unattractive to produce automobiles in Turkey and likely to move the manufacturing base to other countries as the wage in Turkey rises with the continued economic growth.

Despite criticisms, it should be reminded that subcontracted production of automobile components can provide opportunities for upgrading the local small firms' capabilities. In addition, the cluster policy should be focused on upgrading the capabilities of local firms. In this sense, it is important to have strategic target indicator. In the case of Turkey, the recommendable indicator could be 'localization ratio' or the number of 1st tier or 2nd tier component producers in Turkey. The national and regional policy should be focused on increasing the localization ratio or the number of 1st tier or 2nd tier component producers. The cluster policy needs to develop the system to provide packaged service to small firms. The cluster policy should be targeted at solving huge variety of problems the local firms face in their business activities. In order to solve the problems, the bottom up approach to identify the problems and exploring solutions needs to be adopted. Also, the cluster policy should reflect the automobile maker's demand in the cluster. Followings can be recommendable for reflecting automobile maker's demand: First, one of the recommendable programs is a cooperative program, such as R&D program, between large firms and small firms on the condition of the large firms' purchase if the results proved to be successful; Second, the cluster policy needs to be designed in close consultation with automobile makers. If the cluster policy initiative is not compatible with the automobile makers' strategy, there cannot be fruitful results in spite of governmental efforts; Lastly, organizing the channels of communications for reinforcing communications is important for bottom up approach. Organizing local meetings or clubs among firms is required for drawing out projects designed to solve problems at the company level.

Clustering in Turkey is important in order to be able to tackle / cope with the competition in the global markets where companies have to face with the continuous innovation, joint research, product design, marketing, procurement, training and other collaborative activities which pin down firms within clusters to compete successfully in global markets, which arise a) due to integration into EU and b) as a necessity of the globally changing economic atmosphere of the world. Therefore, clustering is being supported in Turkey through different, direct and/or indirect programs and policies. In order to achieve the goals of these different programs or policies, short term, medium and long term goals should be set with the participation of all actors (industry, university, government) and the technologies to be focused should be defined. Necessary steps for the institutionalisation according to these goals and preferences should be taken. That requires serious political will and decisiveness.

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Chapter 01

Development Strategy and Evolution of Korea's Innovation System

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Chapter 01

Development Strategy and Evolution of Korea's Innovation System

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1. Introduction

Considering the relationship between industrialization and science and technology, it is quite natural that the Korean innovation system (KIS) mirrors the stages of industrial development in Korea. When Korea launched its industrialization drive in the early 1960s, it suffered from almost all the problems that the typical poor economies had to face in those days. Korea, a resource-poor country, had neither capital nor technology required for industrialization. It was then a barren land as far as science and technology was concerned. So, it had to opt for an outward-looking development strategy - a development strategy reliant on foreign resources, capital, market and technologies. The 1960s were a period of technological learning for the development of light industries. During the 1970s, Korea focused on the development of heavy machinery and chemical industries, and it was during this period that the government created the Government Research Institutes (GRIs) in the fields of heavy machinery and chemicals to compensate domestic industries for their technological weaknesses. In this stage, Korea relied on foreign sources rather than domestic R&D for the technologies required for industrialization, and therefore, Korea's S&T policy was geared to facilitating learning from foreign technologies, while at the same time developing domestic S&T infrastructure.

It was only in the early 1980s that Korea embarked on serious efforts for indigenous R&D. The changes in economic environments in the early 1980s stimulated Korea to invest in R&D. On the one hand, industrial development reached such a stage that Korean industries could no longer rely on imported technologies and cheap domestic labor for competition in international market. On the other hand, as Korean industries had grown to be potential competitors in international market, foreign companies became increasingly reluctant to transfer technologies to Korea, making it inevitable for Korea to develop an indigenous base for research and innovation. To meet the challenge, it required highly trained scientists and engineers as well as financial resources to support R&D activities that are by nature uncertain and risky. Korea was fortunate in this respect, because it already had a large pool of well-trained scientists and engineers, and also because the large conglomerates were financially able to venture for new technologies. In the mid-1990s, Korea's R&D investment neared 3% of GDP, of which private industries accounted for more than 80%. This was a period when Korea's R&D grew in a massive and rapid way. Korea's efforts to attain technological competence bore fruits: in the 1990s, Korean industries emerged as new leaders in memory chips, cellular phones, LCDs and others, and established themselves in world markets in such areas as shipbuilding, automobiles, home appliances, and telecommunications.

But the Asian financial crisis of 1997 struck a serious blow to KIS. Private businesses responded to the crisis by cutting R&D investments in a massive way. In the face of declining R&D investments in the private sectors, however, the government increased R&D spending to 5% of its budget, focusing on the development of IT and IT industries. In 2003, government's share in the gross R&D expenditures rose to almost 26% from 20% before the crisis. During this period, IT sectors played key roles in innovation in Korea, leading Korea's recovery from the economic crisis as well as Korea's move toward a knowledge-based economy. Recently, Korea has tried to make more regionally balanced approach: strengthening innovative capacities at local and provincial levels and tightening the linkage between the industry and universities.

This chapter provides an overview of the research, development and innovation system of Korea, identifies the strength and weakness of the system, and attempts to draw policy lessons for late-comers. The basic premise of the chapter is that Korea's innovation system has evolved in response to the stages of economic development, but with differing roles in each stage. Korea's innovation system had grown as playing a supportive role at the early years of industrialization but later years the innovation system has acquired an endogenous dynamism which enables to play a leading role in economic growth. In addition, the chapter will show that the government can expedite the growth and transformation of the innovation system through articulated initiatives that are proactively responding to the industrial needs.

The historical overview of the interaction between the innovation system and economic development in this chapter will give a background understanding of discussions in the following chapters. The three chapters will cover such topics as the linkage between universities and the industry, the creation of university entrepreneurship and supportive programs thereof, and the cluster approach that helps strengthen innovative capabilities of industrial complexes.

2. Industrialization and Technology Development

2.1. Initial Setting

When Korea first launched its industrialization drive, it was a typical poor developing country with poor resources and production bases, small domestic market, and a large population, depending on foreign powers for national security. The economic situation in the early 1960s in Korea was more than bleak: Korea's GNP in 1961 was only 2.3 billion US dollars (in 1980 prices) or 87 US dollars per capita. Then, the main source of income was the primary sectors, with the manufacturing sector accounting for only 15% of GNP. International economic interactions were also very limited. In 1961, Korea's export volume was only 55 million US dollars and imports 390 US dollars. All these state that Korea was then one of the poorest countries in the world, suffering from all the socio-economic problems that poor countries faced in those days.

Scientific and technological situation was even worse. There were only two public institutions for scientific research and technological development: the National Defence R&D Institute created right after the end of the Korean War, and the Korea Atomic Energy Research Institute which was founded in 1959. On such a base, the Korean government invested 9.5 million US dollars on R&D in 1963, employing less than 5,000 research scientists and engineers.[1] So, as far as science and technology was concerned, Korea was no more than a barren land.

2.2. Technology Acquisition for Industrialization

It was in 1962 that Korea launched the First Five-Year Economic Development Plan. This and subsequent plans created huge demand for new technologies that were in no way available from domestic sources. Lacking in technological capability, Korea had to rely almost completely on imported foreign technologies. At the early stage, Korea pursued two objectives in this respect: promoting the inward transfer of foreign technologies and developing domestic absorptive capacity to digest, assimilate and improve upon the transferred technologies. Of various alternative channels for technology acquisition, such as foreign direct investment (FDI), foreign licensing (FL), and turn-key plant importation, FDI is often advocated as the most effective means for developing countries to acquire new production skills and management expertise. Unlike in other developing countries, however, FDI played less important role in

1. There is no statistics on the number of R&D manpower for the early 1960s in Korea. The number here is an estimate based on the figure for 1969, which was 5,337. (MOST 1984)

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Korea as a source of capital and technology.[2] In contrast to the minor contribution of FDI to Korea's acquisition of foreign technologies, arm's-length methods such as reverse engineering, original equipment manufacturing (OEM), and foreign licensing (FL) have been critical to transferring technologies and supplementing local efforts.

Korea resorted to long-term foreign loans to finance industrial investments. The Korean government brought in large-scale foreign loans and allocated them for investments in selected industries, which led to massive importation of foreign capital goods and turn-key plants. For the purpose of acquiring necessary technologies, industries later reverse-engineered imported capital goods.

Table 1-1 | Foreign Technology Transfer to Korea, 1962-2006

(Unit: million US dollar)

Source	1962-1966	1967-1971	1972-1976	1977-1981	1982-1986	1987-1991	1992-1996	1997-2001	2002-2006	Total
Foreign Direct Investment										
Japan	8.3	89.7	627.1	300.9	876.2	2,121.7	1,549.0	5,765.6	8,194.7	19,533.3
US	25.0	95.3	135.0	235.7	581.6	1,467.4	2,548.6	16,701.0	14,840.9	36,630.6
All others	12.1	33.6	117.3	184.0	309.6	2,046.9	4,308.1	35,449.4	28,116.0	70,577.0
Total	45.4	218.6	879.4	720.6	1,767.7	5,636.0	8,405.7	57,916.1	51,151.6	126,741.1
Foreign Licensing										
Japan	-	5.0	58.7	139.8	323.7	1,383.6	2,437.0	2,449.0	2,448.0	9,244.8
US	0.6	7.8	21.3	159.2	602.7	2,121.9	3,687.5	7,724.0	11,621.0	25,946.0
All others	0.2	3.5	16.6	152.4	258.5	853.9	1,193.3	3,021.0	5,395.0	10,894.4
Total	0.8	16.3	96.6	451.4	1,184.9	4,359.4	7,317.8	13,194.0	19,464.0	46,085.2
Capital-Goods Import										
Japan	148	1,292	4,423	14,269	20,673	54,641	80,775	76,046	111,280	363,547
US	75	472	1,973	6,219	12,434	33,098	64,681	74,697	79,202	272,851
All others	93	777	2,445	7,490	17,871	33,213	75,387	101,291	205,898	444,465
Total	316	2,541	8,841	27,978	50,978	120,952	220,843	252,034	396,380	1,080,863

Source: National Statistical Office.

2. This is basically due to the government policy that restricted FDI in various ways, say, ownership restriction, repatriation restriction, technology transfer requirement, export requirement, etc. Such a restrictive policy was taken partly because multi-nationals were then viewed by many Koreans as promoting the perpetuation of economic and technological dependence, reinforcing the asymmetrical relationship between the industrialized and the developing countries. (Vernon 1977, Stewart 1978) Foreign investors also did not view Korea as an attractive place for foreign investment. Even though Korea took a very open and liberal policy on direct foreign investment in the 1960s, few investments were made primarily because of the questions about Korea's political stability and economic outlook.

Private companies' responses to such restrictive policies varied across industries. In the case of such light industries as shoes, clothing, textiles, and some intermediate goods for import substitution as well as export, the major sources of technological learning were OEM production arrangements and technical training as a part of turn-key base plant importation. The Korean firms benefited the most from the OEM production arrangements because they offered opportunities to work with foreign buyers who provided everything from product designs and materials to quality control at the end of the production. This was especially so in the case of garment and electronic industries. (Hobday 1995)

During the 1970s, Korea made massive investments in machinery and chemical industries.[3] For the development of chemical industries, Korea relied largely upon turn-key plant importation, which included technical training programs as part of the packages. In the case of heavy machinery, FL was an important channel for technology acquisition. (Chung and Branscomb 1996) To compensate domestic industries for their technological weakness, the government created government-funded research institutes (GRIs) in the fields of heavy machinery and chemicals, such as the Korea Institute of Machinery and Metals (KIMM), the Electronics and Telecommunications Research Institute (ETRI), the Korea Research Institute of Chemical Technology (KRICT), the Korea Research Institute of Standards and Science (KRISS), the Korea Institute for Energy Research (KIER), the Korea Ocean R&D Institute (KORDI), etc. These institutes worked with private industries in building technological foundation for industrial development.

In short, Korean industries were dependent more upon informal channels for technology acquisition than formal channels. The Korean approach to technology acquisition resulted in both positive and negative effects. On the positive side, this policy enabled Korea to acquire technologies at lower costs, and precluded the constraints often imposed by multinationals on local firms' efforts to develop their own capability. The approach was effective in maintaining independence from the dominance of multinationals. Negative effect is that Korea had to give up an important access to new technologies that might have been available through direct equity links with foreign firms. By restricting FDI, Korea failed to set global standards in domestic business operation. Much worse, large-scale foreign loans that had been brought to finance the massive importation of capital goods, plants and FL contributed to the financial crisis in 1997.

3. In the mid-1970s, the Korean government adopted a new set of development strategies, shifting from the promotion of labor-intensive industries in the 1960s to the development of heavy-chemical industries (HCI). The so-called HCI drive was accompanied with planned development of large-scale industrial complexes. It was the Fourth Five-year Economic Development Plan (1977~1981) that, for the first time, had a separate section on Industrial Complex. The Fourth Plan contained an investment plan of six heavy-chemical industrial complexes including Changwon Industrial Base. (The Government of the Republic of Korea, The Fourth Economic Development Plan, 1976, pp 92-94.)

3. Domestic Technological Activities

As industrial development continued into the 1980s, the technological requirements of Korean industries became more complex and sophisticated. At the same time, advanced countries began to view Korea as a potential competitor in international market, and, therefore, foreign companies became increasingly reluctant to transfer new technologies to their Korean counterparts. To facilitate international technological interaction of private industries, the government loosened its regulation of FDI and liberalized FL during the 1980s. However, the deregulation and liberalization did not lead to significant increases in FDI inflow and FL.

The government viewed this as a signal that to sustain the development, it is imperative to build indigenous R&D capability. The government launched the National R&D Program in 1982 and took various policy measures to promote and facilitate private R&D activities.[4] Private industries responded to the policy by investing in R&D in a massive way. Thus, the relationship between technology imports and R&D changed. The ratio of technology imports to business R&D declined sharply from about 40% in 1981 to 20% in the mid-1980s and to 10% in the early 1990s.[5] This implies that Korean industries turned to indigenous R&D for technology acquisition. R&D investment has since undergone a quantum jump. Korea's R&D investment, which stood at only 368.8 billion won (430 million US dollars, 0.62 % GDP) in 1981, rose to 10,878 billion won (13.5 billion US dollars, 2.4% of GDP) in 1996, to 13,848 billion Won (12.2 billion US dollars, 2.4% of GDP) in 2000, and to 27,345 billion won (28.6 billion dollars, 3.2% of GDP) in 2006. Over a period of twenty-five years between 1981 and 2006, R&D investment in dollar terms increased sixty-six times, with an average annual growth rate of 16.8%. Korea invests a lot more of its income in R&D than others with the same or higher income and as of 2006, Korea now is the 6th largest spender in R&D in the world.

Such a phenomenal increase is largely attributed to private industries. In 1981, the government accounted for 53.5% of the nation's total R&D investment, but the government's share declined to 19.4% in 1990. The government's share further decreased to 16% in 1994, but the tendency was a little reversed afterwards and the figure went up to 24.5% in 2002. Now, the private sectors account for 75% of the gross national investments in R&D. As private industries lead R&D investment, R&D activities in Korea are very much focused on applied research and technology development, reflecting the interest of private industries. In the 1980s, about 83% of R&D funds were used for applied research and technology development, but the share increased to 87% in the 1990s. Korea spends far less on basic research than advanced

4. The national R&D program and incentive policies are discussed in detail in the sections on government sector and industrial R&D.
5. OECD(1996)

countries, such as the US, Japan, France and Germany. The general tendency is that the richer a country is, the more it invests in basic scientific research. But Korea's investment in basic scientific research has declined over time despite the economic growth, which is against the conventional anticipation.

There may be many factors that have contributed to the rapid increase in private sector R&D investments, but basically such an increase has been possible because the Korean firms have been put under market pressure for technology development. The government contributed to such a development in two indirect ways. First, the outward-looking development strategy (export-drive) of the government drove domestic industries out to international market, putting them under fierce competition. In order to survive the competition, they have had to keep up with technological changes by investing heavily in R&D.

Second, the government's industrial policy that favored large firms gave birth to a unique business organization in Korea, "Chaebol," that is similar to "Zaibatsu" of Japan before WW II. Chaebols enjoy greater financial affluence owing to the economies of both scale and scope of their business operation. Chaebol companies, which are usually big international operators, have deeper pockets and are able to engage in risky and expensive R&D projects that are even unthinkable for small- and medium-sized firms. This is well explained by the fact that top twenty firms compose about 57% of the total industrial R&D investments in Korea. (KITA 2004)

Most importantly, Korea has been able to increase R&D investments at such a rapidity because it has an abundant pool of highly-educated manpower that could meet the increasing demand for research and development services in both private and public sectors. Considering the fact that R&D investment is more constrained by the lack of human resources than financial limitation in both developed and developing countries, we can say that Korea prepared itself well for development by investing heavily in education and human resource development.[6]

R&D in Korea had been growing rapidly and continuously until Korea was hit by the financial crisis in 1997. R&D was one of the most damaged victims of the crisis. In a survey undertaken in early 1998, many companies responded that they would cut R&D investments and R&D personnel by almost 20% in response to the crisis. Actually, industrial R&D expenditures decreased by 10% in a nominal term from 884.4 billion Won in 1997 to 797.2 billion Won in 1998, and R&D personnel by 15% from 102 thousand in 1997 to 87 thousand in the next year. This was a serious blow to the Korean innovation system. If the crisis had

6. There are cases where R&D investments are constrained by the shortage of suitable manpower. OECD (2003) emphasizes the importance of the supply of skilled scientists and engineers as one of the framework conditions for achieving R&D spending target.

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continued several more years, the Korean innovation system would have collapsed. Fortunately, however, Korea recovered from the crisis in a relatively short period of time: it took only two years for the industrial R&D to recover and rise over the level prior to the financial crisis. There are two factors behind this development: one is the government's efforts to make up for the decrease in industrial R&D expenditures by increasing government R&D expenditures. The share of government in the gross R&D expenditures increased from less than 20% before the crisis to 27% after the crisis. Government R&D funds flew into private industrial sectors, in particular, small technology-based firms and helped them maintain and expand innovation activities. The other is the promotion of IT and IT-related ventures that led

Table 1-2 | Basic Statistics on Korea's R&D

	1965	1970	1975	1980	1985	1990	1995	2000	2003	2006
R&D expenditure	2.1	10.5	42.7	282.5	1,237.1	3,349.9	9,440.6	13,848.5	19,068.7	27,345.7
Government	1.9	9.2	30.3	180	306.8	651	1,780.90	3,451.80	4,663.20	6,632.1
Private Sector	0.2	1.3	12.3	102.5	930.3	1,698.90	7,659.70	10,387.20	14,326.60	20,631.3
Govt vs. Private	61:39	97:03	71:29	64:36	25:75	19:81	19:81	25:75	25:75	24:76
University R&D	NA	0.4	2.2	25.9	118.8	244.3	770.9	1,561.90	1,932.70	2,721.9
Govt Res Inst R&D	NA	8.9	28.1	104.5	367.2	731	1,766.70	2,032.00	2,626.40	3,497.1
Corporate R&D	0.2	1.3	12.3	81.4	751	2,374.50	6,903.00	10,254.70	14,509.70	21,126.8
R&D/GNP	0.26	0.38	0.42	0.77	1.58	1.95	2.51	2.40	2.63	3.23
Manufacturing Sector R&D expenditure	NA	NA	16.7	76	688.6	2,134.70	5,809.90	8,584.90	12,400.68	19,025.8
Percent of Sales	NA	NA	0.36	0.50	1.51	1.96	2.72	2.17	2.64	2.88
Number of Researchers	2,135	5,628	10,275	18,434	41,473	70,503	128,315	159,973	198,171	256,598
Govt Research Inst.	1,671	2,458	3,086	4,598	7,542	10,434	15,007	13,913	14,395	16,771
Universities	352	2,011	4,534	8,695	14,935	21,332	44,683	51,727	59,746	65,923
Private Sector	112	1,159	2,655	5,141	18,996	38,737	68,625	94,333	124,030	173,904
R&D expenditure per researcher (1,000won)	967	1,874	4,152	15,325	27,853	47,514	73,574	86,568	96,223	120,308
Researcher per 10,000 Population	0.7	1.7	2.9	4.8	10.1	16.4	28.6	34	41.4	53.1
Number of Corporate R&D Centers	0	1	12	54	183	966	2,270	7,110	9,810	13,324

Source: Ministry of Science and Technology.

to an IT boom in the early 2000s. The government's commitment to IT development is well reflected in the fact that the share of IT in government R&D expenditures rose to 33.5% in 2002 from 13% in 1997. Such a pro-IT policy fuelled innovation in IT sector, which then affected innovation activities in other sectors. This policy not just helped the Korean innovation system recover vitality but also resulted in promoting Korea's transition toward an information society.

As to the results of the R&D efforts in Korea, evaluations are mixed. Some criticize that Korea excels other countries in R&D inputs, say, human and financial inputs, but lags behind in outputs. Others say that R&D results have not been effectively linked to industrial uses. All in all, the major criticism is that Korea's R&D investments have not been efficient enough to be economically justified. Most of the criticisms are targeted at public research. Those criticisms are, however, based on anecdotal evidences rather than formal analyses.

Despite such criticisms, one cannot deny the positive contributions that the R&D efforts have made. Rapid growth in R&D investment has led to a remarkable increase in patent registration. The number of patents granted by the Korea Industrial Property Office (KIPO) increased from 1,808 in 1981 to 120,790 in 2006, with an average annual growth rate of about 17%. What is more encouraging is the growth of patents granted to Koreans. The proportion of the patents granted to Koreans was only 13% of the total patents registered (or 232 in number) 1981, but the figure rose to 74% in 2006, recording an average annual growth rate of about 24%. (See Table 1-3) Furthermore Korea ranks fourth in the world in terms of the number of patent applications in US patent office, trailing only after the US, Japan and Germany in 2006. (OECD, 2008)

Table 1-3 | Patent Application and Granted

		1981	1985	1990	1995	2000	2003	2006
Application	National	1,319	2,703	9,082	59,236	72,831	90,313	125,476
	Foreign	3,984	7,884	16,738	19,263	29,179	28,339	40,173
	Total	5,303	10,587	25,820	78,499	102,010	118,652	166,189
Granted	National	232	349	2,554	6,575	22,943	30,525	89,303
	Foreign	1,576	1,919	5,208	5,937	12,013	13,640	31,487
	Total	1,808	2,268	7,762	12,512	34,956	44,165	120,790

Source: Korea Patent Office.

R&D efforts have also contributed to the development of high-tech industries in Korea. Table 1-4 shows the changes in manufacturing decomposed into the top 10 leading industries. Each period is marked with leading industries, which changed from labor-intensive light industries including food and beverage and textiles to capital-intensive heavy and chemical

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industries and to high-technology industries such as the electronics sector. Until the early 1980s, the food and beverage and textile and apparel sectors led in manufacturing growth, with about half of manufacturing, but the growth of these two sectors has been slowed over the years. Electrical and electronic products had the leading role in 1990 and 2000; second were the automobile and the chemical industries in 1990 and 2000, respectively. These three industries all had higher growth rates than light industries such as textiles and apparel. Based on in-house R&D, Korean industries have recently emerged as the world leaders in semiconductor memory chips, cellular phones, and LCD, and also established themselves in the world market in the areas of shipbuilding, home appliances, automobile, telecommunication, and so on.

Table 1-4 | Top 10 Leading Industries in Korea's Manufacturing Sectors

(Percent of GDP)

Rank	1970		1980		1990		2000	
	Industries	Share	Industries	Share	Industries	Share	Industries	Share
1	Food & beverage	28.6	Textile & apparel	19.2	E&E products	14.6	E&E products	25.2
2	Textile & apparel	20.4	Food & beverage	19.0	Automobile	13.2	Chemicals	13.9
3	Chemicals	11.5	Chemicals	13.1	Food & beverage	12.9	Automobile	11.3
4	Automobile	9.1	E&E products	10.4	Chemicals	12.9	Basic metal	8.0
5	Paper & printing	5.5	Basic metal	6.7	Textile & apparel	11.5	Food & beverage	6.9
6	Non-metallic mineral products	5.3	Automobile	6.1	Basic metal	9.0	Machinery	6.9
7	Coal & petroleum refinery	4.2	Coal & petroleum refinery	5.5	Non-metallic mineral products	5.6	Textile & apparel	6.9
8	E&E products mineral products	3.7	Non-metallic	5.3	Machinery	5.5	Fabricated metal products	4.8
9	Machinery	2.3	Paper & printing	3.9	Paper & printing	4.6	Paper & printing	4.3
10	Basic metal metal products	1.5	Machinery	3.7	Fabricated	3.8	Coal & petroleum refinery	4.2
	All manufacturing (% of GDP)	21.2	All manufacturing (% of GDP)	28.2	All manufacturing (% of GDP)	28.8	All manufacturing (% of GDP)	29.4

Source: Bank of Korea, National Accounts and Statistical Yearbook, various issues.
Note: Shares are of manufacturing value-added total. E&E = electrical and electronics.

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4. Government and Public Sector R&D

Since the early 1960s, the government has played a key role in Korea's development. The government first initiated science and technology development as a part of the national economic development plan, and has led the development, not just as a rule-setter but also as a target-setter as well as a financier. As discussed in the preceding part, science and technology policy in Korea has been closely linked to industrial development, and thus policy priorities have been adjusted in response to the changes in industrial development targets. In the 1960s and 1970s, the government set specific policy goals and led the private industries in pursuing the goals. But as industrial development proceeds, it has become increasingly difficult for the government to intervene in economic as well as R&D activities because of the increased scale and complexity of industrial activities. Therefore, the pattern of government intervention in science and technology has also changed from direct involvement as a target-setter and commander-in-chief type leader to indirect involvement as a facilitator and promoter. This is a natural course of change in view of the growth of private industries in R&D as well as management and information capabilities.

4.1. Evolution of Public Sector R&D

When they first launched the national R&D program, government R&D expenditures were only 263 billion won, but the expenditures have increased more than seventeen times over the past two decades. Together with the increases in investment, the nature of the National R&D Program has also changed over time. In the formative stage (roughly during the first four years, 1982-85), the main objective of the program was to facilitate the absorption of foreign technologies. In other words, the focus of the program was placed on the development of technologies required for the local production of major products, parts, components and materials which were considered essential to industrial development in those days. During this period, the National R&D Program relied totally on a bottom-up approach for project selection, and priority was given to those proposals involving private enterprises.

Table 1-5 | Government R&D investment, 1982-2006

	1982	1985	1990	1995	2000	2003	2006
Total amount in billion Won	263.3	304.3	649.9	1,779	3,452	4,663	6.632
Percentage of the GERD	49.4	24.6	19.4	18.9	24.9	24.6	24.3

Source: KITA(various years)

The subsequent five years, 1986-1990, can be dubbed as a take-off stage, because the objective of the program was gradually switched from simple internalization of foreign industrial technologies to the development of core technologies that private industries were not able to tackle due to technical and financial risks. The program also aimed at building up a technological base for high-technology industries. Accordingly, project selections were partly linked to long-term technology development plans.

Table 1-6 | Changes in the National R&D Program by Stages

	Formation stage(1982-1984)	Take-off stage(1985-1990)	Maturing stage(1991 -)
NRDP objective	Internalization of Foreign technologies	Development of Core technologies	Creative research Future-oriented research
Planning	No planning: Bottom-up	Based on loose Long -term plan	R&D planning Technology foresight
Main actors	Government R&D Institutes (GRI)	Main: GRI Minor: Universities and Industries	Main: GRI, with increased role of universities and industries

Source: MOST (1997b)

At about the end of the take-off stage (around the end of 1980s and early 1990s), other ministries began to establish their own R&D programs in order to solve the problems in the areas of their purview. The Ministry of Commerce, Industry and Energy launched the Industrial Base Technology Development Program in 1987 and the Alternative Energy Development Program in 1988. The Ministry of Information and Communication created the Information and Communications Technology Development Program in 1989, and several other ministries followed these ministries in the subsequent years. Up until 1987, the National R&D Program of MOST was the only government-sponsored R&D program, and actually, MOST was the sole player in public sector research. But with the emergence of other ministries on the scene, the role of MOST has been reduced gradually. Now, the share of MOST in the government R&D expenditures stands at only 20.6% (2003).

The rapid growth of government R&D investment has been entailed by increased political pressure for economic and social contributions of the investment. The question has been "What good do the government R&D programs do for the future of the nation?" At the same time, the private industrial sector, as a major financial contributor, became increasingly sceptical about the economic values of the results of government R&D investments. On the other hand, as individual ministries created their own R&D programs, the problem of inter-ministerial resource allocation emerged as an important policy issue. In other words, the diversification of government R&D programs brought up a new set of issues, such as duplication of research efforts, delineation of R&D areas among different ministries, inter-ministerial R&D priority-setting, efficient allocation of the R&D budget, and so on.

Table 1-7 | Government R&D Programs by Ministries

Ministry	Year initiated	Major Program	Management agencies
MOST	1982	Specific R&D Program	Korea Institute of Science & Technology Evaluation & Planning (KISTEP) Korea Science & Engineering Foundation (KOSEF)
MOCIE	1987 1988	Industrial Base Technology Development Program Alternative Energy Development Program	Korea Institute of Industrial Technology Evaluation & Planning (ITEP)
MIC	1989	IC Technology Development Program	Institute of Information Technology Assessment (IITA)
MOE	1992 1996	Environmental Engineering Technology Development Program Environmental Basic Technology Development Program	National Institute of Environmental Research (NIER)
MOCT	1994	Construction Technology Development Program	Korea Institute of Construction Technology (KICT)
MOAF	1994	Agricultural Technology Development Program	Agricultural R&D Promotion Center (ARPC)
MHW	1995	Health and Medical Technology Development Program	Korea Health Industry Development Institute (KHIDI)
MoEd	1983	Basic Scientific Research Support Program	Korea Research Foundation (KRF)

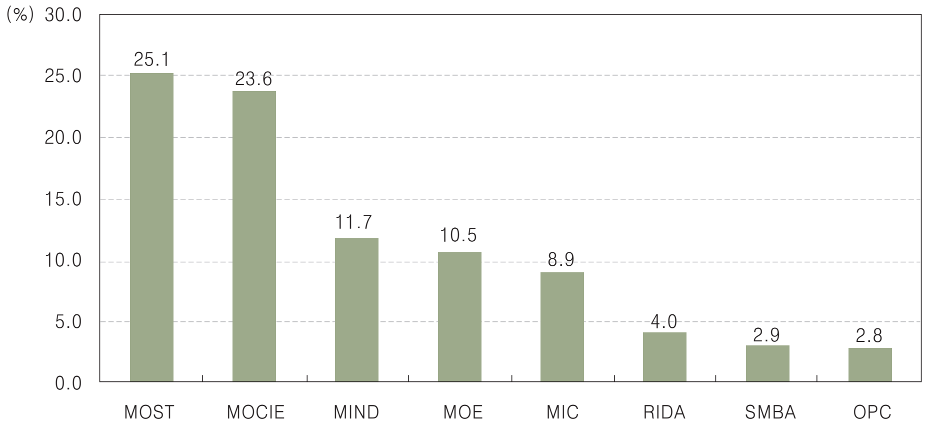
Notes: 1) MOST: Ministry of S&T; MOCIE: Ministry of Commerce, Industry and Energy; MIC: Ministry of Information and Communications; MOE: Ministry of Environment; MOCT: Ministry of Construction and Transportation; MOAF: Ministry of Agriculture and Forestry; MHW: Ministry of Health and Welfare; MoEd: Ministry of Education.

2) Including the Small and Medium Enterprise Administraion.

3) Including the Agriculture Promotion Administration and the Forestry Administration.

Source: MOST (1997a), NSTC (2003).

Figure 1-1 | The share of government R&D investment , by ministry/administration



Source: NSTC(2003).

All these issues boil down to the question: How to allocate the limited resources to which areas? The question is not only technological but also economic and political in that government R&D program is justified only by the taxpayers' consent to the investment. To deal with the issues, the government adopted the concept of technology planning and evaluation in implementing the government R&D programs in the mid-1980s. In other words, in setting priority for technology development, the government employed a strategic approach based on long-term planning. Industries and academia participated in the process so that the interests of private industries and academia could be reflected in the planning process of the government R&D programs. It was during this period that industry-academia-GRI collaborative research was first undertaken as part of the government R&D programs. The International Cooperative Research Program was also launched during this period.

Yet, it was not until 1992 that a Korean system of public sector R&D management took form. In that year, the government launched the Highly Advanced National (HAN) Project, which is a ten-year inter-ministerial R&D program to develop core technologies for the industrial development toward the 21st century.[7] HAN Project is the first government R&D program that was developed through a full cycle of planning process - technology foresight

7. HAN Project is broadly categorized into two groups. One is the product technology group, which focuses on the development of specific products, particularly high-technology products that have the potential of creating competitive advantages in the world market. The other is fundamental technology development, including core technologies that are indispensable for raising the level of the economy and society and improving the quality of human life. (See more explanations in OECD, 1996)

activities, inter-ministerial consultation, etc.

Through these stages, the government R&D expenditures grew very rapidly from 263 billion Won in 1982 to 4,664 billion Won in 2003. As a result of such growth, the role of MOST, as a funder of R&D, has been reduced from the central and sole player in the public sector R&D to just one of the major players.

4.2. Government Research Institutes (GRI)[8]

GRIs are the major players in government R&D. They operate with the financial assistance of the government, but are independent non-government organizations operating under the provisions of the civil laws and the Law for the Creation and Promotion of the Government Research Institutes (1999). Therefore, GRI researchers are not government employees.

There are 28 GRIs in the fields of science and technology, and they conduct 42% of the government R&D programs in terms of expenditure. GRIs employ about 8,600 scientists and engineers, of whom about 40% are Ph.Ds and 50% masters degree holders. Of the total R&D expenditures by GRIs in 2003, 45.5% was devoted to technology development, 35.4% to applied research, and remaining 19.1% to basic research. This shows that the major role of GRIs still has not changed much despite the changes in social and economic environments. Over 93% of research funds came from the government, while the inflow of funds from industries was less than 7%, signifying the fact that despite the overwhelming industrial research orientation of GRIs, industry-GRI research interactions are not that pronounced.

The Korea Institute of Science and Technology, the first GRI, was established as an integrated technical center to assist industrialization by finding solutions to simple technical and practical problems and helping internalize imported foreign technologies. With the development of heavy machinery and chemical industries in the 1970s, the demand for technical supports such as those KIST provided in the 1960s increased in various industries. To meet the demand, the government spun off from KIST a number of specialized institutes in the priority industrial areas, namely, electronics, telecommunication, energy, machinery, chemicals, shipbuilding and marine resources. These institutes operated under the patronage of the ministries that were responsible for the development of the respective industries. To accommodate these institutes as well as private R&D labs, the government started the development of the Daeduk Science Town in 1970s.[9]

8. This part draws upon NSTC (2003), and the statistics cited are for 2002, unless indicated otherwise.
9. The development of Daeduk Science Town in the City of Daejon, about 150 km south from Seoul, primarily intended to host GRIs but also expected to make more balanced regional development, mitigating heavy concentration of government institutions almost on the capital regions.

Entering into the 1980s, environments surrounding GRIs changed very rapidly. Private industries began to establish in-house R&D systems in order to build up technological capability to cope with increasing market competition. Universities, which had been heavily teaching-oriented, also launched various efforts to develop research capabilities. These two developments squeezed the position of GRIs within the Korean innovation system. The ground for GRIs was much eroded.

There also are criticisms that they have not done as much contributions as they have spent, and that GRIs have overly expanded their span of activities as a means to claim more resources, causing duplications among themselves and leading to severe wastes of resources. Another strand of criticism is that the demand for the services of GRI has changed and therefore, the roles of GRIs should be redefined. In response, the government downsized GRIs and merged some of them to reduce overlaps and then put GRIs under the jurisdiction of MOST, hoping to promote inter-institutional flow of research personnel and resources.[10] Along with this, they launched the National R&D Program, and enacted the Law for the Promotion of Government Research Institutes (1982), which provided the legal base for GRIs. GRIs were transformed from industrial technical research centers into institutions for government R&D.

After almost twenty years of operation since then, the criticisms against GRIs had not been toned down. GRIs had to undergo another round of major reform and reorganization. Reasons for the reorganization are that resource wastes resulted from barriers to inter-institutional mobility that existed between and among GRIs, and that GRIs tended to work for the interests of their patrons (ministries) rather than those of the nation. This suggests that the reform of GRIS in the early 1980s failed in accomplishing what the reform aimed at. Again, they not only downsized GRIs in terms of both budget and personnel but also redefined their functions and classified them into three different groups. They were put under three research councils, which were newly created. The research councils report directly to the Prime Minister's Office. Some GRIs were allowed to stay under MOST or other ministries as that was deemed required for efficient operation. For example, the Korea Atomic Energy Research Institute is under MOST even after the reorganization. The research councils and GRIs under them are shown in Table 1-8.

Now, in accordance with the amendment of the Framework Law for Scientific and Technological Innovation, the three research councils and their member institutes have been moved from the Prime Minister's control and put under NSTC for better coordination. GRIs' R&D activities are now geared more to the development of future-oriented technologies and technologies in the public domain, but still the debates on the roles of GRIs have not come to an end.

10. There were exceptions to this reform, and some GRIs were allowed to remain under the patronage of individual ministries.

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Table 1-8 | Budget of Government Research Institutes

	No. of Institutes	No. of employees (Head Count)	Budget (Million Won)		Ratio ofGov't Funding(%) (B/A)
			Total Amount(A)	Gov't Funding(B)	
Total	83	26,517	11,149,971	4,601,519	41.3
GRI	55	15,306	3,479,656	1,611,466	46.3
1. 5 Research Councils	44	9,676	2,272,451	810,900	35.7
- Korea Research Council for Economic & Social Science	14	1,552	214,549	133,838	62.4
- Korea Research Council for Humanities &Social Science	9	636	118,195	61,783	52.3
- Korea Research Council for Fundamental Science and Technology	4	1,229	343,809	150,341	43.7
- Korea Research Council for Industrial Science and Technology	9	3,535	862,050	204,397	23.7
- Korea Research Council for Public Science and Technology	8	2,724	733,848	260,541	35.5
2. Research Councils expenses	5	57	22,817	21,901	96.0
3. Others	6	5,573	1,184,388	778,665	65.7
Non Research Gov't Funded Institutes	28	11,211	7,670,315	2,990,053	39.0

Source: Ministry of Planning and Buget

4.3. Universities

Universities are a rich pool of high-quality scientists and engineers. They have highly-qualified research manpower of over 59 thousand, of whom 38 thousand hold Ph.D. degrees, 20 thousand master's degrees. Universities harbor approximately more than 30% of the total research manpower of Korea, but Ph.D. level research scientists and engineers are extremely concentrated in universities (72.3%).[11]

11. See <Table 1-2>

Even though universities command the largest pool of qualified scientists and engineers, they account for only 10.1% of the gross national R&D expenditures, which is smaller than the combined share of GRIs and national labs (12.6%). This reflects the situation of Korean universities, in particular, research environments. First, in many universities, professors cannot afford to engage in serious research because of excessive teaching obligation. Amazingly, the student-professor ratio (number of students per professor) at Korean universities exceeds 34. Even at national universities, which are in much better situations, the ratio stands at 29.[12] Second, as many universities place more emphasis on teaching at undergraduate levels, graduate programs have not been well developed. Naturally, universities are very poor in research facilities, and university education is not linked to research. Third, university professors are not put under pressure for research. Once employed, they are almost automatically tenured. Even though there are some requirements they have to meet in order to stay at the teaching job, those could be met without serious research efforts. Therefore, university research is very much concentrated in a few top universities.[13]

As one may anticipate, university R&D activities are directed more toward basic research than others sectors - of the total R&D expenditures in 2003, 36% were devoted to basic research, 32.8% to applied research, and 31.2% to development. Naturally, universities rely more on the government for research funds (75% of the university research funds are from the government.). Over 50% of the funds were spent on engineering research, while scientific research received only 18.9%. Other major areas are medical science (16.3%) and agriculture (5.9%).

Overall, universities in Korea have not been such an important actor in R&D as their foreign counterparts are. Various factors may be behind this, but the fundamental reason is the extreme teaching-orientation of Korean universities. To reorient Korean universities toward more research-oriented institutions, the government has taken various measures, including the "Brain Korea 21" Program, which is to support selected universities in their transformation into research- and graduate education-oriented institutions. For this program, the Ministry of Education and Human Resources has been pouring 90 billion Won every year since 1999. Universities also have been making efforts to reform the education and research systems. This and other government efforts to upgrade university research and education started to bear fruits in various ways. Most significant is the growth of scientific publications, of which universities are the major producers. Korea now ranks 15th in the world in terms of the number of SCI

12. Ministry of Education (1998)
13. The situation has been alleviated in recent years - government has increased the share of local universities in R&D funding. NURI (New University for Regional Innovation) is a good example. The primary goal of the project is to contribute to the local economic growth via strengthening local university's educational and research capabilities. Under the NURI project, government fund is allocated to 13 cities and provinces based on population and number of students and universities.

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publications, but what is more impressive is the fact that Korea recorded the highest growth rate in SCI publication over the past decade.

Table 1-9 | R&D structure at universities

		1997	1998	2000	2003	2006
R&D Expenditure (billion won)		1,271.6 (9.4% of Gross Nation R&D)	1,265.0 (11.2%)	1,561.9 (11.3%)	1,932.7 (10.1%)	2,721.9 (10.0%)
Source of Fund	Government	52.0%	52.1%	60.4%	75.1%	86.0%
	Industries	47.5%	47.7%	39.4%	24.5%	13.7%
	Foreign	0.5%	0.2%	0.2%	0.4%	0.2%
Nature	Basic research	37.8%	40.1%	42.4%	36.0%	33.4%
	Applied research	31.5%	33.8%	30.5%	32.8%	32.2%
	Development	30.7%	26.1%	27.2%	31.2%	34.4%
Areas	Sciences	-	18.5%	20.0%	18.9%	19.7%
	Engineering	-	49.1%	50.3%	50.2%	50.1%
	Agriculture	-	7.0%	6.5%	5.9%	5.1%
	Medicine	-	17.6%	11.4%	16.3%	16.2%

Source: KITA (2004).

5. Supportive Measures for Industrial Technology Development

5.1. Overview

Korea has implemented various kinds of policy measures that aim to promote industry's technological activities. These measures can be broadly classified by their characteristics into four schemes: national R&D programmes (NRDP), infra-structural programmes, institutional support system, and incentive system. Government's industrial technology policy has focused mostly on technology programmes, and other policy measures played a minor role. For example, as of 2000, the government as a whole spent 3 trillion won in NRDP, which accounted for 82 % of government's total R&D budget. To complement mission-oriented NRDP, the government has other policy measures that intend to enhance technology diffusion and fill the institutional gap between innovation actors. The list of policy tools for such an objective includes educating and training research personnel, compiling and diffusing technical information, encouraging cooperative R&D by establishing cooperative R&D facilities and promoting spin-off activities from public research. The direct funding from the government budget to GRI is classified as "Institutional Support." The budget of GRI is in general composed of two sources: on the average, one third of GRI budget is funded directly by the government and the rest is filled with revenues from contract research. Incentive measures are to induce and assist private enterprises' technology development activities. The list includes tax-exemption for firm's R&D spending, financial support with preferential loans, and subsidy of technology development.

Table 1-10 | The Scheme of Korea's Industrial Technology Policy

	National R&D Programmes	Infra-structural & Diffusion	Institutional Support	Incentives
Objectives	To develop Core industrial technologies	To enhance intermediary functions and to fill the gap among innovation actors	To nurture GRI and to strengthen GRI's research capabilities	To induce/assist private enterprises' tech. Development activities
Tools	Ministries' R&D programmes	Research personnel, technical information, coop. R&D facilities, regional R&D centers, spin-off, etc.	Funding for GRI's operational expenses and "basic" research projects	Tax-exemption Financial support Subsidy for technology development
Effects On Industry	To expand knowledge/ Technology pool for industrial use	To facilitate diffusion and to make better industry's use of technologies	To bring up helper/partner for industry's tech. development	To strengthen industry's own technological capabilities

Source: Author's compilation.

5.2 Evolution of Korea's Incentive Schemes for Industrial Technology Development

The first incentive measure was applied in the early 1960s in which the corporate tax was deducted or exempted for FDI accompanies by technology requisite. Since then, a number of incentive measures were introduced during the 1970s. A majority of supportive measures implemented during this period, however, aimed to promote or facilitate technology transfer,

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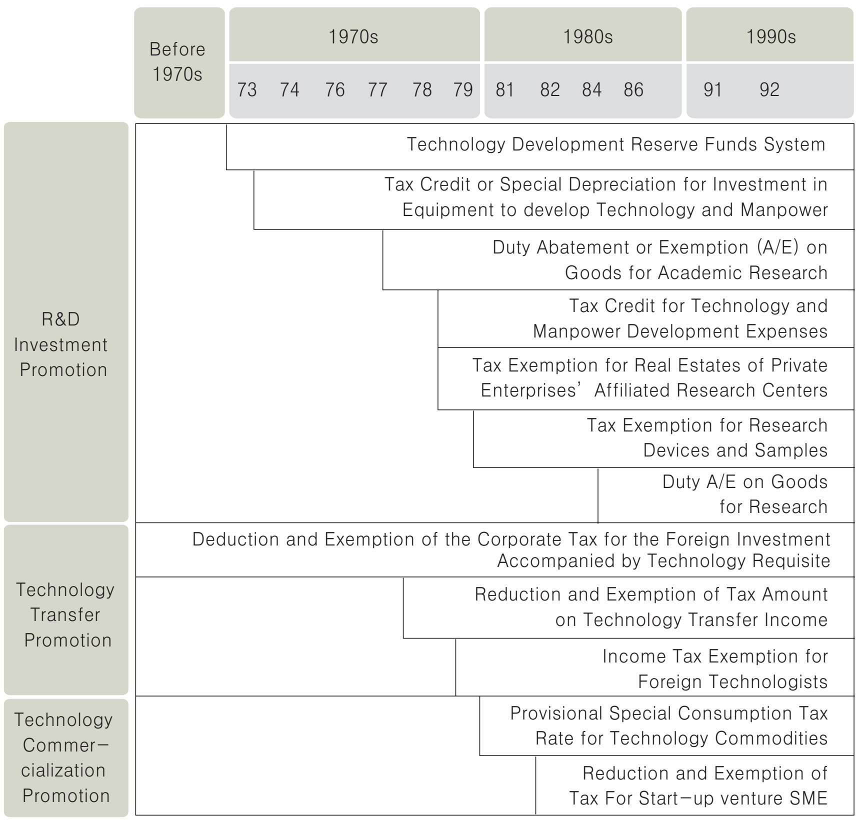
rather than internal R&D. The list of measures was considerably expanded or modified during the 1980s. The upsurge of incentive measures during this period was not accidental, rather it reflected the changes in private enterprises' technological activities - in-house R&D of the private sector was activated in much more bigger sale during the same period. Responding to this trend, the industrial policy of the government shifted the policy paradigm to promoting in-house R&D rather than technology import. This change was materialized by the enactment of "The Industrial Development Law", which marked a turning point of industrial policy from sectoral support to functional support. Afterwards, the direction of incentive policy is moving toward a more indirect way such as putting more weights on construction of science and technology infrastructure and development of human resources. Further, in accordance to the WTO's subsidy rule, industrial policy emphasizes R&D support, while reducing conventional measures.

Figure 1-2 | Chronology of Major Technology Policies



Source: Compiled from Ministry of Science and Technology, (1997b).

Box 1-1. The Efficacy of Government Policies (Kim, 2003)

Despite the wide and various arrays of policy measures for industrial technology development, there are very few studies on policy effectiveness. Exceptionally, the late Professor Linsu Kim made persuasive judgments on these from three aspects: (1) policies to create market needs for technology development, (2) policies to increase S&T capabilities, and (3) policies to provide the linkage between demands and supply.

Demand side policies can cover three areas: export promotion, competition policy and government procurement. Export promotion, by pushing firms into highly competitive international markets, has been more influential than other policies in forcing firms to expedite technological learning. Exporters also created capacity in excess of local market needs to achieve economies of scale; this led to crises and forced them to accelerate technological learning to maximize capacity utilization. Competition policies also increased the need for technological effort. The government enacted the Fair Trade Act in 1980 to prohibit unfair practices in the market and to restrict the growth of the chaebol. At the same time, the government began to liberalise the local market, bringing down tariff and non-tariff barriers, so forcing Korean firms to compete against multinational firms not only in the export but also in the domestic market. In 1986, the government introduced legislation to protect intellectual property rights, pre-empting the reverse engineering of foreign products. These policies forced Korean firms to further intensify technological effort. Government procurement is often mentioned in the literature as an important tool in creating local demand for technological effort. However, except for significant government procurement of personal computers at the formative stage of the industry in the early 1980s, this policy did not play a significant role in Korea in creating demand for technological effort.

Major supply-side policies cover human resource development, technology transfer and domestic R&D. The formation of human resources enabled Korean industry to master mature production technologies through reverse engineering in the early years. However, the Korean government made a critical mistake in neglecting to invest in research-oriented tertiary education in preparation for knowledge-intensive industries, creating a major bottleneck in innovative technological learning in the 1990s. Korea restricted reliance on FDI, enabling local firms to retain managerial independence and allowing them to set the direction of technological learning. The government gradually relaxed restrictions on licensing in the 1970s, as Korean industries progressed into more complex technologies. The government's role in R&D was relatively small relative to other countries, accounting for only about 20~25 percent of total R&D in the 1990s. The government's R&D was largely directed to keeping increasingly weaker GRIs afloat and to mission-oriented national projects. Some national projects had significant results, such as the development of electronic switching systems and CDMA mobile telephone systems. In general, however, R&D policy neglected diffusion-oriented projects like upgrading the quality of tertiary education and university research.

Preferential financing and tax incentives are the major instruments that lubricate the linkage process between demand and supply. The impact of the preferential financing on facilitating R&D

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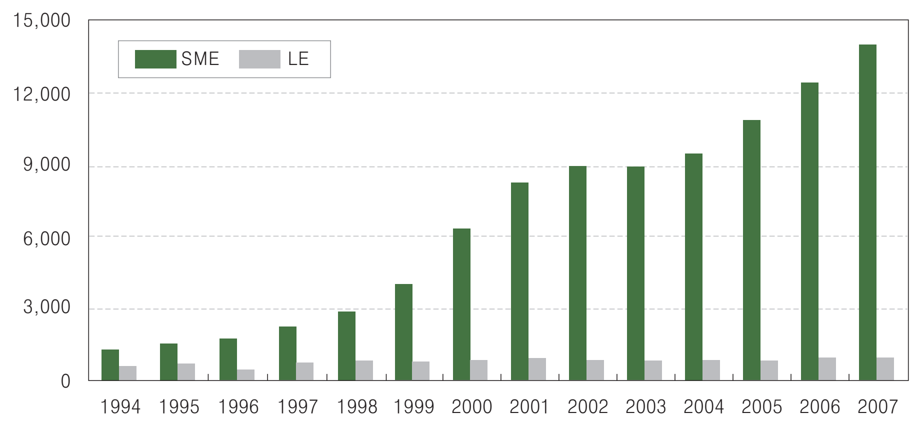
activities, however, is dubious. Its interest rates, ranging from 6.5 to 15 percent, were far higher than similar loans in other countries. Tax incentives were another indirect mechanism to make funds available for corporate R&D. Preferential financing and tax incentives definitely provided funds for corporate R&D activities and lowered their costs, but were peripheral in promoting R&D in Korea.

6. Changes after the Financial Crisis

6.1. Quick Recovery of Industrial R&D

The financial crisis in 1997 and the restructuring efforts afterwards have rendered an unexpected effect to the Korean business. Profitability comes to be recognized more important than market expansion. This is not the exception in the firm's spending for technological development. Companies, particularly large firms, have endeavored to downsize and streamline R&D laboratories in line with business restructuring. Large firms' downsizing movement has forced many R&D personnel to leave; and many of them have established small-scale specialized R&D laboratories or technology-based small firms. As is shown in <Figure 1-3>, the number of corporate R&D centers is increasing very rapidly after the financial crisis, and most of newly established corporate R&D centers are small-sized.[14] The increasing number of small-scale specialized R&D centers or technology-based small firms will change the industry's landscape. First, a direct effect is the increases in SME's R&D expenditure and intensity.

Figure 1-3 | Number of Corporate R&D Centers



Source: Korea Industrial Technology Association

Second, the existence of technologically agile small firms will make changes in business relationships, particularly between large firms and small firms. Supporting statistics are following. <Table 1-11> compares the changes in R&D expenditures and researchers between SME and large enterprises. SME' total R&D expenditures have doubled between 1997 and 2000, whereas large enterprises increase only by 5.1%. The increases in SME' total R&D expenditures are partly caused by the fact that the number of SME that spend in R&D activities is also sharply increasing, as is manifested by the sharper increases in the number of SME R&D centers.

The R&D intensities, defined by the ratio of R&D expenditures over sales, of SMEs are also increased from 2.8% in 1997 to 3.1% in 2000. In contrast, R&D intensities by large enterprises have decreased from 2.1% in 1997 to 1.8% in 2000. In sum, not only the number of those SMEs that spend for R&D is increasing, but also SMEs are more intensifying R&D activities than before the financial crisis. The same observation and the conclusion can also be applied to the case of researchers. During the period from 1997 and 2000, SMEs are strengthening their R&D activities by sharply increasing researchers, whereas the number of large enterprises' researchers remains almost the same as before.

Table 1-11 | The changes in R&D activities

	R&D Expenditure in billion won (As percentage of sales, %)				Researchers (Doctoral level)			
	1997	2000	2003	2006	1997	2000	2003	2006
SME	1,090.2 (2.82)	2,106.4 (3.14)	3,425.4 (3.57)	5,105.1 (3.28)	17,703 (474)	36,494 (1,543)	52,332 (2,291)	-
LE	7,755.1 (2.07)	8,148.2 (1.81)	11,084.2 (2.05)	16,021.7 (2.16)	56,990 (3,613)	57,839 (3,878)	71,698 (5,562)	-

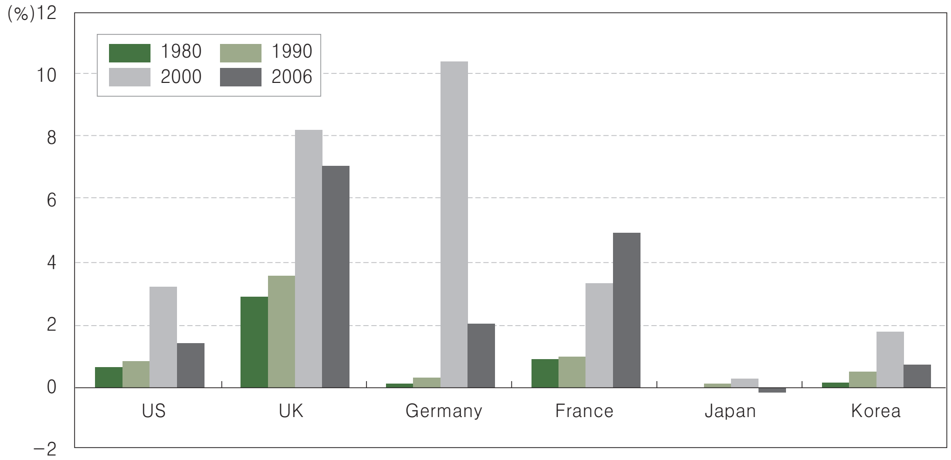
Source: MOST, Report on R&D Activities, various years.

14. In addition to the large firms' restructuring, there are other factors to contribute to the increases in small-sized corporate R&D centers. Among these are the government's drive to create "venture" companies and changed capital market conditions for start-up companies.

6.2. The Role of Foreign Owned Companies

Before the financial crisis, foreign owned companies had played a minor role in the Korean economy. As is shown in <Figure 1-4>, inward foreign direct investment (FDI) had been quite low for long years. Consequently, foreign owned companies had never played a significantly important role in the Korean economy. This is more evident in technology and innovation issues. Although heavily dependent upon foreign technologies, technology transfer in the private sector mostly went through licensing contracts rather than FDI. (OECD, 1996) And technological activities of foreign owned companies are mostly product modifications meeting to the local demand conditions.

Figure 1-4 | Inward FDI as percentage of GDP



Source: OECD, International Direct Investment Statistics Yearbook 2000.

The situation has drastically changed after the financial crisis of 1997. FDI inflows into Korea increased sharply thereafter. The sharp increase in inward FDI since 1997 was due to the favorable investment environment, depreciation in the local currency and asset values, the Korean government's promotion of investment through deregulation, increased number of company offerings as a result of corporate restructuring and privatization of government owned companies. (KPMG Consulting, 2001, p. 6.) What effects have the increases in FDI on the Korean industry's technological activities? It is not easy to give a concrete answer to the question, since no in-depth comprehensive study on the technology-related activities of foreign owned companies has been done yet. Instead, we will try to trace the changes that happened due to the increased FDI and to infer the implications of the changes to the Korean economy.

<Table 1-12> shows the number of foreign owned companies that spend for R&D, classified by the share of foreign ownership. The number has increased from 329 in 1997 to 462 in 2000, a 40% increase for three years. Among 462 companies in 2000, 333 are minority owned foreign companies and the remaining 129 are majority owned foreign companies. As is shown at the last column, the number of companies spending for R&D has also highly increased: from 2,522 in 1997 to 3,269 in 2000, a 30% increase for three years. Therefore, the number of foreign owned companies spending R&D outpaced that of domestic companies spending R&D.

Table 1-12 | Foreign owned companies that spend for R&D

	Share of foreign ownership			Total
	More than 0 and less than 50 %	50 to less than 100 %	100 %	
1995	236	23	15	274 (2,150)
1997	256	40	33	329 (2,522)
1999	287	97	61	445 (2,601)
2000	333	74	55	462 (3,269)

Notes: Numbers in parenthesis are total number of companies that spend for R&D.
Source: Ministry of Science and Technology, R&D Survey, each year.

6.3. Clusters and Regional Innovation System

As a means to industrialization, Korea has built many industrial complexes across the country. Building industrial complexes started from scratch at the beginning of the industrialization, since Korea was poorly endowed with natural resources and differences of industrial bases among localities were almost negligible. Population density might be a criterion: Seoul and its vicinities and urban areas have been favored as the industrial complexes, but there are great discrepancies across regions. According to Korea Industrial Complex Corporation, as of 2007, there exist 646 industrial complexes in Korea, which host 34,224 companies and employ 1,335 thousand workforces. The location of industrial complexes concentrates on two regions. Capital Region (Seoul and its vicinities, Inchon Metropolitan City and Kyong-gi Province) holds 41% of companies or 33% of employees; and, Southeast Region (Busan, Daegu, Ulsan, and Kyong-sang Provinces) holds 31% of companies, or 43% of employees. These two regions take three quarters of Korea's industrial complexes.

Building industrial complexes was intended to have synergic effects by amassing individual firms and related supporting institutions in one place. Naturally, industrial clusters mirror the regional distribution of industrial complexes. But the question is whether the industrial clusters act as a mechanism for interaction and learning and what can be expected from the clusters. If well connected, industrial complexes are valuable assets for the development of innovation networks and clusters. But most of Korea's industrial complexes do not play a mechanism for inter-firm networks and learning. There are various supporting institutions that aim to help resident firms, but the frequency of use and the degree of satisfaction of the services offered by these supporting institutions are below than expected. And only small portion of resident firms are doing collaborative R&D with other firms or innovation actors such as universities and government research institutes[15].

Against a role as the drivers of industrialization they have played in the past decades, industrial complexes or industrial clusters in Korea now face a new challenge: to become a more knowledge-based, technology-intensive centers of industrial activities. The existence of industrial base in a region greatly influences the nature of economic activities of the region. Together with other innovation actors and supporting institutions, industrial complexes can be the cornerstones of the regional innovation systems. The question is whether the industrial base in a region can act as a learning mechanism for the region. In this regard, most of industrial complexes in Korea face new challenges: transforming industrial complexes into innovation clusters.

As is the industrial activities and industrial complexes, there are wide differences in the region's research capabilities. Capital regions composed of Seoul, Inchoen and Kyonggi province take the lion's share of Korea's R&D resources, with an exception of Daejon where Daeduck science town is located.(<Figure 1-5>) Recently the Korean government started to develop innovation clusters and to construct effective regional innovation systems across the country. The main policy concern here is the recognition that most of industrial complexes that had developed until the early 1990s were centred on production base and will face the limits of further growth which necessitates innovation capabilities. Started with seven industrial complexes, the government tried to implement the concept and later expanded to include twelve regions. Among the government's initiatives, the most comprehensive one is the National Balanced Development Plan. The basic concept of the Plan, started in 2004, is to make regional economic development self-sustained and self- reliant for each region or province through combining research activities of university and public research institutions with industrial activities. Despite some success stories (see the <Box 2>), there are many tasks and difficulties to overcome to achieve the goal of establishing self-sustained regional

15. Kim and Suh (2003) have detailed analysis of Korea's major industrial clusters - Daeduck valley in Deajeon city, Gumi electronics cluster, biotechnology cluster in Kyonggi province, Daegu textile industry, and Changwon machinery industry. All these regional clusters are assessed whether they are acting as innovation clusters. They conclude negative assessments to most of Korea's industrial clusters.

innovation systems, among which the most important task is to strengthen the region's research and innovation capabilities, where local/regional universities are expected to play a key role.[16]

Box 1-2. The case of Wonju Medical Equipment Cluster

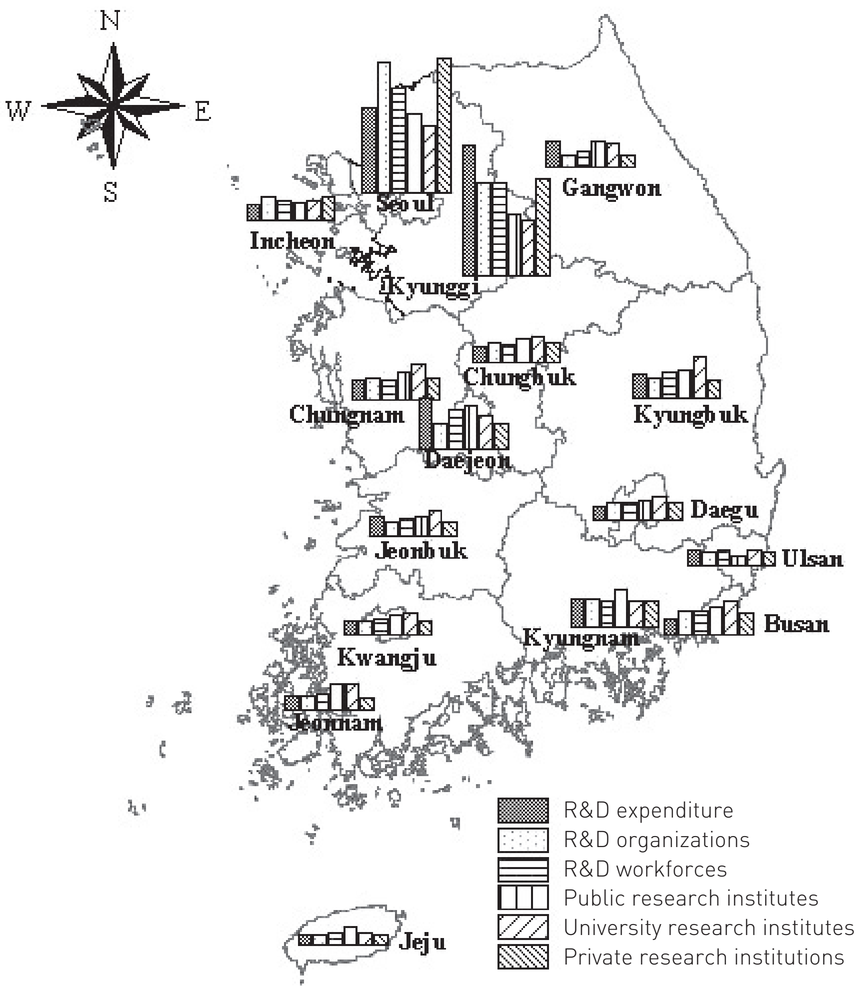
Gangwon-do Province has been the most underdeveloped region in Korea. Comprised of mountains and high hills, the Province's industrial activities are mostly centered on coal-mining and cement production with some agricultural products at high-mountain areas. However, the top export product of the Province has changed from cement to medical equipment since 2002 - the change was due to the development of Wonju Medical Equipment Cluster (WMEC). The Medical School of Yonsei University in Wonju campus in Gangwon-do initiated the concept of WMEC: combining university research to industrial development. Yonsei's Wonju Medical School has medical engineering department that has produced quality research and a large number of graduates for long years. The concept began to be materialized in 1996 when Wonju City government built a 10, 000 square-meter medical equipment production complex and tried to attract domestic companies therein. The choice of medical equipment complex was not accidental; Medison Co., one of the Korea's leading companies in medical equipment production, already had operated a plant near Wonju City with small number of part suppliers.

The development of WMEC has been underwent three ways - technology development, business incubation and production for the market. Yonsei Medical School plays a key role in technology development. Yonsei University created Medical Equipment Research Center at its Wonju campus and has been actively participated in Wonju Medical Equipment Technopark project where regional universities including Yonsei Medical School, Wonju Chamber of Commerce and Wonju City Government work together as partners. Business Incubation Center, where new businesses and new products are developed, is also a partnership project of these institutions including the City Government and local universities. Industrial complex established by the city government hosts those already established companies that are producing consumable products.

WMEC is a rare success case in Korea - creating new business through combining university research and industrial development. Three things contribute to the success of WMEC: the existence of quality research in the region, the financial support of the local government, and active participation from the industry.

16. Chapter 4 of this report deals with two clusters: Changwon machinery cluster and Ulsan automobile cluster. Despite their similarities as leading industrial complexes in Korea, the chapter contrasts the underlying factors that make two complexes differ in terms of innovation cluster.

Figure 1-5 | Regional distribution of R&D resources in Korea



Source: Courtesy to Dr. Kwon Young-Sub at KRIHS, based on the data from MOST (2004).

7. Conclusion and Policy Lessons

7.1. Strength and Weakness of the Korean Innovation System

Korea has made enormous development in science and technology over the past four decades. By making continuous and massive investments in human resource development and R&D, Korea succeeded in building up a unique innovation system on a barren land. The factors that have influenced the Korean Innovation System (KIS) the most are (1) outward-looking development strategy, (2) industry-targeting development policy, (3) large-firm oriented industrial policy, (4) human resources, (5) government-led S&T infrastructure building, and so on. These are also the sources of the strength and weakness of KIS.

The very strength of KIS is its dynamism that is fuelled by the strong commitment of the government to "technology-based national development" and private industries' efforts for competitiveness. Despite the short history of R&D, Korea has already harvested rich crops from the endeavor in the forms of patents, scientific papers, and exports of technology-intensive products, such as semiconductors, cellular phones, LCD, automobiles, and others.

Yet there are problems, too. R&D activities in Korea have grown very rapidly, led by private industries under active promotion policy of the government. Even though Korea spends larger share of GDP on R&D than other countries, it still lags far behind advanced industrial countries in terms of the absolute size of R&D expenditures. The challenge is how to overcome the disadvantage of being a small economy.

Second, the discussions so far show that Korea has reached near the level of an advanced country in terms of scientific and technological inputs, but also suggest that Korea still has a long way to go to reach advanced countries in terms of R&D productivity. The most important source of inefficiency is the lack of interactions and exchanges between the major actors of innovation, say, universities, research institutes, and industries. Inter-sector mobility of scientists and engineers is extremely low in Korea.

Third, the weakness in basic sciences poses a fundamental problem for KIS, because scientific capability determines the technological potential of a nation. Since the Korean R&D efforts have been devoted overly to industrial technology development, scientific research has been more or less neglected. The lack of strong scientific base already works as a limit to technological progress in Korea. The weakness in science as a matter of fact results not just from the funding policy that favors technology development but also from weak university research capability. Therefore, strengthening university research base poses one of the major policy challenges.

Fourth, excessive reliance on private industries for R&D investments has made the innovation system very vulnerable in two ways. On the one hand, the system places so much emphasis on applied research and development that it failed to build up a strong foundation required for the long-term development of science and technology. On the other hand, the R&D system responds too sensitively to changes in economic and business environments. For instance, large Korean enterprises responded to the financial crisis of 1997 by cutting their R&D spending by about 14 %, destabilizing the R&D system. If the crisis had continued for several more years, the whole system would have collapsed.

Fifth, despite the remarkable performance of Korean industries in technological development, Korean industries harbor fundamental structural problems that have to be redressed to sustain the technological dynamism. First, the extremely high concentration of R&D activities poses a serious problem. High concentration means that only a few large firms are actively involved in R&D, while others are not. If this persists for long, this will dichotomize Korean industries into technologically advanced and retarded firms and sectors. This will result in reducing inter-firm and inter-industry interactions that are the key elements of innovation. Second problem is the weakness of SMEs in R&D. This is important because even Chaebol companies would not be able to sustain competitiveness without technologically strong domestic SMEs. Third problem is the insufficient interactions between industries, universities and GRIs. The lack of active interactions between R&D performers makes the distance farther between labs and market.

7.2. Lessons for Latecomers

The Korean experiences offer some lessons for policy-makers responsible for education, trade, and technology development of developing countries. There is no doubt that education builds a nation's ability to absorb new knowledge and technology. Education gives rise to individual's initial tacit knowledge, which is an essential building block in technological learning. So the government should assume full responsibility for taking necessary measures to promote human resource development. For example, investing in education in advance, as Korea did in the 1960s and 1970s, is essential in laying a foundation for industrial development. To help the workers to cope with changes in technology, the government should provide vocational and technical training or take measures to promote such training at work places. As an economy develops toward an advanced level, technological competence becomes a critical factor. To build up the competence, it is required to nurture high-calibre scientists and engineers who are capable of dealing with the developments at scientific and technological frontiers. In other words, advanced education in science and technology should come first in preparing for entrance into a developed world. In the case of Korea, education and industrialization helped each other in sustaining and accelerating mutual development.

Education made technological learning and therefore, industrialization possible, while industrialization enhanced the rate of return on investment in education, further promoting demand for education.

Korea's industrialization evolved from imitation to innovation. In the initial stage, Korean industries attained technological capability through informal channels for technology transfer, such as OEM production arrangements, reverse engineering of imported machines, technical training as part of turn-key plant importation, and so on. Contrary to the experiences of other developing countries, FDI played a modest role in technological learning in the course of development in Korea. To lay the initial technological foundation, many Korean industries resorted to non-market processes, relying on the technological absorptive capacity of their workers for technology acquisition. This approach enabled them to acquire technology at lower cost and maintain independence in business operation. But Korea had to pay a great cost for this - it had to abandon many of the technological opportunities that foreign direct investors might have offered.

By adopting an outward-looking development strategy, the government drove Korean industries out into competitive international market, putting them under great pressure for technological learning and/or development. Korean industries responded to such pressures by investing heavily in technology development. By developing technological competence, they have been able to survive international competition, and establish world prominence in such high-technology areas as telecommunications, semi-conductor memory chips, LCD, automobiles, shipbuilding, and so on. Protectionist policy may be effective in creating initial market opportunities for domestic industries, but if such a policy is prolonged, industries will develop immunity against market pressure for innovation. It may be for this reason that export-oriented firms achieved technological learning more rapidly than import-substituting firms.

In sum, Korea owes very much to its human resource and the outward-looking development strategy for the technological development and industrialization. Two major lessons form the Korean experiences are: First, human resource is the key to science and technology development and thus to economic growth, and second, nothing can better motivate private businesses to invest in technology development than market competition. But for Korea to sustain the past development into the future, it has to further strengthen basic scientific research capability and improve framework conditions for innovation, the core of which is competitive market.

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Chapter 02

Development Strategy and Evolution of Turkey's Innovation System

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Chapter 02

Development Strategy and Evolution of Turkey's Innovation System

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1. Introduction

Turkey is one of the largest industrializing countries in the world. It has now established a considerable industrial base, and specialized mostly in medium-technology (automobiles, consumer durables, chemicals, etc.) and low-technology industries (textile and clothing, food, etc.). Purchase of imported machinery and equipment had been the main form of technology acquisition during its industrialization drive until the end of the last millennium.

Turkey is now at cross-roads. The last decade (1990s), characterized by growing public deficit, unstable macroeconomic environment, boom-and-bust cycles, and mediocre productivity growth, proves that the mode of development based on imitating foreign technology is not sustainable. The attempt, against all odds, to establish a national system of innovation in the same decade, and the surprisingly successful cases of certain industries and firms point to another option for industrial development: Turkey could establish a well-functioning national system of innovation, and carry on its drive for industrialization through innovation.

This chapter presents a short description of industrial development and the evolution of the innovation system in Turkey since the early 1960s. It identifies major periods of industrialization and technology development, explains the developments in technology policy in the 1990s, and draws lessons for technology policy for sustainable development.

2. Industrialization and Technology Development

2.1. Initial Settings and Long-term Growth Cycles

The Turkish economy has experienced distinct growth cycles since the establishment of the Republic of Turkey in 1923.[17] A descriptive analysis of the patterns of GDP growth reveals that we can identify five growth cycles in the Turkish economy (see Figure 2-1). The beginning and the end of each cycle were marked with a major economic and/or political crisis. The mode of development, economic policies and the growth performance also differ from one cycle to another.

The first cycle is observed from the establishment of the Republic until the Second World War. The government in the early years inclined to follow a "free-market" approach, but after the Great Recession in 1929 that also severely affected the Turkish economy through weakening external trade links, the government adopted a state-led industrialization policy. The aim of the industrial policy was to establish "main" industries (textile, food, chemicals and light engineering) by the state. This period is characterized with high but widely fluctuating growth rates generated by a weak and underdeveloped economy with almost no industry at the very beginning. During this period, the share of agriculture in GDP remained around 45 percent, and the share of industry increased in the 1930s, from 12.1 percent in 1928 to 18.8 percent in 1939.

The period from the Second World War to the 1960s is the period of transition towards a multi-party political system, and gradual opening of the economy to the world markets. Although the economy achieved rapid growth in the first half of the 1950s, the growth rate declined sharply in the late 1950s. During this period, the state channelled its investment mostly towards infrastructure (such as roads, ports, energy generation) and there was a moderate increase in the share of the industry in GDP. The main drive for industrialization came in the third period after 1960.

2.2. "Planned" and "Export-led" Industrialization

The period from the 1960s to 1980s is characterized by import substitution industrialization (ISI) policies. The State Planning Organization (SPO) was established in 1960 to prepare five-year development plans covering all aspects of economic development and the new constitution, adopted in 1961, envisaged (indicative) planning as a major tool for economic development.

17. For detailed information on the Turkish economy, see Boratav et al. (1996) and Kepenek and Yent?rk (2008).

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The Scientific and Technical Research Council of Turkey (TUBITAK) was established in 1963 to develop science and technology policies in line with the development plans, and to support and to conduct basic and applied research in "natural sciences." The second (1968-1972) and third (1973-1977) 5-year development plans emphasized the importance of technological development and technology transfer as drivers of economic growth. The concept of "technology policy" was introduced in the fourth 5-year development plan (1979-1983). During this period, TUBITAK put more emphasis on "scientific research" than on "technological development."

The state played an active role in developing a number of industries that produce intermediate products and machinery and equipment through state-owned enterprises (SOEs). Foreign direct investment (FDI) remained at very low levels, and technology transfer from abroad was regulated and monitored by the SPO. Growth rate of GDP per capita was quite high until the late 1970s (about 3-4 percent per year on average), but it proved impossible to sustain high growth rates after the oil price hikes in 1974 and 1979. Poor export performance and growing import bill led to a serious balance of payments crisis, and the economy fell into a crisis in 1979-1980.

The government announced a comprehensive stabilization program, backed by the IMF, in January 1980. The program was implemented by the military government that took over in September 1980. The long-term aim of the program was to change the structure of the economy by removing the dominance of the state in key industries, and to adopt an export-oriented "growth" strategy. The government used generous subsidies to promote exports, which were also encouraged by a sharp real devaluation of the Turkish Lira. The import regime was completely changed: quantitative restrictions and non-tariff barriers were eliminated gradually in the first half of the 1980s, tariffs were reduced in the late 1980s, and Turkey joined the Customs Union (CU) with the European Union (EU) in 1996.

The government removed a number of barriers to foreign investment in the second half of the 1980s (requirements on local equity participation, restrictions on the transfer of earnings, etc.). Moreover, the capital accounts were fully liberalized in 1989. As a result of these policies, the FDI inflows increased substantially, from about US$ 100 million per year in the 1980s to about US$ 1,000 million in the 1990s. Although its share is declining over time, the manufacturing industry alone accounted more than half of cumulative authorized FDI in the 1980s and 1990s.[18]

18. Privatization of public assets has attracted substantial FDI after 2002, and annual FDI inflows reached US$9.8 billion in 2005 and US$19.8 billion in 2006 (see the web site of the Undersecretariat of Treasury, www.treasury.gov.tr).

The manufacturing industry responded rather swiftly to export promotions, the real devaluation of the Turkish Lira, and real wage cuts in the early 1980s. The value of exports jumped from US$ 2.9 billion in 1980 to US$ 7.1 billion in 1984. The manufacturing industry was the engine behind the export boom. The share of manufactured products in exports increased from 36 percent in 1980 to 72 percent in 1984. Exports continued to grow at very high rates in the 1980s, and reached US$ 13 billion in 1990. The growth rate of exports was lower and erratic in the 1990s, but nevertheless the value of exports increased US$ 28 billion in 2000.[19]

Manufacturing output increased rather rapidly in the 1980s. The average growth rate of real manufacturing output was slightly higher than 8 percent in the period 1983-1993. However, the instability has increased substantially since the early 1990s due to growing public deficits and capital account liberalization, and the economy trapped into boom-and-bust cycles in the 1990s. There were three major crises over a short time period (1994, 1999 and 2001), during which the manufacturing output declined sharply. The last crisis in 2001 was the most serious one, and marked the end of the fourth growth cycle that started in 1980.[20]

“Science and technology policy” was not on the agenda for policy makers in the 1980s. The first comprehensive policy document, titled “Turkish Science Policy: 1983-2003” was prepared by SPO and TUBITAK in 1980. The document presented a detailed policy for scientific and technological development, set ambitious goals, and envisaged the establishment of a new institution, the Supreme Council for Science and Technology (BTYK), chaired by the Prime Minister, to design, coordinate and implement science and technology policies in Turkey. The proposals suggested in the document were ignored by the government, and the BTYK, which was supposed to meet bi-annually, had its first meeting in 1989.

The BTYK had its second meeting in 1993, and accepted another policy document, this time titled as “Turkish Science and Technology Policy: 1993-2003,” which laid down the foundations of technology policy in the 1990s. This document, together with the Seventh 5-Year Development Plan (1996-2000), explicitly mentioned that the main aim of technology policy in Turkey should have been the establishment of a well-functioning national system of innovation (NSI), and proposed a number of new initiatives and institutions that form the NSI. Although the rising instability and the subsequent boom-and-bust cycles created a hostile environment for any long term investment, including R&D, the governments in the mid-1990s introduced R&D support schemes and a number of new programs without a coherent and systematic framework.

19. In the same period, imports increased at almost the same rate, from US$ 7.9 billion in 1980 to US$ 22.3 billion in 1990, and US$ 54.5 billion in 2000.
20. The economy achieved very high growth rates after the 2001 crisis (the average annual growth rate of GDP was 7 percent in 2002-2007). The post-crisis performance raised the issue of achieving the sustainability of high growth rates for a long time period.

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2.3. Comparative Patterns of Productivity Growth and Structural Change

In order to assess the performance of the Turkish economy, it would be necessary to conduct a comparative analysis. GDP per capital in Turkey relative to the US for the 1960-2007 period is depicted in Figure 2-2. The data for Korea, a case for a rapidly growing and industrializing country, are also presented in the same figure for comparison.

There seems to be no convergence in GDP per capita in Turkey and the US. GDP per capita in Turkey was around 20 percent of the US level in the 1960s, and after a slight increase, it remained stable within the 20-25 percent range since the early 1980s. As a result of rapid growth in Turkey, there is a sharp improvement in relative GDP per capita after the 2001 crisis. The Korean economy, after a decade of stable level at 10 percent of the US income, started to grow rapidly in the mid-1960s, and reduced the gap with the US.

It is possible to decompose the sources of growth in GDP per capita into three components, employment ratio, working time, and labour productivity per hour worked, as follows:

$GDP/P = (GDP / H)(H / E)(E / P)$ where P denotes population, E the number of employed people, H the average annual number of hours worked per employee. The employment ratio, E / P is determined by the unemployment ratio (U / L) and the labour market participation rate (L / P), where L is the number of people in the labour market. GDP per hour worked, GDP/H, is the proper labour productivity variable, and it reflects the effects of technological change in the long term.

The employment ratio in Turkey and Korea relative to the US is shown in Figure 2-3. There is a sharp reduction in the relative (and absolute) employment ratio in Turkey since the early 1960s as a result of high birth rates (that leads to an increase in the share of young people), and urbanization (the labour market participation rate among urban women is very low). Korea, on the contrary, experienced an increase in the employment ratio during the same period.

The average annual working time depicts diverging patterns for Turkey and Korea. Although there is a slight decrease in the relative working time in Turkey,[21] it increased rather sharply in Korea in the 1960s and 1990s, and started to decline gradually in the 1990s.

When we eliminated the effects of changes in the employment ratio and working time from

21. There is indeed no data on the average annual working time in Turkey for that period, and the data for Greece were substituted for Turkey. Since the relative change during the whole time period is less than 10 percent, the results would not differ much had we assumed even a constant level.

the changes in GDP per capita, we will end up with the labour productivity per hour data which are depicted in Table 2-4. The growth rate of relative labour productivity in Turkey was slightly higher than the growth rate of labour productivity in Korea in the 1960s and 1970s (3.2 percent vs. 3.0 percent, from 1964 to 1978). Turkey continued to improve its productivity level relative to the US in the 1980s, but Korea achieved faster growth in the same period. Macroeconomic uncertainties and boom-and-bust cycles had negative impact in the 1990s, and Turkey did not improve its relative productivity for a long time, whereas Korea continued to increase its productivity almost at the same rate it had achieved in the 1980s.

Our descriptive analysis indicate that labour productivity is not the main factor that is to be blamed for poor performance of the economy since the early 1960s, but the declining employment ratio had played a very important role.

The data on the structure of the economy provides an explanation on the weak employment performance of the Turkish economy. Figure 2-6 shows the changes in the structure of the Turkish and Korean economies from 1960 to 2007. The figure is arranged so that the location of the country on the triangle shows its structure. If agricultural sector constitutes all GDP, the country will be located on the bottom-right corner, whereas a country specialized completely in services will be located at the top corner.

As shown in the figure, Turkey and Korea had a structure dominated by agriculture and services (the share of agriculture was 36 percent in both countries, and the share of services was 46 percent in Turkey and 48 percent in Korea in the first half of the 1960s). Korea achieved a rapid industrialization in the 1960s and 1970s so that it moved quickly towards the “industry” corner, and there was a structural change favouring mostly services in the 1990s. As a result of this rapid transformation of the Korean economy, the share of industry in GDP exceeded 40 percent in the late 1980s. Turkey, on the other hand, had a slow structural change toward industry and services in the 1960s and 1970s. The share of industry reached its maximum level in 1988 (27 percent), then it remained almost constant in the 1990s. The lack of employment generation in urban sectors (industry and services) in Turkey seems to be the main cause of the decline in the employment ratio since the early 1960s.[22]

The structure of the industry has also evolved differently in Turkey and Korea. Following the OECD classification, the manufacturing value added is classified into three categories, low-technology, middle-technology and high-technology. In the early-1960s, Turkey and Korea had a similar industrial structure which is characterized by the dominance of low-tech industries like textiles, food, etc. Korea had a rapid change in the structure of the industry towards high-

22. The low level of labor market participation rate among urban women in Turkey explains to a large extent the decline in the employment ratio in that period.

technology and medium-technology industries since the early 1970s so that at the end of the second millennium, high-technology and medium-technology industries accounted for 21 percent and 39 percent of manufacturing value added, respectively.

Turkey achieved a rapid industrial transformation in the 1960s and 1970s toward medium-technology industries thanks to the planned development strategy that aimed at establishing intermediate inputs producing sectors through state-owned enterprises. However, the export-led "growth" strategy reversed that trend in the early 1980s because the export boom of the early 1980s was achieved mostly by low-technology industries. The structure of the industry moved towards medium-technology industries in the late 1980s and 1990s at a very slow pace. The lack of restructuring of the industry towards high- and medium-technology industries is another factor that contributes to poor productivity performance, especially in the 1990s, because it caused a break in the process of accumulating technological capabilities.

Box 2-1. Technology acquisition and capability building in petrochemicals industry

The petrochemicals industry received a special attention during the early "planned development" era of industrialization. After the establishment of petroleum refineries in the 1950s and early 1960s, the policy makers in Turkey perceived the development of the petrochemicals industry as the next step forward because the petrochemicals industry, one of the main users of petroleum refineries, achieved high growth rates in developed countries after the Second World War. The private sector itself also supported the idea of developing a petrochemicals industry in Turkey.

Petkim, a state-owned petrochemical company, was established in 1965 and its first plant in Yarimca began operations in 1970. The feasibility study for the Aliaga plant was completed in 1974, and all license agreements were signed in 1976-77. But construction was not completed until 1985 because of the lack of financial resources. The Aliaga plant went into operation in 1985, and its initial ethylene production capacity was 350,000 t/year, i.e., at the efficient scale when its project was prepared. The feasibility study for the third plant was prepared in 1992. Although the study suggested that it would be feasible to establish another plant with 500,000 t/year ethylene capacity in Aliaga, it was never realized.

The development of the petrochemical industry depends on the accumulation of investment capabilities that are crucial in establishing better plants at low cost during the development process. Investment capabilities in the petrochemical industry could be classified into three groups: license (the process technology itself), engineering and procurement (design and development of process equipment), and construction and assembly (installation and, in some cases, production of certain components).

Process licenses, and engineering and procurement services were acquired from various well known petrochemicals and engineering companies in the case of Yarimca plant. Foster-Wheeler was the main constructor. In the case of Aliaga plant, licenses and major engineering services were obtained from foreign countries, but detailed engineering activities were performed by domestic companies, and construction and assembly activities were assigned to domestic companies. The plant was started up by Petkim personnel experienced in the Yarimca plant.

The accumulation of domestic technological capabilities have followed a logical sequence: First, the company itself has acquired operational capabilities at the Yarimca plant; Second, while using that operational experience at Aliaga, domestic firms started to perform engineering, construction and assembly activities. In the next step, i.e., in the third plant, domestic firms would be expected to move upward towards technologically sophisticated activities like engineering and procurement, and to use their knowledge in other developing countries. However, the accumulation of technological capabilities has come to a halt with the interruption of further investment although the SPO, in the early 1970s, had planned to establish four petrochemicals plants in two decades: the first one in Yarimca was already operational in 1970 (60,000 t ethylene capacity). Other plants would have begun their production in 1979 (350,000 t), 1986, and 1991 (DPT, 1974: 18). However, the second one in Aliaga (350,000 t) had to wait until 1985, and the third plant was never established. The timing of the establishment of petrochemicals plants in Korea is strikingly similar to the initial plans of the SPO. The first plant was built in Korea in 1972 (two years after the Yarimca plant, with 155,000 t ethylene capacity), and the next ones in 1979 (355,000 t), 1989 (two plants, 650,000 t), and 1991 (300,000 t). New plants and expansion projects helped to boost the ethylene production capacity that exceeded 5 million t in the late 1990s. The tale of the petrochemical industry in Turkey shows the importance of the continuity of investment activities for the accumulation of technologies capabilities and technical change in technologically advanced sectors.

3. Domestic Technological Activities

As the descriptive analysis in the previous section shows, Turkey achieved rather high productivity growth in the 1960s and 1970s, but the productivity performance was weak especially in the 1990s. The sources for technology acquisition will be analyzed in this section to understand changes in the productivity performance. Because of data availability, the analysis will be focused on manufacturing industries.

There are two main sources of technology acquisition: indigenous technological activities and technology transfer. It is generally assumed that research and development (R&D) activities are the main input for in-house, indigenous technology development.[23] A firm can also acquire

23. R&D activities could enhance a firm's absorptive capacity so that an R&D performer could benefit more from technology transfer, i.e., R&D may have two faces (see Cohen and Levinthal, 1989).

a new technology by transferring it from others through license and know how agreements, embodied in machinery and equipment, or imitation.

3.1. Technology Transfer

License and know how agreements are frequently used by developing countries to transfer technology from technologically developed countries. Although there is no historical data on license and know how expenses in Turkey, we can use some proxy variables to understand the extent of its use by manufacturing firms.

The Turkish Statistical Institute (Turkstat) collects the data on technology transfer through the Annual Survey of Manufacturing Industries from all manufacturing establishments that employ at least 10 people. The proportion of firms that transferred technology from abroad through license and know how agreements has been very low in Turkish manufacturing (less than 2 percent in the 1980s and 1990s).[24] However, technology transferees are usually large firms so that it would be more informative to look at their market shares.

Table 2-1 provides the data on the market share of technology transferees in low-technology and medium-technology industries.[25] As may be expected, technology transfer from abroad is more important in medium-technology industries than in low-technology industries. Because of mature and relatively simple technologies used in low-technology sectors, domestic firms do not need to transfer technology from abroad. The market share of technology transferees remained less than 15 percent throughout the period. Technology transfer played a more important role in medium-technology industries where the market share of technology transferees was above 30 percent in the mid-1980s. The number of technology transferees, and subsequently their market share, increased gradually until the 1994 Crisis (45 percent in 1993). There is a rapid decline in the market share of technology transferees in the turbulent years of the 1990s (to 32 percent in 2001).

FDI is often regarded as an important channel through which domestic firms acquire (foreign) technologies. Foreign firms are, by definition, multinational firms and they are likely to have advanced technologies. Domestic firms could imitate foreign firms' technologies, or they could be forced to adopt new technologies because of the competitive pressures exerted by foreign firms.

24. Since Turkstat introduced a major change in survey methodology in 2002, we use the data for the 1982-2001 period.
25. Because of its small size, high-technology industries are grouped together with medium-technology industries.

The market share of foreign firms increased rapidly, especially in medium-technology industries, in the late 1980s as a result of green-field entry and acquisition of domestic firms. Their share was slightly above 20 percent in medium-tech industries in the mid-1980s, but reached 40.6 percent in 1993. It is interesting to observe that the share of foreign firms declined sharply during the 1994 Crisis (37.2 percent) and recovered afterwards, reaching 45.8 percent in 2000. However, the 2001 Crisis had stronger effect on foreign firms so that their market share in medium-technology industries dropped to 42.6 percent in 2001.

The entry of foreign firms into low-technology sectors has been limited, possibly because of the fact that domestic producers were quite competitive in these sectors. The share of foreign firms in low-tech industries increased slightly in the second half of the 1980s, but remained less than 14 percent throughout the 1990s.

Strong foreign presence in the market is neither sufficient nor necessary for transfer of technology from foreign to domestic firms. An econometric study on spillovers (Lenger and Taymaz, 2008) suggests that there are no spillovers from foreign firms to domestic firms operating in the same industry, i.e., horizontal spillovers do not make any significant contribution to technological activities of domestic firms. The effects of foreign firms on technological activities of other firms in vertically related industries (vertical spillovers) are weak and ambiguous. The main channel of spillovers from foreign firms is labour turnover: the transfer of workers, formerly employed by foreign firms, constitutes an important channel for technology transfer.[26]

Finally, embodied (foreign) technology can be transferred through acquiring (foreign) machinery and equipment. As a proxy for embodied technology transfer, we look at the changes in investment intensity (investment expenditures/value added ratio) for manufacturing industries (Table 2-1). Investment intensity increased in medium-technology industries in the mid-1980s during the export boom, but it remained stable within 10-15 percent range in the 1990s in both low- and medium-technology industries. The investment data indicates that the Turkish manufacturing firms had acquired foreign technology embodied in machinery and equipment possibly at a lower rate in the 1990s than in the 1980s. For a comparison, recall that the investment intensity in the Korean manufacturing had been close to 30 percent before the 1997 Crisis, and it declined dramatically after the crisis but still remained quite high compared to the industrial countries (around 16 percent in the early 2000s). The same rate, for example, in the US was only about 8 percent in the same time period.

The share of capital goods (machinery and equipment) in imports and exports can be used

26. This finding reveals the importance of tacitness of knowledge that makes it difficult to transfer technology through passive mechanisms (demonstration effects, reverse engineering, etc.).

to assess both the extent of embodied technology transfer from abroad, and the type of specialization within the world economy. In the early 1980s, the share of capital goods in imports was much higher than its share in imports (20 percent vs. 5 percent). The share of capital goods in imports increased rapidly in the second half of 1980s and reached 37 percent in 1993. There has been a gradual but continuous decline in the share of capital goods imports since 1997 because of rapid rate of growth in intermediate and consumption goods imports. The share of capital goods in exports was almost constant during the 1980s, but it had achieved a remarkable growth in the 1990s so that it increased from 5 percent in 1990 to 19.7 percent in 2001. The increase in the share of capital goods in exports is an indication of the structural change in manufacturing industries towards medium-technology sectors, because a large part of the increase in capital goods exports is accounted by non-electrical machinery and motor vehicles.

3.2. Domestic R&D

R&D activities constitute a major input for indigenous innovative activities even if firms, especially small and medium-sized firms, could innovate new products and processes without any formal R&D.

Turkstat, cooperating with TUBITAK, started to collect the data on R&D activities on a permanent basis in 1990. Therefore, the data on R&D activities before 1990 are not available. There is some anecdotal evidence that suggest that the number of R&D performers in the 1980s was very low. For example, one of the major R&D performers and the leading consumer durables producer in Turkey, Arcelik, has established its R&D division in 1991 as a result of difficulties in getting licenses for new products.

The proportion of R&D performing firms was only about 1 percent in the early 1990s. The number of R&D performers increased gradually in the first half of 1990s (1.4 percent in 1995), but thereafter, following the introduction of public R&D support scheme, their proportion increased substantially, to 2.1 percent in 1997, and 2.5 percent in 2000.

The share of R&D expenditure in GDP was low and did not show any upward trend in the first half of 1990s (see Table 2-2).[27] R&D expenditures started to increase rapidly after the 1994 Crisis so that the share of R&D in GDP had an upward trend, and grew almost 0.5 percentage points in ten years. The numbers of R&D personnel and researchers has increased at almost the

27. Turkstat modified substantially its methodology for calculating national accounts and revised GDP series in 2008. Therefore, we present the R&D/GDP data by using both the “old GDP series”, and the new revised one (“new series”) in Table 2-2. The revised GDP estimate for 2007 is about 30 percent higher than the former estimate.

same rate, and the number of R&D personnel per 10,000 people jumped from 8 in 1994 to 30 in 2007.

The increase in R&D expenditure since the mid-1990s is accompanied by a remarkable change in the composition of R&D activities as well. The private sector has played an increasingly important role both in funding and in performing R&D. The share of the private sector in R&D funding was around 30 percent in the first half of the 1990s, but it increased, with some fluctuations, to 46 percent in 2005-2007. Foreign sources had a negligible share in R&D activities throughout the period.

More than 60 percent of all R&D was performed by universities in the late 1990s. However, the share of the private sector in R&D increased rapidly after 2003 and reached 41 percent in 2007, and the share of universities declined to 48 percent in the same year. The rest of R&D (about 11 percent) was performed by the public sector including TUBITAK research centres.

The analysis on domestic technological activities shows that indigenous technological activities in Turkey have been very weak in the 1980s. License and know how agreements and acquisition of (foreign) machinery and equipment were the main sources of acquiring (foreign) technology. FDI played more important role since the late 1980s. Domestic R&D activities received more attention in the mid 1990s. There seems to be a “structural break” in R&D expenditures in 1995. The average annual growth rate of real R&D expenditures was almost three times higher than the growth rate of real GDP, so that the share of R&D expenditures in GDP increased rapidly, from 0.37 percent in 1998 to 0.71 percent in 2007 (revised GDP series).[28]

In spite of the rapid growth in domestic R&D since the mid 1990s, the growth and productivity performance of manufacturing industries in particular was unsatisfactory. However, the benefits of R&D seem to be realized in medium and long term. The data on the number of scientific papers reveals a substantial increase in scientific output (Table 2-4). The number of papers published in scientific journals covered by SCI, SSCI and A&HCI increased 18 percent per year from 1995 to 2002. The rate of growth in scientific output exceeds by far the growth rate of R&D expenditures in Turkish universities. Although scientific activities respond rapidly to new incentives and R&D funding, the response of technological activities is slow and observed with a considerable lag. The data on patent applications to and patents granted by the Turkish Patent Institute show that domestic patent applications took off only in the early 2000s, and the number of patents granted to domestic firms and individuals had a noticeable increase in the last couple of years (Table 2-4).

28. The average annual growth rate of real R&D expenditures was about 12 percent in the period 1998-2007.

Although there is no long term data on innovations, the surge in R&D expenditures is expected to enhance innovativeness of domestic firms. A recent survey on Turkey reveals that more than half of firms operating in electrical machinery and equipment and motor vehicles industries introduced product innovations (new products) in 2005 whereas the proportion of innovative firms is lower in traditional sectors like textile and food and beverages (Figure 2-8). It is thus not accidental that these two sectors, motor vehicles and electrical machinery and equipment sectors have been the engine of growth and exports after the 2001 Crisis in Turkey. The evolution and performance of these two sectors will be studied in detail in Section 6 of this chapter.

4. Government and Public Sector R&D

The government adopted import-substituting industrialization policies in the early 1960s and the Scientific and Technical Research Council of Turkey was established in 1963 to develop science and technology policies. The first 5-year development plan (1963-1967) charged TUBITAK to organize, coordinate and encourage basic and applied research in "basic sciences".[29] Consequently, TUBITAK focused its activities on basic (scientific) research and education of scientists, and its main research institute (the Marmara Scientific and Industrial Research Institute) was established in Gebze in 1972. As a result of the lack of a systematic and consistent technology policy, large state-owned enterprises that dominate certain industries[30] had to rely on transferring technology from abroad. They accumulated substantial technological capabilities through technology transfer. Unfortunately, these enterprises could not continue to build up and to benefit from their technological capabilities in the 1980s because they were denied to carry on investment activities under the new policy environment that aimed at eliminating all SOEs in the economy (for the case of petrochemical industry, see Box 2-1). There was not any noteworthy initiative that aimed at influencing the rate and direction of technological change in Turkey in the 1980s.

There were a number of attempts in the 1990s to develop a consistent technology policy. There were two notable initiatives undertaken by the government in the 1990s: the Technology Development Foundation of Turkey (TTGV) was established in 1991 to provide R&D support in the form of interest-free loans, and the Technology Monitoring and Evaluation Board of TUBITAK (TIDEB) started to give grants for R&D activities in 1995. These new initiatives

29. For the evolution of science and technology policies in Turkey, see Arıkan et al. (2003).
30. The SOEs produced more than 50 percent of output in 1980 in meat, sugar, alcoholic beverages, tobacco, pulp and paper, fertilizers, plastics, petroleum refineries, iron and steel, agricultural machinery, ship building, and manufacture of railroad equipment industries.

were instrumental in raising R&D expenditures after 1995, as it was discussed in detail in the previous section. The government provided substantial funding for public R&D (mainly through TUBITAK) after 2005.

4.1. Evolution of Public Sector R&D

After decades of neglect and lack of funding, public expenditure on R&D increased substantially after the 2001 Crisis. The Supreme Council for Science and Technology (BTYK) set the target for R&D/GDP ratio as 2 percent for 2010 at its 10th meeting in September 2004, and, for the first time, public funds were allocated specifically for R&D in the central government budget starting in 2005.

The detailed data on public expenditures on innovation and technology programs since 2005 are shown in Table 2-5. Total annual public expenditure amounts to one billion US$ per annum during the 2005-2008 period. TUBITAK, as a funding agency, gets the largest share of the public funding (about 30 percent), but a substantial part of TUBITAK budget is used to finance industrial and academic R&D projects. TUBITAK is also an R&D performing agency, and its research centres have received about 10 percent of public funding.

About one fifth of public funding for R&D is provided directly to universities. The share of universities has declined to some extent in the last four years. Universities could also get public funding from TUBITAK for their research projects (see “academic research projects” in Table 2-5).

The share of other public research institutions (RDIs) is very small (in total, less than 2 percent). The Nuclear Energy Council (TAEK) has the highest share among public RDIs. Although its R&D funding doubled in 2006 and 2007, its share in total public funding is around 1 percent.

The Ministry of Industry and Trade had also a remarkable increase in its R&D funding, but the budget for its affiliate organization, the Small and Medium-sized Industry Development Organization (KOSGEB), experienced almost a compensating decline in 2006. TTGV and the Undersecretary of Foreign Trade had sizable budgets (in total, about 6 percent of public funds). Note that these two institutions provide R&D funding, mostly for the private sector.

The data on public sector R&D reveal that most of public R&D is concentrated in universities. TUBITAK’s research centres constitute the backbone of public RDIs. Other institutions seem to play only a secondary role in public R&D in Turkey.

There are four main socio-economic objectives that account for almost 80 percent of public R&D: Exploration and exploitation of the Earth, agricultural production and technology, industrial production and technology, and defence technologies (Table 2-6). It is interesting to observe that public R&D expenditure on health, environment and energy is very low. Given the fact that these are technologically dynamic and economically important fields of research, the lack of any apparent upward trend in R&D expenditures in these fields is worrying.

4.2. Universities

Universities are the main R&D performing sector in Turkey. They account almost half of R&D performed in Turkey in 2007. In terms of researchers, their share is much higher: 66 percent of all R&D personnel in Turkey are employed by universities. Since the R&D personnel in universities are also involved in teaching activities, the share of universities in R&D personnel in terms of full-time equivalent is somewhat lower (47 percent).

The R&D personnel employed in universities are of high-quality. About 95 percent of research scientists and engineers with PhD degree are employed in universities (90 percent in terms of full-time equivalent).

Most of the funding for R&D performed in universities comes from public sources (see Table 2-7). The share of the private sector in university-performed R&D is low but is increasing steadily (from 18 percent in 1996 to 23 percent in 2007). Universities do not attract much foreign funding for their R&D activities.

Almost half of R&D has been performed in health sciences in the last decade, but its share declined sharply from 62 percent in 1996 to 41 percent in 2003. The figures on R&D performed by universities on health sciences (Table 2-7) and the share of public R&D for "protection and improvement of human health" (Table 2-6) seem to be inconsistent. The figure for the share of health sciences in R&D performed by universities (Table 2-7) is significantly higher than the share of health sciences in public R&D because the former data include a part of gross salaries of academicians and other university personnel whereas the latter data include only expenditures for research projects.

Social sciences, engineering, humanities and natural sciences have all increased their shares in university-performed R&D in the late 1990s, whereas there is a continuous decline in the share of agricultural sciences. Note that these trends merely reflect shifts in the shares of academic personnel in the respective fields which are changing independent of any science and technology priority set by the government.

5. Supportive Measures for Industrial Technology Development

There has been a radical change in technology policy in Turkey in the 1990s as a result of determined efforts of TUBITAK. In order to secure the commitment of the government, the Supreme Council for Science and Technology (BTYK), that was established in 1983 and held the first meeting in 1989, was activated by TUBITAK and its second meeting was held in 1993. In that meeting, the BTYK accepted the first policy document in Turkey that called for the establishment of a well-functioning national system of innovation.

5.1. Technology and Innovation Policy Making

The BTYK is now the highest-level technology policy making and co-ordination body in Turkey. It is chaired by the Prime Minister, and is constituted by the related ministers (National Defence, Economy, National Education, Health, Forestry and Rural Affairs, Industry and Trade, Energy and Natural Resources), representative of other public institutions (Council of Higher Education, State Planning Organization, Undersecretaries of Treasury and Foreign Trade, Turkish Atomic Energy Authority, Turkish Radio and Television), and the private sector representative (Union of Chambers and Commodity Exchanges of Turkey). Representatives of other related governmental organizations, non-profit foundations, chambers and major technical universities are invited to the meetings.

All major technology policy proposals initiated by TUBITAK have been approved and introduced by the BTYK. Following the decision of BTYK in 2001, TUBITAK launched a project called “Vision 2023”, in order to “i) build an S&T vision for Turkey, ii) determine strategic technologies and priority areas of R&D, iii) formulate S&T policies of Turkey for the next 20-year period, iv) get a wide spectrum of stakeholders involved in the process, thus to gain their support, and v) create public awareness on the importance of S&T for socio-economic development” (see Saritas, et al., 2007: 1380). The constituent block of the project was a comprehensive technology foresight study that was carried out in Turkey the first time at the national scale.

The BTYK endorsed, in its 11th meeting in March 2005, “priority” technology areas as suggested in the Vision 2023 Strategy Document, and asked all public institutions, including public universities, to take into consideration these technological areas in designing and implementing research programs. However, the “National Defence Research Program” and the “National Space Research Program,” both announced in the same BTYK meeting, as well as the “Public Research Programs” on Agriculture, Health and Energy announced in the next meeting in September 2005, were incompatible with the basic philosophy of the Vision 2023 project, and R&D prioritization has been done in an ad hoc fashion in the subsequent policy initiatives (Saritas et al., 2007).

The government adopted recently two main policy documents, the National Science and Technology Strategy (2005-2010) and the National Innovation Strategy 2008-2010, and set the following targets for the 2007-13 period: i) increase R&D expenditures to 2 percent of GDP, ii) raise the share of privately financed R&D to 60 percent, iii) expand the number of researchers to 80,000, and iv) augment the internet penetration rate to 60 percent.

5.2. Institutional Changes and Building an Innovation System in Turkey[31]

Turkey implemented a number of policy initiatives to establish and to re-structure institutions and their relationships that make up a national system of innovation in the 1990s. One of the most important initiatives has been about policy making. Although TUBITAK has been responsible for “promoting, developing, organizing, conducting and coordinating research and development in line with national targets and priorities”, the lack of political support was the main obstacle for the effective of implementation of technology policy initiatives.

The BTYK has been active since 1993, and has provided the authority on policy design, coordination and implementation. TUBITAK functions as the Secretariat to BTYK and is the central player in the NIS with the key responsibility in formulating, designing, coordinating, and implementing technology policy. Other key institutions involved in policy formulation and design are the State Planning Organization, the Ministry of Industry and Trade, and the Council of Higher Education.

TUBITAK owns a number of public RDIs, such as Marmara Research Centre (in Gebze, it consists of seven institutes on information technologies, energy, food, genetics and biotechnology, chemical and environmental technologies, materials, and earth and marine sciences), Defence Industries R&D Institute (Ankara), National Electronics and Cryptology Research Institute (Gebze), Space Technologies Research Institute (Ankara), National Metrology Institute (Gebze), and Basic Sciences Research Institute (Istanbul). The Marmara Research Centre, the largest RDI, has been restructured in the 1990s. It provides contract R&D and analysis and testing services to industry and currently earns 50-60 percent of its income from contract work. There are a lot of RDIs that belong to various ministries (for example, there are 64 R&D centres operating under the Ministry of Agriculture and Rural Affairs). These

31. For institutions and policy initiatives, see Arikan et al. (2003), European Commission (2007 and 2008), and Correa et al. (2008).

RDIs, with the exception of the Nuclear Energy Council and National Boron Research Institute, have quite limited R&D budgets and are not involved in contract work.

There are six university-industry joint research centres (USAMP) established by regional universities and industrialists (Ceramics Research Centre in Anadolu University, Eskisehir; Textile Research Centre in Ege University, Izmir; Biomedical Technologies Centre in Hacettepe University, Ankara; University-Industry Joint Research Centre in Cukurova University, Adana; Automotive Technologies R&D Centre in Istanbul Technical University, Istanbul; METU-OSTIM Advanced Manufacturing Systems and Technologies Centre in OSTIM Organized Industrial Zone, Ankara). These centres are aimed at promoting innovation through university-industry-government interactions.

Private companies have been establishing dedicated research units at an increasing rate especially since the mid-1990s. Technology parks and incubators have been established to support private sector R&D. There are 28 technoparks within universities under the Law of Technology Development Regions, and 20 incubators (TEKMERs) operated by KOSGEB. There are also two private incubators established by Ericsson (Ericsson Mobility World) and Siemens (Siemens Business Accelerator).

Technology Development Foundation of Turkey (TTGV), established in 1991, is a non-profit foundation providing support for R&D projects through the finance provided by the Undersecretariat of Foreign Trade (UFT) and by their own resources. TTGV has also Pre-Incubation Support Program, Risk Sharing Facility Support Program and Start-up Support Program through its company Teknoloji Yatirim A.S. in order to stimulate the establishment of new technology based firms.

TUBITAK is the main institution that provides financial support for industrial and academic research projects through a variety of programs. R&D project support activities are partly funded by the UFT and the other programs are financed out of TUBITAK's own budget. In addition, TUBITAK assists the Ministry of Finance in the execution of the R&D tax postponement and tax exemption schemes and to the Undersecretariat of Treasury in the R&D investment incentive scheme. KOSGEB implements various support programs, including financial support, for small and medium-sized industrial firms. There are only three venture capital companies established in Turkey, and the number of start-ups invested is very small. The underdevelopment of the venture capital and business angel sector is regarded as one of the main constraints to the performance of Turkey's NIS (Correa et al., 2008).

In the past decade, the government has modernized, and established several NIS institutions including the Turkish Standards Institution (TSE), the National Metrology Institute (UME), the Turkish Patent Institute (TPE), Innovation Relay Centres, Turkish Accreditation Agency

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(TURKAK), and Competition Authority. These institutions provide technical services, or help to establish an environment conducive for innovation and technology diffusion. There are also a large number of non-governmental and sectoral organizations that play an important role within the NIS (for example, the Quality Association of Turkey, the ICT Foundation of Turkey, the Informatics Association of Turkey, the Automotive Manufacturers Association of Turkey, etc.).

The overview of the institutional set-up shows that Turkey has almost all components necessary for a well-functioning NIS. There are certainly some weak points in the system (for example, venture capital, intermediary institutions for technology diffusion, etc.), but the main ingredients for a NIS have been put in place since the mid 1990s.

5.3. Supply Side Policies and Incentives for Industrial Technology Development

The policies followed since the mid-1990s have converged around four main policy objectives:

- Increase the rates of expenditures on research and technological diffusion (particularly ICT) by enterprises;
- Strengthen co-operation between public or higher education research organizations and enterprises on R&D activities;
- Increase the number of new innovation intensive enterprises created and their survival;
- Increase the rate of commercialization of R&D activities by the research sector (Correa, et al. 2008; see Table 2-8).

Until very recently, technology policy measures had focused primarily on the first two objectives. A large number of new measures introduced since 2005 have aimed at the last two objectives (see European Commission, 2007 and 2008).

As a result of generous subsidies provided for R&D, real R&D expenditures in Turkey increased 170 percent in only five years after 2002 (from 2.3 billion TL in 2002 to 6.4 billion TL in 2007, at constant 2008 prices). The growth rate of real R&D expenditures surpasses by a substantial margin the rate achieved by the EU countries. R&D intensity in Turkey is somewhat low, even compared to major East European countries, but it also exhibits a steep upward trend.

TUBITAK's industrial research support scheme is the main mechanism to encourage R&D in Turkey. The scheme is based on R&D grants, i.e., it provides direct cash subsidies for R&D. Other programs, for example, the technopark program, provide subsidies indirectly by reducing the tax burden on R&D performers.

The amount of industrial research subsidies remained at low levels in the initial years of the program because of the limited number of R&D projects applied for support, but it increased rapidly in the first half of the 2000s, and exceeded 250 million TL (about US$ 200 million) in

Box 2-2. The impact of public support for R&D

The initiation of R&D support programs in Turkey in the early 1990s has been one of the most important institutional novelties leading to the establishment and development of a national system of innovation. The Technology Development Foundation of Turkey (TTGV), established in 1991, supports R&D by providing interest-free loans. Besides TTGV, the Technology Monitoring and Evaluation Board of TUBITAK (TIDEB) is the other major R&D supporter in Turkey. TIDEB started to give "R&D grants" on September 15, 1995 in accordance with the "Decision on R&D Support" taken by the Board of Money, Credit and Coordination on June 1, 1995. TIDEB serves as the referee institution, while the Undersecretariat of the Prime Ministry for Foreign Trade pays for the grants, which go to the firms at a rate of up to 50 percent of the R&D expenditures in Turkish liras. R&D support rate depends on such factors as the share of the products (produced through R&D) in total sales, employment of PhD researchers, R&D services obtained from universities, R&D performed within techno-parks, and projects undertaken in priority areas. 10 percent of the original support is additionally granted in case that the R&D activity results in a patent. The Small and Medium-sized Industry Development Organization (KOSGEB) introduced a complementary policy of providing loans and grants to cover a part of R&D-related expenses of SMEs in 2003.

TIDEB and TTGV conducted a study on the impact of public R&D support in Turkey (for details, see Özçelik and Taymaz, 2008; Taymaz and Üçdogruk, 2009). The main findings of the study can be summarized as follows:

- Firm size (in terms of real output) has shown up as an invariably significant determinant of R&D intensity. There is a strong evidence that shows large firms are more likely to conduct R&D. Although SMEs are less likely to conduct R&D, if they overcome the first obstacle of conducting R&D, they spend proportionally more on R&D than the LSEs do. R&D intensity is higher in small than large firms.
- Public R&D support by no means crowds out private R&D activity of the firms in Turkish manufacturing industry. On the contrary, R&D support even stimulates the firm-financed component of R&D intensity. This effect is even stronger for small firms, i.e., R&D support policies are more beneficial for small firms.
- Moreover, when the market share of R&D support recipients increase, other firms (competitors) tend to increase their R&D intensity as well, i.e., public R&D support has indirect R&D stimulating effects as well.
- Technological characteristics of the firm matter, too. Those firms that use capital intensive technologies and employ more skilled people are more likely to conduct R&D. These findings show that there are strong complementarities between different types of capital and R&D, and human capital accumulation would encourage the use of more advanced technologies to improve indigenous technological activities.
- Foreign owenership itself does not have any impact on R&D activities.

2007 (see Figure 2-9). Private sector funding for R&D increased at a very high rate in the same period, and, because of growing awareness of the program, the number of firms/projects applied for R&D support had a higher growth rate. Consequently, the ratio between direct R&D subsidies (in the form of TUBITAK industrial R&D grants) and private funding for R&D grew from less than 1 percent in 1996 to 4 percent in 2000 and 9 percent in 2007. Although the share of direct subsidies in private R&D is still very low, the public R&D support program has stimulated R&D activities in Turkey (see Box 2-2).

6. Changes in the New Millennium: Developments after the 2001 Crisis

The 2001 crisis was the worst economic crisis Turkey had ever experienced since its foundation in 1923. As a result of the crisis, GNP dropped by 8 percent in 2001 (new GDP series). A short period of turmoil in financial markets had a severe toll on public finances and the share of government debt in GDP has increased sharply. As the Lira depreciated by 30 percent in six months, inflation picked up very rapidly to reach 70 percent by the end of the year.

A comprehensive stabilization and restructuring program was put in place to address the bottlenecks of the economy, i) to ensure the sustainability of the government debt burden through a primary surplus of 6.5 percent of GNP over a couple of years, and ii) to rescue the banking system. The banking sector reform was implemented without any further delay.[32]

The Turkish economy achieved historically high growth rates since 2001. GDP grew at high rates for 6-years in a row since 2001 (the average annual growth rate of GDP reached 7 percent). Exports increased at phenomenal rates during and after the crisis in 2001: the average annual growth rate of the value of exports (in US$) was about 25 percent in the period 2001-2006. Two sectors, automobiles and consumer electronics, are among the leading sectors behind the export boom. It would be informative to analyze the factors behind the success of these sectors that are technologically the most dynamics sectors in the Turkish economy.

The first automobile assembly plant in Turkey was established in 1960, and a number of joint ventures entered into the market in the late 1960s. Under the ISI policy, the automobile industry in Turkey aimed at satisfying domestic demand, and there were almost no exports until the late 1980s. Domestic production increased until 1976 (total production reached 110 thousands units), but declined until 1980 because of supply shortages. There had been an

32. This section draws extensively on a study by Taymaz and Yilmaz (2008).

increase in the number of local suppliers in the Marmara region during the 1970s. Production increased steadily after the early 1980s, and as a result of increasing demand and the prospects of the Customs Union with the EU in 1996, the industry expanded its production capacity in the early 1990s.

The economic crisis in 1994 had a disastrous impact on production that declined by almost 50 percent. In spite of the 1994 crisis, the industry attracted FDI, and new companies (for example, Toyota in 1994, Honda and Hyundai Asan in 1997) or new plants by existing companies (for example, Ford in 2001) expanded the production capacity. Total production gradually increased after the 1994 crisis and exceeded its 1993 level in 2000 partly as a result of increasing exports to the EU countries. The 2001 Crisis was a step backward in production (up to the 1994 crisis level), but the industry bounced back very strongly after the crisis, and achieved almost 4.6-fold increase in output from 2001 to 2006 (or 2.3-fold increase from 2000, the peak year, to 2008, see Table 2-9). Exports played an important role in increasing automobile production in the post-crisis period (Table 2-10).[33]

The Information and Communication Technology (ICT) industries[34] in Turkey have been relatively underdeveloped, and have had a small share in total manufacturing output. Turkey initiated a comprehensive program to modernize the information and communication infrastructure in the late 1980s. This program led to substantial investment in infrastructure and encouraged a number of foreign firms to invest in Turkey. Other segments of the industry (computers, components and consumer electronics) had moderate growth rates in the 1980s. After years of stagnation and even a slight decline in real output, the consumer electronics sector started to grow very rapidly in the mid-1990s, and achieved almost 10-fold increase in real output in a decade (from 1995 to 2005). Most of the increase in the output of consumer electronics sector in Turkey is accounted by rapid increase in the production and exports of colour television receivers (see Çakir, 2004).

The decline in the exports and production of colour TV receivers in recent years is directly reflected in the decline of the industry's production index by 16 percent in 2006 and 30 percent in 2008. The industry's fortunes are further worsened by the fact that it is losing market share not only in the EU market but also in the domestic market due to rapid switch from tube TV receivers to plasma and LCD TV receivers.

33. Hereafter, "automobile industries" refer to motor vehicles (ISIC 3410), motor vehicle bodies, trailers and semi-trailers (ISIC 3420), and parts/accessories for motor vehicles (ISIC 3430). ISIC codes refer to International Standard Industry Classification, Revision 3.
34. The ICT industries refer to office, accounting and computing machinery (ISIC 3000), electronic valves, tubes, etc. (ISIC 3210), TV/radio transmitters; line communication apparatus (ISIC 3220) and TV/radio receivers and associated goods (ISIC 3230). Since the TV/radio receivers and associated goods sector constitute the bulk of output and exports, we will focus our attention on this sector.

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The pattern of productivity growth in TV/radio receivers and automobile sectors is very similar to the pattern of output growth. An analysis of the indices of labour productivity[35] reveals that labour productivity growth rates in TV/radio receivers and motor vehicles were comparable to that of manufacturing industry (Table 2-9). The automobile industry did not increase its labour productivity to a large extent from the early 1990s until the early 2000s, a period dominated by the boom and bust cycles. The negative and detrimental effects of economic crisis on labour productivity in the motor vehicles industry are seen in 1999 and 2001. However, labour productivity has recovered rapidly after the 2001 crisis and increased more than four-fold from 2001 to 2007 (two-fold for motor vehicle parts and components).[36]

The TV/radio receivers sector achieved very high labour productivity growth from the mid 1990s until 2005. The average annual growth rate of labour productivity exceeded 10 percent for a decade, but dropped sharply in 2006 due to the fall in output.

To sum up, the TV/radio receivers sector achieved above average growth rates in productivity since the mid-1990s, whereas the automobile industry's productivity growth performance is almost equal to the manufacturing average. However, the level of productivity is also important is assessing industrial performance. The data on labour productivity reveal that there are substantial productivity differentials between TV/radio receivers and automobile final producers and other manufacturing industries. Motor vehicles industry is 86 percent more productive than the manufacturing industry average, whereas productivity differential reaches 52 percent for TV/radio receivers. Components producers for ICT and automobiles (electronic components, automobile bodies and automobile components) are much less productive (about 53, 59 and 78 percent of the average, respectively).

The recent performance of TV/radio receivers and automobile industries is seen most strikingly in export figures. Total exports increased 2.6 times from 2000 to 2005, but the increase in the export value for TV/radio receivers, motor vehicles, motor vehicle bodies and motor vehicle parts were even much higher (3.6, 7.6, 2.6, and 3.4 times, respectively). As a result, the share of these four sectors in total exports jumped from 9 percent in 2000 to 18 percent in 2005. However, TV/radio receivers did not keep its export momentum due to shift in consumers' demand towards LCD and plasma TVs, and the value of TV/radio receiver exports declined by 31 percent from 2005 to 2008.

Motor vehicle exports reached 14,726 million US dollars and motor vehicle part and components 4,227 million US dollars in 2008. Imports of motor vehicles and components also

35. Labor productivity here is defined as output per employee.
36. Although the data on motor vehicle bodies (ISIC 3420) sector are also presented, it should be noted that the share of this sector in total output and export values of the automobile industry is negligble.

increased as a result of integrating in the global production chains. Turkey imported 9,496 million US dollars of motor vehicles and 5,812 million US dollars of components in 2008. As a result of rapid growth in motor vehicles exports, Turkey has become a net exported in this sector since 2006.

Changes in the direction of foreign trade in TV/radio receivers and automobiles provide useful evidence on the mode of integration into the global economy. Turkey increasingly imports electronic components (and some ICT products such as computing machinery) from developing countries, and sells final products (mainly, TV sets) made of these components to developed countries (mainly the EU countries). The direction of foreign trade in the case of automobiles is completely different. Turkey imports a large part of motor vehicles and components from developed, mainly the EU, countries. A large proportion of Turkey's exports of motor vehicle components go back to the EU countries. In other words, intra-industry trade has become more important between Turkey and the EU in motor vehicles and components.[37] Turkey both imports and exports these products at an increasing level to/from the EU, i.e. the Turkish automobile industry has fully integrated with the European production chains.

The automobile industry in Turkey has proved to be a vibrant and growing sector, and achieved an outstanding export performance in the last decade in spite of the macroeconomic problems that plagued the country. What are the main factors behind its performance?

The automobile industry is well integrated within international production chains. From its inception in the 1960s and 1970s until the late 1990s, foreign firms, either through joint ventures with major domestic business groups, or through wholly owned subsidiaries, have been dominant in the industry. These companies were oriented towards the domestic market until the early 1990s, but they were able to seize new market opportunities opened by the Customs Union with the EU in 1996. New foreign companies entering the Turkish market in the second half of 1990s have targeted the EU market as well. These companies have strong links with their subsidiaries in the EU, and intra-firm trade has apparently played an important role in producing automobiles in Turkey and marketing them in the EU countries.

Although the automobile industry is well integrated within international, or more specifically, European production chains, it has also benefited to a large extent from the existence of a strong domestic industrial and supplier base. The automobile parts and components sector has developed to some extent in the 1970s and 1980s, and has attracted foreign investment in the 1990s. Strong and responsive supplier-producers links have enabled automobile producers to expand their capacity and output rapidly after the 2001 crisis.

37. Since most of automobile companies in Turkey are owned by multinational companies operating various manufacturing plants in European countries, a large part of intra-industry trade is indeed intra-firm trade.

The automobile industry in Turkey would not be successful had it failed to adopt itself on time to new conditions imposed by the CU. The Automotive Manufacturers' Association (OSD) played an instrumental role in anticipating new challenges, and orchestrating a common course of action to face these challenges. The OSD regarded the CU as an inescapable fact, and considered it as an opportunity in the early 1990s. The first challenge was to adopt massive EU rules and regulations affecting the industry. The process of discovering, understanding and transposing EU rules and regulations proved to be useful in enhancing the competence of technical personnel employed by automobile producers (and government officials). After achieving a certain level of technological sophistication necessary to satisfy the EU rules, the technical personnel pushed forward to improve quality and to introduce new designs (especially in the commercial vehicles segment) to be more competitive in the EU market. "Research and development" has become a catchword in the late 1990s. Current plans drawn by industry representatives are targeting to make Turkey the third largest producer in Europe by 2013 as well as making it a centre for design and research and development.

The structure of TV/radio receivers industry in Turkey is rather different than that of the automobile industry. The TV/radio receivers industry is dominated by a few large domestic firms that are not supported by any domestic supplier base. TV/radio producers use mostly commercial-on-the-shelf components and import them from the East Asian and the European countries. Domestic electronics components sector is almost non-existent, and TV/radio producers could outsource only some non-electronic parts to local suppliers.

The components used by TV/radio producers (the most important being cathode ray tube (CRT) for colour television receivers) and their final products are commodity-like products sold in almost perfectly competitive markets where profit margins are razor-thin. Moreover, CRT televisions are perceived as "old technology" and are being displaced by new technology like LCD and plasma televisions in developed country markets. Under those adverse conditions, Turkish producers have become quite successful in the EU market by producing the right product at the right time in the right place.

In the 1990s, the CRT television technology was a mature technology and new LCD and plasma technologies were expected to displace CRTs rapidly especially in the large-screen television market. This means that technological entry barriers were low in this market segment in which the European producers would be forced to exit. CRT colour television segment, which was still the largest television segment during the 1990s in the EU, was the only segment where new producers would enter. Turkish TV producers have become competitive in this market thanks to their flexibility and low-cost manufacturing.

When Turkish producers entered into the EU market en masse in the mid 1990s (right after the CU in 1996), Asian producers had low production costs and were competitive against the

Turkish producers that rapidly increased their productivity over time. However, that was the right time to enter the EU market because the European Commission imposed provisional (1994) and definitive (1995 and 2002) anti-dumping duties on colour television receivers originated in China, Malaysia, Korea, Thailand and Singapore. The European Commission initiated anti-dumping proceedings concerning imports of colour television receivers originated in or exported from Turkey in 1992 and 2000, and decided not to impose any duty. In other words, the EU anti-dumping measures imposed on low cost Asian producers provided Turkish producers a kind of “infant industry protection” at a crucial time.

Finally, the Turkish TV/radio receiver producers were located in the right place. They were located very close to a major market (the EU), and employed skilled labour at low cost. Geographical proximity provides cost advantages over Asian producers but more importantly it helps to reduce the delivery time. According to Karabatl and Tan (2005), the delivery time to Europe is 1-2 weeks for Vestel, the main Turkish producer, but 1.5-2 months for Chinese producers. Thus, Turkish producers can operate on a “made-to-order” basis, thanks to their short delivery time and manufacturing flexibility.

TV/radio receiver producers had been very competitive in the European markets in the late 1990s and early 2000s, but they were not successful to the same extent in adopting new technologies, and moving up in the quality ladder. The sluggish response in adopting and developing new technologies could have disastrous implications for the whole sector. The sharp decline in exports after 2005 is an indication for the seriousness of the problem. The tale of TV/radio producers in Turkey points to the importance of technology policy. Firms can sustain their competitiveness in dynamic industries only if they become innovative. Firms can be innovative only within an intensive web of interactions with other firms (suppliers, buyers, and, even, competitors), consumers, research institutions, etc., i.e., if they can form and be part of innovation networks. Technology policy is an essential ingredient in creating innovation networks.

7. Conclusion and Policy Lessons

Turkey adopted import substitution industrialization policies in the 1960s and 1970s. During this period, the economy achieved, on average, respectable growth rates, and the growth rate of labour productivity was similar to the rate observed in successfully industrializing countries of the same period. The concept of “technology policy” was not on the policy agenda, and the main institution in charge of science and technology policy, TUBITAK, emphasized scientific research in its activities. However, in spite of the lack of an explicit technology policy, large state-owned enterprises were successful in building up technological capabilities, and training engineers.

After the balance of payment crisis in 1980, the export-led “growth” policies were adopted under the auspices of international organizations. The dominant neo-liberal understanding was unsympathetic to any role of the state in the economy, and there was not any attempt to formulate any technology policy in the 1980s. The export boom in the 1980s was achieved by changing relative prices, most importantly, by real devaluations and real wage cuts. Thus, labour intensive, low-technology sectors were the engine of export growth. The 1990s were characterized by growing public deficit, unstable macroeconomic environment, and boom-and-bust cycles, and the productivity growth rate was very low throughout the decade. In spite of macroeconomic uncertainty and acute short term problems, new policy initiatives, led mainly by TUBITAK, were surprisingly successful: main policy documents since the early 1990s adopted officially a specific technology policy aimed at establishing a national system of innovation in Turkey. Public R&D support programs were introduced the first time in the mid-1990s, and a number of institutions and organizations that form the building blocks of a national system of innovation have been established or restructured so that Turkey has now an innovation system in place.

What are the main strengths and weaknesses of Turkey’s innovation system? The main strength is the fact that almost all institutions necessary for a well-functioning NIS exist in Turkey. There are some weak institutions and links, but the institutional set-up is almost ready. Moreover, there are a good mix of policies and programs that encourage the supply of R&D. The most important R&D support policy is the industrial R&D support scheme implemented by TUBITAK (R&D grants) and TTGV (R&D loans), and the effectiveness of these is documented by econometric studies. Most of R&D support programs have been introduced recently, but there are some studies that show that they are likely to have a positive impact on R&D (see, for example, DDK, 2009).

Although the BTYK has been active in recent years in formulating technology policies, there seems to be no strategic vision and coherence in various policies and programs proposed and implemented. The government has substantially increased the funds available for R&D in recent years, but these funds have been allocated to a large number of projects without any focus and explicit prioritization. Public RDIs, with the exception of TUBITAK’s research centres, are under funded, and do not have well-designed research agendas.

Existing R&D support schemes are all supply-side policies, i.e., they attempt to increase the supply of R&D by reducing its cost (direct subsidies, tax deductions for R&D personnel, etc.). However, the impact of supply side policies is likely to be limited. There seems to be a need for complementary demand-side policies (most importantly, the use of public procurement to demand higher quality/new products, and enforcing and regulating quality standards and technical requirements).

There seems to be no specific policy regarding technology transfer from abroad and technology diffusion within the industry. Acquisition of new machinery (embodied technology) seems to be the main form of technology upgrading in Turkey. However, firms, especially small and medium-sized ones, do not have sufficient knowledge about new technologies, and are not able to operate effectively modern machinery and equipment. Technology transfer and diffusion policies would be helpful to increase productivity and to enhance competitiveness.

Finally, innovative small firms find it difficult to commercialize their technologies, and to finance investment necessary to achieve rapid growth. Existing industrial policy tends to protect failing firms, but do not provide sufficient incentives and support to (potentially) thriving firms.

The Turkish economy has bounced back rapidly after the 2001 Crisis and grew rapidly in six years in a row (2002-2007). The sectors that were engine of growth in the post-Crisis period were medium-technology industries (specifically, automobiles and consumer electronics) that increased their exports to the EU at a very high rate. But, the engine of growth in consumer electronics (TV/radio receiver industry) seems to be slowing down since 2005, and shrinking demand for motor vehicles in the EU during the recent crisis in the world economy led to a significant drop in exports and output of the Turkish automobile producers. Moreover, traditional industries, burdened by intensifying competitive pressure of Asian producers, find it difficult to protect their shares in international as well as in domestic markets.

There seems to be two options for the Turkish industry. The first option, emphasized mostly by producers in traditional industries, is based on enhancing the competitiveness of domestic firms by reducing their costs, first and foremost, by cutting real wages, and lowering taxes and subsidizing inputs (for example, energy). This option was tried many times before and has been proved to be unsustainable. The second option requires firms to move towards high value added products and activities. The tale of automobile and consumer electronics industries is the evidence for the fact that imitation of foreign technology is not any more sufficient for sustained growth. Firms need to develop technological competence, and to be innovative. However, because of complexity and convergence of existing technologies, even the largest firm does not have all resources necessary to be innovative. Firms can be innovative only within an intensive web of interactions with other firms (suppliers, buyers, and, even, competitors), consumers, research institutions, and the main objective of technology policy is to help establishing innovation networks.

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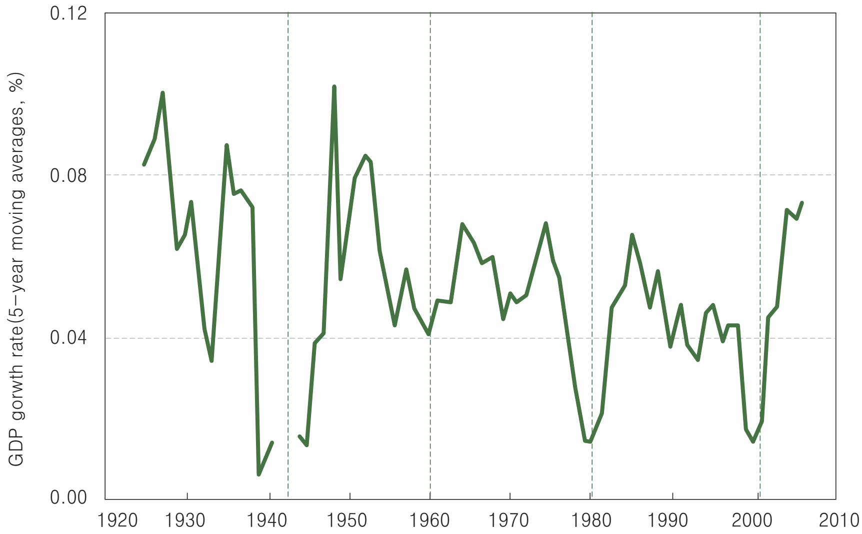
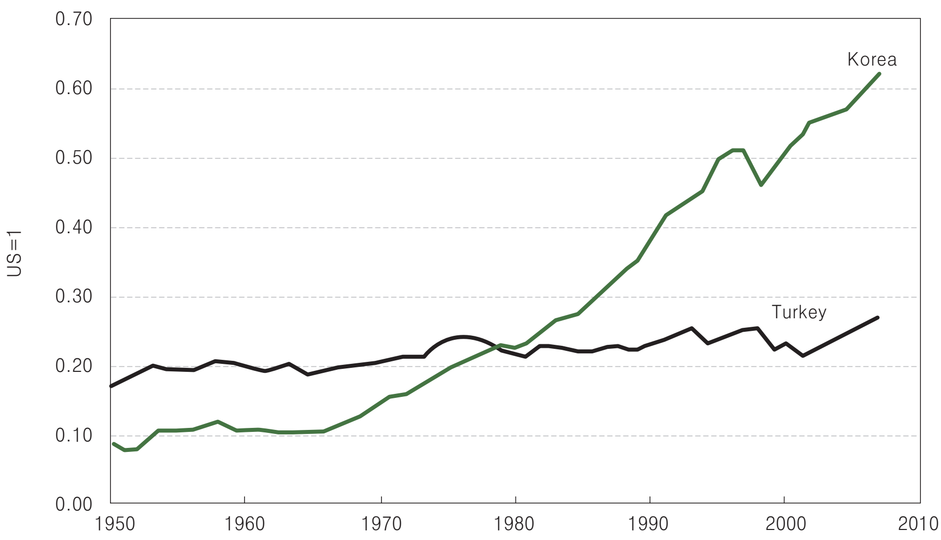
Figure 2-1 | Long-term patterns of GDP growth, 1923-2007



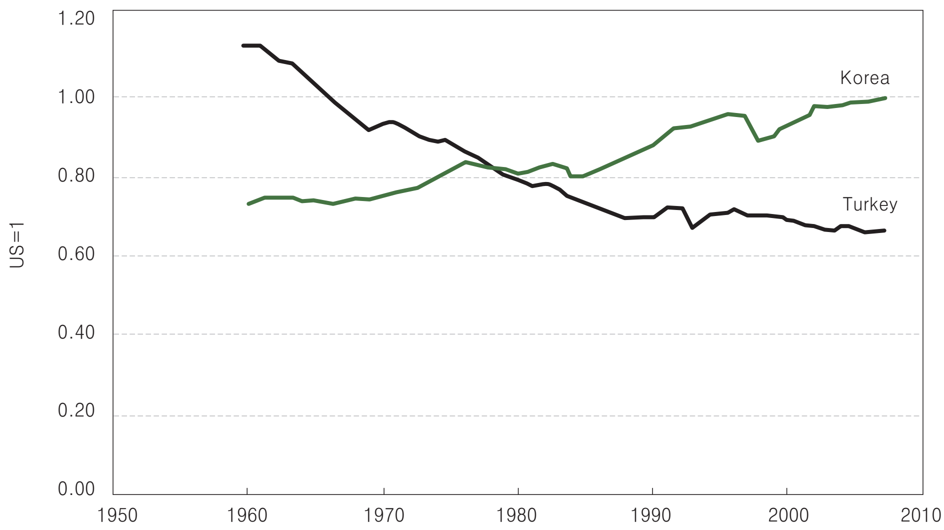
Source: Calculated from Turkstat data.

Figure 2-2 | GDP per capita in Turkey and Korea relative to the US, 1950-2007



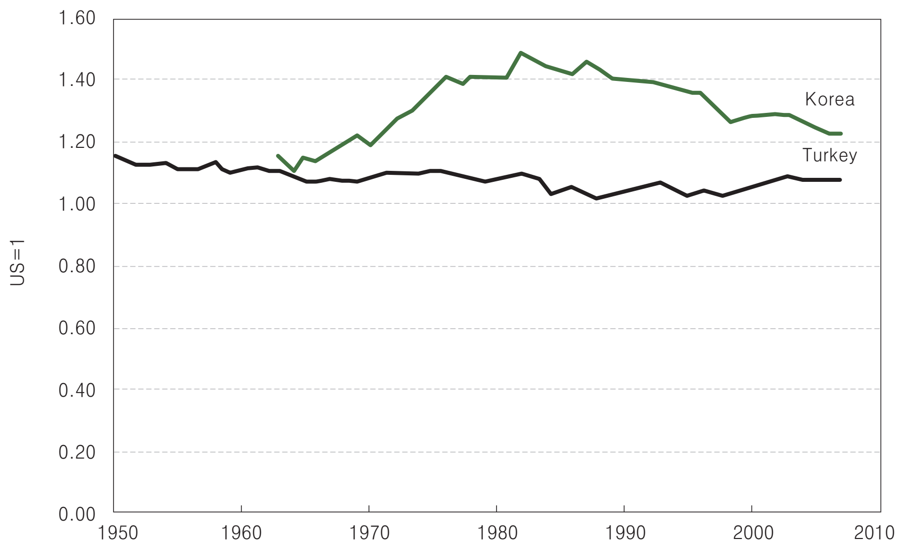
Source: The Conference Board and Groningen Growth and Development Centre, Total Economy Database, September 2008, http://www.conference-board.org/economics/

Figure 2-3 | Employment ratio in Turkey and Korea relative to the US, 1960-2007



Note: Employment ratio is defined as the ratio between the number of employees and total population.
Source: See Figure 2.

Figure 2-4 | Average working time in Turkey and Korea relative to the US, 1950-2007



Source: See Figure 2.

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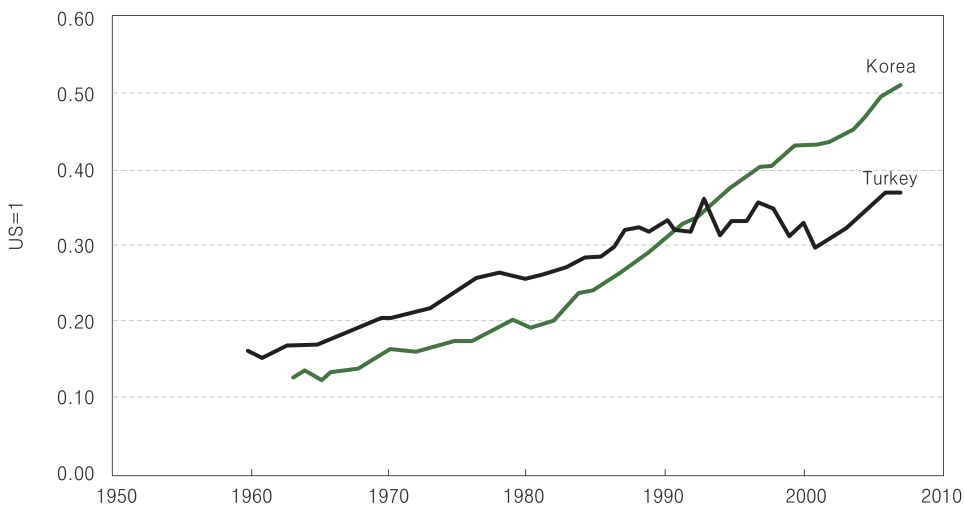
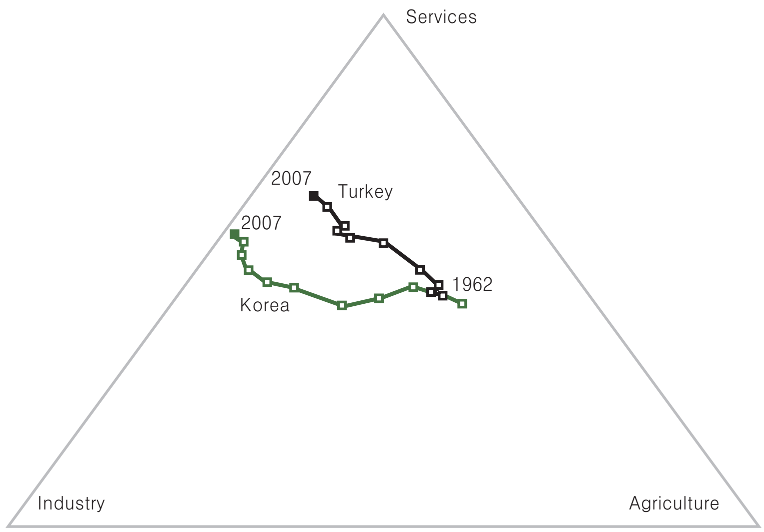
Figure 2-5 | GDP per hour worked in Turkey and Korea relative to the US, 1960-2007



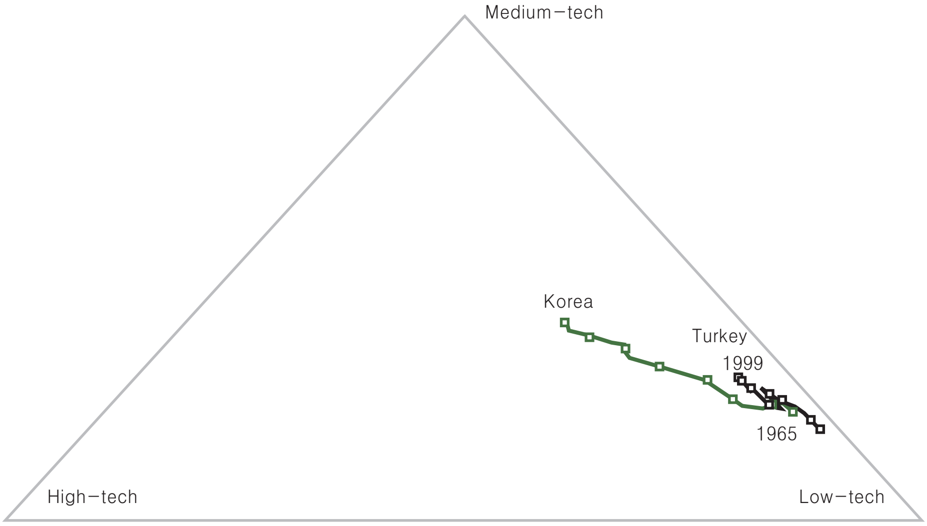
Source: See Figure 2.

Figure 2-6 | Structure of the economy, Turkey and Korea (1962-2005)



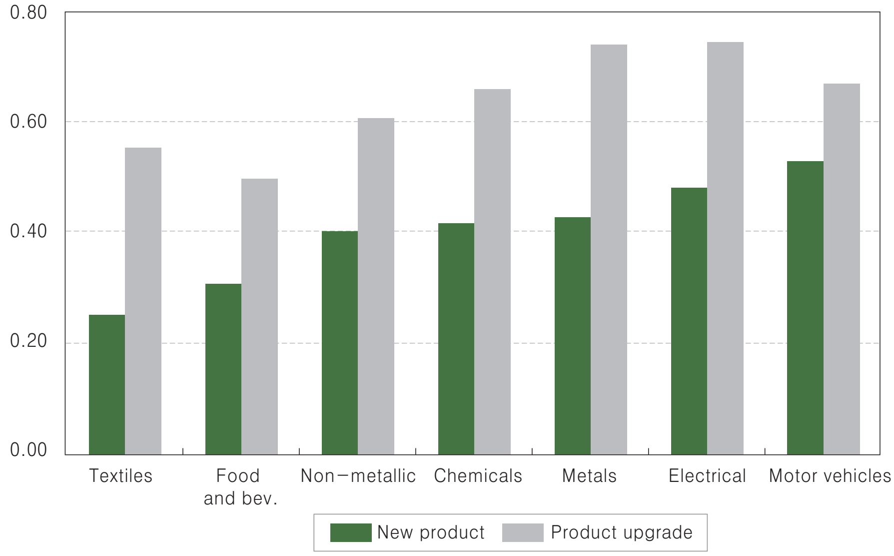
Source: Calculated from the World Bank, World Development Indicators, 2008.

Figure 2-7 | Structure of manufacturing industry, Turkey and Korea (1965-1999)



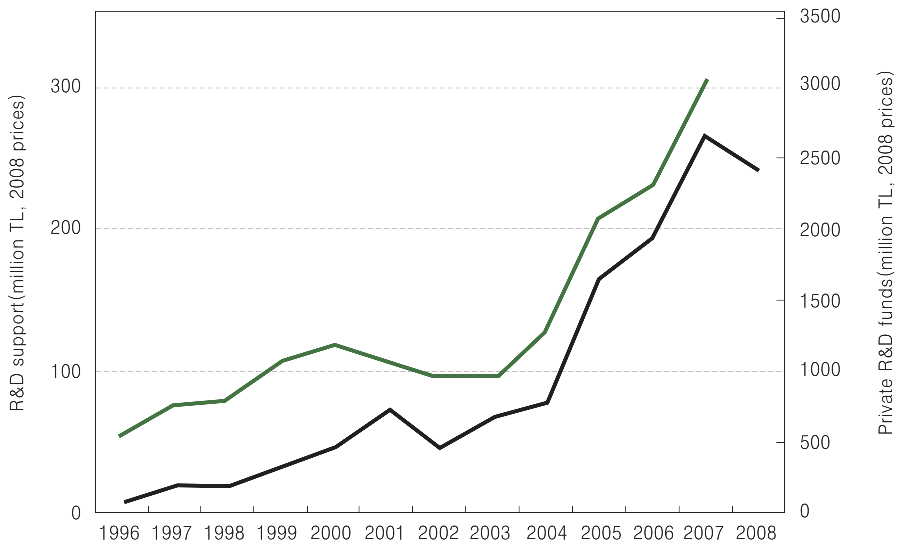
Source: Calculated from UNIDO, Industrial Statistics Database, Rev 2.

Figure 2-8 | Introduction of a new products and product upgrades by industry (percentage of firms)



Source: World Bank, Turkey Investment Climate Survey 2005.

Figure 2-9 | Industrial R&D support and private R&D funding, 1990-2008 (million TL, 2008 prices)



Source: TUBITAK

Table 2-1 | Descriptive statistics on technology sources, 1982-2001

	Market share of technology transferees		Market share of foreign firms		Investment rate (investment/value added)		Share of capital goods in	
	Low tech	Medium tech	Low tech	Medium tech	Low tech	Medium tech	Exports	Imports
1982			0.078	0.228	0.100	0.143	0.052	0.217
1983			0.078	0.235	0.107	0.190	0.047	0.206
1984	0.155	0.317	0.085	0.228	0.139	0.267	0.044	0.198
1985	0.141	0.331	0.110	0.213	0.166	0.281	0.084	0.218
1986	0.121	0.354	0.113	0.255	0.114	0.188	0.055	0.299
1987	0.119	0.327	0.118	0.262	0.134	0.183	0.117	0.234
1988	0.089	0.342	0.116	0.265	0.173	0.123	0.055	0.235
1989	0.083	0.356	0.142	0.294	0.144	0.115	0.041	0.236
1990	0.038	0.388	0.137	0.306	0.162	0.136	0.048	0.292
1991	0.024	0.430	0.117	0.348	0.097	0.137	0.057	0.312
1992	0.089	0.434	0.117	0.374	0.133	0.104	0.073	0.338
1993	0.080	0.449	0.125	0.406	0.108	0.114	0.072	0.368
1994	0.037	0.412	0.124	0.372	0.102	0.141	0.081	0.305
1995	0.047	0.398	0.128	0.369	0.131	0.107	0.096	0.303
1996	0.055	0.420	0.117	0.378	0.197	0.140	0.114	0.332
1997	0.052	0.400	0.107	0.391	0.147	0.153	0.109	0.357
1998	0.044	0.345	0.112	0.409	0.140	0.151	0.122	0.347
1999	0.099	0.288	0.115	0.419	0.105	0.140	0.159	0.317
2000	0.126	0.335	0.126	0.458	0.107	0.132	0.172	0.314
2001	0.134	0.324	0.135	0.426	0.132	0.161	0.197	0.269

Note: Technology transferees are those firms that transferred technology from abroad though license and know how agreements.
Source: Calculated from Turkstat, Annual Survery of Manufacturing Industries

Table 2-2 | R&D expenditures and researchers, 1990-2007

	R&D/GDP ratio(percentage)		Number of researchers per 10,000 people	
	Old series	New series	R&D pers	Researcher
1990	0.320		8	5
1991	0.530		8	6
1992	0.490		8	6
1993	0.440		9	6
1994	0.360		8	7
1995	0.380		9	7
1996	0.450		10	8
1997	0.490		11	8
1998	0.500	0.370	11	8
1999	0.630	0.470	11	9
2000	0.640	0.480	13	10
2001	0.720	0.540	13	11
2002	0.670	0.530	14	11
2003	0.610	0.480	18	15
2004	0.670	0.520	18	16
2005	0.790	0.600	22	18
2006	0.760	0.590	26	20
2007	0.903	0.710	30	23

Source: Turkstat

Table 2-3 | R&D expenditures by source of funds and performer, 1990-2007 (percentage)

	R&D Expenditures by source of fund				R&D expenditures by performer		
	Public	Private	Other dom	Foreign	Public	Private	Univer
1990	0.714	0.274	0.009	0.003			
1991	0.701	0.285	0.013	0.001			
1992	0.640	0.338	0.018	0.004			
1993	0.652	0.312	0.028	0.008			
1994	0.604	0.330	0.049	0.017			
1995	0.624	0.308	0.048	0.020			
1996	0.566	0.368	0.066	0.000			
1997	0.537	0.418	0.026	0.019			
1998	0.533	0.418	0.045	0.004			
1999	0.477	0.433	0.042	0.048			
2000	0.506	0.429	0.052	0.013	0.062	0.334	0.604
2001	0.480	0.449	0.063	0.008	0.074	0.337	0.589
2002	0.506	0.413	0.069	0.012	0.070	0.287	0.643
2003	0.570	0.362	0.052	0.016	0.104	0.232	0.663
2004	0.570	0.379	0.048	0.003	0.079	0.242	0.679
2005	0.501	0.433	0.059	0.007	0.115	0.338	0.546
2006	0.486	0.460	0.049	0.005	0.117	0.370	0.513
2007	0.484	0.471	0.040	0.005	0.106	0.413	0.482

Source: Turkstat

Table 2-4 | Patents and scientific papers, 1995-2008

	Number of patent applications			Number of patents registered			Scientific papers
	Domestic	Foreign	Total	Domestic	Foreign	Total	
1995	170	1520	1690	58	705	763	3093
1996	189	713	902	47	554	601	3925
1997	203	1328	1531	7	443	450	4583
1998	207	2276	2483	31	743	774	5384
1999	276	2744	3020	28	1097	1125	6195
2000	277	3156	3433	23	1113	1136	6426
2001	337	2877	3214	58	2051	2109	7811
2002	414	1460	1874	73	1711	1784	10314
2003	490	662	1152	93	1087	1180	12425
2004	685	1577	2262	68	1868	1936	15403
2005	935	2526	3461	85	3087	3172	16679
2006	1090	4075	5165	122	4183	4305	18889
2007	1838	4351	6189	318	4472	4790	21779
2008*	1910	3855	5765	290	3560	3850	

*As of November 18, 2008

**Papers publoshed in journals indexed by SCI, SSCI and A&HCI

Soures: Patents: Turkish Patent Institute; Scientific papers: TUBITAK

Table 2-5 | Public expenditures on innovation and technology programs, 2005-2008 (million TL)

Implementing agency	2005	2006	2007	2009
Universities	274.2	278.7	256.3	253.8
TUBITAK(Research Centers)	108.8	155.0	141.8	183.8
TUBITAK(Turkey Research Area Program)*	346.0	415.0	425.0	450.0
Academic research projects	90.0	80.0	85.0	105.0
Industrial research projects	116.0	215.0	215.0	175.0
Research projects of public institutions	50.0	50.0	50.0	65.0
Defense and space research projects	50.0	60.0	65.0	80.0
Researcher development	25.0	5.0	5.0	15.0
Science and technology awareness	15.0	5.0	5.0	15.0
Public Institutions	36.2	49.3	80.2	78.2
Nuclear Energy Council(TAEK)	6.3	13.1	20.0	18.9
Ministry of Industry and Trade**	-	11.0	16.9	17.6
Ministry of Agriculture and Rural Affairs	2.2	2.5	4.0	3.6
Ministry of Health	0.1	6.2	5.2	4.9
National Boron Research Institute***	0.1	3.0	6.0	6.3
Ministry of Energy***	-	-	-	1.0
KOSGEB	12.5	5.4	4.6	6.5
TTGV	8.9	35.6	35.4	35.5
State Planning Organization	1.1	10.0	18.0	18.0
Undersecretary of Foreign Trade	40.0	42.0	63.5	na
Total(million TL)	1182.4	1441.8	1501.9	1527.1
Total(million US$)	877.6	1002.6	1148.4	1175.5

*TUBITAK funds the projects of other institutions' R&D projects.

**Includes SAN-TEZ program that supports PhD students' theses that aim to solve specific problems, and the support for the infrastructure of technoparks.

***Includes programs that supports other institutions' projects.

Source: Correa et al., 2008. 6.

Table 2-6 | Public R&D expenditures by socio-economic objective, 1996, 2003, 2007 (percentage)

Implementing agency	1996	2003	2007
Exploration and exploitation of the Earth	0.016	0.245	0.286
Infrastructure and general planning of land use	0.029	0.002	0.007
Control and care of the environment	0.048	0.022	0.045
Protection and improvement of human health	0.037	0.024	0.043
Production, distribution and rational utillsation of energy	0.037	0.033	0.043
Agricultural production and technology	0.259	0.160	0.207
Industrial production and technology	0.132	0.285	0.108
Social structures and relationships	0.004	0.001	0.005
Exploration and exploitation of space		0.021	0.027
Research funded by universities		0.040	0.022
Non-oriented research		0.006	0.013
Other civil research	0.310	0.022	0.048
Defence	0.128	0.139	0.145
Total(million TL)	7.9	229.3	642.8

Source: Turkstat

Table 2-7 | R&D structure in universities, 1996, 2003, 2007 (percentage)

	1996	2003	2007
Source of fund			
Public	0.747	0.716	0.685
Private	0.180	0.208	0.233
Other domestic	0.074	0.076	0.080
Foreign	0.000	0.001	0.002
Scientific field			
Natural sciences	0.042	0.081	0.091
Engineering	0.092	0.146	0.146
Health sciences	0.617	0.407	0.422
Agricultural sciences	0.097	0.063	0.056
Social sciences	0.107	0.201	0.181
Humanities	0.045	0.102	0.103
Totla(million TL)	41.5	1457.4	2934.8

Source: Turkstat

Table 2-8 | Policy Measures in the National Innovation System

Objectives	Related Programs
Raise private R&D and innovation	Risk Sharing Facility Support, Support Programme for the first R&D Projects of SMEs, Environmental Technologies Support Programme, Energy Efficiency Support Programme, Renewable Energy Support Programme, R&D Tax Exemption, Support for R&D Investment, State Support for R&D(TTGV), State Support for R&D (TUBITAK-TEYDEB), Technology Research and Development Support
Increase the commercialization of knowledge by universities and public research institutes	Industrial R&D and innovation support (San-Tez) of MoIT, Patent Support Program, Scientific and Technological Cooperation Networks and Platforms Support Programmme(ISBAP), Commercialization Project Supports, Supports for Establishment of Technoparks (the Law on Technology Development Zones), Joint Technology Development Projects, Young Entrepreneur Development Programme, Industrial Property Rights Support
Expand the number of science based start-ups	Support Programme for Technology-and Innovation-focuses Entrepreneurshp, Start-up Support, Pre-Incubation Support Programme, New Entrepreneur Support, Establishment of Technology Development Centers TEKMERs)
Augment technology duffusion(including ICT use)	Environmental Technologies Support Programme (also for private R&D above), Energy Efficiency Support Programme (also for private R&D above), Support for Hining Qualified Personnel by SMEs, ICT Support, Machinery/Equipment Support for Common Use by SMEs, Training Support, Consultancy Support for SMEs

Source: Correa et al., 2008: 43.

Table 2-9 | Indices for selected sectors, 1999-2008 (1997=100)

	Manuf D	TV and radio 323	Motro vehicles 341	Bodies for mv 342	Parts for mv 343
			Production Index		
1999	96	145	78	47	84
2000	102	192	123	56	96
2001	92	179	61	46	79
2002	102	281	82	26	84
2003	112	337	128	17	99
2004	124	460	205	20	115
2005	130	485	226	29	120
2006	137	409	248	25	133
2007	143	287	270	25	161
2008	138	222	281	18	162
			Labor productivity Index		
1999	105	116	79	85	91
2000	114	152	109	118	97
2001	113	162	57	111	78
2002	125	210	83	80	87
2003	134	208	109	51	91
2004	145	233	145	51	88
2005	153	234	145	68	84
2006	162	199	152	53	88
2007	167	195	149	52	102
2008	169	180	155	35	106
			Number of production workers index		
1999	91	133	99	57	92
2000	89	127	112	47	99
2001	82	110	106	41	100
2002	82	135	98	35	97
2003	84	161	117	33	109
2004	85	197	142	39	130
2005	85	207	156	42	143
2006	84	205	164	46	151
2007	86	149	181	49	158
2008	86	117	200	54	171

Note: The data for 2008 include the first 3 quarters.
Source: Turkstat

Table 2-10 | Export statistics for selected sectors, 1999-2008 (million US$)

	Total	Manuf D	TV and radio 323	Motor vehicles 341	Bodies for mv 342	Parts for mv 343
Exports						
1999	26587	23958	677	1002	37	575
2000	27775	25518	843	1021	44	680
2001	31334	28826	871	1736	47	873
2002	36059	33702	1475	2412	60	1131
2003	47253	44378	1837	3908	68	1461
2004	63167	59579	2762	6811	92	1910
2005	73476	68813	3018	7802	115	2308
2006	85535	80246	2922	9711	142	2824
2007	107272	101082	2544	12843	307	3866
2008	132003	125173	2075	14726	381	4227
Imports						
1999	40671	33936	284	2191	21	1143
2000	54503	44200	426	4184	32	1750
2001	41399	32686	220	1226	22	958
2002	51554	41383	275	1647	43	1228
2003	69340	55690	462	4296	80	2034
2004	97540	80447	703	8112	138	3547
2005	116774	94208	809	8271	112	3948
2006	139576	110379	953	8328	154	4812
2007	170063	133938	1518	9377	199	5521
2008	201823	150130	1590	9496	206	5812

Source: Turkstat

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Chapter 03

University and Industry Linkages

Chapter 03

University and Industry Linkages

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1. Introduction

Korea has been known as one of the countries that had enjoyed the most remarkable economic growth. Back in the 1960s, iron ore, tungsten, and raw silk were Korea's major export goods. In the 1970s, the major export goods changed to textile, clothes, plywood, and wig, but those goods still did not require a broad science base. In 2000s, high technology industries were leading the Korean Economy. It is not clear how the universities had contributed to this transition process from low technology based economy to high technology based economy. Even though there are controversial debates over how much Korean universities have contributed to the success of the Korean miracle, it is certain that higher education and its research have indirectly played an important role in the transition process.

The contribution of Korea's universities to technology development and economic growth tends to be underestimated because of its indirect characteristics. In terms of research, Korea's universities could not measure up to other advanced counterparts. Rather the government research institutes and the research laboratories of the leading companies have been famous for their performances in research and development as well as technology adaptations.

One of the most important functions played by the universities is to supply human resources with good educational background to private companies. While most companies have actually run their own research institutes, and spent 7.7 times as much as universities do in R&D as of 2006, universities are the main sources of the science and technology support to the private companies. The Korean professors also contributed to the Korea's innovation system by participating in R&D projects individually or by acting as policy advisers either for the government or for the private companies.

Traditionally, the connection between basic research and industrial innovation is explained by a linear model of knowledge production and transfer. The linear model is a framework for understanding the process of knowledge creation from basic science or theories to development and commercialization. Even though it is epistemologically correct, the linear model fails to help us to understand the economic and social determinants of knowledge creation. Steinmueller (1994) argued that the linear model had been criticized on making little account of the role of technology in shaping the aims, methods, and productivity of science and neglecting the non scientific origins of many technological developments, even though it was useful as a heuristic for examining the basic research and industrial innovation. Rosenberg (1992) suggested that the emergence and diffusion of new technologies instrumentation were central and neglected consequences of university basic researches.

The major role of universities is unarguably to perform scientific research, but Korea's universities are not as strong as other universities in the advanced countries in the frontier research. Fransman (1994) observed that Japanese universities have often been an important source of intra-frontier research for Japanese companies. This observation can also be detected in Korea too. Professors in top research universities have been connected to the private companies. They have performed the research projects personally for private companies in developing technologies either from the science knowledge or applications of the technologies to commercialization. However, these activities were not institutionalized and the relationship between universities and private sector had a tendency to rely on the private connections. The Korean government recognized the importance of the cooperation between universities and the private sector, and provided the legal framework and incentive mechanism in order to make universities play more active roles in technology development process.

The linkage between universities and industry is rather complex. As Pavitt (1984) puts it, most technological knowledge is not generally applicable and easily reproducible. It is specific to firms and applications. Moreover it is cumulative in development and varies among sectors in source and direction. Therefore universities and private firms should have a long term relationship so that they can accumulate the technological knowledge in the dynamic technical trajectory.

As globalization prevails and the competition gets more intensified, people tend to be convinced that the more value can be created from the knowledge and the transition to the knowledge based economy is more essential for the economic growth. Even though leading companies are investing more money on R&D than before, they tend to ask more help from universities and complain more on the performance of the universities. Ironically this tendency tells us how important the role of universities is. The remaining question is how we could change the system so that the economy could be upgraded.

This chapter is to introduce the essential factors of the Korean model for university and industry linkage and to evaluate the efforts for upgrading the linkages. Section 2 underscores the importance of the ecosystem of the technology development. Even though the linkage models are similar, the performance would be very different if the ecosystem is different. In the section, the theoretical aspect of the ecosystem is discussed and the ecosystem of the Korean case is represented. Section 3 mainly focuses on the Korean model of university and industry linkage and explains the effort of the government for upgrading the linkages. Section 4 evaluates the performance of the Korean model, and Section 5 concludes the chapter.

2. The Ecosystem of the Technology Development

2.1. Tripartite Interactions: the Government, Industry, and University

The ecosystem of the technology development consists of human resource providers, capital providers, science and technology providers, and policy makers. Interactions among those agents produce talented researchers, and R&D results. Moreover, R&D can be commercialized and its value can be realized through those interactions. The self sustaining ecosystem is such that all agents in the system can benefit from the activities and that the innovators and entrepreneurs can expect opportunities to be compensated in the system without endless public supports. For example, the science and technology provider can get sustainable capital inflows either from firms or from capital markets. The developed technology should be commercialized so that the capital providers can get returns from their investments. The human resource provider can also have an incentive to produce more qualified human resources within an interactive system. Policy makers can provide the incentive mechanism so that all the agents can perform their own responsibilities without pumping the huge amount of public money in.

In the ecosystem of innovation, universities are essential. During the period from the 1960s to 1970s, the private firms in Korea did not pay attention to develop any new technology, and instead, they made more efforts to catch-up the technology gap between the advanced countries and Korea. As a result, the major breakthrough occurred in the process technology rather than the new product technology. The process technology is for enhancing the efficiency of producing goods rather than for making new goods. One of the main reasons for this tendency is that money required for the process technology is small, and its time of cashing out is short.

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After the Korean firms accumulated their capital and the stock market responded to the technology ability of the firms, the firms began to put their money to develop new products and basic science due to the changed environment as well as the global competition.

The technology development process requires time and money. Any sustainable technology development process contains the cashing out process. Firms are accustomed to thinking of the marketability when they begin to develop the new technology and the new products. However, universities usually have a different incentive mechanism. Most researchers in universities are not able to have concrete understanding of marketability of their research, and they are inclined to publish academic papers which are usually far from the commercialization. Even though commercialization of the technology is very important for the sustainable technology development, universities have not been very active in this area until recently. Therefore, universities have enjoyed their own autonomy in the technology ecosystem. Exogenous input such as public research funds is very important to strengthen the research capability of universities.

Universities have most of the valuable research personals and environment for creativeness and innovation, and they have contributed to building up the knowledge in the academic sense, but in Korea, their main agenda is concerned mostly about education. Many success stories of university-oriented technology development and commercialization in the developed countries have influenced the policy makers and professors for a decade. Ventures and stock market listings, and commercialization of technologies are perceived as essential elements to improve innovative environment and universities' capacity. Now, many policy measures have been taken to transform the universities' incentive mechanism, but still universities contributed to mainly expanding the knowledge base by producing human resources.

Table 3-1 | Major Players in the Technology Development

Players	Role	Characteristics	Incentive Transformation
University	Science and technology Provider Human Resource Provider Exogenous	Exogenous Passive	Organizational restructuring
Firm	Science and technology Provider Capital Provider	Endogenous Active	Capital market enhancement
Government	Policy maker Capital Provider	Exogenous Passive	Incentive compatible policy making

The linkage between university and industry is very important in a couple of viewpoints. The first view point is that linkage itself is for making the ecosystem sustainable; and the second one is that there is a way of contributing to make the society more innovative. Even though the importance of the linkage has been emphasized, and there is some progress, there are many issues unresolved.

Universities have contributed to the industry by supplying the talented human resources. This indirect conduit of the linkage should not be belittled. The direct linkages are various: performing the joint R&D projects with industry; nurturing venture firms in the university incubators; consulting the firms in the individual bases; turning universities into business entities for selling their R&D results; and spin offs are a few examples.

There are two basic issues before the discussion of university-industry cooperation. One of the issues is to change the incentive mechanism of universities. Universities are traditionally an educational institution. As such an institution, universities have been independent in providing curriculums for a long time. However, there are many criticisms about the competitiveness of university education in terms of how well university education meets the needs of a competitive economy. Because higher education is too professional, others, except professors, cannot intervene in changing the curriculum in response to the firms' need. Moreover, Korean professors have enjoyed privilege and respect so that it has been very slow in changing in response to the outside demand. Even though there have been policy concerns to change the laggard higher education, the results of those efforts are not promising.

Since 1994, the Ministry of Education, Science and Technology and the Korean Council for University Education have conducted the comprehensive evaluation of university education and the categories of the evaluation were university management innovation, education quality, educator capacity, student support system, infrastructure, university-industry cooperation, strategic specialization. Along side of the evaluation, there have been many financial aid programs for university R&D and human resource development. The government spent 4,488 billion won as of 2005, which was 2.29% of the total government budget and 0.56% of GDP. As of 2005, the budget to enhance the educational competitiveness was 9.5% of the total financial support, which was much smaller than the budget for R&D. Most of the budget allocated to universities were spent on the current expenditure so there has not been much room for universities to change their governance and meet with the needs of the business sector.

Even though many policies have been implemented, Korea's universities need to increase their educational competitiveness. Moreover, universities have to find out an incentive mechanism by which the curriculums and other educational provision are to be adjusted to meet the demand of the economy and to contribute more to the economy.

The other issue is to build up the R&D capability of universities. According to the 2007 assessment in terms of the number of publications in the journals listed by science citation index, only Seoul National University and Yonsei University are ranked in the top 100 universities in the world. Considering the economic size and the number of universities in Korea (there are 195 universities and 107 junior colleges as of 2007), this concisely shows the level of the global competitiveness of universities in Korea.

The Korean government addressed this issue and has tried to enhance core ability of each university. The Ministry of Education enacted a law that could establish the advisory committee for university specialization. The committee may coordinate the financial support for universities from various ministries so that each university may focus on its core competency.

Compared to other countries, Korea spends relatively less R&D investment to universities and the private companies spend relatively more. The financial scale of universities in Korea is approximately 21 trillion won (2.5% of GDP) as of 2005. The government spent 4.5 trillion won, which is 22.7% of the total budget of university, that is, far less than OECD average (78.1% as of 2005). Therefore, the Korean government has to spend more in order to improve the R&D capability of Korean universities, which is a basis for industry upgrade under the condition that those investments must be more efficient.

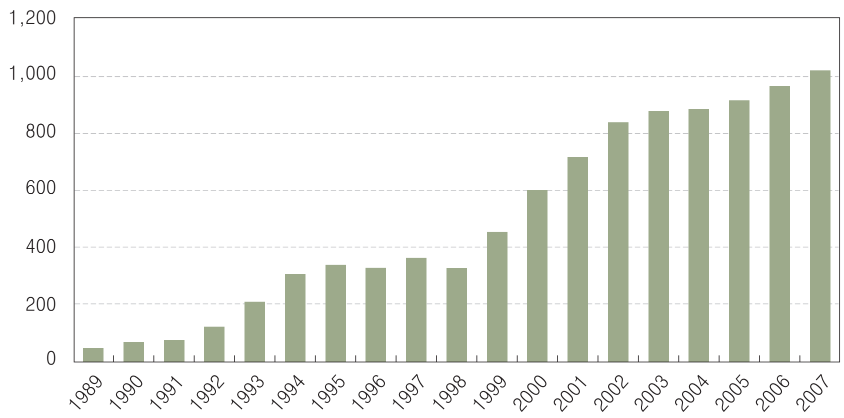
The policies for changing incentive mechanism and improving the R&D capability of universities are ongoing processes, and these policies are also necessary for universities and industry linkage. At the same time, more importantly, the ecosystem of the technology development should be effective and sustainable. Therefore, the Korean government has provided legal framework and incentives so that universities can have their own mechanism to accumulate the capital by appropriating their R&D results.

2.2. For a Self-sustaining System

The technology development has been achieved as the industry developed. The co-evolutionary industrial policies worked out successfully, and the technologies have embodied in the industry. In this process, universities have involved in indirect ways; supplying human resources, influencing the science and technology policies through the related government committees, participating in national or private R&D projects. In 1990s, there was a tendency of expecting new lucrative business related with new technologies and innovation.

The most important enhancement in innovation system in Korea is that the government opened the door for venture capitalists to cash out their investment and for small firms and technological firms to be able to raise the capital. The Ministry of Finance announced “Plans for organizing market for revitalizing the stock transaction of the small and medium sized firms" in 1986 and established the over-the-counter market in Korea Securities Dealers Association in 1987. In 1996, Korea Securities Dealers Association established KOSDAQ (Korea Securities Dealers Automated Quotation) market. In 1997, the government amended the Securities and Exchange Act in such a way that the investors could be protected from unfair activities and the transactions could be promoted on the bases of accountability and stability. The stock market has played an important role for mobilizing the capital for R&D. After the introduction of KOSDAQ, the number of firms listed in KOSDAQ has tremendously increased from 47 in 1989 to 1022 in 2007. Even though there were booms and busts, the capital market contributed to promoting many venture firms in 2000s.

Figure 3-1 | The Number of Firms listed in KOSDAQ



Source: Bank of Korea DB

There were other changes in 1990s. Before 1990s, the linkage between universities and industries were rather indirect. Even though the Korean ecosystem is moving forward to the more self-sustaining system, the system needs more impacts from science based knowledge for upgrading. Recognizing the essential needs, the government emphasized universities' role in the industrial development via R&D. In other words, universities became the most important tool for the government to improve industries. This is because universities have most knowledge capital and science base in Korea. Universities have well trained researchers, and relatively good R&D facilities. The companies in basic industries have already established innovative capacity, and they are leading innovators.

Table 3-2 below shows two facts; one is that the Korean ecosystem becomes more private oriented and self-sustaining and the other is that universities become more active in cooperating with industries. During the 2000s, firms had more patents out of the cooperation between private firms than the cooperation between firms and universities. During the 1990s, public institutes contributed most joint patents with private firms, but the number of joint patents decreased in the 2000s. Instead, the number of joint patents between universities and private firms has increased tremendously.

Table 3-2 | Joint Patents Distribution by Cooperating Institutions

Cooperative agents	1990-1994	1995-1999	2000-2004	1990-1999 annual average	2000-2005 annual average
A with A	281	914	1752	120	301
A with B	521	2138	928	266	156
A with C	20	155	312	18	62
A with D	848	1281	427	213	72
A with E	1	10	43	2	9
B with B	1	10	72	2	18
B with C	5	16	4	3	1
B with D	10	63	136	8	23
B with E	0	1	10	1	2
C with C	2	0	3	1	2
C with D	2	64	269	9	45
C with E	0	0	2	0	1
D with D	2	23	34	4	7
D with E	771	2663	4521	343	767
E with E	156	1056	2637	121	454

Note: A: private firms B: public institutions C: non-profit organization D: university E: individual
Source: Author's calculation from the data of Ministry of education, science and technology (www.mest.go.kr)

The increasing tendency of university and industry cooperation resulted from the government efforts. The list of those efforts is as follows even though it is not comprehensive:

- Establishing institutions for self-sustaining ecosystem
- Enhancing universities' innovation capacity
- Changing incentive mechanism of universities
- Providing Diffusion channels of universities' technologies
- Encouraging joint R&D with industries
- Making universities play an important role in the regional innovation system and regional development
- Providing Legal Framework and institutions to implement the above measures

These efforts will be discussed in the following sections, but the Korean ecosystem for innovation is moving forward to more self-sustaining system, while universities are starting to play more important roles in the system.

3. The Korean Model of University and Industry Linkage

3.1. The Generic Model

3.1.1 Incentive Mechanism Reforms

University and industry linkages are complex. In order to strengthen the linkage, there should be a comprehensive approach rather than a step-by-step or piecewise approach. Tripartite relationship among university, business, and government involves various organizations which have different incentive mechanisms for themselves. Therefore, legal framework and government actions should be provided in order to change the incentive mechanism so that those institutions can actively participate in the cooperation and have the so called win-win results.

The relationship between university and industry had been indirectly established for a long time. In Korea, professors in universities have been respected by wide population in the Korean society as a kind of social mentors rather than the technology providers. Traditionally, the business activities by selling their knowledge or providing the knowledge had been regarded as something that the intellectuals should not do. However, in reality, there had been needs from the society, and many professors ironically actively have participated in the government as a member of various committees and had consulted the firms and participated in the R&D projects. Recognizing that this practice had limitation in strengthening the linkage systematically, the government has tried to change the system and practice of university and industry linkages.

Before the government addressed this issue, the relationship was indirect. Students paid tuition to the university, and took the courses that professors provided. In this practice, the relationship between students and professors remained in a traditional and ethical one. There was no incentive mechanism that professors took care of students' needs and cared for the industrial education demands. After students graduated from universities, they worked in industries with limited knowledge about the real business world, and they had to adapt themselves to the new environment. While professors had linkages to industries through the relation with former students as their mentors, professors had no incentive to delve into the reality of industries. Industries had many social mentors but they did not have technicians and trouble solvers that could really help them to solve their specific problems including technology development and strategies.

The previous system had the following problems: First, there was no mechanism that gave professors any incentives to meet students and social demand and to change their curriculums for industrial demand; Second, there was no mechanism that universities should invest more R&D for their benefits; Third, there was no direct liaison organization for deepening the relationship between universities and industries; Fourth, there was no flexibility in governance of universities for facilitating the cooperation with industries. In order to address these problems, the government has implemented the policies, which can be classified as incentive mechanism reforms, provision of linkage support system, and competence building.

Incentive mechanism is very important to establish the virtuous cycles in enhancing the cooperation between universities and industries. First of all, the government recognized the importance of assessing the performance of the universities since 1994 and differentiating the financial support. Especially, the public and national universities had been remained as autonomous entities for a long time because the society believed that the universities had to be free from all political influences and remained as a social guardian against the political dictatorship and for the democracy. After most Koreans believed that the certain level of democracy was established and that the performance evaluation had nothing to do with the political independence, the government implemented the national wide evaluation of universities and differentiated salary scheme of professors according to their performance in the national universities. Most private universities also followed the government reform policy. At first, the professor's performance evaluation focused on the areas of teaching and academic research, but it is changing towards emphasizing research funds, the patents, and joint works with private firms. The incentive of publishing academic papers has become much stronger in the professors' performance evaluation.

According to the Ministry of Education, Science, and Technology (2008), the number of publications in Scientific Citation Indexed Journals by the Korean researchers has increased to 25,494 in 2007 from 9,854 in 1998. The number of publication was 11,332 in 1999, 23,099 in 2005, and 23,297 in 2006. This steady increase in the number of publication is partly due to the performance evaluation and stronger tenure screen.

Moreover, most universities have implemented professors' performance evaluations that put more emphasis on university and industry cooperation. In 2007, 116 universities out of 140 surveyed universities included the domestic patent registration performance criteria, and 114 universities included the international patent registration criteria. Their weights in the evaluation were around the number on average from 14% to 22% of the weights on the academic paper publication in SCI journals. Table 3-3 illustrates how universities approach the issue of the cooperation. This changed attitude is due to the changed social demand and the changed laws such as "Industrial Education Promotion and Industry Cooperation Promotion Act" in 1995 and "Special Act for Venture Business Promotion" in 1997.

Table 3-3 | Relative Weight of University and Industry Cooperation Activities compared to SCI publications in Annual University Instructors' Evaluation

(unit: number, %)

Classification	2006		2007	
	Number of universities	Average Ratio	Number of universities	Average Ratio
Domestic Patent Submission	29	9.8%	41	14.0%
Domestic Patent Registration	97	17.4%	116	22.0%
Foreign Patent Submissio	29	10.4%	41	17.5%
Foreign Patent Registration	99	15.9%	114	20.8%
Technology Transfer Cases	10	5.2%	19	12.6%
Technology Transfer Revenue	22	14.8%	32	12.1%
Technology Consulting Cases	19	4.5%	28	7.9%
Technology Consulting Revenu	-	-	14	11.9%
University and Industry Joint Research Cases	30	19.6%	28	14.1%
University and Industry Joint Research Funds	-	-	48	21.3%
Professors Startups	13	3.5%	16	8.1%

Source: KRF(2007, 2008)

Especially for public and national universities, the changes in legal framework for university and industry cooperation were more essential. It has been customary for most universities to follow the national universities' policies for their instructors.

According to the legal reform for the cooperation, for example, universities were able to provide the facilities and land for the venture business and professors of universities became able to participate in venture businesses for longer time than the university regulation and the tertiary education law. Even national universities could utilize the revenues from renting their facilities without redemption to treasury. These efforts were expected to change the incentive mechanism for promoting the cooperation with industry.

3.1.2. Linkage Supporting System

The second stream of policies for promoting the cooperation is to build up the linkage supporting system. Because the Korean government has emphasized the importance of science and technology development for a long time, the approach to link universities and industries has been very comprehensive. The approach includes the areas such as regional development, industrial complex development, and industrial human resource development as well as science and technology development. Therefore, there should be a coordinating body to govern these activities across ministries, government agencies, industries and universities.

The National Science and Technology Council (NSTC) was established in January 1999 as the nation's highest decision-making body for science and technology policies. The president of Republic of Korea is the chairman of NSTC. NSTC has the subordinate committees for preparing the strategic plans and their action plans. Among the ministries, the Ministry of Education, Science, and Technology, and its agencies are basically the most important bodies to strengthen the linkages. However, other ministries focused on the linkage because they wanted to use the capacity of universities as leverage.

First of all, it was an imminent policy agenda to establish the system to improve the industrial technology and human resource development for better competitiveness. In order to address this issue, the government proposed the act for promoting industrial and energy technology in 1994. This act showed the change in the policy. The previous government policy was to target the specific industry and to support the industry, which was the so called picking-the-winners policy. From this act, even though the government maintained a strategic approach, the government abandoned the targeting approach and instead, adopted the functioning approach in the industrial policy. In the act, there were many articles to establish the infrastructure of technology development and to promote the joint R&D among public research institutes, universities, and private firms internationally and domestically. The act specified the article that enabled the government to plan the specific promoting programs. This law has changed to "Act for Industrial Technology Infrastructure Building" in 1999 and to "Industrial Technology Innovation Promoting Act" in 2006.

There are articles to allow the government to establish "Industrial Technology Development Committee" and to make the government responsible for the funds that will be needed for promotion. In the act, there are many important government agencies that will implement the government policies. The Korea Science and Engineering Foundation (KOSEF) and Korea Research Foundation (KRF) have supported various joint researches between universities and industries. Those foundations also contributed to the human resource development by strategically using the evaluation criteria for emphasizing on the participating researchers' capabilities and the human resource development aspects in the projects. In addition to these supports, KOSEF run the program that support universities which hire those who had experience in the public sector for a long time. This program aims at giving the college students the opportunities of learning the practical experiences in the field outside academia.

More importantly, the government addressed the direct channel of intensifying the linkages. There have been many established governmental agencies and foundations to address this issue. By the law “Industrial Technology Innovation Promotion Act,” the Korea Industrial Technology Foundation (KOTEF) was established in 2001. In order to reinforce future growth potential through innovation of technology, the government recognized the need to foster competence of schools, companies, the government and other entities to initiate technological innovation and to create and spread environment of technological innovation across the nation. KOTEF is to play a pivotal role in the course of promoting knowledge-based technological innovation. As a major mission, KOTEF builds an interlinked network where technological innovation-initiating entities participate and seek cooperation with international entities to promote industrial technology development.

“Industrial Education and Industrial-Academic Cooperation Promotion Act” is the most important law that governs the industry and university linkage as well as the cooperation between industries and vocational schools. The law basically specifies the roles of the government and various committees, and industry-university linkage organizations, and provides the legal basis for establishing the technology holding companies of universities and other appropriate treatments for promoting the industry-university linkages.

The Korea Research Institute for Vocational Education and Training (KRIVET) was established in September 1997 to support the national policy on human resources development and the development of the vocational capacity of the Koreans through lifelong learning. KRIVET has maintained a close partnership with two ministries in particular - the Ministry of Education, Science and Technology, and Ministry of Labor. KRIVET advises the two ministries regarding vocational education, training, and human resource development policies, and supports policy implementation. KRIVET implemented various projects for promoting the Industrial cooperation such as “Industrial Cooperation Center University Program,” “Industrial Cooperation Organization Support Program,” and “Local Firms Tailored Education Support Program.”

Universities responded quickly to the changed law and the demand from society. They also established Industry-University Cooperation offices in the independent incorporated bodies. For example, Seoul National University established “SNU R&DB Foundation” in 2003, Yonsei University established “The Yonsei University Industry-Academic Cooperation Foundation (IACF)” in 2004. Both were the offices of research affairs before they became an incorporated entity. Most universities followed this kind of transformation of internal organization according

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to the changed law of "Industrial Education and Industrial-Academic Cooperation Promotion Act."

Those are the centers of the industry and university cooperation, which include the technology transfer, joint R&D, consulting, and providing tailored curriculum for the private firms' specific needs. Those are the centers of maintaining the patents that have been achieved from the professors' researches. The law provides the necessary measures for the sustainability of those organizations including the revenue handling procedures and the property right management. Every university can establish the legal entity without any approval procedure.

By the law, in principle, the property right belongs to the corporation or the foundation, which is a subordinate to the university. The president of the university reserves the right to appoint the director of the foundation. "Invention Promotion Act" specifies that the invention of employees in the private sector belongs to the person who actually invented it, but "Industrial Education and Industrial-Academic Cooperation Promotion Act" specifies that the property right belongs to the corporation in national university. Therefore, the universities can handle all the detailed jobs that are related with the property rights including the application, dispute settlement, and transfers.

The government provided the linkage supporting system by changing laws and supporting the transformations of the university organization financially, and changing practices in various supporting projects. Currently, most universities have established the linkage supporting system. Some of them turned out to be successful, while most universities still have to wait for the future performance.

Another goal is to make universities involved in direct business and build the technology transfer and commercialization system. The office of university and industry cooperation is the core which manages the university-industry linkage and handles the research budget of the universities. It began to be established in 2003. It is a foundation as a legal entity. In 2003, only 12 universities established the office or foundation, but in 2004, 117 universities established the office. Its revenue comes from various activities of industry related works. As in Table 3-4, the most of the revenue comes from the overhead from the government research projects, and the second source of budget is the overhead cost that is paid by the industry research projects. Other activities such as technology transfer and business incubators do not create budget revenue.

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Table 3-4 | The Revenue of the University-Industry Cooperation Foundations

(unit: million won, %)

	A	B	C	D	E	F	G	H	I	J	K
Average amount	53.4	2.5	19.0	38.0	62.3	249.1	814.7	27.9	182.2	52.9	1502.1
Class 1	3.56	0.16	1.27	2.53	4.14	16.58	54.24	1.86	12.13	3.52	100
Class 2	11.67					70.82		1.86	12.13	3.52	100
Class 3	28.25						54.24	1.86	12.13	3.52	100

Note: A: technology transfer, B: consulting C: university firms D: business incubator E: other cooperation with industries, F: overhead cost from industry project, G: overhead cost from government project, H: Operational budget allocation, I: from previous account, J: contribution, K: total sum, class 1: ratio to the total revenue, class 2: ratio of research cooperation to non-research cooperation in terms of total average revenue, class 3: ratio to the total revenue when the funds of joint R&D with firms are included in the industry-university cooperation activities.

Source: Korea Research Foundation (2007, p.69)

One of the conduits of technology diffusion is university-related venture business. University-related venture business can be defined as follows: 1) the case when professors start business; 2) the case when universities invest or institutesare related with universities; 3) the case when students are involved in university research projects; 4) the case when the businesses use incubator in universities for a period less than 5 years; 5) the case when 5 year or less old firms have joint projects with universities; 6) the case when 5 year or less old firms receive the technology transfer from universities in developing the current business.

The number of university-related venture business reached 1,473 at the end of April, 2005. On average, each university has 6.6 venture firms if it has any. Most of university-related venture firms were established out of the joint research projects with universities, while the number of the firms that professors or students started for themselves is only 245, which is relatively small. This shows that professors and students have less incentive to devote themselves in business area. Hong and Kim (2006) surveyed the university-related venture firms on the strategy of listing on the stock exchange, but only 4.2% were listed, and 13.1% were in the process of being listed. 49.4% responded that they will not list and 26.6% wanted to list on the stock exchange. Most university-related venture firms took financing problem as the major barrier. Judging from these observations, universities are still far away from business, and therefore, the supports and policies are needed for the stronger linkages.

3.1.3. Competence Building

The most important thing in the cooperation with industry is the competence of universities either from academic perspectives or from business perspectives. Universities have their own goals which have lasted for a century in Korea; professors are independent, and respected from the Korean society. Excellent scientists want to join the faculty club for a cozy life. There have been increasing concerns over this tradition in Korea. The government has two goals for transforming universities into competitive institutes that can play a core role for upgrading Korea. One goal is to introduce competition in an academic society through evaluating universities by an academic standard, especially, education and research. For example, the government announces every year how many articles are published in SCI journal and how each universities perform in the evaluation. This will, hopefully, enhance the innovative capacity of universities.

The other goal is to enable universities to participate in the business sector. The government provides legal framework and actions for this goal. Universities are enabled to do business by establishing office of cooperation between university-industry cooperation. Professors can let the office for University-Industry cooperation do the venture business while maintaining academic positions.

These two goals are rather contradicting; good academic performance does not necessarily mean good business. In practice, however, these two goals seem to work well and have synergetic effects. Industries have an incentive to invest on education as human resource management, and the government allows private universities to establish the special classes as a way of university-industry cooperation. Curriculum of those classes tends to meet the industry demand.

There were other policies that influenced professors to change their teaching contents. For example, there was NURI project since 2004 (2004~2008). NURI is acronym of New University for Regional Innovation. The goal of the project is to make local universities specialized and to nurture human resources readily adaptable to the local industry. The budget of the project was US$ 260 million per year, $1.3 billion in total. 109 local universities, 130 project units, and 170,000 students participated in the project. 20,000 trainees participated in on-site training program at major companies.

Not only in education but also in research, there are synergic effects because the government distributes research funds to only those who have cooperative projects with industries. Since 1999, the policy named as “Brain Korea” has been implemented, and the government poured approximately US$ 290 million per year. The goal of this policy is to nurture top ten research-oriented universities in key fields, to join the world’s top ten ranking in terms of SCI-paper publication, and to become one of the world’s top ten advanced countries in terms of technology transfer from university to industry (from 10% in 2004 to 20% by 2012). As a result, cooperation with industries as well as publication at the academic journals increased. Industries have invested more than $100 million of investment for the joint work with universities participating in this project.

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Generally speaking, the Korean Model of university and industry linkage consists of three categories. One is to reform the incentive mechanism so that both the university and private firms may actively, voluntarily, and sustainably participate in sharing the knowledge. Education, research, and business activities can achieve their maximum level of the contribution of the society by the synergetic effects. The second one is to provide the legal and financial basis for preparing the linkage system. The last one is to build up the competence of universities so that they can meet the demand of the industry either in education or in research. Figure 3-2 summarizes three categories of the government policies.

Figure 3-2 | Categories of the Government Policies

Incentive Mechanism Reforms	• University assessment • Professor performance revaluation • University–Industry Linkage Institute • Legal framework and institute building
Linkage Supporting System	• Technology development • Human resource development • Technology transfer and commercialization • Technology consulting and supports • Equipment sharing program
Competence Building	• University Specialization • World Class University/ NURI, BK21

3.2. Legal Framework and Government Policies for University-Industry Cooperation

3.2.1. Characteristics of the Legal Framework

The government has provided the comprehensive support to promote the industry and university cooperation. In order to implement those policies, the government had to have the legal basis. There have been many revisions of laws and many newly enacted laws regarding the

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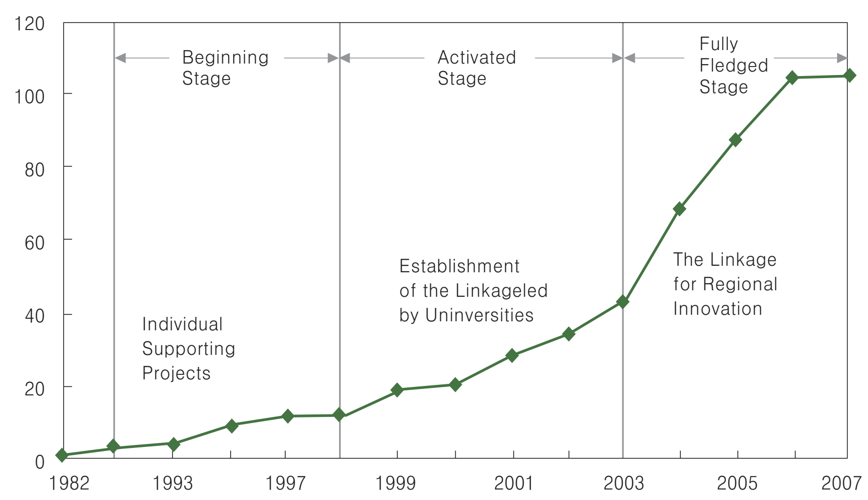
enhancement of the cooperation. The main law directly related with the linkage is "Industrial Education and Industrial-Academic Cooperation Promotion Act," but there are various laws which use the university and industry linkage to pursue their own goal.

Lee and Koh (2006) described the stages of the Korean university and industry linkage policies. The concept of the linkage was introduced in 1960s. "Industrial Education Promotion Act," which was changed into "Industrial Education and Industrial-Academic Cooperation Promotion Act," was enacted in 1963, and "Vocational Training Act" was enacted in 1967. These laws focused on training technicians whom the firms needed on the job. After Korea succeeded in upgrading the industry, the government tried to enhance the industry and university linkages. The Ministry of Science and Technology supported "Specific R&D Projects" since 1982, and supported "Mid-term Core Technology Development Projects" and "Outstanding Research Center Development Projects" in the 1990s. Since 1998, universities led the linkage by strengthening the competitiveness of universities and the infrastructure and the system was set up. In this period, the university and industry linkage had its full fledged system. Since 2003, the government tried to use the linkage as a core to improve the regional innovation system and to develop the regional economy. "Special Act for National Balanced Development" was enacted in 2004. In this special law, there were many articles to support the local universities' capacities and their cooperation with the industry.

Figure 3-3 | University-Industry Cooperation Support Projects by Stages (unit: cases)



Source: Lee and Koh (2006, p.64)

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There are many policies which can be categorized as system building, legal base for government planning, job oriented education program, equipment and facility support, human resource exchange, joint R&D and business operation, DB building and sharing, business startups in the universities, and specialized organizations for the linkages. Various laws have many articles governing these categorized supporting functions.

Table 3-5 | University-Industry Cooperation related Legal Framework

classification	A	B	C	D	E	F	G	H	I	J
System building	2	24, 25-35			5,11			8		
Legal base for Government Planning	10	4	3	4	4	6	3		4-5	
Job oriented education program	12	7,8,22	7-9, 12,14		6				6	
Equipment and Facility support		11,13, 18,19		17,23				18(4)		
Human resource Exchange		9, 12(2)	21		8	10	11,17, 19	16	8,15	
Joint R&D and business operation		37		12,13,14, 15,16	9	10	21	18(2)		5
DB building and sharing			23	21	7			16(2)	7	
Business Start-ups in School		36					14	18(3)		
Specialized Organization	22,28	14,25, 38	16,18	5-10				23		

Note: A Special Act for National Balanced Development
B Industrial Education and Industrial-Academic Cooperation Promotion Act
C Job Training Promotion Act
D Technology Transfer Promotion Act
E Joint R&D Promotion Act
F Act for Industrial Technology Infrastructure Building
G Act for Industrial Technology Complex Support
H Special Act for Venture Business Promotion
I Special Act for Small and Medium Sized Firms Manpower Support
J Act for Industrial Technology R&D Corporation Support
The number of the table indicates the article number of the law and the number inside ( ) indicates the number of sub-clause of the article

Source: Lee and Koh (2006, p. 23)

The most interesting thing that can be observed in Table 3-5 is that most laws establish the legal base for the government planning and support. By this base, the government can approach strategically or with a roadmap to enhance the linkages. Even though the market is the most important selection mechanism, there has been room for the government to steer the movement of the market. It might be controversial whether the plans or the strategies proved to be successful, but the strategic thinking and allocations of resources according to the strategies are better than the intervention without any.

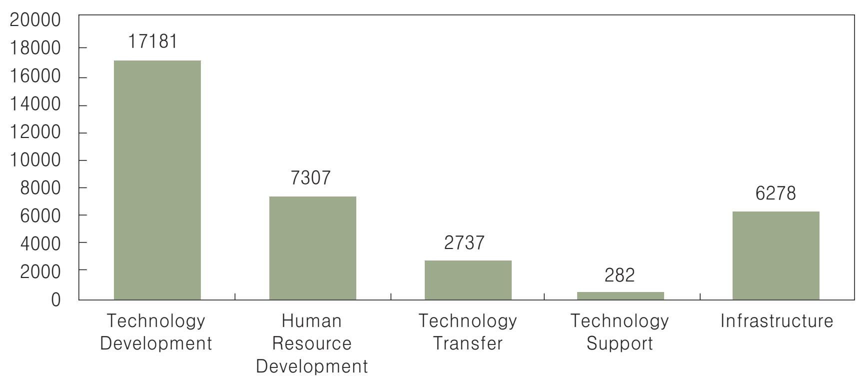
3.2.2 Government policies

Based on the legal framework, the government has actively supported the cooperation between universities and industries. Because the government has been convinced by the fact that the cooperation is the most important factor for upgrading the industries and maintaining the competitiveness, the Korean government implemented comprehensive projects in order to enhance the linkage. The policy spectrum contained the major elements related with the linkages are as follows;

- Human resource development
- Technology development
- Technology transfer
- Technology support
- Equipment sharing and infrastructure building

The budget for university-industry cooperation in 2006 showed that the technology development is a key for the cooperation. The total budget for the technology development was

Figure 3-4 | The Budget for University-Industry Cooperation by Types as of 2006. (unit: 0.1 billion won)



Source: Lee and Koh (200), p.68

1718.1 billion won in 2006. The next largest budget of 730.7 billion won was allocated to improve the human resource development. As we can see in the budget allocation, the actual cooperation between universities and industries comes from both technology development and education areas.

The Ministry of Education, Science, and Technology has paid more attention to fostering the competency of universities' R&D capacities and education, while the Ministry of Knowledge Economy has been responsible for the policies from industrial perspectives. Other ministries have implemented the policies for their own goals.

As most countries do, Korea has many government agencies. The performance of the policies actually depends on the capacity and intent of the agencies. Many agencies have been established for a long time, and even though the name changed, the history of the agencies has lasted more than a decade on average. Therefore, there have been systematic implementations for those policies. The Board of Audit and Inspection of Korea (BAI) has the comprehensive right to audit and inspect the government agencies. In 2005, for example, BAI inspected the operation of support program to universities. The government spent 5 trillion won every year (5.5 trillion won in 2003) on R&D and about 20% of the spending went to universities. There were a few cases of mishandling the research funds of professors, but in the inspection report, Korea Research Foundation and Korea Science and Engineering Foundation used a pool of 25,000 referees each, and the system turned out to be appropriate with stronger post audits. This kind of regular audits and inspections on the agencies and agencies' operation and practice has helped the agencies to improve their accountability and capacity for the policy implementation.

Table 3-6 shows the examples of the industry and university linkage programs. The Ministry of Education, Science and Technology spent relatively larger amount of budget for establishing the linkage and making the linkage much stronger.

The Ministry of Education, Science and Technology spent more on human resource development and capacity building of universities. The different aspects of the spending strategy was that even in human resource development programs, the programs should address the issues of the industry and university linkages. That is, the programs required universities to educate students in a way that their graduates meet the demand of the industries. The Ministry of Knowledge Economy concerns more about the technology development and transfer for industries. The large conglomerates have built up the independent R&D capacity. So the Ministry of Knowledge Economy addresses three issues: One, the frontier path finding projects which needs the talents and gurus of universities; Two, the small and medium sized firms; Three, regional development.

Regional development was a politically popular issue. Since 2003, the government had a comprehensive plan for the regional development. For example, NURI21 was to enhance the capacity building for local universities. NURI21 was for fostering educational capacity under the condition that universities restructure themselves by specializing on the areas that the regional industries demand. "Regional Industry Promotion Program," "Regional Innovation Industry Base Building Program," "Regional Innovation Center," "Regional Innovation System Specialization Program (RIS)," "Region Innovative Human Resource Development Program," and "Techno Park Program" were implemented for the regional development with the concept of cluster and regional innovation system.

Even though there was massive investment in this area, there were criticisms about the efficiency of the investment. One of the success stories is the case of Yonsei University and Wonju Medical Equipment Industry, which shows the possible application for other developing countries' regional development. The complete understanding of these policies has to come, but the regional development outcome is not yet obvious to everyone. Due to the global competition, the regional economy cannot survive if the back-up technology is not competitive.

Table 3-6 | Government Agencies and their Linkage Programs

[Programs related with The Ministry of Education, Science and Technology]

Institute	Program	Main Support Area	Budget 2006 (0.1 bil. Won/ 0.1 mil. USD)
Korea Research Foundation			
	Special purpose program	HRD	76.7
	BK21(Research University)	HRD	2900
	NURI(local university specialization)	HRD	2600
	Connect Korea (TLO, Patent search, tech. Export etc)	Technology Transfer	287.7
Korea Research Institute for Vocational Education and Training			
	University-Industry cooperation core college and university program etc	HRD	450
Other	College and University specialization programs	HRD	2300
Korean Science and Engineering Foundation			
	Specific R&D program	Technology Development/ Equipment and Infrastructure	2366
	Basic science research program	Infrastructure	820
Korea Industrial Technology Association			
	University-Industry Cooperation Personnel Training Program	HRD	
Other	Science Park Development program etc.	Infrastructure	340

[Programs related with the Ministry of Knowledge Economy]			
Institute	Program	Main Support Area	Budget
Korea Institute of Industrial Technology Evaluation and Planning			
	Growth engine technology development program etc. (all programs are the type of consortium among universities, research institute, and firms)	Technology Development	3169
	University-Industry cooperation Linkage program etc	Equipment and Infrastructure	451
	Center for comprehensive electronic parts	Technology Support	9
	Promotion of technology transfer and commercialization	Technology Transfer	405
	Regional industry promotion program etc	Technology Development / Technology Support / Infrastructure	3572
	Regional innovation industry base building program	Technology Development Transfer and Commercialization / Technology Support / Infrastructure	515
	Techno park building program	Equipment and Infrastructure	200
	Industrial complex innovation cluster program	Technology Support(for providing solutions by networking)	462.5
	Regional Innovation Center	Equipment and Infrastructure	480
	Regional Innovation System specialization program (RIS)	Technology Development/Technology Support (supporting for more region-specific industries)	591
	Regional technology innovation program	Technology Development/Technology Support / Equipment and Infrastructure	335
Korea Industrial Technology Foundation			
	University-Industry cooperation specialized	Technology Development/Technology Support/ HRD	848
	High valued industry human resource specialized development program etc.	HRD	217.5
	Region innovative human resource development program	HRD	240.8
	Regional innovation industry base building program (human resource development program)	HRD	10

Korea Industrial Technology Association			
	Program for Search and Transfer of Technologies unused by Universities and Research Institutes	Technology transfer	20
Korea Technology Transfer Center			
	TBI etc	Technology transfer	
Institute for Information Technology Advancement			
	New Growth Engine Core Technology Development Program	Technology development	4846
	Information and communication human resource development program	HRD	727.5
	Regional IT specialized research institute establishment and operation program	Infrastructure	65
	Business Incubation Center program	Infrastructure	
Korea SW Industry Promotion Agency			
	Information and communication human resource development program	HRD	149.4
	IT technology management specialists education program (KAIST) etc	HRD	89.4
Small and Medium Business Administration			
	Industry University Research Institute Joint R&D projects	Technology Development	426
	Industry-University Cooperation Office Support Program	Technology Development/ HRD	70
	Business Start-up Graduate School	HRD	10
	Support Program for Firm's Research Institute on Campus	Equipment and Infrastructure	34
	Business Incubator Program	Equipment and Infrastructure	153
	Other programs		152

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[Other ministries' programs]

Ministry	Agency	Program	Main Support Area
Ministry of Maritime Affairs, and Fisheries	Korea Institute of Marine Science and Technology Promotion	Marine-Bio 21 Program, etc.	Technology Development
Ministry of Environment	Korea Institute of Environmental Science and Technology	Next Generation Core Environmental Technology Development Project etc. Technology Development	
Ministry of Labor	Human Resource Development Service of Korea	Growth Engine Specialized University Support Program, etc.	HRD
Korean Intellectual Property Office	Korea Invention Promotion Association	Patent Commercialization Support program	Technology Development Transfer and Commercialization /Technology Support
Ministry of Health, Welfare and Family Affairs	Korea Health Industry Development Institute	Bio-Commercialization Technology Development Program, etc.	Technology Development
Ministry of Agriculture and Food		Core Strategic Technology Development etc.	Technology Development

Source: Author rearranged the contents from Lee and Koh (2006, pp.69-71)

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4. The Performance Review of the Model

4.1. An Overview: SWOT Analysis

4.1.1. Strengths

The government used the industry and university linkage as a core across a wide range of development strategies. In fact, the private firms and the market forces have been the major factor for the development of the Korean economy and the industrial upgrading. The government policies were effective in several important points when the Korean economy had to take the tide of upgrading the industries. The technologies that professors and researchers of public and private institutes jointly developed became globally competitive. However, Korea is experimenting a new approach. That is, the government places universities in the lead of the development process and opening the future. The most important strength is the fact that the Korean government recognizes the importance of the linkage.

Because of the economic success in last 40 years, the Korean economy has strong pillars to support the knowledge economy. As Suh and Chen (2007, p 9) showed the result of knowledge assessment methodology (KAM) by the World Bank, Korea's performance in terms of the basic score card knowledge indicators is strong.

Table 3-7 | R&D Expenditure by Institutes

(unit: 100 million won, %)

Type	Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total	Expenditure	121,858	113,366	19,218	138,485	161,105	173,251	190,687	221,853	41,554
	Ratio	100	100	100	100	100	100	100	100	100
	Growth	12	7	5.2	16.2	16.3	7.5	10.1	16.3	8.9
Public Institutes	Expenditure	20,689	20,994	19,792	20,320	21,602	25,526	26,264	29,646	31,929
	Ratio	17	18.5	16.6	14.7	13.4	14.7	13.8	13.4	13.2
	Growth	9.1	1.5	-5.7	2.7	6.3	18.2	2.9	12.9	7.7
Universities	Expenditure	12,716	12,651	14,314	15,619	16,768	17,971	19,327	22,009	23,983
	Ratio	10.4	11.2	12	11.3	10.4	10.4	10.1	9.9	9.9
	Growth	24.8	0.5	13.1	9.1	7.4	7.2	7.5	13.9	9
Companies	Expenditure	88,453	79,721	85,112	102,547	122,736	129,754	145,097	170,198	185,642
	Ratio	72.6	70.3	71.4	74	76.2	74.9	76.1	76.7	76.9
	Growt	11.1	9.9	6.8	20.5	19.7	5.7	11.8	17.3	9.1

Source: Ministry of Education, Science and Technology (Http://english.mest.go.kr)

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Table 3-7 shows R&D expenditure by types. As of 2005, companies spent 76.9% of the total R&D expenditure and universities spent only 9.9%. This ratio has been stable for a long time. However, the absolute amount of the R&D spent by universities has increased annually by 10.2% on average since 1997.

Universities generally have high quality of researchers in various fields. Korea's R&D expenditure structure is led by private companies so that the number of researchers employed by the companies is larger than that of researchers in universities. The growth rate of the number of researchers in universities is 4.5% on average since 1997. Considering the research funds and the number of researchers, universities are a good source of innovation and researches.

Table 3-8 | The Number of Researchers by Institutes

(unit: person, %)

Type	Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total	Researcher	138,438	129,767	134,568	159,973	178,937	189,888	198,171	209,979	234,702
	Ratio	100	100	100	100	100	100	100	100	100
	Growth rate	4.5	6.3	3.7	18.9	11.9	6.1	4.4	6	11.8
Pub. Institutes	Researcher	15,185	12,587	13,986	13,913	13,921	14,094	14,395	15,722	15,501
	Ratio	11	9.7	10.4	8.7	7.8	7.4	7.3	7.5	6.6
	Growth rate	-2.2	-17.1	11.1	-0.5	0.1	1.2	2.1	9.2	1.4
Universities	Researcher	48,588	51,162	50,151	51,727	53,717	57,634	59,746	59,957	64,895
	Ratio	35.1	39.4	37.3	32.3	30	30.4	30.1	28.5	27.6
	Growth rate	7.2	5.3	-2.0	3.1	3.8	7.3	3.7	0.4	8.2
Companies	Researcher	74,665	66,018	70,431	94,333	111,299	118,160	124,030	134,300	154,306
	Ratio	53.9	50.9	52.3	59	62.2	62.2	62.7	64	65.7
	Growth rate	4.9	-11.6	6.7	33.9	18	6.2	5.1	8.3	14.9

Source: Ministry of Education, Science and Technology (Http://english.mest.go.kr)

In addition to the funds and researchers, universities have been usually indirectly related with the central government, local governments, and industries for a long time. Therefore, it is not surprising to have emphasized the cooperation among the government, industries, and universities. Furthermore, through economic development, universities have played an important role by providing talented graduates and participating in specific researchers individually. Therefore, the time has come to link universities and industries more systematically.

4.1.2. Weaknesses

The major weakness of the linkage was the incentive mechanism of the universities. In addition to the incentive mechanism, the competence of universities was in question. In globalized world, the technology that companies need is the most updated one, but sometimes professors lag behind the trend because of the academic tradition and the teaching load.

Competency of universities is very important because it can create the trust and cooperation which are needed the most in the long term relationship for technology development. Even though there have been potentials in universities, the potentials have not been utilized to its full capacity. R&D expenditure is heavily concentrated to a group of the exceptionally large companies, while other small and medium sized companies have no resource to invest on R&D.

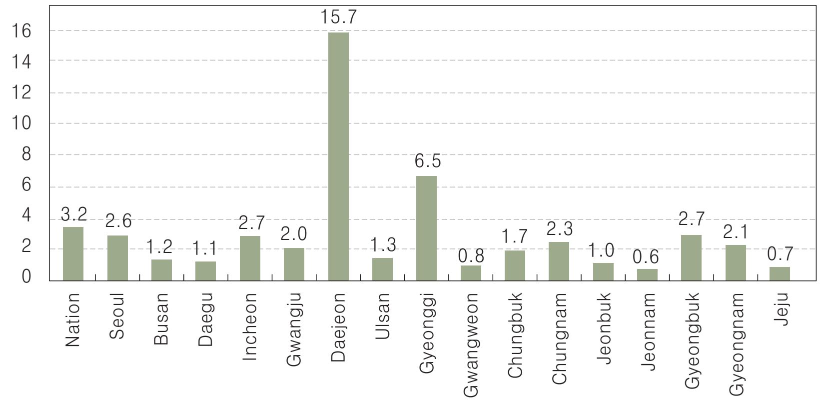
As for the concentration rate of the total industrial R&D expenditure in 2005, the top 5 companies took up 42.0%, top 10 companies used 48.4%, and those in the top 20 expended 55.6% respectively. In terms of the number of researchers, the concentration rate of the top 5 companies was 30.6%. The data on the concentration of researchers by company type in 2005 showed that large corporations took up 59.3% with 91,514 researchers, small & medium sized companies 19.8% with 30,619 researchers, and venture businesses 20.9% with 32,173 researchers.

This concentration created the problem that those who have the money and resources have less incentive to cooperate with universities and those who need the cooperation have no resource to invest money in the cooperative projects with universities. This is one of the reasons why the government has to address this issue.

R&D investments by region have been concentrated on the specific region such as Daejeon, where the Korean government built the R&D cluster for a long time, resulting in many public research institutes located in the region. Other than Daejeon area, Seoul and Gyeonggi province show much higher ratios than any other provinces. This concentration was pointed out as a barrier to develop the regional economies other than Seoul and Gyeonggi province. The debate was about the national balanced development. The proponents argued that the support to strengthen the innovative capacity of other region was essential for the regional development. Others criticized that the emphasis on using the regional innovators and universities would weaken the developmental momentum because of the competitiveness of the innovative capacity.

Figure 3-5 | R&D per GRDP as of 2006

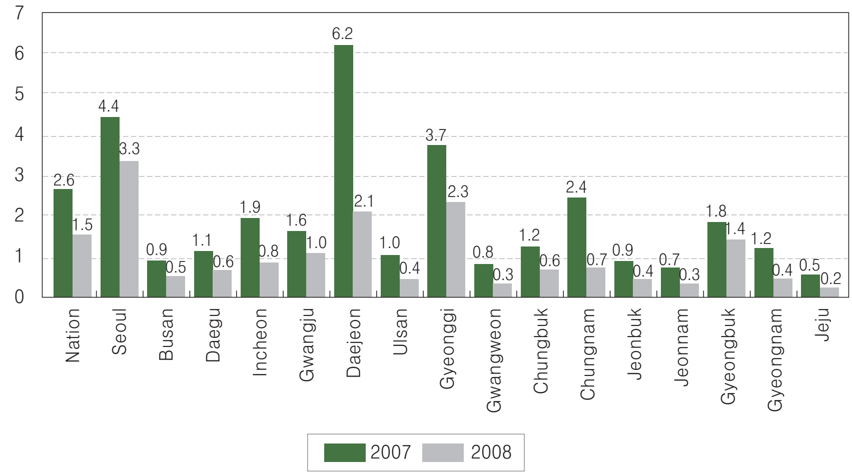
(unit: %)



Source: www.rsid.or.kr

Figure 3-6 | IPR per Population by Regions: Comparison between as of 2007 and 2000

(unit: %)



Source: www.rsid.or.kr

4.1.3. Opportunities

The ecosystem of technology development has been upgraded in the last two decades. In 1986, the government enacted two laws: one is “Small and Medium Business Start-ups Support Law”, and the other one is “The Financial Assistance to New Technology Business Law.” Under these laws, the venture capital can invest small and medium business start-ups with new technologies. The government can also support those start-ups by using Small Business Corporation’s funds. Small Business Corporation was established in 1979 as a government agency to implement the policies for promotion of small and medium sized firms. The Korean small and medium sized manufacturers with high potential and knowledge based business or venture firms etc. can access financial loan packages.

Moreover in 1996, the Korea Securities Dealers Association and securities companies established KOSDAQ (Korea Securities Dealers Automated Quotation) market. Before its establishment, venture capitalists had difficulties to cash out their investment. In 1999, the government eased the conditions of listing on the KOSDAQ market so that many lucrative firms such as telecommunication firms had the opportunities to raise the capital through KOSDAQ.

Table 3-9 | The Venture Capital Outstanding

(unit: billion won, number)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008.6
Venture Capital Companies	147	145	128	117	105	102	104	101	100
(Paid-in Capital)	2139.1	2219.4	1965.1	1865.1	1652.8	1536.8	1553.7	1555.8	1571.4
Venture Capital Association (Funds)	326	396	412	430	424	400	350	332	326
(Amount of Funds)	2463.4	3051.2	3269.8	3578.7	3817.2	3936.4	3833.6	3947.9	3991.8

Source: SMA (2008), p.78

The capital markets opened new channels for venture capitals and start-ups. The number of venture firms has increased steadily even though there have been fluctuations due to stock market volatility. The number of venture firms was 2,042 in 1998, and increased to 11,392 in 2001. As the stock market plummeted in 2002, the number decreased to 8,778. The number is 15,008 in 2008. This increase was partly due to venture capitals including Kibo Technology Funds.

The most important source of capital has been from non-profit institutions initiated by the government. Kibo was founded in 1989 by the Korean government as a non-profit guarantee institution under the special enactment, “Financial Assistance to New Technology Businesses Act” which was revised and titled “Kibo Technology Fund Act” in 2002. Kibo has contributed to the national economy by providing credit guarantees to facilitate financing for new technology-based enterprises while promoting the growth of technologically strong Small and Medium Enterprises (SMEs) and venture businesses.

Table 3-10 | Kibo Technology Fund's Major Services

Technology Guarantee	Guarantees for monetary liabilities to financial institutions -Guarantees given to new technology businesses - Obligation to provide at least three-quarters of the total technology guarantees under the Kibo Act Guarantees given to innovation-leading SMEs - SMEs with excellent technologies, the nation's top 10 next generation growth engine industries, as well as six promising industries for future growth (6T) and knowledge-based service businesses Technology Appraisal Guarantees - Guarantees to qualified businesses through Technology Appraisal Certification System
Technology Appraisal	Adoption and utilization of the Technology Appraisal Certification System - Future-centered value appraisal of businesses for loans, guarantees and-investment Technology Value Appraisal - Appraise intellectual properties - Evaluate collateral value of technology - Assess monetary value for technology transfer Feasibility Assessment of Technology - Certify venture enterprises - Select the beneficiaries of government project funds - Appraise technology for extending technology guarantees Comprehensive Technology Appraisal - Appraise corporate value for investment - Designate "superior-technology" companies - Support venture businesses for KOSDAQ-listing
Technological and Managerial Advisory Service	Business Consultation - Help SMEs rationalize management - Facilitate technology development - Clear managerial and technological obstacles Support for Company Restructuring and Technology Transfer - Provide financial & legal advice for restructuring - Formulate business strategies for technology transfer - Provide match-making service between sellers and buyers
Management of Guarantee Defaults and Claims	Investigation of Debtor's Properties Subrogation Payments Legal Procedure for Debt Collection

Source: Kibo Technology Funds (http://eng.kibo.or.kr/)

Table 3-11 | Kibo Technology Funds' Capital Fund Formation and its Performance

(unit: US$ million)

	2006.1	2005	2004	2003	2002
Guarantee Outstanding(A)	11,599	11,244	12,941	13,981	13,764
Contributions	793	946	819	427	415
From the Government	634	342	593	246	262
From the Financial Institutions	159	604	226	181	153
Capital Funds(B)	1,172	788	756	872	1,318
Leverage Ratio(A/B)	9.9	14.3	17.1	16	10.4

Source: Kibo Technology Funds (http://eng.kibo.or.kr/)

As Table 3-11 shows, the government had contributed US$ 634 million and other financial institutions US$ 159 million as of January 2006. With this, Kibo Technology Funds provided US$ 11,599 to venture firms. Most venture firms received this guarantee. 78.1% of venture firms received this guarantee and could borrow the operating capital from banks. Generally speaking, these government efforts and preferential treatments to venture businesses have created new opportunities.

Table 3-12 | Venture Business's Source of Funds

(unit: cases,%)

Source of Funds	Venture Capital	Technology Appraisal Guarantees	Technology Appraisal Loans	R&D Firms	New Technology Support	Pre Venture Business	Total
The number of firms	605	11,920	346	2,354	0	34	15,259
Ratio(%)	4.0	78.1	2.3	15.4	0	0.2	100.0

Source: Kibo Technology Funds (http://eng.kibo.or.kr/)

With financing supporting system, Korea can have the sustaining and viable ecosystem of innovation. Technology development and the realization of its value became a routine for entrepreneurs. The linkages between universities and industries open new opportunities in the globally competitive business environment.

4.1.4. Threats

Even though the linkages are important in developing the economy and upgrading the industry, they have been treated as auxiliary. The linkages usually have been weak and lacked in the sustainability. The cash flows to venture business and R&D are not enough. The time to value creation requires relatively longer time horizon. The uncertainty is relatively high. The university and industry linkage is to face with the new risk.

The previous linkage was rather weak and indirect. In the past, those firms who had the specific R&D needs had to rely on outside resources such as public research institutes and universities. Now many private firms have their capacity to develop new technology. The previous approach of the cooperation remains effective, but the new era needs more aggressive approach which is much riskier in order to take the new tide. Venture business and R&D commercialization from universities are imminent issues, but due to the global competition, the competitiveness of the linkage and the market condition became more important. The chance of success will decrease unless the funds supporting these activities are enough.

IBM (2007) claimed that the Korean venture businesses were plunged into a death valley. That is, many venture business firms are experiencing the difficulties to financing the sufficient working capital in a timely manner. Usually venture capital tends to invest on those firms that last for three to seven years in business. As of 2005, only 20.9% of the firms that had venture capital investment were less than 3 years in business. The number of the invested firms is decreasing, while the amount of investment has increased because of the global competition and the risk of failure.

Business cycles ironically affect the venture capital and the linkages activities. The industry and university linkage requires longer horizon to see the results, but the investment depends on the current economic situation. The worldwide financial crisis and economic depression will affect the R&D activity and the cooperation, when the cooperation is needed the most.

The government's role to fill the gap between the private cooperation and the necessary investment is very important. Kibo Technology Funds or other non-profit supporting funds are important, and their capital for the guarantee and the lending for venture business firms have played a crucial role.

4.2. Linkage Offices' Capabilities

The most important government policy to promote the cooperation between industries and universities is to establish and promote the linkage offices. There are various types of linkage offices; linkage offices in the joint organizations of government and private sector such as Techno Park and in Cluster Promotion Organizations, and linkage offices in universities. After the revision of the law, most universities established industry-university cooperation offices. In 2003, 10 universities had the linkage offices, and in 2004, 87.1% of 140 surveyed universities established them as an independent corporation according to KRF (2008). The average staff of the offices was 16.9 in 2007, and among them, half of the staff were university staffs and the other half were independently hired for the linkage corporation. The maximum number of staffs was 80 persons, and there were cases where only university staffs worked in the linkage officse and there were no other independent staffs.

The sources of revenue in university-industry cooperation offices are not diversified and the disparity of the revenues across universities is large. Compared to the survey result in 2006, the average of revenue increased. The main source of revenue, however, is the overhead cost paid by the public and government research projects. This means that the sustainability of the linkage is not strong, and the government role is still important.

Table 3-13 | The Revenue of Industry-University Cooperation Offices as of 2007

(unit: million won)

Sources of Revenue	Average	Min.	Max.
Technology transfer	151.6	0	6,595
Consulting	48.6	0	4,659
Univ. firms	28.2	0	980
Business Incubation	55.9	0	388
Education by Commissioning	140.1	0	5,789
Other cooperation.	68.1	0	799
Overhead cost for private research	341.2	0	9,079
Overhead cost for public research	1155.9	2	12,991
Contribution	367.9	0	9,687

Source: KRF (2008), p.41

The good news is that the average revenue from industrial cooperation is increasing. It was 98.5 million won in 2005, 175.2 million won in 2006, and increased to 492.5 million won in 2007. There are few universities that created the value added beyond expectation, but on average there are many universities that cannot cover their costs considering the average revenue and average staff number. Generally speaking, the system and the performance of the office improved. The success will depend on the ability of the universities to cooperate with industries and R&D and technology development capacity.

4.3. Competency Improvement of the University

The core issue is to build up the competency and to change the orientation for more cooperation with industries. Academic abilities such as publishing papers are actually linked with the capability for the industrial cooperation. However, the orientation is also an important factor because it requires the time and efforts to apply R&D results and science knowledge to the specific application for industrial needs.

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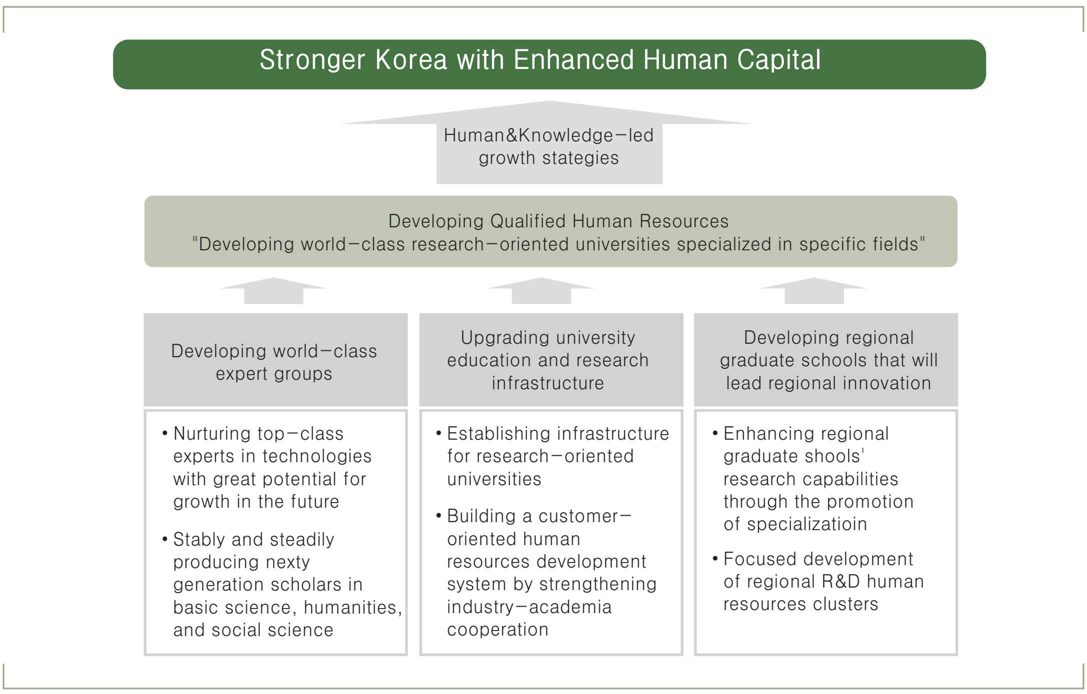
According to IMD (2006)'s World Competitiveness Yearbook, Korea's ranking in terms of university education was 50th, which was lower than Turkey and Japan (49th). Competency of universities is important, because excellent research will be commercialized and be an engine of economic growth.

Recognizing the importance of universities' capacity, the government supported many programs to improve the competitiveness of universities. For example, Brain Korea 21 program is to nurture the world class research universities. During the period from 1999 to 2005, the program of the first phase benefitted 89,366 researchers and 20,000 graduate students. In 1998, the number of articles published in SCI index journals was 9,444, and increased to 23,515 in 2005. 34% of the articles published in SCI journals were funded by Brain Korea 21 program. The second phase from 2006 to 2012 will spend 2.3 trillion won. By the year 2012, 10 research-oriented universities with global competitiveness will be established, and Korea will become one of the ten most advanced countries in the world in knowledge transfer from universities to industries (Korea ranked 21st in 2005, according to IMD). In 2006 alone, the participants of the program submitted 3,709 domestic patent applications and 845 international patent applications. There are other programs such as NURI and World Class Universities that focuses on the improvement of the universities' competitiveness.

Figure 3-7 | Vision of Brain Korea 21



Source: KRF(http://bnc.krf.or.kr/home/eng/bk21/aboutbk21.jsp)

Table 3-14 | The Patent Registration as of 2007

Ranking	Industry	Patent	Ranking	University	Domestic	International
1	Samsung Electronics Co.,Ltd	11,033	1	KAIST	1,780	558
2	LG Electronics	7,871	2	Seoul National Univ.	1,430	110
3	Samsung SDI	3,916	3	Yonsei Univ.	1,103	266
4	Hynix Semiconductor	2,558	4	Korea Univ.	914	60
5	Hyundai Motor Company	1,847	5	Postech	866	170
6	Dongbu Electronics	1,706	6	Hanyang Univ.	704	26
7	Posco	1,671	7	Inha Univ.	59	15
8	Samsung Electro-Mechanics	1,372	8	GIST	488	74
9	SK Telecom	1,248	9	Sungkyunkwan Univ.	427	22
10	Daewoo Electronics	1,184	10	Pusan National Univ.	403	16

Source: KRF (2008), p.149, for university patent holdings and Korean Intellectural Patent Office homepage

4.4. Technology Transfer

To promote technology transfers, there have been various policies. “Connect Korea” program is a program established since 2006 to support technology liaison offices (TLO). The concept of the program is to establish Core TLO as the form of consortium of TLOs of the universities in the region. 18 universities are selected as a core TLO center university in 4 regions. This program aims to provide opportunities of connecting the technology providers and technology demanders: networks of researchers in the universities, venture capitalists and firms, local government officials, business service providers. From this program, the government expects to build a virtuous cycle: technology development, transfer, and investment for R&D. This program is from UCSD’s CONNECT. In 1985, UCSD established a TLO (called CONNECT). 900 technologies have been commercialized, and USD 1.1 billion was invested. Recognizing this successful performance of TLOs, the government supported those TLOs by 3 billion won in 2006 and will support 7.5 billion won per year for next 5 years.

The implementation of “Connect Korea” is as follows. First of all, the government will select core TLOs with the help of local governments in selecting the core university. By evaluating the regional R&D capabilities, regional industrial structure, the distribution of technology demanders etc., the government selects and establishes the consortiums with the help of a core university in forming consortium with other neighboring universities. The major works are as follows;

- Building DB for their technologies, and patent information
- Establishing National network
- Nation-wide technology search engine development
- Evaluations on the technology level, marketability etc.

From these activities, the government expects that universities will have incentives to inverst more in technological development and to actively find opportunities for commercialization and transferring of technology. This program will strengthen the connectivity of the regional innovation system so that it will contribute to regional industrial development.

The performance of technology transfer is remarkable. In 2003, the contract of technology transfer was 210, and increased to 951 in 2007. The revenue from the transfer was about 2.0 billion won, and increased to 16.4 billion won.

Table 3-15 | Technology Transfer and Commercialization

Classification		2003	2004	2005	2006	2007	total
# of Contracts	Cases	210	243	587	563	951	2,554
	Changes(%)	-	15.7	141.6	-4.1	66.9	-
Revenue from transfer	Revenue (mil. Won)	1,973	3,184	6,323	9,033	16,415	36928
	Changes(%)	-	61.4	98.6	42.9	81.7	-

Source: KRF (2008), p.222

4.5. Human Resource Development with Industrial Cooperation

One of the issues in upgrading the industrial clusters is how to improve the quality of workforces in the regional industrial complexes. The core college and university programs for industrial cooperation addressed this issue, and provided the policy packages in order to promote the linkages between industries and universities as well as developing the human resources. Basically two ministries provided the budget for this purpose. Table 3-16 shows the budget allocation of the last 5 years.

Table 3-16 | Financial Support for Industrial Cooperation Core College and University Program

(unit: billion won)

Classification	2004	2005	2006	2007	2008	Total
Ministry of Knowledge Economy	20	22	22	20	23.5	107.5
Ministry of Education, Science and Technology	20	22	22	22	22	108.0
Total	40	44	44	42	45.5	215.5

The target schools are 8 universities and 5 industry colleges. The support areas are 1) joint R&D with local firms and consulting, Technology transfer, and R&D center tailored for local firms, 2) equipment sharing programs that support equipment sharing with local firms and provide the equipment and facility for training employees of local firms and students of vocational schools, 3) changing the university operation system for industrial cooperation needs that includes changing the incentive mechanisms of professor recruiting and performance evaluation., 4) human resource development for the need of local firms and industries that include the educational program for the employees of local industries and seminars and conferences.

The performance of the program for the last 3 years is evaluated as satisfactory. The specialized curriculum trained 50,108 persons and the tailored department's enrollment was 1604 students. The number of university trained employees by the commission was 4,603. The number of technology transfer was 237, and the number of consulting was 10,105. The number of the patent application was 756, and the case of equipment sharing was 38,717. The number showed the increasing tendency.

4.6. The case of Yonsei University and Wonju Medical Equipment Industry

Wonju Medical Equipment Industry has developed from cooperation among university, central and local governments, and it is one of the successful stories of the government policy. It started from the effort of the faculty of Biomedical Engineering, Yonsei University Wonju Campus. The faculty of Biomedical Engineering applied for Techno Park project of the Ministry of Commerce and Trade in 1997, but it failed to receive the support. In 1998, Wonju city helped to establish a university incubator for medical electronics. The incubator started at very small scale, which was only 660 m2. 11 firms moved into the incubator. Those firms' technologies were originated from the professors of department of biomedical engineering, and they began to produce the test products in 1999, and they could display their products at Korea International Medical and Hotel Equipment (KIMES). These activities were essential accomplishments which enabled Yonsei University Wonju Campus to be designated as Technology Innovation Center (TIC) by Ministry of Commerce, Industry and Energy. Wonju city provided factory site in the industrial complex, and those firms from the incubator could have production system for their products.

In 1999, the Ministry of Science and Technology recognized Research Institute for Medial Instruments (now, the Institute of Medical Engineering, Yonsei University) as "Regional Research Center (now, RIC)". RIC program was to transfer the technologies that the universities had to the industries in which the region was specialized in.

Small and Medium Business Administration supported the incubator for medical instrument of Yonsei University. University had three elements for the medical industry development, which are R&D support function (RRC), business incubator (TIC and Incubator center), and production function (industrial complex provided by the local government).

In 2000, Yonsei University Wonju Campus was designated as "Venture Business Cultivation Promotion Region" by Small and Medium Business Administration. Wonju City and Yonsei University Wonju Campus made efforts to build "Wonju Medical Electronic Industry Promotion Center" where "Medical Measurement and Rehabilitation Engineering Research Center" and "Advanced Medical Appliance Technology Innovation Center" and other supporting facilities could move into. Yonsei University provided the land and Wonju City and the central government supported 7 billion won for the construction. The construction of the center began in 2000 and finished in 2002. Since 2003, the government supported the Wonju Medical Equipment Industry in various ways.

In 2003, Wonju Medical Equipment Industry Techno Valley was founded and was to support the R&D in order to operate the facilities, and to promote Wonju Medical Equipment Industry by educating and advertising. In 2004, Wonju received "Innovative Cluster Promotion Support."

In 2004, Yonsei University Wonju Campus received "NURI" for medical appliance engineering education for 5 years, and BK21 in 2006. By these supports, Yonsei University Wonju Campus became a hub for supplying the technology, the education, and the necessary consultation to the Wonju Medical Equipment Industry.

Yonsei University Wonju Campus received "Regional Innovation Center Support (RIC)" for 9 years from 1999 to 2008 (Wonju campus received RRC and TIC, but RRC and TIC were merged into RIC). The total fund was 8.5 billion won. The first step was to develop the basic technologies that firms needed the most. The period was from 1999 to 2002. Most Wonju medical firms were small sized and did not have enough capital and strategies to catch up the

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advanced technologies in the current market. During the period from 2003 to 2005, after the university succeeded in providing technologies, it provided a core technology for the global competition, and since 2005, the technology was commercialized. From the support of RIC, Yonsei Universities incubated 11 firms and performed 40 research projects. The joint R&D with firms succeeded in commercialization. For example, the joint R&D with “Mediana” produced the items and sold 17 billion won only in 2007. The joint R&D with “HumanTech” was successfully commercialized, and produced 4.8 billion won from 1999 to 2007. In total, 9 joint R&Ds were commercialized, and many others are to be commercialized. During the period from 1999 to 2008, 24 R&D results were applied for patents, and 17 were registered as patents. 9 items registered as utilities. 57 university technologies were transferred to firms.

Table 3-17 shows the number of firms and its performance. Before Yonsei University Wonju Campus made an effort for medical industry, no one recognized Wonju’s medical industry. It started with 11 venture firms in incubators, and now Wonju medical cluster has 74 firms and employed 1729 persons. Still compared to large companies’ employment and sales scale, those of Wonju are relatively small, but the efforts showed the so called “Can-Do-Spirit” and the possibility of developing regional economy by universities’ efforts.

Table 3-17 | Firms and Products in Wonju Cluster Pilot Complex

	The number of firms	Amount				New products		Employment
		Total amount	Domestic	Export	Ratio	2005	2006	
Wonju	65	153631	69861	83770	43	29	74	994
Hongcheon	5	182148	32042	150106	51			536
Heongseong	1	15911	15911	2075	4.4	2	6	168
Chuncheon	3	5621	2588	3033	1.6			31
Total	74	357311	106566	250745	100			1729

It is very difficult to judge which factor is the most important factor, because the case of Wonju enjoyed the comprehensive support. Every support was made through the selection procedures based on the evaluation and competition. The success depends not only on the support but also on the entrepreneurship. Professors were not sitting on the R&D money, instead they struggled to survive and succeed. The decade’s struggle of the transition from nothing to something was a key for the successful story. We can say that the seed was the self-generated entrepreneurship, and that it prospered with the help of the local and central governments.

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5. Conclusion

Behind the remarkable economic growth, there have been many talented people form universities. But universities have always been behind the scene until recently. Samsung electronics alone has more patents than several major universities have altogether. Basically, Korea has the private sector leading ecosystem of technology development, which is gaining its self-sustaining momentum. Now Korea has entered into a new phase of development in the globalized world economy. Korea needs more innovative people with creative thinking. We do hope that universities can handle this problem. Korea is experimenting on the transformation of universities in a way that they can be more directly involved in the innovation and technology development process.

Korean experiences proposed three propositions as follows;

- Proposition 1: There is no jumping process from low technology to high technology
- Proposition 2: There is always a gap between business need and professors' incentive
- Proposition 3: The success of the projects depends on the implementation, and the successful implementation depends on thorough evaluations.

The policies to promote the industry and university cooperation should be comprehensive. Otherwise, the effectiveness of the policies will be diminished. Proposition 1 suggests that the policy horizon should be long, and the strategies should be prepared according to the current situation by step-by-step approaches. For the regional development of Wonju by using the linkage, it took a decade to see the performance and share the results even in the successful cases.

Proposition 2 explains why the Korean government used the government funded research institutes rather than universities. However, this does not suggest that the university and industry cooperation is not important. Rather, it suggests that it is a difficult task to build up the linkages and to promote the collaboration and that there should be different strategies according to its development stages of the ecosystem.

The recent data, however, shows an optimistic sign of a change. Some professors successfully became CEOs of their own venture firms, which produce the fist-in-the-world products. A decade long relationship with firms helped universities to produce competitive technologies ready for commercialization. Some doctors in university hospitals established a venture firm with their technology. The atmosphere of the ecosystem has changed due to the success stories.

Still universities and industrial linkages in the ecosystem of technology development are exogenous, and not sustainable without the government support. Therefore, proposition 3 remains important. Proposition 3 reminds us of the importance of implementation. The government agencies' capacity is a key for the efficient implementation. International cooperation as well as the full usages of domestic resources will be helpful for evaluation and assessment.

I would like to reiterate the importance the ecosystem of the NIS. Entrepreneurship is a necessary condition for the successful system, but it is dependent on the social and cultural aspect. It is also important to point out that the government fund is not a sufficient factor for the success and that it should be considered as auxiliary supports. One of the reforms made in Korea is that the revised law allows universities to run the technology holding companies. There should be a channel for venture firms to be listed in the stock market like KOSDAQ.

Building the self-sustaining ecosystem is a difficult task. The system led by the private sector may lack in the long term vision. In this respect, the government is expected to provide longer term R&D investments such as R&D expenditure on basic science and investment for the future industrial transition. Therefore, the system should consist of many different institutes and institutions which are incentive compatible and are fully synergetic.

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KIBO's Technology Appraisal

Types of Technology Appraisal

What constitutes the types of KIBO's technology appraisal is "Appraisal of Technology Value," "Appraisal of the Commercial Viability of Technology Project "and "Comprehensive Technology Appraisal." When a company applies for a technology appraisal, KIBO selects one of those appraisal types in accordance with the applicant's demand. In any cases, the result of the appraisal is presented in a standard "Technology Appraisal Report", with the monetary value of technology or appraisal ratings expressed on the report.

Technology Value

The monetary value of subject technology is valued through this type of appraisal. TAC's sfaff determine the market value of the technology mainly through the calculation of the monetary value of present and future income generated by technology. It is a sophisticated technique that requires expertise and knowledge of the current level of technology and foresight with regard to future directions.

This appraisal type is employed for the purposes of transferring, buying or selling technology. When domestic or overseas businesses or individuals want to transfer or introduce technology, when a technology is being transacted, or when technology business units are being merged or acquired, this method is employed to ensure a secure and fair transaction or transfer. It is also used to assess the collateral value of technologies.

Viability of Technology Project

This type of appraisal refers to a feasibility study on the determinants of the technology factor and business prospects. After the appraisal, a rating or an opinion on the commercial viability is provided to the applicants or to the authorities concerned.

KIBO is entitled to certify the legal status of venture businesses by evaluating technology and business potential of tech-savvy companies. With respect to the certification, this type of appraisal is conducted. This is also performed for the purpose of helping the government, local authorities and financial institutions to select beneficiaries of their policy funds or other financing facilities.

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Feasibility Assessment

This type of appraisal refers to a feasibility study on the determinants of the technology factor and business prospects. After the appraisal, a rating or an opinion on the commercial viability is provided to the applicants or to the authorities concerned.

For those looking for a promising business to invest in or lend to, KIBO's technology appraisal reports serve as a good reference. This appraisal helps minimize risk for financial institutions and investors, including angel investors, by presenting a clear picture of the business with focus on its technology.

This comprehensive technology appraisal serves to qualify enterprises for KOSDAQ listing. The Korea Securities Dealers Association has designated Technology Appraisal Center(TAC) of KIBO as an official Technology Appraisal body for venture enterprises that otherwise do not meet the KOSDAQ listing requirements.

Technology Appraisal Center

In its capacity as a specialized technology evaluation institution, KIBO has been operating Technology Appraisal Centers (TACs) since March 1997, with the aim of making reliable appraisals of the technologies owned by corporations. The Korean Government has accredited TAC as the technology evaluation institution under the "Act on Special Measures for the Promotion of Venture Businesses", the "Invention Promotion Act", and the "Foreign Investment Promotion Act."

Thus, TAC has been given a mandate to provide assistance programs implemented by government agencies and financial institutions. TAC helps to promote the start-up and development of SMEs and venture enterprises by providing them with easier access to funding through the appraisal of business prospects and technologies registered for patent rights or utility models, as well as through conducting feasibility study for the commercialization of new technologies and creative ideas.

The services of TAC have been proved to be of great help for the SMEs and venture enterprises which often face difficulty getting loans from financial agencies for lack of physical collateral, commercializing their creative ideas, having legal status for certified venture enterprises, attracting investment or selling or buying technologies.

Technology Value Appraisals

TACs appraise the worth of corporate technologies so that their value can be used to make decisions on KIBO's credit guarantees; as reference data in technology collateral loans and in investment decision-making by financial institutions; or to set a standard price for technology transfers or transactions.

The technologies eligible for appraisal include not only those for which rights are registered (or currently pending) under the Patent Act, the Utility Model Act, or other intellectual property rights laws, but also commercialized technologies which belong to companies with advanced technology.

Technology Appraisal Guarantees

TACs evaluate technologies and business prospects of applicant companies (including would-be start-ups) in relation to special funds established by government agencies and local governments, such as the SME and Venture Start-up Fund. Upon evaluation, TACs provide one-stop credit guarantee services to secure funding from various sources for the operations, facilities and technology development of venture start-ups.

Evaluation of Technology and Business Prospects

TACs assess technology value and business prospects under agreement with various government agencies and local government offices to help them select the beneficiaries of loans, investments or other assistance programs.

Certification of Venture Enterprises

With KIBO's designation as an official technology evaluation institution under the "Act on Special Measures for the Promotion of Venture Businesses," TACs also provide an objective evaluation of the technology and commercialization capability of venture firms applying for various kinds of assistance.

Evaluation for Angel Investment

In order to help promising start-ups attract equity investment and to offer new opportunities for individual investors seeking high-yield investments, TACs conduct evaluations of technologies and business prospects of start-up companies.

Evaluation for KOSDAQ Listing

TACs facilitate the KOSDAQ listing of venture enterprises, which lack certain prerequisites and cannot otherwise meet listing criteria in such areas as business track record, sales or financial status, instead offering an alternative measure of their health by providing evaluations of their technology

Brokerage of Technology Transfers

TACs act as an intermediary in technology transfers between companies, institutions and individuals by introducing new technologies into the technology market in order to promote commercialization of technology. Technologies eligible for brokerage include patent rights, new design rights for practical use, technologies owned by research institutes, private companies, etc., and technologies that have been evaluated by the TAC

Kibo's Technology Rating System

Indicators

Large Category	Medium Category	Small Category (Appraisal Items)	Reviewing Points
CEO's technological ability	Technology Management Ability	Technological Experience (Knowledge)	- CEO's Technological Experience - Technology Management Strategy - Depth of Technological knowledge - Depth of Technological Understanding
		Business Management Ability	- Management of Technology Human Resources - Ability of managing business Crises - Managerial Volition & BusinessSkills
		Human Constitution & Teamwork in the Management	- Scholastic Achievements &Careers - Participation in capital-raising. - Relationship & Teamwork with CEO
Technological Ability	R&D Ability	Promotion Ability in Technology Development	- R&D-devoted Department/Organization - Percentage of Superior R&D Human Resources
		Track Records in Technology Development & Authentication	- Present Situation in R&D Investment - Possession of Core Technologies - Percentage of R&D Investment

Large Category	Medium Category	Small Category (Appraisal Items)	Reviewing Points
	Superiority of Technology / Product	Degree of Technological Innovation	- Technological Differences - Difficulty in copying - Position in Technological Life-cycle
		Technological Completeness	- Technological Completeness - Technological Self-reliance - Correspondence with Business Strategy
		Degree in Technological Extension	- Inner/Outer Ripple Effect - Possibility in Technological Application or Extension
Marketability	Marketability of Technology / Product	Competitive Situation	- Market Structure - Competitive Situation/Intensity in the same industry - Market Entrance
		Market Formation	- Market Size - Market Growth - Restrictions/Encouragements (ex. Laws or Regulations)
		Product Competitiveness	- Product Recognition - Market Share - Comparative Advantage over substitutes
Business and Profit Prospects	Productivity of Technology/ Product	Capacity of transforming technology into products & Manufacturing Capacity	- Easiness in acquiring manufacturing facilities - Easiness in recruiting manufacturing human resources - Easiness in acquiring materials & parts
	Operational Capacity	Operational Capacity	- Capital-raising - Capacity of Creating Value added - Reasonableness of Investment Volume
	Business Capacity of Technology /Product	Marketing Capacity	- Validity of Sales Plan - Customer Diversification & Loyalty - Marketing Human Resources
	Profit Prospects	Capacity of Creating Profit	- Sales Growth - Ordinary Income to Sales
		Profit Prospect	- Return on Investment - Rate of Return on Investment

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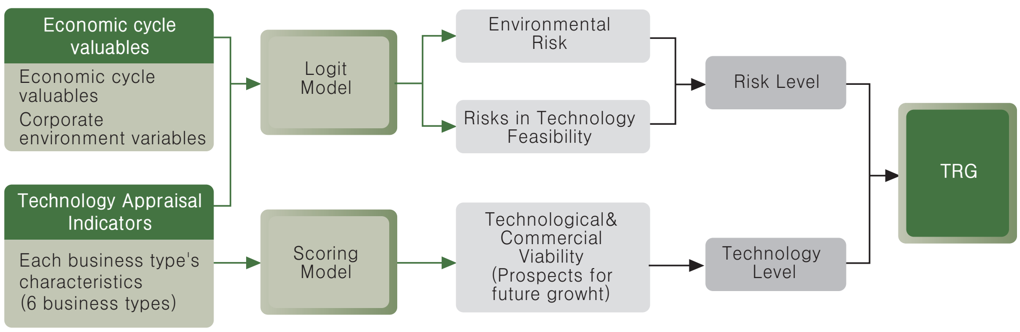
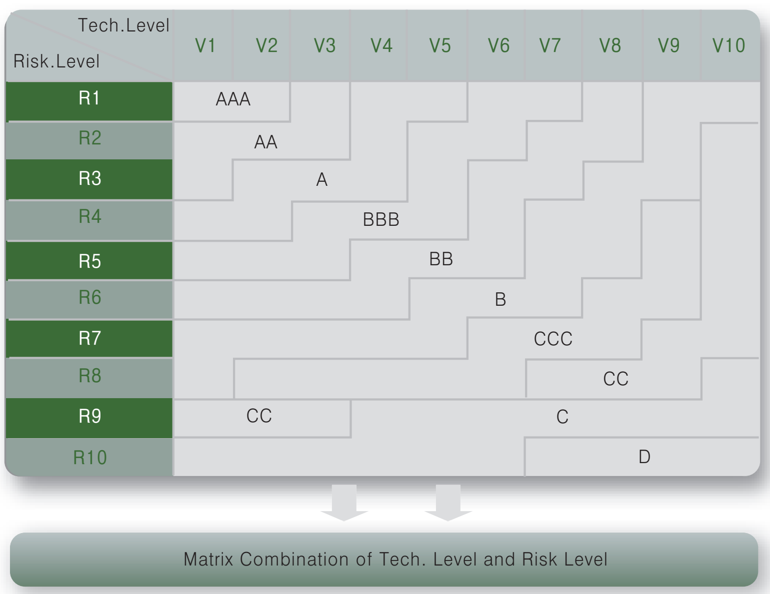
Calculation Flows



Technology Rate Grade (TRG) system



Distribution

	Before the second half of 2006[1]		2007		Total	
	cases	share	cases	share	Cases	share
AAA	10	0.1%	5	0.1%	15	0.1%
AA	165	1.1%	181	1.7%	346	1.4%
A	1,241	8.5%	1,090	10.1%	2,331	9.2%
BBB	2,963	20.4%	2,460	22.9%	5,423	21.4%
BB	4,492	30.9%	3,290	30.6%	7,782	30.8%
B	5,078	35.0%	3,470	32.2%	8,548	33.8%
CCC	240	1.7%	149	1.4%	389	1.5%
CC	183	1.3%	69	0.6%	252	1.0%
C	96	0.6%	33	0.3%	129	0.5%
D	61	0.4%	8	0.1%	69	0.3%
Total	14,529	100.0%	10,755	100.0%	25,284	100.0%

Objects of Analysis : Technology Appraisal(TA) cases done with KTRS (2005. 7. 1 ~ 2007. 12 .31)

1) Before the second half of 2006 : TA cases done with KTRS from Jul 1 2005 to Dec 31 2006.

By appraisal purpose, the appraisal cases relating to Kibo's guarantee facilities took up 39.8% of the total appraisal cases.

Current Defaults

TRG	TA Guarantee		Guarantee Default		default rate
	cases	share	cases	share	
AAA	5	0.1%	-	-	-
AA	138	1.5%	-	-	-
A	963	10.8%	3	2.5%	0.31%
BBB	2,142	24.1%	15	12.7%	0.70%
BB	2,800	31.5%	44	37.3%	1.57%
B	2,845	32.7%	56	47.5%	1.97%
CCC	4	0.0%	-	-	-
CC	1	0.0%	-	-	-
C	1	0.0%	-	-	-
Total	8,899	100%	118	100%	1.33%

Objects of Analysis : Approved TA guarantee cases done with KTRS from Jul 1 2005 to Dec 31 2006. Time Point of Default : Dec 31 2007

Guarantee Default : Debtor's repayment delay, dishonored bill or check, business closing and bankruptcy, or creditors' filing claims for subrogation payment and the forfeiture of period profits for guaranteed bank loans.

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Chapter 04

University-Industry Linkages in Turkey

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Chapter 04

University-Industry Linkages in Turkey

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1. Introduction

Developed and underdeveloped countries adopt distinctive strategies for their long term national strategic plans and techno-economic policies, and run their National Innovation Systems, which also cover preferred technology transfer mechanisms. The underdeveloped countries' technology transfer systems mostly depend on the transfer of know-hows, licensing and purchase of machineries from others. In these transfer mechanisms, the tacit knowledge cannot be transferred and not assimilated for further technology development and there is a strong and continuous dependence to other countries. On the contrary, the developed countries' national innovation systems depend on such technology transfer systems, where R&D activities and university-industry collaboration forms seen and in that the technology is generated, transferred disseminated and continuously developed.

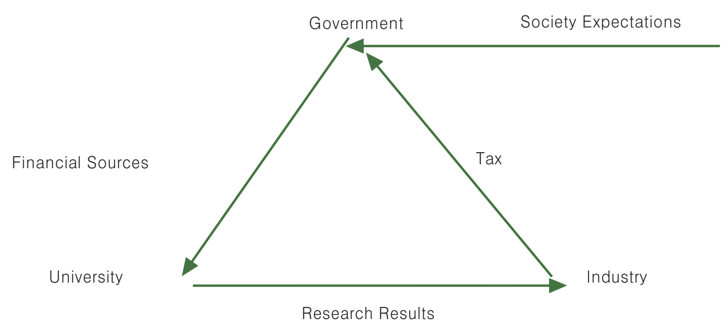
Based on the mentioned perspective, science and technology producing system, knowledge production mechanisms and the relationship between science and technology should be designed accordingly and well designed and effective university-industry linkages and cooperation mechanisms are vital for knowledge based economies.

In this paper, the Turkish system of university-industry relations within historical and current perspectives are examined, and some views are highlighted.

2. Changes in University-Industry Collaboration and Recent Models in the World

From the historical perspective, universities have always been in a primary position in the knowledge production system. First, universities were established in the middle ages and their task was limited to the education of students. During the 19th century, a second dimension was added to the universities' mission called 'Research'. This critical change in universities was named as the 1st academic revolution (Wittrock, 1993 and Etzkowitz, 2001). The type of the research was 'basic' or 'fundamental' and the linkage between basic science and economic welfare was described by Vannevar Bush in the 'Science: The Endless Frontier' report.

Figure 4-1 | University-Industry-Government Classical Relation

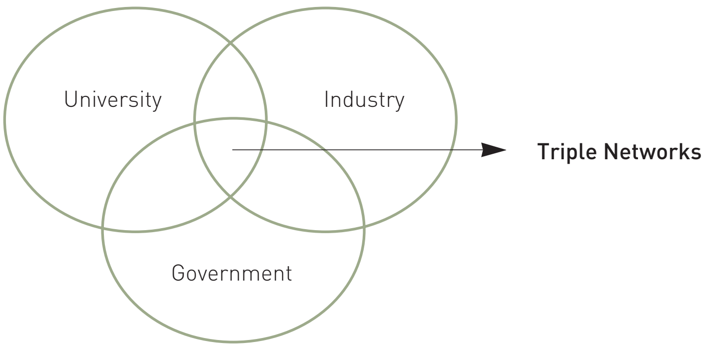


In this system, basic research is funded and since funds were taken from a society as a tax payer, there should be social contract between society and the universities. In classical collaboration, tax being paid by industry and distributed to universities through the government and the outputs of university projects were indirectly used by the industry.

Due to the ever greater dependence of the economy on knowledge production and societal expectations from these primary knowledge producers, the universities have been moving towards a new form during the last 25 years.

Some models have been trying to explain the changes in research system in its social context. The most popular model is "Triple Helix" of university-industry-government relations. The convergence and crossing over of three main actors which are research, business and government, have been explained by Etzkowitz (1995) and further developed by Leydesdorff. The triple Helix thesis states that the university can play an enhanced role on innovation in an increasingly knowledge-based economy. In contrast to the traditional linear system, the model refers to a spiral model of innovation that captures multiple reciprocal relationships among three institutional settings (Public, private and academy) at different stages in the capitalization of knowledge (Viale, et al, 1998). The Triple Helix model resulted by the final convergence of these three worlds can be represented by actors, institutions, and the rules and regulations. Depending on those changes in relationships, some recent models and mechanisms are designed and conducted all around the world.

Figure 4-2 | Triple Helix (Etzlowitz and Leydesdorff, 2000)



However, pre-competitive R&D activities are still supported by public funds because of insufficient private sector investments especially in some critical fields such as defence, health, environment, etc.

The new modes of knowledge production and knowledge application are different from 1980s' approaches and they begin with generic problem definition, continue with problem solving and end if the society is satisfied from the results. They cover all recent and non-linear models and depend on somehow large networking, trans-disciplinary approaches and interaction with society expectations. Since all beneficiaries -firms, public authorities, universities, R&D suppliers, society representatives, financers etc. - are involved and take part in these large networks, some serious weaknesses such as difficulties in coordination and managing at various levels, threaten the new knowledge production system. In this recent system, R&D activities and public-private partnership are shaped and oriented mainly by market conditions.

In many developed countries, especially in the US, knowledge production system in the new economy are designed and conducted to motivate the royalties from patents, license agreements and other outputs received during or after the researches, which are important resources of income. The researchers can establish spin-off firms by using their research outputs. Establishment of high technology firms for the commercialization of research outputs depend on a number of arrangements on institutional flexibility, intellectual property rights, etc.

Briefly, different types of mechanisms have been established to obtain more advantages from public-private collaborations especially in developed countries. Of course, the mechanisms should be in parallel with recent trends in Research-Technology Developments and Innovation (RTDI) systems and be appropriate with national and cultural behaviours.

3. Situation in Turkey

The interaction between science and industry takes various forms in different countries, owing to differences in institutions, regulatory frameworks, research financing, IPRs regime, the status and mobility of researchers etc.

As a historical perspective of situation on university- industry relations in Turkey, we see a weak co-operation with the traditional university-industry linkages (UIL) mechanisms.

Much common co-operation mechanisms are; summer industrial practice of students from universities, contract base projects for firms, providing laboratory and some special design services via university centres etc.

However, especially last 15 years some radical laws and programs have been designed and implemented which are in line with recent trends in RTDI system such as Technology Development Zone Law for technoparks, University Industry Joint Research Centres Program (USAMP), R&D Law etc. But, it is still early to say that overall co-operation activities are successful for creating critical mass for knowledge production.

3.1. Historical Perspective of UIL

3.1.1. RTDI and UIL Related Issues in Five Yearly Development Plans

The UIL is embedded in Turkeys' science and technology policy documents while the Five-Yearly Development Plans provide the necessary budgetary allocation for innovation policy.

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The First Five-Year Development Plan (1963-1967)

Although advanced technology usage, research and technical development notions were emphasized in the first plan, it is hard to state that there were proper implementations of technology transfer and education policies and R&D activities. One of the most important steps in the Turkish ST policy is the establishment of the Scientific and Technical Research Council of Turkey (TUBITAK) in 1965 as a result of the First Five-Year Development Plan (1963-1967) in order to prepare and coordinate implementation of the Turkish Science and Technology Policy.

The Second Five-Year Development Plan (1968-1972)

Science and research topic was taken as a separate section in the plan. However, the focus of this topic was explained only within a generic conceptualization and remarkable UIL practices were not available.

The Third Five-Year Development Plan (1973-1977)

The general and current conditions of technology policies were explained in the plan. At the same time, the vital role of advanced technologies for the industrialization had been underlined. The general principles of technology transfer were much more emphasized.

The plan emphasized two main deficiencies affected by UIL in Turkey: first, the absence of an institutional mechanism which provides maintenance of technology transfer and creation of links between technological inventions and industry; and second, lack of infrastructure which provide production of technology in a country.

The Fourth Five-Year Development Plan (1979-1983)

The insufficiency of resources for R&D activities, the lack of organic links between R&D institutions and industries, non-establishment of national knowledge flow system, insufficient capability of technology assimilation, and the high cost of technology transfer were highlighted in the plan.

At the beginning of the 1980s, ‘Turkish Science Policy: 1983-2003’ was prepared under the coordination of the Minister of State with direction of the Minister Prof. Nimet ?zda?. This was the first time that a detailed science and technology policy document had been prepared.

In this document, technology had also been considered as a basic criterion and priority areas of technology put forward. This new approach has necessitated the establishment of a new institution: The Supreme Council for Science and Technology (SCST), which enabled the design of science and technology policies with the participation of ministers, high-level bureaucrats and representatives of non-governmental organizations, who take part in economy management and arrangement of the main fields of activity in social life. In addition, some emphasis have been put on related areas such as development of the R&D activities concerning industrial needs and reinforcement of their relations, more investments in R&D activities, reestablishment of technology policies that would include preferential technology production and transfer regarding sectoral needs. Furthermore, acceptance of the legislation on industrial ownership rights.

However, 'Turkish Science Policy: 1983-2003' could not been in effective and put in a shelves as many other remarkable and valuable National RTDI documents which was prepared by all related parties and with experts participation.

Also, The Supreme Council for Science and Technology (SCST) was established in 1983, but not able to make regular meetings, in other words it was not effective.

The Fifth Five-Year Development Plan (1985-1989)

It was well described in this plan that the structure of the industrial policies during the planning term were mainly depended on importing without scientific and technological investigation. Moreover, it was emphasized that industries prefer ready-packed technology transfer, rather than scientific and technological research in the country, so this process resulted in a more dependent industry.

For the purpose of finding solutions for economic and industrial problems via R&D activities, the targeted sectors, sub-sectors, and areas were pointed out. Therefore, in order to remove the infrastructural deficiency of Turkey in science and technology, and to increase the role of Techno-parks, State Planning Institute (DPT) supports for public institutions and universities R&D activities have been initiated.

The Sixth Five-Year Development Plan (1990-1994)

Some topics such as supporting R&D activities, advanced technology transfer, production of technology, etc. were mentioned in a broad sense in the plan. The tangible results of the policies iterated in the plan have been the establishment of five Techno-parks, two Advanced Technology Institutes, National Metrology Institute and Turkish Patent Institute.

In addition, two targets were announced which was to raise the proportion of GDP reserved for R&D activities up to 1 percent , and to increase the number of the full time equivalent R&D

personnel as 1 per 15 thousand economically active people.

The establishment of climate for the university-public-industry collaboration and for this purpose, encouragement of establishment and diffusion of techno-parks were pointed out in the plan. The support of universities both in the basic and applied research would be increased. The precedence would be given to advanced technology areas like bio-technology, ICTs, microelectronics, satellite technology, nuclear technology, advanced materials, etc. Starting from this term, in order to determine the expenses that Turkey has made, the Statistics Institute for the R&D activities and the number of the research personnel, the R&D questionnaires were started and it has been continuing.

The Seventh Five-Year Development Plan (1996-2000)

In accordance with the export-oriented market economy policies, instead of detailed production numbers and regulations, a general framework and policies targeting at the improvement of general competition capabilities of the country, have been intended in the plan, which is a distinguishing approach that separated this plan from the previous plans. In the plan, this approach has been formulated as ‘alternation projects’ under the heading of Progress in Science and Technology, which outlines several principles and policies appropriate for the contentment of technological needs.

At the same time, these principles and policies were in accordance with the ‘Science and Technology Policy of Turkey: 1993-2003’, a report that was approved by the Supreme Council for Science and Technology at its meeting on the February 3, 1993.

For instance, “...while determining management rules of the insufficient financial resources of the country, the priority would be given to science, technology, education and R&D areas because of social, economic and long-term our interests.” Furthermore, more concrete targets and policies were also mentioned in the plan; developing generic technologies, knowledge networks & infrastructures, procurement policies of state, venture capital, supporting private sector R&D activities, establishment of technology centres, parks, institutes, and patent rights etc.

However, the Seventh Five-Year Development Plan could not reach its targets properly either.

The Eighth Five-Year Development Plan (2001-2005)

The Eighth Five-Year Development Plan starts with explaining the general and current developments in the world. The assessments of process of globalization, knowledge economy and knowledge society are consistent with Fifth Kondratieff cycles.

After this assessment, the basic argument of the thesis which supports the need for harmonization among the science-technology-industry policies, education/training policies, and R&D policies, is also underlined in the Plan. Furthermore, the situation of science and technology and the targets determined but could not be achieved in the period of the Seventh Development Plan are explained in order to prevent previous failures.

Similar to the Seventh Plan, general framework and policies rather than detailed production numbers and regulations are stated in the Plan. The targets and aims, which are stated in the plan, also show compliance with the statements of Vision 2023 Project. The objectives, principles, policies of the Plan are outlined as: increasing competitiveness capability of industry at international level; restoring of physical, human and legal infrastructure in order to improve scientific and technological capability; supporting joint R&D activities within a university-public-private sector cooperation; restructuring legal implementations for increasing performance of NIS; supporting R&D activities in the fields of advanced applications such as, information and communication technologies, new materials, aerospace and space technologies, nuclear technologies, oceanography, technologies on utilizing and exploiting sea and underwater riches, mega science and clean energy technologies; increasing the number of Industrial Parks etc. To put it briefly, the aim of the plan in terms of science and technology policies is stated as:

“Strengthening its social structure, ensuring stability, completing structural reforms and realizing basic transformations required by the information society, besides benefiting at the highest level from the opportunities created by globalization and minimizing its unfavourable aspects, shall also play a key role in preparing Turkey for the future and in attaining a more effective status within the world (Article 19).”

The Ninth Development Plan (2007-2013)

The ninth development plan has been prepared for seven years instead of five. Under the headline of ‘Technological Improvement and Innovation’ some main findings are as follows;

- In the previous development plans, national industrial policies and RTDI strategies were handled separately. But they should be planned and redesigned together with targeting the competitiveness of the national industry.
- Technological improvements are not to cover only high-tech areas, but should concentrate on the development of technology and knowledge base in all areas.
- Turkey has several RTDI programs and mechanisms. They should go through impact assessments and should be taken necessary actions accordingly.
- The R&D personnel development programs should be designed together with universities.
- Since, almost 84% of firms acquired necessary technologies via buying new machinery,

and only 7 % of them are developing technologies with R&D, related UIL and co-operation mechanisms should be designed.

3.1.2. Main Milestones for UIL and RTDI Policies

As mentioned, in 1983 the government issued the first policy document "Turkish Science Policy, 1983-2003" that mainly focused on increasing R&D activities in the country and defining priority technology areas.

The other important milestone in connection with the policy document is the establishment of the Supreme Council of Science and Technology (BTYK) in 1983, which has been chaired by the Prime Minister. Meantime, TUBITAK was assigned as the secretariat to the BTYK.

The second policy document "Turkish Science and Technology Policy: 1993-2003" was prepared by TUBITAK and approved by the BTYK in February 1993.

Another important policy document is the project on "Impetus in Science and Technology" (1995), which was embedded in the Seventh Five-Year Development Plan as one of the "Fundamental Structural Transformation Projects". Referring to the above-mentioned documents, the main objective of the science and technology policy is defined as "establishment of the National Innovation System that would enable systematic operation of the whole institutions and mechanisms required to carry out scientific and technological research and development activities and to transform the results of those activities into economic and social benefit".

In August 1997, the BTYK approved the "Policy Agenda on Science and Technology for the Years 1996-1998" that covers immediate arrangements and preparations for the establishment of the National Innovation System as the main theme of the National Science and Technology Policy. The August 1997 decisions BTYK centred around "innovation" stressing necessary actions to be taken for "research on regional innovation systems."

One of the remarkable efforts on the science and technology policies of Turkey for the 2003-2023 period started with the Vision 2023 Project in the beginning of 2002 under the coordination of TUBITAK and following the decision of the BTYK. The project mainly covers implementation of the national technology foresight study through 11 panels in different socio-economic activity areas, and Delphi surveys on public, private sector and NGOs.

The Vision 2023 Project includes three more sub-projects, which are "National Technology Inventory", "Turkish Researches Inventory" and "National R&D Infrastructure". These sub-projects aim at collecting and analyzing information on the technological levels of industrial sectors, technology acquisition sources and methods and inventory of researches.

Another important document is 'SME Strategy and Action Plan' which has been prepared in accordance with what has been stated in the 2003 Accession Partnership Document relating to SMEs on "developing and executing an SME Strategy in compliance with the European Charter for Small Enterprises and the Multi-annual Program for Enterprises and Entrepreneurship, and ensuring that such a strategy shall promote the improvement of business environment especially when funding is needed" and it has been approved by the Decision of the High Planning Council No. 2003/57 dated November 10, 2003. This document was prepared with high level participation and negotiation.

A series of revisions had to be made on the SME Strategy and Action Plan, which was approved by the Decision of the High Planning Council and the final revision has been made for 2007-2009 period.

In this plan UIL issue has been described as follows;

'During the stage of turning scientific knowledge produced at our universities and research centres into marketable commercial products and thus creating added value, in order to increase SMEs' efficiency, mechanisms to attract researchers into industrial practices should be improved, effectiveness of Technologic Development Regions should be increased, product-focused basic research should be encouraged, such activities as organizing national network structures, fairs, etc. should be organized to bring researchers and manufacturers in a safe environment and their effectiveness should be boosted.'

One of the recent initiations which is also interesting in UIL issue is called 'Coordination Committee for the Improvement of Investment Climate' (YOIKK), which begun its studies on March 2002. There are already 12 committees under this platform and R&D is one of them. According to 2008 action plan of this committee, UIL related activities are planned as follows;

- Reorganization of 'Universities Revolving Funds' to motivate academicians for co-operation with industry,
- Establishment of technology transfer offices in universities,
- Establishment of interfaces in Organized Industrial Zones to convey industries' needs to universities.

One of the recent efforts for creating research network at nationwide has been conducted by TUBITAK. In light of the results of the Vision 2023 project, the BTYK decided to design "Turkish Research Area" (TARAL) where the private and public sectors and non-governmental organisations strategically focus and collaborate on R&D. TUBITAK has been assigned as the organisation responsible for the effective functioning of TARAL. Integration of TARAL with the European Research Area (ERA) has also been one of the main tasks of TUBITAK.

In March 2007, the BTYK approved the "National Innovation Strategy" prepared by TUBITAK for the years 2008-2010 in which several UIL related matters are tackled.

There are some other policy documents more or less interested in UIL issue. As a brief analysis, we can say that in almost all policy documents of Turkey, the scope of requirements for national innovation policy and as a particular topic UIL topics are well articulated.

The documents have also been addressing the creation and growth of innovative enterprises by means of financial supports, venture capital finance, tax incentives, training and consultancy with a special emphasis on SMEs. Regarding the improvement of key interfaces in the innovation system, the policy consists of actions for research on regional innovation systems, establishment of university-industry joint research centres, preparation of the master plans of national information infrastructure, establishment of national academic network, and restructuring public R&D institutes.

As seen above, some detailed and special attention in promoting interactions and co-operations between the research community and the business sector has been given in the science and technology policies of Turkey especially after 1990s.

As a result of these efforts, a number of initiatives have been activated to promote interactions and co-operation between research community and business sector.

3.1.3. Categorization of Mechanisms Which Support University-Industry Linkages (UIL) Directly or Indirectly

As it was mentioned above, the main steps and initiatives to promote and co-operate UIL issue has been started since the 1990s.

As an implementation side, the remarkable and effective mechanisms and models can be categorized in 5 groups as follows;

1- Project Oriented, Publicly Supported Co-operative Programs,
2- Institutional Co-Operative Structures Oriented with Public Program
3- Contract Based Projects and Training Programs in Universities
4- Institutional Bodies Owned or Dominated by University for Co-operation
5- Informal Networks and Other Initiatives

1) Project Oriented, Publicly Supported Co-operative Programs

1-A) R&D Projects Supports Foster Linkage Indirectly

1-A-1) Industrial R&D Projects Supports

Main steps to tackle the UIL issue in this context were started in 1991. Since then, TTGV has been co-operating with experts from universities and research institutes to evaluate and supervise technology development projects of industry. A pool of nearly 1500 experts has been formed for this purpose.

Regular visits to the companies by these experts who also act as mentors for projects supported by TTGV, increase the interaction between science and industry, and create a common ground for future co-operation.

The same applies to the industrial R&D projects supported by TUBITAK-TIDEB (the name of this department was converted to TUBITAK-TEYDEB in 2006) since 1995.

Another important measure taken was adoption of the Decree on State Support for R&D in December 1994. In accordance with the Decree, TUBITAK-TEYDEB increases the amount of support in case an industrial company cooperates with a university and/or a research institute in its R&D project.

Moreover, between the period of 1994 to 2006, the Decree had allowed for a grant to the universities and/or public research centres of up to $100,000 for an R&D project if they cooperate with a local industrial company in international programs such as Eureka.

1-A-2) The Support Program for Scientific and Technological Research Projects

This TUBITAK program is built to support research for generating new information, doing scientific interpretation or solving technological problems in compliance with scientific basis, and projects having advanced technology applications. The purpose of the program is to increase the national competitive capacity in international market within the framework of prioritized areas.

Universities, public and private corporations can apply to this program. The amount of support is max. 120.000 TL annual and support duration is max. 36 months. Since, most of the applications are coming from Universities, it can be assumed as an indirect linkage effect.

1-A-3) Support Program for Research Projects of Public Institutions

This program is for public institutions and is designed to solve their problems or satisfy their requirements by means of R&D projects. As the "Customer Institutions", public institutions can propose projects in which universities, private firms or public R&D institutions act as "Project Executors".

It is one of the favourable programs since there is no budget limit with maximum support duration of 48 months. But again, main applications are from universities as of 2008.

1-B) Industrial Thesis Supporting Program (San-Tez)

This new program has been launched by the Ministry of Industry and Trade in 2006, for strengthening the university-industry collaboration.

The aim of this program is to:

- Commercialize academic knowledge by transferring into high value added technological products;
- Solve the problems faced by the industry in cooperation with universities;
- Develop R&D and technological culture of SMEs;
- Increase the allocated fund by private sector for R&D budget (aimed to be increased up to % 1 of DGNP till the end of 2010);
- Contribute the increase of patents registered;
- Contribute the increase of qualified R&D personnel;
- Increase the competitive power of innovative and R&D capacity.

Within the context of this program, 75% of the total project budget is provided by the Ministry of Industry and Trade as a grant. The rest of the budget is being covered by the company who will commercialize the output of the project.

As 2006 and 2007 statistics show, 111 eligible projects have been funded among 293 project proposals from 30 universities.

Total SAN-TEZ budget for 2007 was 6 million US dollars and the allocated total fund for 2008 budget of these projects is 7 million US dollars.

1-C) The Support Program for the Initiative to Build Scientific and Technological Cooperation Networks and Platforms (ÍSBAP) and Incentive on Pre-competitive Cooperation Projects in R&D Law -No.5746

This program is built to support the establishment of cooperation networks and platforms between national and international corporations, units and groups about the areas such as basic sciences, engineering, health and social sciences, especially in order to align and develop our country with science and technology foresights. Industrial and business corporations, universities, public corporations and consortium of those can apply to this program.

Support system depends on 50% matching grant with max. amount of 250.000YTL annual and support duration is max. 36 months.

As end of 2008, five consortiums have been found as an eligible in this program.

According to 'Law on Supporting to R&D Activities-Law No.5746,' the pre-competitive cooperation projects has been motivating with some tax incentives.

Although this article are not directly focused on UIL, these two programs, ISBAP and 'pre-competitive cooperation project incentive of R&D law' have the potential for fostering UIL.

1-D) Brokerage Events Support Program (PPPDP)

After organizing one national and one international event by itself, TUBITAK has started to give financial support for Brokerage Event Organizations of universities since 2001. As of 2008, about 18 Brokerage Events organized by several universities has been supported by this initiative and hundreds of projects presented for match-making opportunities. The atmosphere being created in those events are also promoting and motivating co-operation and also facilitating the transfer of research results from universities to industry.

2) Institutional Co-operative Structures Oriented with Public Programs

2-A) Technology Development Zones (TDZs)

Another important step taken to stimulate interaction and co-operation between research community and business sector is the issuance of the Technology Development Zones Law to regulate the establishment of techno parks in co-operation with the universities and research centres to provide the infrastructure required for facilitating technological innovation.

The aim of the Technological Development Zones Law numbered 4691 and enacted in July 2000 through the cooperation of universities, research institutions and the production sector, is to create technological information in order to give the industry of the nation a structure fit for international competition and exportation, to introduce innovations in products and production methods, to raise the quality or standard of products, to increase productivity, to decrease the costs of production, to commercialize technological knowledge, to support production and entrepreneurship, to enable small and medium-sized enterprises to adapt the new and advanced technologies, to create opportunities of investment in technology intensive areas by taking into account the decisions of Science and Technology Higher Council, to create job opportunities for researchers and qualified persons, to help the transfer of technology and to provide the technological infrastructure which will quicken the entry of the foreign capital which, in turn, will provide high/advanced technology. Technology Development Zones Law has been effective since 2001 and conducted by the Ministry of Industry and Trade (MoIT).

The establishment and management of TDZs are under the responsibility of 'Managing Company' which is founded as a joint-company.

It is assumed that a managing company is also responsible for providing consulting services in education, patenting, firm establishment, technology transfer, financing, venture capital, marketing and exporting social structures are integrated.

The founders or share holders of the managing company could be as follows:

- There must be at least one university;
- Members of the Turkish Union of Chambers and Stock Exchanges;
- Local Administrations;
- Banks and Financial Associations;
- Domestic private legal entities;
- Foundations and associations related with R&D and technology development;
- Relevant public institutions;
- Unions of Exporters.

Foreign private legal entities may also participate in the management company, according to the Law of 'Incitement of the Foreign Capital'.

Companies that are presently using or intent to use high/advanced technologies and willing to develop or produce new and innovative technology or software by using the possibilities universities and the companies graduated from Technology Development Centres (TEKMER) can take place in TDZ.

The legislation promotes R&D companies to situate in a synergic atmosphere of TDZs and to develop their R&D capabilities by applying some incentives. Supports and Tax incentives provided by Law (till the end of 2013) are:

- Grant support for land procurement, construction of infrastructure and management building;
- Income and corporate tax exemptions for the managing company and R&D companies;
- Income tax exemptions for the salaries of the researchers, software engineers, and R&D

Box 4-1. METUTUCH (METU-Technopolis)

METUTECH is the first and the largest science park in Turkey. It is located in METU Campus, on 113 hectares of land with a 40 hectares construction area and approximately 200,000 m^2 of enclosed area, is 7 km far from the city centre of Ankara, and lies in the western corridor of the main development axis of the city.

The studies on METUTECH project were started in 1987 to support the formation and development of high-technology based companies, to ensure the development of technology, and to maximize the university-industry cooperation. After a period of investigating other science park models around the world, a feasibility study was prepared in 1988. Following this, the METU-KOSGEB Technology Development Centre (TEKMER) was founded in 1992 as a technology-based business incubator.

The success of the incubation centre encouraged METU to further invest in the idea of science and technology parks. Therefore in 1997 The METU-Technopolis Concept Project and Business Plan were completed. In the same year, the foundation of the first building of Science Park, HALICI Software House, was laid, and the detailed projects for the second building, called METU Twins, was completed. In 1999 The METUTECH Management Model was developed. In 2001 The METU-Twins Building and the METU-Halıcı Software House were put into complete service with no vacancies. In 2003, the third building, Silver Blocks, was put into complete service. The construction of the fourth building, namely the Silicon Blocks, was started in 2003 to meet the rising demand of companies.

Services provided by METUTECH

Services provided by METUTECH can be categorized under four different program types; that are, training programs, consultancy services, value added services and site management services. Training programs comprise of the 75 % of the total amount of value added services, whereas consultancy services on international marketing, technology transfer, IPR (Intellectual Property Rights), international legal advising, and funding comprise of the 15 % of these services. Other areas of services include events, travel, catering, and etc. Site management services include facility management, data and telecommunication services, security, landscaping, and management services, etc.

Fundamentally, METUTECH's existing company profile is based on software development and electronics industry. METUTECH, which has reached an enormity of 3730 personnel, 2800 of which are the researchers (86% of the total staff are university graduates, and 20% of which have Ms, Ma, or PhD degrees.) in 216 firms 99% of which are SMEs and including multinationals such as SBS, MAN, Siemens on the 60.000 sq m closed area, is the biggest and the most successful science park of Turkey. Over 600 R&D projects completed of which 200 faculty members participated. Around 50 companies have been involved in joint projects with the university. The incubation centre of METUTECH (TEKMER) serves 38 start-ups and micro sized companies; most of which are the spin offs from METU.

According to the development plan of METUTECH by the end of 2015, METUTECH will reach to a number of 250.000 square meters closed area, 10.000 employees working in 500 companies.

personnel working at the zone;

- Value added tax (VAT) exemptions for the software development activities.

The law provides incentives for mobility of academic staff to work with the private companies located in the techno parks as well as stimulating academics to establish their companies or to be a shareholder in the companies and/or to take part in the managements of companies located in techno parks.

As of 2008 some statistics related to TDZ are as follows:

- 31 Technology Development Zones (TDZs) established 18 of them are active;
- 928 firms in TDZs (local (896), foreign (32) ;
- Sectoral Distribution: Software & IT (465), Electronics (56), Defence (47) ; Telecommunication (18), medical or bio-medical (18), advanced materials (15) ; industrial design (18) and environmental (9) and others;
- 7.650 R&D staff and 2.435 technical support personnel in TDZs;
- 2, 560 R&D projects are being carried out in TDZs;
- 208 patents issued;
- 395 m $ export total from TDZs firms.

2-B) Technology Development Centres (TEKMER) and Without Wall Incubators (DTI)

TEKMERs and DTIs program has been launched and conducted by KOSGEB which is a non-profit, semi-autonomous organization established with the objective of improving the conditions of SMEs and enhancing SMEs competitive capacity by providing financial support and technical and managerial assistance.

Technology Development Centres as a kind of incubators being established jointly by the universities and KOSGEB are also important for closing the gap between universities and the business sector. There are 20 incubators established in the universities and 6 DTI throughout the country.

TEKMERs in Turkey are quite important in providing assistance for micro firms - especially for start-ups - and help them to survive in their vulnerable stages.

Expectedly, incubator firms are better linked to universities although most of the interaction is in the form of informal contacts.

As one of the main aims of incubators, TEKMERs are providing the more efficient atmosphere for networking, integrating high-tech industries, universities, public organization and other related institutions. This point is extremely important since those relations are weak in Turkey.

It was argued that the effect of interaction with universities is not strong enough in explaining the performance differentials between and of incubator firms. The survey also showed that PhD and masters degree in TEKMERs are only slightly higher although TEKMERs enable new opportunities for both students and academic personnel.

One of the other findings of the study is that entrepreneurs are accepted in TEKMER after an assessment of their projects. So, personnel in those are more qualified.

2-C) University-Industry Joint Research Centres Program (USAMP)

The "University-Industry Joint Research Centres Program" implemented by TUBITAK-TIDEB between 1996 and 2006 aimed at creating an environment favourable to joint R&D activities of universities and industrial companies.

The purposes of this program was to utilize the resources which the University/Industry Joint Research Centres Program had obtained from industrialists and the state, in areas of research adopted by the industrialists in such a way as to encourage cooperation between universities and industry, to direct research being carried out at the universities toward industrial and technological developments thus achieving accumulation of information in these areas, to educate and train graduates experienced in areas of industrial research, to increase the research potential of the university by employing mostly Master's or Ph.D. students at the Centre and to ensure continuity for cooperation between universities and industry by creating centres which could become self-sufficient with funds obtained from industrialists and other sources within a definite period of time.

The financing of the Centre was provided by TÜBÍTAK and the industrialists. The contribution of TÜBÍTAK could not exceed the contribution of the industrialists.

The performance of the Centre had been undergone referee evaluation annually.

The Administrative Board consisted of one representative from the university, one representative from TÜBÍTAK, and a minimum of three and a maximum of seven representatives from the industry, depending on the nature of the Centre.

The Centres were categorized in three groups as Sector Specific, Technology Specific and Regional. The common services provided by the Centres were R&D projects ('Common Benefit Projects' which are a kind of pre-competitive joint research - and contract basis research), testing and analysis services, consultancy, training, engineering. They could also provide additional services according to the industrial demand like as advanced manufacturing tools (CAD/CAM, rapid prototyping, etc.)

Six Joint Research Centres are established as a 'USAMP Centre' which are given below in different areas and they are all still active even after terminating the program.

1. **Ceramic Research Centre**: Established in March 1998 at Anatolian University, Eskisehir and functioning as a sector-specific centre.
2. **Adana University-Industry Cooperative Research Centre**: Established in May 2000 at Cukurova University, Adana and functioning as a Regional Centre.
3. **Textile Research Centre**: Established in December 2002 at Ege University, Izmir and functioning as a sector specific centre.
4. **Automotive Technology R&D Centre**: Established in 2003 at Istanbul Technical University, Istanbul and functioning as a sector specific centre.
5. **Advanced Manufacturing Technologies Centre**: Established in April 2004 at OSTIM Industrial Zone, Ankara in cooperation with Middle East Technical University and functioning as a regional centre.
6. **Biomedical Technologies Centre**: Established in April 2004 at Hacettepe University, Ankara and functioning as a technology specific centre.

USAMP was a suitable model for 'Triple helix' perspectives. And, the centres have good potential for brain gain since Turkey is one of the countries that suffer from brain drains.

3) Contract Based Projects and Training Programs in Universities

3-A) Contract Based Industrial Projects with University Revolving Fund System

As in other countries, contract based industrial projects are one of the most common and old mechanisms for UIL. However, those kinds of projects should be conducted in accordance with the Higher Education Council Laws' (YOK) related articles which are not favourable for academicians in Turkey. According to the legal YOK mechanism, researchers who provide services to firms not located in techno parks must transfer 70 percent of project income to their universities and cannot start their own businesses. This isolates scientists and researchers from the industrial world.

3-B) Universities Continuing Training and Education Centres (SEM)

Almost all universities design and conduct continuing training and education programs regarding the needs of industries.

Box 4-2. Ceramic Research Centre (SAM)

Ceramic is one of the biggest sectors in Turkey with almost 1.5 Billion USD turnover and 50% export ratio. In ceramic tiles, Turkey is 3rd in Europe and 6th in the world with the production size of 300 million m2 and in ceramic sanitary ware 1st in Europe in production and in export.

However, the main production system is depending on a process base with very low added value and a little R&D activities in the industry.

Till the establishment of SAM, there was almost no existing dialogue between ceramic companies and university.

The first idea for a research centre came from the ceramic industry and 'University-Industry Joint Research Centres' Program (USAMP), started by TUBITAK at similar times, was an excellent tool to start with.

At the beginning phase, there was neither a similar research centre to take as a model example nor institutional university-industry cooperation in the country, and almost a few industrial experience of university research staff.

The easiest and the most effective way to start the dialogue was to provide test/analysis services at reduced rates and with fast response (especially for production problems).

This was also good learning process to understand the industry needs better.

During the first year, maximum technical support along with test/analysis and delivering effective solutions with interpretation and consultancy developed trust between industry and SAM.

After the first year; pre-competitive or common interest R&D projects which was also USAMP approach financed by membership contributions has been settled.

SAM 'Technical Committee' which is composed of R&D managers of firms and academicians are the main driving force for joint project determinations and are good interface between industry and university.

10 years after establishment, companies producing almost 90% of the total ceramic outputs in Turkey are members of the Centre. Its' infrastructure is excellent also for advanced researches.

Some statistical results of SAM are;

- More than 13.000 Test/analysis many of them should be assumed as mini R&D
- 40 Common benefit projects,
- Several contract based projects,
- Hundreds of consultancy services,
- Sectoral trainings,
- Conformity assessment test and analysis with accredited infrastructures,
- Industrial PhD Program (2004-2010) has been designed and conducted.

As a result of SAM activities, more than 50 million USD equivalent adding value has been generated with the total 1.4 million USD contributions from TUBITAK and industries.

After end of USAM Program, SAM has made its new technology road map and 13 new innovative common benefit projects have been started accordingly.

3-C) Career Programs in Co-operation with Industries

Some universities have designed and implemented some MS or PhD career programs which are fulfilling the needs of the industrial sectors.

Some grants are also provided by industry to such programs and in some cases students are being matched with specific research project suit for firms need at the beginning and the performance audit has been conducted with the participation of the industry. Some public organizations - especially DPT - are also providing funds to promote such kind of initiatives. Industrial PhD Program conducted by SAM is one of the good examples for those initiatives.

4) Institutional Bodies Owned or Dominated by University for Co-operation

4-A) University Institutions or Centres for Co-operation

In order to facilitate interaction and co-operation with industry, almost all universities have established centres in their field of expertise. BILTIR at METU, Industrial Relationship Research and Application Centre at Yıldız Technical University (YTU) and EBILTEM at Ege University are some examples of those kinds of centres.

In BILTIR, there are three units: Industrial Design and Manufacturing; Automation, Robotic.

Industrial Relationship Research and Application Centre of YTU provide technical consultancy services to the industry while it also acts as a liaison office for university-industry relations.

Regarding the service types and some outputs in UIL related matter, EBILTEM's achievements are remarkable in this category.

4-B) Technology Transfer Office (TTO)

As a recent trend, some universities have been establishing TTO while several universities are in attempting phase. Inovent in Sabanci University, TTO in Hacettepe University TDZ, Gazi TTO in Gazi University are some examples. The established TTOs are in very early phase and not possible to give deep statistics, except Inovent.

Inovent, the technology commercialization company tied to Sabanci University, is one of the successful and the mature one. It specializes in development, commercialization and management of intellectual properties developed by universities, research institutions, technology companies and entrepreneurs in Turkey.

Box 4-3. Ege University Science and Technology Centre (EBILTEM)

EBILTEM was established in 1994 to bridge the gap between the industry and the university.

The mission of the centre is to form an effective interface between industry and university, with the support of Ege University's infrastructure and expert manpower.

Some services providing by EBILTEM to SMEs are;

- Access to National and International R&D funds (TEYDEB, TTGV, KOSGEB, EUREKA, vs.)
- Guidance for Intellectual Property Rights (TPE Liaison Office)
- Guidance for New Investment Projects (Industrial Relations Unit),
- Information about EU Programs (EU Coordination Unit),
- Forming new collaborations and joint projects with foreign universities and companies (via partnership in Different Networks),
- Transnational Technology Transfer (IRC-EGE Centre),
- Foreign Expert Support (Netherlands Senior Expert (PUM) Unit),
- Guidance to exchange scientists (Ege Mobility Centre via ERA-MORE)
- Scientific support from the University, analytical services and consultancy (Laboratory Services Unit).

Some statistics as performance indicators of EBILTEM since 1998 are;

- Coordinates 28 R&D support programs for Academicians
- (%32) 90 out of 279 projects co-financed by industry.
- 190 contracted projects for industry.
- Over 1000 projects promoted in 5 National Brokerage Events and 8 Project Competitions - supported by Foundations,
- 600 potential projects in "Project Pool",
- 42 projects found large scale application- national Technology Transfers,
- Services targeted at University students - Coordination of Science and Technology Club, Initiation of Certificate Programs - jointly with stakeholders
- Services targeted at the general public - Science Fair, European Researchers' Night activities, TUBITAK High School Project Competition,

Assistance to Support SMEs

- Processed 537 patent, 1019 trademark, 211 industrial design applications
- Created 2 Spin-Off Companies
- Coordinated/Participated in 5 FP6 and 3 FP7 projects to assist regional SMEs with total budget of 3.5 M€
- Assisted 2O SMEs to obtain national R&D Funds,
- Facilitated the visit of 15 foreign experts
- Visited 706 SMEs
- Conducted Technology Audits for 124 companies
- Organized and participated 127 technology matching events
- Facilitated 2.084 meetings between 926 Turkish SMEs and EU Companies.
- Realized 67 Transnational Technology Transfers between Turkish and European SMEs,

In its website, it is mentioned that Inovent combines the functions of technology transfer, company formation, business incubation, investment sourcing and business development to accelerate commercialization and business growth. Inovent's activities include discovering and evaluating intellectual property, providing strategic guidance and help in protection of intellectual property rights, selection and realization of appropriate models of commercialization (licensing or establishment of spin-off), investment sourcing, developing business plans, conducting business development functions for its portfolio companies and providing advisory services on technology commercialization. Innovent has seven companies in its portfolio already.

5) Informal Networks and Other Initiatives

There are also some efforts especially through Chambers of Industries to foster co-operation.

Box 4-4. Summary: Categorization of Mechanisms Support UIL Directly or Indirectly

1-Project Oriented, Publicly Supported Co-operative Programs
- 1-a R&D Projects Supports Foster Linkage Indirectly
  - 1-a-1 Industrial R&D Projects Supports
  - 1-a-2 The Support Program for Scientific and Technological Research Projects
  - 1-a-3 Support Program for Research Projects of Public Institutions
- 1-b Industrial Thesis Supporting Program (San-Tez)
- 1-c The Support Program for the Initiative to Build Scientific and Technological Cooperation Networks and Platforms (ISBAP) and Incentive on Pre-competitive Cooperation Projects in R&D Law -No.5746

2- Institutional Co-Operative Structures Oriented with Public Programs
- 2-a Technology Development Zones
- 2-b Technology Development Centres (TEKMER) and Without Wall Incubators (DTI)
- 2-c University-Industry Joint Research Centres Program (USAMP)

3- Contract Based Projects and Training Programs in Universities
- 3.a- Contract Based Industrial Projects with University Revolving Fund System
- 3.b- Universities Continuing Training and Education Centres (SEM)
- 3.c- Career Programs in Co-operation with Industries

4- Institutional Bodies Owned or Dominated by University for Co-operation
- 4.a- University Institutions or Centres for Co-operation
- 4.b- Technology Transfer Office (TTO)

5- Informal Networks and Other Initiatives

Some kind of informal networks mainly called itself 'Platforms' could also be addressed with in UIL context. One of the remarkable platform was called as 'TARGET' established in 2001 as a result of a focus group activity leaded by Tofas, one of the biggest automotive manufacturers of Turkey, but not survived after implementing some successful co-operative projects.

The most recent and effective co-operative initiative is 'USIMP' which is the acronym of University-Industry Co-operative Centres Platform. This network has been established by University-Industry Joint Research Centres formed under USAM program. Several organizations such as TTGV, Competition Forum, PICMET, EBILTEM, etc. have been the members afterwards. This platform aims to design effective UIL mechanisms specific for Turkey and to spend necessary efforts to activate those.

In May 2008, USIMP organized National UIL Congress successfully and this organization will be repeated annually.

Also, some non-governmental initiatives such as National Innovation Initiative led by Competitiveness Forum (REF) of Sabanci University and Turkish Industrialists' and of Businessmen's Associations' (TUSIAD), Turkish Economy Policies Research Foundation (TEPAV) by TOBB have tried to make lobby and provide information to policy makers for further RTDI system and for enhancement for UIL particularly.

4. SWOT Analysis for University-Industry Linkages in Turkey

Strength:

- Several mechanisms and attempts are available to foster co-operation between the business and research communities and university R&D financed by industry has increased sharply (see Fig. 4-3),
- Turkey has a solid knowledge-base with well-known universities and R&D Institutes, and scientific output has risen substantially (see Fig. 4-4),
- Some good practices such as USAMP, EBILTEM, METUTECH are available to learn from lessons and for being optimistic on UIL related matter.
- Increase in the political commitment to designing and implementing mechanisms for UIL.

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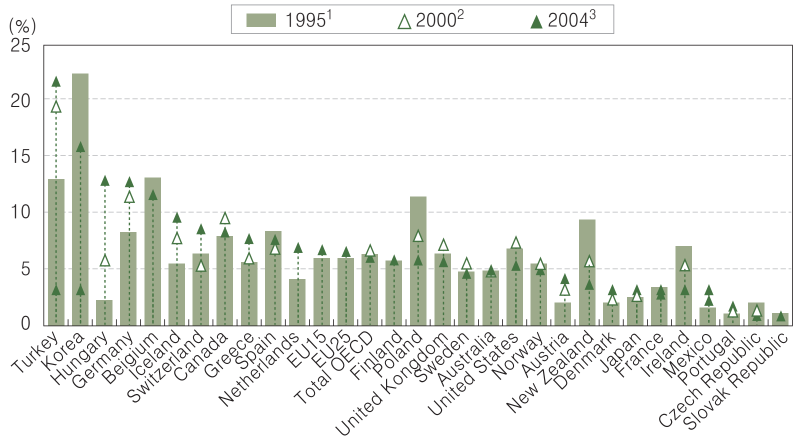
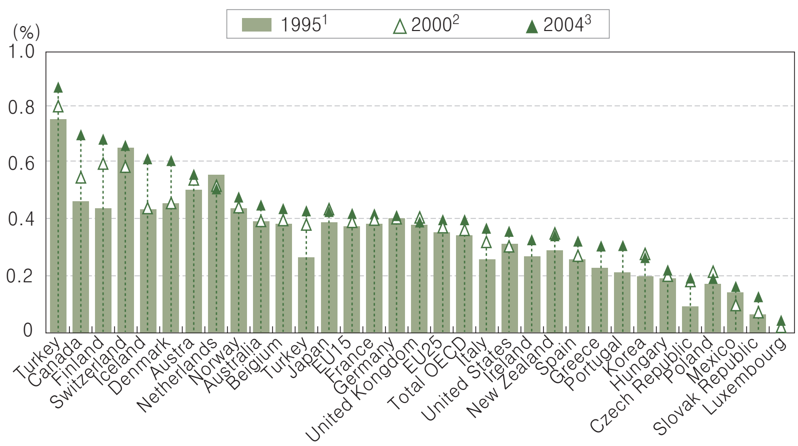
Figure 4-3 | Share of higher education R&D financed by industry, 1995, 2000 and 2004



Source: OECD STI, 2005

Figure 4-4 | Higher education research and development

(Unit: As a % GDP)



1. 1996 instead of 1995 for Switzerland, 1993 for Austria.
2. 1998 instead of 2000 for Austria; 1999 for Greece, Norway, New Zealand and Sweden.
3. 2002 for Australia, Austria and Turkey; 2003 for Greece, Iceland, Italy, Mexico, New Zealand, Portugal, Sweden, United Kingdom, EU15 and EU25.

Source: OECD, Main Science and Technology Indicators, June 2005.

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Weakness:

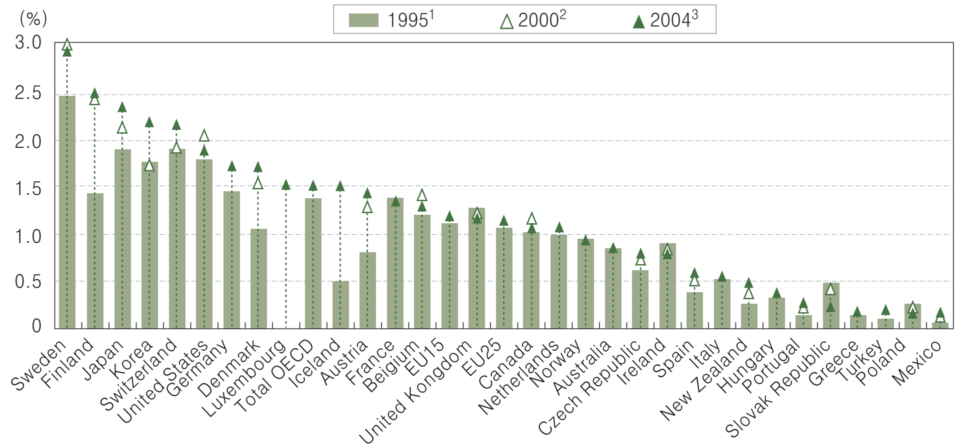
- Historically and culturally, co-operation between the business and the research communities is weak in Turkey.
- Industry capacity in general perceives the quality of Turkish scientific institutions as quite low, which limits their interest in collaborating with local researchers.
- Main regulatory framework in Turkey depends on the linear innovation systems and not favourable for recent trends such as hybrid institutions between related actors.

Figure 4-5 | Linear Innovation Model

- Most of the UIL programs initiated by the public are imitated from abroad and assimilation efforts of those according to the local characteristics are not enough..
- The total number of researchers in Turkey are very low when compared to other countries. Regarding the number of researchers in business sector, situation is much worse.
- Most of the programs have not undergone impact assessment, so periodical improvements with regard to the assessment results are not a common case.
- The academic curricula is not prepared according to the needs of the business.
- Although as most R&D is performed by universities in Turkey (universities account for 58.9 percent of the country's R&D expenditure, employ 73.2 percent of researchers) and produce a high level of scientific output, weak transformation of this output into innovation. Also BERD intensity as % of GDP is extremely poor (see Fig. 4-6).
- Insufficient number and quality for intermediaries to improve communication and co-operation between the private sector and academia.
- The current university regulations and legislation (e.g., the university revolving fund regulations) are not favourable to encourage collaboration.
- Required data for impact analyses on spin-off, start-ups and technology licensing are not available.
- The programs and initiatives for UIL providing by public organizations are mostly supply driven characteristics and do not regard demand side sufficiently.
- Collaboration between firms and researchers within the Technoparks and the creation ratio of high-tech start-ups is low and the networking efforts in Technoparks are limited with host university.

Figure 4-6 | BERD intensity by country, 1995, 2000 and 2004

(Unit: As a % GDP)



1. 1993 for Austria, 1996 for Switzerland.
2. 1998 instaed of 2000 for Austris; 1999 for Denmark, Norway, New Zealand and Sweden.
3. 2002 for Austria and Turkey; 2003 for Australia, Greece, Iceland, Mexico, New Zealand, Portugal and Sweden.
Source: OECD Main Science and Technology Indicators Database, June 2006

Opportunities:

- Universities and Public authorities have been designing a new measure to support masters and doctorate thesis programs prepared by university students in line with the needs of the industry.
- Some new measures such as R&D law aim to facilitate industry-researcher cooperation directly or indirectly have been introduced.
- Awareness and capacity building efforts for collaboration are widening through universities, industrial umbrella organizations etc.

Threats:

- Turkish economy is still depending on the traditional sectors which are conservative and hesitate to make co-operation with universities.
- Universities have no policies for UIL specific measures. So, some valuable attempts for enhancing UIL still depend on the personal efforts and cannot be institutionalized.
- ‘Mode 1’ knowledge production mechanism is still dominant in universities.

5. UIL System Analyses for Turkey With Respect To the Recent RTDI Trends in the World

5.1. Main Dynamics for Non-Linear RTDI Model

As mentioned in Section B, in the knowledge-based (or knowledge-driven) economy, the innovation approach and the system of innovation depend on very complex social networks and such new system is very different from the traditional model. At the same time, the dynamics of the knowledge production and control system have also been changed sharply. Beginning from problem definition, the main tendency has been changing from discipliner approach to trans-discipliner, in parallel with changes in the innovation system. Similarly, university has been playing more active and enhanced role, and its relations with industry exhibits very complex dynamics ever than before in a knowledge based economy.

Above mentioned changes have been proposed as a recent model for the evaluation of the knowledge-based economic relations or driving forces of knowledge production and innovation systems. Some interacting (or interrelated) dynamics which can be modelled as a non-linear evolutionary pattern with chaotic behaviours are as follows;

1- The new model of National Systems of Innovations (Lundvall, 1988 and Nelson, 1993)
2- The model of an emerging ‘Mode2’ of the production of scientific knowledge (Gibbons, et al. 1994) and,
3- The model of a Triple Helix of university- industry-government relations (Etzkowitz & Leydesdorff, 1995)

Some important complex networking characteristics such as internationalization, open innovation, etc. should also be underlined as a result of or derived from recent trends mentioned above.

Almost all countries, firms, universities, etc. have been re-evaluating their systems and re-shaping them accordingly.

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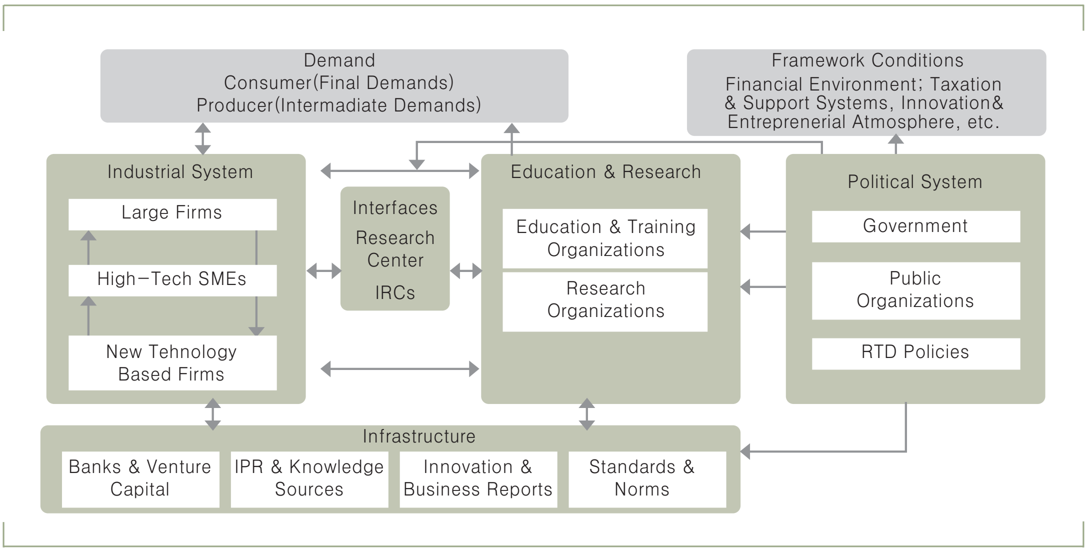
Figure 4-7 | The National System of Innovations



Source: Erik Arnold & Stefan Kuhlman, RCN in Norwegian Research & Innovation System

5.2. Situation in Turkey With Respect To the Recent RTDI Trends

When we closely look at the Turkish NIS with in this context the main findings are;

Turkey has almost all required public institutions in its NIS at a national level.

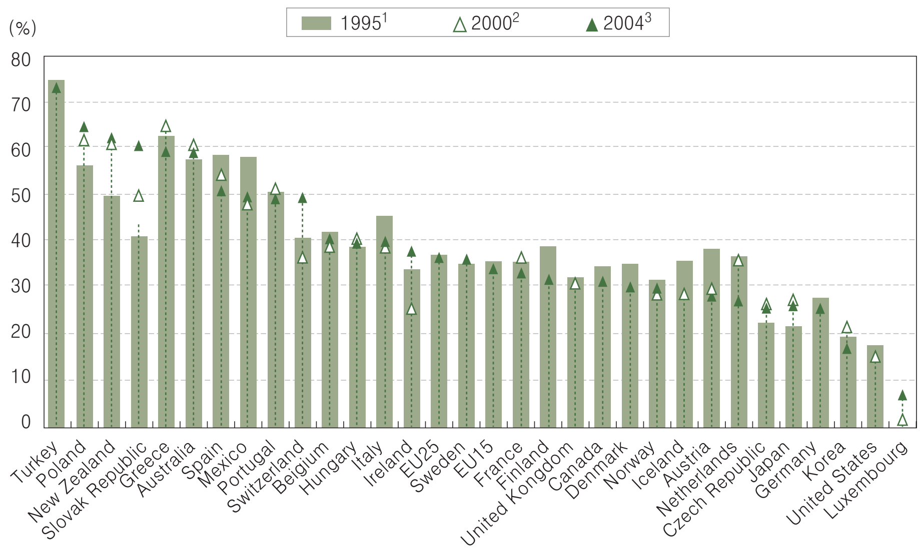
As a knowledge production potential, there are 130 universities (39 of them private) which together account for about 2/3 of Turkey's total R&D spending. Three-quarters of universities have technical faculties and research centres that also provide R&D and innovation-related services to the industry. Lifelong Learning Centres which mainly belong to regional universities all over the country provide short-term training and certificate programs. Major universities have established centres to create and disseminate knowledge.

The average annual growth rate of the Turkish publication share in the world total amounts to 14.4% in 1991-2007. The absolute increase from about 1,300 papers in the sciences in 1991 to more then 17,000 in 2007 is even more impressing. This evolution mirrors the growth of R&D expenditure on GDP which rose from 0.32% in 1992 to 0.67% in 2004, but does not reach the EU standard of about 1.9% yet.

According to the publication output in the sciences and applied sciences, Turkey jumped from 38th in 1991 to 19th in 2005.

Share of researchers in universities as a percentage of all, Turkey is in the first rank among OECD countries.(see Fig 4-8)

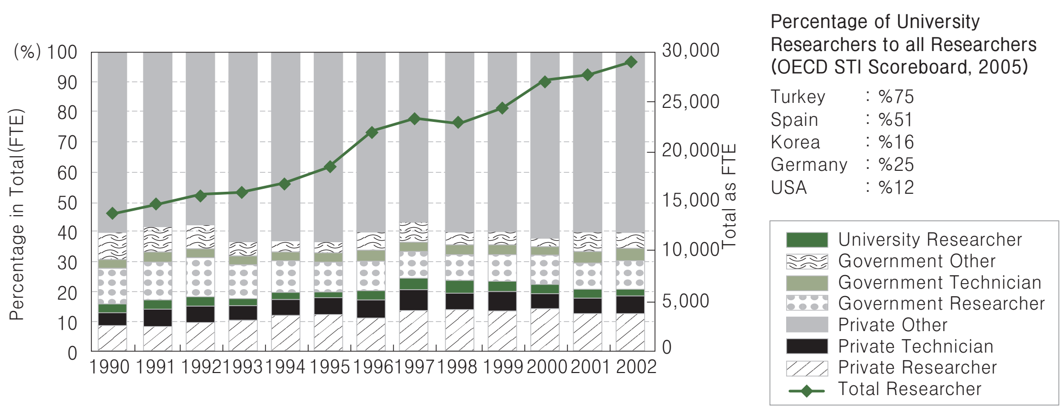
Figure 4-8 | Higher education researchers



1. 1993 for Austria, 1996 for Switzerland.
2. 1998 for the United Kingdom, 1999 for Mexico and the United States.
3. 2002 for Australia, Austria, Canada and Turkey; 2003 for France, Germany, Greece, Iceland, Italy, Mexico, Netherlands, New Zealand, Norway, Portugal, Sweden, EU15 and EU25.

Source: OECD Main Science and Technology Indicators, June 2006

Figure 4-9 | Breakdown of FTE Researchers



Source: TUik, 2004

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5.2.1. Publication profile in Turkey

It is argued that the paradigmatic patterns in publication profiles could be distinguished in four groups in the world:

I. the ‘western model’ with clinical medicine and biomedical research as dominating fields;

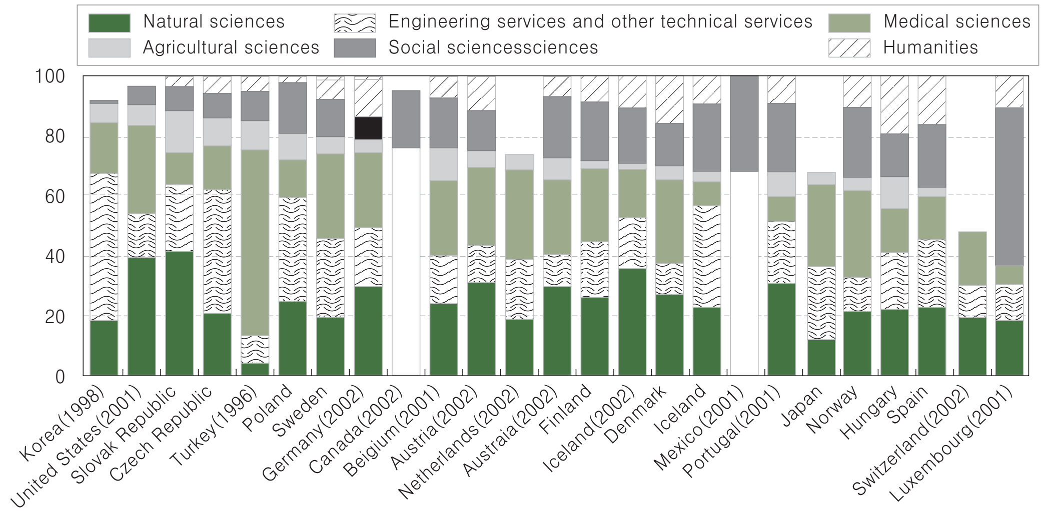
II. the characteristic pattern of the former socialist countries with prevailing activity in chemistry and physics;

III. the ‘bio-environmental model’ with biology and earth and space sciences in the main focus;

IV. the ‘Japanese model’ with engineering and chemistry being predominant.

Turkey’s profile does not uniquely fit in any of the above categories (see Figure 4-10). It can rather be considered as a mixture of Types I and III. The evolution is characterised by two general trends, particularly, by growing relative activity in Medical sciences and Agriculture & Social sciences and decreasing weight of natural sciences and engineering.

Figure 4-10 | Higher education research and development expenditure by field of study, 2003[1]



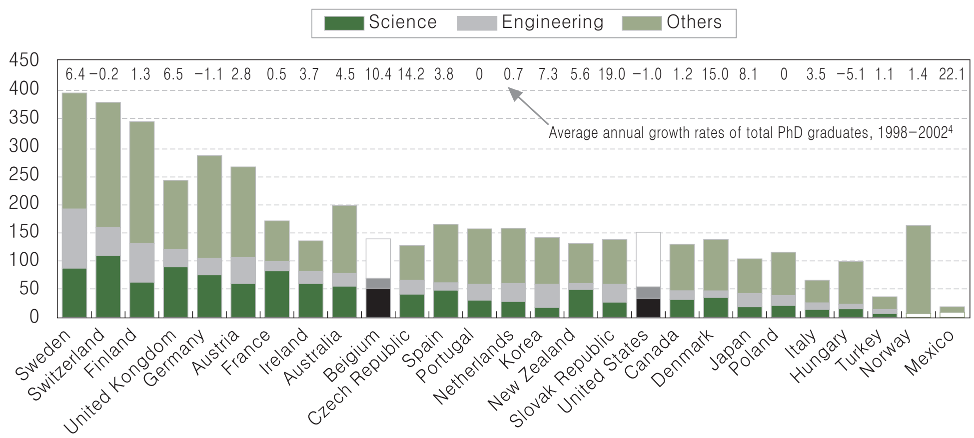
1. In Korea, R&D in social sciences and the humanities is excluded, as is R&D in the humanities in the United States.
Source: OECD, R&D Statiatics(RDS), November 2005.

5.2.2. Human Capital for RTDI

As mentioned, there is a significant increase in scientific output. But, within the context of innovation performance, it is relatively low level of transformation of applied knowledge into innovations and into business developments.

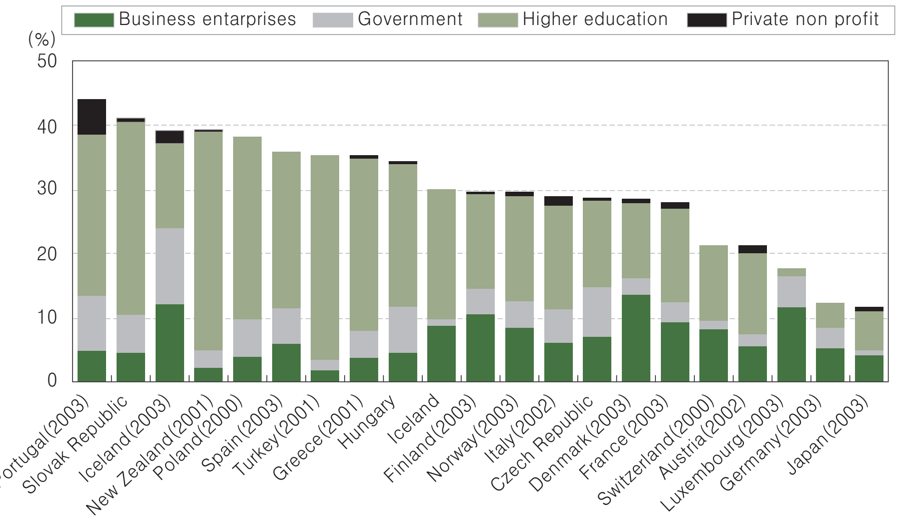
Also, the total number of researchers in Turkey are very low when compared to other countries (see Fig. 4-11). Situation in business sector are much worse. (see Fig. 4-12).

Figure 4-11 | PhD graduates in science[1] and engineering[2] and other fiedls, 2002[3], per million population



1. Sciences include life sciences, physical sciences, mathematics and statistics, and computing
2. Engineering includes engineering and engineering trades, manufacturing and processing and architecture and building
3. 2000 instead of 2002 for Canada and Portugal.
4. 1999 instaed of 1998 for Denmark, Mexico and the Slovak Republic; 2000 for Belgium and Portugal; 2001 for Poland.
Source: OECD, Education Database, June 2006

Figure 4-12 | Women researchers, 2004



Source: OECD, Main Science and Technology Indicator Database, June 2006.

As regards to the percentage of female researchers, Turkey is in front ranks and almost all are working in universities or for governmental organizations.(see Fig. 4-13)

Figure 4-13 | Human Capital

- 1,900,000 students in 76 universities (%40 female)
- 110,000 working towards advanced degrees (25,000 PhD)
- 76,000 academicians (%37 female)
- Engineering Dept: 113,681 registered (16,481 graduated in 2003) - Top students still choose engineering!
- Science Dept. (including computer): 102,897 registered (14,700 graduated)
- R&D Staff: 28,964 (FTE - 2002); Private: 5,918 - very low (Germany ~480,000 (FTE) total)

- **There are over 50,000 Turkish students enrolled in University Programs abroad. (Over 13,000 are in the US, %2.6 of all foreign students in the US, in the top 10)**
- **Ministry of Education and Higher Education Authority have generous scholarship programs**

5.2.3. Main Findings

There are more than 100 public research institutes, most of which are not very active in establishing linkages with the business sector. But only about one dozen centers carry out industrial R&D and innovation intermediaries such as TUBITAK's Marmara Research Centre (MAM) and other TUBITAK institutes.

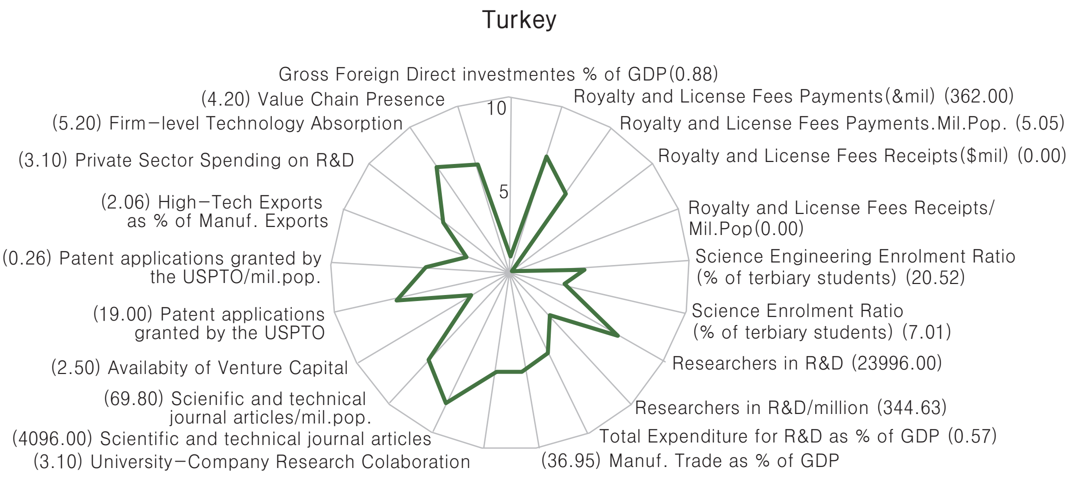
Several public organizations have been providing several programs which aim to promote UIL directly or indirectly. But a few programs are successful to create the critical mass.

Regarding the surveys on innovation indexes for countries done by OECD, WB, EC, etc., it is possible to say that Turkey's overall knowledge production capacity in the world and the innovation performance are not good. (see Fig. 4-14 and Fig. 4-15)

Some of the reasons of this poor performance besides having such infrastructure and programs could be:

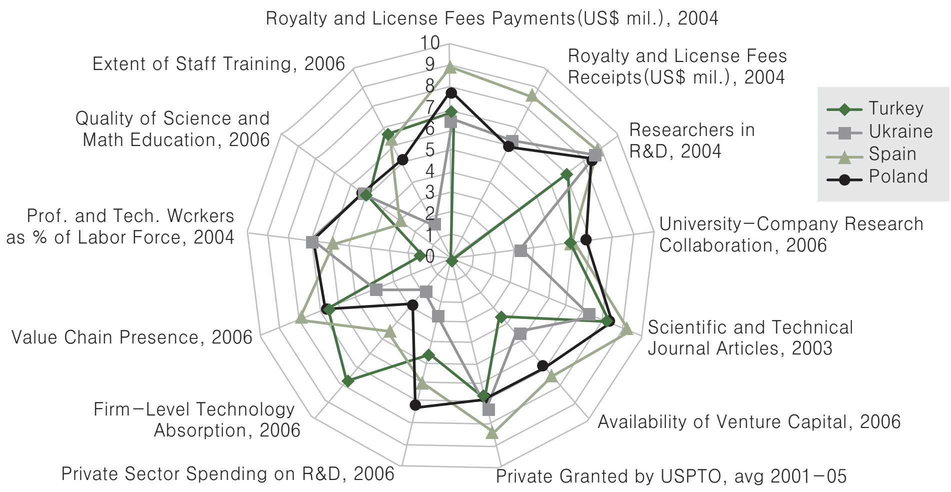
- There are missing link and coordination and synchronization problems between programs and organizations;
- Country's legal and regulatory systems are not suitable or may cause conflict for recent or

Figure 4-14 | Turkey



Source: World Bank.

Figure 4-15 | Turkey Compared in terms of selected KE Metrics



Source: WB Knowledge Assesment Methodology Homepage: http://www.worldbank.org.kam non-linear trends. For example, one of the very effective and cost benefit triple helix model of university-industry-government interaction program, USAMP was established in 1996, but was abolished by the end of 2006, since the Turkish legal provisions are not suited for such hybrid institutions.

In another example, on the one hand the main university regulations (revolving fund) create disincentives for researchers to provide services to the enterprise sector and the main rules regarding academic promotion do not encourage collaboration with the business sector, on the other hand TDZ law enable academicians to establish firm or to make collaborative works with firms in Technoparks.

- The current IP laws favour researchers in the allocation of royalties for commercialized research, but hindering universities to commercialize R&D outputs.
- It is difficult to conduct some effective mechanisms in traditional and low skilled-labour sectors which are still dominant in the Turkish economy.
- Big companies are one of the driving forces for UIL. In Turkey, less big companies are available to lead or dominate for co-operation between university and industry.
- The total number of researchers in Germany is about 11 times more than in Turkey.

As a summary, a linear view of innovation is still valid in current science and technology strategies and in main RTDI mechanisms in Turkey. The figures for the number of researchers and for R&D share of business sector are other handicaps for fostering UIL.

In order to convert national systems from linear to non-linear approach, the beginning point can be to analyse the conceptual background of recent global RTDI system and to review related current laws and regulations in Turkey accordingly. It should also be regarded to re-design national system in cooperation with beneficiaries and with demand driven approach in stead of top-down and supply driven base.

6. Conclusions and Some Views on How UIL Can be Improved

Beginning with the ‘Vision 2023’ study, there is an exponentially increased effort by the BTYK to improve the science, technology and innovation system in Turkey. Especially last 3-4 years, in line with the objective of the BTYK to increase R&D spending to 2 percent of the GDP in 2010, the government has allocated the biggest funds ever, although it is still far from this 2% challenging target.

For the past 10 years, several attempts on UIL related mechanisms have been initiated by several public and private organizations. Since then, the lack of a systematic approach to monitoring and evaluating of innovation programs has become a significant weakness of the Turkish governance system. It is difficult to provide some statistical results of those mechanisms but from the results, we can say that overall success ratio is quite low.

However, regarding the existing infrastructures, policies, mechanisms and committed resources, Turkey has a good potential for UIL related matters particularly.

In order to activate those potentials, some of the possible accelerators would be;

- Scientific developments are considered as the main source of technical innovation. Industry mainly seeks for co-operation with university for short-term and industrially oriented projects. Too much emphasis and fund allocation on short-term co-operative projects driven by the industry carries the risk of under-investment in scientific research and long-term technologies with broader applications. In addition, too much focus on commercialisation of publicly funded research carried out by universities and public laboratories will distract the required concentration for long-term research which is required to meet public goals in the areas of health, energy and defence, etc.
  In other words, it is also required to have the national scientific knowledge-base generated in long-term by universities and public R&D laboratories. Obviously, those kinds of efforts should be financed by public resources.
  So, the public funds should be distributed in balance between the two ambitious goals. At the same time, the university should have its research policy and priority. Some universities may prefer long-term and fundamental research, while others - especially regional ones - may prefer to concentrate on the industrial driven research. Each university should make their roadmaps and design and establish their systems and mechanisms accordingly. Since the university should be a pioneer especially at the beginning phase of UIL, they should prepare their policies, declare them and then negotiate for funding for their overall goals and targets.

- Almost all developed countries have nation-specific and R&D dependant public procurement policies in which domestic firms and universities have been motivated for R&D co-operation with some incentives. Turkey should reshape its procurement policy in a similar way. Some organizations such as Undersecretary for Defence Industry (SSM) and Bor Institute (BOREN) are already in good track.

- As mentioned before, enactment of better laws and legislation to enable hybrid institutional structure in which measures like “Triple Helix” model of university-industry-government interaction similar to USAMP is required.

Also, there is a need to revise university regulations and legislation in order to encourage collaboration with industry.
For this purpose, an umbrella law for 'University-Industry Co-operation' could be useful.

- Coordination efforts for complementarity between public programs run by different institutions are one of the main requirements.

- Already, each Technoparks in Turkey are aiming to the networking limited within the frame of a hosted university. It is known that the success is correlated to the network size. So, some platforms and supportive funds would be provided for Technoparks co-operation programs such as 'Ankara Technoparks Platform' initiated by TTGV and three Technoparks.

- Some special emphasis should be given to university-industry co-operation, while designing and implementing regional innovation strategies, clustering and other networking activities which are currently popular and in the agenda of Turkey.

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Chapter 05

Technology, Entrepreneurship, and Incubation

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Chapter 05

Technology, Entrepreneurship, and Incubation

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1. Introduction

Like Turkey, the small and medium sized business sector of the Korean economy is generally recognized as one of the most important and dynamic parts of the economic system. Small high technology firms, an outgrowth of entrepreneurship, have been proliferating as never before since the 1997 Korean economic crisis. The Korean government responded to the economic crisis by founding and operating business incubators to facilitate the creation and support the survival of small and medium sized businesses in Korea. While there were only twelve business incubators authorized by the Small and Medium Sized Business Administration by 1997, as of 2008, there are about 400 business incubators. While the number of business incubators in Korea has been increasing dramatically, there are still many problems in terms of incubator management, the quality of services, etc.

In this research, entrepreneurship (Entrepreneur) means a person who assumes the risks of a business or enterprise with starting and operating new high-tech ventures. Venture business means the firms in which some of few creative business challengers establish to commercialize their innovative technology with highly advanced technical power and technological knowledge. These businesses may take high risk because of poor capital even with a high possibility of success, but also have a high success potential on the basis of unique technical knowledge and new advanced technology.

If successful, venture businesses can bring high profits, create new and high paying jobs, open new markets, and facilitate technology development. Despite these merits, high risk is also part of the venture businesses. The success rate of venture businesses is reported to be around 20% worldwide (NCVA, 1996). But if properly supported by national and local governments, universities, research institutes, and other related institutions, it is reported that the success rate can be as high as 50% (Gompers, 1996).

Daeduck technopolis in Korea has been highly interested in nurturing venture business because Daeduck technopolis has highly qualified researchers working together. This has been regarded as very important infrastructure and potentials for venture business. Since 1997, the venture business fever occurred around Daeduck technopolis, and it has been in the nationwide spotlight. All technology business incubators in Daeduck Technopolis had stimulated commercialization of researcher's innovative research results.

The basic research question to be addressed here is "Were there a highly motivated entrepreneurship and start-up potentials for high-technology industry around Daeduck Technopolis and were the high-tech venture start-ups coming before the Korean economic crisis?"

This study also needs to find the answer on the following research question. "Are the services provided by incubators directly or indirectly through it, such as financial support from community and technical expertise services from research institutes, helpful to hatching and growing high-tech venture businesses?" In other words, it is necessary to do research on the influential factors on start-up and contribution factors on growth of high-tech start-ups in terms of support systems of business incubators and other related institutions including universities, research institutes, central government, local government and so on. It is also very important to verify another research question. "Are Daeduck Technopolis' business incubators effective to birthing economic development? This subject is closely related not only with the regional economy, but also with nationwide interests.

In order to answer the research questions mentioned above, first of all, this study will introduce Daeduck Technopolis historically, which is divided into timely section, 1) prior to the Korean economic crisis in 1997 to recognize environment and entrepreneurship of high technology industry in Daeduck Technopolis, 2) 10 years afterwards under strong support policy for venture business from the government, and 3) 10 years later to grasp the outcome of technology based venture businesses and business incubators.

Finally, this study is trying to find policy implications for stimulating entrepreneurship, commercializing high technology, and nurturing venture start-ups in METU Technopolis and other places in Turkey and Daeduck Technopolis in Korea as well after identifying and comparing entrepreneurship and the incubators for nurturing venture businesses between them.

2. High-Technology and Start-ups Environments in Daeduck Technopolis before Government's Active Drive for Venture Businesses

2.1. Status of Daeduck Technopolis and Venture Business

In an effort to propel an export-oriented economic policy after 1960, Daeduck Research Park, the heart of the Daeduck Technopolis, was designed to maximize the effectiveness of research results by concentrating on research institutions in a designated region and recognizing the importance of scientific technology. For this reason, in 1973, the government started to develop the Daeduck Research Park which emphasized education and research but de-emphasized the role of production.

In 1997, Daeduck Research Park was completed and covered an area of $27.5km^2$ and was comprised of seven governmental organizations related to scientific technology, sixteen governmental research institutes, twenty-five private research organizations and four educational organizations. In total, there are fifty-two organizations which employ approximately 17,000 people. Most of them are scientists, engineers and technicians. All of these research institutions together function as the largest and the best domestic research development organization of advanced industry and has also been recognized as an excellent research complex of science & technology internationally. In Daeduck Research Park, the research institutes were mainly composed of new materials and precious chemical products (27.4%), energy and natural resources (19.6%), electrical and telecommunication (9.8%), and so on. Most research institutes are related to advanced technology.

In December 1999, the guidelines for Daeduck Research Park were revamped and the existing research town was redirected to the high-tech industry. On September 28, 2000, the President of Korea proclaimed the region as Daeduck Valley (Science Town). After the late 1990s, many ventures were born and the volume of exports, sales, employment and patents registered was rapidly increasing, Therefore, Daeduck Research Town, a university affiliated science park, evolved into Daeduck Technopolis. The region developed from a research institute complex and Daeduck Research Town to a cluster of ventures and Daeduck Technopolis.

On the other hand, the City of Daejeon in which the DRP is located, has attempted to support the DRP by developing the industrial complex like Science Park later, in which the advanced technology oriented companies are built. The City of Daejeon is going to boom the venture capital firms by using the advanced technology resulting from the research institutes in the Daeduck Science Town (DST). However, most of research institutes which are controlled by the government have emphasized the long or medium term national strategic research project, excluding practical research works which might be applied to local manufacturing industries.

It can be argued that there are high start-up potentials in DST because there are about 6,500 Ph.D. degree holders. Highly qualified research manpower in public and private research institute is highly concentrated in DST. This means that there is a high possibility of commercialization of research results or production of high-tech commodity from high technology related in DST.

2.2. Potentials of Entrepreneurship and Incubation for Venture Business Promotion

① Trends and Climate of Research Institutes toward Venture Start-ups

As of 1997, active spin-out motion from R&D centers was happening in DST. For the last 6 years, 40 spin-off firms from the DST have been found in the survey of Daejeon metropolitan city. There were three cases of business formation in DST in 1991, but it grew to 12 cases in 1995 and eight cases in 1996.

This chapter uses the survey on 27 research institutes to investigate their climate for their researchers' start-ups in DST which was done on January 1997. The survey questioned whether the research institutes allowed their researchers to use their research results for their own businesses or not. A total of 14.8% of the respondents answered that they recommended their researchers to open their own businesses, and 25.9% of them did not interfere with researchers planning to hatch their own venture businesses. But 51.9% of them did not allow their researcheres to use the research results for their own businesses. The attitude of Research Institutes was not so open-minded for these active spin-off activities. Research results produced from DST were usually not allowed to be used by researchers who wanted to open their new businesses. If this climate was changed, spin-offs from DST might be much easier.

There was, on the other hand, the potential in Daejeon City in terms of business incubation. In the Technical Business Incubator in KAIST, 21 new graduates had moved their businesses to the Daejeon area. In addition, 5 start-up firms were operating in Chungnam National University's TBI. In order to support these kind of small start-up firms, Daejeon City One Stop Business Supporting Service Center for small and medium sized businesses was made. With these supporting organizations and TBI facilities, business formation was relatively active in Daejeon compared with other cities in Korea.

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Table 5-1 | Trend toward Venture Start-ups in Daeduck Technopolis

Year	1991	1992	1993	1994	1995	1996
# of businesses	3	2	6	8	12	8

The research institutes were asked to answer whether local businesses might use the research equipment and facilities of the DST or not. A total of 11.1% of research institutes answered that if researchers paid the fee, they could use them whenever they wanted, and 37.0% of the respondents responded whenever they were not occupied, they were allowed to use them. But almost half, 48.1% of the respondents answered that only limited numbers of staffs were allowed to use the facilities. Furthermore, 22.2% of the respondents answered that only research staffs might use them. It means that there is a relatively high barrier to local industries.

② Venture Capital and Community Climate for Venture Business

Venture capital, in general, means the invested capitals or firms which get back high interest and the invested dividends when venture businesses grow successfully. However, venture capital has high risk potentials because capital is invested for the commercialization of the innovative technology and establishment of the new firm without any guarantee of the venture business's success. It may take relatively long time to get back the invested capital after venture businesses arrive at the profit point. It is also uncertain whether the venture firm will succeed or not. The success rate of venture businesses is very low, usually under 20% in the start-up world. Even though the Korean venture capital had grown since the late 1980s, it was still at the beginning stage in terms of scale as compared to developed countries.

The history of venture capital in Korea can be summarized as follows. The Korean Technology Promotion Company was established for supporting the commercialization of KAIST's research results in 1974, and the Technology Development Company, Ltd. opened to supporting the Korean technology development in response to the needs of the government and private company in 1980. Based on the Small and Medium Sized Venture Business Nurturing Law enacted in 1986, eight Venture Business Investing Companies were established. Since then, 23 Venture Business Investing Companies being 43% of the total opened in 1990.

At the end of 1995, 53 venture capitals were officially registered, including 4 new technology assurance companies and 49 venture business investing companies. The new technology assurance companies which were established by both the government and 100 companies have tried to invest in small and medium sized companies which intend to commercialize their new technology.

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Table 5-2 | Developing Stages and Management Environment of Korean Venture Capital

	initialization(1974-1985)	First growth(1986-1995)
Number of venture capital	1-4	16-53
Level of venture Capital start-ups	Low	High
Economic environment	Rapid economic growth	Economic stagnation
Institutional environment	• government's recognition of the importance of technology • development of small and medium sized businesses	• enactment of small and medium sized business nurturing law(1986)

Source: Daewoo economic research institute, 1996. 7

Venture Capital Investment Company had been leveraged by the funds such as equity, investment, and loans, from both the Small and Medium Sized Industry Promotion Agency and the Venture Capital Union. The company provided financial aids to the venture businesses on the basis of equity or debt capital as shown in the following table.

Table 5-3 | Annual Investment of the Korean Venture Capital Investment co.

(unit: 100 million won)

Year		1987	1988	1989	1990	1991	1992	1993	1994	1995
# of investment company		17	23	30	52	53	54	52	51	49
Accumulation of investment	number	211	443	661	924	1,116	1,231	1,354	1,599	1,947
	convertible	215	131	661	248	1,169	465	1,924	774	2,399
	bond	1,214	2,647	1,514	2,798	2,034	3,132	3,889	3,762	6,873
	total	346	908	1,635	2,698	3,523	4,161	4,833	7,021	10,636

Source : The Korea Investment Company Association [Vencom]. 1996.1.

As other financial aid systems, there were government support and bank support. The government supports were mainly implemented by the Small and Medium Sized Business Promotion Agency, and this agency invests in or lends to the organization which supports small and medium sized business establishments. Then, this organization invests in the small and medium sized start-ups. In the case of municipal governments, they provided funds given by the central government with venture capital investment companies as a loan type.

Table 5-4 | Financial Support of Korean Small and Medium Sized Business Promotion Agency

(unit : million won)

	achievements	1995	1996
Loan to investing company	52 firms	9,900	13,000
Equity to investing co. group	10 groups	14,000	14,000
Consulting company support	567 cases	1,000	1,300
Loan to incubation center	4 centers	1,559	3,400
Supporting lectures for start-up	15 cases	-	200
Management support	-	300	300
Total		26,759	32,200

Source: Small and Medium Sized Business Promotion. 1996. 2

In addition, start-up funds are also provided by the banks including Small-Medium Industry Bank, Dongnam bank, Daedong Bank, and so on. Their interest rate was 12-13% per year as of September 1996.

Venture businesses in Daejeon city could get funds at a relatively low interest rate of 7% yearly at the cap of 700 million won for facility cost and 200 million won for the operation cost at the maximum rate until 5 years had passed after their establishing date. The total of 18 businesses had received financial support reaching 8,000 million won in 1996. And the facility renewing fund was provided to the small and medium sized businesses which have a plan to try to change their businesses to high value added businesses by factory automation, technology development, change of business type, cooperation with big company, and information-oriented development. When the researchers try to establish a firm, they can get a loan at the interest rate of 5% a year. The city of Daejeon supported 101 companies with 29,200 million won financially in 1996.

Business settlement funds were provided to the small and medium sized business to be able to make their business management stable by small amounts of money. The financial support cannot exceed 200 million won at the interest rate of 7.5% per year, but in case of researcher's start-up, at the annual interest rate of 5.5%. A total of 35.2 billion won as business settlement funds were provided to the 423 companies in 1996. And the Daejeon City Credit Assurance Union was established on April 1997 for enhancing mortgage and funding capacity of small and medium sized business with 21.2 billion won.

3. Entrepreneurships of Technology Start-ups

In order to recognize entrepreneurship and technology start-up needs in Daeduck Science Town, this chapter uses the study which had surveyed 102 professors of both the college of engineers and the college of natural sciences and 151 graduate students of a college of engineers who had relatively high possibilities for their venture start-ups in Chung-Nam National University(CNU). The survey was administered in June of 1996.

① Start-up Needs and Their Technology Fields

Even till then, it was unusual for professors, researchers, and graduates to open their venture business based on high technology in Korea. In this survey, approximately 85.3% professors and 58.3% graduate students have thought about their start-up businesses. Moreover, it showed that 36.3% of professors and 6% graduate students had thought about their venture businesses specifically.

Table 5-5 | Start-up Needs of Professors and Graduates of CNU

	Professor	Graduate
Thought Specifically	37 (36.3%)	9 (6.0%)
Thought Vaguely	50 (49.0%)	79 (52.3%)
Never Thought	13 (12.8%)	61 (40.4%)
N.A.	2 (2.0%)	2 (1.3%)
Total	102 (100.1%)	151 (100.0%)

If the circumstance permits, 52.9% of professors and 27.8% graduate students would like to establish their own businesses directly. There were remarkable venture business potentials because some professors possessed the specific technologies which they were able to link with the marketplace.

Observing the start-ups related ideas and technologies, 99% of professor and 94% of graduate students had those ideas and technologies. In the case of professors, the survey listed in particular order such as Machinery (19.6%), Electrical & Electronics (18.6%), Mechatronics (13.7%), New Materials (12.8%), Information Communication (12.8%), Metallurgical (7.8%), Environment (6.9%), Fine Chemical (2.9%), and Life (2.0%). There were many diversifications between professors and graduate students.

Table 5-6 | Start-up Idea of Professors and Graduates of CNU

	Professor	Graduate
Yes	54 (52.9%)	42 (27.8%)
Neutral	35 (34.3%)	65 (43.1%)
No	13 (12.8%)	44 (29.1%)
Total	102 (100.0%)	151 (100.0%)

Table 5-7 | Start-ups Related Ideas and Technology of Professors and Graduates of CNU

	Professor	Graduate
New Materials	13(12.8%)	50(33.1%)
Information Communication	13(12.8%)	20(13.2%)
Machinery	20(19.6%)	22(14.6%)
Electrical & Electronics	19(18.6%)	5(3.3%)
Environment	7(6.9%)	22(14.6%)
Fine Chemical	3(2.9%)	4(2.7%)
Life	2(2.0%)	3(2.0%)
Mechatronics	14(13.7%)	5(3.3%)
Metallurgical	8(7.8%)	3(2.0%)
others	2(2.0%)	8(5.3%)
N.A	1(1.0%)	9(6.0%)
Total	102(100.1%)	151(100.1%)

② Commercialization of Research Results

Investigation on commercialization of research results show that 12.8% of professors already had experiences with them. In additoin, the number of professors who had direct contact with the private corporations for commercialization of their research results amounted to 26.5%. However, in the case of graduate students, even they had comparatively many start-up related ideas and technologies for hatching venture businesses, but they had barely contacted the private corporations for commercialization of their research results.

Table 5-8 | Results of Commercialization of Professors and Graduates of CNU

	Professor	Graduate
Yes	13 (12.8%)	9 (6.0%)
No	75 (73.5%)	141 (93.4%)
N.A.	0 (0.0%)	1 (0.7%)
Total	102 (100.0%)	151 (100.1%)

Table 5-9 | Contact with Private Corporation for Commercialization of Professors and Graduates of CNU

	Professor	Graduate
Yes	27 (26.5%)	9 (6.0%)
No	75 (73.5%)	141 (93.4%)
N.A.	0 (0.0%)	1 (0.7%)
Total	102 (100.0%)	151 (100.1%)

③ Start-ups' Potential Capital Sources

When professors wanted to establish their own businesses, the most considered capital sources were funds from start-up related supporting systems (45 persons, 83.3%). Following were loans from financial institutes (32 persons, 59.3%), their own money (25 persons, 46.3%), and debt capitals from their friends and relatives (5 persons, 14.8%). In the case of graduate students there were similar tendencies with the professors group such as funds from start-up related supporting systems (36 persons, 85.7%), their own money (18 persons, 42.9%), loans from financial institutes (17 persons, 40.5%), and debt capitals from their relatives or friends (7 persons, 16.7%).

Table 5-10 | Potential Start-ups' Capital Sources of Professors and Graduates of CNU

	Professor	Graduate
Start-up related supporting systems	45(83.3%)	36(85.7%)
Own Money	25(46.3%)	18(42.9%)
Friends or Relatives	8(14.8%)	7(16.7%)
Financial Institutes	32(59.3%)	17(40.5%)
Total	54(100.0%)	42(100.0%)

④ Expected Difficulties and Supports Needed for Starting Business

The most difficult issue the professor had when trying to start their businesses were, as follows; funding capital (79.6%), lack of demand for products and marketing (75.9%), shortage of managerial know-how (75.9%), and complicated administrative procedures for opening businesses (50.5%). However, solution of technical problems (35.2%) and fear of failure (31.5%) were not considered to be the major difficulties in starting a business. The graduate students also have similar tendencies with professors; funding capital (73.8%), shortage of managerial know-how (61.9%), lack of demand for products and marketing (54.8%), and complicated administrative procedures for opening businesses (40.5%) were their expected difficulties much like the professors. Both solution of technical problems and fear to failure (21.4%) were relatively minor problems.

Table 5-11 | The Expected Difficulties in Starting Business of Professors and Graduates of CNU

	Professor	Graduate
Funding capital	43 (79.6%)	31 (73.8%)
Lack of demand for products and Marketing	41 (75.9%)	23 (54.8%)
Fear to failure	17 (31.5%)	9 (21.4%)
Shortage of managerial know-how	41 (75.9%)	26 (61.9%)
Complicated administrative procedure for opening businesses	27 (50.0%)	17 (40.5%)
Solution of technical problems	19 (32.2%)	14 (33.3%)
Total	54 (100.0%)	42 (100.0%)

When the professors tried to establish their venture businesses, the most their needed supports from community were capital supports (38.9%), administrative supports including simplifying the complicated procedure for start-ups (35.2%), and Information support (20.4%), managerial support (16.7%), and equipment support (14.8%). The last needed was technical support (11.1%). For graduate students, they showed a slightly different opinion as compared with the professors.

⑤ Opinions for Start-up Promotion

The professors felt the effective way for start-up promotion was the joint researches between start-ups and the research institutes at Chungnam National University (66.9%), legal permission of venture start-ups for students and professors (62.5%), the use of revolving fund collected by governments or university (59.4%), and the use of university equipments. Also, there were

Table 5-12 | Supports Needed for Starting Business of Professors and Graduates of CNU

	Professor	Graduate
Capital support	21 (38.9%)	18 (42.9%)
Managerial support	9 (16.7%)	4 (9.5%)
Technical support	6 (11.1%)	9 (21.4%)
Information support	11 (20.4%)	8 (19.1%)
Administrative support including simplifying the complicated procedure for start-ups	19 (35.2%)	7 (16.7%)
Equipment support	8 (14.8%)	3 (7.1%)
Total	54 (100.0%)	42 (100.0%)

Table 5-13 | Promotion Programs for Venture Start-ups of Professors and Graduates of CNU

	Professor	Graduate
Use of university equipments	25(46.3%)	23(54.8%)
Joint researches between start-ups and the research institutes at CNU	38(70.4%)	26(61.9%)
Legal permission of venture start-ups for students and professors	32(59.3%)	28(66.7%)
Guarantee of return in the case of failure	22(40.7%)	13(31.0%)
Lectures for start-ups	25(46.3%)	17(31.5%)
Fostering start-up climate	16(38.1%)	11(26.2%)
Active introduction of success and failure start-up cases	21(38.9%)	16(38.1%)
Use of revolving fund collected by Governments or University	32(59.3%)	25(59.5%)
Total	54(100.0%)	42(100.0%)

some other promotion programs which had to be considered even if it were not up to the majority. For example, lectures for start-ups (42.7%), active introduction of success and failure start-up cases (38.5%), guarantee of return in the case of failure (36.5%), etc. Generally there were not many differences between professors and students about the opinion for venture promotion programs.

4. Technology Commercialization and Business Promotion during Government's Active Drive for Venture Businesses

In order to accelerate the venture start-up, the Korean government used "Venture Business Verification System" after the Korean economic crisis in 1997. Once an enterprise is verified as a venture business, it shall be given many incentives and supports from the central government. At local level, Daejeon metropolitan city have also developed a lot of supporting projects, such as building one-stop small and medium sized business support service center and technology business incubator (refer to Annex). So the definition of venture business is highly rigid in Korea.

Venture business is defined and described differently from country to country. For example, the United States emphasizes the use of terms like High Technology Small Firm (HTSF) or New Technology Based Firm (NTBF) as venture business while Japan legally recognizes venture business as a firm that invests more than 3% of total sales in Research and Development (R&D). In general, venture business can be defined as a start-up business that a small number of entrepreneurs establish based on core competences and/or high technologies to gain high returns despite high risk. According to KIET (Korea Institute of Economy and Technology) report (1998), the Korean regulations on venture businesses state that the firm is a venture business if the firm invests more than 5% of total sales into R&D, or if sales made by patent and utility model are greater than 50% of total sales, or if venture capital is greater than 20% of stockholders equity, or if stocks undertaken by venture capital are more than 10 % of stockholders equity.

4.1. Technology Commercialization in Daeduck Technopolis

This chapter explores the research, which was done with the survey results of 118 venture businesses in Daejeon and 78 ones in Silicon Gultch, to apprehend technology commercialization in Daeduck Technopolis. Silicon Gultch includes three cities; Austin, Dallas and Houston in the United States. In the year of 2001 when 121 Daejeon and 203 Silicon Gultch target samples were designated, 118 out of 121 questionnaires administered in Daejeon and 78 questionnaires out of 203 administered in United States were returned.

① The Characteristics of Venture Businesses

The most popular venture business choices in Daeduck Technopolis were turned out to be as follows: high technology industries including Software and Telecommnunication (35.6%), Bio-

Medical (9.3%), Computers (17.0%), and Semi-conductors (10.2%) , and Computers (44.9%) and Software and Telecommunication (29.5%) in Silicon Gultch according to <Table 5-14>. Showing much similarity with other researches that spin-offs are the dominant sources of venture business start-ups, most of new venture start-ups in two regions seem to be related with previous business and technology experiences (92.7% and 87.1%) (IC©˜ Institute, 1990; Smilor and Gibson 1989; Kang 2007).

Table 5-14 | Characteristics of Venture Businesses

Demography		Daeduck	Silicon Gultch.
		N = 118	N = 78
Industry	Semi-conductor	12 (10.2%)	2 (2.6%)
	Computers	20 (17.0%)	35 (44.9%)
	SW/Telecom	42 (35.6%)	23 (29.5%)
	Bio-Med	11 (9.3%)	7 (9.0%)
	Others	33 (28.0%)	11 (14.1%)
Association with Previous Experience	Same Industry	37 (34.0%)	23 (29.9%)
	Very close	40 (36.7%)	23 (29.9%)
	Related	24 (22.0%)	21 (27.3%)
	Not related	8 (11.3%)	10 (13.0%)
Venture Type	Production Innovation	49 (41.5%)	24 (30.8%)
	Technology	51 (43.2%)	35 (41.7%)
	Commercialization Other	18 (15.3%)	19 (24.4%)

② Characteristics of Entrepreneurs

According to <Table 5-15>, the dominant age group for venture start-ups in Korea are in order of thirties (52.2%), twenties (23.5%) and forties (24.3%) in comparison to the United States, as twenties (32.1%) and over 45 (35.9%) are the dominant groups.

The Korean entrepreneurs are much different as 16.2% of Ph.D.s, 32.1% of Masters and 16.7% of Bachelors degrees from the U.S. entrepreneurs' 44.9%, 32.1% and 16.7% respectively. While the U.S. entrepreneurs from the sample show balance distribution in majors, the majority of the Korean sample majored in Natural Science or Engineering (82.1%). While most of the Korean entrepreneurs worked in R&D (54.8%) and technical (15.7%) fields before being engaged in venture start-ups, the U.S. entrepreneurs had backgrounds of sales (34.6%) and technical (24.4%). Although many Korean entrepreneurs came from research institutes

(42.6%) and educational institutions (13.9%), one third of venture start-ups were spin-offs from the private sector. In comparison, more than half of the U.S. entrepreneurs were from the private sector (56.4%).

Table 5-15 | Characteristics of Entrepreneurs

Characteristics		Daeduck	Silicon Gultch
Age At Start-up	Under 25	1 (0.9%)	1 (1.3%)
	26~30	26 (22.6%)	24 (30.8%)
	31~35	30 (26.1%)	12 (15.4%)
	36~40	30 (26.1%)	7 (9.0%)
	41~45	23 (20.0%)	6 (7.7%)
	Over 45	5 (4.3%)	28 (35.9%)
Education	HS	2 (1.7%)	5 (6.4%)
	Bachelor	60 (51.3%)	13 (16.7%)
	Master	36 (30.8%)	25 (32.1%)
	Ph.D.	19 (16.2%)	35 (44.9%)
Major	Liberal Arts & Social Sciences	11 (9.4%)	15 (20.6%)
	Natural Science & Engineering	96 (82.1%)	30 (41.1%)
	Others	10 (8.5%)	28 (38.3%)
Previous Expertise	R&D	63 (54.8%)	9 (11.5%)
	Technical	18 (15.7%)	12 (15.4%)
	Students	12 (10.4%)	2 (2.6%)
	Clerical	5 (4.4%)	19 (24.4%)
	Sales	6 (5.2%)	27 (34.6%)
	Others	11 (9.6%)	9 (11.5%)
Previous Institution	Education	16 (13.9%)	1 (1.3%)
	Private	37 (32.2%)	44 (56.4%)
	Public	5 (4.4%)	5 (16.4%)
	Research Institute	49 (42.6%)	10 (12.8%)
	Other	8 (7.0%)	18 (23.1%)

③ Influence Factors on Start-Up

To the question of how much each factor influenced their decision for a venture start-up in the survey, the Korean entrepreneurs of Daeduck Technopolis rated Business Plan as the most influencing success factor, followed by Strong Entrepreneurship and Leadership, Technical

Expertise, Management Capacity, and Business Location (Table 5-16). Well known as the distinguished features of science parks and incubators, which are Financial Support from Venture Capital and Business Angels, Global Networking for Information Sharing, Leadership, Networking with Local Business, Support from Universities and Research Institutes, surprisingly turn out to have the least influence on venture start-ups. The result shows that the ability of the Korean entrepreneurs' themselves and their technologies are the key factors in successful venture start-ups, not the functions and features of science parks and incubators.

Table 5-16 | Top 5 Influential Factors on Start-up

	Daeduck	Silicon Gultch
Top 5	1. Business Plans 2. Strong Entrepreneurship 3. Technical Expertise 4. Management Capacity 5. Business Location	1. Technical Expertise 2. Leadership 3. Business Plans 4. Management Capacity 5. Strong Entrepreneurship
Bottom 5	14. Support from Univ.& Research Institutes 15. Networking with Local Business 16. Leadership 17. Global Networking for Information Sharing 18. Financial Support	14. Business Location 15. Admin & Fin Services 16. Low Cost Space 17. Marketing Capability 18. Utility Services by Incubator

The sign of entrepreneurs seeks independence and self-sustaining routes to start-up instead of the government or other types of support could be interpreted positive. All of the strong government supports and policies, favorable support from financial institutions, and popularity of venture businesses cause uncertainty of true intents in venture businesses. In other words, some entrepreneurs are suspicious that they may take chances to elicit finance and support (Suh, 1997; Lee, 1997).

Another surprise shown in Table 5-16 is that all of Shared Services, Management Services, Low Cost Space offer, and Administration and Financial Services are used to be distinguished features of science parks and incubators, but not much effective for the start-ups. Instead, Technical Expertise is the most influencing factor and the rest in the order of Leadership, Business Plans, Management Capacity, and Strong Entrepreneurship and Leadership according the evaluation of U.S. entrepreneurs. Leadership is the only one success factor related with incubator, and considered significant by the U.S. entrepreneurs.

④ Contributions Factors on Growth

The question of how much each factor actually contributed to the growth of their venture businesses is vital because it deals with actual contributions of the factors on firm growth in parallel with previous section dealt with the influence of factors for start-up.

"Business Plans" were picked out as the most contributing success factor to venture growth for entrepreneurs in Daeduk Valley. In comparison, "Strong Entrepreneurship," "Technical Expertise," "Low Cost Space," and "Management Capacity," "Financial Support from Venture Capital and Business Angels," "Leadership," "Market Conditions," "Global Networking for Information Sharing," and "Networking with Local Business" were evaluated as the least contributing success factors.

Table 5-17 | Top 5 Contribution Factors on Growth

	Daeduck	Silicon Gultch
Top 5	1. Business Plans 2. Strong Entrepreneurship 3. Technical Expertise 4. Low Cost Space 5. Management Capacity	1. Technical Expertise 2. Leadership 3. Market Conditions 4. Management Capacity 5. Financial Support
Bottom 5	14. Networking with Local Businesses 15. Global Networking for Information Sharing 16. Market Conditions 17. Leadership 18. Financial Support	14. Support from Public Sector 15. Utility Services 16. Business Location 17. Low Cost Space 18. Marketing Capability

The fact that the entrepreneurs look for outside help to accelerate the growth of the venture after establishment of venture businesses with their own resources like good business plans, strong entrepreneurship, management capacity, technical expertise could be interpreted as unwholesome sign for venture business policy and strategy in Korea differenced from the influence of factors. Efforts that the Korean government betting enormous amount of tax money into venture capital and building science parks and incubators are not paid off but provide low cost space only. It shows that incubator is not suited to R&D innovation and technology commercialization.

⑤ Expectations vs. Satisfaction

Another question the entrepreneurs were asked was about the levels of their expectations regarding the functions and services of incubators. Table 5-18 informs that entrepreneurs do not have much expectation from Secretarial (Secretary Services, Customer Guidance, Telephone Answering, and Word Processing). It, instead, indicates that what we labeled as Additional (Health and Fringe Benefits, Relocation Consulting, Audio and Video Equipment, Dining Room, Library Facility, and Leadership) and Financial (Loan Assistance, Financial Loan, and Tax Benefits) are the most expected functions. It overall suggests that the entrepreneurs expect incubators to provide more value-added services in exchange of routine, secretarial services and future incubation policy.

Since the prior section deals with expectations of incubators, another important question asked to entrepreneurs with this section dealing with actual satisfaction with the functions and services of incubators, is how much they were satisfied with the functions and services provided by incubators.

Additional (Health and Fringe Benefits, Relocation Consulting, Audio and Video Equipment, Dining Room, Library Facility and Leadership) and Basic (Low Cost Space, Good transportation & Easy Access, Loading and Unloading Dock, Postal Service, Conference Room Facility, Security Services, Warehousing, and Office Furniture Rental) services are the most satisfied categories by the entrepreneurs and Financial (Loan Assistance, Financial Loan, and Tax Benefit) is the least according to table 5-18. However, the most surprised finding is that the entrepreneurs think financial services are in most need and future incubation policy should take this into consideration while they were not happy with incubator functions and services (from 2.11 to 2.77 on the 5-point Likert scale). Some experts advised government financial policies on venture businesses that they are not successful and in need of policy-making process to be more effective.

In accordance with Table 5-18, an answer of final conclusion is that entrepreneurs expected much and were not ever satisfied to the question of whether there were any differences between expectation and satisfaction of entrepreneurs on the functions and services of incubators. Except for Secretarial (Secretary Services, Customer Guidance, Telephone Answering, and Word Processing) functions, the differences were statistically significant. The differences were big enough to conclude that government policy on incubation is not effective, nonetheless the tendency that entrepreneurs might expect much. Significant differences between expectations and satisfaction on Basic and Administrative functions and services, which are the core functions and services, pose very significant concerns regarding the existence of incubators themselves, while Additional and Financial functions and services could be considered as extras. The result demonstrates that the government needs drastic changes in policy regarding functions, services, and operations of incubators in Korea.

Table 5-18 | Expectations vs. Satisfaction

Factors	All		
	Expect	Satisfy	t-value
Basic	3.0008	2.6271	4.29***
Administrative	3.0849	2.3465	7.12***
Secretarial	2.6607	2.5437	1.00
Additional	3.5079	2.7696	6.74***
Financial	3.4985	2.1111	8.64***

* denotes statically significant at the level of alpha = 0.10
** denotes statically significant at the level of alpha = 0.05
*** denotes statically significant at the level of alpha = 0.01

5. Performance of Venture Businesses and Business Incubators in Daeduck Technopolis: 10 Years after Government's Active Drive

The incubators are a means for talented people to establish new businesses. The urgency for supporting technology-based small and medium sized venture businesses became enhanced during the Korean economic crisis in 1997 and since that time, the number of business incubators in Korea has increased rapidly. While there were only twelve business incubators authorized by the Small and Medium Sized Business Administration by 1997, as of 2008, there are about 400 business incubators in Korea. The growth in the number of incubators in Korea can be seen in Table 5-19 below.

Table 5-19 | Incubators in Korea

Year	Number of Incubators
1997	12
1998	18
1999	112
2000	230
2001	250
2002	260
2008	400

Source: The City of Daejeon, 2009.

Twenty business incubators were built and operated in Daejeon too. The business incubators have been trying to start and promote technology and knowledge intensive business ventures through the technology commercialization of research and development results of the universities and the research institutes of Daeduck Technopolis.

To collect the necessary data, three types of surveys were distributed. The three main constituencies were surveyed, incubator managers, current tenant companies, and graduate companies. The questionnaires were administered from October 2005 to January 2006. Seventeen managers of business incubators, ninety-four tenant companies and thirty-six graduate companies responded; the corresponding response rates were 85.0%, 58.8%, 63.2% respectively.

5.1. Characteristics of Entrepreneurs, Business ventures, and Incubator Managers

Table 5-20 shows that the dominant age group for incubator managers is the 50s (43.8%), followed by the 40s (37.5%). Only 6.3% of incubator managers are under 39 or younger. Incubator managers in Daeduck Techpolis generally have a high level of education as 68.8% have Ph.D.s, 25.0% have Master's degrees, and 6.3% have Bachelor's degrees as their highest level of education. The majority of the incubator managers in the sample majored in Engineering (62.5%), followed by Social Science and Liberal Arts (25.0%). Prior to their participation in incubator management, most of the managers were engaged in public sector positions (37.5%) and research institutes (31.3%), including private research institutes. Sizeable proportions of incubator managers are full-time and part-time, but in this study, a slight majority is part-time. These results indicate that most incubator managers are high technology oriented and the managers have knowledge in specific high technology areas. However, they may not be well-suited for dealing with the issues of venture start-ups and technology commercialization because they do not have much experience and knowledge in these areas. The majority of the managers were previously in institutions in the public sector and research institutes, over half work part-time in the incubator, and most have majored in Engineering. This result confirms that they do not have much knowledge in the areas of technology commercialization and business management which are essential for operating a business incubator and hatching and nurturing business ventures.

As summarized in Table 5-20, the age distribution of owners of tenant companies are as follows: 30s (46.3%), 40s (36.3%), and 50s (12.5%). The distribution of graduate company owners showed a similar trend as tenants: 30s (46.9%), 40s (28.1%), and 50s (6.3%). However, these results are significantly different from the analysis taken in the year 2000 (Kang, 2003). Although a few start-up companies in 2000 were established by founders in their 50s, at that time older people were more conservative in taking career risks in Korea. But, the more recent survey reflects an increase by 13.8% of workers in this age group founding companies as early retirement ameliorated this risk. On the other hand, the number of start-ups run by those in their 20s decreased because many of the companies identified as being run by those in the 20s in 2000 have since failed.

The highest level of academic completion of graduate company founders is as follows: 40.6% have bachelor degrees, 34.4% have master degrees, and 18.8% have Ph.Ds. For tenant company founders, the distribution was 21.3% (bachelor), 35.0% (masters) and 42.5% (Ph.D.). One noteworthy element of this data is that the percentage of start-up founders with Ph.Ds is much higher for tenant companies than for graduate companies. One remarkable thing is a phenomenon created by entrepreneurs with Ph.Ds which is unusually high.

In the sample, 78.1% of entrepreneurs from graduate companies majored in Engineering which is far in excess of any other major. For tenant companies, 56.3% have Engineering majors and 30.0% have Natural Science majors. Noteworthy in this result is that Natural Science graduates are increasingly interested in starting technology companies. This outcome is based on the increasing societal interest in biotechnology.

Prior to their current position in their venture start-ups, 50.0% and 38.8% of tenant company founders came from private corporations and research institutes, respectively, while 37.5% and 40.6% of graduate company founders came from private corporations and research institutes. This result could indicate that spin-offs from private companies are increasing at a more rapid rate than companies being created from research institutes. Alternatively, the result could indicate that the failure rate of start-ups from research institutes is much higher than start-ups spun off from private companies.

The industries that graduate companies are engaged in are indicated from the greatest to the least: software/communication (43.8%), computer and semiconductor (15.6%), and mechanical engineering (15.6%). On the other hand, the profile of tenant company start-ups is: software/communication (31.3%), biotechnology/medicine (17.5%), mechanic engineering (12.5%), chemistry (10.0%), environment (8.8%), computer and semiconductor (7.5%), and so forth.

The data on annual sales indicates that graduate companies are further along their growth path: 71.8% of graduate companies have exceeded the $500,000 annual sales mark while only 34.7% of tenant companies have reached that threshold.

To observe the difference between tenants and graduates, chi-square analysis was performed. No statistically significant difference was found between the two groups except for major and annual sales at the significant level of 0.05.

Table 5-20 | Characteristics of Entrepreneurs, Business ventures, and Managers in Daejeon Incubators

Characteristics		Manager	Tenant	Graduate
Age at Start-up	20~29	1 (6.3%)	3 (3.7%)	6 (18.8%)
	30~39	0 (0.0%)	37 (45.7%)	15 (46.9%)
	40~49	6 (37.5%)	30 (37.0%)	9 (28.1%)
	50~59	7 (43.8%)	10 (12.3%)	2 (6.3%)
	Over 60	2 (12.5%)	1 (1.2%)	0 (0%)
Education	H.S.	0 (0.0%)	1 (1.2%)	2 (6.3%)
	Bachelor	1 (6.3%)	29 (35.8%)	13 (40.6%)
	Master	4 (25.0%)	17 (21.0%)	11 (34.4%)
	Ph.D.	11 (68.8%)	34 (42.0%)	6 (18.8%)
Major	Liberal Arts & Social Science	4 (25.0%)	5 (6.2%)	3 (9.4%)
	Natural Science	2 (12.5%)	24 (29.6%)	1 (3.1%)
	Engineering	10 (62.5%)	45 (55.6%)	25 (78.1%)
	Arts	0 (0.0%)	1 (1.2%)	1 (3.1%)
	Others	0 (0.0%)	6 (7.4%)	2 (6.3%)
Previous Institution	University	3 (18.8%)	3 (3.7%)	1 (3.1%)
	Private Company	2 (12.5%)	41 (50.6%)	12 (37.5%)
	Public Sector	6 (37.5%)	3 (3.7%)	1 (3.1%)
	Public & Private Research Institute	5 (31.3%)	31 (38.3%)	13 (40.6%)
	Other	0 (0.0%)	3 (3.7%)	5 (15.6%)
Position	Full-time	7 (43.8%)		
	Part-time	9 (56.3%)		
Industry	Computer/Semi-conductor		6(7.5%)	5(15.6%)
	Software/Telecom		25(31.3%)	14(43.8%)
	Bio-Med		14(17.5%)	1(3.1%)
	Material-Nanotechnology		5(6.3%)	2(6.3%)
	Mechanical Engineering		10(12.5%)	5(15.6%)
	Chemistry		8(10.0%)	0(0.0%)
	Environment		7(8.8%)	2(6.3%)
	Other		5(6.3%)	3(9.4%)
Annual Sales	Less than 0.1M$		24 (29.6%)	2 (6.3%)
	0.1 ~ 0.5M$		28 (34.6%)	7 (21.9%)
	0.5 ~ 1M$		16 (19.8%)	8 (25.0%)
	1.1 ~ 2M$		5 (6.2%)	6 (18.8%)
	2.1 ~ 5M$		5 (6.2%)	8 (25.0%)
	5.1 ~ 10M$		2 (2.5%)	0 (0.0%)
	Other		1 (1.2%)	1 (3.1%)

* Chi-square analysis is performed only between tenants and graduates.

5.2. Performance of Business Incubators in Daeduck Technopolis

① Contribution of Venture Businesses to Local Economy and Their Failure

The direct contribution by business incubators to Daejeon's local economy can be measured by the number of venture start-ups, jobs created, the influx of currency, the increase in local tax revenue, and so forth. As seen in Table 5-21, business ventures in Daejeon metropolitan city had hired 400 employees in 1995, a number that increased to 22,500 in 2004. The inflow of foreign currency by venture businesses has increased from 31 million USD in 2000 to 122million USD in 2004. While the average number of employees per business venture has been increased from 17 in 2000 to 27 in 2004, these businesses have not grown sufficiently to emerge from the small-and-medium sized business category. Moreover, the business incubators in Daeduk Technopolis had started and nurtured a total of 703 business ventures including both graduates and tenants, which make 85% of the total business ventures in Daejeon metropolitan city.

Table 5-21 | Business Venture in Daejeon

Parameter	1995	1998	2000	2001	2002	2003	2004
Number	40	250	500	776	811	814	824
Total Employees	400	-	8,500	16,296	19,800	22,300	22,500
Average Number of Employees	10	-	17	21	24	27	27
Total Amount Exported ($)	-	-	31M	36M	72M	83M	122M

Source: The City of Daejeon, 2005.

Since the KAIST technology business incubator was established in 1994, 20 of Daeduck's business incubators, including Chungnam National University's business incubator, have already graduated 327 business ventures through 2005. Moreover, as of 2005, 376 tenant companies have emerged and are doing business in 467 incubator rooms in 20 business incubators. The business incubators in Daeduck Technopolis started and nurtured a total of 703 business ventures including both graduates and tenants, which make up 85% of the total business ventures in Daejeon City.

On average, the survey revealed that each tenant company paid $29,050 in national (federal) taxes and $4,270 in local taxes while each graduate company paid $36,660 in national tax and $2,160 in local taxes in 2005. Each tenant and graduate company paid $3,650 in taxes to

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Daejeon as a local tax each year (Table 5-22). Beyond the direct tax impact, these ventures support the regional economy through their purchases from other local firms and the growth of related industries in the region to support them.

Table 5-22 | Tax Payment of Business Ventures in Daejeon

(Unit: USD)

All	Tenant			Graduate		
	National Tax	Local Tax	N of Businesses	National Tax	Local Tax	N of Businesses
Total	139,453	20,490	48	73,320	4,320	20
Average	2,905	427		3,666	216	

While there are many start-ups using R&D innovations from universities and research institutes, their success rate is quite low which means that the business incubator must use special caution when commercializing the research of university and research institutions. This outcome is very consistent with the findings of characteristics of entrepreneurs. The failure rate of start-ups founded by entrepreneurs with Ph.Ds is unusually high compared with entrepreneurs with lower levels of education. Further, the failure rate of start- ups from research institutes is high when compared with venture startups from private companies.

The failure rate of business ventures created in a business incubator is shown in <Table 5-23> to be 13.3% which means that there is an 86.7% survival rate and a high success rate for start-ups in the business incubator. The survival rate is high compared with other research results for incubators including a 67% survival rate in Washington (Allen, 1985) and a 86% survival rate in Minnesota (Campbell, 1988). However, a serious concern is that most of the turnovers are start-ups using research from university and research institutes. In addition, the major reasons for failure were "financial problem," "marketing problem," and others were "business plan," and "mistake on evaluation of market potential of product." These causes of failure are the very areas that an incubator should be able to support its tenants. The inability of the incubator to steer these companies away from these failures may be due to the small size of the typical incubator staff and could be related to the manager's lack of understanding and knowledge of commercialization of research. The likelihood of the incubator manager being inadequately familiar with the science of commercialization can be assessed by looking at the education specialty of the incubator managers. 75% of managers in business incubators majored in either engineering or natural science. A more desirable skill set would be a major in business or having a demonstrated talent and ability for technology commercialization and management. Further, there are no institutions in Daejeon for people to be properly educated in technology commercialization, so in all likelihood, this trend will continue.

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Table 5-23 | Tenant's Turnover Reasons in Dajeon Business Incubators

Reasons	Frequency
Financial Problem	9 (28.1%)
Marketing	9 (28.1%)
Business Plan (Management Problem)	5 (15.6%)
Mistake on Evaluation of Market Potential of Product	5 (15.6%)
Technological Competitiveness of Product	3 (9.4%)
Personal Problem (Accident or Health Problem)	1 (3.1%)
Total	32 ((99.9%)

A major reason for tenant failure has been proven to be attributable to the lack of know-hows regarding technology commercialization. <Table 5-24> lists the functions that start-ups need to be provided for incubators to truly provide technology commercialization support. <Table 5-24> also provides a value rating of every function of technology commercialization as surveys by tenant companies, graduate companies and incubator managers.

Tenant companies attached the greatest value to: "linking service with government support system," (4.30) "workforce, education, and research networking of technology commercialization," (4.01) "feasibility analysis of technology commercialization," (3.85) and "technology marketing." (3.83) All functions are valued at some level though no function is rated below 3.5. However, graduate companies indicated a neutral value towards all of the services except "workforce, education, and research networking of technology commercialization." (3.47)

The reason for this disparity of opinion is because while tenant companies focus their attention on the production of a prototype, graduate companies focus on mass production and the dissemination and sale of their products. Graduate companies are in the rapid growth stage that occurs after start-up. During this period of business development, domestic and international networking is necessary for hiring a talented workforce, transferring technology and diversifying transactions. Graduate companies may not recognize the importance of global networking to the same degree as tenant companies do, but many will later realize that information on global markets and information sharing through a global network, will be essential to the growth of their businesses. The most important result from this analysis is the comparative values towards technology commercialization services to that of services which are already provided in incubators. Clearly, the importance of technology commercialization services that are not provided, are more valued than those services which are currently provided. Incubator managers are not aware of the value of such commercialization services despite the fact that these services are seriously required.

The managers of business incubators rated "feasibility analysis of technology commercialization," (4.50) "linking service with government support system," (4.44) and "technology marketing," (4.38) although most functions of technology commercialization surveyed to be helpful. The reason that these issues scored so highly is that the managers have a broader interest in the overall nurturing of all businesses and see the importance of technology commercialization, tenant management, and government support.

Table 5-24 | Need for Technology Commercialization Functions in Dajeon Busines Incubators

Technology Commercialization Functions	Tenant	Graduate	All	Manager
Finding and Evaluation of Technology	3.75	3.03	3.54	4.31
Venture Planning	3.59	3.00	3.42	3.81
Technology Marketing	3.83	3.19	3.64	4.38
Linking Service with Government Support System	4.30	3.25	4.00	4.44
Linking Service with Venture Capital	3.80	3.28	3.65	4.06
Technology Transfer Analysis	3.67	2.94	3.46	4.13
Workforce, Education, and Research Networking of Technology Commercialization Including International Networking	4.01	3.47	3.86	4.31
Technology Commercialization Scheduling service	3.58	3.06	3.43	4.13
Analysis on Competitiveness of Company in Market	3.78	3.09	3.58	4.06
Logistics of Products	3.51	3.16	3.41	3.50
Feasibility Analysis of Technology Commercialization	3.85	3.22	3.67	4.50

② Establishing Roots and Networks within the Community of Business Ventures

Once the business venture in business incubator achieves significant growth and is viably able to sustain itself, it moves or graduates into the greater community for expansion and greater growth potential (NBIA, 2003). It retains contact in the local community because this is where technological connection with university relationships and business connection with customer, supplier, and consultant relationship were created. It is important to maintain these relationships because the relationships assist the business in continuing to thrive and develop (Studdard 2004; Ahuja, 2000).

The development of business incubators for creating and growing business ventures is an endogenous regional economic development strategy. The business ventures being created and taking root in Daejeon contribute, not only to local regional business development, but have also become a performance metric for the business incubator. The number of ventures staying in Daejeon and taking root in the community will increase as their linking and networking with the local industry and community is more closely interconnected. The region where graduates business ventures take root breaks out as follows: 57.9% in Daejeon, 21.9% in the capital area, 12.6% in non-capital area excluding Daejeon, and 7.6% in Chungcheong area. This retention rate is quite low when compared to a similar region in the U.S which is about 70% (Lyons and Kang, 1990).

<Table 5-25> shows the reasons for a venture start-up to take root in Daejeon. The reasons that business ventures locate in Daejeon do vary between tenants and graduates. Tenant companies rated the different reasons in the following order of importance: “existence of research institute and university,” (36.5%) “business venture support policy of local government,” (17.6%) “convenience of transportation,” (15.5%) “low cost land,” (10.8%) and “existence of research institute and university” whereas for graduate companies the following order of importance emerged: (21.4%), “low cost land,” (17.9%) “convenience of transportation,” (16.1%) and “concentration of related industries.” (14.3)

Tenant companies tend to locate closer to universities and research institutes so as to be close to the research that there are commercializing. At the earliest stages of business development, such a locational strategy is reasonable. Such companies also value convenient transportation, low cost land and affordable housing. Local governments developing a support policy for such companies must consider these issues. In contrast, graduate companies have a higher sales rate and utilize more information so they must choose a location which will facilitate their move into the competitive marketplace. In addition, the graduate companies no longer have the great protection of the incubator. Graduate companies have responded that they believe the support policies for business ventures by the city of Daejeon are relatively weak. These companies prefer a more favorable consumer market and seek a place which has a greater concentration of companies in related industries. Therefore, they leave Daejeon. The graduates, which do have a need to receive technology and support services from a university or research institute, will prefer the access to low cost land and convenient transportation and will be inclined to take root in Daejeon. The proximity of the universities and the research institutes while very attractive to most tenant companies is not so appealing to most graduate companies. This fact is illustrated the best by the surveys where tenant companies selected “business venture support policy of local government” as second and graduates selected it as last seventh. The consequence is that the business venture support policies of the city of Daejeon are unattractive for graduate companies.

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Table 5-25 | Location Factors of Business Ventures in Dajeon

(Unit: %)

Location factors	Tenant	Graduate	Linear	Non-Linear
Research Institute and University	54 (36.5)	12 (21.4)	23 (26.4)	22 (23.7)
Convenience of Transportation	23 (15.5)	9 (16.1)	17 (19.5)	18 (19.4)
Business Venture Support Policy of Local Government	26 (17.6)	4 (7.1)	11 (12.6)	14 (15.1)
Low Cost Land	16 (10.8)	10 (17.9)	12 (13.8)	8 (8.6)
Concentration of Related Industries	14 (9.5)	8 (14.3)	11 (12.6)	11 (11.8)
Proximity to Favorable Consumer Market	13 (8.8)	6 (10.7)	9 (10.3)	13 (14.0)
Others	2 (1.4)	7 (12.5)	4 (4.6)	7 (7.5)
Total	148(100.0)	56(100.0)	87(100.0)	93(100.0)

The understanding of the interrelation of tenants and graduates within a region's industry is an important clue to recognizing their decision to take root in Daejeon. As seen in <Table 5-26>, tenant companies are selling their products and services mostly to the capital area (32.8%), Daejeon (21.3%), and the non-capital area except Chungcheong area (21.2%). They buy product inputs from the capital area (35.6%) and Daejeon (33.7%), and obtain the information mostly from Daejeon (39.4%) and the capital area (32.3%). On the other hand, the graduate companies sell to Daejeon (38.3%) and the capital area (36.2%), and buy from the capital area (51.1%) and Daejeon (40.0%), and obtain the information mostly from Daejeon (44.4%) and the capital area (44.4%).

In summarizing these results, tenant companies are more diversified as to the regions to where they sell and from where they buy and get information than graduate companies. When

Table 5-26 | Interrelation between Venture Businesses in Dajeon and Industry

(Unit: %)

Region	Daejeon		Chungcheong Area Except Daejeon		Capital Area		Non-Capital Area Except Chungcheong Area		Overseas		All	
	Tenant	Graduate	Tenant	raduate	Tenant	Graduate	Tenant	Graduate	Tenant	Graduate	Tenant	raduate
Selling Region	29 (21.2)	18 (38.3)	20 (14.6)	5 (10.6)	45 (32.8)	17 (36.2)	29 (21.2)	4 (8.5)	14 (10.2)	3 (6.4)	137 (100)	47 (100)
Buying Region	34 (33.7)	18 (40.0)	4 (4.0)	2 (4.4)	36 (35.6)	23 (51.1)	16 (15.8)	2 (4.4)	11 (10.9)	0 (0.0)	101 (100)	45 (100)
Information Acquisition Region	39 (39.4)	20 (44.4)	8 (8.1)	2 (4.4)	32 (32.3)	20 (44.4)	9 (9.1)	2 (4.4)	11 (11.1)	1 (2.2)	99 (100)	45 (100)

the tenants graduate, they tend to concentrate on such activities within Daejeon and the capital area and are therefore, more tied to Daejeon than the tenant companies.

The degree of networking and the networking path of business ventures within their communities are not only a basis for the growth for start-ups, but this factor evaluates the degree with which ventures take root in the community. The analysis of the networking of venture start-ups within the community is critical because such ventures can be rapidly joined and rooted in the regional economy if business incubators provide them with the necessary networking services within the community that they are located.

As shown in <Table 5-27>, the degree of networking between business ventures and the community which includes universities, research institutes, chambers of commerce, industries, etc, was valued for the following by tenant companies: “finding and referring expert in the field of research and technology,” (3.55) “use of equipment,” (3.36) and “exchange of workforce and information.” (3.33) Graduate companies valued: “exchange of workforce and information,” (3.06) “finding and referring expert in the field of research and technology,” (2.94) and “joint research and development for new products.” (2.91)

The level of networking for graduate companies is overall lower than that of tenant companies. Their networking within the community is actually seriously low. Consequently, their commitment to the community is quite low and they feel free to move at any time to any place. They do not have any real preference for staying in Daejon. An incubator policy for the retention of business ventures in the community is very important.

Table 5-27 | Networking Between Business Ventures and Community in Dajeon

Networking	Tenant	Graduate	T Stat.	Prob.
Joint Research and Development for New Products	3.30	2.91	1.93	0.056
Technology Transfer for Improvement of Existed Production Process	3.11	2.75	2.12	0.036
Exchange of Workforce and Information	3.33	3.06	1.30	0.197
Use of Equipment	3.36	2.84	2.29	0.024
Utilizing Consultant	2.90	2.81	0.50	0.616
Finding and Referring Expert in the Field of Research and Technology	3.55	2.94	3.40	0.001

Observing tenant company and graduate company evaluations of the importance of the path of networking in order to utilize a community network, the response of the tenant company was in the order of “direct contact with university or research institute,” (3.90) “support of government or public institution," (3.78) and "referral of business incubator." (3.75) The response of the graduate company was "informal assembly using personal relationship," (3.31) "support of government or public institution," (3.31) and "direct contact with university or research institute." (2.97) (refer to <Table 5-28>)

In observing the network channels within the community used by start-up companies, tenant companies often prefer more formal routes while graduate companies prefer informal routes. One noteworthy result is that the networking effort of the Daejeon business incubator, which serves companies using the linear model, for retaining venture start-ups in the community, is suspect because of the low evaluation of available network paths by business ventures. Therefore, when a tenant company tried to take root in the community after graduation, the business incubator should not only provide continuous guidance and support for the network in existence while in the incubator but should also continuously build the network path within the community to develop it to a higher standard than currently.

Table 5-28 | Networking Path between Business Ventures and Community in Dajeon

Networking Path	Tenant	Graduate	T stat.	Prob.
Direct Contact with University or Research Institute	3.90	2.97	4.12	0.000
Support of Government or Public Institution	3.78	3.16	3.10	0.002
Informal Assembly Using Personal Relationship	3.69	3.31	1.91	0.058
Referral of Business Incubator	3.75	2.81	4.95	0.000

6. Lessons from Korea and Application to Turkey

6.1. The Importance of the Technology, Entrepreneurship, and Incubation

The world economy of the twenty-first century has been rapidly transitioning from the exchange of commodities and services to the exchange of merchandise and intellectual property based upon science and technology. Therefore, the economic role of the start-up company based upon technology is becoming more important than ever before. Consequently, the success of such start-ups effects regional development and can serve as an index of national competitiveness. However, a start-up, which commercializes the research results from a university or research institute, will be unable to succeed with just an idea and a technology. For a technology start-up to succeed, a good combination of ideas, technology, resources, funds, know-hows of business, and entrepreneurial talent are needed. In practice, very few founders of start-up companies have all of these characteristics. As a result, the business incubator was developed to play the role of complementing the founder team and filling the voids.

Ten years have passed since Korea had adopted the use of the business incubation as a policy tool. The concept and social value of the business incubator has changed over that time due to progressive changes in technology, business practice and society in general. The concept of the business incubator in the 1990s is no longer so applicable to this decade because the traditional and standardized incubator services of that time are not so helpful to tenants of the current day. Accordingly, the time has come to update the concept and the role of the business incubator so as to revitalize its capacity to provide better support to start-ups and to enhance the performance of the incubator itself.

6.2. Linear and Non-Linear Models

The original theories for incubator development were grounded in the linear model. The linear model begins with basic scientific research and evolves into applied and more developmental research followed by the development of a new product or process idea and then the evolution and testing of prototypes to commercial production and finally to diffusion through the market. The linear model is useful in pointing toward a relationship between long-term scientific research and its commercialization and this model continues to dominate much of science and technology policy-making (Massey, Quintas, and Wield, 1992).

Although, evidence indicates that the linear model is not functioning as advertised and is giving way to the non-linear model (Gibson, 1992; Kang 2003; Bakouros, et al., 2002). According to Massey, Quintas, and Wield (1992), there are five major critiques of the linear model. First, there is not just one process of innovation. Second, key basic research occurs not just at the initiation stage. Third, rather than just being used as the "eureka" beginning point of innovation, research results can be used, in one form or another, at all stages of the innovation process. Fourth, the relationship between basic research and commercialization is too complex to be understood as a linear relationship. Fifth, the linear model devalues the contributions of the people involved in innovation, especially users whose ideas and consequent changes of processes and products can be another starting point for new innovations

6.3. Policy Recommendations

6.3.1. Technology Commercialization and Business Promotion

In this paper, the infrastructure and support mechanism for technology commercialization in technopolis has been evaluated with particular reference to Daeduck Technopolis. The critical question is what can be learnt from the experiences of Daeduck Technopolis as to how technopark or technopolis in Turkey should develop in order to support the technology commercialization and business promotion and also to benefit the regional economy as well as the local industrial structure. There are several important findings from Daeduck Technopolis' experience which are important to the future development of local high-tech centers.

First, there is the role of a high-grade university, the location of a variety of research facilities, and the attractiveness of the area to highly-qualified workers and entrepreneurs as a place to live and work together. These are almost certainly essential background for the development of technopolis.

Second, there is the need to create business incubators and technological and financial support mechanism to maximize the opportunities for technology transfer between academic and research facilities and private firms. As seen in the survey, there is high potential for venture start-up in METU like Chungnam National University in Korea. The experience of Daeduck Technopolis showed how university-linked agencies could promote their development.

Third, there is the need for local government initiatives to reinforce technology?led economic development in Turkey. Their efforts should focus on hatching venture businesses, attracting high-tech industries and establishing promotional organizations using a wide array of incentives and institution building. The establishment of industrial parks (Daejeon Technopark) where R&D activities can be promoted and commercialized, makes sense in this respect.

Fourth, Daeduck Technopolis has shown that technological spin-offs and firm creation are of more importance than the relocation of basic research establishments to ensure successful regional economic development and local industrial progress. It also appears likely that policies to promote spin-offs and foster new firms will be a key element in the successful development of technopolis in other localities.

Although unique in several respects, these aspects of Korea's experiences may thus carry policy implications that will be of interest to the Turkish government who want to enhance country's indigenous technological potential.

Even the study indentified that technological spin-offs and several action programs for technological transfer in Daeduck Technopolis were in a fever, relationship between technopolis and regional economy had not reached a sufficient level. One of the major reasons of the weak relationship was that Daejeon had not developed a strong linking mechanism, which was largely composed of action programs, that combines each resource of research institutes, universities, and a community. More importantly, the action programs would act as a window for Daeduck Technopolis, universities, and a community including business society seeking to commercialize research results and relate commercialization of research results to vitalization of regional economy.

Finally, The linking mechanism may be very essential to Technopolis because both research institutes and universities do not know what kinds of specific researches industry wants, and industry does not recognize what kinds of research is done. In order to foster regional economy via commercialization of Technopolis research results, more designated linking programs combining the sectors should be developed. Considering high entrepreneurship in METU in Turkey, Turkey would rather accelerate professors and researchers' technology commercialization by developing a strong linking mechanism in advance than waiting for the establishment of new business. As a linking mechanism, Technology Commercialization Center is very important.

When considering the roles and networks of the major subjects in Turkey and Korea, it is generally unsatisfactory. In the case of Daeduck Technopolis, it is particularly difficult to coordinate regional innovation with commercialization because of the weak linking mechanism. Therefore, effective technology commercialization is especially needed to invigorate the regional economy. A technology commercialization center is one example of an approach to link technology and commercialization.

The Technology Commercialization Center should include the following functions: Technology Commercialization Education Function, Technology Development Commercialization Function, Technology Commercialization Management Function, and Technology Commercialization Network Function. According to each function, four centers can be made as described below.

First, Technology Commercialization Education Center (TCEC) is an educational institute for improving the capacity for technology commercialization. This program has the ability to discover and evaluate technologies, write and evaluate venture and business plans, analyze technology transfer, foster government support and network with venture capitalists. This center will significantly contribute to the training of regional experts for both technology commercialization and in the creation and cultivation of ventures.

Secondl, Technology Development Commercialization Center (TDCC) evaluates and assesses sophisticated technologies developed within universities and research institutes, analyzing the commercialization potential of products and processes. In addition, it reviews the efficiency of economic production processes. Through these services, the technology development commercialization center can fill the role of transferring sophisticated technology and stimulating new business.

Third, Technology Commercialization Management Center (TCMC) is focused on helping and creating newly emerging ventures from commercialized technologies as well as using venture capital to facilitate the efficient transfer of technology.

Finally, Technology Commercialization Network Center (TCNC) is divided into domestic and international networks and its main function is to establish and maintain networks for human resources, education, research and management.

When the technology commercialization center is constructed as a regional innovation strategy, the linking mechanism, that bridge the gaps among sectors of the regional community, will increase effectiveness and help build a strong regional innovation system.

In brief, to increase the capacity in each sector among technology development, production systems and business support, it is important for technology innovation to be involved in the promotion of the regional economy. But the most important factor is strengthening the capacity of the linking mechanisms between the sectors of technology development, production systems, and business support.

6.3.2. Incubators and Business ventures

This research has several policy implications for both Korea and Turkey.

First, technoparks and technology incubators should recognize prevalent non-linear based venture businesses and device appropriate support policy for these types of ventures. <The survey results on venture type show that research based technology commercialization (linear-model) and product innovation (non-linear model) are almost the same in Korea and not much different in Turkey.> These responses suggest that a non-linear model is quite prevalent in the real venture world. So while success to linear based business ventures seems to be focused on knowledge or technology, success of non-linear based business venture is believed to be more management-oriented (marketing, administration, etc). Thus, support activities should be focused to augment these services.

Second, the policy of as much services possible to all venture businesses should be changed to pinpoint services to each venture business as entrepreneurs seem to have good understanding of their business needs and what services they want from technoparks and incubators. The governments should devise policies to support services that venture businesses want, rather than providing what government thinks is necessary for venture businesses. The evaluation of the business incubator's services by incubator graduates is relatively unrestricted and these individuals have the benefit of the experience and knowledge running their business after graduation. The graduates expressed a high level of dissatisfaction because the incubators only provide basic support services and not the specific services that they feel they need for success. The clear dissatisfaction of the graduate companies is an indication that the incubators do have serious problems with their support services. An incubator that only provides basic support services, such as low-cost rent and shared service, can only be of limited help in nurturing a technology-based venture business to success. To some extent, both types of start-ups are having their expectations met in the areas of "shared service," "low rent," and "manager's help" which in reality are the very basic incubator services. When asked about the other services, the companies attach a greater importance to these services, such as global networking services, but are not satisfied with their provision. The lesson is that a venture start-up company using an R&D innovation, either by a private company or by a university/research institute, needs more support services than those basic services that are currently being provided. The effectiveness of the support services provided is more important than any other issue for a technology start-up using R&D innovations.

The third implication is the role and qualification of incubator managers. The main purpose of the Daejeon business incubator is to foster the commercialization of research and development results from universities and research institutes. While most of the incubator managers in Daeduck Technopolis are from research institutes, universities, and the public sector and more than half of them only work at the incubator part-time, majority of them in Turkey came from public sector. This situation produces managers who have no professional experience in technology commercialization and who cannot devote themselves completely to the incubator. Therefore, the role and qualifications of the incubator manager should be changed. Better results would be almost certain if they were professionals in the field of technology commercialization and venture management.

The fourth implication revolves around keeping business ventures in the region and networking support for such ventures. The primary reasons for incubator tenants to leave Daejeon after their graduation are "the weakness of the support policy for business venture in the city of Daejoen," "the non-proximity to a favorable consumer market" and " the non-concentration of related industries." The business ventures that are staying in Daejoen are those graduates which received technology and support services from the university or research institute and those graduates that prefer the more affordable and moderate land price for their location. For the tenants that do try to establish roots in the community after graduation, the business incubator should not only continuously support their connection to an extensive

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business network, but they should improve the quality of the network currently in the community.

The fifth implication is the caring of the company after it graduates from the incubator. While there are many start-up tenant companies that are using R&D innovations from universities and research institutes, their survival rate is quite low after graduation. The conclusion is that business incubators in both Korea and Turkey need effective post-graduation care systems. Such a care system for graduate companies should be actively established, both to increase the company's success and to increase the probability of the company staying in the region. None of the related institutes such as the Small and Medium Sized Business Administration and the city of Daejeon have managed to establish such systems and neither have the incubators.

The final implication is that the number of incubators in Turkey should be increased. As shown in the survey of METU, there is much potential for venture start-ups. However, Turkey government's initiative is almost similar to that of Korean government before 1997. In order to increase the occupancy rate of incubators and foster entrepreneurship, Turkey needs strong government drive including the contextual assignment of budget on them and setting up well-prepared strong support systems for venture start-ups.

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Support Policy Funds

□ SMEs · Venture Start-up funds

- Funds to support those who are preparing business foundation, SMEs less than 5 years from the date of business start-up, but lack of capitals to activate business foundation regardless of their excellent technology and possibility of commercialization.
- Financing support conditions shall be deduction of 0.53%p (base rate) from lending rates of public capitals management fund.
- Lending period shall be within 8 years for facility budget and 5 years for operation budget. 2 billion KW can be lent to each enterprise
- Financing support method shall be direct loans from the Small and Medium Business Administration (SMBA) or loans by proxy from financial institutions after making decisions of enterprises to be supported.

□ Fund for Commercialization of Developed Technology

- Fund to prevent excellent technology that SMEs possess from hoarding and to foster SMEs based on technology by promoting commercialization of the developed technology.
- Financing support method is the same as the SMEs · Venture Start-up Funds. However, 1 billion KW for each enterprise per year shall be lent.
- Financing support method is direct loan from the SMBA

Credit Guarantee System

- A support system for SMEs having credit but also having difficulties to funding due to lack of security capability to lend capitals smoothly from financial institutions.
- For the kinds of credit guarantee, there are loan guarantee used as security for lending a loan or benefit from financial companies, certification of payment used as security for receiving certification of payment from financial companies, bond guarantee that guarantees debt service of principal when issuing corporate bonds, bill guarantee about bills, etc.

Human Resource Support

□ Industrial Technician System

- A system supporting designated enterprises by sending those who are under military duty as technicians or functional manpower.
- In order to have allocated industrial technicians, enterprise shall submit application form of military service designated enterprises in June every year, which is the period of application, to the SMBA and the Military Manpower Administration will inform the result in December.

□ Manpower Employment Package

- A project of the SMBA to connect and introduce youth manpower to SMEs after performing customized work education and field training to the young, who are not employed.
- The SMBA has connected and introduced the young unemployed to the spots of SMEs after educating them with national expenditures based on the understanding of employment demands of SMEs.

□ Fostering Customized Manpower of Industry-Academic Cooperation

- A project that enterprises guarantee employment to technical high school students (college students) who complete the program of <Industry-Academic Customized Manpower Fostering Program> operated under agreement among enterprises, technical high school (colleges) and students of technical high schools (colleges) for two years at least and to delay the students' joining the army during the agreed employment period.
- Required education expenses to complete the <Industry-Academic Customized Manpower Fostering Program are paid by national expenditure and enterprises shall be supported with excellent manpower.

□ Support Induction of Technology Manpower Overseas

- A project supporting induction of high-level technology manpower with specialized knowledge from overseas.
- A project supporting VISA issue, air fare to come to Korea for SMEs hoping induce foreign technology manpower and expenses for staying when inducing technology.

□ SMEs Experiencing Program for College Students

- Giving opportunities of lecture and visit excellent SMEs to college students including students on leave absence to understand SMEs and to raise their recognition about SMEs.
- The SMBA supports training expenses for students at 4-year engineering colleges to have training sessions at SMEs for three weeks during vacations.

□ Authentication System of Excellent Institutions in Human Resource Development (HRD)

- An authentication system to select excellent institutions from evaluation in the whole personnel management and lifetime learning.
- The valid period of the authentication is 3 years and enterprises shall be given preferential treatment from the Government's measures.

Venture Businesses Support Project

□ Venture Business Verification System

- A system to verify venture enterprises. It is to receive the certificate of venture verification after application on the web site, www.venturein.or.kr
- The certificate shall be valid for one year (two years for research and development enterprises) and be re-issued after the valid period.
- Once an enterprise is verified as a venture enterprise, it shall be given supports such as 50 % reduction of the corporation tax and income tax, exemption of registration tax and acquisition tax, reduction of property tax and tax on aggregate land, policy funds and investment funds.

□ Expansion of Business Start-Up Fostering Center and Operation Support

- A project to support expanded establishment of business start-up fostering centers with excellent operation ability for substantialization of operation such as preparing base of independence and to support operation expenses by evaluation fostering centers' achievements to improve supporting service of the centers.
- Support funds 50 million KW of operation expenses per business maximum and within 1.5 billion KW of business expenses per business at maximum for business start-up fostering centers such as colleges or research institutes designated by the SMBA.

□ BizCool for the Young

- BizCool is the compound word of “Business+School”, an education program cultivating entrepreneurship and business mind. It means “To learn business in school curriculum.”
- The SMBA operates various BizCool programs such as special lecture on professional fields, business start-up competition by regions and biz-market by utilizing club activity hours in elementary, middle schools and specialized high schools with recommendation of education offices.
- BizCool for the Young plays the role to foster prepared pre-business starters through early education of entrepreneurship and commercialization ability of the youngsters and to cultivate active ability of pioneering jobs.

□ Support Business Start-up Clubs

- A system to find and support excellent items of business start-up from business start-up clubs with capability of commercialization in high schools and universities in order to promote business foundation of the young.
- For high school students, clubs recommended by principals and for university students, clubs with items for business start-up, item development expenses of 4 - 7 million KW is supported per club.

Support Technology and Management Innovation

□ Evaluation of Validity in Commercializing New Technology Ideas

- The SMBA performs validity evaluation of commercialization through specialized organizations if SMEs or pre-business starters apply to the evaluation upon their new technology or idea.
- The SMBA shares 75% and the applicant shares 25% of the required expense for evaluation per subject.

□ Technology Innovation Support System of Public Institutions

- It is recommended that public institutions operating more than 30 billion KW of R&D budget support certain rate budget for SMEs.
- This nationally supports technology innovation activities of SMEs.

□ SMEs' Technology Innovation and Development Project

- This is a system to support a part of the required expense for development of new products and quality improvement to SMEs possessing ability of technology development.
- For subjects that development can be completed in a short-term, 1 billion per year, for the fields requiring strategical support, 5 billion KW for two years and for cutting-edge and high technology items of high intensive R&D, 6 billion KW for three years are supported.

□ SMEs' Technology Transfer and Development Project

- This is a project to support additionally required development expenses for SMEs to have technology possessed by universities, research institutes and enterprises transferred and put them to practical use.
- Under 75 % of the total business expenses, up to 2 billion KW and within 1 year subjects are supported.

□ Joint Technology Development of Industry-Academic Cooperation Support Project

- Help SMEs solve problems of technology in manufacturing spots by utilizing resource of technology development such as excellent manpower of universities and research institutes and support expenses of development new technology and new products.
- Participating enterprises shares 25 % and the SMBA shares 75% of the expenses of research projects

□ Pooling Use of Research Equipment Cluster Support Project

- A project to support R&D equipment rental fee that SMEs use by composing "Pooling Use of Research Equipment Cluster" among universities, research institutes and SMEs.
- Up to 60% of the equipment rental fee to use research equipment possessed by the supervising institutions for R&D purpose is supported in the limit of 30 million KW per participating enterprise.

□ Opening Use of Experiment and Research Equipments

- Opening use of experiment and research equipment possessed by local SMBAs for SMEs to use easily, which is open throughout the year.
- All the 4,500 equipments possessed by 11 local SMBAs, except for Seoul SMBA, can be used for free upon applications to each local SMBA.

□ Business Conversion Support Project

- Support SMEs with connection to funds and consulting to convert to a new business from the currently operating one due to changes in management situation.
- Free examination of business conversion, assisting 80% of consulting fee and 75% of technology development supporting fee in the limit of 100 million KW per subject are supported.

Supporting Outlets of Sales

□ Support Development and Promotion of SMEs' Joint Brand

- A project to assist 70% of development supporting expense and brand strategy education, which is the support of activating joint brands.
- More than 5 SMEs, associations and corporations (more than 5 participating SMEs) shall be qualified.

□ Support Specialized Exhibitions of SMEs

- A project supporting a part of rental fee of exhibition hall, booth installation fee or promotion fee when participating in specialized exhibitions hosted by non-profit organizations such as associations or societies.

□ Operating Joint A/S Call Center of SMEs

- To raise reliability of the products made by SMEs that averted by customers due to unstable A/S system, the SMBA establishes joint A/S call center and executes for participating enterprises about receiving A/S calls

□ Preferred Purchase System of Developed Products by SMEs' Technology

- This is the system that public institutions purchase developed products by SMEs' technology to support promotion of technology development and expansion of sales outlets

□ Performance Certification · Performance Insurance System

- This is the system to expand public purchase of developed products by technology of SMEs by supporting public institutions to purchase products of certified performance through performance test.

- The valid period of performance certification is 3 years from the date of certification and it may be expanded for three years if t is necessary.
- Performance insurance is for products that the performance is certified. The period of insurance is for one year after delivery of goods.

Export Supporting Project

□ Project of Making Enterprises for Domestic Demand as Export Enterprises

- A project to raise export capability by supporting enterprises for domestic demand with high possibility of export and enterprises in the early stage of export for the whole process of export from the beginning.
- Approximately 1,000 enterprises are selected and supported within the limit of 15 million KW per enterprise and they share 10% of the expense.

□ Project of Sending Trade Promotion Group of SMEs

- Support associations or groups by business types of SMEs regarding common expenses such as booth rental fee, booth installation fee, and transportation fee of exhibition materials when participating exhibitions overseas.
- For the market pioneering groups, rental fee of the consultation spots, bus rental fees, interpretation fees, buyer relation expense and advertisement fee, telecommunication fees are supported.

□ Project to Support Utilizing Private Base of Overseas Expansion

- A project to appoint specialized private institutions with professional ability in major exporting areas as overseas support centers and to support overseas marketing of SMEs by selecting approximately 250 enterprises with high possibility of overseas expansion among SMEs and venture companies.
- Support 60%-80% of the required expenses for overseas expansion

□ Establishment of Export Incubator

- Export incubators in major trading positions like the United States and China and new markets such as the Middle East to overcome the limit of utilizing export agencies and to cultivate original export ability of SMEs have been established and operated.
- Consultation utilizing advisers of local marketing, laws and accounting are provided and

also, working conditions possible to be used as export base at the spots are offered.

□ Support Online Export

- A project to support promotion and marketing for buyers about products by SMEs by using the Internet.
- Constructing home pages, which is the construction of export infra, electronic catalogue and web mail have been supported. For excavation project of overseas buyers, e-mail marketing is supported by making and distributing books, e-books and CDs by collecting products of enterprises with high possibility of export.

Support Women's Enterprises and Enterprises of the Handicapped

□ Support Business Start-up Funds for Women's Enterprises

- This is a system to support women heads of family to start business for living and supports rental deposit of the place of business
- It is within 30 million KW per person and the term of loan is for two years with the annual interest rate of 3%

□ Operation of Women's Business Center

- Expand opportunities for women to participate in economic activities by supporting moving-in space, management and marketing generally to raise the success rate of business start-up of women.
- Early stage of business start-up such as 14 childcare centers nationwide, common office machine engineers, etc. are supported.

□ Business Start-up in Specialized Areas for Women

- Raise the success rate of business foundation through mentoring with succeeded entrepreneurs
- Support women to have education of “Consulting through Theory, 사례 and Practice”, which is a special business start-up education that consists of three steps

□ Customized Business Start-up Lectures for the Handicapped

- A project supporting the handicapped pre-business starters to activate business foundation of the handicapped by developing business start-up items and raising the mind of business foundation through business start-up education.

- For offered lectures, there are success strategy of Internet shopping mall, financing for small business owners, item selection and marketing strategies.

<Daejeon Metropolitan City's Support on Technology, Business Foundation and Incubation>

Support System for Enterprises Moving in Daejeon

□ Financial Support for Businesses Moving in Daejeon from the Capital Region

- Support the subsidy of industry location within 50% of the normal rental fee and up to 50% of investment expenses on facility for enterprises with more than 30 people of regular employment scale for the current three months, doing business in the Capital Region for more than three years with actual results
- In the case that number of employees exceed 20, support less than 500,000 KW per person monthly within the scope of 6 months.

□ Financial Support for Enterprises Moving in Daejeon from Other Regions Except for the Capital Region

- Provide land required for industrial facilities for manufacturing industry and support 3% of the required moving expense of factory facilities. In the case of employment exceeding 30 employees, support less than 300,000 KW per excessive person
- For business service and movie and video industry, support employment subsidy 300,000 KW per person in the case of employment exceeding 10 employees. Support less than 300,000 KW of training expense per person as education and training subsidy for new employment over 30 people.

Support System for Foreigner-Invested Enterprises

□ Tax Reduction and Exemption

- Exempt 100% of corporation and income tax, which are national taxes, for five years and reduce 50 % for two years for high-tech involved industry, industry supporting service business and individual foreigner-invested areas.

- Reduce and exempt 100% of acquisition tax, registration tax and property tax, which are local taxes, for fifteen years.
- For complex type of foreigner-invested areas, exempt 100% of national tax for three years and reduce 50% for two years. In the case of local tax, exempt 100% for fifteen years.

□ Financial Support

- For enterprises that foreigners' investment is over 30% or the first heavy stockholder is foreigner, support land required for rental (support 25% of land location of industry and reduce and/or exempt the rental fee). Support difference in amount for sale under the prime formation cost of land possessed by the Nation, local government, government-invested institutions or personals. For education and training for new employment over 20 people, local government pays 100,000 - 500,000 KW per person monthly.
- Local government pays 100,000 - 500,000 KW per excessive person in the case of new employment over 20 employees within 6 months.

□ Cash Support

- Objects of the support are business with over 30% of foreigner-invested rate
- Supporting fields are land purchase cost, construction fee, equipment purchase expense and subsidies for employment and education and training. The amount of the support is fixed rate of FDI amount through agreement with investors.
- However, financial support and cash support shall not be overlapped. Applicants shall choose one of the two systems.

Daedeok Innopolis Support System

□ Tax Reduction and Exemption

- For enterprises designated as high technology enterprises and research institute enterprises, corporation tax and income tax shall be exempted 100% for three years and reduced 50% for two years.
- For foreigner-invested enterprises and foreign research institutions, 100 of acquisition tax and registration tax shall be exempted and property tax will be 50% reduced for three years after 100 of exemption for seven years.
- For enterprises moving in the industry complex, acquisition tax and registration tax shall be exempted 100% and property tax shall be exempted 100% for five years.

□ Reduction and Exemption of Public Utility Charges

- For water supply service charge, it shall be decreased 19.3% for general use (business use) and 170 KW/ß≥ for industrial use.
- For electric charge, 38% of general use shall be reduced in the case of industrial use.

□ Appeasement of Regulations Regarding Construction

- For education · research institutions within Innopolis and commercialization facility zones, apply 30% of the building-to-land ratio and 150% floor space index50% appeased rules, which are 50% appeased as determined in the relevant acts.

□ Reduction and Exemption of Share in Various Expenses

- For business operators of Innopolis development, development expense share, farming land formation expense, environment improvement expense share and grassland formation expense shall be reduced and exempted.

Support Systems for Local Enterprises in Daejeon

□ Support Management Stabilization Fund

- For SMEs whose headquarter or place of business are located in Daejeon Metropolitan City over 6 months and enterprises of business start-up within Daedeok Innopolis, support funds under 30 million KW with autonomous rate and two years' term of the loan.
- The total amount of annual aid is 100 billion KW and complement of interest difference is offered for the loan.

□ Support Business Start-up · Competitiveness Reinforcement Fund

- For enterprises in Daejeon Region, facility investment fund and operation fund shall be 6% interest of the loan (adjustable rate). The terms of the loan shall be within eight years for the facility investment fund and three years for the operation fund.
- The facility investment funds is the fund required to facility investment to strengthen business start-up and competitiveness of SMEs.The operation fund is a the fund connected to the facility investment. It shall be within 404 of the facility investment fund.
- The total amount of annual aid is 50 billion KW.

□ Support of Daedeok Valley Investment Association

- The Association was established for effective technology and finance support for venture enterprises and high-tech enterprises in Daedeok Innopolis and Daejeon Region.
- This is the fund in which public and private sectors participated. Private company type of association operation company was adopted, out of the operation method focused on business start-up investment company, the venture investment system.
- The term of the project is from 2006 to 2013 (can be expanded for three years) and the total required amount is 10 billion KW
- The limit of the support is within the scope of 15% of investment agreement amount
- Daejeon City's Daejeon SMEs General Support Center supports in the ways of stocks, convertible bond, bond with warrant and so forth

□ Support of Innopolis' Partners

- This is a fund to support venture enterprises in Daedeok Innopolis having financial difficulties to prepare grounds to grow.
- This is a government-invested fund. The total amount is 80 billion KW. In 2007 and 2008, 30 billion KW each year were supported. It is planned to support 20 billion for each of 2009 and 2010.
- The term of business operation is seven years and the payback period is three years

□ Establishment and Support of Daejeon Credit Guarantee Foundation

- A nonprofit and public benefit institution established by contribution from Daejeon Metropolitan city, the Government, financial institutions and enterprises in the region
- The purpose of establishment of the Foundation is to guarantee debt of SMEs having potential of growth, but with no security capability, located in Daejeon Metropolitan City.
- This has been operated since 2000. The guarantee supply amount passed 400 billion KW as of 2009. There are approximately 15,000 enterprises of guarantee supply.
- The maximum limit for the same enterprise is within 40 million KW.

□ Support Outlets of Overseas Sales

- Sending overseas market excavation groups, participation in overseas exhibitions, individual participation in specialized exhibitions, export insurance fee and electronic trade site registration are supported.

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Other Measures of Supporting Enterprises

□ Promotion of Measures for Privileged Treatment for Enterprises

- Award "The Tower of Sales" once a year to enterprises that manage enterprise activities for more than one year in Daejeon City and achieve sales of 10 billion through 3 trillion KW for the first time in the concerned year.
- Reduce the period of issuing passports from one week to 2-3 days by opening the exclusive window for issuing passports to entrepreneurs.

□ Supporting Favorable SMEs System

- Support management stabilization fund and funds for business start-up and reinforcement of competitiveness.
- For the management stabilization fund, the amount is under 20 million KW for the two years' term of loan
- For funds of business start-up and reinforcement of competitiveness, 30 million KW of operation fund, 1 billion KW of facility investment and terms of the loan such as three years for the operation fund and 8 years for the facility investment are determined.

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Chapter 06

Technology Based Entrepreneurship and Incubation in Turkey

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Chapter 06

Technology Based Entrepreneurship and Incubation in Turkey

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1. Introduction

As countries develop economically, the ability to innovate becomes an increasingly critical determinant of international competitiveness. In developed nations today, competitive advantage "...must come from the ability to create and then commercialize new products and processes, shifting the technology frontier as fast as their rivals can catch up" (Porter and Scott, 2003). In the words of the European Commission:

> *Competition through innovation appears to be as important as price competition as a reaction by enterprises to market pressures. ...While research is a major contributor to innovation, if there is no entrepreneurial action, there is no value creation. It is the enterprise that organises the creation of value. (European Commission, 2003)*

The ability to innovate has thus become accepted as a crucial prerequisite of enterprise development and entrepreneurship. There are number of factors that affect countries' and enterprises' innovative capabilities:

- Access to knowledge;
- Ability to transform knowledge into competitive products and services;
- Willingness to innovate (in terms of products, processes and organisational changes).

The above-mentioned factors, in turn, are strongly influenced by a range of national, regional and locally determined conditions. In this chapter, we will be examining and discussing "entrepreneurship" policies in Turkey as one of the contributing factors to the "willingness to innovate" and the performance of incubators, science or technoparks (or the like) in boosting the performance of high technology based enterprises both in terms of economic and technological aspects.

The main objective of this report is to evaluate whether technoparks and incubators, named Technology Development Centers (TEKMERs) in Turkey, which are established by the Small and Medium Size Industry Development Organization (KOSGEB), are effective in terms of nurturing venture businesses. For this purpose, basic data for effectiveness of the incubator support services from on-incubator and off-incubator firms are gathered through questionnaires and face-to-face interviews.

2. Importance of Entrepreneurship

Many studies show that there is a correlation between economic development and entrepreneurship (Wennekers and Thurik, 1999; Audretsch and Keilbach, 2003). Further, It is widely acknowledged that industry is becoming increasingly dominated by high technology.

The contribution of entrepreneurship to economic welfare is accomplished in three major ways (OECD, 2001a; Acs et al., 1999; Swedberg, 2000; Foss and Klein, 2002):

- by increasing employment;
- creating and diffusing new technologies;
- developing new and different business models, processes, and techniques that form the basis of the structural transformation in an economy.

Due to the importance of technology based entrepreneurship in economic growth, policy discussions concentrate on the role of the government in entrepreneurship (Karlsson and Karlsson, 2002).

The main output factors from investments (including, for example, education and R&D) in innovation are new products, services, processes or ideas which can either increase productivity or be commercialised. These innovations must be implemented, generally by the implementation in a company context. The ability to transform knowledge can be seen in indicators such as entrepreneurial/business skills, the knowledge intensity of industrial output and trade, the growth/development of companies, and capital market activity (particularly venture capital). Turkey has a young and ambitious population, with budding entrepreneurial skills, yet there is still a lack of adequate business skills to utilise available (venture) capital resources effectively. Turkey's productive output is still focused on low-tech, high labour-intensive product/service segments. Although productivity and trade is on the rise, Turkey needs to increase focus on higher value-added segments in order to ensure long-term competitiveness of its enterprises.

3. Current Performance of Entrepreneurship and Innovative Capacity

A number of indicators have been developed in recent years, aimed at capturing and measuring countries' and firms' entrepreneurship and innovative capacity, such as, for example, investment in R&D, patents, levels of internet access and penetration, science and technology graduates, etc. Furthermore, some indicators do provide quite useful insights. In comparison with selected other countries, according to these indicators, Turkey is shown to be ranked near the bottom in most of the indicators. But in the recent European Innovation Scoreboard 2007 (EIS), Turkey is among the top performers in the "catching up" quadrant when it comes to the trend for the following three indicators: business R&D/GDP, USPTO patents/population, and high-tech manufacturing value-added share. However, the very poor availability of data prevents the generation of a reliable summary innovation index of the EIS and the identification of trends.

\According to the results of National Research and Development Activities Survey (2007) which was conducted by Turkish Statistical Institution (TURKSTAT), share of Gross Domestic Expenditure on Research and Development (GERD) in the Gross Domestic Product (GDP) was 0.71 %. According to the GDP revised in March 2008, share of GERD in GDP was 0.58 % in 2006. The share of the business enterprises in R&D expenditure is increased to 41.3 %. Analyzing the sectors financing R&D expenditure in 2007, 48.4 % was financed by business enterprises, 47.1 % by government, 4 % by other national sector and 0.5 % by foreign funds.

The total number of R&D personnel (full time equivalent) per ten thousand labour force was 29.9. Regarding R&D personnel distribution within sectors, 63.337 of total R&D personnel, 46.6 % was employed in higher education sector, 38.3 % in business enterprise sector, 15.1 % in government sector. Turkey has a low intensity of business researchers, fewer than 1.5 per thousand employees in industry. This is mainly due to the business sector playing still smaller role in the national innovation system than the higher education and government sectors.

Another benchmark of Turkey's ability to compete in the knowledge-based economy is

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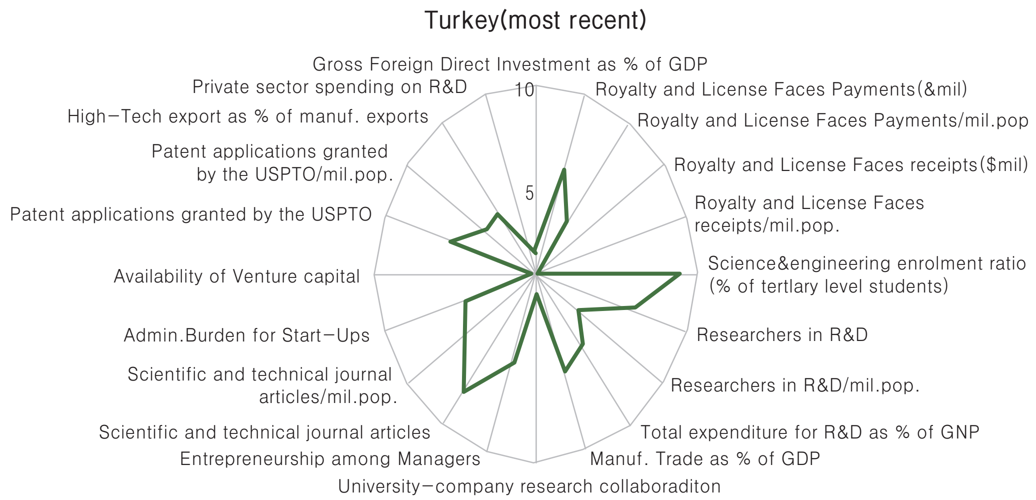
provided by the World Bank's Knowledge Assessment Scorecards 2004 which evaluate Turkey's general position relative to other countries in the Europe and Central Asia (ECA) region. Turkey displays a relative strength in the areas of science and engineering enrolment at tertiary level, scientific and technical journal articles, in the areas of patent applications, and royalty and license fee payments. However, in a number of other areas, Turkey's position is much weaker than the ECA average: royalty and license fee receipts, researchers in R&D (per million population), university-company research collaboration, availability of venture capital, private sector spending on R&D, and gross foreign direct investment (Figure 6-1). Overall, the Turkish scorecard is relatively stronger at inputs (e.g. S&T enrolment) and weaker on the outputs (e.g. high-tech exports) (World Bank, 2004a).

Figure 6-1 | World Bank Knowledge Assessment Scorecard for Turkey (2004)



Another indicator for economic development and innovation is the degree of "informality" (i.e. firms which are able to save costs by evading tax obligations, labour market and product market regulations). According to World Bank 2004 estimates, Turkey's informal economy accounts for 32 % of Gross National Income with is a very high value compared to other countries. The informality may negatively affect the willingness of individuals and companies to accept the risks that are inherent to innovation processes. Secondly, informality may benefit traditional sectors at the expense of new ones.

The World Economic Forum's annual Global Competitiveness Reports have examined many factors enabling national economies to achieve sustained economic growth and long-term prosperity. Global Competitiveness Report 2008-2009 noted a drop by 10 places (63rd out of 134) for the overall competitiveness index ranking for Turkey. According to the report, Turkey

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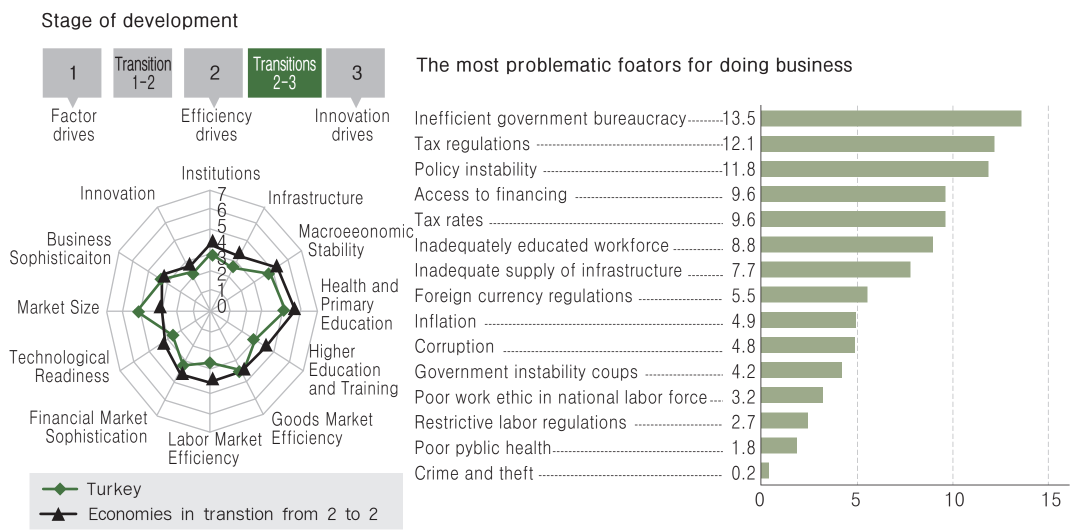
continues to benefit from its large market, which is characterized by relatively high competition (46th). However, some more basic issues must still be tackled, such as upgrading the quality of infrastructure, improving the human resources base (78th), addressing the inefficiencies in the labor market (125th), and reinforcing the efficiency and transparency of public institutions. Indeed, there has been a measurable decrease since last year in the public's trust in government institutions. The overall drop in ranking can also be traced to a weakening of the country's perceived financial market efficiency (which fell from 61st to 76th place). However strengthened trust and confidence in turn are vital prerequisites for a favourable climate for enterprise development and investment. The Global Competitiveness Index ratings in detail and the most problematic factors for doing business is shown with Figure 6-2.

Figure 6-2 | Ratings / Source:The Global Competitiveness Report 2008-2009 (World Economic Forum)



Science-Industry collaboration is an important element of national innovation. The Turkish government has launched a number of initiatives, including incubators, technoparks and technology development zones to address this issue. Some of these initiatives have proven particularly successful thus far according to the "university/industry research collaboration" indicator of Global Competitiveness Report (World Economic Forum, 2008). Turkey has made an improvement from rank 71st (out of 80) to 57th (out of 134). However, there is still room for improvement in a number of areas to increase the level of collaboration between science and industry.

Assessment of the national level of entrepreneurial activity has been initiated in 1991 under

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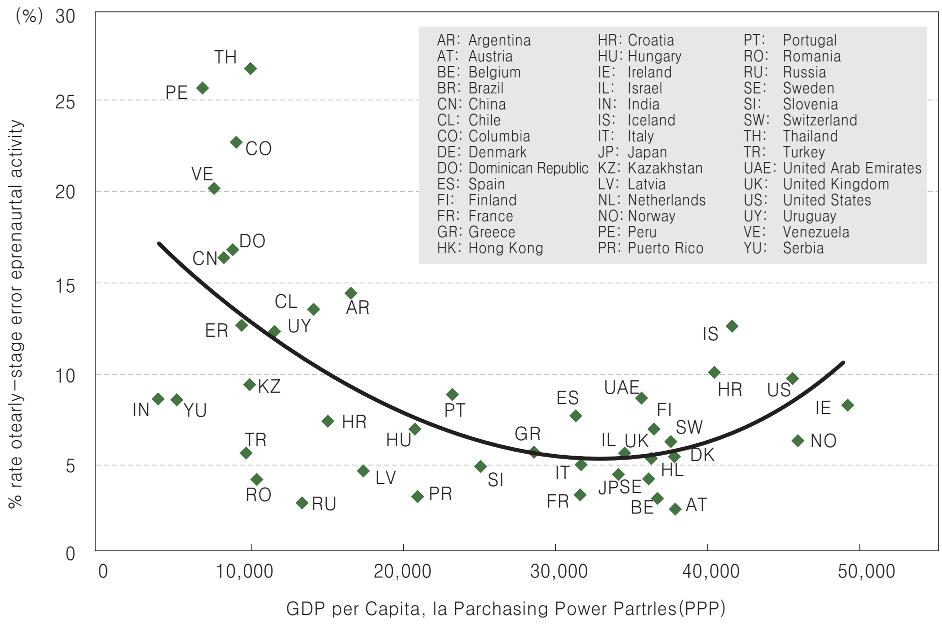
the Global Entrepreneurship Monitor (GEM) Research Program. GEM takes a broad view of entrepreneurship and focuses on the role played by individuals in the entrepreneurial process. GEM 2007 conducted research in-42 countries. Earlier GEM reports demonstrated a systematic, U-shaped relationship between a country's level of economic development and its level and type of entrepreneurial activity. Figure 6-3 illustrates this U-shaped relationship between per capita GDP-levels and early-stage entrepreneurial activity.

Figure 6-3 | Early-Stage Entrepreneurial Activity Rates and Per Capita GDP, 2007



Source: GEM Aduit Population Survery(APS) and IMF.

In high-income countries, as per capita income increases and more opportunities for entrepreneurship arise, the prevalence rate of early-stage entrepreneurship tends to increase. However, cultural, demographic, and institutional influences also shape the picture.

In Table 6-1, different types of indices obtained under GEM 2007 for some selected high, low-medium income countries is given. The first two values show early-stage and overall entrepreneurial activity among number of observations, the third value is the percentage of early-stage entrepreneurial activity with new product market combination, fourth value shows the relative prevalence of improvement driven opportunity entrepreneurship and the last one shows the "ease of starting a business" which is calculated from the World Bank's data. From Figure 6-3 and Table 6-1 it can be concluded that the level of the Turkish entrepreneurship is low compared to many countries included in the GEM study.

Table 6-1 | Global Entrepreneurship Monitor - GEM 2007 Report Statistics

	Early-Stage Entrepreneurial Activity (ESEA) (%)	Overall Entrepreneurial Activity(%)	ESEA with New Product-Market Combination (%)	Share of Improvement Driven Opportunity (%)	"Doing Business" Percentile Index and Rank
Turkey	5.6	10.8	10	40	0.43 / 28
Korea	na	15.0 (2001)	12	na	0.71 / 47
Japan	4.3	12.6	11	55	0.37 / 32
UK	5.5	10.5	21	59	0.15 / 7
USA	9.6	14.1	21	62	0.10 / 4
Finland	6.9	14.0	20	73	0.26 / 16
Slovenia	4.8	9.3	27	77	0.71 / 45
Israel	5.4	7.4	17	52	0.32 / 13
Brazil	12.7	22.4	5	39	0.65 / 40
India	8.5	13.9	10	33	0.78 / 53
China	16.4	24.6	7	44	0.64 / 44

Comparing micro level innovative activities in Europe and Turkey, it is found that the proportion of innovative enterprises is lower in Turkey. Whereas 45% of European businesses are characterised as innovative, 31.4% of Turkish firms are perceived as innovative, according to the State Institute of Statistics Innovation Survey 2004-2006. The proportion of innovative companies increases with firm sizes. While the propensity of undertaking technological innovation activity is around 29.7% for firms with 10-49 employees, it increases to 37.2% for the firms with 50-249 employees and 43.5% for the firms with 250 or more employees. As it is seen, larger firms conducted more innovative activities compared to their smaller counterparts.

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4. National Strategy Documents for Entrepreneurship Development

The primary national strategy document is the 9th Development Plan (2007-2013) which draws a more general framework on policies and strategies and determines priorities including industry and enterprise related issues. The Plan aims to encourage R&D spending, improve the infrastructure for research and foster industry-science relations, via clusters and technology development zones. Within this framework the approach is mainly focused on SMEs and entrepreneurship and it is stated that Technology Development Zones, Technology Development Centres, Technology Transfer Centres and research infrastructure will be established and conditions of existing ones will be improved, networking, clustering and collaboration among enterprises and their cooperation with universities, research institutions and facility structures will be developed, awareness and capacity of enterprises on appropriate production technology selection and innovation will be increased, which is also the thematic concentration of the Medium Term Program.

The Medium-Term Program (2007-2009) has the objective to improve the competitiveness of enterprises, ensure regional development and decrease the disparities. One of the major thematic intervention areas of the Medium Term Program is “Supporting entrepreneurship.” In line with the objectives set out in the 9th Development Plan, in the framework, the SME Strategy and Action Plan (2007-2009) formulates a road map for SMEs and includes measures such as training and incubators to boost SMEs’ capacity to access knowledge from global suppliers and to stimulate collaboration with Turkish universities which has a final objective of increasing competitiveness of SMEs. Intervention areas of the three policy documents are summarized in Table 6-2.

As directly or indirectly indicated in the strategy documents, the basic targets of SME policies are to increase the productivity of the sector, its share in total value added and its international competitiveness. To realize this aim, Turkey has launched several programs such as financial supports, strategic road map application initiated by KOSGEB, Technological Development Centers (TEKMER). Therefore, the importance of SMEs in the economic and social life has started to be acknowledged much better, and accumulation of experience and information in terms of SME policies began to proceed. However, it is a well known fact that the SME policies are not yet at the demanded or required level.

Table 6-2 | Summary of National Strategy Documents

Name of Document	Years	Intervention Area	
		Thematic	Regional
9th Development Plan	2007-2013	• Improvement of business enviornment. • Development of R&D and Innovation. • Ensuring the transformation to high value added production structure in industry and services. • Development of labour market	Ensuring development based on local dynamics and endogenous potentials
Medium Term Programme	2007-2009	• Supporting entrepreneurship. • Supporting innovation, producitivity and effective usage of technology. • Diversification of financial instruments. • Improvement of physical and technological infrastructure of enterprises and increasing the cooperation between enterprises • Wide spreading of institutionalization	Ensuring development based on local dynamics and endogenous potentials
SME Strategy and Action Plan	2007-2009	• Increasing the share of SME credits within the total credit volume of the banking system • Increasing the effectiveness of support by means of developing communicatin and interaction between service providers and SMEs. • The development of transfer capacity and quality immprovement. • Concentrating the supports in the areas of training, consultancy and R&D directed to the development of the technological infrastructure of companies • Entrepreneurship Development • Enterprise Devlopment • Integration of SMEs into International Market • Improvement of Business Environment • Development of Technological and Innovation Capacity	Measures towards the solution of the Turkish SMEs Problems on the national scale Ensuring development of SMEs without any regional discrimination

5. Enterprises

In Turkey, enterprises are represented by the Turkish Artisans and Craftsmen Confederation (TESK) and the Union of Chambers and Commodity Exchanges of Turkey (TOBB). TESK and TOBB with their large number of members are the highest legal entities in Turkey representing the private sector. Today, there are 13 Professional Federations, 82 Unions of Tradesmen and Craftsmen Chambers and 3,166 Chambers of Tradesmen and Craftsmen affiliated to the TESK. Furthermore, TOBB has 364 members in the form of local chambers of commerce, industry, commerce and industry, maritime commerce and commodity exchanges. In this framework, the major function of the TOBB and TESK is to guide and lead the Turkish entrepreneurs.

The Turkish SMEs account for 99.8% of all companies, including those in the service sector and they employ 76.7% of the total workforce. The share of SME investments within the total investments reaches 38%, and 26.5% of the total value added is also created by these enterprises. In addition, SMEs have a market capitalisation of around 50% of GDP and 45% of SMEs export 8% of their turnover, which is lower than the EU average of 13% for SMEs (Koc Bank, 2002; EU Commission, 2002a). The share of SMEs in total export is on average 10%. Moreover, export products consist only a small proportion (<2%, TURKSTAT 2007) of high technology.

According to TURKSTAT, the total number of enterprises in Turkey in 2003 was 1,720,598. The number of enterprises operating in manufacturing industry was around 246,899 in 2003, and increased up to 288,293 in 2006 (14% of total companies). Manufacturing industry employ 32% of the total employment whereas 62 % of the labour force has under the secondary school level of education and only 12 % of total labour force is high school and university graduates. An important factor in the knowledge-based economy is the skill base. The quality as well as the quantity of human resources is critical in paving the way for the innovation and diffusion of technology. Number of researchers per thousand labor force which is 2.3 for Turkey is significantly lower when compared to EU-27 countries, which is 6 (EIS 2007).

The leading sectors are chemical, petroleum and plastic products; textiles and leather; food and beverages; fabricated metal products; electrical machinery and equipments; motor vehicles and basic metals. Among these, textiles and motor vehicles are the biggest exporters (TÜSIAD, 2003).

Based on 2003 figures, SMEs constitute 99.63% of all the enterprises in the manufacturing industry, and they account for 69.7% of the employment (Table 6-3) in this sector with the 32.3% of the total added value creation. As can be seen from the table, almost 90% of the manufacturing industry is composed of micro-scale establishments with 1-9 persons engaged.

Even if they have 27.7 % of total employment, their share in the total added value is 6.5% which shows that their productivity is very low.

Table 6-3 | Distribution of Manufacturing Industry

Number of Workers	Number of Establishments	Establishments (%)	Employment (%)
1-9	221,539	89.7	27.7
10-49	20,325	8.2	20.9
50-249	4,118	1.6	21.1
250 +	917	0.3	30.3
Total	246,899	100	100

Source: TURKSTAT 2003

High-technology industries are often seen as key industries that have positive effects on productivity and competitiveness, therefore, play a crucial role in future economic development (OECD, 2001). It can be expected that the larger the share of high-technology industries, the larger the income to be generated hence the more prosperous will be the country. The share of the medium and high technology sectors in the manufacturing industry in Turkey has increased to a substantial level due to the increases in the production and exportation during the 2002-2005 period. However, when compared with the EU/OECD countries, the share of these sectors remains still low. Employment in medium-high and high technology manufacturing is 2.03 (TURKSTAT, 2004). On the other hand, despite the high level of imported input dependency in these sectors, the increase of added value cannot reach to an expected level.

Table 6-4 | Production and Exportation Structure of the Manufacturing Industry (%)

Technology Intensity(1)	Turkey						EU Export(4)
	Production			Export			
	2002(2)	2002	2005(3)	2000	2002	2005	2003
High	5.9	5.1	6.3	7.8	6.2	6.0	21.5
Medium High	22.5	18.2	25.3	20.4	24.3	28.5	41.9
Medium Low	30.4	26.7	27.0	20.5	22.8	26.9	15.9
Low	41.2	50.0	41.4	51.3	46.8	38.7	20.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Turkstat, OECD Stan Database
(1) OECD Science, Technology and Industry Scoreboard Classification
(2) Covers 10+Employees
(3) SPO Estimation with 2002 Prices
(4) EU Conutires which are OECD members

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5.1. Starting-up Enterprises and Survival Rates

When comparing the Turkish entrepreneurial activity to similar activities in other transition economies, it is shown in Table 6-4 that the overall start-up rate of new businesses in the period 1995-2000 is not particularly high. Between the period 2003-2004, around 31,000 new firms were started throughout the country. A large part of new businesses in 2003-2004 (46%) were formed in the rural areas outside Istanbul, Ankara and Izmir (TURKSTAT, 2004). Entrepreneurs in rural areas are more likely to start a business in wholesale, retail trade, motorized vehicles, furniture, diverse renting and working activities. Such sectors generally represent a higher degree of low-tech and traditional firms, which tend to require less start-up resources enabling the entrepreneurs to start a new business more easily.

Table 6-5 | Turkish Start-ups vs Closed Entreprises Classified according to OECD

Tech Level of Manuf Industy	Entreprises 2002		Start-ups in between 2003-2006			Closed in between 2003-2006			Start-up vs Closed in between 2003-2006			Entreprises 2006	
	#	%	#	% of opened	% of tech level	#	% of closed	% of tech level	Diff	% of closed	% of tech level	#	%
Low	155,717	63.1	32,983	61.0	21.2	8,174	64.5	5.2	24,809	59.9	15.9	180,526	62.6
Low-Medium	58,067	23.5	10,051	18.6	17.3	1,919	15.1	3.3	8,132	19.6	14.0	66.199	23.0
Medium-High	30,176	12.2	9,153	16.9	30.3	2,101	16.6	7.0	7,052	17.0	23.4	37.228	12.9
High	2,939	1.2	1,878	3.5	63.9	477	3.8	16.2	1,401	3.4	47.7	4.340	1.5
Total	246,899	100	54,065	100	21.9	12,671	100	5.1	41,394	100	16.8	288.293	100

Source: M.Cansiz PhD Research Paper, 2008

Although the overall start-up rate of new businesses is relatively low in Turkey, the survival rate is relatively high. Given the favorable condition for SMEs to survive, attention should then be focused on how to increase the actual number of start-ups and how to foster enabling conditions supportive for the business environment and the private initiative in Turkey.

The Law on Amendments on Turkish Commercial Code No:4884, Tax Procedural Law, Stamp Tax Law, Labor Act and Social Securities Law came into force on 17 June 2003. This law enabled association of a company in one day by granting authority to Trade Registries, and company association processes was reduced from 19 transactions to 3 transactions. New regulations on "Opening a Business Place and Work License" have reduced the required number of documents from 52 to 6 for licensing of sanitary business places, and from 43 to 7 for licensing of non-sanitary business places.

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5.2. Successful Enterprises

The Turkish Enterprise and Business Confederation (TURKONFED) supported a study in year 2008, named "Transformation of SMEs: Big Successes of Small Companies." The study was conducted by a group of academicans through surveys, site visits and interviews to determine the reasons behind the successful enterpreneurs, the challenges and the barriers to be successful. Five performance indicators were used such as growth performance, export performance, technology and innovation performance, branded goods performance and added value performance.

The study showed that there are common characteristics of successful enterprises as the followings:

- Success is obtained after a long process, it is not accidental;
- Most of the successful enterprises could not use bank loans at the time of establishment because of the unstable economic conditions, high interest rates and short terms. Instead first investments had been financed by families or friends. As a result to decrease the risk factors, they have preferred to start with small sizes;
- Successful enterprises are aware of the market conditions, customer demands and the competitors;
- Majority of successful enterprises have good knowledge base with qualified personnel;
- Most of the successful enterprises know the importance of technical information and marketing/sales skills;
- The most common characteristics of the successful enterprises is the innovativeness.

There are a lot of challenges for being a successful entrepreneur. Regional or sectoral conditions play an important role. It is found out from the study that it is challenging to be close to the knowledge sources and expert suppliers. The successful enterprises faced a lot of barriers besides challenges during their process such as:

- Funding problem, mainly at the start-up phase;
- The size and scale of the investment;
- Lack of qualified personnel during start-up and growth;
- Lack of quality and patented trademarks knowledge base of the customers;
- Lack of expert suppliers;
- Underdeveopment of networking and clustering;
- Uncertainty of macro-economic conditions;
- High level of bureaucratic procedures for public funding.

The study report also covers some sustainable and systematic policy recommendations

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stating the importance of having incubators supporting start-ups, some other alternative initiatives such as seed capital supports with the provision of tax exemptions to the companies providing those supports, diversification of RTDI support programs and promotion of vocational training.

5.3. Barriers for Entrepreneurs

According to the TURKSTAT Innovation Survey 2004-2006, enterprises indicate economic risk, high cost of innovation, lack of appropriate finance and lack of qualified personnel as the main factors hampering innovation activities. Another aspect is the managerial capacities. When comparing the reliance on professional management in Turkey with other countries, it is found that senior management positions are likely to be held by families or relatives to the entrepreneurs. In this respect, Turkey is ranked 93rd out of 134 (World Economic Forum, 2008). Also, according to the report from the Turkish Industrialist's and Businessmen's Association (TÜSİAD, 2003), education on entrepreneurship is still quite limited. Supporting institutions for entrepreneurs do not have satisfactory human and capital resources. Another factor is access to knowledge, whether it is diffused by standards, acquired through qualified managers or generated by engineers and R&D activities of enterprises.

Another problem of SMEs in Turkey is insufficient access to the financial instruments. This problem stems from the unwillingness of micro sized enterprises to use financial tools due to the harsh conditions and insufficient numbers of financial instruments are available to support SMEs. On the other hand, recent programs providing credits/guaranteed funds to small businesses have been experiencing lack of demand too. This seems to indicate that besides the lack of capital, the lack of people with adequate entrepreneurial skills to make use of the capital that is available is also critical.

Although several legal regulations and measures have been implemented by Turkey like new entrepreneur support mechanisms that aims to promote and disseminate the culture of entrepreneurship by financial supports and loans, it is commonly accepted that instruments, especially financial instruments, are not enough to facilitate the establishment of start-ups and the increase in investment still depends on considerable efforts of intermediary institutions and key individuals.

A study was conducted in 2005 by Prof. Dilek Cetindamar to answer the following three areas of concern: what entrepreneurs need in their startup phase, what problems they encounter, and what they expect from government plus some general questions designed to identify the general characteristics of entrepreneurs and enterprises. The study was based on primary data collected through two surveys covering a total of 185 entrepreneurs, mainly from the two most important cities in terms of entrepreneurship in Turkey. There are four main findings of that study:

- Turkey underutilises youth and women as entrepreneurial resources;
- The existence of a large informal economy tends to support self-employment rather than entrepreneurship;
- Entrepreneurs are not linked with organisations that might be helpful at the startup stage to supply help and expertise in a number of fields such as market and demand research, technological support, qualified human resources, and marketing and advertising;
- Entrepreneurs consider bureaucracy and unstable state policies as their main problems.

6. R&D Based Entrepreneurship Support Programs

Financing of innovation and technological cooperation activities in private sector is mainly executed through the programs run by the Ministry of Industry and Trade (MoIT), the Scientific and Technological Research Council of Turkey (TUBITAK) and Technology Development Foundation of Turkey (TTGV). The Small and Medium Size Industry Development Organization (KOSGEB), Turkish Patent Institute (TPE), Turkish Accreditation Agency (TURKAK) and the Turkish Standards Institute (TSE) are connected to the MoIT.

There has been a surge in new policy measures in recent years aimed at strengthening the links between the research community and the private sector, and promoting the creation of science based start-ups in Turkey. In 2006-2008, a number of new policy measures were introduced to increase R&D. Table below summarizes the amount of public support for private R&D between 2006 - 2008. Grants, tax exemptions/credits, payment of social security

Table 6-6 | Public R&D Supports to Turkish Enterprises (Million TL)

	2006	2007	2008
TUBITAK	215.0	215.0	175.0
UFT	42.0	63.5	n/a
State Planning Organization	10	18.0	18
LOSGEB	5.4	4.6	6.5
TTGV	35.6	35.4	35.5
Ministry of Industry and Trade	11	16.9	17.6
Total	319.0	353.4	252.6

Source: State Planning Organization

contributions of new personnel, and low interest loans are some examples of the various incentives.

Among others, the following measures were directed to finance the development of innovation-intensive start-ups: the "Technopreneurship" program implemented under the new R&D Law No.5746 by all public administrations having a R&D budget, "R&D Support for SMEs" of TUBITAK, and the "Pre-incubation Support" and "Start-up Support" of TTGV are some examples. The Turkish entrepreneurs' patent applications are supported by a program jointly coordinated by TUBITAK and TPE. The Ministry of Industry and Trade (MoIT) is in the process of designing a new program to support patent applications of enterprises. Along with the patent support, various programs are also designed to boost commercialization of R&D, examples of which include MoIT's "San-Tez" project, "Commercialization Project Supports" and "Joint Technology Development Projects" of TTGV. The Ministry of Industry and Trade has been in a process of designing "R&D Products Investment Support Program" and "Marketing and Promotion Support Program" to facilitate commercialization of industrial R&D activities. Incentives provided to the companies located in the technology development zones managed by the MoIT also stimulate private sector R&D and research-industry collaboration.

Researchers need training and mentoring on business planning - from the design and the development of a prototype, to market research and testing and IPR management - which requires some early stage funding. Thus, "business angels" finance and early-stage funds to be provided through public VC initiatives are of particular importance for academic entrepreneurs. Currently, in Turkey all public support programs provide grants and loans and there are no public equity investments in venture capital. A positive development in this area is the launch of the Istanbul Venture Capital Initiative (iVCi) in 2008, a Fund-of-Funds with ¢Ê150 million fund that is envisaged as a catalyst for the private equity sector, by the European Investment Fund with the participation of the TTGV, KOSGEB and the public Development Bank of Turkey (TKB). Details on venture capital sector in Turkey is provided in Annex 2.

The MoIT through its Directorate-General for Small Industrial Estates and Industrial Zones implements studies to stimulate cluster development activities in Turkey and designs a cluster support program which will be initiated in 2009.

6.1. IPR Sytem

One of the main sub-systems of National Innovation System is the Intellectual Property Rights (IPR) system that may have a very important role in promoting technological capability of any nation and a catalyst for development. The degree to which intellectual property is protected highly influences a country's inventive character as it shapes the flow of innovative ideas and products that are developed, which in turn affects creative and economic wealth. Therefore, understanding the legal and economic foundations of the intellectual property system is a prerequisite for comprehending its increasing importance and roll in national strategies for enhancing competitiveness and accelerating the socio-economic development (Alikhan, S. 2000)

Clearly, stronger rights will provide competitive advantages for innovative firms, allowing them to appropriate larger returns from creative activity and generating incentives for additional invention (Maskus, 2000). Therefore, successful IPRs protection is about producing effective, commercially driven results.

A study named the International Property Rights Index (IPRI), an international gauge of property rights, country by country was published by PRA in 2007. An index, which demonstrates countries' IPR protection performances, has been constructed in this study by making use of three core categories essential to the strength and protection of a country's private property system; legal framework, adequate physical property rights enforcement, and respect for intellectual property. Countries were ranked according to this index. The results of the study show that countries in the higher rankings of the IPRI are primarily advanced industrialized economies. Turkey ranks 38th, whereas Korea ranks 25th among 70 countries included in the study. While Norway is at the top of the list with 8.3 points, Turkey's score is 4.8 points, Korea's is 5.8.

Turkey has established an efficient and strong industrial property system in 1994 and 1995 by adopting several Laws, Decree Laws, Regulations and by participating all important international agreements in the field of industrial property protection. In 1994, the Turkish Patent Institute (TPI) has been established. Patent protection in Turkey is based on the Decree Law No: 551 Pertaining to the Protection of Patent Rights which was entered into force in 1995. Turkey has also become a full member of the European Patent Office (EPO) in 2000.

6.2. Incubators and Technoparks as a Policy Tool for Entrepreneurship

Many researchers have paid considerable attention to the role of technical change and innovation in providing a solid base for economic growth. Amongst a set of policy tools, establishing science parks and incubators (and their derivatives) has received widespread attention. Especially after the 1980s many countries have established science parks and incubators for stimulating the flow of knowledge and technology amongst universities, research and development (R&D) institutions and companies, i.e., stimulating interaction within and between agents in the economy. Science parks and incubators as policy tools for Turkish science and technology policy are important for several reasons.

It is believed that incubators are well-suited especially for countries that have rather weak national innovation systems (NIS) (Colombo and Delmastro, 2002). Referring to a number of assessment reports and indicators, the Turkish NIS can be characterized by low technology intensity and low levels of interaction. Thus incubators are basically formed to deal with such shortcomings. Establishing incubators are also one of the main elements of SME policy. It is supposed that the SME policy should aim at SME births, survival and success. Incubators are important mechanisms in this sense.

The key word in the modern learning economy is interaction and science parks and incubators mainly serve for setting the link between university, industry and other actors taking part in the economy. In this sense they can be viewed as special versions of networks and clusters. It is further believed that through networking, both SMEs and high-technology based firms (HTBF) can overcome their weaknesses associated with their small size. Since a number of similar firms are clustered into a physical entity, incubators can also serve as a special type of network. It is a fact that Turkey has certain interaction, coordination and organization problems within and between the institutions. So the policy option of establishing effective science parks and incubators can be a way out for Turkey in this sense.

Another important aim behind incubation is establishing a protective environment for firms in the start-up period. Besides ordinary problems that are present in any other developed country, the Turkish SMEs face another significant obstacle which is the unstable macroeconomic environment. Incubators may assist to overcome this instability in the start-up phase.

It is also a fact that developing countries have limited resources both in terms of technological and human resource capacity. Incubators can assist in the use of resources in a more efficient way. Besides, Turkey is one of the countries that suffers from brain drain. Every year many well-educated technical and scientific personnel move to other countries for reasons associated with better opportunities. Science parks and incubators may be the very last attempt in reversing this situation by enabling these people to implement their knowledge and skills within the borders of Turkey.

● Technology Development Zones (TDZs)

Turkey, like many developing countries, started to use scienceparks or technoparks as its primary strategy for promoting R&D and technology transfer, creating jobs for high-skilled IT and R&D personnel, attracting Foreign Direct Investment, and generating sustainable economic growth and local know-how. Technoparks have found their legal status with the enactment of the law on Technology Development Zones - TDZ (no: 4691) in 2001 and its implementation

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regulation in 2002.

By 2008, 31 Technoparks have been approved in Turkey by the MoIT (under the Technology Development Zones Law of 2003) with 18 of them currently active and housing 890 companies (of which 32 are foreign) that employ 7,437 R&D staff and 2,308 technical support personnel and implement 2,671 R&D projects (in ICT, electronics, defense, telecommunication, medical/bio-medical, advance materials, industrial design and environmental technologies). Some Statistics on Technology Development Zones (TDZs) in Turkey are provided in Annex 3.

Technoparks are supposed to encourage start-ups and spin-offs from universities and public RDIs by offering a combination of infrastructure support and business development services in addition to the natural advantages of proximity to the host research institution. In the case of Turkey, given the generosity of the tax incentives provided by the Technology Development Zones Law, there is a concern that the infrastructure-support side of the business has started to loose its importance.

● Technology Development Centers (TEKMERs)

KOSGEB's incubators (called 'Technology Development Centers' - TEKMERs) are the first initiatives in the country for supporting the start-up of technology-based companies. As from 1991, KOSGEB established 20 TEKMERs jointly with universities. TEKMERs which are established with and located in universities create an environment for stimulation of university-company co-operation. TEKMERs help close cooperation in-between the research community and the business sector.

Since 1991, 1.858 R&D projects have been supported of which 873 of them have been commercialised successfully. 17,949 personnel have been employed and 180 patents have been obtained. There are currently 135 tenant firms that have been supported in these 20 TEKMERs.

Table 6-7 | TEKMER Enterprises

	2002	2003	2004	2005	2006	2007	2008
Number of Firms	133	203	173	204	166	159	135
Number of Personnel	155	218	146	244	312	329	398
Percentage of Firms Engaged in R&D	55%	44%	38%	53%	58%	65%	66%
Number of Graduates	13	44	66	111	87	59	74

Source: KOSGEB

TEKMERs in Turkey share common characteristics with Technology Business Incubations - TBIs. TBIs are not very different from other incubators. By means of TEKMERs, entrepreneurs are provided business-incubator services, services of common facilities, technical/ financial/ managerial consultancy assistance, information services, training programs, laboratory and prototype manufacturing workshops facilities including the financial support for equipment/ material, participation at fairs, software acquirement and qualified workforce together with professional personnel recruitment.

Some of these centers are quite effective in promoting spin-offs and new technology based firms. For example, 80% of the tenants of METU-KOSGEB TEKMER are new companies and 40% of these companies are university spin-offs.

In the provinces in which TEKMERs are not established yet, the same services and support programs are provided to SMEs through a program called “Technology Incubators without Walls” (so called DTIs) in their own units aiming to develop advanced technology in manufacturing and carry on R&D studies. There are seven Technology Incubators without Walls. There are also three private incubators established by Koç Holding and Siemens.

Another institution that shares some common characteristics with incubators in Turkey is the Ericsson Mobility World (former known as the Crea-World) located in Istanbul. This cannot be identified as an incubator because the main objective is neither to facilitate new high-tech firm creation and development, nor the transfer of technology from universities for the commercialization of research. It aims to encourage firms and entrepreneurs to develop, test and commercialize wireless mobile internet applications and services. Like incubators, administrative and technical supports as well as training are made available by the institution. A solid infrastructure and physical working units are also provided. Firms within the Ericsson Mobility World are either supported on a project basis or can obtain the privilege of being a partner. However, it should be emphasized that the Ericsson Mobility World does not fit into the concept of incubators.

7. Entrepreneurships of Technology Start-ups

In January 2009, a survey was conducted to academic personnel of engineering departments in Middle East Technical University (METU). Among all academicians, only 38 responded to our survey. Out of 38, 27 hold a PhD degree while the remaining 11 are graduate students.

According to the survey results, approximately 48% of faculty members and 45% of graduate students have thought vaguely about their start-up business. Moreover, it showed that 19% of faculty members and 36% graduate students thought about their venture businesses

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specifically.

If the circumstance permits, 41% of faculty members and 64% graduate students would like to establish their own businesses directly. When it is asked to name their start-up related ideas, most of the faculty members (31%) and graduate students (35%) replied that they have ideas on information and communication technologies. Again for both groups, the second highest preference occurred to be the electrical and electronics technologies. Metallurgy, fine chemicals, mechatronics, machinery and environment turned out to be the least preferred technological areas.

● Commercialization of Research Results

According to our survey data, 22% of faculty members had previous experiences in commercialization of research results. Out of 22%, the percentage of faculty members who had some contact with the private corporations for commercialization of their research results has been 67%. The commercialization percentage came out to be very high compared to the realizations. For the graduate students, 27% of them had previous experiences, out of which only 33% contacted the private corporations for commercialization of their research results.

● Start-ups' Potential Capital Sources

When the faculty members or the graduate students wanted to establish their own business, the top potential capital sources turned out to be start-up related supporting systems (47% and 33% respectively) and own money (33% and 43% respectively). Friends or relatives and financial institutes have also important potential (20% as a total) for graduate students.

● The Expected Difficulties and Supports Needed for Starting Business

When starting their own businesses, the faculty members had the most difficulty in finding the funding capital (30%), followed by complicated administrative procedure for opening businesses (22%) and lack of demand for products and marketing (17%). However, fear of failure (12%) and solution of technical problems (2%) were not considered to be the major difficulties in starting a business. The graduate students faced similar top two difficulties with the faculty members. Different than the faculty members, shortage of managerial know-hows and fear to failure (both 16%) were important obstacles.

As expected, both faculty members and graduate students mostly needed capital supports in order to start their businesses. Administrative support including simplifying the complicated procedure for start-ups is the second mostly required support. Information and equipment supports are the least preferred ones for both groups.

● Opinions for Start-up Promotion

According to the faculty members, the most effective way for start-up promotion was legal permission of start-ups in the technopark area (20%), joint researches between start-ups and the research institutes in the university (19%), use of university equipments (16%) and guarantee of return in the case of failure (16%). For the graduate students, the results were nearly similar except they also considered active introduction of success and failure start-up cases (13%) as important.

8. Effectiveness of Technoparks and Incubators on Entrepreneurship

8.1. Questionnaire about Entrepreneurship

Sample Data

In December 2008, questionnaires were administered to three main technopark tenants in the Ankara region (Metutech, Bilkent Cyberpark and Hacettepe Technopark), to TEKMERs (incubators) all around Turkey and to OSTIM (Middle East Industry and Trade Center Organized Industrial Zone) enterprises. Where enterprises in technoparks and TEKMERs mostly represent high-tech businesses, enterprises in OSTIM are representatives of low-tech businesses. Detailed information on Metutech and OSTIM are given in Annex 4.

Currently, there are 242 enterprises in Metutech, 165 in Cyberpark and 105 in Hacettepe Teknokent. Total number of responses from three Technoparks was 71, mainly coming from Metutech. From TEKMERs all around Turkey, only 58 out of 200 enterprises responded the questionnaire. There are around 5,000 firms in OSTIM. A small sample of 60 enterprises was selected, out of which 56 enterprises responded.

Characteristics of Entrepreneurs

Table below shows that most of the enterprises (70%) are recently established in TEKMERs. While 45% of the firms in technoparks are newly established, some older firms also take place in technoparks in order to utilize the tax exemption. OSTIM seems to be not preferred by new entrepreneurs, 77% of the firms are older than 10 years. For the entrepreneurs, 25 - 30 range is the dominant age group for ventures in all regions. It may be because the average graduation age from the university is around 23.

Comparing the education level among the regions, it is seen that the majority of the venture owners are university graduates. The high school graduates are more into the low-tech business and start their ventures in OSTIM. While the percentage of people having a bachelor degree is higher in Technoparks, incubators have more people with PhD degrees.

Majority of entrepreneurs in three regions majored in natural sciences and engineering. Only in OSTIM, nearly one third of respondents majored in arts and social sciences. Previous expertise of entrepreneurs are R&D and technical with 60% in Technoparks, technical and other with 69% in incubators and technical and other with 58% in OSTIM. More than half of the entrepreneurs worked at private sector before starting their ventures.

Table 6-8 | Characteristics of Entrepreneurs

Characteristics		Technoparks		Incubators		OSTIM	
Enterprise age	0-5	30	45%	39	70%	6	10%
	5-10	18	27%	5	9%	7	13%
	→10	19	28%	12	21%	43	77%
Entrepreneur Age at Start-up	Under 25	14	20%	9	16%	19	34%
	25 -30	22	31%	16	28%	19	34%
	31-35	9	13%	9	16%	5	9%
	36-40	13	18%	6	10%	8	14%
	41-45	8	11%	9	16%	4	7%
	Over 45	5	7%	9	16%	1	2%
Education	HS	1	1%	4	8%	14	30%
	Bachelor	34	48%	17	32%	29	63%
	Master	30	42%	22	42%	3	7%
	Ph.D.	6	8%	10	19%	0	0%
Major	Arts & Social Sciences	6	9%	2	4%	8	30%
	Natural Science & Engineering	57	84%	44	90%	18	67%
	Others	5	7%	3	6%	1	3%
Previous Expertise	R&D	21	31%	9	16%	1	2%
	Technical	20	29%	19	33%	12	28%
	Students	5	7%	6	10%	8	19%
	Clerical	4	6%	1	2%	7	16%
	Sales	2	3%	2	3%	2	5%
	Others	10	15%	23	36%	13	30%
Previous Institution	Education	11	15%	13	21%	7	13%
	Private	49	69%	33	57%	36	64%
	Public	3	4%	6	10%	8	14%
	Research Institute	4	6%	1	2%	1	2%
	Other	4	6%	8	10%	4	7%

Influence Factors on Start-Up

It can be seen that location is the most important factor for entrepreneurs in all regions, ranking first for incubators and OSTIM, and second for Technoparks. Since Technoparks are founded under the premises of the universities, firms that want to take support from the university or research institute prefer to establish their businesses in Technoparks. Moreover, all the entrepreneurs think that their own aggressive entrepreneurial disposition and strong business skills are the critical influential factors to start a venture.

Although the government showed a great effort on supporting new ventures, surprisingly, capital, manpower, and technology support of government are not in the top list of influential factors. Especially entrepreneurs in OSTIM did not consider this support while deciding to establish their businesses.

Management services and office services supplied by technoparks or OSTIM had no influence for start-up of a venture. Since in Turkey venture capital market is at a primitive stage, it has no effect in new venture establishment. Therefore, it is not an influential factor for entrepreneurs.

Table 6-9 | Influential Factors on Start-up

	Technoparks	Incubators	OSTIM
Top 5	1. Support from Univ.& Research Institutes 2. Location 3. Strong Entrepreneurship 4. International networking 5. Technical Expertise	1. Location 2. Strong Entrepreneurship 3. Low Cost Space 4. Support from Univ.& Research Institutes 5. Business Plan	1. Location 2. Domestic Networking 3. Strong Entrepreneurship 4. Market Conditions 5. Marketing
Bottom 5	14. Admin & Fin Services 15. Venture Capital 16. Office Services 17. Management Services 18. Low Cost Space	14. Leadership 15. Marketing 16. Market Conditions 17. Management Services 18. Venture Capital	14. Support from Univ.& Research Institutes 15. Support from gov./found./ assoc. 16. Venture Capital 17. Office Services 18. Management Services

Contribution Factors on Growth

According to the results of the survey, effecting factors for start-up or growth do not change. Entrepreneurs' own aggressive entrepreneurial disposition and strong business skills also affect their growth. Location is the second important factor on growth. The entrepreneurs in Technoparks base their success on the support taken from the university. While technical expertise is critical for the entrepreneurs in Technoparks and incubators, marketing and networking is more important for the entrepreneurs in OSTIM. This can be due to the low-tech characteristics of the businesses in that region.

Again, the governmental support and venture capital is not considered as a key influential factor for growth. Moreover, management and office services also have a very low effect.

Comparison between influence for start-up and contribution for growth

Most of the factors surveyed have showed no influence (values <=3) either for start-up and growth. Besides, there is a noticeable difference in the evaluation of OSTIM as compared to the technoparks and incubators in terms of the support taken from the universities and research institutes. This result is not surprising when the nature of activities in technoparks and incubators are considered.

Satisfaction Level of Services

According to the results of the questionnaire, the incubator tenants are the most satisfied group with the level of almost all the services supplied by TEKMERs. Technopark firms are highly satisfied with the tax exemption programmes and building security services, whereas the incubator tenants are mostly satisfied with the low cost space as it is the most critical and contributing function to their venture businesses. OSTIM ventures are mostly unsatisfied with the services. This can be due to the service quality or the lack of the services that are needed.

Firm's Principal Businesses

The results of the questionnaire show that the principal businesses of the firms in technoparks and incubators are software, IT or telecom. This could be because of the university's research excellence area. But most of the technoparks in Turkey have a similar technology area distribution even if the technology excellence area of university is different. This can be explained with the law restriction to have manufacturing/production facilities or activities in the technology development zones. In OSTIM, medical and life sciences are rated as the principal businesses of the firms but this can be the result of the selected group of ventures for the survey.

Table 6-10 | Critical Success Factors for Start-up and Growth

Critical Success Factors	Technoparks		Incubators		OSTIM	
	Influence for startup	Contribution for growth	Influence for startup	Contribution for growth	Influence for startup	Contribution for growth
Low Cost Space	1,94	2,00	3,76	3,50	2,25	2,11
Man. Services	2,09	2,08	2,79	2,71	1,84	2,05
Office Services	2,16	2,26	3,16	3,17	1,88	1,93
Admin.&Fin. Services	2,39	2,50	3,08	3,10	2,27	2,46
Leadership	2,66	2,65	3,02	3,17	2,09	2,07
Support from Univ.& Research Institutes	3,94	3,64	3,75	3,36	2,00	1,86
Support from gov./ found./ assoc.	3,27	3,25	3,08	2,84	1,98	1,93
Venture Capital	2,39	2,38	2,76	2,63	1,95	1,96
Market Conditions	3,19	3,09	2,90	3,08	3,16	3,25
Entrepreneurial Culture	3,28	3,13	3,27	3,47	2,70	2,80
Domestic Networking	3,18	3,16	3,08	3,12	3,66	3,40
International Networking	3,38	3,32	3,14	3,12	2,45	2,66
Strong Entrepreneurship	3,50	3,60	3,88	3,74	3,32	3,63
Business Plan	2,91	3,02	3,49	3,30	2,32	2,34
Man. Capability	2,96	3,26	3,43	3,31	2,40	2,79
Location	3,91	3,69	3,90	3,53	3,73	3,34
Marketing	2,92	3,08	3,00	2,93	3,09	2,98
Technical Expertise	3,36	3,48	3,42	3,42	2,55	2,84

Table 6-11 | Satisfaction Level of the Services

Services	Technoparks	Incubators	OSTIM
Low Cost Space	2,05	4,19	2,30
Advertising & Marketing Ass.	2,65	2,68	2,62
Tax Related Services	4,06	3,29	2,35
Cashflow Forecasting	2,38	2,46	1,94
Logistics	2,90	2,78	2,47
Security	4,05	3,34	2,82
Proxy for Tenants	2,67	2,74	1,98
Computer Services	2,95	3,30	2,65
Import/Export Serv.	2,41	2,29	2,36
Relocation Consultancy Serv.	2,68	3,00	2,24
Direct Loans	2,37	3,00	2,44
Leadership	3,41	3,67	2,79
Transportation	3,29	3,36	3,25

Table 6-12 | Enterprises' Business Distribution

	Technoparks		Incubators		OSTIM	
Electrical/Electronical	14	20%	7	12%	10	15%
Computer and Multimedia	2	3%	2	3%	14	21%
Software, IT or Telecom.	38	55%	19	33%	3	5%
Medical and Life Sciences	3	4%	3	5%	26	39%
Machinery	2	3%	9	16%	3	5%
Other	10	14%	18	31%	10	15%

Experience in Starting Own Business

Most of the firms in the three categories lacked initial venture founding experience when they had started their own business. They are mostly coming from private sector with technical work experience referring to previous tables. Only one third of them have been the founder of formal business and almost no investors in start-up. This shows that the firms in the three categories were entrepreneurs lacking experience and in need of guidance and direction.

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Table 6-13 | Experience for Starting up Business

	Technoparks		Incubators		OSTIM	
No experience	48	68%	34	58%	30	54%
Founder of formal business	16	23%	19	32%	14	25%
Employee of recent start-up	4	6%	2	3%	4	7%
Investor in start-up	0	0%	0	0%	1	2%
Founder's family founded start-up	3	4%	2	3%	7	13%
Other	0	0%	2	3%	0	0%

Motivation to Start the Company

According to the results of the survey the primary motivation to start the company is different for the technoparks and OSTIM. The primary motivation of the incubators and technopark is to utilize their own technology and talent, and to be in their own business whereas it is to be in their own business only for OSTIM companies. The majority (70%) of the firms at OSTIM started their own companies for the sake of being in their own business. This can be the necessity-based motive for OSTIM companies such as unemployment acting as a strong push-factor. When the answers of the technopark firms are analyzed, the primary reason is to be in their own business but the close followers of this motive is to use own talent and technology. In this respect the technopark firms and the incubators are alike and it is not surprising as these firms aim at creating and using their own know-hows.

Table 6-14 | Motivation to Start Business

	Technoparks		Incubators		OSTIM	
To utilize your own technology	19	23%	24	29%	5	9%
To best use your talent	24	29%	19	23% 5	9%	
To be in your own business	25	30%	21	26%	39	70%
To do something your like	12	14%	12	15%	3	5%
To earn a large income	2	2%	3	4% 1	2%	
Other	1	1%	3	4%	3	5%

Total Sales in USD ($) for the Most Recent Fiscal Year

The total sales of the most recent fiscal year (2007) are between $300,000 and $ 1,000,000 for technoparks and OSTIM. The sales for the incubators are a lot lower than the other two with

$0 to $9,999 of sales. This is understandable as the incubators' primary purpose is not to generate revenue but it is to create the know-how that will eventually generate sales and revenue out of the venture business. Valorisation which is defined as commercialization of R&D results, has three phases: business invention, business creation and business growth. Incubator tenants are mostly in the business invention phase of which they try to proove the concept where no or very few sales.

Average Sales Growth, on a Year-By-Year Basis

The average yearly sales growth of technoparks is between 1 to 100%, OSTIM is between 1 to 50% whereas the growth of the incubators is between 0 to 20%. Technopark companies are expected to grow more since their business is in medium/high tech with more added-value compared to OSTIM companies.

Table 6-15 | Average Yearly Sales Growth

	Technoparks		Incubators		OSTIM	
0 or Under 0%	5	9%	17	35%	6	11%
1 - 20%	14	24%	13	27%	24	44%
21 - 50%	17	29%	9	19%	15	28%
51 - 100%	12	21%	4	8%	5	9%
Over 100%	10	13%	5	10%	4	8%

Number of People Currently Working for the Firm (excluding owner)

There are firms at various sizes in OSTIM in terms of the number of people working for the firms excluding the owners. But in the technoparks and incubators the majority of the firms employ fewer personnel (micro-level ventures) as the core business function of these firms are in software development and IT.

Table 6-16 | Employment Distribution

	Technoparks		Incubators		OSTIM	
0 - 5 people	19	29%	35	60%	14	25%
6 -10 people	18	27%	10	17%	10	18%
11-15 people	7	11%	1	1%	9	16%
16 - 20 people	7	11%	6	10%	5	9%
21 - 30 people	10	15%	3	5%	9	16%
31 - 50 people	5	8%	3	5%	9	16%

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Employment Growth, on a Year-by-year Basis, from the Time of Start-Up to Present

There is not a noticeable difference between the yearly employment growth rates of Technoparks, incubators and OSTIM firms. From the time of start-up the firms have grown their employment figures by around 50%. While some of the companies in technoparks and a bunch of incubator tenants experienced an employment growth rate of more than 100%, there is not a single enterprise among OSTIM that experienced the same growth.

The Annual Growth of Investment Capital from the Time of Start-Up to Present

There is no annual growth of investment capital from the time of start-up till present for almost half of the incubator tenants which proves the fact that the incubators are not interested in capital investment but rather their investment is in innovating new ideas or technologies. Similarly, a comparison between the Technoparks and OSTIM shows that the firms within the industrial zone are more inclined to grow their capital than the other. 80% of the firms of OSTIM have grown their capital investments by at least some percent.

Table 6-17 | Average Annual Growth of Investment Capital

	Technoparks		Incubators		OSTIM	
Under 0%	10	17%	17	46%	3	6%
1 - 20%	15	25%	0	0%	23	43%
21 - 50%	9	15%	4	11%	18	34%
51 - 100% 8	14%	4	11%	4	8%	
Over 100%	17	29%	12	32 %	5	10%

The Growth Rate of R&D Expenditures

The percentage of R&D expenditures shows how much the firms invest in developing new technologies. The growth rate of R&D expenditures of 74% of the Technoparks firms is between 1 and 100% and the majority of OSTIM firms declare their R&D growth rates as between 1 to 50%. The figures are interesting for the incubators as 26% of the participant incubators show their growth rate of R&D expenditures as below or either 0% and 56% as between 21 and 100%:

Table 6-18 | Average Growth Rate of R&D Expenditures

	Technoparks		Incubators		OSTIM	
Under 0%	3	4%	9	26%	13	25%
1 - 20%	18	26%	0	0%	28	54%
21 - 50 %	18	26%	11	32%	5	10%
51 - 100%	15	22%	8	24%	4	8%
Over 100%	14	21%	6	18%	0	4%

Foundation of an Enterprise

In line with the core competences of technoparks and incubators, the majority of the entrepreneurs in these categories started their businesses with the intention of applying a new idea or a technology discovered during production stage of another product or business or based on R&D results using basic scientific research, knowledge or technologies. However, the firms in OSTIM differ at this point with less foundation on R&D and basic scientific research. Most of the firms in OSTIM were founded by applying a new idea or technology or only as an investment without any new technological ideas. Therefore, it would be logical to expect less tendency of OSTIM firms for research and development activities and thus less likely to have higher R&D spending.

Table 6-19 | Foundation Situation of Firms

	Technoparks		Incubators		OSTIM	
I started my firm applying new idea or technologies discovered during production stage of another product or business.	30	42%	24	41%	25	45%
I started my firm as an investor or a management expert even though I did not have any new technological ideas.	10	14%	6	10%	25	45%
I started my firm based upon R & D results using basic scientific research, knowledge or technologies.	31	44%	28	48%	6	11%

Services Provided

As a general view, firms in teknoparks mostly felt services from “myself”; firms in TEKMERs from “TEKMER” and firms in OSTIM from “myself”. It can be concluded that the services given to the firms in teknoparks and OSTIM are not very effective or they are not at the level of satisfaction. Firms in TEKMERs can be said to be quite satisfied with the services provided. The satisfaction levels for the services are summarized as the followings:

- Only firms in TEKMERs feel that TEKMER provides low cost space. Others think either the space cost is not low (Technoparks) or the space belongs to the owners (OSTIM);
- Firms in OSTIM do not feel / deliver any management services from OSTIM. Incubator tenants deliver managements services mostly from TEKMERs or from private companies;
- Other than firms in incubators, firms do not feel that they take decent office services;
- Administrative and financial services are mostly provided by banks and the firms themselves;
- Other than incubators, firms mostly use their own resources for leadership. Incubator companies are getting leadership service mostly from incubators and universities;
- For marketing services incubator companies use private companies;
- Technopark companies use their own resources or technopark for international network access. Incubator companies use governmental support to do that. This can be the EU Framework Programme contact points;
- For business plan development incubator companies get help from incubators;
- Firms in technoparks and incubators feel that management provides them a good location.

8.2. Questionnaire for TEKMER (Incubator) Managers

A questionnaire was prepared to get some data on the qualifications of TEKMER (incubator) management and to get some data about TEKMERs. The questionnaire was sent to 18 TEKMER managers, out of which 16 responded.

Education Level of Managers

The incubator managers generally have an undergraduate degree (75%) and only 25% of the active managers have higher degrees like master’s or Ph.D.

Field of Study

A majority of the incubator managers in the sample have majors in natural sciences and engineering (56%) followed by the 38% who have majors in social sciences.

Average age of TEKMER Management Personnel

The dominant age group for the incubator personnel is late 30s (31%) followed by early 30s (25%) and early 40s (25%).

Previous Involvements of TEKMER Managers

Prior to being incubator managers, half of them had jobs in technical fields and only 19% was engaged with R&D positions.

Previous Organisation of TEKMER Managers

A majority (88%) of the managers in the sample were engaged in public sector positions since TEKMERs are part of KOSGEB.

Firms' Principal Businesses

The principal business of the incubator firms, as depicted in the table, turns out to be in the fields of electrical/electronical and software, IT or telecom which require higher technologies and know-how. The results are compatible with entrepreneurship survey.

Table 6-20 | Firms' Principal Business

	Number of Firms	%
Electrical/Electronical	150	31%
Computer and Multimedia	30	6%
Software, IT or Telecom.	146	30%
Medical and Life Sciences	40	8%
Machinery	75	16%
Other	39	8%

Number of Firms in TEKMERs

As of 2008, there are 200 firms functioning in the 16 incubators around Turkey, 132 of which are engaged in R&D (66%). It is a good indicator to have a growing percentage of firms engaged in R&D activities. Within these firms 398 people are employed. Number of yearly graduates is around 40%. The related figures are shown in the following table.

Total Sales of Firms in TEKMERs (2007)

As the primary reason for the existence of firms within the incubators is not to achieve sales so that the sale figures for these are quite low compared to commercial companies.

Table 6-21 | Some Statistics on TEKMERs

	2002	2003	2004	2005	2006	2007	2008
Number of Firms	133	203	173	204	166	159	135
Number of Personnel	155	218	146	244	312	329	398
% of Firms Engaged in R&D	55%	44%	38%	53%	58%	65%	66%
Number of Graduates	13	44	66	111	87	59	74

Table 6-22 | Total Sales of Firms in TEKMERs

Total Sales (US Dollars)	Number	%
$0-$9,999	35	18%
$10,000-$100,000	59	31%
$100,001-$300,000	22	11%
$300,001-$500,000	15	8%
$500,001- $1,000,000	11	6%
$1,000,001-$1,500,000	10	5%
$1,500,001-$2,000,000	5	3%
$2,000,001-$2,500,000	7	4%
$2,500,001-$3,000,000	2	1%
$3,000,001-$4,000,000	-	-
$4,000,001-$5,000,000	2	1%
Over $5,000,000	24	13%

Importance of Services Provided by TEKMERs (Perceived by Managers)

As perceived by the incubator managers the most important services provided by the incubators are the low cost space, incubator's location, office services and the administrative and financial services. As rated by the managers, the least important of all the services is the venture capital, which is probably due to the lack of its existence. However, all services are found less satisfactory by tenant firms compared to managers.

Table 6-23 | Importance of Services Provided by TEKMERs

	Managers	Tenants*
Low Cost Space	4,2	3,6
TEKMER's Location	4,1	3,7
Office Services	4,1	3,2
Admin.&Fin. Services	4,1	3,1
Business Plan Preparation Services	3,5	3,4
Management Consultancy Services	3,8	3,4
Leadership	3,9	3,1
Providing Entrepreneurial Culture	3,8	3,3
Support from Univ.& Research Institutes	3,7	3,5
Technical Expertise	3,9	Na
Adv.Design/Prod.Techn. & Lab. Services	3,3	Na
Support from gov. /foundations/ assoc.	3,6	3,0
Venture Capital	2,6	2,7
Domestic Networking	3,3	3,1
International Networking	3,3	3,1
Marketing Services	3,1	3,0
Support to Reach Markets	3,4	3,0

* Average grades from Table 8.4 & 8.5 are used

8.3. Summary of the Main Findings

- Young entrepreneurs are more likely to start a new venture (< 30 years old).
- The entrepreneurs starting high-tech ventures are relatively well educated.
- Engineering graduates are more likely to start a new high-tech venture.
- Most of the entrepreneurs have previous experience in private sector (around 60%), having few experience to start a new business.
- Strong entrepreneurship feature is the main driving force to start a new venture.
- Entrepreneurs select technoparks or incubators to start their venture for the opportunity of having support from universities.
- Incubators are mainly selected because of the opportunity of low cost space and of having support to develop business plans.
- Low-tech companies come together for domestic networking.
- Entrepreneurs are more likely to start high-tech venture in software, IT or telecom technology areas.

- To be self-employed is the driving force for low-tech ventures (necessity-driven).
- To utilize own technology or to use talent are the driving forces for high-tech ventures (opportunity-driven).
- Technopark ventures spend more on R&D.
- No difference in total sales for high-tech or low-tech ventures, but sales growth rate is much higher for high-tech ventures located in technoparks whereas investment capital growth rate is higher for low-tech ventures.
- High-tech ventures are more likely to be micro-sized, low-tech ventures are more likely to be small to medium sized.
- Management and office services supplied by technoparks have no influence on start-up a venture.
- Incubators provide service to their tenants at a satisfactory level.
- Venture capital has no influence on start-up a venture since there is lack of venture capital companies or initiative.
- Tax exemptions make technoparks attractive for ventures even if they are providing space at a high cost.
- Technopark/incubator ventures seem to have better access to governmental supports and international networking.
- There is a lack of marketing services provided by technoparks/incubators.
- Success of ventures in general rests mainly on their own strong entrepreneurship capacity. Besides success of ventures in technoparks or incubators rests also on their technical expertise and on support from universities.

9. Concluding Remarks

The survey results and other related papers show that incubators in Turkey play an important role in supporting technology based entrepreneurship but still technoparks/incubators are not very effective or do not seem to have a strong pull effect for academicians for start-up business. Even if the total number of incubators is low compared to the number of academicians or graduates, the occupancy percentage is low. Entrepreneurial activities like venture start-ups are also not favorably seen or culturally accepted by the academicians.

As it is also stated, there are many agencies providing various services to entrepreneurs or start-ups but the service network or co-operation is not effectively utilized and well-developed to obtain the maximum added-value. Furthermore, there is also a necessity to support enterprises through convenient advisory and training activities from establishment to development and growth phase. Promotion and training/education activities with success stories

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and role models can be helpful for venture capital and business angel investors as well as for potential entrepreneurs.

There is too much focus on IT and software technologies for enterprises at incubators and technoparks. This is unfortunately not related with the expertise of the university and as Turkey there is no strategical national plan for the information or software technologies. There is a need for attracting other technologies to have cross-sectoral R&D.

The establishment and survival of technology based start-up enterprises is hindered also by the lack of early stage funding and an undeveloped venture capital industry. There is a need of public financing to stimulate the development of the venture capital industry and early stage funding.

Framework conditions and design policies of technology development zones - on national and regional level - should enable the development of dynamic, effective and innovative incubators and technoparks. Incubators and technoparks should be constucted as a regional strategy for the effective technology transfer and linking mechanisms. Policymakers should evaluate the available support programmes, better understand entrepreneur's current situation and the barriers for start-up, their growth and development - in order to form appropriate policy mechanisms to support enterprise development.

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A.1. Ministry of Industry and Trade

Technology Development Zones (TDZs)

Technology Development Zones Law regulates the establishment, development, management and supervision of Technology Development Districts. This legislation promotes the use of high/advanced technologies and the development/production of technology or software in technology development zones, and the related R&D capabilities, through cooperation between universities, research institutions, and production sector. Under this Law there are income and corporate tax exemptions provided to the R&D performing companies. The aim of this Law, through the cooperation of universities, research institutions and the production sector is to;

- Produce technological information,
- Develop innovations in products and production methods,
- Increase standards of products and productivity,
- Decrease production costs,
- Commercialize technological information,
- Support technological production and enterprise,
- Achieving the adaptation of small and medium scale enterprises
- The latest and advanced technologies,
- Create investment possibilities in technologically intense areas considering the determinations of the Scientific and Technical High Commission,
- Provide job opportunities for qualified and inquisitive people,
- Help technology transfer and providing technological infrastructure,
- Provide high and advanced technology that will speed up foreign capital inflows.

This Law also provides incentives for mobility of university researchers to work with private companies located in technoparks. Those incentives include;

- Retaining the earnings from such companies by the researcher if she/he works at the company part-time,
- Permitting the full-time recruitment of researchers by companies without paying the salaries by the university/research institute,
- Allowing the academics to complete their studies that have to be conducted by temporary recruitment in the country or abroad, at the companies in the technoparks,
- Allowing academics to start up their company to commercialize research results in the technoparks and/or to become a shareholder in companies located in technoparks and/or

to take part in the management of such companies.

The Ministry of Industry and Trade provides the main financial support mechanism for TDZs. Financial support is granted for land procurement, infrastructure and construction of management building.

SAN-TEZ Programme

"SAN-TEZ" has been launched by Ministry of Industry for developing the university-industry collaboration. The aim of this project is:

- To commercialize the academic knowledge, to transfer the academic knowledge into high added value technological products,
- To solve the problems of industry during production process in cooperation with the universities,
- To provide R&D and technological culture for SMEs.

During the period of 2006 - 2008, a total of 110 projects have been approved to take the support (17 projects in 2006, 68 projects in 2007, 26 projects in 2008)

Pre-Competition Cooperation Projects Support Programme

In order to utilize supports and incentives mentioned in the Law on Supporting R&D Activities numbered 5746, MIT runs the Pre-Competition Cooperation Projects Support Programme.

New Law on "Supporting Research and Development Activities

In April 2008, the Government approved a new Law on "Supporting Research and Development Activities" (Law No. 5746)), implemented by the DG Industrial R&D of the Ministry of Industry and Trade, that provides a range of fiscal incentives for R&D activities by the private sector, (as well as for projects supported by public agencies and international institutions).

R&D Support Program Based on Law No.5746

Implementation of the R&D Law has been initiated after the issuance of the regulations in July 2008 and applications are being received on R&D centers from large companies. These applications are reviewed by the 'R&D Centers Auditing and Evaluation Board', which is composed of five members [one from the MoF (Deputy DG of Income Policies), one from the MoIT (DG Industrial R&D) and three academicians having expertise in the field of projects. First two members are permanent members of the Board but academicians are changed according to the technological area of the project.] After the first review has been done by the Board, projects are evaluated by another three academicians who visit companies and prepare a report based on the main selection criteria. Reports are then reviewed by the Board which makes the final decision on applications.

The MoIT DG Industrial R&D also announced the 'Pre-competitive R&D Support Scheme' and "Technopreneurship support" covered by the Law.

Main Features of the New R&D Law		
Features		Identified Issues
R&D discount (volume of R&D)	100% of R&D and innovation expenditures made by technology centers' enterprises, by R&D centers, in R&D or innovation projects supported by public administrations or international funds, is discounted in the calculation of corporate earnings	• Big companies with over 50 full time R&D personnel can benefit from incentives. • For SMEs, companies getting support from TUBITAK, TTGV and KOSGEB (and Intl agencies) are eligible.
R&D discount (Increment of R&D)	Half the amount of increase compared to previous year in R&D and innovation expenditures made by R&D centers which employ more than 500 full time equivalent R&D personnel is discounted (in addition to 100% of R&D expenditures) in the calculation of corporate earnings	Large companies with over 500 R&D personnel can use the incentive
Tax exemption for R&D personnel	The income tax of R&D and support personnel working for technology centers' enterprises, in R&D centers and for R&D and innovation projects which are supported by public administrations or international organizations or for those projects which are carried out by TUBITAK, those working in pre-competitive research projects and in those enterprises benefiting from Technopreneurship capital support will not be paid at a rate of 90% for those with PhD degrees and 80% for others	• Large companies with over 50 R&D personnel can benefit directly from incentives • For SMEs, only those getting support from TUBITAK, TTGV and KOSGEB (and Intl agencies) are eligible
Social security payments for R&D personnel	Half the amount of social security payments which is required to be paid by the employer of R&D personnel working for technology centers' enterprises, in R&D centers and for R&D and innovation projects supported by public administrations or international organizations, or implemented by TUBITAK will be covered by the Ministry of Finance for five years.	• Large companies with over 50 R&D personnel can use the incentives directly • For SMEs companies getting support from TUBITAK, TTGV and KOSGEB (and Intl agencies) are eligible

Features		Identified Issues
Stamp tax exemption	Any documents to be prepared for R&D and innovation activities within the framework of this law shall be exempt from stamp tax	
Technopreneurship support	Public administrations can provide one time Technopreneurship capital support up to 100,000 TL without collateral	Only recent university graduates can benefit from the support
Pre-competitive research	Budgets created for pre-competitive projects will not be treated as income for the partner organization holding the special account on behalf of the other partners	
Tax exemption for R&D incentives	Grant support provided for R&D activities of companies will not be considered as income if kept in a special fund	

Support programs by MoIT to be introduced in 2009:

- Patenting Support Program; providing financial support for covering the costs of intellectual and industrial property rights (Patent, Utility model, Industrial Design) registration.
- Industrial R&D Investment Support Program; providing an investment support (Seed Capital) necessary for the patented end products of R&D projects.
- Industrial R&D Products Marketing Support Program; providing financial support for marketing activities for the high value added innovative products or production methods.

A.2. TUBITAK - TEYDEB Programmes

TEYDEB's vision is to strengthen industrial research and technological development ability in accordance with National S&T Policy. TEYDEB's mission is: to develop and apply tools for the stimulation of industrial R&D, to involve all the partners in accomplishing the mission, and to accomplish the mission at high quality public service level

Under the program 'State Support for R&D' financed by the DTM, TUBITAK -TEYDEB provides grant support for the projects proposed by the industry. The total amount of funds available each year for the program is determined by annual national budget. Grant financing of up to 60 % of the budget of an R&D project is provided by TUBITAK-TEYDEB while the rest is financed by the company itself.

TUBITAK-TEYDEB also cooperates with the Undersecretariat of Treasury to implement the 'Support for R&D Investment' program for financing the procurement of R&D related equipment by industry. Under this scheme, 50 % of machinery, equipment and software expenses are financed as loans. Tax exemption is also applied for the purchased goods.

TUBITAK-TEYDEB assists the Ministry of Finance in the implementation of the 'R&D Tax Reduction' scheme which is very new. With these measure put in the corporate and income tax laws, Ministry of Finance provides tax reduction for the R&D expenditures of private firms by a ratio of 40%.

Techno-Entrepreneurship Support Programme

To disseminate entrepreneurship concept to technology and innovation focused companies and to encourage undergraduates, graduates, PhD students and alumni to commercialize their knowledge and researches into high value-added products, TUBİTAK started to implement Techno-Entrepreneurship Support Programme.

Under this programme, after the establishment of companies by the entrepreneurs, 75% of personnel, materials, software/hardware/equipment, travel, consultancy, rent and other overhead costs will be covered up to 100.000 YTL for only one year.

SME R&D Support Programme

In order the SMEs to overcome their problems in producing a new product, developing an existing process/product, increasing the product quality, decreasing production costs and developing new production techniques, first two projects of SMEs are supported up to 400.000 YTL for 18 months by TUBITAK.

With this support programme, it is aimed to increase technological and innovation capacities of SMEs, to make them more competitive, to systematically develop projects, to develop high value-added products, to build an organizational R&D culture and to make SMEs to take active roles in the international R&D projects.

Patent Application Promotion and Support Programme

TUBITAK and Turkish Patent Institute launched Patent Application Promotion and Support Program in August 2006. The aim of the program is to raise awareness towards industrial property rights in Turkey and to increase the amount of national and multinational patent applications filed by the Turkish citizens and companies.

upper limit for finance is around US$2,500 as grant (there is not an upper limit for percentage of grants). National and international applications are funded separately. Soft loan is provided for the stages following the research reports of international and regional patent applications. A company may receive grants for a maximum of 20 patent applications per year and an individual may be funded for a maximum of five patents.

A.3. Technology Development Foundation of Turkey (TTGV)

TTGV was founded on 1 June 1991, on the basis of an agreement between the Republic of Turkey and the World Bank, to boost competitiveness of Turkish industry in international markets and support development of technology based innovation in all sectors. TTGV is an NGO, which combines public as well as private sector institutions, umbrella organizations and individuals among its founders. The founders are composed of 29 private companies, 6 public institutions, 7 umbrella organizations (sectoral organizations, chambers, etc.) and 14 individuals.

The World Bank sponsored establishment and operations of TTGV through Technology Development Project between 1991 and 1998, and successful implementation of this project paved the way for the second project, Industrial Technology Project from 1999 to 2006.

By means of the funds provided by the World Bank, TTGV was able to structure itself as an intermediary to provide support in the different layers of the national innovation system. Since 1995, TTGV has been a trusted intermediary of public funds allocated for R&D by the Undersecretariat of Foreign Trade. Apart from this role, TTGV has a strong financial structure to design new support schemes tailored to fill in the gaps detected in the innovation value chain.

TTGV supports technology development activities of the industry including lending of funds and taking credit risk. TTGV covers its administrative expenses from its income and does not receive budgetary support from the Government.

TTGV provides financial support to RTDI (research, technology development and innovation) activities of the private sector companies. By doing so, TTGV aims at catalyzing the process of transformation of innovative ideas to commercial activities and ultimately bringing in competitive power to Turkish companies in global markets. Below is a brief description of TTGV's support programmes.

Technology Development Projects Support:

Supporting technology development activities of private sector is the core activity of TTGV.

TTGV supports R&D and technological product and process innovation projects of industrial companies. Financing of these schemes is provided by UT from the resources of the World Bank and by UFT from the national budget. The UT and World Bank financed 'Technology Development Support' program was launched in 1999.

TTGV finances up to 50% of the total cost of technological product/process innovation projects of the private sector up to a maximum of US$ 1 million. Maximum duration for a project is 2 years and the amount provided by TTGV is repaid by the company in installments in 4 years including 1-year grace period after completion of the project.

Commercialization Projects Support:

This scheme seeks to support companies, which go beyond prototyping stage after utilizing TTGV's Technology Development Projects Support, in the process of transforming outputs of their R&D projects into commercially viable products.

Pre-Incubation Support:

This scheme is providing an early-stage support with the objective of facilitating generation of high-tech business ideas and improving the quality of business plans. It is targeted at persons or companies equipped with technology based business ideas for accommodating cultivation of those ideas. It is also intended to pool high-tech oriented entrepreneurs, new companies or companies in the set-up stage that could qualify for TTGV's Start-up Support scheme.

Start-up Support:

The objective of this scheme is to invest in entrepreneurs with vision and creative, exceptional and high-tech based ideas. Within this context, capital support is extended to entrepreneurs to put high-tech based, significant and plausible business plans into practice. By the end of 2007, 3 investments have been made.

Risk-Sharing Projects Support:

The objective of this scheme is to create technology based companies with growth potential and help them in expanding. The scope is entrepreneurs, new companies and companies in the set-up stage with high-risk low-budget projects in the high-tech field.

Technoparks and Technology Centers

TTGV's role in promoting technoparks is catalytic. TTGV has provided international expert assistance to the sponsoring institutions to design their technopark proposals with international best practices. TTGV has also allocated US$ 8 Million and US$ 4 Million to Bilkent Cyberpark in Ankara and ITU Ari Teknokent in Istanbul, respectively.

On the other hand, TTGV has contacted technopark companies and related universities, to create cooperation among technoparks, to establish more effective lines of communication, to ensure their wide recognition, to take the necessary steps to design effective procedures, to adapt international best practices and to lobby when necessary etc.

Venture Capital Funds

TTGV invested in two venture capital firms, IsGirisim and Turkven. IsGirisim became operational at the beginning of 2001 and has successfully invested in 7 companies, of which 2 investments were terminated with high returns. Turkven, on the other hand, is subject to UK law and is the first independent private equity fund in Turkey. Other than those mentioned above, with European Investment Fund's (EIF) initiation and with TTGV, KOSGEB and TKB's (Development Bank of Turkey) contribution Istanbul Venture Capital Initiative (iVCi) was established in 2007. It is a fund of funds program towards development of PE/VC markets in Turkey. It aims to strengthen the venture capital industry in Turkey and jointly sponsor new initiatives to promote its development in support of technology based companies. TTGV committed 40 Million Euros to the iVCi program to be managed by EIF.

A.4. KOSGEB (Small and Medium Sized Industry Development Organization)

KOSGEB (Small and Medium Sized Industry Development Organization) is a non-profit semi-autonomous organization, affiliated with Ministry of Industry and Trade, established by the Government by a special Law No: 3624. KOSGEB has been established in 1990 with the aim to help Small and Medium Enterprises - SMEs for their rapid adaptation to technological innovations, enhancing their efficiency and competitive capacity in order to increase their contribution to the national economy.

Technology Development and Innovation Incentives Programme

KOSGEB has two 'Technology Development and Innovation Incentives'.

1) Technology Research and Development Incentive

For establishing and developing competitive enterprises that have new ideas and creations based on science & technology and for production or development of new products Technology

Research and Development Incentives are given to enterprises.

Technology Research and Development Incentive is given under the scope of Technology Development Centers, Technology Incubators Without Wall and this programme includes incentives for materials, quality improvement, technological equipment investment, consultancy services, publishing R&D results; technopark rent incentive, office & workshop services and incentives for attending to congress, conference, panel, symposium and technology fairs.

2) Industrial Property Rights Incentive

If an invention or design with patent document, utility model document or industrial design document is a result of researches of enterprises, incentive is given for the costs of patent registration, utility model registration, industrial design registration and integrated circuit topographies registration.

As regards the credit guarantee mechanisms in Turkey, the Credit Guarantee Fund (KGF), that was established in partnership between six organizations including KOSGEB, guarantees up to 50 percent on SME loans (with a maximum amount of EUR 400,000) for facilitating risk sharing and lending among Turkish banks.

KOSGEB's Entrepreneurship Supports

1) Young Entrepreneurs Development Programme

The aim of the programme is to direct high school and undergraduate students to establish their own businesses. In order to achieve this, a free-of-charge 102-hours training and workshop course is designed on entrepreneurship and how to establish a new business venture.

2) General Trainings on Entrepreneurship

For everyone wanting to be an entrepreneur, a free-of-charge 30-hours training on business idea development and business plan preparation is designed.

3) Business Development Center Support Programme

For the companies residing in the Business Development Centers (ISGEM), up to 50.000 YTL support as a grant is provided to cover the rent and personnel costs.

4) New Entrepreneur Support Programme

In order to foster entrepreneurship and new business development a support of up to 44.000 YTL to cover fixed investment costs is given for the entrepreneurs that previously attended the training courses provided by KOSGEB.

ANNEX 2 Venture Capital

There are just three Venture Capital Investment Trusts (VCITs) in Turkey, two of which are currently publicly traded on the Istanbul Stock Exchange with a total portfolio value of about US$69 million. These are Vakif Girisim Sermayesi Yatirim Ortakligi, Is Girisim Sermayesi Yatirim Ortakligi. and KOBI Girisim Sermayesi Yatirim Ortakligi. The size of Is Girisim and KOBI Yatirim are US$78 million and US$20 million, respectively, while that of Vakif Girisim is not disclosed by its managers. There are also other private initiatives by local and foreign investors, such as iLab and Turkven. TTGV invested in IsRisk and Turkven and established a Start-Up Fund (Teknoloji Yatirim A.S.). The total fund size for venture capital and private equity industries is estimated as around US$400 million and annual investments are not more than US$100 million (0.02% of GDP). According to the figures, the utilisation of venture capital by SMEs in Turkey is 2 % which is very low. Moreover, it can be stated that the share of private early stage investments is almost negligible in Turkey whereas in the EU-15 they accounted for almost 28% of total investments in 2006.

The underdevelopment of the sector is in part due to the low level of institutional savings in the domestic capital market but the inadequate legal and regulatory framework that was established in 1993 by the Capital Markets Board (SPK) also hinders the operation of VC firms. The financial incentives - exemption from corporate tax, not subjecting the portfolio administration gains to withholding tax, among others - provided to spur innovation finance have also not been designed specifically for the promotion of venture capital investments.

Existing VC companies mostly don't invest in high-risk businesses (tech start-ups), largely because of the traditionally risk averse culture they have as subsidiaries of banks and because they do not have special expertise and experience in high-tech fields and in mentoring of small entrepreneurs, essential in the survival and growth of VCs as well as firms. The demand for venture capital and business angels' services e.g., deal flow, mentoring and awareness programs for entrepreneurs and researchers is also weak in Turkey. Several factors affects the low deal flow to VC in Turkey including low R&D levels, weak R&D commercialization culture (and support) at universities, limited collaboration between industry and research sector, a lack of intermediaries (such as TTOs), limited understanding of VC investment by firms and the large number of informal accounting that makes valuation difficult for investors and negatively affects the quality and number of VC deals.

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ANNEX 3 Some Statistics on Technology Development Zones (TDZs) in Turkey

Until June 2008, 31 technology development zones have been established under the premises of the TDZ law numbered 4691, which was effective from 2001. (Ankara (6), Istanbul (3), Kocaeli (3), Izmir, Konya, Antalya, Kayseri, Trabzon, Adana, Erzurum, Mersin, Isparta, Gaziantep, Eskisehir, Bursa, Denizli, Edirne, Elazg, Sivas, Diyarbakır, Tokat ve Sakarya Provinces)

Out of 31 TDZs, only 18 are operational. (Ankara (4), Istanbul, Kocaeli (3), Izmir, Konya, Antalya, Kayseri, Trabzon, Adana, Mersin, Isparta, Eskisehir, Bursa Provinces). The data provided below comprises only these 18 TDZs. In 2001, first established TDZs were Metutech and TUBITAK-MAM. With the increasing number of TDZs (coupled with the tax incentives given by law), the number of companies reached to 928 (as of June 2008).

As of June 2008, 10.086 personnel are actively employed by the companies in TDZs. Of this number, approximately 75% is R&D personnel and 25% is support personnel and staff.

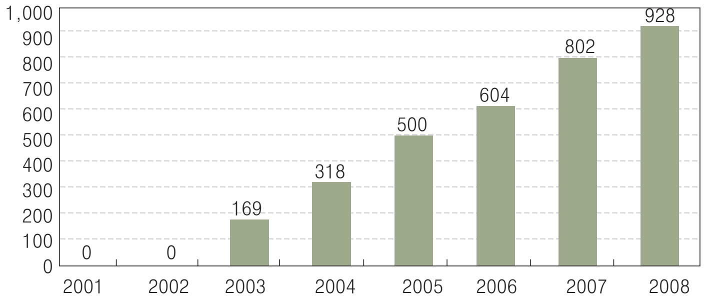
The main technological areas of the companies in TDZs are software development, IT, electronics and advanced material technologies respectively. Other than these, companies are engaged in design, nanotechnology, biotechnology, automotive, medical technologies, and renewable energy. The number of R&D projects managed by the companies in the TDZs has reached to 2.560.

It took on average 3 years for the companies in TDZs to make exports on technology. Top 5 countries that products/services were mostly exported to are USA, Japan, Israel, UK and Germany. Total exports summed to USD 395 Million in the first half of 2008.

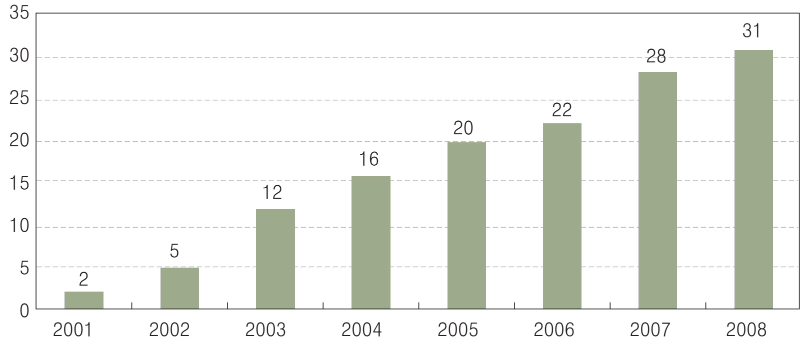
There are currently 32 companies with international partners. Total number of foreign investment in the zones has reached to USD 450 Million.

A cumulative number of 209 patents are taken by 2008, which can be an indicator of the success of the R&D projects.

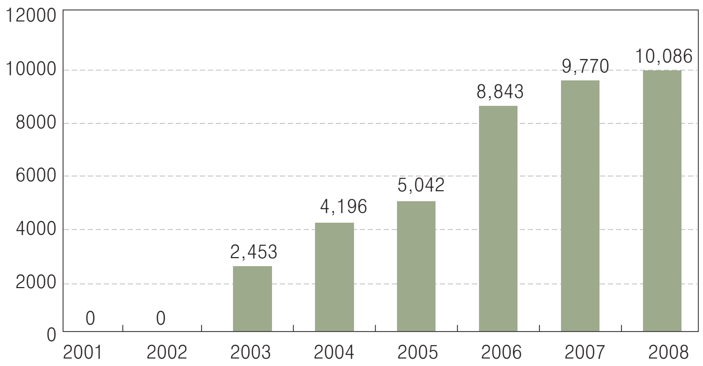
Number of Companies



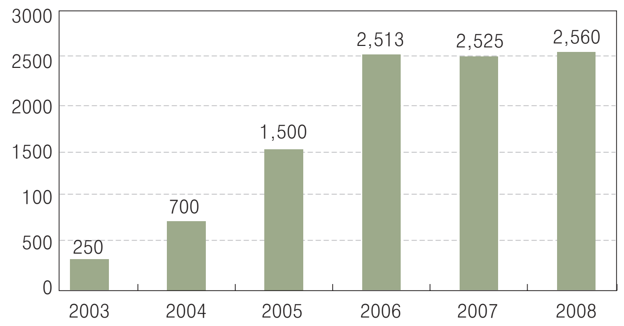
Total Number of Technology Development Zones



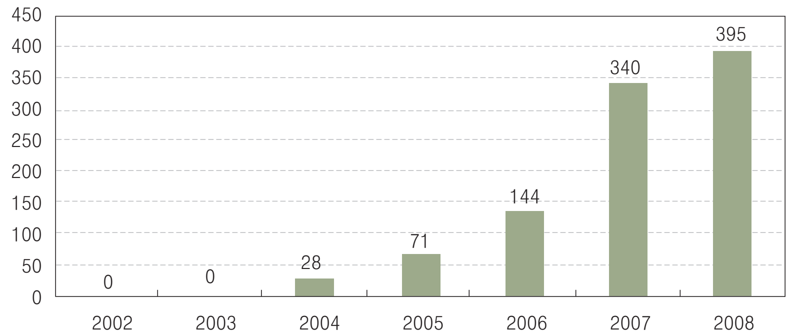
Total Number of Personnel in TDZs



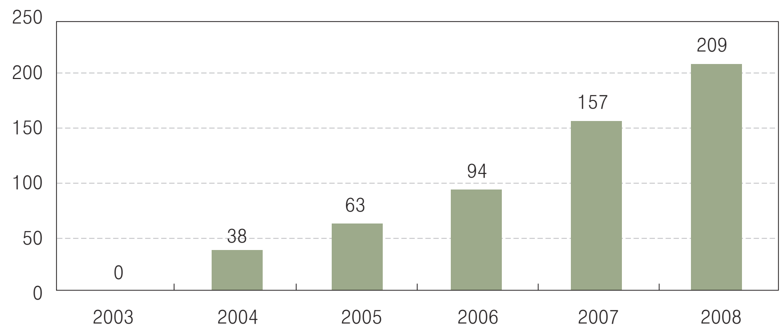
Number of R&D Projects Developed in TDZs



Total Exports from TDZs (million USD $)



Total Number of Patents in TDZs



OSTIM - Middle East Industry and Trade Center

Middle East Industry and Trade Center (OSTIM), in which most of the enterprises are manufacturers, is an Organized Industrial Region in Ankara.

Story of OSTIM is a rare success story which began to take shape 40 years ago and slowly evolved into what it is now. In 1967, in order to provide developing industry expansion of Ankara, OSTIM "Small Industrial Region" became operational out of the city center on the area of five million meter square by a group of businessmen. Construction of OSTIM Small Industry Site was completed in 1980's. Growing up and developing by the productive contribution, OSTIM was registered as "Organized Industrial Region" by Industry and Trade Ministry in 1997. By this "Organized Industrial Region" identity, OSTIM has completed its infrastructure and superstructures and became a magnet for the SMEs providing ideal production ambience.

The region is preferred as a "pilot application area" for many supportive projects for SMEs and is recommended as a "regional progress model" in the developing countries.

From 1992 forward OSTIM administrative board has been trying to modify the competition power of small entrepreneurs in addition to the infrastructure problems such as road, water, drain, rain water, electricity and landscaping of the region.

In order to transform the region into a well known brand name, OSTIM Management forms efficient structures and produces, administers and implements various projects. OSTIM Management provides such services as electricity, natural gas, zoning-habitation procedures, environment, security, promotions, internet, human resources, education and health services to those enterprises at OSTIM and undertakes such projects as OSTIM TeknoCity, OSTIM Telecommunications, OSTIM USAM (University-Industry Collaboration Center), Organized Industry Newspaper, Guide and Exports catalogue in order to support SME establishments. In addition, OSTIM enterprises get benefits of Telecommunication Center, Consultancy and Educational Services, Apprentice Training and Education, Occupational Training Center, KOSGEB, Quality Association, Quality Control Laboratories, Fair Organisation, Energy Production, Employment Agency and consultancy companies. With such a compact structure, OSTIM has become a SME town producing 10,000 different products under 100 main groups with the efforts of 5000 enterprises with 50,000 employees.

OSTIM Production Profile

In OSTIM, out of 5000 firms, 31% firms are activating in trade, 69% firms are operating in manufacture and other business areas. Also 46% firms operating in metal sheet working, 42% machining, 8% plastic processing and 4% chemical production. 90% of the enterprises employ 10 or less employees. 40% of enterprises employ university graduates.

There are 17 sectors of which main industry production sectors are; Construction Machines and Materials, Machine and Machine Parts, Plastic and Rubber, Electric-Electronic, Healthcare Equipments, Automotive and Defense Industry.

Exports from the region amounted to 300 million dollars in the year 2007. Around 40% of enterprises are exporting. Amongst the countries that OSTIM enterprises exported goods to be Africa, USA, EU countries, Scandinavian countries.

OSTIM Research and Development Center

OSTIM and METU collaboration with the support of TUBITAK, OSTIM Middle East Advanced Production Systems and Technologies Research and Development Center (ODAGEM) was established in 2004. At this center, education, certification, consultancy and engineering services are given in order to solve problems of industry. Besides, R&D activities are carried out in order to help industry produce high technological products with low costs.

Cluster Projects in OSTIM

OSTIM gives special consequence to Regional Improvement Models and under this concept OSTIM has been carrying out three cluster projects: Construction and Engineering Machines Cluster, Renewable Energy Cluster and Defense Industry Cluster.

METUTECH - METU-Technopolis

METUTECH is the first and the largest science park in Turkey. It is located in METU Campus, on 113 hectares of land with a 40 hectares construction area and approximately 90.000 m^2 of enclosed area, is 7 kms far from the city center of Ankara, and lies in the western corridor of the main development axis of the city. METUTECH supports the creation of synergy between industry, university and public institutions through infrastructural/ structural opportunities developed for academicians, researchers and companies using/ producing technology.

The studies on METUTECH project were started in 1987 to support the formation and development of high-technology based companies, to ensure the development of technology, and to maximize the university-industry cooperation. After a period of investigating other science park models around the world, a feasibility study was prepared in 1988. Following this, the METU-KOSGEB Technology Development Centre (TEKMER) was founded in 1992 as a technology-based business incubator.

The successful results attained in METU-TEKMER had subsequently fortified the idea of forming a techno park. After the preparation of the development plan of METUTECH in 1997, the construction process started and the first two buildings were put into service in 2000. In the year 2001 when the law of Technology Development Regions no. 4691 was issued, METUTECH was approved and declared as a "Technology Development Region" by the law.

Teknopark Inc. - The Management Company

Established in 1991 as a joint stock company by Middle East Technical University Development Foundation, Teknopark manages the first and the biggest science park of Turkey. Teknopark Inc. is responsible for the application of the strategies and programs specified by the Executive Board and fulfills these duties and responsibilities through the Board of Directors and its executive officers.

Key objectives of METUTECH are as follows:

- To enhance national R&D potential
- To assist in regional RTD and to be one of the elements of sustained regional development.
- To enhance international collaboration, and networking
- To maintain a strong collaboration between industry and university
- To assist in transforming the university's research infrastructure and information accumulation into economic value
- To create suitable environment for technology transfer
- To create employment for qualified human resources
- To encourage and support entrepreneurship and innovation
- To promote university based start-ups and spin-offs.

Application and Evaluation Process

Companies or organisations that do wish to take part in METUTECH and benefit from the Law of Technology Development Regions, submit their pre-applications to the management company, Teknopark Inc.

The primary criterion for selecting firms depends on their contribution to the METUTECH's vision of being one of the leading technology development regions by providing high value products and services. In the selection process sectors were determined taking the industrial profile of Ankara into account along with the resources of the university and the competitive advantages it possesses.

In this sense, ICT, electronics, telecommunication, aerospace, environment, bio-technology, nano-technology, advanced materials are the privileged sectors for METUTECH. Production activities are not permitted within the region. Only the prototype production of projects and products based on R&D activities and restricted production activities based on R&D activities.

In the scope of METUTECH, there are four main groups of tenant classification regarding their qualifications: Companies that are considerably large in scale that can create R&D and technology production (mature companies); start-ups (with the priority of those that qualify that are qualified as spin-offs and entrepreneurs); public and private research centres, NPO's and NGO's; and persons and companies that provide the parties with supporting products and services.

The profile preferred within these companies should be innovative and technology based, and inclined to cooperate with the other parties, primarily with the university. Being involved in research and development activities, and possessing reasonable amount of managerial, financial, and human resources are preliminary qualifications. These companies should also possess the qualifications of being respectful to the environment, human rights and social justice.

Services provided by METUTECH

Services provided by METUTECH can be categorised under four different program types; that are, training programs, consultancy services, value added services and site management services. Training programs comprise of the 30 % of the total amount of value added services, whereas consultancy services on international marketing, technology transfer, IPR (Intellectual Property Rights), international legal advising, and funding comprise of the 70 % of these services. Other areas of services include events, travel, catering, and etc. Site management services include facility management, data and telecommunication services, security, landscaping, and management services, etc.

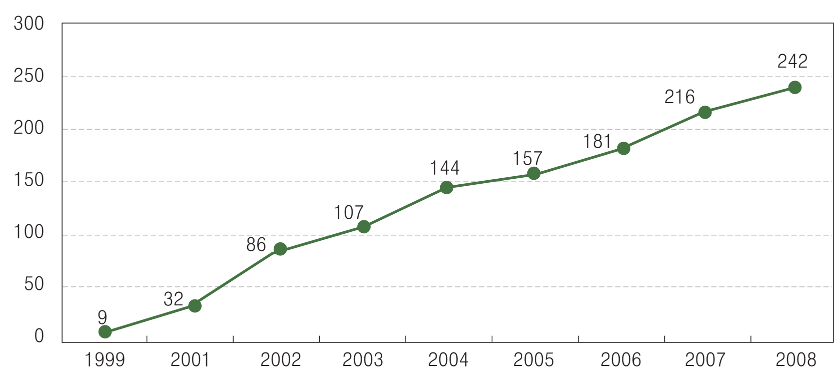
Progress to Date

At present, combining METU's research capacity and information pool with the innovative capacity of entrepreneurs, METUTECH is not only the largest science park of Turkey, but is a model that is appropriated by many newly developing science park administrations and they benefit from the experiences of its management company in their development processes.

Fundamentally, METUTECH's existing company profile is based on software development and electronics industry. METUTECH, which has reached an enormity of 3000 personnel, 2500 of which are the researchers (86% of the total staff are university graduates, and 20% of which have Ms, Ma, or PhD degrees.) in 242 firms 99% of which are SMEs and including multinationals such as SBS, Cisco, Siemens on the 87.000 sq m closed area, is the biggest and the most successful science park of Turkey. Over 400 joint R&D projects completed of which more than 300 faculty members participated. Around 150 companies have been involved in joint projects with the university. The incubation centre of METUTECH (TEKMER) serves 40 start-ups and micro sized companies; most of which are the spin offs from METU. Up to now more than 40 start-ups and spin offs graduated from TEKMER and moved to technopark buildings.

According to the development plan of METUTECH by the end of 2015 METUTECH will reach to a number of 250.000 square meters closed area, 10.000 employees conducting R&D activities in 500 companies.

Some Statistics for METUTECH



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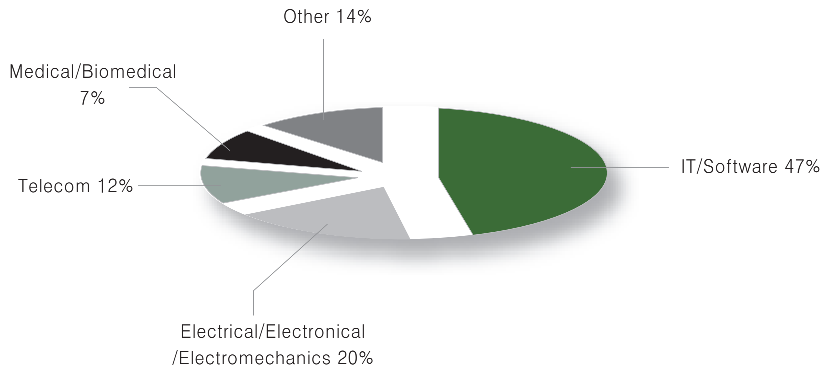
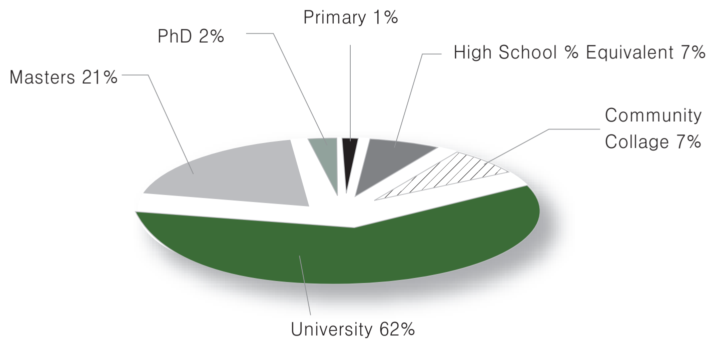
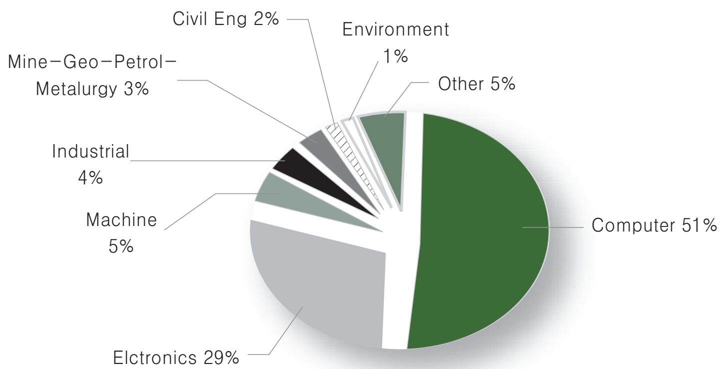
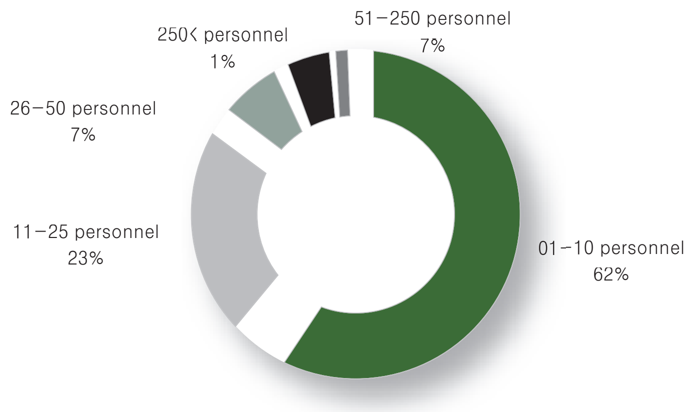




R&D Personnel w.r.t Expertise

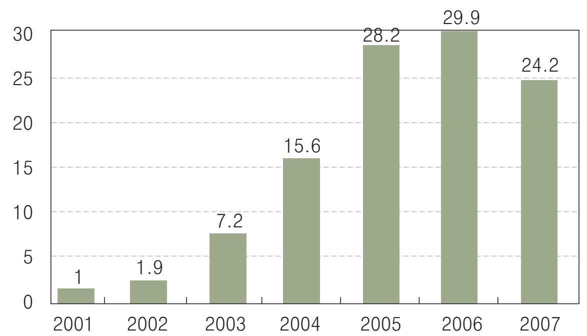


Company Personnel Count

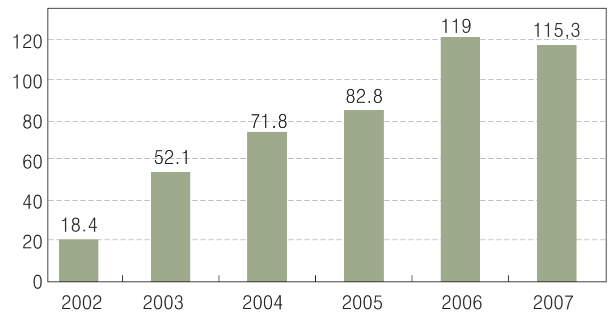


Export figures of R&D products; Export Markets: USA, Singapore, Hong Kong, Dubai, EU, Japan, Israel etc.

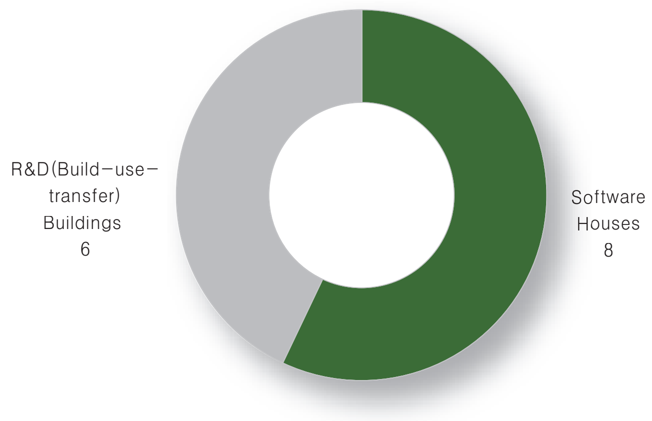
R&D Export of Firms in Metutech



Technopolis Compaines R&D Turnover Figures (million $)



Buildings of Technopolis (14 in totla)



METUTECH R&D Projects		
2005	2006	2007
124	64	57
381	481	476
505	545	533
390	548	709
31	34	28

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Chapter 07

Industrial Upgrading with Cluster Approach

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Chapter 07

Industrial Upgrading with Cluster Approach

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1. Introduction

In Asian NICs, the policy drive for upgrading the industrial structure has been one of the most important policies for their strategic drive to successful industrialization. Korea is one of the Asian NICs which could be successful in industrialization with the policy drive towards transforming the traditional industrial sectors into high value added industrial sectors. Here, industrial upgrading means (i) making firms to move from labour intensive industries to capital intensive industries and (ii) making firms to gradually produce higher quality or higher value added products through their enhanced capabilities. For example, if the share of productions of mobile phones rise in the total manufacturing sector in a developing country, industrial structure of the country has to be shifted to the information & communication technology. But if the firms in the country engage in simple assembly production, firms remain at low value added activities. Therefore, industrial upgrading should include both (i) shift of the industrial structure and (ii) shift of firms' activities into high value added activities.

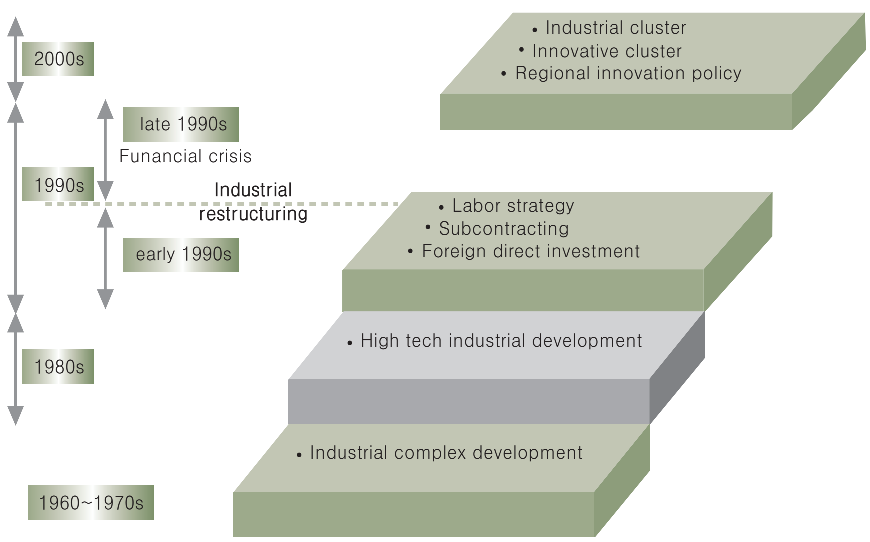
The industrial upgrading policy of Korea can be briefly introduced as the following. Korea has been upgrading the industrial structure from the 1960s. The heavy and chemical industry policy (1970s), Import Substitution Policy (1960-1980s), High tech development policy (1980s) focused on information and communication technology (ICT) and contributed to the industrial upgrading. From the 1990s, there has been emergence of a systemic policy approach by making more innovative actors participate in industrial activities and encouraging networking among innovative actors: policy drive for encouraging industry-university-governmental research institute cooperation, technoparks for encouraging innovation activities at regional level. In the

2000s, the systemic approach extended to regional innovation policies. Regional cluster policy took a role of upgrading the industrial structure at the local level (see Figure 7-1 for the cluster policy in historical context). The policy was mainly focused on upgrading the capabilities of small firms at regional levels, whose weak capabilities have been the chronicle problem of the economy. The policy could be driven by the new participatory government which started from 2003 and emphasized the national balanced development.

This report discusses the cluster policy of Korea with cases of a specific industry. It was expected that Turkey could get concrete details of the policy from the case of the specific industry. As a case industry, this report selects the automobile component industry because the automobile industry, including the component industry, is one of the most promising sectors since the automobile sector is leading the export sector in Turkey and also one of the best industries which revealed successful accumulation of technological capability among the manufacturing sectors. Korea's automobile component industry is a successful industry which contributed to the industrial upgrading of the manufacturing sector. Therefore, it was expected that cases on the automobile component industry shall provide useful information to Turkey.

This report focuses on the following points in discussing the two cases in Korea: (i) the recent policy changes in one of the best clusters in Korea; (ii) lessons on the importance of

Figure 7-1 | Cluster policy over the history of Korea's industrialization



Source: Park (2007b).

strategy of automobile makers in the cluster, which could be learned from the automobile cluster.

This report first introduces the framework of the discussion on the cluster policy, followed by the discussion on the brief history of the development of the Korean automobile component industry. There shall be a brief introduction of local cluster policy as a new policy approach for industrial upgrading.

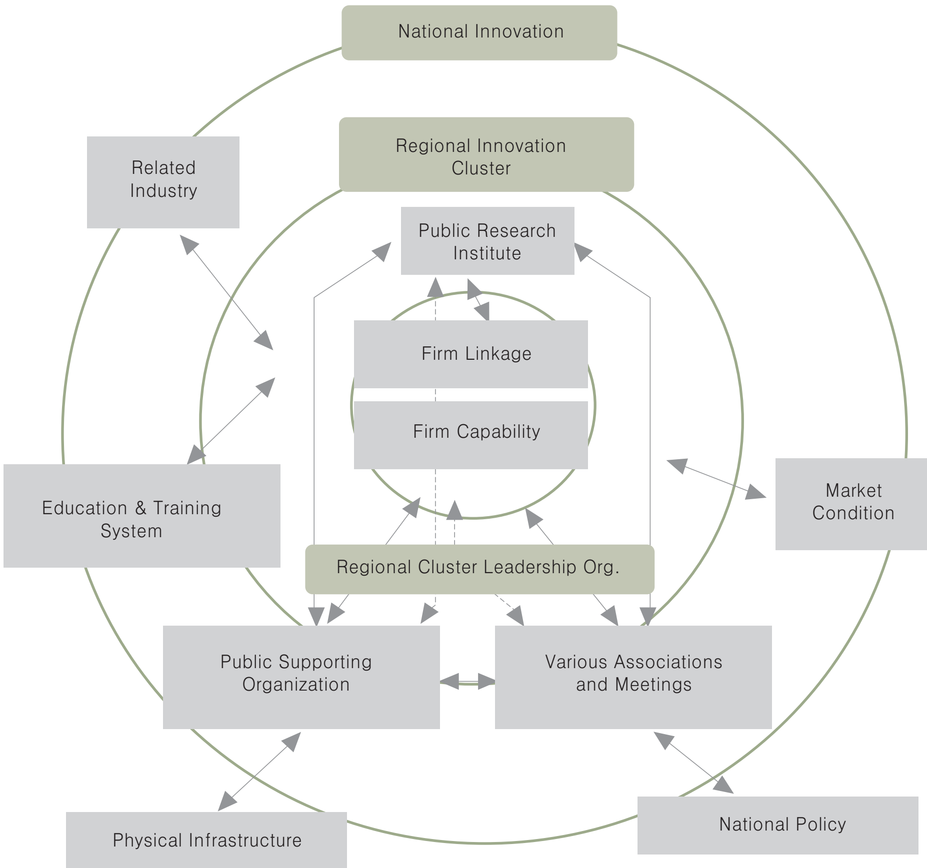
This report selected Changwon cluster as the best cluster to be introduced to the Turkish government. It is one of the best clusters in Korea and the cluster which is similar to Ulsan automotive cluster where there are leading large firms and subcontracted small firms in the cluster. In addition, it is the best cluster to reveal progresses made over the last decade by comparing the current situation with the paper written on the same cluster in 2000 by the author. The other case, Ulsan cluster, which is the largest automobile cluster, shall be discussed in relation to the automobile maker's strategy. The discussion on the Ulsan cluster shall be focused on explaining how the cluster policy for the automobile component industry can cause tensions with the strategy of the automobile maker. Finally, the policy lessons shall be drawn out.

2. Framework of Understanding the Cluster

This report uses the following framework in understanding the cluster policy. The framework reflects the regional innovation system approach and the "the learning region theory" (Storper 1993, 1995; Morgan 1995, 1997) and also national innovation system approach (OECD 1999). The cluster is understood as a kind of regional innovation system. The cluster is a part of the national systems of innovation. At the core of the cluster, there are the firms' capabilities. If the firms' capabilities are rising, then the cluster's capabilities are rising. If the firms' capabilities decline, then the cluster capabilities decline. The firm mainly interacts with supplier firms and user firms in innovation activities.

According to the existing innovation survey in almost every country in the world, firms regard the customers and supplier firms as more important than university and other public research organizations as a source of innovation. Therefore, the firm linkage among firms is positioned at the core of the cluster. The firm also interacts with public organizations (for necessary public services) and public R&D institutes (for securing knowledge) and educational institutions (for securing workforce and training) and various associations. The regional innovation cluster is rounded with smaller circles in the diagram. It is under the influence of regional cluster organization which facilitates networking among the agents. Morgan emphasizes the regional cluster leadership as important for the dynamic growth (Morgan 1997).

Figure 7-2 | Frame of Understanding the Cluster



Source: Author.

The firms' innovation activities in the cluster are also influenced by physical infrastructure and national policy.

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Box 7-1. ASIAN NIC's drive for industrial upgrading

The Turkish policy has been directly related to the EU policy due to its relationship with the EU. The author of this report had participated in the collaborative research project on national systems of innovation of six European countries and four East Asian countries, which was produced by Edquist and Hommen (2008). During the discussion in the workshop of the project, the author could observe that there emerged a certain consensus on the difference of the EU and East Asian countries that the science and technology policy in EU does not emphasize the role of the policy in supporting industrial upgrading while the policy in East Asian countries emphasize the role in supporting industrial upgrading. The Asian NICs, particularly Korea, Singapore and Taiwan, have been known as the countries where the state played an important role in achieving rapid industrial growth through their entry into promising dynamic industrial sectors, particularly through policies of education (especially in engineering), targeting production for export and rewarding high export performers, and supporting R&D and innovation (Lall 2000). Edquist and Hommen (2008) mention Ireland as the country where the state had the similar role.

In the country's drive to shift to the higher value added industrial structure, there were Chaebol firms in Korea, OEM ODM small firms in Taiwan and FDI firms in Singapore. The government provided the knowledge infrastructure such as government research institutes and other intermediary institutes to support the company's efforts to upgrade higher quality products and the higher quality new industry products. The government also churned out the human resources with higher technical skills and engineering educational institutes.

3. Development of Automobile Component Industry in Korea

The policy for the automobile industry was borne in the 1960s and actively driven in the 1970s. The Korean government set up the heavy and chemical industry policy in 1973 in order to drive a shift in the industrial structure from labor intensive industries to capital intensive industries. In the policy, the automobile industry was one of the capital intensive industries such as machine industry, petrochemical industry, steel industry, automobile industry among others. The goal of the policy of the automobile industry was mass production of own brand car model. The policy not only aimed at increasing the share of automobile production volume in the economy but also at enhancing technological capability of Korean firms. The policy was originally oriented at meeting the domestic demand and later to stimulating exports.

Table 7-1 | Summary of the Automobile Local Production Plan

Preparation stage (67~69)	Planning stage	
	1st stage(70~72)	Second Stage(73~76)
1. Establishment of assembly business 2. Nurturing related industry 3. Maximum utilization of existing facility	1. Establishment of machine component industry 2. Mass production of components 3. Setting up engine molding plant 4. establishment of body press center	1. Manufacturing local standard car 2. Completion of 100% local production 3. Mass production of a single car type 4. Completion of local production of components 5. Price to the level of international standards
Ratio of local components: 32%	Ratio of local components: 100%	Ratio of local components: 100%
Keeping three assembly plants → Making core component plan → Making single car type (mass production)		

Source: O(2000)

The policy for the automobile component industry is a sub set of the policies for automobile industry. Because the Korean government aimed at nurturing local brand automobiles, the Korean government considered nurturing component industry as essential for supporting the growth of the automobile industry. In driving the automobile industry, increasing the ratio of components produced in Korea to the total components assembled for an automobile (from here, it is called 'localization ratio') is regarded as strategically important to increase higher value added activities in the automobile sector. The localization ratio has been monitored by the government and the government pressed the automobile makers to use locally produced components and the government supported the local component makers' efforts to produce local components in the 1970s.

According to the automobile industry plan in 1969 (Table 7-1), the government planned to produce a car type in mass production system in the early 1970s and the plan was actually implemented by Hyundai Automobile who not only developed the Korean brand original car but also have been aggressive in purchasing local components. Hyundai Automobile started producing its own brand 'pony' model in 1975. Hyundai Automobile became successful in producing and selling its own brand 'pony' to the local market and abroad. With the expansion of the automobile production, the automobile component makers could find opportunities for businesses. The total volume of production of automobiles was 12,751 cars in 1975 (Hyundai Automobile 5,426 cars) and was expanded to 113,584 cars in 1979 (Hyundai Automobile 71, 744 cars) (KIET 1997, p.52). The localization ratio of Hyundai Automobile's best selling car model was 85% in 1975 and risen to 98% in 1984 (KIET 1997, p.53). Hyundai could have a turning point in the 1980s the with success in securing a successful market share in the US market.

The policy drive for upgrading the component industry was through the vertical linkage policy which was started with the law in 1975 (the law for facilitation of vertical supply chain[Gey-yol-hwa[38] in Korean]).[39] Under the law, the government designated the components/parts that large firms should procure from SME firms. 35 automobile component makers were specified as the companies under the vertical supply chain relationship. This law provided entry barriers to other candidate firms (KIET 1997, p.183). The designated firms under the supplier relationship with the automobile makers were provided with the direct policy support. In addition, the firms were treated specially in the implementation of the policy program for small firms: the priority rule was applied in selecting firms out of applicants of the program (KIET 1997, 183). The law was revised in 1982 to drastically increase the number of designated firms.

The supplier association for each automobile maker was formed : the association for Kia Motors in 1977 and the association for Hyundai Automobile in 1984. In the association, the automobile maker had a role of tutors to other supplier firms. The Gey-yol-hwa Law was abrogated in 1995 to induce more competition among component suppliers and carmakers as well. The Korean automobile makers also expanded their global sourcing strategy and also global production strategy by setting up factories abroad. Therefore, the automobile component makers who could have stable customer relationship with the automobile makers (or first tier component makers) were exposed to more severe competitive pressure. These left the Korean small firms with harsher conditions in getting order from the Korean automobile makers. The local small firms had to make efforts to survive. The cluster policy was the one which could help small firms' efforts in the region.

4. Local Innovation Policy as a New Policy Approach for Upgrading Industrial Structure

Korea's state led policy of industrial upgrading were mainly implemented through selecting promising industries, investing resources into the sector, sometimes including market

38. Gey-yol-hwa means building a system of business networks where large assembler is atop and numerous smaller parts suppliers below. The law aims to promote the formulation of vertically integrated inter-firm networks.
39. Yun and Park (1984, p. 28)

protection. Due to the globalization and the Korean government's increased liberalization, the Korean government was stripped of traditional policy means. After the financial crisis in 1997, the Korean government has reformed the economy as globally opened economy, liberalizing the economy to the level more advanced than the one recommended by the IMF who provided the financial resources during the crisis. The government gradually adopted the systemic approach which provides market friendly conditions for industrial growth. Contrast to large firms who have emerged as one of the major global players, the small firms were vulnerable to international competition. Therefore, the regional innovation policy emerged as an important strategic policy for helping local small firms to engage in production of higher quality, higher value added products.

There have been some policy initiatives for encouraging innovation activities in regions from the late 1990s. The examples are the regional innovation center program (for universities) (started in 1995) and the techno park program (started in 1997) and the program for strategic regional industries (started from 1999). However, it was from 2004 that the local innovation policy emerged as an important policy when the new government emphasized balanced national development. For the brief summary of the local innovation policy over the last 10 years, please see the regional innovation system initiatives in the following table. The following discussions introduce two cluster cases.

Table 7-2 | Regional innovation system initiative over the last 10 years

Infrastructure building	Techno parks, Regional industry promotion centers
R&D support	Increase of regional government R&D share from 27% in 2003 to 36% in 2006 Regional innovation centers in universities, Regional R&D clusters
Human resource development	Regional industry related human resource development through NURI program
Coordination and networking	Regional innovation councils, Regional innovation agencies, Networking of industry university and research institute through key universities

Source: Lee (2008)

5. Major Progresses Made in the Cluster Policy in the Case of Changwon Cluster

Changwon cluster has similarities with the Turkish automobile cluster and Marmara Automotive Cluster, in that Changwon cluster is the cluster where there are large manufacturing plants and subcontracted small firms. This section discusses the differences by comparing the current status with Lim (2003) which carried out research on Changwon cluster in 2000.

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Figure 7-3 | Location of Changwon Industrial Complex

Source: KICOX, Introduction of Changwon Industrial Complex, 2006
as cited in Park , p.5.

5.1. Introduction

The Korean government established a national machinery industry complex as a manufacturing base of defense industries in Changwon in 1974, located 43km west of Pusan, the second largest city in Korea and the port city. Changwon is a city in Gyeongsangnam do, and the first planned city for machinery industrial complex. The Ulsan Car Industry Complex in Ulsan and the Aircraft Industry Complex in Sachun are within less than two hour drive distance. The site is in a basin on firm ground, surrounded by mountains, making it suitable for a machinery industry complex. It is ten minute drive from the South Seas Expressway Masan IC and the Kyung-Chun Railroad Line passes through it and it is 40 minute drive from Kimhae Airport. The port of Masan is 10 km away, however, since the capacity of Masan is relatively small, most firm's business is with the port of Pusan.

The government worked to attract Chaebol firms to the defense industry in the Changwon Industrial Complex at the beginning. In the 1980s, Changwon was developed as a machinery industry complex to meet non-military demands. In the 1990s, there emerged machinery and machinery component producers leading machine exports in Korea. After the financial crisis in 1997, new multinational firms such as Volvo Construction Equipment Korea (VCEK), Clark Material Handling Asia, FAG Hanhwa Bearing came to Korea. The following table shows that growth of the Changwon industrial complex which is the main part of the Changwon cluster.

Table 7-3 | Growth Trend of Changwon Industrial Complex (1975 - 2005)

Sectors	1975	1980	1990	2000	2005
Output (100 million won)	2	4,550	59,690	182,780	291,725
Number of Company	44	120	315	1,026	1,620
Number of Employee (1000 persons)	1.1	29	80	72	73

Source: South Eastern Headquarter, Industrial Facts of Changwon Industrial Complex, 1975, 1980, 1990, 2000, 2005 as cited in Park (2007, p.5.)

5.2. Characteristics of Changwon Cluster

The industry district literature from the stream of economic geography (Park,1996) classifies the Changwon area as a satellite platform area. Markusen (1996) wrote that local firms in a satellite platform maintain close relationships with their external headquarters. Basically, most of the machinery firms in the Changwon cluster were relocated as local factories of big firms whose headquarters are in Seoul region. The local firms in Changwon cluster did maintain close relationships with their headquarters in the metropolitan region. In 1998, Changwon had 39 factories or branches in the machinery industry[40] and employed 20,523 workers (Changwon Municipal Office, 1999). These firms all needed to maintain close relationships with their headquarters in Seoul area. There were also 483 independent firms together employing 8,545 people.

The characteristics observed a decade ago still remain. Changwon Industrial Complex is led by large-size companies. These large-size companies are highly competitive in global markets and obtain their market shares. There are Doosan Heavy which has number one market share in the world in sea water generating facility plant, Samsung Tech Win which ranks 5th in the world digital camera market, and the Doosan infracore which is one of the major five machine tool manufactures in the world and LG electronics which is the one of the major three companies in the world in consumer electronics. Majority of small firms are weak in their competence and remain in production activities, not having strategic relationships with large firms and threfore, small companies have been mainly engaging in production and there are firms who do not have the design capability (Park 2008, p.6).

In Changwon in 2006, there were 1,702 companies. 1,012 companies were in the machine sector (59.5%), 247 companies in electrics and electronics (14.5%), 244 companies in transport

40. 29 ‘manufacture of other machinery and equipment’ according to ISIC

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equipment which includes automobile makers and automobile component makers (14.3%), 67 companies in steel (3.9%), 48 companies in petrochemical (2.8%) (Park 2008).

Figure 7-4 | Linkages of Changwon machinery firms

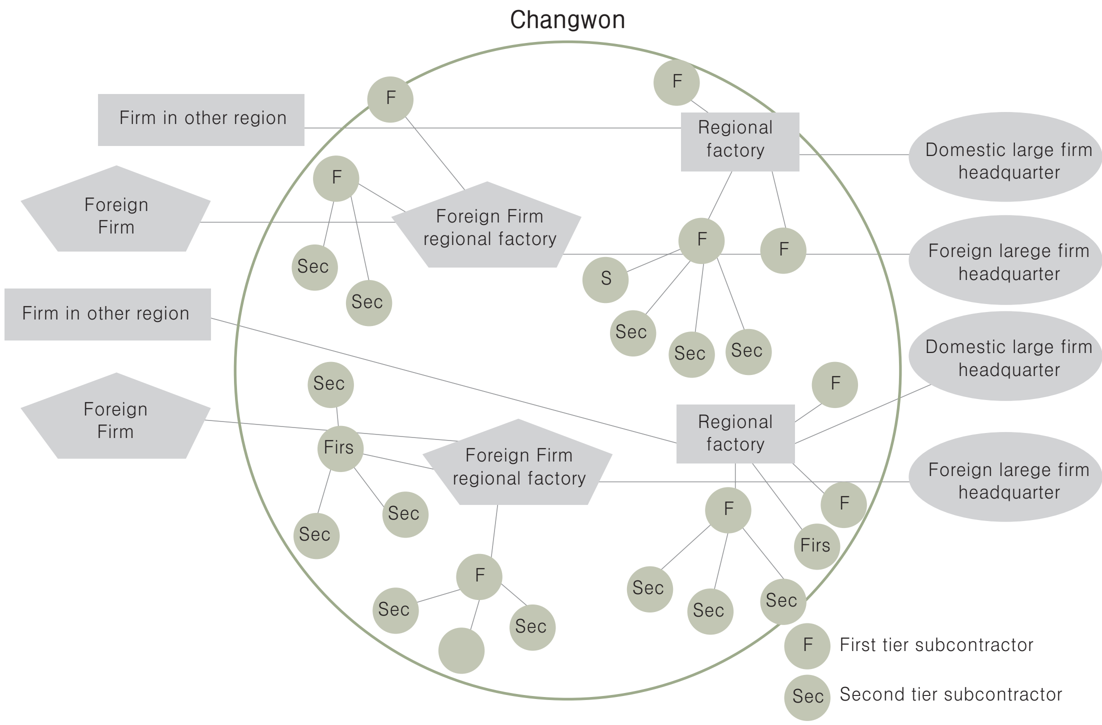


Table 7-4 | Major companies and products in Changwon

- Doosan Heavy Industry: Nuclear Power Plant, Desalination Plant
- Doosan Infracore: Construction Equipment, Machine Tool, Industrial Vehicle
- LG Electronics: Air Conditioner, Refrigerator, Washing Machine, LCD & PDP TV
- Rotem: Rolling Stocks, Defense, Plant & Machinery
- STX Engine: Marine Diesel Engines, Engine Parts
- GM Daewoo: Automobile(Compact Car)
- WIA: Machine tool, Air Craft Parts, Machinery Automation, Robotics
- Other: Camera(Samsung Techwin), Excavator(Volvo) ¢п MNCs
- Volvo, Phillips, Denso, Fanuc, etc.

Source: Lee (2008)

5.3. Policy Change over a Decade : The Local Drive for a Transition from a Satellite Cluster to a Networked Cluster

From the late 1990s, the government has gradually been expanding the policies for encouragement of the development of local industries. Changwon was selected as one of the four regions under the central government's program of promoting regional industries: the four includes Gwangju for optical industry, Changwon for machine industry, Daegu for textile industry and Busan for footwear industry. 'Mecha-Know 21,' the local government's plan which was supported by the central government's program of promoting regional industries, was started in 2000, aiming at the development of the local industry (especially machinery industry) in Kyungnam Province including Changwon. 'Mecha-Know 21' lasted until 2008.

In 2004, the central government initiated industrial-complex-innovative-cluster program. The program was aimed at turning the industrial complexes into R&D based industrial complexes. The central government selected seven industrial complexes which include the complexes in Banwol & Siwha, Ulsan, Changwon, Gumi, Wonju, Gunsan and Gwangju. Changwon started to receive funding from 2005 as one of the seven innovative complexes. Therefore, from 2005, the Changwon complex began to be supported by the government's two programs: 'Mecha-Know 21' and 'industrial-complex-innovative-cluster program.' There have been changes in Changwon cluster over a decade due to the two policies. The followings will discuss the Changwon cluster in 2000.

5.3.1 Changwon Cluster in 2000

Lim (2003) reports, based on the study in 2000, that there are a lot of problems in the Changwon cluster. There have been policy programs implemented in Changwon which were sometimes overlapping with each other and were not systematically coordinated to serve local small firms effectively. The local government had little room for policy decision making. The local government was the implementer of the plans and decisions made by the central government. The local government means Kyungnam Provincial Office and Changwon Municipal Office. The local public agencies were also the mere implementers of the decisions or policies made by the headquarters which are mostly in Seoul. The examples of the public agencies include SBA (Small business association), SBC (small business corporation) Kyungnam office, KCCI (Korea Chamber of Commerce and industry), the industrial complex at Changwon. Therefore, the policy for the local industry was top down policy. Each policy program dealt with the specific aspect of the firms' activities but there was no coordinated program to solve the problems identified at the company level. The fragmented efforts of not-connected public agencies and universities were not enough for solving the problems. There have been weak linkages between local government and firms in setting up plans for the local development (Mecha-Know 21). For example, the Kyungnam Machinery Industry Supporting Plan (Mecha-Know 21) did not reflect continuous dialogue between firms and the local government or local public agencies. Even though there was local government's effort to hear the opinion of firms through meetings during the preparation of the plan, there was no feedback on the progress of the plan after the meeting (Lim 2003) . In other words, the participation of the firms in the process of drawing up the plan and implementation of the plan was passive.

5.3.2 The Policy Changes after 2000

The 'Mecha-Know 21' program has been implemented since 2000. Because there has not been any local governmental initiative for the development of the local industries before 2000, there remained problems of the system of policy implementation. One of the problems was that the local government did not have discretion in policy implementation. The special accounting system for national balanced development was setup in 2005. The system allowed the local innovation account which gave the discretion of the local government's decision making in budget planning and spending. Another problem of the system in 2000 was that the policy drive for networking among the innovation actors in the cluster has not been enough for achieving any significant enhancement in the cluster. Changwon cluster could get funds from the program of industrial-complex-innovative-cluster since 2005. With the two policy changes, there could be more room for the policy plan and implementation by the local government in supporting small firms' innovation activities. There could be more systemic efforts to support the local small firms' innovation activities by the cluster agencies.

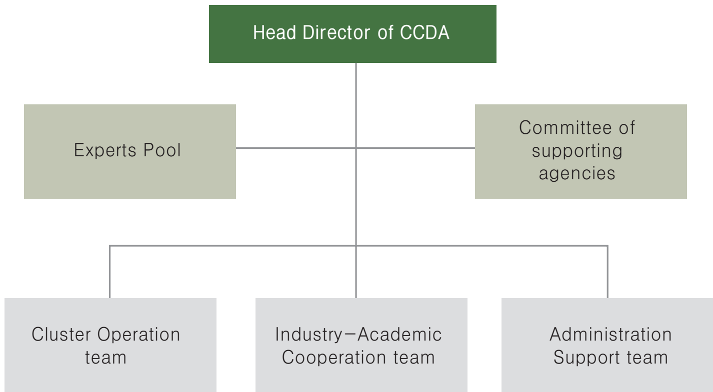
5.3.3 The Changes in Changwon Cluster after 2000

The biggest changes in Changwon cluster after 2000 are changes driven by Changwon Cluster Development Agency. Changwon Cluster Development Agency was set up in 2005, after Changwon cluster received funding under the program of industrial-complex-innovative-cluster. Changwon Cluster Development Agency (CCDA) revealed a new policy approach. Changwon Cluster Development Agency's mission was to build networks among the main actors and act as a broker.

The CCDA consists of 30 staffs and it has the division of cluster operation team, industry-academic cooperation team, administration support team. The CCDA has an expert pool and a committee of supporting agencies in the region.

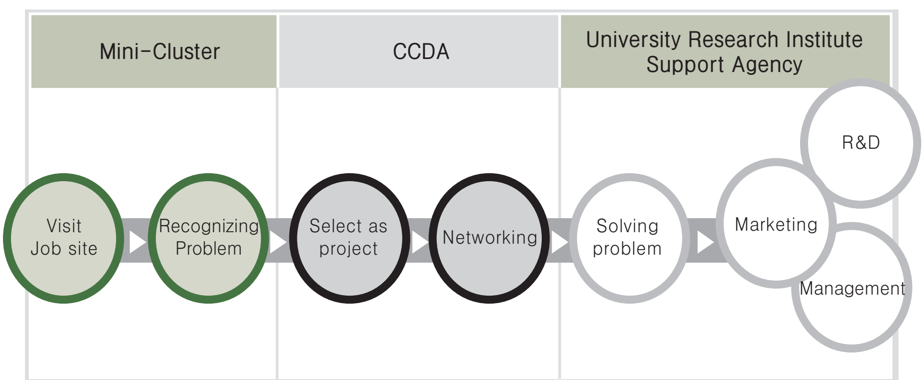
The CCDA's project is implemented with bottom up approach with active participation of firms. The projects for supporting small firms are developed out of mini-cluster activities. The mini-cluster activities include a visit to the mini-cluster member companies, technology seminars and workshops. The local companies can participate in five mini-clusters in specialized industrial areas such as metal and material, die-mold, electro-mechanics, machine tool, trans-equipment (Park 2007). The five mini-clusters include 44 leading large firms and other small firms which are related to the large firms in sub-contacting relationship and other business relationships. The mini-cluster has 698 people as members. 571 members are from the companies and 29 are from research institutes and 71 are from universities and 27 are from public supporting agencies in 2008 (Changwon cluster development agency 2008b). In the mini-cluster activities, problems can be identified. After problems are identified, projects to solve the problems are proposed. CCDA coordinates networking among member companies and university, governmental research institutes and public agencies for solving the problems. Finally, university, research institute and support agency solve the problems by carrying out R&D activities and by providing other relevant services (Park 2008, p. 14).

Figure 7-5 | The organization of CCDA



Source: CCDA (2008a)

Figure 7-6 | Processes of Total Care Service



Source: CCDA (2008a)

Table 7-5 | Cases of Total Care Service

Sectors	Areas
Technical Development (24)	Joint development & technology transfer (24)
Management (52)	Mentor (10), Industrial design & industrial right (4), Pilot production (19), Test & analysis (16), Design (3)
Marketing (84)	Exhibition and developing overseas markets (82), international certification (2)
Others (45)	Training (8), funding (19), coordinating (18)
Total (205)	

Source: CCDA, internal materials, 2008 as cited in Park (2008, p.14)

Table 7-6 | Comparison between the traditional support system and innovative cluster project

	Reflect the demands	Strategic consulting	Process management	Expert pool	commercialization
Traditional system	△	x	x	x	x
Cluster project	○	○	○	○	○

Note: △ (medium), X (low), O (high)
Source: Author's own adaptation. Park (2008, p.12)

For example in 2007, out of mini-cluster activities, CCDA found 301 problems and it provided the activities of total care service in 2007. 205 cases of total care service for solving the problems were delivered. The largest number of cases, 82 cases, were on marketing (particularly exhibiting their products and developing overseas markets) (See table 7-5)

According to Park (2007), the CCDA's approach is different from the traditional approach in that the approach is pursuing to reflect the demand, to utilize expert pools, to provide support for management of processes, to provide support for commercialisation. This approach resulted in innovative programs which reflect the demand from firms. The best example is the program for supporting cooperation among large firms and small firms. In 2007, there were four large firms, who had 270 firms as subcontractor firms, who participated in the program (CCDA 2008 b). In the program, large firms should purchase products from small firms if the cooperative R&D projcets turned out to be successful in producing satisfactory results (CCDA 2008 b).

The collaborative problem solving processes were supported by the network of the public agencies, the local government and universities. There was the cluster council for organizing the meetings among 20 public agents including Kyungnam provincial office, Changwon city, Kyungnam techno park, Regional innovation councils, Small Business Corporation, KOTRA (Korea Trade-investment Promotion Agency) (Kikye Journal 2007). There is an advisory council for providing advises on cluster strategy, which consist of president of universities,

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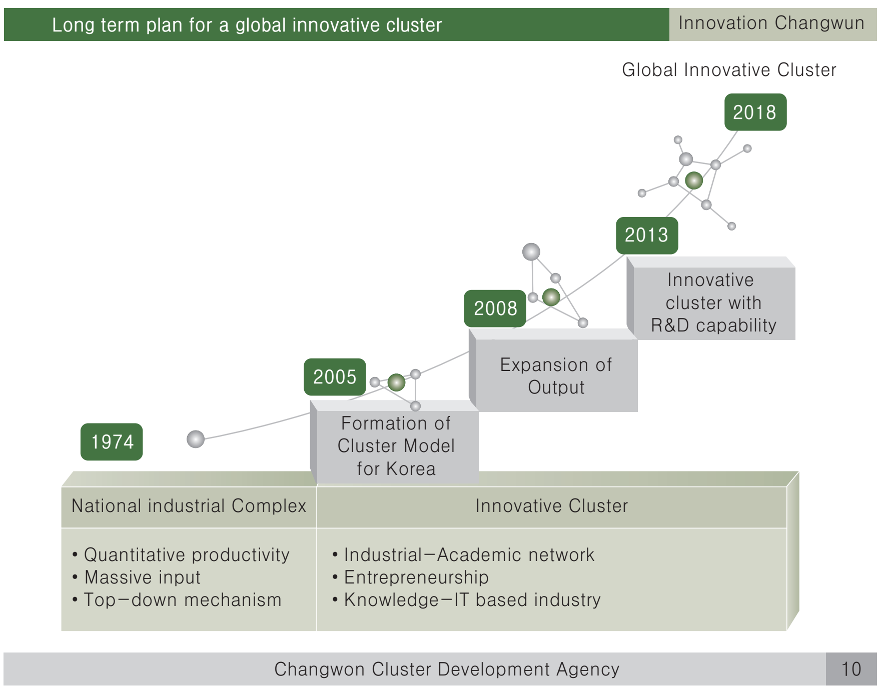
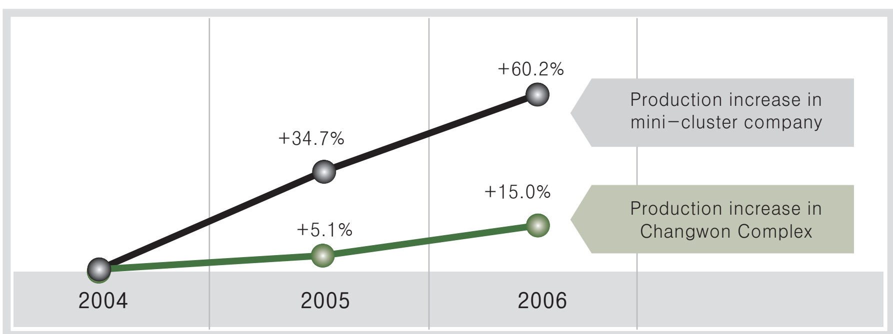
CEOs of companies, and the heads of the local governments. All of these did not exist at the time of research in Lim (2003). The trends of sales and production of the member firms are shown in Figure 7-8.

Figure 7-7 | Long term plan for a global innovative cluster



Source: CCDA (2008)

Figure 7-8 | Rapid growth of mini cluster member companies



Source: CCDA (2008a)

With the extended discretion in planning and implementation of the local government's budget, the local government could participate in driving the development of the local industry to the extended extent. The cluster agency could also contribute to the development of the cluster with the long term vision (see Figure 7-7). The cluster council was set up for cooperation in implementing the plan and the vision of the development to the local industry. In this sense, cluster leadership organization has been set up over the last decade.

Table 7-7 | The production trend of the cluster member firms of mini clusters

Item	'04	'05	'07
		Production	Production
Production increase in Changwon Complex	USD 27billion	USD 29billion	USD 37.7billion
Production increase of Changwon mini-cluster member company	USD 2.6billion	USD 3.1billion	USD 3.9billion

Source: CCDA (2008a)

6. Ulsan Automobile Cluster and the Automobile Component Industry: Importance of Firm Strategy

This report on the Ulsan cluster shall focus on the importance of firm strategy in dealing with the cluster policy. Ulsan and Changwon cluster have the same policy background. Both Changwon and Ulsan started to receive funding from the central government's program of industrial-complex-innovative-cluster as 'experimental clusters' in 2005. Both clusters have also been funded by the central government's policy for supporting the development of the local industries. In the case of Ulsan, the program was " Ulsan Auto Valley" which is similar to "Mecha-Know 21." Ulsan cluster also has Ulsan Cluster Development Agency and mini-cluster activities.

Ulsan is the largest automobile cluster in Korea, with Hyundai Automobile's main factory with 1.6 million car/year facility, the largest automobile factory in the world. The 'Ulsan Auto Valley' program was made possible by the governmental support in 2003. 'Ulsan Auto Valley' program was designed to support automobile industries in Ulsan area. The core of 'Ulsan Auto Valley' program includes the followings: automobile component innovation center, building the industrial site for automobile components and building industrial sites for modularization.

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The automobile component innovation center was established to help small firms' technical innovation and quality improvement and start up of small firms. The main function was R&D, testing and issuing certificates, and technical trainings. The center, being equipped with equipment for testing, can provide testing service to small firms who cannot afford to buy equipments. The center bought 37.4 million dollar worth equipments (Automobile Component Innovation Center, 2006). The center accommodates 21 firms providing service in the area of engineering analysis, component design, test evaluation, pilot product development, development of transportation equipment, and supporting firms. The majority of firms are new firms established either by the graduates of incubation center in Ulsan university or leavers of other companies (Cho 2008, p. 12).

Table 7-8 | Firms in Automobile Component Innovation Center

Function	Number of firms
Engineering analysis	3
Component design	6
Test evaluation	3
Prototype development	2
Development of transportation equipment	4
Supporting firms	3

Source: Ulsan automobile component innovation center, 2006.

The "Auto Valley" program had some projects which were not compatible with the automobile maker's strategy, while some were compatible. For example, the project of training design skills for automobile component makers in collaboration with Hyundai Automobile and the center has been implemented without causing tensions. However, provision of testing service and provision of the certificate of the tested results to automobile component makers are not in harmony with Hyundai Automobile's strategy. Hyundai's strategy is moving the R&D and testing facility to Namyang, which is at four hour drive distance. As a part of the program, the projects of building the industrial site for automobile components and industrial site for modularization can also cause tensions with the company's strategy. Because the majority of R&D functions of Hyundai is migrating to Namyang area, Hyundai cannot be as cooperative in the Ulsan Auto Valley's R&D projects for supporting automobile component or testing functions as in the case of projects of training designs for automobile component makers. If Hyundai decides to be cooperative in testing and R&D of automobile components under the Ulsan Auto Valley's program, that means that Hyundai Automobile maintains or increases R&D or testing functions for automobile components in Ulsan area. However, Hyundai's strategy is concentrating on R&D and testing activities of automobile components in Namyang area.

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Ulsan's cluster policy case reveals the importance of the company's strategy in designing the cluster policies. The strategy of the cluster policy needs to be compatible with the large firms which have the dominant status.

7. Policy recommendations

So far, the cluster of the automobile component industry has been discussed. The root of the successful development of the automobile component industry in Korea goes back to the national plan for developing the automobile industry in Korea. The Korean automobile component industry could grow with the expansion of the successful automobile makers' growth. The strategic plan and policy drive at national and local level has been important for the successful industrial growth. In the two cluster cases in Korea, there were strategic policy drives for local industries. In the case of Changwon, it was 'Mecha Know 21' which was targeted at machine industry and in Ulsan 'Ulsan Auto Valley' for automobile industry. The industrial-complex-innovative-cluster program was added to support the networking in the clusters.

From the experience of Korea, followings can be suggested. In order to achieve the dynamic growth of the automobile component in the Marmara automotive cluster, which is the largest automobile cluster in Turkey, the government needs to have the strategic plan for upgrading the automobile component industry and allocation of resources for supporting the plan. These plans need to be supported by the central government.

In the case of Turkey, automobile component industry is likely to return benefits to Turkey that are higher than the investment made by the Turkish government. With the strong automobile component industry, Turkey can keep or expand the number of employees working in the automobile manufacturers and component manufacturers and get taxes out of the employees and the companies in the automobile industry. The automobile and component industry is one of the best industries creating employment effects. If the Turkish government does not succeed in enhancing the competitiveness of the automobile component industry, then the automobile makers in Turkey would find it increasingly unattractive to produce automobiles in Turkey and likely to move the manufacturing base to other countries as the wage in Turkey rises with the continued economic growth.

There are some criticisms in Turkey on the role of the automobile makers in upgrading the capabilities of local small suppliers, arguing that the automobile makers (or the first tier component makers) transfer the technology (specially production technology) to the limited extent and do not permit opportunities of local companies to upgrade the capabilities to the higher value added or R&D intensive component production. Some would argue that there is no spillover effect to the local second or third tier suppliers of the quality management practice and production management practice which have been accumulated in the automobile manufacturers or the 1st tier automobile component makers.

However, subcontracted production of automobile components can provide opportunities for upgrading the local small firms' capabilities. It should be reminded that the Taiwanese automobile component makers, even though Taiwan does not have international automobile makers, have similar number of US patents granted to the number of patents owned by the companies in Korea which has international automobile makers. The Taiwanese automobile component makers accumulated their technological capabilities from their experience of subcontracting relationship with the Japanese automobile makers.

The issue is how to devise the system leading the local component makers to grow through their subcontracting relationship with automobile makers or first tier subcontractors. There is a sound report, "A Road Map of Road Maps"(Version 3 in 2009) for the growth of the Marmara cluster which has thorough analysis of the cluster and provides comprehensive policy directions. The report needs to be developed as a national plan and the central governemnt's financial support is required.

The cluster policy should be focused on upgrading the capabilities of local firms. In this sense, it is important to have a strategic target indicator. This indicator is important for monitoring the performance of the policy implementation. In the case of the Korean automobile industry policy, the strategic indicator was the 'localization ratio' (see section 3 for definition). In the case of Turkey, the recommendable indicator could be 'localization ratio' or the number of 1st tier or 2nd tier component producers in Turkey. The national and regional policies should be focused on increasing the localization ratio or the number of 1st tier or 2nd tier component producers. In order to increase the localization ratio or the number of 1st tier or 2nd tier component producers, the policy program should be developed to provide packaged service to small firms, ranging from R&D (or component development) to manufacturing and marketing. Small firms, being lack of their capability, are likely to lose in gaining the market even though they succeed in component development. Therefore, the packaged service needs to be delivered.

The cluster policy needs to develop the system to provide packaged service to small firms. The Turkish experts' view on the local small firms is that the local companies do not have enough advanced design, design verification, production and management techniques. The cluster policy should be targeted at solving huge variety of problems the local firms face in their business activities. In order to solve the problems, the bottom up approach to identify the problems and exploring solutions needs to be adopted. The Changwon Cluster Development Agency's total case service system can be a good example of developing the system to provide packaged service.

This packaged service should be delivered by an organization which can design and deliver packaged service through networking public agencies, universities and consultants, like the cluster development agency in Korea. There needs to be funding for establishing and operation of cluster development agency for facilitating of networking.

The cluster policy should reflect the automobile maker's demand in the cluster. Followings can be recommendable for reflecting automobile maker's demand. First, one of the recommendable programs is a cooperative program, such as R&D program, between large firms and small firms on the condition that the large firms purchase the products if the results of the cooperative R&D proved to be successful. Although there has been policy programs in Turkey which encourages cooperative R&D between firms and universities, there has not been cooperative R&D programs emphasizing cooperation between large automobile makers and local small firms. Second, the cluster policy needs to be designed in close consultation with automobile makers. If the cluster policy initiative is not compatible with the automobile makers'

Box 7-2. UK regional government's cluster policy case

Because Turkey has a close relationship with the EU, this study selected a case of the policy in a region similar to the situation in Turkey. In the Turkish automobile component industry, the FDI automobile maker as the customer is important. This study selected a case where the FDI is important as a customer for the growth of the local industry. This report selected the Welsh local government policy model.

The policy of Welsh local government in UK can provide insights on the policy for the Turkish government. In the 1990s, The Welsh government has been interested in holding MNC's branch plants by providing favorable environment for businesses. In order to provide the favorable environment, the Welsh development agency organized a network of organizations called Team Wales (Morgan 1997) which would provide aftercare services to FDI firms. They also set up Source Wales program which emphasizes supplier development program.[41] Source Wales Program pursues long term relationship between major buyers and local suppliers which would emulate Japanese supplier relationships. The Welsh government took its cue from the experience of Japanese firms. There were 50 Japanese firms in the region. Source Wales stimulated formation of supplier associations in Wales where new skills and techniques were exchanged between buyers and key suppliers and large customer companies act as a tutor to SMEs. There was also a technology support program to enhance the capacity for product, process and organization innovation in small companies. The agency delivers the service through on site technology audits which identify the strengths and weaknesses of each firm. These audits are funded by EU's STRIDE program (Morgan 1997, 499). The policies are oriented to organizing user-producer relationship and providing services and other favorable environments.

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strategy, there cannot be fruitful results in spite of governmental efforts. Third, cluster policy needs to have the central government's budget system which allows room for the decision making by the local government and agents. Without the budget system, the local authorities have little room for local initiatives. Fourth, organizing the channels of communication for reinforcing communication is important for bottom up approach. Organizing local meetings or clubs among firms is required for drawing out projects designed to solve problems at the company level. The mini-cluster of Changwon provides a good example. The Chagwon's case of mini-cluster communities are mini units for sharing information and identifying problems of firms. With these communities, the problems can be identified at firm level and the project for solving problems can be initiated.

41. Source Wales has been acclaimed as an innovative and effective programme (Wicksteed, 1996)

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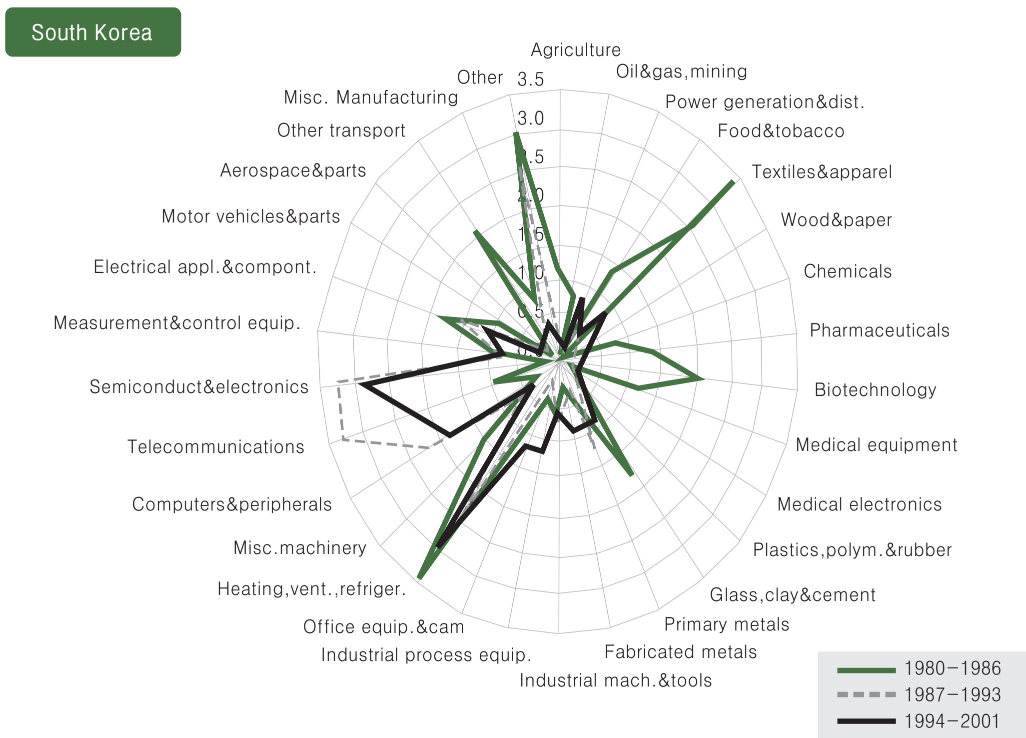
The following diagram clearly shows that Korea's specialization of R&D activities, in terms of patenting activities, have shifted from traditional industries such as textiles to electronics and semiconductors (Lim 2008, p. 510).

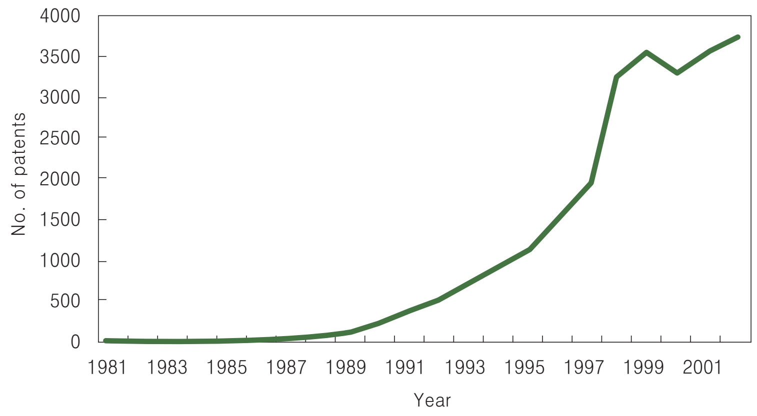
Figure 7-A-1 | Historical changes in revealed technological advantage (RTA) in patenting in eight nations, 1982-2001



Source: K. Wang, M.-T. Tsai, Y.-L. Luo, A. Balaguer, S.-C. Hung, F.-S. Wu, M.-Y. Hsu and Y.-Y. Chu, Intensities of Scientific Performance: Publication and Citation at a Macro and Sectoral Level of Nine Countries, ESF Working paper, Science and Technology Information Centre - National Science Council, Taipei, Republic of China, 2003. As cited in Lim (2008, p.513)

With these shifts in Korea's specialization, the quality of R&D activities has been dramatically enhanced as have been revealed by soaring patenting activities over the last two decades in the US patents (Lim 2008, p.117).

Figure 7-A-2 | Korea's Patenting Trends in the US.



Note: Number of patents as shown by patents registered wih the USPTO.
Source: USPTO website, 9 March 2003. Lim (2008, 117)

This shift of industrial structure has been driven by the policies for upgrading industrial structure. The upgrading policies can be divided into three categories: (i) government driven selection of sectors and investment in the specific sectors, (ii) provision of factor conditions such as infrastructure (railway and highways) and educational institutions(for provision of workforces) and R&D institues(for provision of knowledge) for industrial upgrading, (iii) systemic approach for upgrading the higher value added activities of the specific sectors.

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Chapter 08

Clustering in Turkish Automotive Industry

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Chapter 08

Clustering in Turkish Automotive Industry

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1. Background of Automobile Sector in Turkey

There are several strategic points to take into consideration in the Turkish Automotive Industry (the Turkish acronym is TOI) as it is in the world automotive industry. They are the followings:

- Globalization,
- The innovation and R&D,
- Production efficiency / cost minimization,
- To enter the European market and emerging markets for sales,
- Further rationalization of supply chain,
- Scale Economy and catching up.

The scale economy and catching up question seems to be a distinctive issue in the Turkish Automotive Industry. However, as it has been explained below, this has been losing its "strategic" character as the TOI's integration to Europe increased. Moreover, some analysts and industry experts argue that diminishing economies of scale will stop and reverse the trend of consolidation.

At present, there are some new technological developments which will initiate some important structural changes in the sector. It is more urgent to follow and assess these developments and adopt them. For example, Ford-Otosan produces internal combustion engines for heavy duty vehicles. Otherwise, imported engines are adapted to new model vehicles in the other firms. However, the competitiveness of the TOI is concentrated on body and interior automobile trim. It is the same from the point of view of the suppliers as well.

Technological fields on which TOI should focus, is listed below:

a. advanced power transmission and propulsion systems, electrical and hybrid vehicles, new fuel systems;
b. active/passive safety;
c. new materials.

Consequently, in order to turn the developments into an advantage for TOI, it is very important that main consideration is given to electrical and hybrid vehicles, the technological developments concerning their design, design validation and production are given proper attention and works to be adopted accordingly in order to produce the related technologies in this field. Thereby, it can be possible to pass over the stages of design, design validation, investing in production of internal combustion engine as an important part of an automobile. It is advisable to focus in the next 10-15 years on "niche" automobiles which are to be produced in smaller production scales.

Leaving the policy of "import substitution industrialization" during the 1980s, Turkey adopted herself to "export oriented industrialization" policies. This has also solved the balance of payment problem. However, it was obvious in 1990s that this model of industrialization with one parameter was not sufficient to fill the gap between the imports and exports. The economic crisis of 2001 had taken place. The growth speeded up after the crisis and the automotive sector's share in this was great. The production has risen and employment has increased, value added got bigger and the exports grew as the sector became "number one" exporter in the Turkish economy.

It is during this period that the automobile industry has been well integrated within that international production chains, especially the European production chains. *[a]*

On the other hand, the gap between imports and exports grew bigger both in the sector and in the economy in general, with one exception, the automobile bodies (See Table 8-1).

Table 8-1 | Export and Import Values on Automobile Industry in Turkey

Export and Import Values on Automobile Ind. in Turkey	Exports(US$ million)		Imports(US$ million)	
	1990	2005	1990	2005
Motor vehicles	81	7802	794	8271
Automobile bodies	3	115	8	112
Automobile components	90	2308	480	3948

Source: UNIDO, Industrial Demand-Supply Balance Database, 2007

From the following tables on "Revealed Comparative Advantage" and "Import Penetration Rate" (Table 8-2 and Table 8-3) that cover the developments from 1996 to the end of 2004, the competitiveness of the Turkish automotive industry in the world markets is on the increase. This, however, comes together with the import density and import dependency. This, taken together with the picture reflected from the previous Tables 8-2 and 8-3, (see Figure 8-1) shows a need for new re-institutionalization based on high productivity in the sector, low costs and R&D.

Table 8-2 | Revealed Comparative Advantage in Turkish Automotive Industry

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Sectoral exports (in billion $)*	0,8	0,7	0,8	1,4	1,6	2,3	3,3	5,1	8,1
Total exports of Turkey (in billion $)*	23,2	26,2	27,0	26,6	27,8	31,3	35,8	47,3	63,1
The sectoral export share in country (%)	3,32	2,54	2,96	5,41	5,6	7,46	9,11	10,81	12,84
World's sectoral exports (in billion $)	470	496	525	549	578	590	627	728	847
Total World exports	5391	5581	5498	5712	6449	6183	6482	7551	9153
The sectoral export share in the world (%)	8,7	8,9	9,5	9,6	9,0	9,5	9,7	9,6	9,3
Revealed Comparative Advantage	38,1	28,6	31,0	56,2	62,5	78,2	94,2	112,1	138,8

Source: The Automotive Manufacturers' association (the Turkish acronym is OSD)
(*) Data was taken from World Trade Organization (WTO)

Table 8-3 | Import Penetration Rate

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Sectoral Imports(in units)	93.720	210.035	183.829	175.497	342.174	94.211	83.291	223.224	436.251
Total Demand(Products+ Imports-Exports)(in units)	334.668	526.028	496.493	387.537	676.114	166.184	171.834	409.738	751.262
Import Penetration Rate (%)	28	40	37	45	51	57	48	54	58

Source: The Automotive Manufacturers' association (the Turkish acronym is OSD)

If we have a closer look at the tables and the figure, we can easily deduce that the competitiveness of the Turkish Automotive Industry has considerably increased in world markets. However, this success is based on the increase in import density and foreign dependence. Figure 8-1 displays that there is a need for re-institutionalization focusing on certain fields such as high efficiency, low cost and R&D processes.

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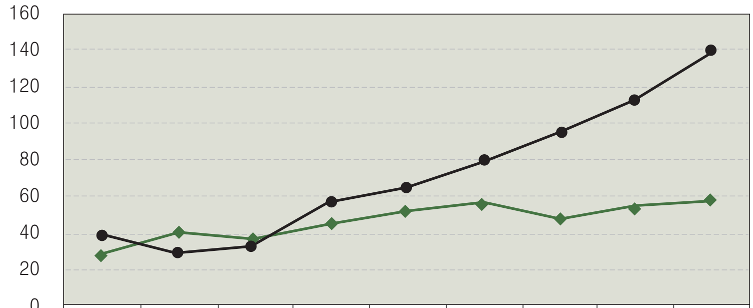
Figure 8-1 | The Divergence among Import Penetration Rate and Revealed Comparative Advantage in Turkish Automotive Industry[b]



	1996	1997	1998	1999	2000	2001	2002	2003	2004
Import Penetration Rate	28	40	37	45	51	57	48	54	58
Revealed Comparative Advantage	38.1	28.1	31	56.2	62.5	78.2	94.2	112.1	138.8

The Definitions

Revealed Comparative Advantage: It is calculated by dividing the ratio of a sectoral export in total export within the country to the ratio of total sectoral world export in total world's export. The number obtained from this calculation with that value greater than 100 refers that the country is specialized in that sector.

Import Penetration Rate: The sectoral import quantity of a product is divided by the number (sectoral production + import - export) in units and then the obtained calculation is multiplied by 100. The rate close to zero means that imports are negligible in internal demand; the rate close to 100 refers that internal demand is met by imports.

One aspect of TOI is that it is concentrated in the Marmara region in the North West of Turkey. Three provinces of Bursa, Kocaeli and Sakarya especially host 11 OEMs and 1000+ suppliers.

Table 8-4 | Automobile Manufacturers in Turkey

MANUFACTURER	PROVINCE	PRODUCTS	LICENSE(S)
Anadolu Isuzu	Kocaeli	Truck, Pick Up, Midi-bus	Isuzu
Askam	Kocaeli	Road Tractor, Truck, Pick Up	Daimler Chrysler/Hino
Ford Otosan	Kocaeli	Passenger Car, Truck, Pick Up, Minibus	Ford
Honda	Kocaeli	Passenger Car	Honda
Hyundai	Kocaeli	Passenger Car, Pick Up, Minibus	Hyundai
Karsan	Bursa	Pick Up, Midibus, Minibus	Peugeot
TOFAS	Bursa	Passenger Car, Pick-Up	Fiat
Renault	Bursa	Passenger Car	Renault
Otokar	Sakarya	Pick Up, Minibus, Midibus	Deutz/Land Rover/ Fruehauf/Amgeneral
Otoyol (Iveco)	Sakarya	Pick Up, Minibus, Midi-bus, Truck	Iveco
Toyota	Sakarya	Passenger Car	Toyota

Source: The Automotive Manufacturers' association (the Turkish acronym is OSD)

In terms of units of production, passenger cars are by far the largest segment (634,883 Units in 2007, indicating a 16% increase on a year on year basis). Pick-ups are the second largest segment of production (391,737 Units in 2007, indicating a 6% increase on a year on year basis). These two segments comprise 90% of total production in 2007. Oyak-Renault, Tofas-Fiat and Toyota are the leaders in passenger cars market, whereas Ford-Otosan is the distant leader in pick-up market. A sizeable portion of the production is being exported in both segments.

As is known, the supply chain of the automotive industry is composed of assemblers (manufacturers or OEM), first, second and third tier suppliers. OEMs (manufacturers) are at the top of the pyramid showing off top world leading performance from the point of view of their acquired manufacturing technologies. Reason for the low average productivity[a] is the low level of productivity of the 2nd and 3rd tiers traditional, unregistered, small size firms. It seems that the productivity question in the automotive sector cannot be significantly solved without reducing this "dualism." Consequently, especially SMEs should be able to create initiatives for the implementation of advanced manufacturing technologies and advanced managements technologies. However, one cannot speak of a public policy aiming this.

Conclusion

Turkish Automotive Industry place in the international division of labor has been "being a production base" and the automotive industry has accepted this role given to Turkey and adopted themselves accordingly. The ownership of the production capacity has increasingly changed hands during the last 10 years through mergers and acquisitions, partnerships, closures, etc. Therefore, one can claim that this sector, where there is an increasing presence of foreign capital, has gained the ability of quality, conformity assessment, production management, procurement, and to some extent partially qualified labour (continuous improvement). Moreover, parallel to this, especially the OEMs have improved their ability to design and design validation. However, this success may not be repeated in the technology development area.

The automotive sector has got problems in transferring technologies from the Turkish universities and producing technology through R&D at every level of the supply chain (the procurement pyramid) and OEM. Technology transfer is made from the parent company abroad. That never lets the company in Turkey catch the leading place.

Second important point is that the know-how in the "quality, conformity assessment, production management, partially qualified labour" accumulated by the OEMs and 1st tier procurers cannot get dissipated to the 2nd and 3rd tier procurers in the sector, i.e. they do not have enough advanced design, design verification, production and management techniques. Dissemination of know-how down the ladder is important.

The followings are proposed in order to upgrade the automotive industry. An important way (tool) of realizing these is the clustering.

2. Upgrading Industrial Structure

Here are some proposals in order to realize the expected "industrial upgrading" and the "transformation of the industrial sector into high value-added industries or translation of industries."

2.1. Common Requirement Areas

There is a well founded infrastructure in Turkey in areas of body (chassis, painted body made of steel sheet, suspension system, steering wheel system, brake system, etc.) and body equipment (internal finishing parts, external finishing parts, etc.) and the sector would like to improve its existing capabilities in these areas. Besides, the sector would like to increase its knowledge acquisition in technological arena of vehicle dynamics, acoustics, vibration, safety and fatigue. Painted steel sheet body, especially the parts made of steel sheet, have an important portion in total cost of a vehicle. Constitution and improvement of engineering services in this area will highly contribute. Production of internal plastic finishing parts and preparation of prototypes are important and costly phases of product development process. Related sectors' capability in Turkey is insufficient in this area and cooperation maybe useful to improve engineering acquisition and situation of suppliers in plastic parts development process. Vehicle dynamics and suspension systems are the areas that are very important for Turkey, have future in the sector and have related suppliers in Turkey. Also in these areas, cooperation, especially in test systems and road tests, between suppliers and main industry are possible. Vibration and acoustics are very important parts of product development process. Also, cooperation in this subject is possible in test systems, runway and anechoic chamber.

2.2. Encouraging Horizontal Structuring

Here, horizontal structures among three or more companies should be encouraged / supported in common requirement areas without looking for an R&D profundity. Cooperation to be done in the subjects of plastic parts, indicator systems and electric distribution systems or in the areas of production technologies and management technologies could be based on such an organizational network.

2.3. Encouraging Integrated Projects / Structures

During several meetings with OEMs [c], it was concluded that extreme requirements and the results of the efforts done for these requirements would be effective only in a very long term. Various projects having profundity in research maybe formed in the areas such as vehicle and engine management systems and electronics, alternative fuels, recycling engine emission systems and injection systems, technology for cars running with boron based fuel cell. That kind of projects should be evaluated as the projects that need the academic knowledge in universities and R&D institutions that are to be realized only by combining the resources and hence require the partnership of two or more companies. These activities, which are called as R&D studies before competition, are far more long lasting and costly than product development projects. Having far heavier and selective evaluation criteria, that kind of projects should be encouraged by supporting comprehensively and for longer periods. Before determining the subjects of that kind of projects, technological foresight should be done and critical subjects that will keep their importance also in future should be chosen.

Besides, an autonomous technology institute or company having an integrated structure may

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be established, which can provide both the required engineering manpower according to the requirements of product development projects and the hi-tech equipment / software that is expensive and can be effective only if it is used collectively. For example, under the partnership of TAYSAD, TTGV and OSD, a company may be formed to provide technology and engineering services. On the other hand, OTAM I can also be taken as an institution where these functions performed.

2.4. Excellence and/or capability centres

They may be constructed especially for rapid prototype, seat and suspension systems. Although the topics here (seat and suspension systems) are not extreme samples, the target is important. These centres should have an extremely netted and integrated structure and be able to produce extremely important integrated projects. While constructing such centres with participation of companies, suppliers, universities, institutions and expert engineering companies, Turkey's priorities should be examined carefully. However, the way of supporting that kind of centres should be different.

2.5. Encouraging Integrating Areas

Two kinds of organizations were considered to improve suppliers' design, design verification, manufacturing and management capabilities:

a. To develop a common project, gathering together more than one supplier around a main company;

b. To direct a supplier in developing products that fit standards of main companies and improves its capabilities, choosing a supplier by more than one main company.

It is an important advantage to construct test centres in integrating areas for tests such as:

a. Vehicle dynamics, vehicle integration, calibration, noise and vibration, safety, emission, developing sensor, acoustics, fatigue, road tests, etc. (virtual and/or visual);

b. Component tests (virtual and/or visual);

c. Type approval (homologation) tests, which collect the possibilities and equipment in one place in Turkey. This also may help to direct R&D studies to Turkey.

2.6. Encouraging Relations with Universities

Dealing with development of a vehicle within a time limited program that is to be produced in high volumes in international standards and competitively in international markets, it is easy to understand - considering the problems regarding time, confidence and purposes - why universities are not preferred to get the same kind of information. Moreover, academicians have to spend extra time to solve the problems out of their interest areas since the information package demanded from the university includes also engineering knowledge beside academic knowledge. However,

a. Engineering knowledge has been acquired for years by licensor. Industry in Turkey is in the phase of getting this knowledge. In later phases, e.g. in phase of developing or constructing excellence centres, it is more appropriate to get this information from universities.
b. Engineering knowledge is in the interest area of engineering companies. That kind of companies may be used as an interface in relations between universities and companies. Expert engineering companies having the characteristics to be an interface may be encouraged.
c. Another solution to utilize university's knowledge acquisition is the research institutions working in these areas. [c]

2.7. Clustering

Today, the clustering is one of the important tools to realize the institutionalization depicted above. Clustering is the name of activities of certain industrial organizations in a definite space, which come together wittingly or unwittingly in horizontal and/or vertical relationships in order to increase their competitive advantages and specific capabilities in the sector. Horizontal relations could be partnership in common project development, cooperation in R&D activities. The vertical relationships could cover activities as subcontracting or procurement. All these make the diffusion of the tacit and codified knowhow possible. Diffusion of know-hows in turn affects positively the innovative activities, creativity and design. This synergy increases the technological level of the region as whole, creates more value added and increases the welfare.

As companies and whole regions face intense challenges of the global economy (the globalization of industries and dynamically changing markets), they require a rapid response to changing opportunities and threats. The development of clusters and knowledge-driven businesses helps to create this responsiveness and the culture of innovation. Continuous innovation (which can be defined as successful application of new ideas and skills), joint research, product design, marketing, procurement, training and other collaborative activities enable business within clusters to compete successfully in global markets. This encourages linked organizations to work and learn together, to deal with opportunities and threats and to focus on achieving the required enhanced competitive advantage for their clusters and regions

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2.7.1. Automotive Clustering in Europe

The European car market is strongly affected by the global competitive challenges and trends, particularly with the pressure of reducing carbon emissions and the advent of new low-cost entrants like Tata Nano.

However, according to the recent report by JATO Dynamics, the European car market is making a recovery. “April marked a reversal in the sales performance for the European car market, posting a 9.4% increase (120,235 units) over the same month a year earlier, with a total sales volume of 1,396,845 units. With a generally positive start to the first quarter of the year, the year-to-date figures for the European market are encouraging, with the market up 0.6% (33,684 units) to total year-to-date sales of 5,484,777 units, compared to the same period last year. Volkswagen continues to lead the European market, topping the sales league in both April and year-to-date, ahead of Ford, Opel/Vauxhall, Renault and Peugeot.”

Automotive clusters in Europe have proven to establish an effective framework for responding to market pressures and increasingly demanding requirements from the automotive lead companies. By joining forces and learning from other partners in the supply chain, small and medium sized automotive suppliers become more competitive. By improving companies’ access to resources such as technology, skills and qualifications, information on market requirements and business support services, clusters enable suppliers to master more complex challenges.

Considering the proven track record in supporting the supply base, suppliers associations and regional development policies have promoted the development of regional automotive clusters in a number of European regions.

Several EU initiatives dealing with automotive clusters in Europe have been developed over time, such as the European Automotive Strategy Network (EASN) etc.

Regional specialization in Europe is of considerable importance, particularly in the automotive sector. Europe is the manufacturer of cars, buses, heavy trucks and automotive assemblies. The European automotive clusters are a significant member of the world economy in the relevant area. Europe Innova determines 39 regional clusters out of a total of 259 regions accounting for 50 percent of employment within the European cluster network. The manufacturers and suppliers of those clusters are global actors; hence they execute their strategies globally. Clustering strategies cannot be separated from national or global policy strategies in this manner.

The most important automotive clusters in Europe are depicted as follows; [d]

Table 8-5 | Automotive Clusters in Europe

Region	Employees	Specialization	Stars
Steiermark-Austria	12.781	2,10	**
Wlaams Gwest-Belgium	46.084	1,64	*
Severovychod- Czech Republic	31.578	3,40	***
Stredni Cechy- Czech Republic	29.511	4,02	***
Jihozapad	17.203	2,30	**
Franche-Comte-France	24.767	5,38	***
Nord-Pas-de-Calais-France	30.989	1,96	**
Stutgart-Germany	136.353	6,62	***
Oberbayern-Germany	82.339	3,70	***
Braunschweig-Germany	79.997	10,73	***
Karlsruhe-Germany	40.694	3,03	***
Kozep-Dunantul-Hungary	17.091	2,96	**
Nyugat-Dunantul-Hungary	16.741	2,98	**
Piemonte-Italy	85.914	3,49	***
Sud-Muntenia-Romania	32.935	2,71	***
Zapadne Slovensko-Slovakia	21.261	2,03	**
Bratislavsky kraj-Slovakia	11.468	2,80 **	
Castilla y Leon-Spain	27.136	2,07	***
Dogu Marmara-Turkey	44.901	4,64	***
Vastsverige-Sweden	42.832	3,66	***
W Midlands-United Kingdom	37.913	2,27	***

Source:Europe Innova / PRO INNO Europe paper N° 5

These clusters are categorized according to the 3-star classification of the European Cluster observatory. In this categorization, there are three criteria;

- ***Size***: if employment reaches a sufficient share of total European employment, it is more likely that meaningful economic effects of clusters will be present. The 'size' measure shows whether a cluster is in the top 10% of all clusters in Europe within the same cluster category in terms of the number of employees. Those in the top 10% will receive one star.
- ***Specialisation***: if a region is more specialized in a specific cluster category than the overall economy across all regions, this is likely to be an indication that the economic effects of the regional cluster have been strong enough to attract related economic activity from other regions to this location, and those spillovers and linkages will be stronger. The 'specialization' measure compares the proportion of employment in a cluster category in a

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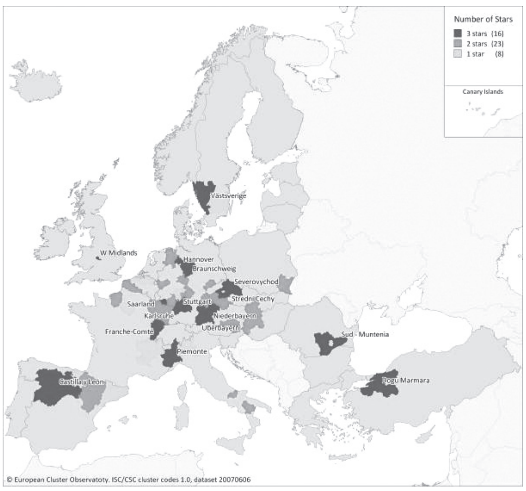
region over the total employment in the same region, to the proportion of total European employment in that cluster category over total European employment (see equation). If a cluster category in a region has a specialization quotient of 2 or more it receives a star.

$$\frac{\text{(Employment in a region in a category) / (Total employment in a region)}}{\text{(Employment in a category in Europe) / (Total employment in Europe)}}$$

- ***Focus***: if a cluster accounts for a larger share of a region's overall employment, it is more likely that spill-over effects and linkages will actually occur instead of being drowned in the economic interaction of other parts of the regional economy. The 'focus' measure shows the extent to which the regional economy is focused upon the industries comprising the cluster category. This measure relates employment in the cluster to total employment in the region. The top 10% of clusters which account for the largest proportion of their region's total employment receive a star. [e]

Figure 8-2 | Leading Automotive Clusters in Europe



Source: European Cluster Observatory

As seen from the above explanations, it is easily understood that the main selective criteria for clustering is employment ratios of the specific region according to the European Cluster Observatory. Although it is disputable, the European initiative is restricted by the lack of several indicators such as patent numbers, value-added, productivity etc. It is difficult to find those values particularly in the new member states and associative states such as Turkey, Israel and Ireland. It is important to note that this classification is not able to state explicitly the knowledge diffusion and information linkages within the clusters.

In conclusion, it is not surprising to note that the most significant automotive clusters are from Germany. The biggest one is Stuttgart with its nearly 140,000 employees. The German clusters are also intriguing for their specialization rates. Braunschweig with its 10.73 specialization rate refers that the employees working in automotive sector is ten times more than the country's average. One can deduce that most of the population in the state is worked in automotive sector. Furthermore, Piemonte (Italy), Sud Montenia (Romania), Severovychod (Czech Republic), Franche Comte (Spain), Castilla y Leon (Spain), Vastsveridge (Sweden) and East Marmara (Turkey) are other important clusters in the European Automotive Industry. East Marmara cluster which is the subject of this report is one of thirteen clusters with three stars. It is the fourth one in the number of employees among the three-stared clusters. Its specialization rate valued at 4.64 is considerable. However, we should notice that this methodology excludes significant indicators for clustering such as patents, science and technology indicators, value-added and productivity etc.

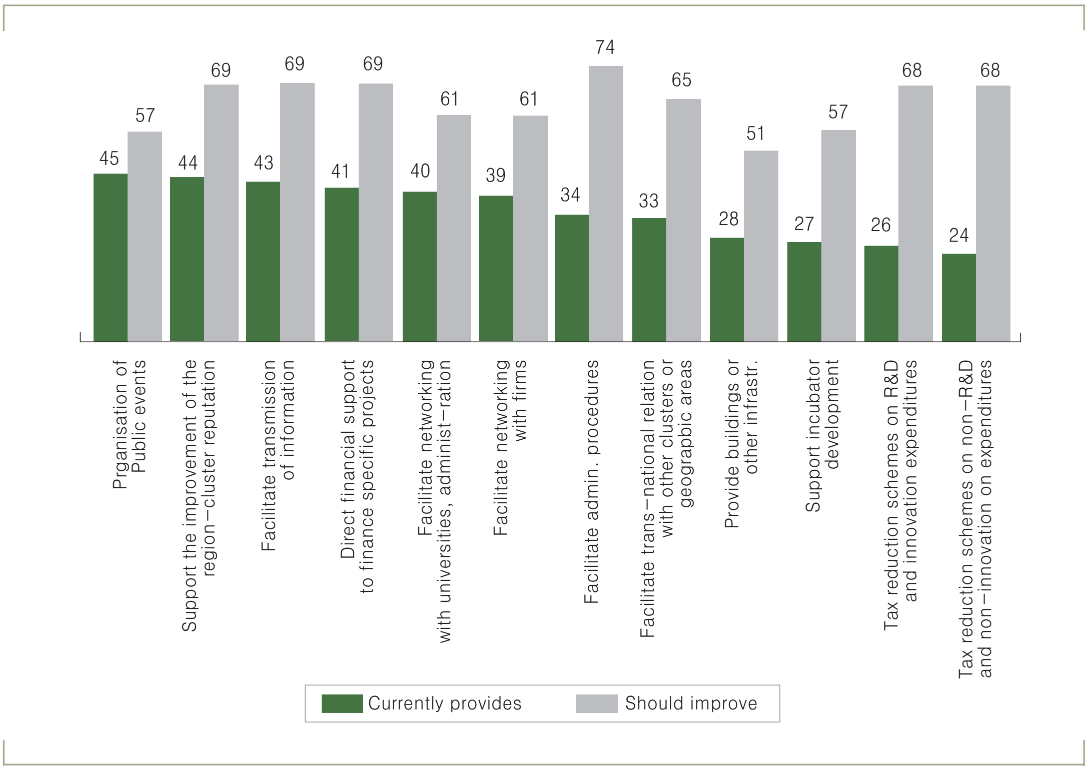
2.7.2. Level of Clustering in Turkish Automotive Industry

Europe Innova also mentioned about East Marmara Automotive cluster in Turkey "Innovation Clusters in Europe Report - a Statistical Analysis and Overview of Current Policy Support" report. Automotive Cluster in Turkey has approximately 45,000 employees and cluster is basically organized around key anchor firms.

The European Cluster Observatory currently identifies regional clusters that are located in the EU-27 Member States, Iceland, Israel, Norway, Switzerland and Turkey. East Marmara Automotive Cluster takes three stars (Table 8-5) according to this study, but Regional Innovation Scoreboard (RIS)[d] benchmarks European clusters on the basis of 7 indicators, including human resources in science and technology, patent applications and employment in medium-high and high-tech manufacturing. RIS presented the regions with the best performing innovation regions in Europe. It is important because this study suggests that a positive correlation may exist between the strength of regional cluster portfolios and regional innovation performance. The Turkish clusters have not been evaluated by RIS. On the other hand, Turkey's innovation system has been evaluated by European Innovation Scoreboard 2006 and Turkey is characterized as lagging country. Although East Marmara Automotive Cluster takes three stars according to European Cluster Observatory that based on employment size of the cluster, innovation capacity of East Marmara Automotive Cluster must be taken into consideration for competitiveness, innovation, productivity and growth. However the RIS measurement of East Marmara Automotive cluster should be implemented specifically for further evaluation of the in terms of innovation capacity.

According to the Innobarometer 2006 survey, the most important areas where cluster firms would prefer to get more support from the public domain are in facilitating administrative procedures, in facilitating information flow, in getting more finance for carrying out specific projects, and in improving the branding of their region (Graph 8-2). Furthermore, tax reduction, both for R&D and non-R&D expenditures, is another area where the cluster firms saw room for improvement.[d]

Figure 8-3 | Support activities of public authorities: assessment of current levels and desire for improvement



Source: Europe Innova / PRO INNO Europe paper N°5

Facilitating transmission of information is one of the major advantages of clusters. Information flow among firms is important since it is one of the main factors that affect the functioning of innovation capacity. The literature also affirms positive relations between innovativeness and networking. Sharing strategic information is a characteristic of innovation based clusters[f]. Automotive cluster in Turkey is organized as a supply chain structure and to mention about information transmission is difficult. Competitive advantage based on innovativeness and creativity provides a strong competitive position to industrial clusters, but as automotive cluster case in Turkey which has limited information flow, cluster tends to be competitive based upon price/cost advantages. In Turkey, it is also expected that local public authorities should support clustering formations in these areas mentioned above.

2.7.3. Technology and Cluster Policies in Turkey

Many policies that have affected clusters are not explicitly called cluster policies, but fall under categories like regional policy, research and innovation policy, industrial policy and SME policy, innovation and technology policy. On the other hand, although there has been a powerful R&D support mechanism for fifteen years in Turkey, these mechanisms could not work as an instrument of long term technological policy. Industry policies and technology policies have been presented by different public organizations. Even though some of these policies are launched concurrently, they have involved conflicting statements or concerning sub-policies, strategies, roadmaps and action plans do not exist. Consequently these policies could not catch up specific aims.

Three important projects are presented here to serve as a basis on cluster policies and on automotive industry long term technology policies in Turkey.

The Vision 2023 project

"The vision 2023" that launched at the beginning of 2002 to design science and technology policy of Turkey for the next two decades is very important as it provides participation and commitment by all stakeholders[g]. The importance of the Vision 2023 emanates from that it foresees consequential technologies for industry in Turkey especially for clusters. In addition to that study, in automotive industry part of "Report for 9th 7-year National Development Plan[b]" challenges of automotive main industry and supplier industry are defined and foresights are stated with SWOT analysis.

Turkish Research Area (TARAL)

"The Turkish Research Area (the Turkish acronym is TARAL)" [g] has been launched in September 2004, which aims to synergize research and technological development activities of the Scientific and Technological Research Council of Turkey, public agencies, non-governmental organizations, private sector companies and universities.

One of the targets under this strategy is to enhance Turkey's integration to ERA (European Research Area). The other targets include, stimulating the implementation of multi-partnership projects under TARAL and the creation of technology platforms, building networks to create synergies for implementing multi-partnership projects to fulfil the objectives of TARAL, forming technology platforms within these networks to contribute to technology foresight activities.

In 2007, TUBITAK started the Support Program to Build Scientific and Technological Cooperation Networks and Platforms to facilitate establishment of technology platforms. Nine technology platforms were started in the sectors of textiles, electric/electronics, metal, automotive, energy, medical, agriculture, construction and marine sciences.

TARAL is important because it determines technology platforms in which cluster actors are congregated.

Law number 5746 on R&D

New law (number 5746) on R&D covers projects which have been developed in collaboration with companies as well. However, clusters have not been mentioned directly.

Technical Assistance for the Development of a Clustering Policy (DCP)

The purpose of the project is "to develop a comprehensive and visionary clustering policy that contributes to the sustainable social, environmental and economic development in Turkey". The Undersecretariat for Foreign Trade as an important agency in improving Turkey's competitiveness is the beneficiary of the project "Technical Assistance to Development of a Clustering Policy (DCP)" for Turkey. One of the main goals of this project is to develop an institutional capacity in the public sector, the private sector, in autonomous organizations, and also in non-governmental bodies, so that they can develop and implement an integrated clustering policy. Using a participatory approach, another important goal of this project is to develop a clustering policy, which is coherent with the regional and sectoral development policies. During the course of the project, twenty clusters will be selected initially and from these, cluster development roadmaps will be developed for ten of these clusters who will be supported with respect to predefined prioritization criteria and in line with the readiness of the clusters. The roadmaps of clusters named Ankara Software Cluster, Izmir Organic Food Cluster, Marmara Automotive Cluster, Mersin Processed Goods Cluster, Eskisehir-Bilecik-Kutahya Ceramic cluster, Ankara Machine Cluster, Konya Auto-Supplier Industry Cluster, Manisa Electrics and Electronics Cluster, Denizli- Usak Household Textiles Cluster, Mugla- Bodrum Yacht Construction and Tourism Cluster will be considered to develop.

In many countries of the World and especially in the European Union, clustering policy has become an important tool for fostering competitiveness and for accelerating economic development through the pooling of resources and utilizing common strengths. Through its Lisbon Strategy which was proclaimed in 2000, the European Union has set its strategic goal for 2010 to make the European economy the World's most competitive and dynamic knowledge economy. In this respect, in future years, clustering policy will be a frequently used tool both in the European Union and also in Turkey for supporting social and economic development. The overall objective of the DCP project is to improve the competitiveness of Turkey in international markets through exploiting the synergies between the Turkish and European clusters and thereby contribute to the EU's Lisbon Strategy.

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The DCP Project has certain targets to achieve:

- Improvement of the institutional capacity of the Undersecretariat for Foreign Trade and other relevant organizations to develop and execute an integrated clustering policy;
- Preparation of a strategy for the development of a National Clustering Policy. The activities to be carried out within the scope of the project are grouped under three components, namely "Capacity improvements for the development and execution of a National Clustering Policy," "Development of a National Clustering Policy" and "Cluster Mapping and Analysis."

In addition to the main beneficiary of the project, the followings are considered to be key Stakeholders in the project and will be closely involved in its implementation. These are Government Institutions, Research Centres, Universities and NGOs as listed below.

Government Institutions

- Ministry of Industry and Trade
- State Planning Organization (DPT)
- Ministry of Agriculture and Rural Affairs
- Undersecretariat of Treasury
- Small and Medium Sized Industry Organization (KOSGEB)
- The Scientific and Technological Research Council of Turkey (TUBITAK)
- Southeastern Anatolia Project Regional Development Administration (GAP)

Research Centres, Universities, NGOs

- The Union of Chambers and Commodity Exchanges of Turkey (TOBB)
- Turkish Industrialists' and Businessmen' Association/Sabanci University
- Independent Industrialists' and Businessmen' Association (MUSIAD)
- Chambers of Industry
- Chambers of Commerce
- Exporters' Unions

Marmara Automotive Cluster (MAC)

MAC is developed as a part of DCP which covers Bursa, Kocaeli and Sakarya provinces. In "Report for 9th 7-year National Development Plan," SPO (State Planning Organization) defines technology areas, which with a number of key technologies and innovation areas, such as various engine technologies, sensors, actuators, telematics etc, that could be instrumental in future competitiveness of the automotive industry. Although it is nearly impossible to develop skills and capabilities in all these areas, the vision of Marmara Automotive Cluster state that they can and should definitely improve its innovation capacity.

Being at the forefront of innovation in some areas: Marmara Automotive Cluster can target certain technologies areas and aim at being at the forefront of innovation in these areas. These areas should ideally be based on the unique characteristics of the cluster. In other words, there should be an innovation focus, for which the clusters will be critically acclaimed globally. "Existence of sufficient local demand on this front (innovation) will be determinant on cluster's success"[i].

Being an early adopter of emerging technologies in other areas: In other critical areas the cluster should develop skills and capabilities (such as technology transfer) to adopt the emerging automotive technologies as early as possible.

Key Strategic Priorities of MAC cluster are:

Priority 1: Cluster Consolidation and Upgrading
- Pro-actively consolidate the Marmara Automotive Cluster by creating a sense of urgency and a shared vision, behind which the actors of the cluster can unite regardless of their corporate strategies.
- Upgrade the quality of its business environment, technology and skills base, and infrastructure.

Priority 2: Collaborative Innovation
- Boost innovation performance and knowledge transfer within the cluster and the Region, through enhanced collaboration and networking among the cluster enterprises, knowledge

institutions and government organizations.

Priority 3: Global Integration and Networking

- Strengthen global linkages of the cluster and increase its level of participation in international business, learning and innovation networks

Priority 4: Cluster Promotion and Image Building

- Develop and promote the international cluster brand and improve its export and investment promotion activities.

MAC project accomplish its function by implementing the roadmap of the cluster. Clusters and cluster initiatives that will come into being are deliberated to be developed by local natives.

3. OKUMKAP (Capacity Building Project for Automotive Clusters) [j]

OKUMKAP may be regarded/approached as a sub project of MAC. The project is aiming to establish a Research and Technology Development culture among the automobile supplier companies which are located in and around Bursa, and to realize cluster and network structures which are based on pre-competitiveness R&D, in addition to establish a platform where they can participate in the programs, which will enable them to build relationships with international manufacturers' similar structures.

In accordance with the aims of TTGV (Technology Development Foundation of Turkey), it is designed and developed by the governorship of Bursa, the Industrialists and Businessmen Association of Bursa (BUSİAD), Association of Automotive Parts and Components Manufacturers (TAYSAD), Bursa Branch of Chamber of Mechanical Engineers (MMO), Uludag Exporter Unions (UİB), Mechanical Engineering Department of Uludag University's Engineering Faculty (UU), Automotive Manufacturers' Association (OSD).

Background of Automotive Sector in the province of Bursa

The established automotive industry in Bursa is in an evolutionary process where it seems it has partially completed:

a) The stage of industrialisation, i.e. mass production and consumption;

b) The stage of being a regional agglomeration (industrial region), accompanied by certain innovative structures [science and techno-park of Uludag University, company incubators, innovation networks, innovative partnerships (R&D partnerships)].

At this stage of development, it is expected that the growth will be towards the regional innovation cluster (in the other words technological region) in the Bursa automotive industry. In the process of establishment of technological region, the following developments are observed: a) Main companies reduce the number of procurer companies and transfer technology to those procurers; b) design/ design validation activity increases; c) new standards of quality and production are demanded from the procurers; d) the demand shifts from the component production to subsystems and modules; e) supplier companies begin investing on R&D, that is begin taking the innovative responsibility; f) company mergers and acquisitions (M&A) are observed; g) specialisation in process technologies grows; h) marketing and know-how development begin partial autonomy from production field; i) some procurers get independent and get internationalised; j) even some competitive procurement companies make foreign investments as well; k) procurement companies expand into markets independent of the main companies.

These trends are partially being observed in the development of the automotive sector in Bursa region. The aim of OKUMKAP is to speed up the development of the existing structure into a “knowledge-based cluster”.

However, in order to have a conversion of these trends into a technological region (a cluster of technology/innovation), a fast establishment of institutionalisation is needed. In other words,

a) “New Innovation System of the automotive support industry in Bursa” (it may also be taken as Bursa-Sakarya-Kocaeli upper cluster) is to be imagined and defined; b) local innovation capabilities should be assessed; c) supporting tools for the learning and innovation activities should be supplied; d) an interaction of R&D and innovation activities should be prepared; e) a technological foresight should be made aiming the creation of an innovation strategy; f) and the establishment of a local development plan. Local structures should be made to affect the central political decision making bodies.

On the other hand, in order that the automotive support industry in Bursa to gain competitiveness in the world market, it should improve the already developed supply chain cluster structure around the big OEMs (like Oyak-Renault and Tofas-Fiat) into a cluster structure where suppliers establish a technological know-how transfer in between each other. This will make their evolution into a structure where the support industry firms will supply the OEMs more sub-systems and modules than the parts only, and gain power to stay alive independently.

There were two searching (fact finding) conferences [k] and [l] at two different dates in 2008, where the aim was the assessment of local innovation abilities and the local technological foresight in order to help creation of an innovation strategy. When studied, it would be seen that most of the participants of these conferences were automotive industrialists of Bursa. That is why the output of these two conferences was assessed including the local Bursa data.

In addition, three resources [b], [h], [m] have been used for the national innovation strategies that will make up the framework of the Bursa automotive industry's clustering activities.

Specific / Prioritised Aim of the Project:

- It is to create the awareness for the future networking structures and clusters and to develop the necessary intellectual infrastructure, by working with at least twenty (20) firms; to prepare the infrastructure for the clustering activities, involving 20-25 participants (project leaders) from the companies and other partner institutions which have the potential to become automotive support industry clusters:

- To prepare the common grounds for the development of common projects and to establish "local creation" of R&D projects.

- The project leaders are to participate in the workshops that are to be prepared on the basis of the companies' needs; they are to develop, prepare and present R&D projects determining the RTD potentials of the firms in order to make them eligible for receiving project support both from inside the country and abroad.

There are two distinctive features of this project; it is both proactive and operational.
Moreover:
Development of common projects between the partner companies will be an important means to create open innovation and information/knowledge flow between the supplier companies.

This is an important step towards the cooperation of university and industry in order to achieve the innovation-based cluster and this Project aims to realize it. One participant of the Project is Uludag University. UU has a department of automotive engineering.

All the activities within the framework of the Project are being evaluated through the use of different methods of assessment.

In this project the set up is established /organized in such a way that ensures facilitation by public authorities of administrative procedures and information flow.

Current Situation:

Following the works which started in May 2008 a password-protected website has been developed in which the participant companies share their projects with the others. There are also two subprograms realised.

1. Program: Creation of technology-based cooperation and multi-participant project development (total 80 hrs)
2. Program: training for the automotive sector on Energy and Environment focusing on competition (total 16 hrs).
3. Technological auditing activity is still continuing.

4. Conclusion

There are number of agglomerations in many regions and sectors in Turkey. Studies show that some of them have evolved into clusters. Clustering in Turkey is important in order to be able to tackle / cope with the competition in the global markets where companies have to face with the continuous innovation, joint research, product design, marketing, procurement, training and other collaborative activities which pin down firms within clusters to compete successfully in global markets, which arise a) due to integration into EU and b) as a necessity of the globally changing economic atmosphere of the world. Therefore, clustering is being supported in Turkey through different, direct and/or indirect programs and policies. As a result upgrading of the sector can be realized.

However, there are certain obstacles to development:

1. There is a need to have a common or at least complementary public policies and long term strategies on the side of the governmental institutions.

2. There is a need to define the supporting tools which will enable the realization of policies taking into account the Turkey's realities. In other words, differing public policies and the supports they supply should be in harmony with each other.

3. The endeavours of the second and third tier companies in the supply chain into the advanced manufacturing or advanced design techniques are not supported. Therefore, these companies are obliged to upgrade their industrial structures with their own limited resources.

4. The most important issue for the sector is the ability to follow and understand the global

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trends and breaking points in the technological development. There is a need from the point of view of the companies, and related academic and research institutions and public institutions to constantly update its foresight. There is a need for defining the issues to focus on the basis of this foresight, and the creation and development of funds, grants and other supporting mechanisms. And finally, there is a need to have all this, more or less permanently, within a sustainable architecture. Of course, it is not necessary to mention that the several public policies and supporting mechanisms should be complementing each other towards a common goal.

Short term, medium and long term goals should be set with the participation of all actors (industry, university, government) and the technologies to be focused should be defined. Necessary steps for the institutionalisation according to these goals and preferences should be taken. That requires serious political will and decisiveness.

Even if nothing happens, the most important reason to have the technology based clustering is, that the companies cooperate with each other through clusters, to develop joint projects and the technological know-hows on these activities are quickly spread among firms, where this kind of cooperation can happen between the university and a research institute and/or a company or between companies.

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