AN ASSESSMENT OF
TURKISH SCIENCE AND TECHNOLOGY POLICIES, 1983-2005:
A SECTORAL ANALYSIS

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ABSTRACT

AN ASSESSMENT OF TURKISH SCIENCE AND TECHNOLOGY POLICIES, 1983-2005: A SECTORAL ANALYSIS

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The main aim of this dissertation is to evaluate Turkish science and technology policy documents, namely "Turkish Science Policy: 1983-2003", "Turkish Science and Technology Policy: 1993-2003", "National Science and Technology Policy: 2003-2023 Strategy Document", and Turkish ever-first foresight study "Vision 2023"; to discuss the impacts of those documents to Turkish science and technology and make some further policy recommendations for the future. For this reason, first, the history of Turkish science and technology policy making processes is summarized and the targets of the documents are examined. Second, the outcomes and the realization of the goals are discussed in terms of science and technology indicators and R&D intensification among some leading industrial sectors of the country such as automotive, textile, clothing and information and communication technologies. In addition, the R&D intensification of Turkish total manufacturing is analyzed via using Sanjaya Lall's industry categorization method. Turkey intensely exports resource based and low technology goods while importing medium and high technology ones. The scarce of demand for technology and R&D which is the main reason behind the malfunction of technology policies, is basically depended on the mentioned structure of Turkish industry. Finally, it is concluded that in spite of some achievements, the implementation of Turkish science and technology policy documents are of insufficieny depended on the lack of political authority and

responsibility and of the coordination among industry, institutions and society as a whole.

Keywords: Turkish science and technology policies, R&D indicators, sectoral R&D intensification

ÖZ

TÜRK BİLİM VE TEKNOLOJİ POLİTİKALARININ
BİR DEĞERLENDİRMESİ, 1983-2005:
SEKTÖREL BİR ÇÖZÜMLEME

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Bu tezin amacı, Türkiye'nin şu ana kadar hazırlanmış bilim ve teknoloji politikası belgeleri olan "Türk Bilim Politikası: 1983-2003", "Türk Bilim ve Teknoloji Politikası: 1993-2003", "Ulusal Bilim ve Teknoloji Politikaları: 2003-2023 Strateji Belgesi" ve Türkiye'nin ilk öngörü çalışması Vizyon 2023'ü değerlendirmek; bu belgelerin Türk bilimine ve teknolojisine etkisini tartışmak ve gelecek için bazı politika önerileri yapmaktır. Bu nedenle, ilk olarak Türkiye'nin bilim ve teknoloji politikalarının tarihçesi incelenmiş ve yukarıdaki belgelerin hedefleri belirlenmiştir. Bu hedeflerin getirileri ve gerçekleştirilip gerçekleştirilemedikleri bilim-teknoloji göstergeleri ve otomotiv, tekstil, hazır-giyim, bilgi ve iletişim teknolojileri gibi ülkenin önde gelen sektörleri bağlamında tartışılmıştır. Buna ilaveten, Türk imalat sanayisindeki AR-GE yoğunluğu, Sanjaya Lall'in teknoloji yoğunluğunu göz önüne alarak yaptığı sektörel sınıflama yöntemine göre araştırılmıştır. Bu araştırmadan Türkiye'nin daha çok doğal kaynak ya da düşük teknolojiye dayanan ürünlerde ihracat yaptığı, ve orta ve ileri teknoloji ürünlerini ithal ettiği ortaya çıkmıştır. Bilim ve teknoloji politikalarının uygulanmasını zorlaştıran Türk sanayinde teknoloji ve AR-GE talebinin az olması bu endüstriyel yapıyla ilişkilendirilebilir. Bazı başarılarına rağmen, Türk bilim ve teknoloji politikalarının uygulamasının yetersiz kaldığı, ve bunun ardındaki gerçek nedenlerin siyasi sahiplenmenin bulunmaması ve

sanayi, kurumlar ve tüm toplumun arasındaki eşgüdüm eksikliği olduğu sonucuna varılmıştır.

Anahtar kelimeler: Türk bilim ve teknoloji politikaları, AR-GE göstergeleri, sektörel AR-GE yoğunluğu

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CHAPTER 1

INTRODUCTION

After the centuries of change experienced by the people, we are now in the era in which development and economic growth could only be gained with the success in science and technology. As capitalism develops and capital accumulation expands, new organisational forms like multi-national enterprises (MNEs) have emerged, and these enterprises have begun to gain their competitiveness basically from their research and development (R&D) efforts. This situation emphasizes more the importance of science and technology. After the 1970's, the development of computer and information technologies have speeded up the pace of these processes. And after the 1980's, with the help of liberalisation of financial markets, a new term has begun to be more common, namely "globalisation". This shortly-explained historical perspective concludes that economic welfare can only be provided by the knowledge-based, technology-intensive activities and products.

As a latecomer, Turkey had began its industrial efforts after the year, 1923; the establishment of the Republic. This establishment also depicted a transition from an agriculture- based empire to a modern nation state. The founder of the Republic, M. Kemal Ataturk put the objective of reaching and passing the level of contemporary civilizations. This goal constitutes the philosophy of the industrial, scientific and technological development efforts later on. Firstly, government took the lead in industrialisation efforts and built up agriculture and resource based factories. It should also be mentioned that modern universities are founded in the year 1933, with the help of scientists escaping from Nazi fascism. After the year 1950, entrepreneurship was supported by the government and more liberal policies had begun to be applied. But until the establishment of TUBITAK in the year 1963, it could not be seen a common-mind in science and technology producing and evaluating processes. In addition, even after the establishment of TUBITAK, it took about twenty years to make a science and technology policy. The ever first Turkish science and technology policy document was made in the year, 1983 and the second was in the year, 1993. The Supreme Council of Science and Technology (BTYK) was decided to be established after the first policy document, but BTYK could be convened six years later in the year, 1989. There were lack of disciplinized efforts, integrity and continuity for implementing these two policies and governments had not been decisive about them. These deficiencies prevented the implementation of many decisions taken in these documents. Thus, a newer, broader and wider project, namely "Vision 2023," had been decided to be prepared. The foresight part formed the backbone of the project. Many conventions, workshops and two rounded DELPHI survey were made with the contribution of many academicians, specialists and industrialists, so the science and technology perspective of Turkey for 2023 have been determined. Turkey has tried to find its technological path in those studies, but the wide participation by attendants from many areas of specialization advised many areas of technology.

Regarding to those arguments, in this study, we have intended to evaluate the implementation of Turkish science and technology policies prepared in the last 25 years. Those policies are;

1) "Turkish Science Policy: 1983-2003" (1983)
2) "Turkish Science and Technology Policy: 1993-2003" (1993)
3) "National Science and Technology Policy: 2003-2023 Strategy Document" (2003)

For attaining this aim, first, we will draw a theoretical framework related to science and technology policy studies in Chapter 2. Neo-classical approach, evolutionary approach and the context of national innovation system will be briefly discussed. Second, we will summarize the history of Turkish science and technology policy making efforts. Then, we will discuss the main parts of those policies stated above. Turkish ever-first foresight study which is the basis of the last policy document, will also be analysed. Third, we will investigate Turkish main science and technology indicators such as 'percentage of GERD (Gross Domestic Expenditure in R&D) in GDP (Gross Domestic Product)', 'the number of R&D personnel', 'the distribution of GERD between business enterprise and government' and 'world ranking of Turkey in ISI', and then compare them with other countries in chapter 4. This investigation will clarify the scientific and technological position of Turkey and the performance of S&T policies in terms of R&D indicators. Fourth, we will make a sectoral analysis of Turkish manufacturing in Chapter 5. Two main sectors (automotive; textile and clothing) and a promising one (information and communication technologies) will be discussed by using their foreign trade values. Akarsoy's (2002) 'Model for the Assessment of The Sectoral Technological Situation' will be utilized in the section of automotive sector (Section 5.1). In this chapter, the R&D intensification of Turkish manufacturing sector will also be analyzed via using Lall's (2000d) sectoral categorization method and R&D intensification will be determined in Turkish industry. We will discuss the results of those analysis in the context of policy documents and find out to what extend they are successful. Lastly, we will draw a conclusion in chapter 6, by evaluating our findings from chapter 3, 4, 5 in the scope of Turkish science and technology policy documents.

CHAPTER 2

SCIENCE AND TECHNOLOGY POLICIES: THEORETICAL FRAMEWORK[1]

Science and technology policies are the policies which aim to produce advancements related to science and technology such as scientific discoveries, technological innovations and technology diffusion. There are two ruling theories in economic literature concerning with those policies; namely neo-classical theory and evolutionary theory. They have been commonly used while determining science and technology policies in developed countries and OECD. In this chapter, we will briefly analyse those theories in order to establish a theoretical base for this dissertation. In addition, we will draw a framework for 'National Innovation System' and science and technology policy tools defined in literature.

2.1 Neo-classical Approach to Science and Technology

In this approach, technology is defined with the help of production function that uses technology while determining the relationship between inputs and outputs. It is assumed that every firm in the market has been completely informed about those inputs and outputs. Neo-classicals mainly argue that resources could be used most efficiently via establishing fully competitive markets. According to this approach, markets will provide required resources for technological innovations.

There are three requirements for perfect markets that work efficiently. Those requirements and their definitions are stated below;

---

[1] This chapter is prepared by mainly using Taymaz (2001, pp. 5-29)

a) <u>Excludability and rivalry:</u> This term means that only one customer could buy a merchandising good and that good should be bought again once it is consumed by a customer. In other words, purchasing a good excludes its re-usage by other customers. It should be taken into account that these features do not belong to public goods.

b) <u>Transparency:</u> This term refers that customers are fully informed about the quality and prices of merchandising goods in the market.

Nelson (1959) and Arrow (1962) indicate that technological innovations and knowledge do not have specifications such as those stated above. Hence, the results are 'market failure' and the scarcity of resources for technological progress. The reasons for market failure can be stated as follows;

a) Technological innovations are of some powerful aspects related to public usage. Those aspects considerably decrease rivalry and excludability features of them. In addition, technological innovations strengthen and improve themselves when they diffuse in industry and in the market. Those aspects distinguish them from normal and commonly-used merchandising goods.

Discovery and ever-first production of technological innovation is expensive. Once an innovation is produced, its cost reduces. That aspect of technological innovation necessitates scale economy in order to find investment for its production. Investors demand for becoming monopole in the market or some legislation such as intellectual property rights in order to gain sufficient amount of profits. However, monopoly and intellectual property rights do not get along with neo-classical theory which set up its base upon perfect competition.

b) Technological innovations include some uncertainties. First, it is not clear whether the newly designed innovations succeed technically. Some theoretical designs could not work practically, particularly in engineering applications. This is called as 'technological uncertainty'. In addition, once design and production phases of an innovation have been completed, it is still uncertain whether it is approved or preferred by customers. This is known as 'market uncertainty' of an innovative activity. Finally, the response of rival firms to a successful innovation is unknown. Sometimes, rivals could react to the innovation in such a way that the newly-established innovation looses its value in the market. This type of uncertainty is 'trade uncertainty'. Hence, the investments made for the innovation become null. As a result, sufficient resources for technological innovation are not allocated in free markets and the cost of finance become higher with respect to other investments.

c) When technological innovation is produced, it may not be known by anyone in the market. Hence, there is no one to be present for evaluating innovation. In contrast, technological innovation and 'know how' are of no value if it is known and applied by every one. This is called as 'Arrow's dilemma' in the economic literature. As Taymaz (2001, p.8) states, "the value of knowledge is impossible to evaluate when it is unknown, and, there is no need for its purchase when it is known". Transparency can not be a feature of technological innovation in the scope of neo-classical theory.

d) Externalities: Innovative firms cannot completely benefit from their innovations because of the diffusive aspects of innovations. Hence, those firms loose competitive advantage to their rivals. As a result, innovative activities are not promising for firms, and market mechanisms cannot sufficiently allocate resources to innovation for public benefit.

To summarize, there is under-investment for innovation in the scope of neo-classical approach. Developing countries in macro level and small and medium-sized enterprises in micro level mostly experience this problem. Private benefits from research and development are quite limited, especially in developing countries. Hence, government intervention should raise private benefit level to public benefit level via using intellectual property rights even though it is contrary to the spirit of neo-classical theory. In addition, government should invest on some crucial technologies such as military and environment-friendly technologies for sustaining its existence. These reasons constitute a base for government intervention in neo-classical economics.

Because of its contradictory nature such as the lack of externality, rivalry and transparency features; inclinations of firms to become monopole; the necessity of intellectual property rights and the scarcity of resources for technological progress;

Taymaz (2001) compiled some critics to this approach on the literature. These are stated below;

1) This approach neglects the possibility of change and progress which firms could experience in their present conditions.
2) Firms mainly suppose to become monopole from technological innovations; however, this is completely against to the spirit of neo-classical approach which depends on perfect competition in the markets.
3) This approach is not systemic and it examines the actors in the market as being isolated from each other.
4) Although neo-classics mainly emphasizes to neutrality among industrial sectors, there are several successful examples among the countries which make proper sectoral choices.

2.2 Evolutionary Approach to Science and Technology

This approach has been widely accepted after Nelson and Winter wrote their book in the year, 1982, namely "Evolutionary Theory of Economic Change" (Nelson and Winter, 1982). The hypothesis of this approach is mainly depended on Schumpeter's thesis which defines technological change as a 'creative destruction' process in the market. According to Schumpeterian points of view, technology creates new opportunities while defeating actors that cannot adapt to emerging technological system. Technological progress is considered as the driving force of the economy in long terms. The main difference between neo-classical theory and evolutionary theory is that evolutionary economists mainly emphasize innovation and learning processes in economic progress. Table 2.1 briefly explains those differences between these ruling theories in the literature.

Evolutionary economics perceives technological progress as an inefficient process like other evolutionary processes in nature. However, in the scope of this approach, that inefficient empirical process is indispensable for technology because of the uncertainties experienced in every aspect of life. In addition, knowledge production, protection and diffusion are of considerable importance because innovation and learning processes are the bases on which theory is constituted.

Table 2.1 Main Differences between Neo-Classical and Evolutionary Approaches

Neo-classical approach	**Evolutionary approach**
mainly concerns with resource allocation processes	mainly concerns with technological innovation processes and adaptation to those emerging technologies
examines technological progress via using a representative firm	examines the interaction between firms and other actors such as universities, laboratories etc.
emphasizes equilibrium and maximization of profits	emphasizes innovation (mutation) and selection in terms of Darwin

This approach assumes that phases of technological progress like discovery, innovation and diffusion have interaction with each other. Technological progress is not a linear process in this scope. Figure 2.1 depicts that relationship among those phases. In addition, there are more interactions realized by the actors of society as a whole. Interactions should not only be experienced among the actors in the market. Non-market mechanism can participate to those interactions. Hence, technological innovation should be examined in a systemic way. There are three different systemic approaches in this context;

a) Approach of Technological Systems: Technology is considered as social and managerial system instead of being a physical good. It is defined by knowledge diffusion realized in a technological area of specialization or in a group of technological sectors related to each other. Going beyond the market mechanism is a pre-requisite for technological progress.

b) Approach of Industrial Clusters: The subject of this approach is on industries and firms that have interaction with each other. Those industries are based on key technologies. The term of interaction plays the main role in the scope of this approach as well.

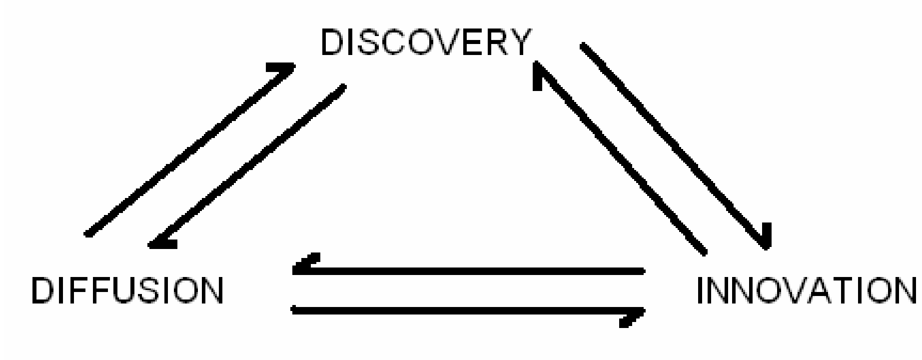

Figure 2.1 The interaction among phases of technological progress according to evolutionary economics

c) Approach of National Innovation System: This approach examines learning processes and networks that reinforce learning in national level. Freeman (1987) and Lundvall (1988) firstly put this systemic approach in economic literature. Establishing a 'National Innovation System' (NIS) has been the main concern of Turkish Science and Technology policies; hence, we will give broad theoretical information about NIS in section 2.3.

Technology and innovation policies of evolutionary economics are related to the systemic approaches stated above. The main feature of those policies is to develop technological capabilities of firms and NIS as a whole in a systemic way. The main aims of evolutionary policies are;

1) Forming a suitable environment for innovation,
2) Developing innovation culture, increasing diffusive effects of innovation and absorption capacity of firms, encouraging entrepreneurship,
3) Providing firms to reach required financial and technological resources,
4) Establishing non-market mechanisms for efficient information diffusion,
5) Hindering systemic failures.

Evolutionary policies mainly aim to constitute environment suitable for innovation instead of solely creating financial supports. Those policies also intend to develop scientific networks.

Finally, evolutionary economics perceives technology and innovation policies as an evolutionary process in their development path. According to evolutionary economists, trial and error, empirical studies and diversity of policy applications are of considerable importance while constituting technology policies.

2.3 National Innovation System

As having mentioned above, the term of NIS was firstly suggested by Freeman and Lundvall in their papers published in the year, 1987 and 1988, respectively. NIS is a complementary concept to the systemic approach of evolutionary economics. Freeman (1987, p.1) defined this term as "a network of public and private institutions forming, importing, changing and diffusing new technologies via their activities and interactions".

Market and non-market institutions affecting the pace of innovation and technological diffusion constitute NIS within a country. (OECD, 1998, p.61) According to those definitions, institutions can be classified as follows;

1) Public and private firms that have innovative activities
2) Research institutions
3) Scientific system
4) Supporting institutions
5) Financial institutions
6) Institutions that develop, apply and evaluate innovation and technology policies

As a systemic approach, evolutionary economics also takes into account some other parameters determining the performance of those institutions stated above. Those are;

a) Macroeconomic and regulatory issues
b) Education system
c) Communication infrastructure
d) Product markets
e) Conditions related to labour and capital markets

The diffusion of information, the increase of communication opportunities, the emerging context of new economy and recent technological advancements are the reasons for the necessity of NIS. The interaction between scientific information, research and product development process has been deepening. The citations made by new patents to scientific papers have tripled its volume in USA (Metcalfe, 1995). Hence, technology intensity in new products has been considerably increasing.

Furthermore, the structure of scientific knowledge and technological information used in products are changing continuously. Generic technologies have gained importance in this perspective. Information could be used in a variety of disciplines. New products require knowledge from several technological areas of specialization.

Mostly, a firm is not capable of compensating all requirements of a product by using its own resources. In addition, it is impossible for a firm to fully exploit a new innovation and discovery because information is lack of features such as excludability and rivalry. Tacit knowledge should also be taken into account; hence non-market mechanisms gain importance while market mechanism is not working in this context.

The pace of technological change and demand for new technologies and knowledge bring the term "learning economy" into existence (Lundvall, 1998). In this context, Lundvall (1998, p.3) argues that "what really matters for economic performance is the ability to learn (and forget) and not the stock of knowledge."

To summarize, managing those learning and forgetting processes can be considered as the main aim of NIS. However, "it usually takes decades rather than years to fundamentally reorient regional and national systems of innovation" (Lundvall, 1998, p.3). The main aim of S&T policies in the scope of evolutionary economics is to establish and fasten the establishment of NIS.

2.4 Policy Tools for Science and Technology

Lastly in this chapter, we will briefly examine policy tools implemented during policy making processes. Policy tools can be defined as the tools which are orienting the pace and direction of scientific and technological developments within a country. The commonly-used policies in technology and innovation are;

a) <u>Development of scientific system</u> aims at supporting basic research and education.

b) <u>Supporting R&D activities</u> is an effective policy for increasing R&D intensity within country.

c) <u>Diffusing technological innovations</u> is of significance for the benefit of all actors within the system from the advancements in science and technology.
d) <u>Policies towards driving demand</u> are also important because industry is not willing to invest for an innovation which is not profitable in the market.
e) <u>Organization of labour processes</u>
f) <u>Establishing high-tech firms</u> is an essential policy, particularly in OECD documents, in order to advance in high technological areas of specialization.
g) <u>Evaluation of science and technology (S&T) policies</u> is of considerable importance since the S&T policies are admitted as an trial and error and evolutionary processes in the scope of evolutionary economics.

And common tools for implementing those policies can be stated as follows;

a) <u>Legislative and institutional regulations</u> include intellectual property rights, organizing competition and putting standards etc.
b) <u>Purchasing policies</u> are especially used in developing military technologies.
c) <u>Researches in public R&D foundations and universities</u> are useful for advancing in basic researches whose nature owns considerable trade, technologic and market uncertainties.
d) <u>Supporting private R&D</u> is composed of tax incentives, project donations, royalties etc for encouraging business enterprise sector towards research activities.
e) <u>Supporting techno-parks and incubators</u> provides services and incentives for know-how creating and high-tech firms.
f) <u>Providing coordination in R&D activities</u> via directing R&D activities according to technological priorities.

While deciding policies and their implementation tools, two parameters should be known about the policy. Those are as follows;

1) To which technological progress phase the policy belongs,
2) The technological problem which is tried to be solved

Finally, we would like to emphasize that Turkish Science and Technology policies will be investigated in this framework in our thesis.

CHAPTER 3

THE HISTORY OF TURKISH SCIENCE AND TECHNOLOGY POLICY MAKING

After drawing some theoretical framework to this study, we will discuss a historical perspective of Turkish Science and Technology(S&T) Policy. The past is chronologically divided into five sub-periods according to the change of characteristics in science and technology making process. In the first period, there are no specific S&T policy making efforts. It was a part of industrial policy. Turkey was in pre-industrialisation period. In the second one, there was no specific S&T policy as well; however scholars prepared some reports aiming only the progress in basic sciences. Those reports could be counted as science policies. Furthermore, the establishment of 'State Planning Organization'(DPT) in that period can be considered as a milestone in policy making. In the third period, we could see certain S&T policies which targeted to develop the nation both in science and technology. Only the last policy, namely "National Science and Technology Policy: 2003-2023 Strategy Document", has gone one step further and has targeted to establish 'National Innovation System' (NIS). In the next section, we will briefly explain those periods, their main specifications and shortly evaluate Turkish national innovation system.

3.1 The Pre-1960 Period

Turkish Republic has been considered as one of the inheritors of the Ottoman Empire. The Ottoman Empire could not successfully achieve her own industrial movement while some European states successfully pursued their own industrial progresses in both economic and social fields. The Empire, which had remained as an agriculture-based economy for a long time, could not adopt herself to “the new rule of the game”. Europeans had bested the Ottomans since the beginning of the 17^{th} century.

After the establishment of the Republic, M. Kemal Ataturk and his colleagues had plans to make the Republic catch up European industrial level. However, Turkish industrial structure was nearly non-existent. In the year, 1927, an industrial inventory was documented and only 322 industrial firms were noted. Moreover, only 30 percent of those firms had more than 30 workers. Those firms were mostly in textile and garment sectors, and the number of total workers was only 17000. Those numbers were far behind the Europe’s numbers (Yücel, 1997, p.46).

In the first decade of the Republic, science and technology policies were the part of industrial policies. Several industries were intended to be supported by appropriate laws. The first technology transfers were realized in cements and sugar industry (Yücel, 1997, p.45). In spite of these minor successes, industrial and technological development was slow because of the lack of social, economic and cultural infrastructures of Turkish society as a whole.

Sumerbank, which was established in the year, 1933, took the responsibility of Turkish production sector. It led to the emergence of textile, iron and steel, cement, ceramic industries as a whole. Turkey covered her own needs in those sectors with the help of Sumerbank and decreased its dependence on foreigners. Many factories were composed of many contemporary and technology-intensive machines. Farmers, state officers, merchants etc. (all people lived in the country) made contribution to the establishment capital of Sumerbank. “The income earned by the Turkish people was evaluated in the self-development of Turkish people at the first time in Turkish history” (Yücel, 1997, p.46).

Furthermore, Etibank was established by the directives of Ataturk in the year, 1935. The goal was to extract natural resources of the country and to cover the needs of Turkish industry for raw materials and energy. Etibank made great contributions to the emergence of Turkish coal, steel and iron industries. Etibank (later name, Eti Maden) still has the rights of exploitation on Boron minerals which will be strategically important in the world economy of the 21st century (http://www.etimaden.gov.tr).

In addition to that, university reforms were enacted in the year, 1933; Darülfünun was closed and a modern high education school, namely Istanbul University was founded. Many scientists and researchers who escaped from the Nazi fascism, joined to the academic staff of the Istanbul University. Those scientists made great contributions to the formation of a scientific thought in the country and to the foundation of other universities.

In spite of those promising developments, the World War II slowed down Turkish successes in science and technology development. The contemporary government in power stopped investments in production sector because of the possibility of entering the war. New technology transfers and new machine and equipment purchasing slowed down as well. The monetary and natural resources protected with precautionary motives. As a result, although Turkey did not take part in the war, mobilization for war applied by the government destroyed the newly flourished industrial efforts.

After the year, 1950, The Democrat Party declared to leave the production sector to the private sector and the role of the state was to complete the infrastructure of the country such as making roads, railways etc. Interestingly, the capital accumulation of entrepreneurs augmented. For example, the increase of value added in the year, 1960 was three times larger than the year 1950 (Yücel, 1997, p.48).

3.2 The Period between the years 1960 and 1980

In this period, S&T policy researches and strategic planning in S&T were firstly put on the agenda in Turkey. The Constitutional Law of Turkey legislated in the year, 1961, emphasized the importance of planning in economic, cultural and social development of nations. Hence, State Planning Organization (DPT) was established in the year, 1960. That establishment could be considered as a milestone in Turkish policy making. The mission of DPT was determined to assist and to make suggestions to government in policy making processes of economic, social and cultural fields within the country (http://www.dpt.gov.tr/must/tarihce.asp). Development Plans began to realize development in a planned manner. In this scope, DPT prepared the First Five Year Development Plan and that plan announced the need for policy planning process and tools for attaining that goal. This plan and its followers has mainly targeted to establish market economy and to work it efficiently; however, the level of government intervention changed according to the economical realities of the periods. For example, the plans between the years 1960 and 1980, were prepared via taking into account ‘import substitution’ and the requirements of closed economies while those prepared after the year, 1980, were more liberalised and were suitable for open economy. In addition, government invested into infrastructures of the country instead of establishing factories in production sector and manufacturing sector was left to private entrepreneurship after the year, 1980. Appendix C also summarizes S&T policies covered by development plans.

The establishment of TUBITAK (Turkish Scientific and Technical Research Institute) was one of the successes of this period. The main goal of TUBITAK is to organize basic and applied research in natural sciences, to provide coordination among them and to encourage scientific research. It is also responsible for directing research to the targets mentioned in the development plan (Göker, 2002, p.2).

During this period, science policy mainly included basic and applied research in natural sciences. In addition to that, technology policy was borrowed from OECD projects prepared for less developed members of OECD such as “The Pilot Teams Project on Science and Economic Development”. The main goal of that project was to establish science and technology on the development of social welfare state. The Turkish project team[2] was formed in the year, 1963, and finished their research in the year, 1967. Turkish economic and industrial structure was explicitly stated that some development strategies and technological areas were determined. However, those proposals were not taken into consideration in the second, third and fourth development plans. Türkcan (1998) noticed the reason of this situation as follows;

> …our industry was not at the technology demanding level, it was newly set up and its technology was transferred from foreigners. While industrialists were only interested in ‘how it is produced’, the last aim of them was to generate new technologies (Türkcan, 1998).

This suggestion completely matched up with Charles Cooper’s opinions who prepared a “confidential report” for TUBITAK. Cooper (1971) briefly stated

[2] The Turkish project team included Phd. Atilla Karaosmanoğlu, Phd. Necat Erder, Phd. A. Sönmez, Phd. Demir Demirgil, Refet Erim, Cevdet Kösemen, Selçuk Özgediz, Phd. Ergun Türkcan and Prof. Erdal İnönü as the project manager (Türkcan, 1996).

that Turkish economy tended to be technologically stagnant. The industrial demand for technology was low. The main frame of applied S&T Policy was "supporting basic and applied researches in natural science without regarding any priority of its social and economic benefits" (Göker, 2002, p.5).

In the lack of interest, TUBITAK basically concentrated on two main points that was absent since the establishment of the Republic. The first one was to create a statistical analysis about Turkish research staff and Turkish research institutions. Thus, "The Inventory of Research Personnel and Research Institution" was documented in the year, 1965. The second one was to establish research centres. Some of the most important establishments were "The Documentation and Information Centre" and "The Research Institute of Marmara" (MAE) which were founded in the year, 1967 and in the year, 1972, respectively.

"The Inventory of Research Personnel and Research Institution" was important because that inventory firstly provided data on research and development (R&D) in Turkey. Some of the results of that inventory were as such;

1) The total personnel worked on R&D were about 4000.
2) The ratio of R&D expenditure in Gross National Product (GNP) was 0.37 per cent.
3) There were many research institutions in agriculture but their productivity was low and there was no coordination between them. The levels of research and research personnel were not enough.
4) There was no R&D and technological development in industry.
5) The numbers of scientific papers which was included in Science Citation Index (SCI), were negligible. Turkey was in forty-first position which was behind Iran and Pakistan and far behind Egypt (Özdaş, 2000, pp.30-31).

Regarding those results above, Turkey was considered as a country far behind from the developed countries, and even among many developing countries.

3.3 The Period between the years 1980 and 1993

The frame stated above continued until the beginning of the 1980s. TUBITAK and MAE reached a relatively high level of research capacity comparing to the 1960s. Those institutions carried out many research projects since their foundations. The state, TUBITAK and NATO had sent academicians abroad with free scholarships. Those researchers completed their researches and received their master or PhD. degrees. The number of universities and the attendance of students to universities were increased. TUBITAK organized many scientific symposiums and supported many research projects. Universities introduced research projects as well. The scientific environment in Turkey was ready for the country's very first S&T Policy.

The need for S&T Policy was discussed in the convention of TUBITAK Science Council[3] and eventually an "Orientation Committee" was established in the year, 1981.[4] This committee cooperated with YOK (High Education Council of Turkey), TUBITAK, AEK (The Institute of Atom Energy), MTA (Control and Research Agency of Mining), several ministries and some industrial partners for accomplishing its goals.

After the establishment of the Orientation Committee, some documents including "The Nuclear Program", "The Evaluation Report of TUBITAK", "Energy in Turkey and in the world", "R&D in Turkey and in the world" were prepared. A new research group prepared a new inventory for evaluating the position of Turkey in R&D in the year, 1983. The results obtained by this inventory are given below;

1) The numbers for researchers and the technicians in R&D were 16955 and 8735, respectively. (Full time equivalents were 7747 and 2689, respectively.)
2) The ratio of R&D expenditures in GNP was 0,24 per cent.
3) The number of researchers in 10000 persons who had economical activity, was 4,2.
4) It was recognized that the industrial research started in Turkey but it was weak.

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[3] The convention date was 03.03.1981

[4] It was composed of the scholars stated below; (Özdaş, 2000)

- Prof. Dr. Nimet Öztaş: The former TUBITAK General Secretary
- Refet Erim: The former assistant of TUBITAK General Secretary
- Prof. Dr. Ataç Soysal: The chief of Operational research in TUBITAK-MAE
- Atila Candır: State Planning Organization(DPT) specialist.
- Ender Arkun: TUBITAK Specialist
- Şefik Onat: Chief executive in the Ministry of Foreign Affairs

5) Turkey had the factor of 1/10 relative to the industrialized countries. (This meant that the average size of R&D in industrialized countries was ten times greater than Turkey) (Özdaş, 2000, p.35)

Those results were far behind the developed countries and even behind the developing ones. For example, Turkey had only 378 papers published in SCI while USA, UK, Germany, Japan and France had 174.123, 38.580, 23.101, 27.177 and 33.602 papers, respectively (The Task Force on Higher Education and Society, 2000, and Gürüz, 2001). In addition, Korea's 'percentage of GERD in GDP' was 0.56 percent in the year, 1980, and 1.41 percent in the year, 1985, even though Korea recently started her development efforts in those years (http://www.stepi.org). Those shares were significantly higher than Turkey's shares, however, those two countries simultaneously started to their development efforts.

Hence, Turkey's first science and technology Policy, namely "Turkish Science Policy: 1983-2003," was created in the year, 1983. The main goal of this policy was to make Turkey be among the top 20 industrialized countries in the world. The committee determined the basic objectives as stated below;

1) The goals about R&D expenditure were;

a) To increase R&D expenditure annually by %15.

b) To distribute research funds with respect to the priorities of the country.

c) To increase the ratio of R&D expenditures in GNP from 0,2-0,3 per cent to 1 per cent in the year, 1993 and to 2 per cent in the year, 2003.

2) The goals about constituting research personnel were;

a) To promote the quantity and the quality of researchers.

b) To organize the researchers according to the needs of the country.

c) To increase the number of researchers in 10000 persons who were economically activated, from 4,2 to 15 researchers in a 10 year-period and to 30 researchers in a 20 year-period as a full time equivalent.

3) The goal about contributing to the world science literature was to participate in the top 30 of SCI by the year 1993, and in top 20 of SCI by the year 2003.

4) The establishment of the Supreme Council of Science and Technology (BTYK) was decided. Parliamentarians, prime minister and some of the high level officers of TUBITAK constituted BTYK which was considered

as the highest council in decision making of Turkish science and technology policies.

5) The preparation of "The Project of Encouraging High Technology" was determined.

6) The establishments of a metrology centre and a biotechnology centre were stated (Özdaş, 2000, pp.43-44).

However, the implementation of those decisions was not realized. For example, "The Project of Encouraging High Technology" was completed in the year, 1985. CNC (Computer Numeric Control) manufacturing, industrial robotics and advanced materials were determined as the main high technology areas. However, the development in those technologies has not been achieved sufficiently until now.

The first convention of BTYK gathered together six years later in the year, 1989 after the first decision of its establishment. At this convention, scientists suggested to form a research fund, nevertheless the parliamentarians did not take that suggestion into consideration. Even though Özdaş and her colleagues reported many times to the President Turgut Özal, the ruling government, namely Anavatan Party[5], surprisingly insisted on blocking this fund. In fact, politicians ignored the decisions of the ever first science and technology policy in this period. We like to criticize a common view among the people in Turkey. Turkish media and neo-liberal intellectuals within the country always argued that Özal prepared Turkey to a new emerging context, namely globalization, after the end of Cold War. Some infrastructure investments in ICT technologies, some railway and highway investments and liberalization of the markets etc. were considered as a proof. However, the ignorance of research funds realized by the government did not support that claim. We strongly believe that if Özal and his colleagues had tried to prepare Turkey for the fierce competition of globalisation, they would not have ignored science and technology policies and related funds in such a manner stated above. The investments made by Özal's government mainly aimed to prepare suitable environment for global cartels all over the world instead of increasing Turkey's competitive position in science, technology and industry.

[5] Özal was the founder and president of Anavatan Party (Homeland Party) which was formed by his followers and colleagues.

For the establishment of a biotechnology centre, the first Biology Department in TUBITAK Research Centre in Gebze was opened in the year, 1983. As a metrology centre, The National Metrology Institute was founded in the year, 1993.

As for the quantitative goals of “Turkish Science Policy: 1983-2003” in R&D expenditure, R&D personnel and SCI, the statistics of Turkey in the year, 1990, are written below;

a) The total number of R&D personnel both in public and private sector was 37877 and its full time equivalent was 16246.
b) The number of researchers was 7 in 10000 persons who have economic activity.
c) The ratio of R&D expenditures in GNP was 0.33 per cent.
d) In SCI, Turkey was in the fortieth place (Özdaş, 2000, p.53).

Although there was an increase in the number of researchers and R&D expenditure with respect to the year, 1983, it was far behind the goals of “Turkish Science Policy:1983-2003” .

The last important development in this period was the establishment of “Turkish Technology Development Foundation” (TTGV) in the year, 1991. This establishment was neither in the context of Turkish S&T policy document nor in the development plans. An international debt contract signed between Turkish Republic and World Bank obligated its establishment. The vision and mission of the foundation was determined as follows;

> Mission: Enforcing international competitiveness of manufacturers via supporting technological innovation activities within the country.
> Vision: Sustaining the proactive role towards constituting and improving national innovation system and protecting ecological system; internationally playing a main role as a model in its area of specialization (http://www.ttgv.org.tr).

TTGV provided a unique mechanism and played a crucial role in conducting public R&D funds to the private sector and it was the only foundation of its own kind within the country. TTGV supported 480 projects and gave 170 million USD as R&D support funds, hence provided to form a R&D volume over 340 million USD within the country. Moreover, TTGV served out 26 million USD support fund to Turkish Industry for maintaining ecological purposes required by Montreal Fund.

TTGV also contributed to the formation of Bilkent and ITU techno-parks. In this context, TTGV was honoured as "The Best International Practice" of World Bank (http://www.ttgv.org.tr).

3.4 The Post-1993 Period

It is a fact that Turkey was not able to realize the goals of "Turkish Science Policy: 1983-2003", TUBITAK revised this policy and prepared a new one, namely "Turkish Science and Technology Policy: 1993-2003," offered in the second convention of BTYK in the year, 1993. At this convention, an incentive was formed for R&D from "Development and Support Fund" and it was published in "Official Gazette"[6]. Even though this decision was published in Official Gazette, this fund was not activated.

First of all in this policy, Turkey's position in science and R&D was determined as follows;

a) R&D expenditures were not sufficient.
b) The quantity and the quality of the researchers were insufficient.
c) R&D in universities was weak because of the intensity of the courses.
d) The scientific books and publications for R&D were not sufficient.

The main aim of this policy was to enable Turkey to catch up the countries with high scientific and technological level. The tool for attaining this aim was "reaching the contemporary generic technologies" that are stated below;

a) Information and communication technologies.
b) Advanced Material technologies
c) Biotechnology
d) Space and Aeronautical technologies
e) Nuclear technologies

The technologies labelled as a, b, c, had diffusive effects and connected to almost every sector of the industry. Thus, they were vital for the economic development.

In addition, "catching-up process" was defined in five steps;

[6] The official document of the Turkish Government which contains the new laws legitimated by the parliament.

1) Technology transfer
2) Analyzing and learning the transferred technologies
3) The diffusion and fusion of the learned technologies in every economic field
4) Gaining the skills of further creation of learned and diffused technologies
5) Mastering in scientific disciplines connected to these skill creations.

Hence, Schumpeterian/Evolutionary Economic doctrines of the literature whose basis are ongoing learning processes and interaction as noted in Section 2.3, completely matched up with this ‘step by step process’ (Göker, 2003). In line with the contemporary S&T policies, the requirement for systemic coherence was noticed. In this context, a contemporary S&T policy was documented.

The quantitative goals of the Turkish Science and Technology for the next ten year period are as follows;

a) to increase the number of researchers to 15 for 10000 persons who were economically active.
b) to exceed the ratio of 1 per cent for R&D expenditures in GNP.
c) to become in the Top 30 of SCI.
d) to have private sector share 30 per cent of the R&D expenditures in the country.
e) to develop in the area of information and the communication technologies (TUBITAK, 1993, p.6).

In fact, this policy document contained the very similar objectives of the first one, a few additions were included. Turkey did not reach its target and the same target was reset for a further decade.

This policy was followed by the preparation of the document called “The Project for Impetus in Science and Technology” in the year, 1995. In this project, Turkey determined the areas of progress in technology. These areas were the information networks, flexible manufacturing-flexible automation technologies, train technologies like TGV (Train a Grande Vitesse) and MAG-LEV (Magnetic Levitation), aeronautical, space and military technologies, genetic engineering, biotechnology and advanced material technologies. However, in those areas Turkey has not realized the expected development until now except for the aeronautical, military technologies in which Turkey has gained a place in Top 10 of SCI (Directorate General For Research, 2003, p.299).

Another noticeable development in this period was the establishment of “Turkish Sciences Academy” (TUBA) in the year, 1993, which was pointed out in “The Sixth Five Year Development Plan”. The main objectives of the academy are;

a) encouraging researches and scientific identity
b) honouring scientists
c) orienting youngsters to science, technology and researches
d) protecting and improving social status of scientists
e) assisting in improving the standards of scientific studies to the international level.

For attaining those aims, TUBA has offered many scholarships, reward and honours to the scientists within the country later on.

The third convention of BTYK was held in the year, 1997 and the last S&T policy document, namely “Turkey’s Science and Technology Policy” was revised. The main difference of this document was to establish “National Innovation System” which is of significant importance for forming a knowledge-based society. This was the first time the target of establishing ‘National Innovation System’ was put on the agenda. This BTYK meeting was the informer of a brand new policy including the term of national innovation system. In that meeting, it was also determined that Turkey lacked commitment to realize its science and technology policy in integrity, continuity and political stability.

The realization of the quantitative goals of this period stated in “Turkish Science and Technology Policy: 1993-2003” were as such;

a) The number of researchers was 13.1 for every 10000 persons who were economically active.
b) The ratio of R&D expenditures in GNP was 0.64 per cent.
c) Turkey was in twenty second place in SCI (TTGV, 2004, p.3).
d) The private sector share in R&D expenditures became 33.4 per cent (OECD 2004).

As of the beginning of the year 2000, Turkey achieved two of its quantitative goals. It participated in the top 30 of SCI (Science Citation Index) and the private sector share in R&D reached to the intended target. The requirement for published papers in SCI in academic advancements may help to boost this success as will be discussed in Section 4.4. Furthermore, the privatization efforts after the year, 1980, and the increasing share of private sector in whole economy may help to raise the private R&D share. The legislation of "The law of R&D support to the industry sector" may also be effective in this trend as will be discussed in Section 4.1. Nevertheless, Turkey was far behind its basic goal which was to reach the developed country level.

3.5 Vision 2023 Project and Fore-sighting the Future

As having missed the most of the goals of former policies, in December 2000, BTYK decided to prepare a new science and technology policy for the period between the years, 2003 and 2023 (BTYK, 2000a, p.14). Not only the failure of the former policies affected the decision of making a brand new policy, the ongoing EU candidacy process of Turkey influenced that decision. Akkerman (2006, p.59) stated that the decision to join EU Framework Programs, taken by the Supreme Council in December 2000 (BTYK, 2000a, p.25), coincided with the decision to create a new S&T policy for Turkey.

Hence, TUBITAK was assigned to complete that mission, then started its preparations at the beginning of the year, 2001, and examined the implementation of Turkish S&T policies prepared so far. Most of the previous targets were missed because of lacking of social and political supports. Then, TUBITAK came to a decision that S&T policies isolated from public and political support has no chance to have success, thus a more holistic approach should be treated for broader participation. The policies should be connected to social and sectoral policies and to the national innovation system (TUBITAK, 2004a, pp. 8-10). TUBITAK also examined many country experiences and their methodology related to S&T policy making. The preparation period took about a year and as a result TUBITAK designed "The Vision 2023: Science and Technology Strategies Project" formed by four sub-projects called "Technologic Capacity", "The Inventory of Researchers", "The Infrastructure of National R&D" and "The Technology Foresight" (Figure 3.1). That project presented in the 7th meeting of BTYK convened on December 23, 2001 (BTYK, 2000b, p.9). Since the member countries of EU mainly base on their S&T

policies to foresight, the backbone of the project was determined as the technology foresight part. In addition, TUBITAK was assigned as project coordinator, while State Planning Organization (DPT) was determined as supporting organization. Other executing organizations were The State Statistics Institute (DIE), The Turkish Academy of Sciences (TUBA), The Turkish Technology Development Foundation (TTGV), and The R&D Department of Ministry of Defence (MSB/ARGE) (BTYK, 2000b, p.15).

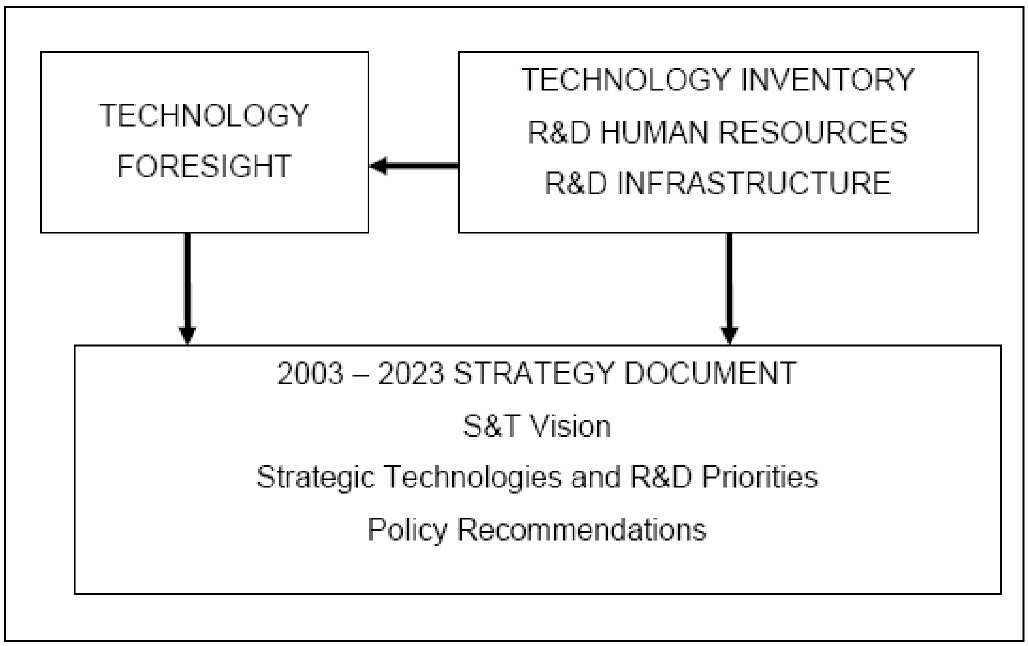

Figure 3.1 The Vision 2023 Sub-Projects and their Interaction (Akkerman, 2006, p.61).

Source: TUBITAK (2004b, p.11)

Technology foresight projects were first to use in Japan in the 1970's and they are widely used in Europe nowadays. As related to that global trend, TUBITAK began to prepare Turkey's ever first technology foresight project as the basis of "Vision 2023" while all other three sub projects were considered as a provider for empirical data about science, technology and human resources of the country. A steering committee was established with the participation of 27 governmental organizations (several related ministries and governmental offices, DPT, YOK, TUBA, The Undersecretaries of Treasury, Small and Medium Industry Development

Organization (KOSGEB) etc.), 29 non-governmental organizations, professional associations and chambers and nine universities. In addition, an executive committee composed of higher status member of TUBITAK, DPT, TTGV and Undersecretariat of Defence Industry, was also established. However, TUBITAK documentation gave few references to the studies of executive committee and as Akkerman (2006, p.62) stated, it was not possible to decide to what extend there was coordination between these organizations in the implementation of project later on". The designed organization scheme of the project and the interaction between committees are given in Figure 3.2.

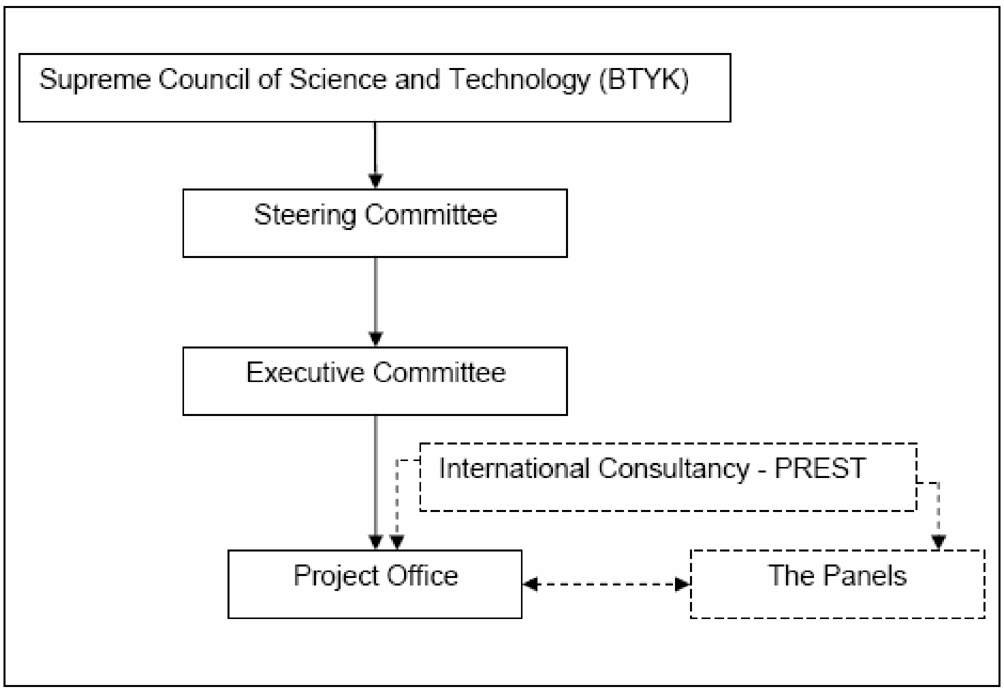

Figure 3.2 The organization scheme of the Vision 2023 Project (Akkerman, 2006, p.61)

Source: TUBITAK (2004b, p.11)

In the 8th meeting of BTYK, the project budget was 3,1 million YTL including personnel expenses (BTYK, 2002, p.8). Policy Research in Engineering, Science and Technology Institute of the University of Manchester (PREST) provided the consultancy under the financial support of British Council. Prof. Denis Loveridge and Dr. Micheal Keenan of PREST were assigned as consultants for the technology foresight project of Vision 2023 (TUBITAK, 2004b, p.30).

The objective of Turkish foresight exercise was to determine the needs of socio-economic sectors and the scientific and technological capabilities required by them (Akkerman, 2006, p.63). Hence, TUBITAK decided ten socio-economic (sectoral) fields and two thematic fields according to their importance for Turkey. Those fields are stated below;[7]

1) Education and Human resources (Thematic Panel)
2) The Environment and Sustainable Development (Thematic Panel)
3) Information and Communication
4) Energy and Natural Resources
5) Construction and Infrastructure
6) Chemicals
7) Textiles
8) Machinery and Materials
9) Health and Pharmaceuticals
10) Defence, Aeronautics and Space
11) Agriculture and Food
12) Transportation and Tourism

Expert panels were organized in those selected fields with the participation of 20-25 experts per each panel from public organizations, private sectors, universities and NGO's. TUBITAK held 192 conventions and 36 workshops with those specialists between the years, 2002 and 2004. Two-rounded DELPHI survey was also employed with 2400 specialists. The results made contributions to the final reports of expert panels and roadmaps of technological activity areas. The mixture of DELPHI results and findings of expert panels was the ever first practice realized in the technology foresight studies all over the world; thus much more international attention was paid to the results of Vision 2023 (TUBITAK, 2004a, p.20). As a result, those studies became the basis in determining the technological development areas and policy tools which were stated in "National Science and Technology Policy: 2003-2023 Strategy Document".

[7] Chemicals and Textiles panels were seperated from each other in the further phases of the Project.

The main goal of that policy document was to provide the perfection in science, technology and innovation; sustainably produce and increase its gross national product with its own resources including human (TUBITAK, 2004b, p.9). Other goals are;

a) to get competitiveness superiority in industrial manufacturing
b) to have higher life quality
c) to have sustainable development
d) to strengthen the infrastructure for transition to the knowledge-based society.

Goals as a whole aimed to create a welfare state. To attain those goals, technology foresight exercises determined eight strategic technology fields and 480 underpinning technologies. The eight major strategic technology fields and their related technologies were depicted in Table 3.1.

Table 3.1 Strategic Technology Fields and their Related Technologies determined in Vision 2023

Strategic Technology Fields	**Related Technologies**
Information and Communication Technologies	Integrated Circuit Design and Production Technologies Image Units Production Technologies Wideband Technologies Image Sensors Production Technologies
Bio-technology and Gene Technologies	High Scale Platform Technologies: Structural and Functional Genome Science, Transcriptomics, Proteomics and Metabolomics Recombinant DNA Technologies Cell Treatment and Stem Cell Technologies Drug Scanning and Design Technologies Therapeutic Protein Production and Controlled Release Systems Bio-informatics

Table 3.1 (continued)

Nanotechnology	Nanophotonics, Nanoelectronics, Nanomagnetism Nanomaterials Nanocharacterization Nanofabrication Quantum Information Processing on Nano Scale Nanobiotechnology
Mechatronics	Micro/Nano Electromechanical Systems and Sensors Robotics and Automation Technologies Basic Control Technologies and Other Generic Areas
Technologies Related to Production Processes and Systems	Flexible and Agile Manufacturing Technologies Rapid Prototyping Technologies Surface, Interface, Thin Film and Vacuum Technologies Metal Shaping Technologies Plastic Parts Manufacturing Technologies Welding Technologies High Speed Machining Technologies
Materials' Technologies	Boron Technologies Composite Materials Technologies Polymer Technologies Smart Materials' Technologies Magnetic, Electronic and Optoelectronic Materials' Technologies Light and High Strength Materials' Technologies
Energy and Environment Technologies	Hydrogen Technologies and Fuel Cells Renewable Energy Technologies Energy Storage Technologies and Power Electronics Nuclear Energy Technologies Environment Sensitive and High Efficiency Fuel and Fuel Combustion Technologies Water Purification Technologies Waste Management Technologies
Design Technologies	Virtual Reality Software and Virtual Prototyping Simulation and Modelling Software Grid Technologies and Parallel and Distributed Computing Software

Source: TUBITAK (2004b, p. 33)

"National Science and Technology Policy: 2003-2023 Strategy Document" determines three pillars for accomplishing its goals. The first pillar was "focusing". Focusing refers to;

a) The public R&D funds should be devoted to the strategic technological fields and their related technologies in public and private R&D activities
b) Researchers, universities and industrialists should be encouraged to study in those strategic fields and university industry relationship should be enforced.
c) PhD. And Post PhD. Programs, university research and researchers should be organized according to those technological priorities.

In other words, "focusing" means the integration of 'Turkish Research Area' and 'European Research Area' (TUBITAK, 2004b, p.29). "Focusing" was at the heart of the model of the S&T strategy as depicted in Figure 3.3.

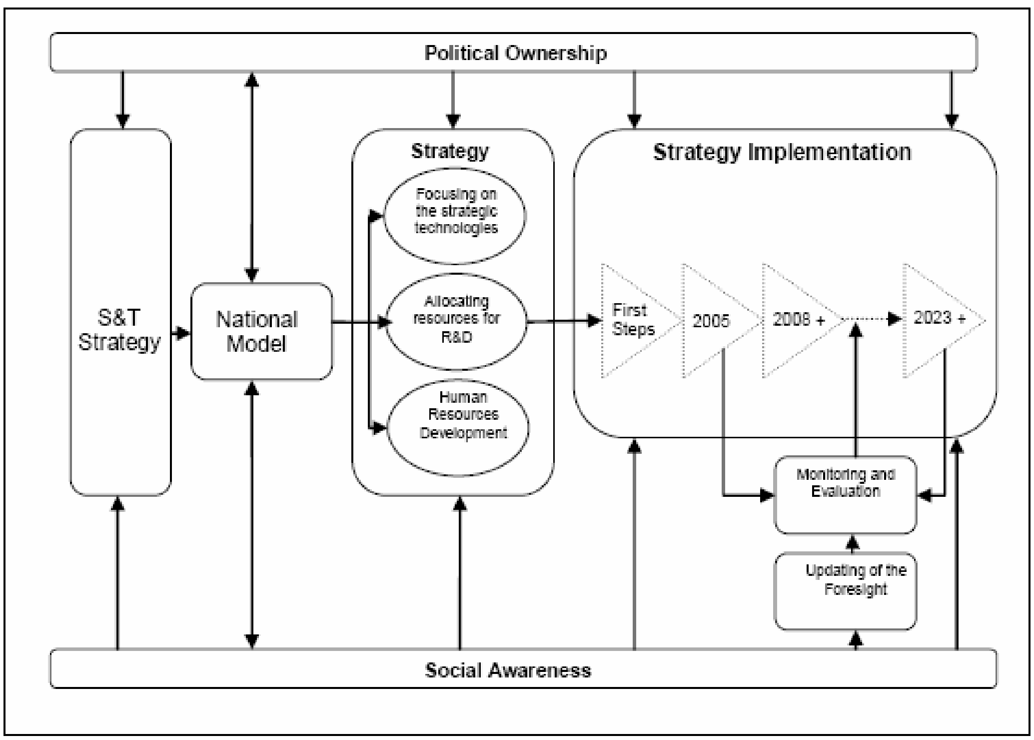

Figure 3.3 The model of the S&T strategy (Akkerman, 2006, p.119)
Source: TUBITAK (2004b, p.27)

The second pillar was to constitute networks among scientific researchers, society and industry (firms or individuals creating economic and social benefits from new technologies) in determined strategic technology fields. That constitution processes and their orchestration has left to the responsibility of government. In addition, enterprises providing venture and risk capital are added in the scope of those networks and that is completely convenient to the 'National Innovation System' approach as examined in Section 2.4.

The last pillar was the 'systemic coherence' of that focusing process. The connection between S&T policies and other governmental policies such as education policies, taxes, industry policies, investment policies etc. should be established. That systemic coherence provided to establish 'National Innovation System' and to have a 'knowledge-based' economy.

Moreover, three approaches were determined for having success in the strategies documented. Those are;

1) <u>Political Approach:</u> The document strongly emphasizes that strategies cannot be realized unless the political decisiveness and sustainability are provided. Governments should implement S&T policies in a manner that is far away from actual politic conflicts. That manner should become a tradition in political environment.
2) <u>Public Administration Approach:</u> Public sector, public enterprises and institution workers and in fact public bodies as a whole should be aware of Vision 2023, its strategies and targets. Short and long term planning, resource allocations and projects etc. should be in coherence with the strategy document.
3) <u>Social Awareness Approach:</u> Social support is essential for becoming a knowledge-based economy. Hence, society as a whole should be acknowledged about the Vision 2023 strategies and the importance of S&T technology in our century. Media should be used in that acknowledgement process (TUBITAK, 2004b, pp.31-32).

After having stated the pillars and approaches of the document, the main strategies for gaining perfection in science, technology and innovation are such;

1) Focusing on the strategic technology fields and related technologies
2) Allocating Resources to R&D

3) Educating required human resources
4) Political ownership
5) Creating awareness in whole society
6) Establishing a system for monitoring and evaluating 'Vision 2023'
7) Establishing a revising system for 'Vision 2023' in coherence with its ongoing evaluation (TUBITAK, 2004b, p.32).

The policy tools selected for focusing on those strategies are determined as follows in the document;

1) Public and Military Procurement based on R&D: The document sees public procurement as an obligation for gaining capabilities on R&D. Long-term public procurement policies should be determined as an assistant to the scientific and technological developments. In addition, the main objective of military policies should be the procurement of military instruments from national firms and enterprises that have R&D capabilities. Some legislative regulations should be made in public procurement laws in that way.
2) National R&D Fund and National Research Program: There is a need for a framework program such as that developed in EU. National R&D Fund and National Research Program should be set up for establishing Turkish Research Area.
3) Guided R&D Projects: Those are the R&D projects whose objectives and limited conditions are certain and whose finance is partially or fully compensated by the government. Universities, public and private enterprises and research centres were coordinated for innovative activities in technology, process, product and services by using guided R&D projects (TUBITAK, 2004b, pp. 36-37).

Lastly, some quantitative values about research activities and human resources are determined in this document. Those are as follows;

a) the ratio of R&D expenditures in GNP should be increased to 2 per cent until 2013.
b) the private sector share in R&D expenditures should be increased to 60 per cent.

c) the share of high technology R&D expenditure should be increased to 40 per cent in private manufacturing sector.
d) participating in Top 10 of SCI. (among European Union countries)
e) The number of researchers should be 60 per 10000 workers who have economical activity (The private sector share should be 50 per cent in that value).
f) The number of PhD students with the age of 25-34 should be five per 10000 workers who have economical activity (TUBITAK, 2004b, pp.38-41).

In the document, the last objective we mention here is to establish "The National Innovation System" (NIS) which intends to form a knowledge-based society. NIS is a contemporary concept included by all modern S&T policy studies. Turkish S&T policy in power, namely "National Science and Technology Policy: 2003-2023 Strategy Document" emphasizes the importance of the establishment of Turkish NIS and relies on NIS to become a knowledge-based economy;

> National Innovation System will constitute the backbone of knowledge-based economy. National Innovation System will become an instrument for Turkey in;
> - creating value-added based on qualified work force and on science and technology as a resource of knowledge,
> - increasing her national income via gaining competitiveness in global markets,
> - providing sustainable development (TUBITAK, 2004b, p.31).

The document also emphasizes the importance of 'Local Innovation Systems' which mainly targets to develop local innovative and creative activities.

On the one hand, "National Science and Technology Policy: 2003-2023 Strategy Document" keeps in step with this trend and tries to provide integrity in the system as a whole; on the other hand, in spite of its widely participated base, superiority and complexity with respect to other S&T policy documents makes it difficult to be applied. The foresight project of Vision 2023 and DELPHI survey resulted in 65 technological activity topics and 480 underpinning technologies grouped under eight strategic technologies. Although this is not excessive with respect to other countries' foresight results, particularly in developed countries, it should be noted that Turkey has scarce sources relative to developed countries such as the United Kingdom, the United States, and Japan etc. (Keenan, 2003). Akkerman (2006, p.135) criticises that "it is difficult to draw a conclusion as to what is considered as priority for Turkey". Akkerman (2006, p.136) also finds the eight strategic technologies as too general to be prioritized. Once the policy document is created via taking into consideration the findings of the foresight projects, expert panels and DELPHI surveys, it is not surprising that the same complexity is also seen in the policy document. The ruling S&T policy of Turkey suggests eight strategic technology fields and 43 related technology topics. Even those technology topics are not sufficiently clear and cannot be understood what it refers because most of them have wide range of application areas. For example, let us take developing renewable energy technologies. Renewable energy can be obtained from sun, wind or water etc. The priority among them is not explicitly determined in the policy document.

Furthermore, the end of this policy seems to be similar as the former policies. Göker (2005, p.7) strongly suggests that there is no intention to apply that like other policies. The interim plan prepared by DPT for the years 2006 and 2008 does not take into account the strategies formulated by Vision 2023. In addition, even though S&T special expertise commission report of Ninth Development Plan made by DPT refers to the Vision 2023 strategies, the plan does not mention about their implementations and makes its own vision (DPT, 2006a). Göker (2005) concludes that a strategy that is not taken into consideration in short and medium term has no chance to be implemented in the long term.

Finally, we have come to a decision that Vision 2023 and its policy document, namely "National Science and Technology Policy: 2003-2023 Strategy Document", are put aside after a few period passed from its preparation with its high complexity and ambiguity. The lack of political authority and responsibility is also effective in that process. The coordination between TUBITAK and DPT has not been be set up. DPT has not given sufficient reference to Vision 2023 and its policy document in their development plans. DPT's technology vision and TUBITAK's technology vision have diverged in short and long term strategies and plans.

3.6 Turkish National Innovation System

The term of 'Turkish National Innovation System' was firstly put on the agenda in the document, namely "Turkey's Science and Technology Policy", in the 3rd meeting of BTYK convened in the year, 1997. In this document, the main target was the establishment of 'National Innovation System' (NIS) which refers to make scientific and technological researches, to exploit the findings of those researches and to transform them into social and economical benefits in a systemic coherence with its institutions and mechanisms (TUBITAK, 1997, p.35). In this context, the establishment of Turkish Patent Institute, National Metrology Institute, TUBA, TTGV etc. is considered as the occasions afforded for the purpose of constituting NIS.

Taymaz (2001, p.34) evaluated those efforts shown since the beginning of 1990s as stated below;

1) Although some policies and priorities were open to be discussed (this condition is convenient to the evolutionary nature of science and technology policy making as discussed in Section 2.2), the policies towards establishing NIS were successfully designed and recommended. However, the problem was in the implementation phase instead of design.
2) The regulations about intellectual property rights were made by the enforcement of international contracts signed by Turkey. Hence, legislative framework was completed in this context.
3) The financial support provided by TTGV and TUBITAK-TIDEB[8] were the applications towards financing technological development and constituting the R&D and innovation culture among the society.

Generally, Turkey is considered as in the start-up phase. The research projects have been encouraged. Teubal (1995 and 1997) hardly argues that the most important failure is the insufficiency of R&D projects instead of market failures at the beginning of the NIS establishments. In line with this argument, the lack of demand on R&D intensive activities supports this claim in Turkish industry as will be discussed in Section 5.4. Turkey cannot completely exploit research funds reserved by EU and TTGV. Industrialists do not have intention to solve problems via using R&D activities. According to Teubal's arguments, this situation can be surpassed by reaching a considerable amount of R&D activities among the whole

[8] TIDEB is abbreviation of the "Department of Technology Monitoring and Evaluation" in TUBITAK.

industry. Until reaching that level, research projects, coordination among institutions and interactions between the agents that constitute NIS should be supported in a systemic manner. In this scope, the solution for Turkey is to make R&D activities become widespread among the country for the purpose of constituting her NIS.

3.7 Concluding Remarks

This word chain summarizes Turkish S&T policy making history: "Make it- Do not apply- Revise it- Do not apply- Remake it- Do not apply". The lack of application was due to the lack of political and administrative responsibilities. Especially, in the first ten year period after the first science and technology policy, Turkey did not attain most of its goals and lost its very precious time. The important aspect of this decade was its convenience to the Perez's paper. Perez (1988) mainly suggested that developing countries could catch up developed countries more easily in fast and radically changing technological eras. Institutions are weak in those countries and it is more probable to adopt new systems and technologies to technologically developing countries because they are more flexible than the developed ones. Göker (2002, p.7) claimed that the 1980s depicted the features of an era like this. The Cold War nearly comes to an end and information and communication technologies (ICT) is fastly developing. Japan benefits from this fastly changing environment and catches up Europe and the United States. A great opportunity seems to be missed for Turkey while 'the rule of the game' is changing.

In the second period, more effort exercised nevertheless, Turkey could not be ranked as a developed and industrialised country in the scope of scientific and technological efforts. S&T policies were not applied in a systemic manner required for establishing a NIS. The awareness of the importance of S&T in society considerably increased but it is far behind the requirements.

In addition, BTYK meetings were not carried out periodically until the year, 1999. Governments did not admit the council and its functions. Its functionality was weak. Policies were not completely implemented. Göker (2004, p.7) strongly argued that this non-functional BTYK depicted the non existence of national S&T policy. This unwillingness of politics combined with the irrelevance of industrialists on demanding R&D and technology slowed down the progress in S&T within the country. Turkish industry was composed of Small and Medium sized Enterprises (SMEs) and those enterprises were not interested in spending for R&D because of their low budget and fluctuating economic environment experienced in Turkey. The environment of Turkish business culture is not suitable for such technology demand as stated in Akarsoy's (2002c) model in Section 5.1. Furthermore, Turkish economy do not basically depend on technology production.

To summarize, Turkish socio-economic and political structures are not appropriate for developing science and technology. Its S&T policies are put aside without any application. There is no owner of these policies among politicians. Sociologically, the concepts of institutionalism, strategic planning and future projection are non-existent. The understanding of the term 'sustainable development' in political environment is weak. Although Turkish people have great potential of entrepreneurship, that potential is not active in scientific and technological areas. There is no coordination and cooperation in the establishment of NIS and Turkish NIS has not sufficient volume for developing enough number of researches and for evaluating the funds reserved by the government, TUBITAK or EU. Finally, the policies offered until now do not match to the existing structure. Most planners claim that they made the best plan, but rarely applied. If it is not applicable, the plan cannot be considered as the best one. A plan should consider the existing structure as given and produce policy tools in consistent with needs and characteristics of this structure.

CHAPTER 4

THE QUANTITATIVE ANALYSIS OF TURKEY'S SCIENCE AND TECHNOLOGY POLICIES

In this chapter, Turkish S&T Policy will be analysed quantitatively. Turkish scientific indicators in R&D such as 'percentage of Gross Domestic Expenditure in R&D (GERD) in GDP, 'the number of R&D personnel', 'the distribution of GERD between business enterprise and government' and 'world ranking of Turkey in ISI' will be displayed. These indicators are some of the most commonly used indicators for measuring scientific and technological performance of nations and display their positions in the area of R&D intensity, sectoral distribution of R&D expenditures, the share of researchers in human resources, scientific publications and intellectual property rights. In addition, Turkish performance in those indicators will be compared with some developed countries such as the United States, the United Kingdom, Sweden and Japan; with some newly industrialised countries such as Taiwan, South Korea; with some developing countries such as Brazil, Argentina, China; and with some of its neighbours such as Greece and Russia. This comparison provides to find out Turkey's position among different country groups.

4.1 R&D Intensity

Before the preparation of the first S&T Policy, namely "Turkish Science Policy: 1983-2003", the ratio of R&D expenditures to GDP was 0.24 (Özdaş, 2000, p.35). No considerable increase has occurred until the year, 1991. It might be the result of a change in the calculation method, although no support was found for that argument. In the year, 1993, it was 0.44 and was relatively low compared to the objective. The indicator decreased its minimum in the year, 1994, in which an economic crisis took place, but it began to increase by the year, 1995. (Figure 4.1) "The law of R&D support to the industry sector" was effective in this increasing trend. However, this trend ended in the year, 2001, because of the sharpest economic crisis of Turkey in the Republican history. Turkey has not reached the nation's maximum level occurred in the year 2001, yet. In the second S&T policy document, namely "Turkish Science and Technology Policy: 1993-2003," the objective was to reach one percentage again, however; it could not be attained.

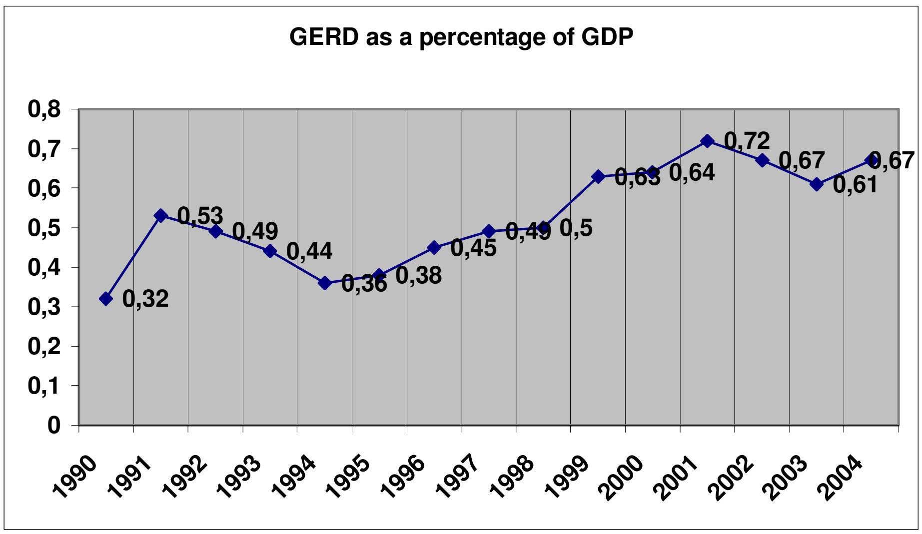

Figure 4.1 GERD as a percentage of GDP in Turkey
Source: TUIK R&D Statistics (2006)

4.2 Sectoral Distribution of R&D Expenditures

The common objective of Turkish S&T policies is to increase business sector shares in R&D investments. Figure 4.2 displays 'percentage of GERD performance of business enterprise sector'. This indicator begins to increase by the year, 1995. The promulgation of "the law of R&D support to the industry sector" should be the reason of this increasing trend. The indicator reaches its maximum level in the year, 1999. Similar to 'GERD as a percentage of GDP', it decreases sharply by the crisis year, 2001. After this year, the expenditure percentages of business enterprise and higher education sectors diverged. The weakening of

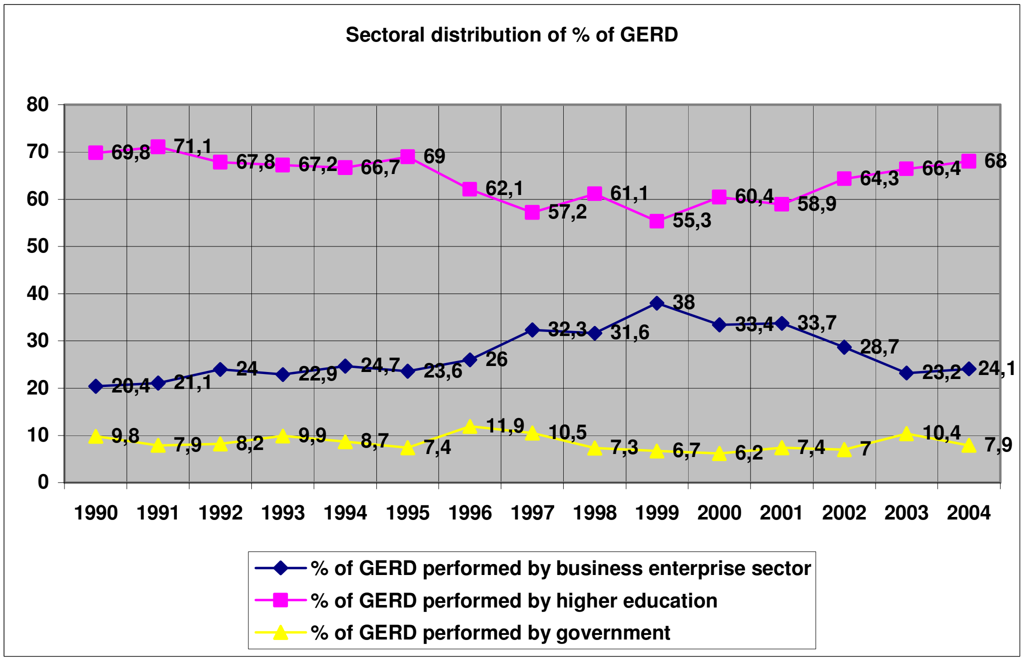

Figure 4.2 Sectoral percentage Distribution of GERD in Turkey[9]

Source: TUIK R&D Statistics (2006) and OECD Main S&T Indicators (2004-2)

business enterprise sector by the crisis can be the reason for this divergence. The higher education, which has less risk than the other R&D investors, has taken the responsibility of nationwide R&D. Thus, the common objective of S&T policy deviates from its origin. This deviation explicitly depicts the negative effects of economic crisis and destabilization on private sector R&D investments.

In addition, even though this indicator is above 30 percent between the years, 1997 and 2002, the private sector share which is targeted as 30 percent in "Turkish Science and Technology Policy: 1993-2003," cannot be accomplished in the year, 2003. As stated above, the R&D expenditure of business enterprise considerably decreases after the crisis. Naturally, it is not possible to invest on R&D by private sector while they try to survive.

[9] For the years between 1990-2002, "Main Science and Technology Indicators 2004-2" was used. For the years 2003 and 2004, they are calculated from TUIK R&D Statistics (2006) (http://www.tubitak.gov.tr/home.do?sid=477&pid=468).

4.3 Human Resources: Researchers

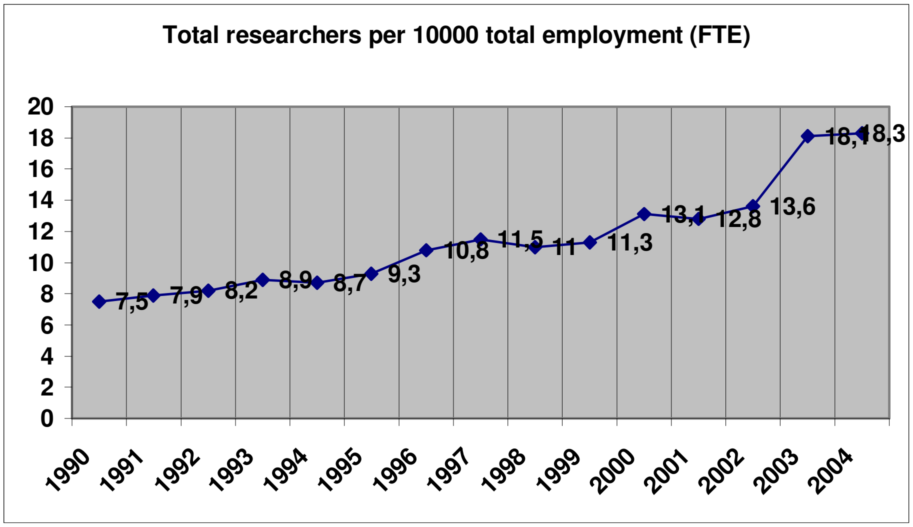

Figure 4.3 Total Researchers per 10000 Total Employment (FTE=Full time equivalent)

Source: TUIK R&D Statistics (2006)

The indicator of 'total researchers per 10000 total employments (FTE)' is one of the most stabilized S&T indicators. It increases continuously except in economic crisis years; 1994 and 2001. In the first S&T Policy document of Turkey, namely "Turkish Science Policy: 1983-2003," the aim is to reach 15 researchers in the year, 1993 and 30 researchers in the year, 2003. However, Figure 4.3 denotes that the numbers were 8.9 and 18.1 researchers, respectively. From the perspective of this policy, the objective cannot be attained.

In the second policy document, the target is 15 researchers per 10000 employments. This value is 18.1 researchers in the year, 2003; this is one of the few attained goals of the second policy. The elimination of deskilled workers from total work force after the crisis of the year, 2001 can be the reason for that increasing trend. A further support for this claim comes from the indicator, namely 'GERD as a percentage of GDP" depicted in Figure 4.1. There is no considerable increase of expenditure on R&D after the crisis year, 2001. It fluctuates about the value of 0.65 per cent. If that indicator has increased, we can relate that increasing trend of number of researchers to the more investments made in R&D sector. However, there is no argument for suggesting that hypothesis. Turkey spends the same share of her GDP on R&D. In addition, the radical increase experiences in the years 2003 and 2004, can be explained by a different calculation method applied for the indicator. However, we can not run into an argument in that way.

4.4 Scientific Publications

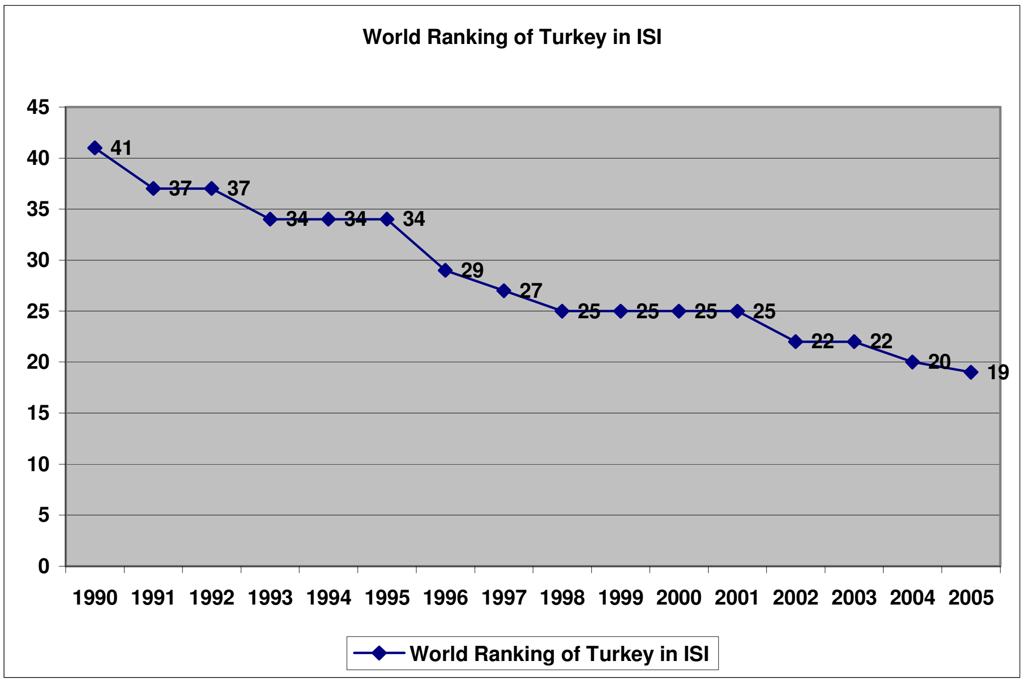

Figure 4.4 World Ranking of Turkey in ISI
Source: TUBITAK Statistics and ISI database (2006)

The numbers of Turkish scientific papers published in SCI increases. As a result, Turkey has stepped up to upper positions in world ranking for twenty years. Turkey is at the thirty-forth place in the year, 1993. But the same goal in the second policy document, it is easily realized in the year, 2003 by being in the twenty second place. The objective of being at the top 20 countries contributing to the world science literature states in the first policy is accomplished in the year, 2005. Even though this is a promising result for the future, Turkey has not been one of the top 20 industrialised countries of the world, yet. This success in scientific publications has not reflected into the industry sector as a whole because the connection between Turkish industries and universities is quite-limited. We argue that the main responsibility on that disconnection belongs to industrialists. The demand for R&D from industrialists is nearly non-existent. They do not perceive university research as a solution to industrial problems. Supports for that claim comes from a report of Akarsoy (2002c, p.7) in which industrialists clearly notice that universities seem to be the last option for solving R&D problems.

Furthermore, Arıoğlu and Girgin (2002, p.3) relate the increase in scientific publications to the following reasons;

a) The promotion program in scientific publications applied by TUBITAK
b) University promotions to scientific publications
c) The increase of the importance of scientific publications in academic career advancements.
d) The increase of Research Funds
e) The support of DPT in technology projects
f) The increase in number of academicians

Turkish success in academic publications can be mainly related to that criteria applied in academic career advancements. However, there is much to do for catching up developed nations in the scope of publication quality. The citations to these academic writings are not sufficient. In their studies, Arıoğlu and Girgin (2002, p.5) indicates that countries like Argentina, Hong Kong and Mexico have nearly same number of publications but take two times more citations than Turkey. Furthermore, Ireland and Chile have nearly half of the number of publications and also take two times more citations. Citations depict the quality and impact of publication, its actuality and its contribution to the world science literature. Hence, more citations mean more people benefit from that publication. In this context, Turkish publications do not seem to be influential on academic environment. They are about incremental contributions rather than radical ones. This is another point to take into account for Turkish S&T policy making.

4.5 Intellectual Property Rights

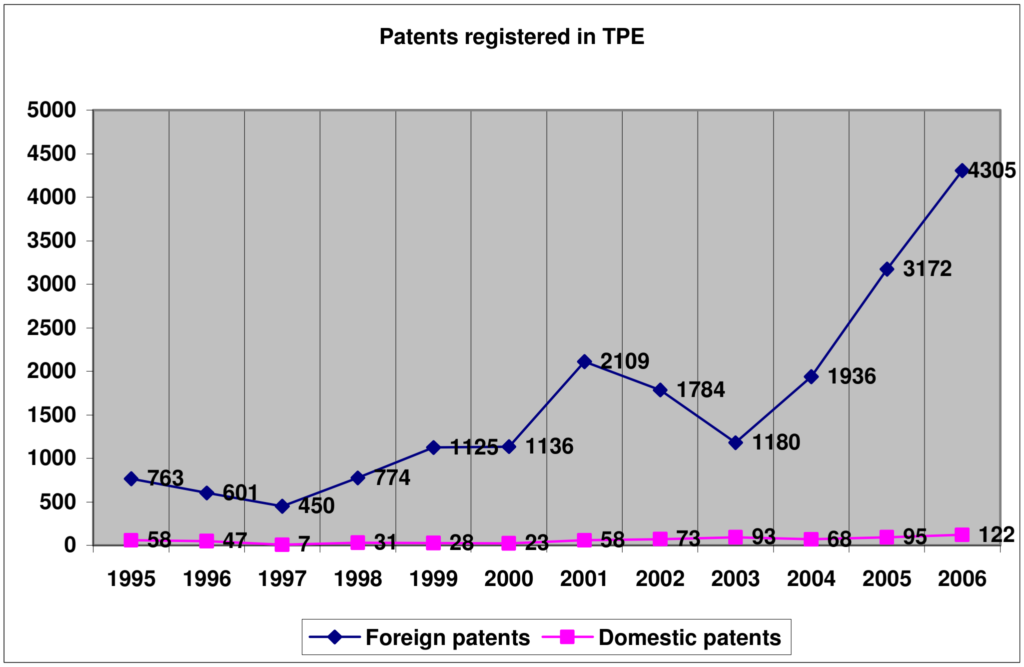

Figure 4.5 Patents registered in TPE

Source: Turkish Patent Institute(TPE) (2006) and TUBITAK (2006)

The number of patents taken in Turkey can be divided into two periods; before and after the year, 2001. Foreign patent and domestic patent numbers both increased sharply at the mentioned year even though it was a year of a devastating crisis. Domestic patents sustained this trend except the year, 2004. Foreign patents declined in the year, 2003 but it has increased since that year. In this period, privatization and foreign direct investment (FDI) have speeded up. Multi-national enterprises (MNEs) have intensely entered Turkish market. The increasing number of foreign patents can be considered as the results of these ongoing processes. However, the number of domestic patents is insignificant relative to the number of foreign patents.

Patents can be counted as concrete results of scientific activity and innovation. They also entail intellectual and industrial property rights. It is important to note that they depict the owner of the technology and innovation. Thus, the high intensity of foreign patents has the main role in innovative activities taken place in the country and the market.

The increasing numbers of national patents are the results of properly working S&T policies. National innovation systems and all Turkish S&T Policies mainly aim to produce nation's own technology and patents. In this context, those policies do not seem to be sufficiently successful. Another support for that claim comes from Table 4.1 which clearly displays the non existence of Turkey in globally recognised triadic patent families.

4.6 A Cross-Country Comparison

After evaluating Turkish main S&T indicators graphically, we will compare these main indicators with the data of some selected countries. We will begin by "percentage of GERD in GDP" which depicts the amount of a nation's GDP granted for R&D. Sweden is ahead of the other nations with nearly 4 percent as seen from Table 4.1. It breaks 'the rule of 3 percent'[10] which states that a nation will not spend more budgets after its "percentage of GERD in GDP" reaches that share. In addition, the countries like Germany, France, Sweden, and Japan which are most creative in taking patents, also spend above 2 percentage to R&D from their budgets. The most successful NICs, namely South Korea and Taiwan are also spending above 2 percent. Mediterranean countries such as Italy, Spain, Greece and Portugal spend less from France, United Kingdom, USA, Canada etc. even though they are considered as the developed nations of the world. For the year, 2006 values, Turkey only passes Brazil and Argentina and this is not enough for compensating the objectives of Turkish S&T policies as a whole.

Second, "percentage of GERD performed by business enterprise" is another important indicator that shows the importance of R&D given by the capitalists and industrialists of a nation. A higher amount of business share depicts the awareness of capital in the development of science and technology for evaluating and maximizing itself. This share is always above 50 percent in the developed market economies such as the USA, The United Kingdom, Sweden, Netherlands, France, Germany etc. It should also be stated that it is a great success of Taiwan and South Korea to make this ratio 64.4 percent and 76.9 percent, respectively. It is interesting that as a planned economy, China has the ratio of 68.3 percentages as if it falsifies those

[10] This is a goal determined by the European Union in the Convention of Lisbon in the year, 2000.

Table 4.1 Main R&D indicators of several countries (2006)[11]

No	Country	% of GERD in GDP	% of GERD performed by business enterprise	Total researchers per 10000 total Employment(FTE)	Total publications in SCI	% share of Triadic patents+
1	Argentina	0,43	32,2	20,7	N/A	0,02
2	Brazil	0,57	N/A	N/A	11657	0,08
3	Canada	1,95	52,4	64	38511	1,19
4	China	1,15	68,3	11,6	N/A	0,21
5	France	2,16	61,9	71,8	54324	4,87
6	Germany	2,38	69,9	61,4	75608	13,23
7	Greece	0,63	29,3	34,8	5171	0,01
8	India	0,77	N/A	N/A	18623	0,10
9	Ireland	1,14	65,3	52,6	4653	0,10
10	Israel	5,28	76	N/A	11971	0,78
11	Italy	1,04	47,8	29,2	36244	1,76
12	Japan	2,80	75,2	101,9	79609	26,93
13	Netherlands	1,87	57,8	49	21249	1,96
14	Portugal	0,83	36,2	37,6	3402	0,02
15	Russia	0,97	68	62,8	28037	0,17
16	Singapore	2,21	66,2	99,1	3376	0,21
17	South Korea	2,68	76,9	75,6	13384	1,09
18	Spain	1,23	54,4	50,4	24820	0,26
19	Sweden	3,99	75,7	117,7	16642	1,86
20	Taiwan	2,18	64,4	69,5	9833	0,22
21	Turkey	0,58	24,2	13,6	6066	0,01
22	United Kingdom	1,69	63	50,6	91654	4,11
23	USA	2,4	70,1	88,2	312073	34,32

suggestions written above. Turkey's worst indicator is this one with the share of 24.2 per cent. First, it is behind the objective of its S&T policies and second, five per cent away from the closest country at the table, namely Greece. It reveals that the

[11] Some values depicted in the Table 1 was calculated from this formula;

- % of GERD in GDP = R&D expenditures (PPP)(OECD Main S&T Indicators 2006-2) / GDP estimates (PPP) (CIA World Factbook 2006)
- Total researchers per 10000 Total Employment(FTE) = Total researchers (FTE))(OECD Main S&T Indicators 2006-2) / Labor Force (FTE) (CIA World Factbook 2006)

% of GERD performed by business enterprise sector was taken from OECD Main S&T Indicators 2006-2.

Total publications in SCI and % of GERD in GDP for India and Brazil were taken from Arioglu and Girgin (2001).

% share of Triadic patents were taken from OECD Main S&T Indicators 2004-2.

recognition of the importance of R&D in Turkish business enterprise is weak, thus government expenditure on R&D emerges as the main engine of Turkish innovative capacity.

Third, the indicator of "Total researchers per 10000 total employments (Full Time Equivalent)" which shows the researchers share in total employment is above 50 researchers in all developed and newly industrialised countries except Netherlands. In Turkey, this value seems to be 13.6 researchers according to the latest calculation of this dissertation. Turkey passes only China and the goal of having 30 researchers per 10000 total employments mentioned in Turkish S&T policies cannot be accomplished. The data have also shown that Mediterranean countries such as Spain, Portugal, Italy, Turkey and Greece, is behind the average value of NICs and developed nations. Sweden and Japan constitutes 'upper league' of this indicator with their values more than 100 researchers per 10000 total employments. Research and development sector is of considerable importance for employing workers in these countries.

Another indicator, "Total publications in SCI", is necessary for evaluating a nation's capability of making scientific researches and of contributing to the world scientific literature. This is intensifying in four grand nations, namely the USA, The United Kingdom, Japan and Germany. Turkey's publications in 1999 are low and cannot be compared with them. Turkey is ahead of Portugal, Ireland, Singapore and Greece whose population is below her own population. In spite of this reality, Turkey's overall position is always increasing as depicted in the section 4.4. This indicator belongs to one of the few accomplished goals stated in S&T policies.

The last indicator we like to comment about is "percentage share of Triadic patents". This share depicts the patents globally recognised because triadic patents are the patents which are approved by three major patent offices of the world; namely, United States Patent Office (USPTO), European Patent Office (EPO), Japanese Patent Office (JPO). The high share of triadic patents relate to the existence of trans-national or multi-national enterprises. In spite of its name, these enterprises belong to few developed countries such as the USA, The United Kingdom, Japan, France, Germany etc. Further support for this claim comes from Table 4.1. The USA whose economy is constructed by big MNEs like Microsoft, Youtube, General Motors etc., has the highest share with 34.32 per cent. Japan is another example of this kind with MNEs; namely Sony, Toyota, Mitsubishi and has the share of 26.93 per cent. Germany (BMW, Bayer, Mercedes), France (Renault, Carrefour, Airbus), United Kingdom (Vodafone) are of share, 13.23, 4.87, 4.11 per cent, respectively. But someone might object that some of the developing countries like Sweden, Canada and Netherlands do not support this claim in spite of having MNEs but it is reasonable to state that these countries have high shares regarding to their population. They also have high shares relative to NICs and developing countries. This indicator also depicts the commercial use of scientific publications and advancements. The natural result of setting up NIS and good industry-university interaction is the success in taking patents. Turkey's share in triadic patents is only 0.01 per cent. The rise in SCI ranking and scientific publications do not reflect this criterion. This supports Arıoğlu and Girgin who show explicitly that high technology exports and efficiency is independent from scientific publications in their studies (Arıoğlu and Girgin, p.12). Figure 4.5 displays that only few Turkish patents are of domestic origin. This is one of the most disappointed areas of Turkish S&T policies.

4.7 Conclusion

In the perspective of S&T indicators determined in S&T policy documents, Turkey has not realized the desired values except for scientific publications and World ranking in ISI. In spite of some promising developments, Turkey has been behind NICs and far behind the developed countries. University-industry interaction and the awareness of the society in developing S&T have not been completely activated. Capitalists and industrialists are willing to invest in R&D-intensive areas. The demand from industrialists has been quite-limited although we have determined some positive and promising increase in business expenditure on R&D after the promulgation of 'The law of R&D support to the industry' in the year, 1995. Especially, the main problem in business sector has been the absence of a business management culture that has tried to solve industrial problems with the help of R&D. Further support for this claim comes from the unused R&D funds of European Union reserved for Turkey. Turkish business sector does not achieve to produce enough research projects for evaluating those funds. In this manner, in order to increase GERD, the state and higher education have taken the responsibility; 'Government

Expenditure on R&D' (GOVERD) is admitted as the main driving force of Turkish innovative capacity even though Turkish S&T policy documents have tried to increase the share of business enterprise sector on R&D expenditure. However, Turkish newly-established and premature NIS is not ready to advance in S&T even if it has the sufficient amount of monetary resources.

Furthermore, scientific publications addressed to Turkey cannot provide considerable contribution to Turkish economy and industry. Turkish non-existence in triadic patents supports this claim. The domination of foreign patents can easily be seen among the country. The absence of MNEs that belong to Turkey can also be effective on this trend. We have found that the countries with MNEs are succeeding in obtaining patents. As a developing country, Turkey cannot apply its S&T policy in a planned manner such as Taiwan and South Korea, thus its quantitative indicators left behind those countries. Those countries are at the 'Newly Industrialised Countries' group while Turkey is still considered as a developing one. We have also determined the negative effects of economic crisis taken place in the years, 1994 and 2001. As a result, properly working NIS, seriously and systemically applied S&T policies and macro-economic stabilization are the main components for sustainable development and for gaining competitiveness in the global arena and Turkey is lacking of those features.

CHAPTER 5

THE SECTORAL ANALYSIS OF TURKISH SCIENCE AND TECHNOLOGY POLICY IMPLEMENTATIONS

In order to reach their development targets, developing countries should not only produce science and technology but also apply them into industry. In this chapter, we will analyse four of the most advanced and technology intensive sectors in Turkey; namely, automotive, textile, ICT (Information and Communication Technologies) and total manufacturing. We have selected those sectors for the reasons stated below;

a) <u>Automotive sector:</u> It is the biggest exporter sector of Turkey. The innovations and technologies used in automobile and vehicle production are of diffusive effects to other sectors of production.
b) <u>Textile&Clothing sector:</u> In spite of being a labour-intensive sector, we should take into consideration the recent mechanization and modernization efforts taken place in this industry. It is also strategically important for its high capacity of employment in Turkey. Furthermore, textile industry is considered as the second strongest exporter sector of Turkey after leading for several years.
c) <u>ICT sector:</u> This sector has appeared since the 1980s and has transformed not only business sector but also every aspect of life at all. Hence, to gain competitiveness in ICT sector is vital for adopting the new era, namely ‘Information Age’. It is considered as the ‘future technology’ in a globalising world.
d) <u>Total Manufacturing Sector:</u> The demand for technology is suspicious in Turkish industry; however the R&D intensification of industrial

structure is of considerable importance for demanding technology. For this reason, we totally intend to inquire Turkish Manufacturing Sector and try to find out its structure related to R&D intensity via using Lall's technology categorization method.

Now, we will take a closer look at each of those sectors in the perspective of Turkish S&T policies. Firstly, we summarize the history of mentioned sectors in the world, and secondly, we examine the recent situation in these sectors in the scope of Turkish S&T policy documents. Lastly, we analyze the R&D intensification of Turkish total manufacturing sector.

5.1 Automotive Sector

Automotive sector has been considered as the leading industrial sector of the 20th century. Mass production system known as 'Fordism' was first adopted into automotive industry. The new system practiced not only in automotive industry but also in some of the industrial sectors such as durable goods, machine tools, aircrafts, and white goods industries etc. The system provided middle-income classes of the society to easily buy most of those goods. After 'the Great Depression' in the year, 1929, Keynesian policies implemented some new techno-economic paradigms, such as Fordism, in many factories. This paradigm created big national and capitalist economies depending on huge demand on the market that resulted in the biggest and fastest economic growth in the history of the world. Then, Fordism transformed to a more flexible production system, namely Toyotaism.[12] The demand for more differentiated products has led to the emergence of this new production system which is more innovation friendly because of the more dynamic market structure. With the help of that emerging context and of the integration of ICT technologies and production technologies (CNC technologies, CAD (Computer-Aided Design)/CAM (Computer Aided Manufacturing), automation, robotics etc.), automotive industry still sustains its effects on industry and on society as a whole.

[12] Other names of that production system are Lean production, Ohnoism or Flexible Manufacturing System.

Automotive sector has begun to develop in Turkey since the 1960s. The firms are of foreign origin with a domestic partner except BMC.[13] BMC is the only brand belongs to Turkey while other firms, namely OYAK Renault, ToyotaSA, Fiat (TOFAŞ)[14], Hyundai, Ford, Otokar etc., are the joint ventures with foreign firms. At this part of the dissertation, we are going to examine the present situation and technological capacities of Turkish Automotive industry by using the 'Model for the Assessment of the Sectoral Technological Situation' (Akarsoy, 2001). This model is suitable for wide participation both from industry and academy. Akarsoy (2002a, 2002b, 2002c) firstly applies 'Model for the Assessment of The Sectoral Technological Situation' into Turkish Automotive Industry. According to this model, we can suggest the following;

Automotive industry has recently ruled the basic concepts of the industry. Automobile design is of three parts;

a) To gain production "Know-how"
b) Design verification
c) Design

Turkey seems to be weak in steps; b and c. Turkish automotive industry is not capable of removing the lack of capabilities in the mentioned steps. Thus, they tend to operate with foreign firms and licensors for gaining 'know-how' and producing in world standards. However, this trend decreases the value-added produced in the sector.

The sector is effective in technological areas stated below;

a) Prototyping
b) Metal fatigue
c) Manufacturing technologies
d) Statics and elasticity
e) Mechanics
f) Transmission components
g) Clutches and differentials

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[13] BMC was founded by England. It is the abbreviation of 'British Motors Company'. After several years from its establishment, it was sold to Turkish entrepreneurs. Now, its capital formation is completely composed of Turkish capital.

[14] The Company of Turkish Automobile Factory

In more critical technologies such as electronics, engine design or production and in more contemporary technologies such as active security, telematics, Turkey follows current trends in the automotive sector. Main industry procures those technologies from the foreign partners. However, Turkish industrialists have no intention to establish cooperation with universities even though universities have the sufficient technological knowledge especially in the areas such as metals, plastics, acoustics, fatigue, vibration, dynamics etc.

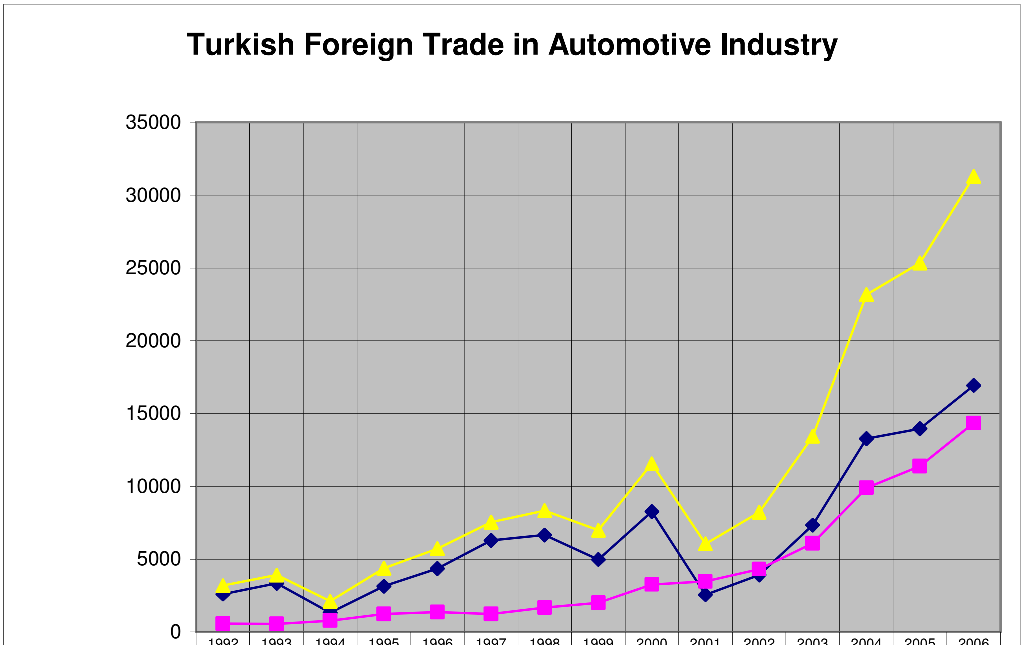
We can state the strong aspects of Turkish Automotive Industry as follows;

a) The industry has reached a considerable “know-how” level in manufacturing.
b) Both the international standards and the importance of producing within them have been grasped.

In contrast, the weaknesses of the sector are;

a) There is no future projection in R&D projects in which foresight and vision are of considerable importance.
b) Main industry have some difficulties in diffusing its “know-how” to lower parts of the sector; namely, subcontractors.
c) Main industry is not capable of determining the “limit conditions” crucial in automobile designing.
d) The industry-university cooperation is not sufficient. Main industry is not used to solve the problems with the help of R&D (Akarsoy, 2002c, p.12).

Turkey has attained a successful position in global automobile production chain after the efforts shown for about half a century. However, European, South Korean and Japanese strategies have been more effective than Turkish strategy in that success. Europeans prefer to intensify on R&D and design instead of production. Their targets towards becoming a knowledge-based society are influential on that preference. Europeans also try to benefit from low-wages in developing countries. In addition, Far Eastern countries consider Turkey as an entrance to European market. Thus, Turkey benefits from its geo-political position and low-wage labourers while becoming a successful manufacturer for global automotive sector.



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Import	2604	3351	1323	3145	4361	6287	6649	4992	8275	2573	3908	7345	13278	13946	16930
Export	569	558	794	1246	1371	1249	1675	1998	3274	3475	4319	6095	9906	11398	14350
Total vol. of trade	3174	3910	2118	4391	5732	7537	8324	6991	11550	6048	8227	13440	23184	25345	31280

Figure 5.1 Turkish foreign trade balances in Automotive Industry (* in million USD)

Source: OSD (2006, p.11)

We emphasize an important contradiction. In spite of Turkey's high productive capacity, Turkey has continuous deficit in its foreign trade accounts. Figure 5.2 explicitly depicts that deficit do not take place only in two exceptional years, 2001 and 2002. Turkish import is considerably decreased in the crisis years, 1994 and 2001. The year, 2002, is considered as the continuation of the crisis year, 2001. The main reason behind the decreases in import is the significant augmentation of USD exchange rates experienced during the economic crisis and as a result, market demand for imported products is considerably low. Furthermore, we can suggest that the volume of foreign trade has sharply increased for four years (Figure 5.1). The decreasing deficit percentage in total foreign trade is a plus in this increasing trend. This ratio has decreased to ten percentages. It means that Turkey gives fewer deficits and loses fewer reserves while exporting the same volume of product. This ratio is considerably low relative to the years before 2001 (Figure 5.4). In contrast, the rate of imported intermediate goods in exports has considerably increased since the year, 2001. Those imports triple their volume in a four-year period as seen from Figure 5.3. Hence, Turkey's export performance can be considered as highly dependent upon her intermediate goods imports. Total value-added and profits reduce for the same amount of exports for four years. As a result, automotive exporters have not considerably contributed the economy, and in this context they have contributed more to the countries from which they import in their industrialization process in terms of total value-added and total employment.

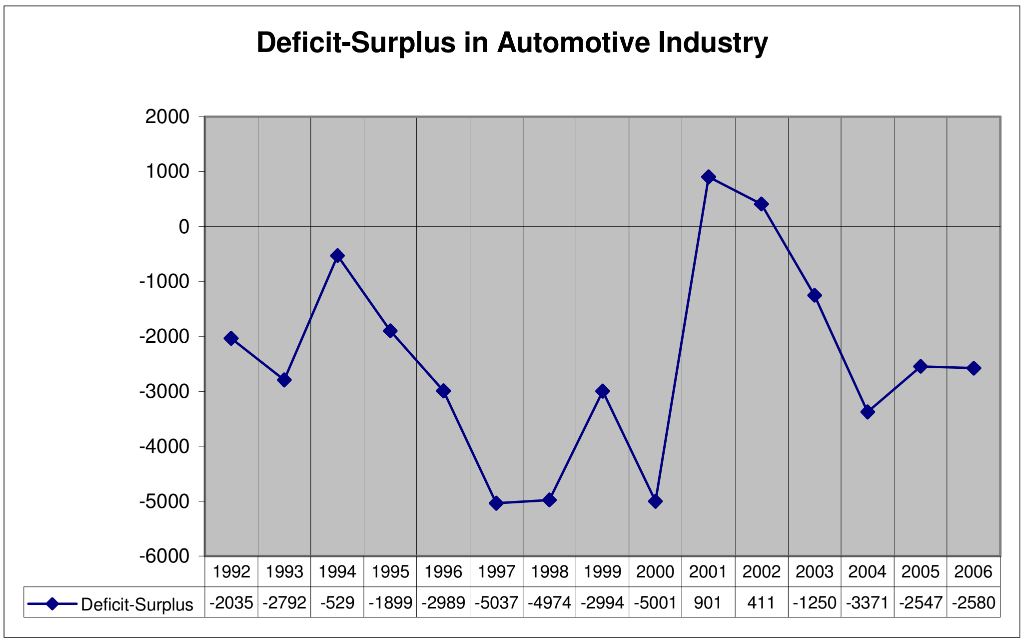


Figure 5.2 Deficit-Surplus in Turkish Automotive Sector Foreign Trade (*in million USD)

Source: OSD (2006, p.11)

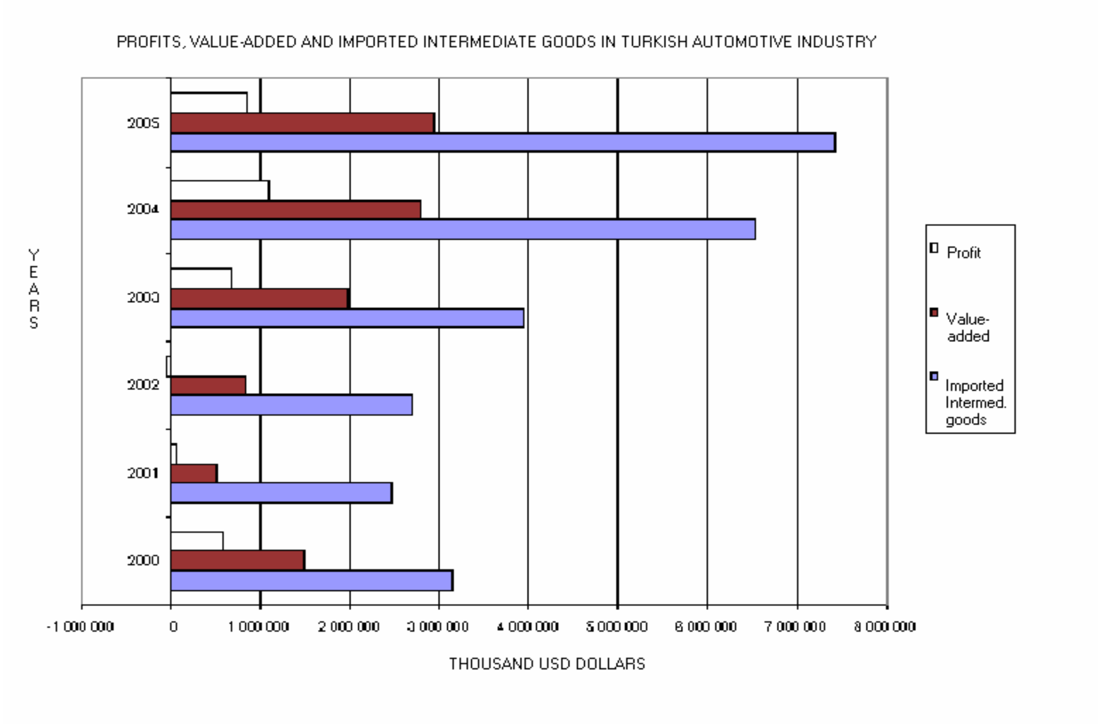
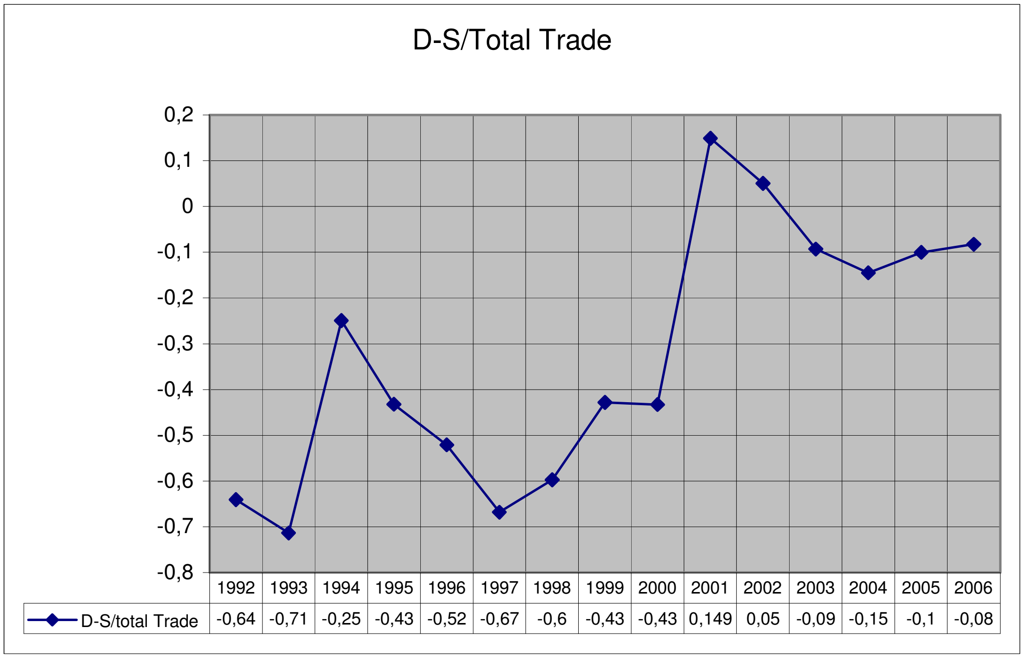


Figure 5.3 Profits, value-added and imported intermediate goods in Turkish Automotive Industry

Source: Tutan (2006, p.12)

Turkey has succeeded in being a competitive automotive producer and owing some traditional technologies such as prototyping, metal fatigue, mechanics etc. However, it is far behind to become a technology centre. Nahum stated this reality as follows;

> Turkey has a considerable productive capacity and has become a production centre. However, the shares of R&D and 'after-sales services' are relatively increased in global value-chain with respect to production. Thus, it means that the amount of Turkish share in total value-added decreases if Turkey only stays as a production centre. Furthermore, Turkey is losing its position to latecomers. (…)
> It is an obligation for Turkey to gain skills and capabilities in R&D and 'after-sales services' while sustaining its production capacity (TUBITAK, TTGV, TUSIAD, 2000).



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
D-S/total Trade	-0,64	-0,71	-0,25	-0,43	-0,52	-0,67	-0,6	-0,43	-0,43	0,149	0,05	-0,09	-0,15	-0,1	-0,08

Figure 5.4 Percentage of Deficit or Surplus in Total Foreign Trade

Source: OSD (2006, p.11)

Nahum (2001) also emphasizes that Turkish industry should transform its structure as a production centre into a technology centre for sustaining its development.

> We are in the position of a technology exporter and user instead of being a creator of our own technology. It is a strategic choice to stay like that. (…) Turkey should produce technology whether she intends to become a developed country. In contrast, Turkey stays as an assistant to developed countries while importing their technology (Nahum, 2001).

There are two ruling opinions for developing future technologies;

1) To intensify in the technologies at which we are good. (Prototyping, production technologies etc.)
2) To invest in newly flourished technologies for a long period and to go ahead when these technologies are dominant. (Fatigue, application software, alternative fuels etc.) (Akarsoy, 2002b, pp. 16-17)

Alternative fuels, fuel cells, electrical engines, the optimization of internal combustion engines and diesel engines, vehicle dynamics, thermodynamics, finite element analysis, computerized fluid dynamics, software for engine ignition, advanced material technologies (especially aluminium and magnesium), advanced management and production techniques seems to be critical in the future (Akarsoy, 2002c, 14). Thus, we strongly recommend for Turkey the second option of future technology development stated above. Turkey should invest in a newly flourished technological field that is so crucial in global automotive sector. Our suggestion for that technology is fuel cells. The earth will experience a global warming in the next fifty years. Thus, it is impossible to fully continue with fossil fuels because of their pollution effects. In addition, engine is the most important part of an automobile and is considered as 'the heart' of an automobile. In this context, producing effective engines seems to be crucial for the future of the sector. Even though some experts state that it is impossible for Turkey to have a brand name in automobile production (Akarsoy, 2002, pp.10-13), we strongly argue that advancement in future engine technologies provides Turkey to have her own brands in automotive sector.

Furthermore, advancements in fuel cells should be parallel to advancements in boron technologies. Turkey has the 70 percent of world's discovered boron reserves. The development of fuel cell technologies that use manufactured boron to store hydrogen fuel will open a new road for Turkey in 21st century. Turkey has a chance to be one of the energy monopolies of the world.[15]

In line with our arguments, the last policy document of Turkey, namely "National Science and Technology Policy: 2003-2023 Strategy Document", emphasizes the importance of hydrogen and boron technologies. Internal combustion engines ignited by hydrogen fuels and hybrid cars based on fuel cells are stated as design technologies suitable for increasing total value-added in the sector. Alternative fuels, hydrogen storage and combustion technologies are selected for sustainable development and environment protection. The document has suggested advancing newly flourished technologies without quitting from manufacturing in successful sectors such as textile, clothing and automotive. Boron technologies seem to be a high value-added technologies that can possibly help to advance both in the materials sector and the automotive sector (TUBITAK, 2004b, pp.13-22).

In the context of S&T policies, each policy emphasizes the importance of automotive sector and contemporary technologies stated above. For example, the first and second policies state the significance of generic technologies such as

[15] For further information on those technologies; www.hidrojenforumu.org and Özdemir S., S., et al. (2001).

flexible manufacturing and automation, environment-friendly technologies and advanced material technologies as discussed in Chapter 3. But they do not seem to be applied. Göker (2003, p.21) strongly argues that there has been no incremental progress in those generic technologies because of the lack of orchestration of the government and of the absence of systemic coherence. Another support for this claim comes from the TIAD[16] statistics. Machine tools are the machines which are used for designing and producing machine parts. Those machines are widely recognized by their flexible manufacturing techniques and automation. They increase the productivity of the manufacturing processes via using its flexible nature. In this flexible and technology- intensified sector, Turkey exports 213 million USD in the year, 2005, while imports 798 million USD (TIAD, 2006). Turkey is highly dependent upon foreign products and cannot afford to produce sufficient machines for compensating her own markets' demands. Hence, Turkey cannot go one step further in automotive-related technologies in contrast to her policy documents.

Finally, last developments are promising for Turkish Automotive Industry. These are some R&D projects carried out by the main industry (Akarsoy, 2005, pp.18-30), the establishment of some automotive programs in universities such as Hacettepe, Boğaziçi etc., the establishment of OTAM (The Research Centre for Automotive Technologies), 80 projects about boron technologies and fuel cells carried out by universities (Oksay, 2007, pp.12-14). The last policy document, namely "National Science and Technology Policy: 2003-2023 Strategy Document" has taken into attention the contemporary generic technologies used in automotive sector as stated above. In addition to hydrogen technologies and fuel cells, fuel combustion technologies, boron technologies; flexible and agile manufacturing technologies, high speed machining technologies and metal shaping technologies are determined as strategic technologies in the document (TUBITAK, 2004b, p.29) (Table 3.2). Their roadmaps have been drawn (TUBITAK, 2004b, pp. 77-137). The strategic technologic improvements selected for the very technologies are determined year by year and a path is documented. If those roadmaps and their paths are followed together with those promising developments, the main industry is a milestone for more technology intensive sectoral structure. The systemic coherence and political authority are required for further improvements. Resource allocation to

[16] The Association of Machine Tools Businessmen (Takım Tezgahları İşadamları Derneği)

R&D, educating technical personnel, encouraging private sector R&D, orienting the industry to more R&D intensive areas, recruiting more R&D personnel and decreasing the intermediate goods imports via producing more parts of an automobile in domestic subcontractors are seen as basic challenges of the sector. Technological capabilities of subcontractors is improved via establishing networks, increasing university-industry interaction, intensifying R&D and financing R&D projects. The sectoral policies should be related to economic, education and technology policies in a systemic manner. As the first exporter sector of Turkey, automotive sector is indispendible for the country. The sector seems to be stayed ahead for years in this context. Turkey should earn reserves in the future by increasing the R&D projects, design intensification and productivity via using flexible manufacturing technologies. The sector has diffusive effects and high employment capacity, and the sectoral growth will affect the whole economy. In parallel with the S&T policy documents, Turkish automotive sector will stay as a strategic one in the future. In addition to being a production centre, Turkey should be 'technology centre of excellence' in some of the related technologies stated above.

5.2 Textile&Clothing Sector

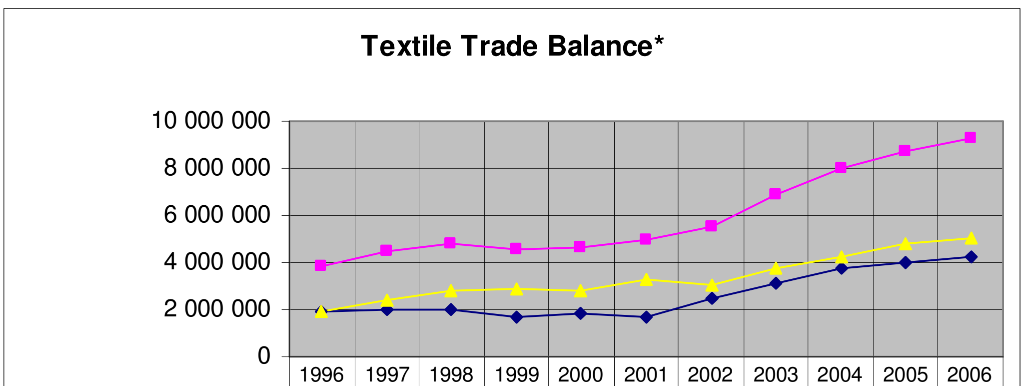
Textile and Clothing (T&C) sector is known as the major sector of Industrial Revolution experienced by Western capitalism in 17th, 18th and 19th centuries. The foundation and the rise of Western capitalism firstly took place in the United Kingdom beared on the shoulders of the innovative efforts and discoveries made by many T&C machine inventors; namely Hargreaves, Arkwright etc. (Freeman and Soete, 2003, pp.39-65). Those inventors not only discovered and innovated some useful and more productive machines but also became entrepreneurs. Hence, they helped capitalism to settle down as an economic system. As having seen in the experience of the United Kingdom, T&C sector is generally considered as the first sector realizing the 'take-off' in the road of development. In the history, many developed countries such as Japan, South Korea etc. began their development process by the advancements taken place in T&C sector. This sector exhibits high employment capacity with its labour-intensive structure. Developing countries with their high unemployment ratios and low capital accumulations perceive T&C sector as indispensable. As Taymaz (2002, p.2)) stated, T&C industries have played a very important role in the early industrialization process of almost all countries since the Industrial Revolution. In spite of that important aspect, low value-added per employee has been a sectoral feature because of sector's low productivity capacity. Thus, developing countries should direct into R&D and capital intensive sectors after advancing in T&C sector in order to become a developed one.

The establishment of Sumerbank in the year, 1933, is considered as the beginning of Turkish T&C industries. Government invested for and supported Sumerbank in order to set up the industry in the country and to decrease the dependency on foreigners in the mentioned areas of specialization. Sumerbank took the lead until the end of 1970's. It provided an infrastructure for private sector in textile and clothing. After the 1980's, government changed the economy policy and the privatization have speeded up. Hence, the T&C industrial employment in public sector decreased from 18 percent by the beginning of 1980's to 2 percent in the year, 1996. The share of T&C in manufacturing value-added increased from 13 percent in the year, 1981 to 16 percent in the late 1990's. The textile part of that ratio was 12 percent while clothing took 4 percent. T&C industry also provided 34 percent of total employment in the country (Taymaz, 2002, p.3).

As a developing country, Turkey has become important exporter in the sector after the change of economic policy in the year, 1983. The exporting efforts have started by the beginning of the 1980's. The export boom realized by Turkey in that period was mainly due to T&C sector. The share of T&C in total export revenue doubled from the year, 1980 to the year, 1995. Export revenue of T&C jumped from 0.9 billion USD to 9.9 billion USD (Taymaz, 2002, p.3). In the following ten years, Turkey has maintained that trend. As seen from Figure 5.5 and 5.6, she has doubled her exports in clothing industry and has boosted her textile exports from 3.8 billion USD to 9.25 billion USD. In contrast to automotive industry, Turkey seems to earn reserves from T&C sector which is nearly 15 billion USD in the year, 2006. We should also note that similar to the automotive industry, Turkish exporting performance have speeded up after the economic crisis year, 2001. Turkey has become a significant exporter in this ongoing period. Sectoral imports have increased as well. Textile imports have quadrupled. Clothing imports increased from 191 million USD to 1 billion USD in a ten-year period. There are some reasons behind the increase of the sectoral imports. Those are as follows;

a) Chinese competition and its cost advantage
b) The ongoing increase of costs which is taking place in Turkish manufacturing industry as a whole. (especially in energy and transporting costs)
c) The incapability of Turkish industrialists to have their own brand names
d) The low R&D intensity in Turkish T&C industry
e) Exchange rates in which the value of USD is extremely low.

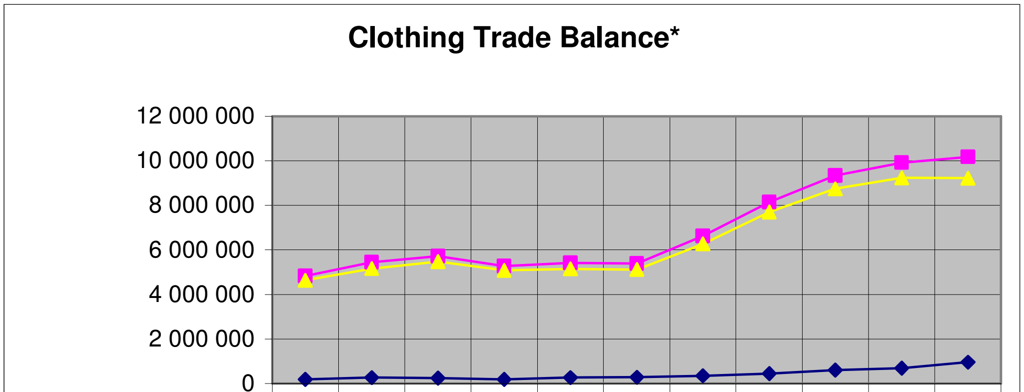
However, that increase mainly depends on the export boom experienced after the mentioned year. Turkey continues to earn more reserves from the sector. The Turkish positive trade balance has never decreased in the last ten years. In addition, the trade volume had an ongoing increase and came to the value of 24.5 million USD. Total trade in the year, 2006, was two and a half times more than the year, 1996 (Figure 5.7).



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Textile Import	1 882	2 036	2 004	1 645	1 852	1 682	2 500	3 094	3 786	3 974	4 203
Textile Export	3 817	4 450	4 794	4 557	4 614	4 943	5 532	6 841	7 998	8 742	9 263
Textile Trade balance	1 935	2 413	2 789	2 911	2 761	3 260	3 032	3 747	4 211	4 768	5 059

Figure 5.5 Textile trade balance (* in million USD)

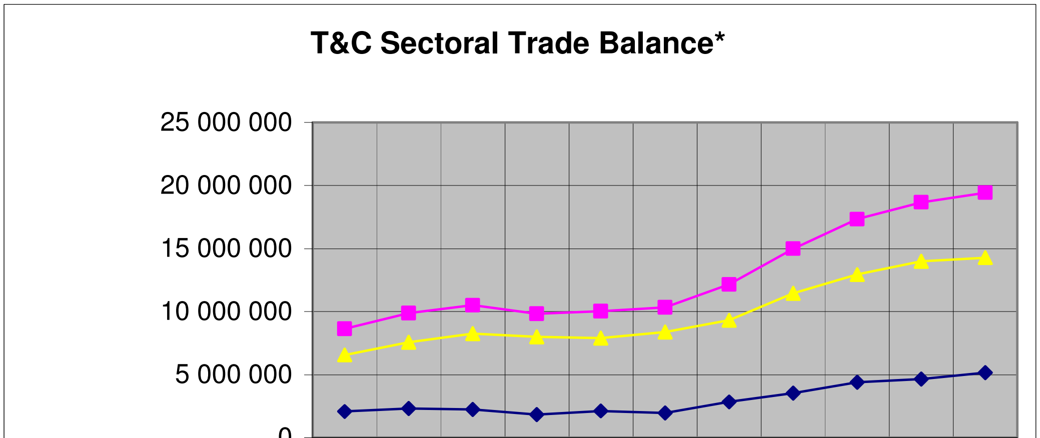
Source: TUIK Statistics (2006)



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Clothing Import	191	276	248	185	266	277	346	449	601	693	959
Clothing Export	4 829	5 442	5 715	5 270	5 417	5 397	6 615	8 153	9 340	9 924	10 170
Clothing Trade Balance	4 638	5 165	5 467	5 084	5 150	5 120	6 269	7 703	8 738	9 231	9 211

Figure 5.6 Clothing trade balance (* in million USD)

Source: TUIK Statistics (2006)



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
T&C Sectoral Import	2 073	2 313	2 252	1 831	2 119	1 959	2 846	3 544	4 387	4 668	5 162
T&C Sectoral Export	8 647	9 892	10 509	9 827	10 031	10 341	12 147	14 995	17 338	18 667	19 434
T&C Sectoral Trade Balance	6 573	7 579	8 256	7 996	7 912	8 381	9 301	11 451	12 950	13 999	14 271

Figure 5.7 T&C sectoral trade balance (* in million USD)

Source: TUIK Statistics (2006)

European Union has been the main importer of Turkish T&C products. 80 percent of Turkish exports go to the European Union. Germany is the biggest importer and Turkey exports about one quarter of her total T&C manufacturing to this country (Taymaz, 2002, p.4). European Union takes some quantitative measures in the year, 1984; however, those measures come to an end after the agreement of customs union. The United States seems to be the second in importing Turkish products. Turkey has more advantages in clothing rather than textile in European market. In contrast, Turkish powerful side is textile in the United States. Turkey seems to have superiority to Mexico in spite of Mexican geographical and custom advantages for the US market (Taymaz, 2002, p.12).

For the future prospects, Turkey seems to have four determinants that affect the sectoral progress (Taymaz, 2002, pp.16-22);

a) Exchange rates: As an exporter, Turkey is considerably affected by the exchange rates. Taymaz (2002, p.16) determined that Turkish export performance has highly depended on the fluctuations of Turkish Liras(TL) values. In addition, TL has considerably increased its value relative to USD since the year, 2002. According to estimates, reel value of YTL should be around 2.30 with respect to USD. However, nowadays 1 USD is equal to 1.30 YTL in the exchange market (Tutan, 2006, p.5). T&C industrialists are complaining about those recent exchange rates. It is more difficult to export now in Turkey with respect to four years ago. Profits are minimized in T&C sector. According to our impressions in Denizli which is one of the centres of T&C manufacturing in the country, T&C industrialists have begun to evaluate their capital in some other economical activity areas, such as machine equipment, machine manufacturing, food, gross markets etc.

b) Elimination of quotas after the year, 2005: It was commonly argued that the application of that elimination applied by the rules of World Trade Organisation (WTO) would not considerably affect the export performance of Turkey in T&C sector because 70 percent of the USA and the EU imports were independent from those quotas. Further support for this claim comes from Figure 5.7, in which total sectoral import increased from 4.6 billion USD to 5.1 billion USD and this trend can be considered as normal while taking into consideration the former years' increases. However, that suggestion has not been completely appropriate. Some sub-sectors have serious complaints about the Chinese uneven competition. In his report, Öngüt (2007) forecasts that at the beginning of the year, 2020, decreases of exports will be able to reach to the shares of 20 per cent and 47 per cent in textile and in clothing industries, respectively. In addition, the decrease experienced in production will be 23.1 and 33.4 in those industries, respectively (Öngüt, 2007). That is another point of consideration for policy-makers and sector experts.

c) Productivity and wages: Recent mechanization and modernization efforts have sustained the relative productivity level of Turkey. Nevertheless, that level should be advanced if Turkey is willing to reach the EU and the USA level. As Taymaz (2002, pp.14-15) stated, Turkish relative productivity level is far behind the developed countries. Turkish T&C industry is about 30 percent as productive as the United States' one. Hence, Turkey's export-oriented position is mainly due to the low wages. The average wage level in Turkey is 20 percent of the average United States' level.

d) New marketing strategies: Supplier relationships, geographical proximities and product innovations have become more important in the sectoral level. Developing new brand names, establishing new marketing channels and coupling the strategies with the biggest EU and USA companies are of great importance more than ever.

Some policies should be implemented for removing the complaints stated above and for maintaining the export-oriented structure of the sector. Firstly, although the exchange rate stability achieved in recent years is a positive progress for the sectoral development, the high-valued TL seems to be a problem for reaching higher export values. New exchange rate policies should support the export-oriented structure of the sector. The value of TL should be increased in long term while sustaining macro-economic stability and investment opportunities. Secondly, for gaining more productivity, recent mechanization and modernization efforts should be speeded up and some input costs, especially in energy and transportation, should be decreased. In addition, some protective and appropriate law legislations should be made in the perspective of international agreements for competing against the uneven Chinese competitors and for gaining advantage in the global markets. Thirdly and the most importantly, Turkey should develop its own brand names and should establish new marketing channels in the sector for increasing the sectoral value-added.

Establishing new networks and positioning in the global arena are vital for Turkish T&C industrialists. The sectoral R&D should be developed for attaining this aim. Design processes, production and plant organisations, advancements in technical textile[17], innovations in generating and adapting new products are essential in order to gain high productivity levels and to gain global competitiveness.

Further support for those claims comes from the last DPT report. Ongut (2007, pp.131-142) strongly suggests the following that are parallel to our policy advices stated above for the sake of the sector in the future;

a) Decisiveness and motivation should be increased on the firm base.
b) The coordination among the firms and sectoral agents should be provided.
c) Macro-economic stability should be sustained and suitable investment environment should be improved.
d) Shadow (underground) economy should be avoided.
e) Transportation and customs infrastructures should be developed.
f) The faculties and colleges related to textile and clothing should be revised for educating students in a more creative way.
g) The sector should focus on design, creativeness and fashion design instead of low value-added activities.
h) University-industry interaction should be conducted and R&D should be made on sectoral technologies such as technical textile, multi-functional clothing products, textile machines, textile chemicals and synthetic fibres.
i) Trademarks and industrial property rights should be improved. Legislative regulations should be made in those areas. For instance, support for trademarks is limited with an amount of three million dollar. This is not an effective support in global environment. The cost of being a brand name is more and more expensive. Hence, fewer firms should be supported with more investment. Öngüt (2007) offers that only three firms should be selected and 50 million USD per firm should be given

[17] Technical textile is the most R&D intensive sectoral area of specialization including the innovations in new product characteristics such as inflammable, flexible, wrinle-proof materials etc. (Taymaz (2002))

every year. This seems to be logical for effectively encouraging brand making.

j) Monitoring of and protection on 42 selected categories of T&C sector should be carried out against imports from China.

Furthermore, we strongly argue that the productivity gain in the sector should not be realized in the expense of wage decreases. In the context of last S&T policy of Turkey, namely "National Science and Technology Policy: 2003-2023 Strategy Document", to have higher life quality and to have sustainable development are stated as some of the main targets of S&T policies. Thus, the development and export boom with lower wages and life quality will be meaningless. In that perspective, we hardly criticise Öngüt's opinions about flexible manufacturing including part-time employment and temporary recruitment (Öngüt, 2007, p.136). Technology and design intensive T&C sector will be the solution for Turkey although Turkish S&T policy documents have not paid so much attention to T&C sectors. By the beginning of the first document, namely "Turkish Science Policy: 1983-2003", T&C technologies have been rarely emphasized and not considered as strategic ones. The last document has broken this rule and has made some suggestions about T&C and its related technologies. For example, according to the document, 'computer integrated production' which means the integration of textile production chain from ordering to marketing will be effective in the future. Computer-aided design and production become widespread. Techno-textile and person-specific production of clothes will be seen as emerging trends. More flexibility will be required in manufacturing processes and those processes will be computerized. In this context, CAD-CAM technologies, robotics and sensor technologies are seen as strategic for future developments (TUBITAK, 2004b, p.56).

Finally, we suggest that T&C sector is essential for Turkish economy with its high employment and export capacity. T&C sector seems to be the first that is earning reserves in manufacturing trade balances and Turkey fills most of her trade deficits with the help of the sector. Quitting from the industry is not a logical option for a country having high unemployment rates and high trade deficits such as Turkey. Creating own brand names via using technology, increasing design intensive activities and creativeness, flexible manufacturing, allocating more resources to

R&D, educating designers and technical personnel are seen as indispensible for the bright future of the sector.

5.3 ICT Sector

In contrast to common view, Information and Communication Technologies(ICT) include not only computers but also radios, televisions, radars, mobile phones, broadcasting equipments and the related technologies such as microelectronics, electronic components, robotics, semi conductors etc. However, the emergence and diffusion of ICT did not occur without the technological progresses achieved in computers. Computer technologies have been considerably and fastly developed since the invention of the ever first computer, namely Z3, by Zuse in the year, 1941 (Freeman and Soete, 2003, p.202). Those developments have helped computers increase their efficiency and decrease their prices. Thus, the rate of computer usage in whole society, especially in developed countries, has hugely increased. Table 5.1 clearly depicts the productivity increase of the computers.

Table 5.1 The productivity increase in computers

Changing Area	**1960's**	**1980's**	**1990's**
Number of computers in OECD zone	30000	in millions	in hundred millions
Number of full time programmers in OECD zone	200,000	> 2,000,000	> 10,000,000
Number of processes per second for an average computer	1000	in ten millions	in billions
Number of processes per 1 USD cost by an average computer	100000	in hundred millions	in ten billions

Source: Freeman and Soete (2003, p.450)

Today, most economists and engineers commonly admit the importance of ICT. ICT have transformed agriculture, industry and services sectors radically. As Freeman and Soete (2003) noticed, ICT deeply affected not only all functions of firms but also all functions of industry and services as a whole while earlier technology systems such as steam power and electricity commonly had an influence on the firm level in the past. Scientific researches, marketing inquiries, design and development, machines, devices, industrial plants, production and distribution systems, marketing, manufacturing and even public administration were affected by those radical technologies. The common use of Internet has supported those changes since the late 1990's. Information has begun to diffuse in such an easy and fast way that the world has never seen before. By regarding those arguments, many scholars strongly argue that ICT have started a brand new era, namely "Post-Industrial" society (Freeman and Soete, 2003, p.450).

Table 5.2 Cross-country IT indicators

	USA	Japan	Mexico	Korea	Turkey (1985)	Turkey (1990)
IT Investment per capita (US $)	400	400	14	45	3	12
Software as percentage of ICT	42	35	36	24	7	13
PCs as a percentage of total computers	45	30	55	40	17	44
Hardware exports (US $ billions)	21	17	0.5	3.5	0	0.02
Computer student/million population	1000	830	230	1100	130	160
R&D as a percentage of GDP	2.9	2.9	0.4	1.8	0.1	0.2

Source: World Bank (1993) (p.15)

Turkey has lately started its infrastructure investments on ICT at the beginning of the 1980's. The closed-economy period and the political instabilities took place among the years, 1960 and 1980, could be the reasons for the absence of the infrastructure. The latecomer, Turkey, is compared with some countries at the Table 5.2. Turk Telekom (former name, P.T.T.)[18] built up Turkish communication infrastructure until the beginning of the 1990's. High quality telephone lines were established and their coverage among the country was tripled. In addition, more than half of the network was digitized. In the second half of the 1980's, the share of telecommunications investments in GDP was annually 1 percent. Hence, those efforts formed suitable environment for ICT market developments in 1990's and 2000's. Computer usage became widespread among public and private institutions.

[18] The Company of Turkish Telecommunication. P.T.T. was the abbreviation of "Posta, Telefon, Telgraf (Mail, Telephone, Telegraph)". It was a state–owned business enterprise. It made infrastructure investments by using its internal telecom revenues.

Almost all universities founded computer and IT-related departments. The ever first internet connection in the country was realized in Middle East Technical University (METU) in the year, 1993. The capacity of internet line was upgraded to 256 kbit per second in the year, 1996. Microsoft started a subsidiary in Istanbul in the year, 1993 and IBM speeded up its investments during those years. Banking sector was fastly computerized. By January 1994, there were 3,681 ATM[19] machines across the country (Kirlidog, 1996, pp.107-110). Nowadays, Turkish ICT market has reached significant growth rates as seen from the Table 5.4. ICT have mainly benefited from liberalization of imports experienced since the year, 1980 (Kirlidog, 1996, p.108).

Table 5.3 Turkish ICT Industry Development 2001-2006[20] (million US Dollar)

Sub-sector	2001	2002	2003	2004	2005	2006*	CAGR**
Hardware	1.054	1.400	1.540	1.768	2.227	2.700	20,70%
Software	293	336	393	452	618	780	21,63%
Services	823	775	847	1.122	1.412	1.690	15,48%
Software related Services	658	620	678	898	1.130	1.352	17,40%
Total Software (Products and Services)	951	956	1.071	1.350	1.748	2.132	17,52%
Consumption Materials	74	122	90	113	141	165	18,91%
IT Total	2.244	2.633	2.870	3.455	4.397	5.335	20,70%
IT Sector Growth		17,3%	9%	20,3%	27,2%	21,3%	
Communication	6.847	7.517	8.592	11.815	14.380	17.390	20,49%
ICT Total	**9.091**	**10.150**	**11.462**	**15.270**	**18.777**	**22.725**	**20,11%**

Source: Interpromedya (2005) and IDC Reports(2005)

Software sector has attained the first place in annual growth rates; however, the difference with other sub-sectors does not seem to be significant. We can deduce that ICT sector has homogenously grown with all its sub-sectors. The whole sector has doubled up its volume in a four-year period among the years, 2001 and, 2005.

[19] ATM is the abbreviation of Automatic Teller Machine which is commonly used for interactive banking services.

[20] * Forecasted, ** (Compound Annually Growth Rate)

The forecasted amount for the year, 2006, seems to support that achievement. Furthermore, ICT Industry growth rate is three and a half times higher than the GNP Growth Rate as seen from the Table 5.4. This percentage clearly depicts the promising aspect of the sector for the fastly developing national economy. In spite of that high growth performance, sector's share in GNP is quite limited with its 6 percent. More investments on ICT will provide GNP to grow faster. In this perspective, ICT sector seems to be strategic for Turkey.

Table 5.4 ICT Industry in National Economy

	2002	**2003**	**2004**	**2005**	**2006***
GNP Growth Rate (%)	7,9	5,9	9,9	7,6	6
ICT Industry Growth Rate (%)	11,6	12,9	33,2	23	21
The Ratio of ICT in GNP (%)	5,5	4,8	5	5,2	6

Source: DPT Statistics (2006)

According to Güder and Taşçı (2006), the estimated total employment in ICT industry is 65,000 personnel in the year, 1996, and 81,000 in the year, 2002. Its forecasted amount for the year, 2006, is 130,000 personnel (Güder and Taşçı, 2006, p.15). However, ICT sector needs to recruit more and more employees. There are 21,096 students in 448 different faculties of Turkish universities related to ICT TUBISAD and YASAD, 2003). Turkish Informatics Foundation (TBK)[21] estimates that IT specialists deficit is 160,000 personnel in whole country and by annually 10 percent increase, the forecasted deficit will reach the amount of 235,000 specialists in the year, 2007. Nevertheless, the sectoral wage level is considerably lower than the US and the EU levels in spite of that employee deficit.

Achievements in ICT industry are mainly due to the joint ventures established with foreigners and to techno-parks. For example, there are four foreign-based firms in the top 5 software firms of Turkey, namely Microsoft, IBM Turk, Oracle and SAP Turkey. The only exception in the list is Havelsan with its Turkish military origin (Interpromedya, 2005). In addition, 63 percent of Turkish techno-parks are composed of ICT firms (Güder and Taşçı, 2006, p.11). We can argue that

[21] TBK is the abbreviation of "Türk Bilişim Kurumu (Turkish Informatics Foundation)"

the concept of techno-parks is settled in Turkey with the help of ICT sector and especially of its software sub-sector. Those developments achieved in techno parks depend on two reasons. The first one is National Software Industry Development Project started by TTGV with the help of the United Nations in the year, 1996. The second one is ‘Technology Development Regions Law’ legislated in the year, 2001. That law provides institutional and income tax incentives for firms until the year, 2013. Those incentives include software and R&D based activities. However, techno parks cannot be counted as developed ones relative to those established in developed countries.

In the scope of Turkish S&T policies, ICT and its related technologies have always been important as noted in Chapter 3. For example, the second policy document, namely “Turkish Science and Technology Policy: 1993-2003” indicated ICT as one of the five strategic technologies. In addition, the last policy document, namely “National Science and Technology Policy: 2003-2023 Strategy Document”, has selected ICT as one of the eight strategic technologies as well (Table 3.1). Integrated circuit design and production technologies, image units production technologies, wideband technologies, image sensors production technologies improved for ICT. The technological roadmaps have drawn in the document (TUBITAK, 2004b, pp.77-137). Design and production are of significance especially in micro electronic systems (MEMS) and integrated circuits. Improvements in those technologies can be decisive and create high value added. ICT can provide opportunities in flexible and agile production systems which is required by the whole sectors of industry, particularly by automotive, textile and clothing sectors. However, politics did not pay so much attention to the sectoral technologies like other technologies stated in S&T policy documents. The efforts have stayed limited with some legislations and projects some of which are mentioned above. The lacks of venture and seed capital in technology investments have blocked further developments of ICT sector and techno-parks. On the other hand, some promising developments have occurred. Turkish programmers have reached some capabilities on open-coded software such as Linux. The ever first open coded operating system of Turkey, namely Pardus, prepared and finished in the year, 2006. Gaining capabilities on open-coded software are of importance especially in military and public services. Furthermore, Turkey was considered as one of the top nations in e-government applications after the efforts shown by the several governments by the late 1990's (Darrell, 2001). That might be highly promising for the Turkish S&T efforts if the effective usage of e-government can become widespread among people.

Furthermore, some of the countries that are admitted as successful such as India, Ireland etc., can be a model for Turkey. For example, India has experienced a considerable compound annual growth rate (CAGR) in software sector since the year, 1994. This rate was 37 per cent between the years, 1994 and 2001 and about two times greater than Turkey's rate (Lal, 2001, pp.105-117) (Table 5.3). Similar to Turkey, India completed her communication infrastructure at the beginning of 1990s. Economy policies has continuously liberalised. Among the years 1991 and 1997, Indian government supported the investments on ICT and generally those investments have been made via using public enterprises. The establishments of software technology parks (STPs) and electronic hardware technology parts (EHTPs) have augmented the sectoral exports via using export promotion policies. STPs have acted as a solution provider for software exporting firms. They also provide infrastructure services such as high speed data communication. EHTPs have mainly designated for producing electronic and hardware parts. Those parks have customs and tax incentives up to 50 per cent. Software sector is seen as more successful when we have taken into account the export structure of India. Software production was quadrupled in the year, 1999 (Lal, 2001, p.110). After the year, 1997, FDI have speeded up in the country. More MNEs has entered into Indian market. Tax and custom incentives encouraged investors. Some of the zero import duties on capital goods which was designated to be implemented two or three years later, were brought to earlier dates. The barriers on the way of investors have demolished fastly. Human resources management have taken into attention seriously and private sector, public institutions and universities have educated people with the help of courses begining from six months to five years. Computer and software applications was widely used. The courses have involved wide range of application and expertising areas and they have been appropriate for every kind of user from high level to low level. In line with Indian position, most of the Turkish techno-parks works similar to STPs in India. As stated above, most of techno-parks are mostly effective in software development. Some infrastructure services could be provided to them by the government. In contrast, Turkey has not succeeded in producing hardware. More

FDI-pull policies as promulgated in India should be implemented in this manner. Zero import duties could be afforded to capital goods. Some tax and custom incentives could be implemented as well. R&D support could be provided. MNEs such as Intel and Microsoft could be recalled to manufacture in Turkey via creating required investment-friendly environment and educating appropriate human resources. With its insufficient graduates, Turkey requires more IT experts in the sector. Universities should triple and quadruple their number of students. More IT-related courses such as "Bilge Adam" etc. are required for providing high skilled experts. Computer literacy should also be improved among people via using basic courses in widely accepted software such as MS Office, Windows etc. E-government applications should become widespread for properly and efficiently working government services.

In conclusion, ICT will be indispensable in every aspect of life in the future. With its diffusive effects on every single sector of industry, having competence on ICT will be crucial for a nation in globalising world. Turkish performance on ICT is promising, yet, it is still far behind successful nations of the sector such as India and Ireland. Turkey should apply its S&T policies in higher determination and should prepare some further policies for the future. Instead of respecting to the mercy of international cartels such as Microsoft and Intel, Turkey should take some measures and 'nationalising' seen in the example of 'Pardus' should be supported. Lastly, the growth in the sector should be speeded up by investing higher amounts of seed and venture capitals. Techno-parks should be improved and techno-entrepreneurship should be supported.

5.4 Total Manufacturing Sector

The main aim of capitalist enterprises has always been towards making more profits via increasing productivity. Productivity gains can be generally realized by technological and organizational improvements. For example, Fordism was a kind of organizational improvement which provided huge productivity gains. Hence, Ford could produce 15 million cars in a fifteen-year period between the years, 1908 and 1923; and this amount of car was more than the amount of total cars produced until that organizational change. In addition, CNC machine tools, robotics and automation technologies were considered as technological improvements. Those improvements have provided firms to produce considerably high amounts of products. Flexible production which has been a necessity in fluctuating markets experienced by the world since the crisis of 1970's, could be possible with the help of those technologies. In this scope, technology and innovation were of great importance in survival of capitalism whose history was full of entrepreneurs demanding for technology.

However, the existence of that demand is suspicious for Turkey. The usage of support funds provided by TTGV, TUBITAK and the EU, is quite limited. Turkey can benefit from most of R&D support funds from the EU in the year, 2006. Industrialists do not seem to be interested in those funds. For inquiring this situation, we will analyze the technological structure of Turkish imports and exports and try to find out whether Turkish manufacturing sector is suitable for technology demanding. We will use Lall's (2000d) technology categorizations for attaining this aim. According to Lall (2000d, p.8), sectors in industry is divided into four sub-parts with respect to their R&D intensifications. Those parts are as follows;

- Resource-based (RB): mainly processes foods and tobacco, simple wood product, refined petroleum products, dyes, leather (not leather products), precious stones and organic chemicals.
- Low technology (LT): such as textiles, garments, footwear, other leather products, toys, simple metal and plastic products, furniture and glassware.
- Medium technology (MT): mainly automotive products, most industrial chemicals, standart industrial machinery, and simple electrical and electronic products.
- High technology (HT): fine chemicals and pharmaceuticals, complex electrical and electronic machinery, aircraft and precision instruments (Lall, 2000, p.8).

Table 5.5 divides Turkish manufacturing sectors stated in TUIK statistics[22] into the sectoral groups stated above.

[22] TUIK sectoral export and import statistics. Sectors are classified according to ISIC, Rev.3.

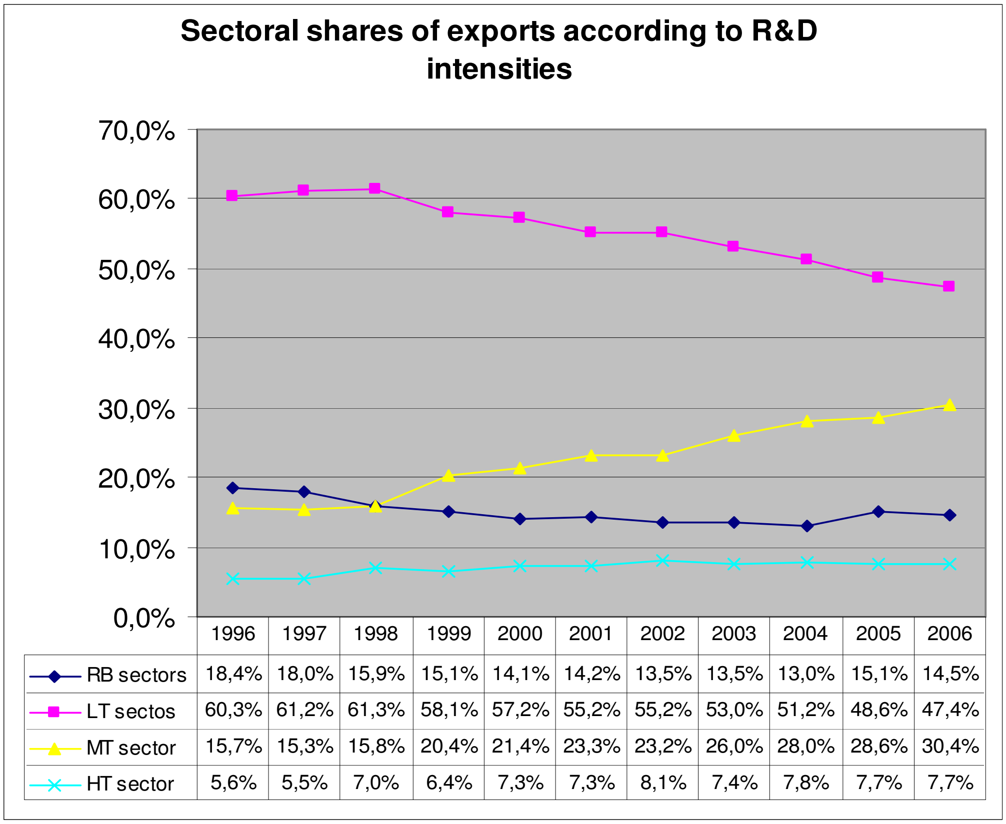
Table 5.5 Turkish Manufacturing Sectors according to their R&D intensification.[23]

Turkish Manufacturing sectors			
Resource-based	**Low technology**	**Medium Tech.**	**High Technology**
Food products and beverages	Textile	Chemicals and chemical products	Electrical machinery and apparatus
Tobacco	Wearing apparel	Machinery and equipment	Communication and apparatus
Wood and cork products	Luggage, saddlery and wood wear	Office, accounting and computing machinery	Medical, precision and optical instruments, watches
Paper and paper products	Printing and publishing	Motor vehicles and trailers	
Coke, petroleum products and nuclear fuel	Rubber and plastic products	Other transportation	
Other non-metallic minerals	Manufacturing of basic metals		
	Manufacturing of fabricated metal products		
	Furniture		

After having presented the sectoral classification, we are ready to investigate technological intensification of Turkish manufacturing. Figure 5.8 depicts Turkish exports according to sectoral groups stated in Table 5.5. Low technology (LT) sectors consists of nearly half of Turkish manufacturing exports even though there seems to be a tendency of decreasing in their shares in the last decade. Textile sector which is in the second place among the exporter sectors plays the main role in the lead of LT sectors and takes half of the exports with a volume of 19 billion USD in the year, 2006 (Appendix A). In addition, the decreasing tendency of LT is depended on the export boom of medium technology (MT) sectors provided by its sub sectors, namely automotive and machine-equipment sectors. Those sectors have realized nearly 18 billion USD of exports in the year, 2006. Hence, MT sectors have

[23] Classification has been made by the authors.

increased their sectoral shares continuously and have reached a considerable amount of 30,4 percent in the year, 2006.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
RB sectors	18,4%	18,0%	15,9%	15,1%	14,1%	14,2%	13,5%	13,5%	13,0%	15,1%	14,5%
LT sectos	60,3%	61,2%	61,3%	58,1%	57,2%	55,2%	55,2%	53,0%	51,2%	48,6%	47,4%
MT sector	15,7%	15,3%	15,8%	20,4%	21,4%	23,3%	23,2%	26,0%	28,0%	28,6%	30,4%
HT sector	5,6%	5,5%	7,0%	6,4%	7,3%	7,3%	8,1%	7,4%	7,8%	7,7%	7,7%

Figure 5.8 Sectoral shares of exports according to R&D intensity

Source: TUIK Statistics (2007)

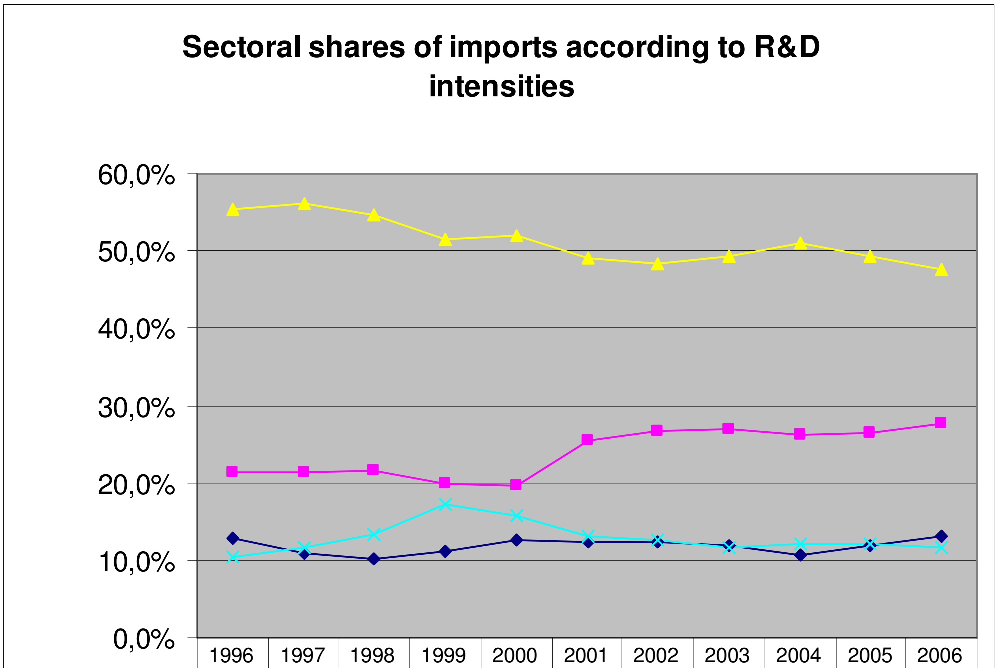
In spite of the slight decrease in the share of RB sectors, those sectors have boosted their export performance and have reached three and a half times more exports with respect to the year, 1996. Particularly, coke and petroleum products have made considerable contribution to this export boom. The export in those products reaches from 260 million USD to 3.4 billion USD. (Appendix A) However, the export performance of MT sectors has increased faster than the RB sectors. MT sectors have increased their export volume from 3 billion USD to 24 billion USD while RB sectors started the nearly same amount but reached only 11 billion USD in the year, 2006. This is the main reason behind that slight decrease.

High technology (HT) sectors have experienced a slight increase in their sectoral shares. Its share was 5,6 percent in the year, 1996 and it has increased to 7,7 percent in the year, 2006. Even though, this is equal to 38 percent of sectoral share increase in the last decade, those sectors have remained as negligible in export structure of Turkey. Electrical machines and communication apparatus are of 3 billion USD export volume per each. However, communication apparatus has grown two times faster and has reached from 300 million USD to 3 billion USD in a ten-year period (Appendix A). The widening of mobile phones and spreading GSM technologies have supported this trend.

In general, Turkey's exports are mainly in low R&D intensified sectors. 62 percent of Turkish exports belong to resource based and low technological areas of specialization. However, that share decreases from the amount of 80 percent to 62 percent in a ten-year-period between the years, 1996 and 2006. The main reason behind that reality is the high performance of medium technology sectors related to automotive and machine and equipment sectors. Those sectors have grown ten times from 2 billion USD to 20 billion USD in total while the main driving force of LT sectors, namely textile and clothing, has increased from 8 billion USD to 20 billion USD (Appendix A). This could be considered as a catching-up process, however, mentioned structure still infers a kind of "developing" or a "latecomer" position for Turkey instead of a developed one with its basis on RB and LT sectors.

After having evaluated Turkish export structure, we will analyze Turkish import structure by using the same method. Figure 5.9 depicts Turkish imports according to sectoral groups stated in Table 5.5.

Medium-technology (MT) sectors have played the main role in imports. Nearly half of Turkish imports belong to those sectors in spite of a considerable decrease experienced in the last ten-year period. The leading of MT sectors can be related to intermediate goods imports needed for automotive industry of which export success is maintained in the expense of high imports and chemicals and its products. Intermediate goods imports have doubled in the last four years as seen from Figure 5.3. Turkish trade deficit in automotive explicitly supports this claim (Figure 5.1). Furthermore, liberalization of the economy, customs union agreement and more opportunities in automotive trade have made contributions to those imports. In the context of chemicals and its products, Turkish imports have reached from 6 billion USD to 19 billion USD; hence, have tripled in the last decade (Appendix B). Chemicals and its products have given the biggest trade deficit among all the sectors. This sector should be examined; however this is not the subject of this thesis.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
RB sectors	12,9%	11,0%	10,2%	11,3%	12,6%	12,4%	12,5%	11,9%	10,7%	12,0%	13,1%
LT sectors	21,4%	21,4%	21,6%	20,0%	19,8%	25,4%	26,6%	27,0%	26,3%	26,6%	27,7%
MT sectors	55,4%	56,0%	54,7%	51,6%	51,9%	49,1%	48,3%	49,4%	50,9%	49,3%	47,6%
HT sectors	10,4%	11,6%	13,4%	17,2%	15,7%	13,0%	12,5%	11,7%	12,1%	12,1%	11,6%

Figure 5.9 Sectoral shares of imports according to R&D intensity
Source: TUIK Statistics (2007)

Low-technology (LT) sectors have increased their shares from the beginning of the year, 2001, in which a sharp increase was experienced. Surprisingly, the main reason in that import boom is not textile and clothing sector. The truth behind that reality is a sharp increase in the imports of manufactured basic metals. Its import volume is about eight times greater than the year, 1996, and has reached nearly 17 billion USD in the year, 2006. Possibly, raw materials for the automotive sector boost the sectoral imports. In addition, Chinese competitive advantages in costs have made some contributions to that sectoral performance.[24] There is no significant increase seen in other sectors.

Resource-based (RB) sectors have been stagnant in their sectoral shares in the last decade. Those sectors have the average of 12 percent in imports which is a little less from the export share percentage. Petroleum products have taken the lead in that sectoral category with an amount of 7.3 billion USD import, in the year, 2006. If Turkey's dependence on foreign energy resources can be lowered via developing renewable energy technologies and hydrogen technologies as targeted in the last policy document, namely "National Science and Technology Policy: 2003-2023 Strategy Document", Turkey will reduce a considerable amount of its trade deficit.

High-technology (HT) sectors have been stagnant except the year, 1999, in which they reached a peak with 17 percent. Its average value is about 14 percent and this share is two times greater than the sectoral export value. Electrical machinery and apparatus sector and communication and apparatus sector imported nearly the same amount of volumes with five billion USD per each in the year, 2006, and made Turkey give trade deficits about two billion USD per each. (Appendix B)

In general, nearly 60 percent of Turkish imports belong to R&D intensified sectors in which MT sectors take the main part. Those sectors (MT+HT) have experienced a slight decrease from 65 percent to 60 percent in the last decade. It is a quite low decline relative to the mentioned situation about export share decreases of RB and LT sectors. Similar to the export structure, Turkish import structure infers a developing country or a latecomer model while taking into consideration the high amount of technology intensive sectors' (MT+HT) imports.

After having analyzed the structure of Turkish manufacturing sector according to R&D intensification, we can conclude that Turkey exports low technology intensified goods and imports technology intensified ones. This is obviously a developing country position in global trading. Generally, Turkey exchanges its low-value added products with high value-added ones in global value chain. Some scholars might object this argument by taking into consideration the rise in MT products, however, we defend the claim that the rise is mainly due to the imports of intermediate goods. It is a fact that although total value-added produced in

[24] China shows a considerable performance in metal manufacturing recently and have become the biggest manufacturer in metal sectors.

the sector is slightly increased, this amount cannot be compared with the increase in intermediate goods imports (Figure 5.3). This is also a proof of low R&D-intensified sectoral position.

Therefore, demand for technology is naturally low in Turkey while taking into consideration the scarcity of R&D intensification in Turkish industrial structure. The awareness of industrialists for R&D and cultural traditions can make some contributions to this scarcity. Thus, we cannot suppose the effective usage of R&D funds provided by different resources such as EU, TUBITAK and TTGV since that lack of demand exists among the industry as a whole.

In the scope of S&T policy documents, Turkish S&T policies cannot succeed in creating technology demand. This is another point to consider in S&T policy-making processes of the future. Even the last and most contemporary policy document, namely namely "National Science and Technology Policy: 2003-2023 Strategy Document", has not suggested any policies towards increasing technology demand. The importance of university-industry interaction and public procurement policies is emphasized. Undoubtfully, the improvements on the technologies stated in the document could make a path for technology demanding, the way for more demands from the industry should be more clearly identified. Guided R&D projects may be one of the solutions to this problem, however, how the number of guided projects will be increased is not clear in the document.

Finally, Turkey is a country which consumes more than she produces. In this manner, Turkey has high amount of trade deficits (55 billion USD in the year, 2006) and finance that deficit via using foreign investment most of which is indirect and not towards producing goods and services. Speculative capital has reigned the country. Turkey does not seem to sustain this economic structure for a long time while taking into attention the possible risk of decreasing global capital amount and investments. Hence, Turkey should orient her economy to more production intensive activities. Manufacturing sector has a key role in this manner in the future. Only high value-added manufacturing sector could provide higher life standards to the nation. High value-added is a result of R&D intensified manufacturing processes. By the way, Turkey should make some policies for growing her manufacturing sector and creating a technology demand within the sector. The growth of sector could be realized by more investments and more convenient macro-economic environment for producing instead of importing, servicing or trading. The demand for technology could be provided by more capital accumulation. Turkey should create an economy in which investors has more chance to earn reserves when they invest on R&D and technology instead of evaluating their capital on shareholding or financial markets. Investments should direct towards to the R&D intensified manufacturing sectors for the sake of the nation.

5.5 Conclusions

In this chapter, we have analyzed two important sectors of Turkey, namely, automotive and textile-clothing industries and a promising one; namely Information and Communication Technologies sector. In addition, we have examined the technological structure of Turkish manufacturing sectors as a whole according to their R&D intensifications. We have intended to find out Turkish current situation to guide us in making science and technology recommendations. Some of our findings and suggestions are stated below;

Firstly, Turkey continuously increases its foreign trade volume in automotive industry. Although Turkey has trade deficit in the sector, deficit-total trade ratio has decreased considerably (Figure 5.4). Turkey has gained considerable ‘know-how’, especially, in production. However, Turkish total value-added is low in automotive industry because of the scarcity in design and design verification processes and of the high amount of intermediate goods imports. Turkey should increase the value-added via taking more action in automotive designing and investing in crucial future technologies. We have suggested fuel cell and boron technologies for future of the industry. In the content of science and technology policy, we strongly defend the claim that those technologies are strategic technologies. The last policy document of Turkey, namely “National Science and Technology Policy: 2003-2023 Strategy Document”, has taken into consideration those technologies and selected as strategic. We suggest that the roadmaps drawn in the document should be implemented in a disciplined manner. In addition, a more realistic exchange rate and domestic intermediate goods production are required for the purpose of increasing total value-added in the sector.

Second, Turkey has benefited from being a low wage economy in textile and clothing industry until now. However, this trend has begun to be collapsed for three main reasons. First of all, the sector cannot compete with cheaper Indian and Chinese products. The lack of a brand name is recognized. In addition, the over-valued YTL inhibits the exporting capabilities. Finally, mechanization and modernization efforts are not sufficient and Turkey is about to loose its position which was taken from Italy ten years ago. For removing those incapabilities, the productivity level should be supported by further mechanization and modernization efforts and T&C sector should intensify in designing and marketing processes. Some macro economic tools should be used for removing pressure on the sector applied by the actual exchange rate regime. In the scope of technology policies, more value-added designing activities, further mechanization and having own brand names could be advised in the sectoral level; however those advices could find a place in the policy documents of Turkey. The precautions and strategies offered in the last DPT report (Öngüt, 2007, pp.131-142) should be implemented in a planned manner for the sake of the sector (Section 5.2).

Third, ICT sector is fastly growing in Turkey with the help of infrastructure investments made during 1980's. That successful growth performance has been generally realized via techno-parks. There were two successful technology policies implemented while attaining that success. 'National Software Industry Development Project' and 'Technology Development Regions Law' are two good examples which can be rarely seen in Turkish S&T policy efforts. We have concluded that whether the sector can be supported via sufficient seed and venture capital investments, Turkey will be effective in those technologies of 21st century. Indian ICT development experiences could draw a path in this context.

Lastly, we have investigated the existence of technology demand which is the driving force of all industries. We have found that Turkish R&D intensification is quite-limited in the manufacturing sector. Turkey exports resource-based, low and medium technology products while importing medium and high technology ones. Exported MT products are composed of high amount of intermediate goods imports although the sharp increase experienced for ten years infers a catching-up process. Hence, Turkish industry does not seem to have sufficient need for technology. This situation can be considered as the proof of unwillingness while demanding technology. As having mentioned in Akarsoy (2002a, p.12), the industrialists prefer to transfer technology instead of making R&D or coordinating with universities. In the scope of S&T policies, all policies of Turkey strongly aimed to produce R&D intensified products. In this context, those policies generally seem to fail. The main target of technology policy making should be transformation of the mentioned structure into an R&D-intensified industry level in the future.

CHAPTER 6

CONCLUSION

The aim of this dissertation is to summarize Turkish science and technology policy making efforts, to examine their implementations, to find out their reflections into the Turkish industry as a whole and to make some policy recommendations according to the findings of the study.

Firstly, we discussed the history of Turkish S&T policies prepared in the last 25 years. Turkey succeeded in policy making and made three documents, namely "Turkish Science Policy: 1983-2003" (1983), "Turkish Science and Technology Policy: 1993-2003" (1993) and "National Science and Technology Policy: 2003-2023 Strategy Document" (2003), respectively. However, the implementations of those documents were not promising. After the first policy document, there was no noticeable action taken place. Even the most important decision-the establishment of BTYK- stated in the document, was firstly convened six years later from its establishment decision. Among the years 1983 and 1993, Turkey lost its very precious time when 'the rule of the game' was changing and information and communication technologies (ICT) were spreading all over the world. Second document was prepared according to the requirements of contemporary policies. However, this document's implementation was limited as well. The convention of BTYK meetings was not carried out periodically. Even though some progresses such as establishment of techno-parks, the increasing awareness about S&T among the whole society and the success in scientific publications were experienced, the second document missed most of its goals. The establishment of 'National Innovation System' was firstly put on the agenda in the 3rd BTYK meeting taken place in the year, 1997. This led to the emergence of a requirement for a brand new policy. In this perspective, the decision of preparing a new technology policy document based on a foresight study was taken in the 6th meeting of BTYK. Hence, 'Vision 2023 Project' prepared by the wide participation of public and private agents and a bottom-up strategy was implemented to attaining such aims. The technology foresight studies were carried out via making 192 conventions, 36 workshops and two-rounded DELPHI surveys. Then, strategic technology areas and related technologies were determined and reflected into the last policy document. However, those underpinning technologies are too broad and it is difficult to implement for a developing country such as Turkey. We criticized that broader perspective because Turkey is of scarce resources and a purification of those strategic technologies should be made in a more realistic manner. For future studies, we strongly argue that those studies should contain fewer technological areas of specialization. In contrast, the last technology document drew a path for establishing a national innovation system in line with evolutionary economics in a successful manner. Its recommendations based on systemic coherence compensated the requirements of contemporary S&T documents. Hence, it is considered as a successful one. However, we have determined that Turkish NIS is newly flourished and the most important contribution can be made via increasing the number of researches instead of reserving more funds to R&D. Turkey's problem seems to be the scarcity of research projects while we have taken into consideration the unused funds provided by TUBITAK, TTGV and EU. In line with Teubal's arguments, this is a result of NIS which cannot reach sufficient volume for effectively producing research projects. Future studies should give more emphasis on increasing the number of R&D projects. Guided projects and public procurement should be examined in a broader way. In this chapter, we also criticised DPT which has not completely taken into account the suggestions of the last policy document. Interestingly, DPT has not referred to this document in its interim plans and Ninth Development Plan. This situation lowered the implementation possibility of this document. Future documents should solve the problem of disparity between TUBITAK and DPT. Thus, we summarize the destiny of Turkish S&T policy documents in a word chain: "Make it- Do not apply- Revise it- Do not apply- Remake it- Do not apply". This unsuccessfulness in implementation process has mainly depended on the lack of political and administrative responsibilities, the collaboration of institutions, the demand in the industry, strategic planning and future projection.

Second, we analyzed Turkish S&T indicators determined in S&T policy documents such as ‘percentage of GERD (Gross Domestic Expenditure in R&D) in GDP (Gross Domestic Product)’, ‘the number of R&D personnel’, ‘the distribution of GERD between business enterprise and government’ and ‘world ranking of Turkey in ISI’. Turkey is behind the desired values except for scientific publications and Turkey’s World ranking in ISI. GERD in GDP ratio is about 0,7 per cent and it is insufficient. The private share in GERD has decreased for four years and is about 25 per cent of the whole industry. This is in parallel with the scarcity of technology demand found in Section 5.4. Turkish private sector generally are not at technology demanding level. However, this situation can be defined as normal while taking into account Turkish developing country position in global economy. As stated in the last document, normally developing countries such as Turkey can benefit from public R&D and universities at the beginning of their take-off position. Nevertheless, future policies should find out the way in which Turkey could allocate more resources to R&D. In the comparison section of the chapter, Turkey seems to be behind the developing countries and far behind the developed ones. Since the industry-university collaboration is weak, Turkey fails into taking patens. Turkish success in scientific publications has not reflected into patent numbers. This is another proof of low R&D-intensified industrial structure. It is another indicator of slight impact of Turkish publications. The citations are not sufficient. Future studies should take into account the quality of scientific publications. Those documents should give more emphasis on quality rather than quantity. Academic advancements should be made according to quality and impact factor in SCI. The significance of quantity should be lowered.

Third, we intended to make a sectoral investigation of Turkey. Automotive sector and textile and clothing sector were selected for their export performances and ICT for its promising nature for the future. Turkey has gained considerable know-how in automotive sector, especially in production. However, Turkey’s capabilities are quite-limited in design and design verification processes. Value-added is low because of the high amount of intermediate goods imports in the sector. Turkey loses its reserves in spite of its high foreign trade volume. Turkey fails in R&D-intensive activities and as a result, Turkish S&T policies whose objective is to create R&D based activities within the country, has not succeeded sufficiently. Furthermore, we strongly recommended fuel cells and boron technologies for the future of the sector. The advancements in those technologies may help Turkey to create higher amount of value-added in order to lessen its trade deficit. More technology specific policies should be made and in this context, Turkey should document a broader policy for fuel-cells and boron technologies for advancing in future. In T&C industry, Turkey benefits from its low wage economy. More design intensive activities, brand making and collaboration with foreign networks were suggested. Contemporary technologies such as technical textile and textile chemicals were seen as future technologies of the sector. Sectoral policy advices stated in the last DPT report were generally agreed upon for the sake of the sector. Giving 50 million USD per firm is a radical policy suggestion that we have strongly agreed upon. In addition, ICT sector has fastly grown in Turkey. Joint ventures and foreign shares are of considerable importance in this performance. Newly established techno-parks have contributed to this trend. However, the lack of venture and risk capital has been seen in the sector. In the scope of S&T policies, 'National Software Industry Development Project' and 'Technology Development Regions Law' can be considered as two successful policy implementations that cannot experience in other sectors. Hence, those policies could be extended in future policy documents for further developments. ICT has always been depicted as a strategic technologies and was emphasized in the policy documents, thus we can argue that the most successful policy implementations have been realized in that sectoral level. The ongoing trend in the world has contributed to this success. Lastly, we analyzed the Turkish manufacturing sector via using Lall's technology categorization method and we intended to find out R&D intensification of Turkish manufacturing. We resulted that Turkey generally exports resource-based, low technology and medium technology goods and imports medium and high technology ones. This seems to be as a latecomer or developing country position although the fast increase realized in medium technology exports infers a sign of a catching-up process. In the scope of S&T policy documents, their objective is always to develop Turkish R&D base and to orient country towards high value-added, technology-intensified products. In this manner, those documents seem to fail since the sectoral transitions from low technology goods to high technology goods have not been realized, yet. These arguments also explain why the industry does not demand for technology. The competitiveness is maintained from low-technology intensive goods and Turkey exports considerably low volume of high technology goods. In this perspective, naturally industry does not seem to have any inclination towards making high- tech R&D. High-tech industry should be improved via using public procurement and guided projects in military technologies and promising technologies such as boron, hydrogen and fuel cell technologies.

In summary, Turkey has not fully exploited its S&T policies. The problem of Turkey is not the absence of S&T policies; however the main defect is the lack of political authority and responsibility, collaboration among institutions. An incompatibility between TUBITAK and DPT has explicitly seen in this context. Although BTYK seems to work more efficiently in last years, it is clearly seen this council has some difficulties in the implementation processes of the policy documents. TUBITAK, BTYK and DPT are three agents that have responsibility in policy making, however their coordination and collaboration is under suspicion. BTYK is seen as the decision-maker while TUBITAK is a policy-maker and DPT is as a plan maker. The solution can be to give the responsibility to only one agent and integrate policy-making and decision-making processes in the future. The agent can be none of the mentioned one; however one of its features should be autonomy. As a latecomer, Turkey should not loose much more of its precious time because of the lack of coordination. As discussed on the former chapters, there is much more to do for ‘reaching and passing the contemporary nations’, and the current situation is far away from this objective of the Republic targeted by the founder of the country, namely M. Kemal Atatürk.

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APPENDICES

APPENDIX A

SECTORAL EXPORTS ACCORDING TO R&D INTENSITY

EXPORTS	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Resource-Based Sectors (x1000 USD)											
Food&Beverages	2 455 094	2 734 175	2 356 634	2 039 929	1 835 504	2 016 235	1 880 733	2 649 558	3 349 424	4 271 660	4 335 418
Tobacco	95 111	118 231	68 388	83 331	123 056	81 052	99 719	89 833	78 045	121 787	181 514
Prod. of Wood-Cork	68 537	75 108	71 015	68 496	63 049	109 402	118 478	145 984	203 728	249 941	334 558
Paper-paper prod.	125 667	154 163	150 018	148 674	164 294	241 729	302 575	367 209	457 442	559 167	601 191
Coke-Petroleum prod. Nuclear fuel	259 199	179 059	240 626	315 195	300 716	416 421	670 126	953 544	1 364 348	2 518 943	3 401 615
Other Non-Metalic Minerals	780 908	931 944	944 522	957 312	1 121 223	1 231 260	1 467 603	1 800 400	2 317 150	2 686 826	2 794 998
Sectoral Total	3 784 516	4 192 681	3 831 202	3 612 938	3 607 841	4 096 098	4 539 233	6 006 528	7 770 137	10 408 325	11 649 293
Sectoral Share	0,1844	0,1798	0,1592	0,1508	0,1414	0,1421	0,1347	0,1353	0,1304	0,1513	0,1452
Low Technology Sectors (x1000 USD)											
Textile	3 817 823	4 450 117	4 794 000	4 557 626	4 614 078	4 943 497	5 532 758	6 841 165	7 998 061	8 742 704	9 263 210
Wearing apparel	4 829 702	5 442 138	5 715 620	5 270 104	5 417 141	5 397 509	6 615 232	8 153 895	9 340 151	9 924 749	10 170 965
Luggage, saddlery, footwear	220 876	299 168	271 494	180 893	189 515	211 786	214 188	285 836	327 960	370 192	436 181
Printing&Publishing	47 725	40 112	40 819	47 624	42 645	42 737	48 737	66 989	82 146	105 048	107 107
Rubber-Plastic prod.	510 218	621 233	685 440	667 851	781 451	940 519	1 084 530	1 464 382	1 958 873	2 485 789	3 014 335
Manuf. of Basic Metals	2 233 719	2 597 253	2 197 973	2 063 810	2 247 065	2 921 211	3 239 350	3 884 446	6 815 628	6 887 671	9 329 798
Manuf. of Fabricated Metal Prod	461 909	522 021	664 303	647 923	660 770	733 472	932 339	1 503 095	2 199 705	2 684 603	3 346 496
Furniture	249 247	299 949	378 723	487 083	631 033	718 910	944 864	1 314 580	1 771 206	2 238 104	2 353 440
Sectoral Total	12 371 219	14 271 991	14 748 372	13 922 913	14 583 697	15 909 641	18 611 998	23 514 387	30 493 729	33 438 860	38 021 530
Sectoral share	0,6027	0,6122	0,6129	0,5811	0,5715	0,5519	0,5523	0,5299	0,5118	0,4859	0,4740

APPENDIX A-continued

Medium Technology Sectors (x1000 USD)											
Chemicals and its products	**1 244 289**	**1 362 510**	**1 277 470**	**1 234 778**	**1 397 489**	**1 480 503**	**1 580 672**	**1 926 341**	**2 556 412**	**2 818 310**	**3 479 174**
Machinery& equipment	**828 739**	**1 000 337**	**1 107 452**	**1 211 737**	**1 375 956**	**1 564 386**	**2 077 511**	**3 118 511**	**3 913 354**	**4 865 027**	**6 001 657**
Office-Account-Comp. Machinery	**21 287**	**28 863**	**42 619**	**60 038**	**63 096**	**52 468**	**39 665**	**40 822**	**52 137**	**69 500**	**88 311**
Motor Vehicles &Trailers	**975 877**	**879 948**	**1 049 170**	**1 614 792**	**1 745 046**	**2 656 691**	**3 602 800**	**5 436 950**	**8 812 615**	**10 226 102**	**12 676 588**
Other Transportation	**155 051**	**302 558**	**315 022**	**770 888**	**882 097**	**948 202**	**528 738**	**1 037 310**	**1 348 708**	**1 706 833**	**2 139 168**
Sectoral Total	3 225 242	3 574 216	3 791 734	4 892 233	5 463 683	6 702 251	7 829 387	11 559 934	16 683 226	19 685 772	24 384 899
Sectoral Share	0,1571	0,1533	0,1576	0,2042	0,2141	0,2325	0,2323	0,2605	0,2800	0,2861	0,3040
High Technology Sectors (x1000 USD)											
Electrical Mach.&Appratus	**771 656**	**743 381**	**755 875**	**692 201**	**825 248**	**1 038 402**	**1 057 077**	**1 220 629**	**1 575 589**	**1 932 751**	**2 821 066**
Communication &appratus	**316 493**	**469 534**	**862 119**	**770 693**	**961 870**	**1 002 269**	**1 574 973**	**1 947 749**	**2 883 024**	**3 150 196**	**3 085 322**
Medical, Precision, Optical inst., watches	**56 633**	**60 997**	**75 284**	**66 834**	**75 201**	**77 352**	**88 978**	**129 203**	**173 412**	**197 504**	**243 671**
Sectoral Total	1 144 783	1 273 913	1 693 278	1 529 729	1 862 319	2 118 024	2 721 028	3 297 581	4 632 025	5 280 451	6 150 059
Sectoral Share	0,0558	0,0546	0,0704	0,0639	0,0730	0,0735	0,0807	0,0743	0,0777	0,0767	0,0767
TOTAL EXPORT	20 525 761	23 312 800	24 064 586	23 957 813	25 517 540	28 826 014	33 701 646	44 378 429	59 579 116	68 813 408	80 205 782

Source: TUIK Statistics (2007)

APPENDIX B

SECTORAL IMPORTS ACCORDING TO R&D INTENSITY

IMPORTS	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Resource-Based Sectors (x1000 USD)											
Food&Beverages	2 008 674	1 761 543	1 452 923	1 050 013	1 155 976	1 014 090	1 361 941	1 633 972	1 904 016	2 114 179	2 438 804
Tobacco	34 093	41 838	51 882	45 796	42 543	39 811	45 829	57 967	73 331	93 459	84 064
Prod. of Wood-Cork	124 865	140 368	164 238	132 407	207 367	106 325	152 907	240 601	399 376	587 490	680 134
Paper-paper prod.	836 543	836 726	860 278	897 767	1 151 604	784 652	1 007 486	1 318 664	1 712 198	2 009 864	2 315 859
Coke-Petroleum prod. Nuclear fuel	1 069 313	1 152 288	966 812	1 284 292	2 587 096	1 798 718	2 191 325	2 832 696	3 796 784	5 506 507	7 373 575
Other Non-Metalic Minerals	459 100	437 767	497 505	411 066	428 021	324 606	411 665	515 594	717 495	1 008 772	1 414 030
Sectoral Total	4 532 588	4 370 530	3 993 638	3 821 341	5 572 607	4 068 202	5 171 154	6 599 493	8 603 200	11 320 272	14 306 466
Sectoral Share	0,1287	0,1098	0,1023	0,1126	0,1261	0,1245	0,1250	0,1185	0,1069	0,1202	0,1309
Low Technology Sectors (x1000 USD)											
Textile	1 882 445	2 036 637	2 004 267	1 645 807	1 852 729	1 682 881	2 500 459	3 094 036	3 786 308	3 974 375	4 203 496
Wearing apparel	191 460	276 456	248 587	185 663	266 365	277 062	346 017	449 987	601 557	693 695	959 467
Luggage, saddlery, footwear	348 326	358 693	306 502	205 401	312 240	269 297	331 492	436 904	618 572	839 113	1 053 919
Printing&Publishing	133 045	157 812	159 356	156 394	250 786	219 565	199 765	250 571	282 243	405 008	375 056
Rubber-Plastic prod.	820 326	888 741	984 715	892 034	1 038 630	813 097	1 073 716	1 433 546	1 941 047	2 140 352	2 559 899
Manuf. of Basic Metals	2 796 056	3 313 228	3 140 745	2 390 383	3 534 475	3 612 013	4 707 450	7 303 544	11 083 551	13 682 666	16 854 642
Manuf. of Fab. Metal Prod	915 381	977 334	1 033 823	834 850	872 787	871 031	1 085 202	1 132 588	1 573 605	1 943 001	2 428 279
Furniture	436 331	524 402	541 423	463 992	607 571	555 919	773 370	960 234	1 248 429	1 372 318	1 816 058
Sectoral Total	7 523 369	8 533 303	8 419 418	6 774 525	8 735 583	8 300 865	11 017 470	15 061 410	21 135 312	25 050 528	30 250 816
Sectoral share	0,2137	0,2144	0,2157	0,1996	0,1976	0,2540	0,2662	0,2705	0,2627	0,2659	0,2769

APPENDIX B – (continued)

Medium Technology Sectors (x1000 USD)											
Chemicals and its products	**6 397 827**	**7 151 764**	**7 197 127**	**6 846 332**	**8 083 680**	**6 775 274**	**8 660 577**	**11 238 032**	**15 134 359**	**17 477 334**	**19 442 570**
Machinery&equip.	**7 468 793**	**7 992 315**	**7 678 273**	**5 065 188**	**5 837 874**	**4 936 880**	**6 474 241**	**8 141 311**	**10 362 811**	**12 209 659**	**14 172 464**
Office-Account-Comp. Machinery	**775 581**	**913 521**	**1 063 009**	**1 206 934**	**1 594 845**	**781 781**	**987 755**	**1 212 504**	**1 766 804**	**2 464 707**	**2 776 403**
Motor Vehicles &Trailers	**3 084 923**	**4 397 831**	**4 142 458**	**3 355 281**	**5 965 641**	**2 206 124**	**2 918 481**	**6 410 789**	**11 795 945**	**12 331 890**	**13 192 399**
Other Transportation	**1 769 052**	**1 844 353**	**1 285 060**	**1 031 851**	**1 474 392**	**1 360 305**	**961 052**	**524 422**	**1 890 129**	**1 926 651**	**2 448 235**
Sectoral Total	19 496 176	22 299 784	21 365 927	17 505 585	22 956 432	16 060 365	20 002 105	27 527 059	40 950 048	46 410 241	52 032 070
Sectoral Share	0,5538	0,5603	0,5475	0,5158	0,5194	0,4914	0,4833	0,4943	0,5090	0,4926	0,4762
High Technology Sectors (x1000 USD)											
Electrical Mach.&Appratus	**1 221 605**	**1 472 298**	**1 652 608**	**1 565 755**	**1 601 295**	**1 220 949**	**1 701 095**	**2 035 752**	**3 175 125**	**4 206 593**	**4 940 940**
Communication &appratus	**1 391 388**	**1 943 514**	**2 353 682**	**3 145 142**	**3 993 720**	**2 035 077**	**2 335 704**	**3 029 337**	**4 530 053**	**4 604 731**	**4 865 205**
Medical, Precision, Optical inst., watches	**1 042 060**	**1 182 868**	**1 239 656**	**1 123 478**	**1 340 605**	**1 000 645**	**1 155 501**	**1 436 715**	**2 053 564**	**2 615 889**	**2 860 065**
Sectoral Total	3 655 053	4 598 679	5 245 946	5 834 376	6 935 619	4 256 670	5 192 301	6 501 804	9 758 742	11 427 213	12 666 210
Sectoral Share	0,1038	0,1155	0,1344	0,1719	0,1569	0,1302	0,1255	0,1168	0,1213	0,1213	0,1159
TOTAL EXPORT	35 207 187	39 802 296	39 024 930	33 935 827	44 200 242	32 686 102	41 383 030	55 689 766	80 447 302	94 208 255	109 255 563

Source: TUIK Statistics (2007)

APPENDIX C

A BRIEF SUMMARY OF TURKISH DEVELOPMENT PLANS IN THE SCOPE OF S&T POLICIES

FIVE YEAR ECONOMIC DEVELOPMENT PLANS	GERD of GDP	R&D PERSONNEL	FOUNDATIONS	OTHER IMPORTANT DEVELOPMENTS
The First Five Year Economic Development Plan(1963-1967) [25]	Increasing Gross Domestic Expenditure on R&D (GERD) to nearly 0.6% of GDP until 1967.	Increasing number of the public sector's R&D personnel from 465 to 1400.	Scientific and Technical Research council of Turkey (TUBITAK) was founded. Also, the purpose of Founding an Economic and Social Research Center.	Developing research and development activities of private sector. Sending 3000 students to abroad for doctorate education.
The Second Five Year Economic Development Plan(1968-1972) [26]	Increasing Gross Domestic Expenditure on R&D to nearly 0.6% of GDP of Turkey	Applying new wage and research financing system to academic personnel	Marmara Research Center (MAE) and Construction Research Center were founded.	Sending 3000 students to abroad for their doctorate education. Increasing the number of projects that have important roles on Turkish economic development

[25] OECD, Ulusal Bilim ve Teknoloji Politikası Raporu, OECD: 1995. (p.9)

[26] i.b.i.d. (p.10)

The Third Five Year Economic Development Plan(1973-1977) [27]	There were not any new targets.	Giving an important duty to TUBITAK for educating academic personnel in Turkey or abroad.	There were not any new foundations.	Transferring the technology & Getting started graduate and doctorate programs on basic sciences and engineering of universities
The Fourth Five Year Economic Development Plan(1979-1983) [28]	There were not any new targets.	There were not any new targets.	Establishing "The Supreme Council For Science and Technology" (BTYK) and "Higher Education Council"(YOK).	That plan criticized TUBITAK's insufficiencies about "connecting system of science and technology with the economic development plans" and "insufficiencies in establishing relations with industry"
The Fifth Five Year Economic	There were not any new targets.	There were not any new targets.	Founding Centers of Excellence in	A Science and Technology Master Plan will

[27] i.b.i.d. (p.10)

[28] i.b.i.d. (p.10)

Development Plan(1985-1989) [29]			some Basic and Applied Sciences.	be prepared on the basis of "1983-2003 Turkish Science Policy". Defining target sectors in which R&D activities will be applied first.
The Sixth Five Year Economic Development Plan(1990-1994) [30]	Increasing Gross Domestic Expenditure on R&D to 1% of GDP of Turkey	Increasing the number of R&D personnel to 15 per 10000 labor force.	Founding an information center that would include technological information from Turkey and abroad. Turkish Sciences Academy was founded. Supporting the establishment of Techno-parks.	Forming a R&D fund Developing relations between Industry-University- Public R&D institutions

[29] DPT, Besinci Bes Yıllık Kalkinma Plani 1985-1989, T.C. DPT Yayın No: DPT: 1974, Ankara: 1984. (p. 159)

[30] DPT, Altıncı Bes Yıllık Kalkinma Plani 1990-1994,T.C. DPT Yayın No: DPT: 2174, Ankara: 1989. (pp.309-311)

The Seventh Five Year Economic Development Plan(1996-2000) [31]	There were not any new targets.	Upgrading the ability of Science and Technology. Educating sufficient human resources for science and technology projects.	Founding the Technology Development & Support Centers and techno-parks	Providing possibility for industry to use Flexible Production-Flexible Automation Technologies. National Defense Industry must be developed. Starting to be used Telematic Services Network in all sectors.
The Eighth Five Year Economic Development Plan(2001-2005) [32]	Increasing Gross Domestic Expenditure on R&D to 1.5% of GDP of Turkey	Increasing the number of R&D personnel to 20 per 10000 labor force.	Legal and Institutional arrangements will be defined regarding Techno-parks and Technology Development Regions. Biotechnology Higher Committee will be founded.	National Innovation System will be completed. Technological cooperation opportunities with EU will be supported Local Information Network will be developed and integrated with International Information Networks.

[31] DPT, Yedinci Beş Yıllık Kalkınma Planı, DPT, Ankara: 1996. (pp. 70-77)
[32] DPT, Uzun Vadeli Strateji ve Sekizinci Bes Yillik Kalkınma Plani 2001-2005, DPT,Ankara: 2000. (pp.125-128)

The Ninth Five Year Economic Development Plan(2007-2013) 33	Increasing GERD in GDP. (No specific value is stated)	Increasing the number of private sector researchers.	Establishing "Technology Transfer Centers" and improving "Technology Development Regions" for further university-industry collaboration.	Public Procurement policy will be made on the basis of national R&D. Technology-based entrepreneurship will be improved. (Risk capitals will be provided.) The cooperation with EU will be improved for further technology transfers.

Source: DPT Development Plans (1963-2007)

[33] DPT, Dokuzuncu Kalkınma Plani 2007-2013, DPT,Ankara: 2006. (pp. 84-85)