ADAPTATION OF TURKEY TO THE EUROPEAN UNION RESEARCH AND INNOVATION POLICIES DURING THE ACCESSION PERIOD

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ABSTRACT

ADAPTATION OF TURKEY TO THE EUROPEAN UNION RESEARCH AND INNOVATION POLICIES DURING THE ACCESSION PERIOD

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The aim of this thesis is to analyze the adaptation of Turkey to EU research and innovation policies in the light of developments in within their own dynamics, and within the framework of obligations of the accession period. A comparative analysis of Turkish and EU policies is made by pointing out the weaknesses of Turkey, which are supported by related indicators specifying the gap between EU in research and innovation capabilities. In accordance with the findings of the comparison of Turkey and EU, this study attempts to develop recommendations for the reassessment of existing policy tools, and to propose new policy instruments within organizational and institutional infrastructure, implementation and further integration with EU in research and innovation. The evaluations highlight that Turkey is experiencing problems in structuring and implementing its policy instruments, rather than developing policy formulations.

Keywords: Science and Technology Policy, Research and Innovation Policies, European Union, Turkey, Accession

ÖZ

TÜRKİYE'NİN ÜYELİK SÜRECİNDE AVRUPA BİRLİĞİ ARAŞTIRMA VE İNOVASYON POLİTİKALARINA UYUMU

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Bu tezin amacı, Türkiye'nin Avrupa Birliği araştırma ve yenilik politikalarına uyumunu hem tarafların kendi iç dinamiklerinde yaşanan gelişmeler ışığında, hem de müzakere sürecindeki yükümlülükler çerçevesinde analiz etmektir. Bu çerçevede, Türk ve AB politikalarının karşılaştırmalı bir analizi yapılmakta, Türkiye'nin zayıf yanları ile araştırma ve yenilik alanlarında AB ile aralarındaki açık, konuyla ilgili göstergelerle vurgulanmaktadır. Bu çalışmada, karşılaştırma sonucunda elde edilen bulgular doğrultusunda, kurumsal altyapı, uygulama ve AB programları ile entegrasyona yönelik olarak mevcut politika araçlarında yapılacak iyileştirmeler üzerinde durulmuş ve yeni politika araçları önerilmiştir. Yapılan değerlendirmeler sonucunda, Türkiye'nin politika geliştirmeden ziyade, politika araçlarının etkin olarak yapılandırılması ve uygulanması aşamalarında sorunlar yaşadığı saptanmıştır.

Anahtar Kelimeler: Bilim ve Teknoloji Politikası, Araştırma ve Yenilik Politikaları, Avrupa Birliği, Türkiye, Katılım

Fatma ve Hüseyin Atmaca'ya,
siz olmasanız, ben olmazdım…

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LIST OF ABBREVIATIONS

ABGS	Secretariat General for EU Affairs
ARBİS	Researcher Information System
BTP-UP	National Science and Technology Policies Implementation Plan
BTYK	Supreme Council of Science and Technology
COST	European Cooperation in the Field of Scientific and Technological Research
CREST	Scientific and Technical Research Committee
DG	Directorate General
DPT	State Planning Organization
EC	European Community
ECSC	European Coal and Steel Community
ECU	European Currency Unit
EEC	European Economic Community
EIB	European Investment Bank
EIF	European Investment Fund
EIS	European Innovation Scoreboard
EPO	European Patent Office
ERA	European Research Area
ERA-MORE	European Network of Mobility Centers
ERC	European Research Council
ESPRIT	European Strategic Program for Research and Development in Information Technology
EU	European Union

EURAB	European Research Advisory Board
EURATOM	European Atomic Energy Community
EUREKA	European Research Cooperation Agency
FP	Framework Program
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
ICT	Information and Communication Technologies
IPR	Intellectual Property Rights
IRC	Innovation Relay Center
IRE	Innovating Regions in Europe
IT	Information Technologies
JRC	Joint Research Center
KOSGEB	Small and Medium Industry Development Organization
KÜSGEM	Small Enterprise Development Center
NGO	Non-Governmental Organization
NIS	National Innovation System
NSF	National Science Foundation (USA)
OECD	Organization for Economic Co-operation and Development
PC	Personal Computer
PPS	Purchasing Power Standard
R&D	Research and Development
RTD	Research and Technological Development
S&T	Science and Technology
SEA	Single European Act

SME	Small and Medium-sized Enterprise
SPK	Capital Markets Board of Turkey
TARABİS	TÜBİTAK National Research Infrastructure Information System
TİDEB	TÜBİTAK Industrial R&D Funding Directorate
TPE	Turkish Patent Institute
TPP	Technological Product and Process
TTGV	Turkish Technology Development Foundation
TÜBA	Turkish Academy of Sciences
TÜBİTAK	Scientific and Technological Research Council of Turkey
TÜİK	Turkish Statistical Institute
TÜRKAK	Turkish Accreditation Agency
ULAKBİM	Turkish Academic Network and Information Center
UME	National Metrology Institute
VEDOP	Tax Office Complete Automation Project
YÖK	Higher Education Council

CHAPTER 1

INTRODUCTION

In the new millennium, competitiveness is regarded as one of the major features of national economies for successful growth and development. According to the OECD, competitiveness is the degree to which a nation can be successful in international markets, while simultaneously maintaining and expanding the real incomes of its citizens over the long-term.[1] However, there are several requirements to achieve success in international markets, one of which is increasing innovation capabilities.

Innovation can be defined as implementing technologically new products and processes, and making significant technological improvements in products and processes.[2] Both producing something new and improving the existing product or process depends on generating and applying the knowledge required for such capabilities, simply known as "knowledge creation".[3] Moreover, knowledge creation process depends mostly on research. Research activities performed at universities, research institutes or within firms have crucial role in knowledge creation.[4] The output in the form of knowledge is transmitted by publications in scientific journals, or by other channels such as conferences and cooperation among firms. This

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[1] OECD, *Technology and the Economy: The Key Relationships* (Paris: OECD, 1992), 26.

[2] OECD, *Proposed Guidelines for Collecting and Interpreting Technological Innovation Data: The Oslo Manual* (Paris: OECD, 1997), 31.

[3] Silvio Popadiuk and Chun Wei Choo, 'Innovation and Knowledge Creation: How are These Concepts Related?', *International Journal of Information Management,* vol. 26, no. 4 (2006): 312.

[4] Luc Soete and Bas ter Weel, *Innovation, Knowledge Creation and Technology Policy in Europe* (Maastricht: MERIT, 1999), 4.

enhances the overall knowledge accumulation in the economy and induces innovative activities.[5]

Although closely related with research, innovation involves complex interactions between the innovator, generally the firm, and its environment. This environment consists of both inter-firm interactions that provide learning and technology diffusion through cooperation, and broader factors shaping the behavior of firms such as organizational and institutional framework, financial support instruments and knowledge diffusion mechanisms. Therefore, innovation process should be considered as a system, where managing such a system and creating the suitable environment for innovation need government policies to be developed and implemented. The systemic approach to innovation introduced "innovation system" concept in 1980s, and research and innovation policies have gradually taken the central role in economic development of countries since then.

The European Union considers innovation as the driving force of economic growth[6] as well, and has based its research and innovation policies on this idea since the second half of 1990s. The European Commission launched an action plan aiming to foster innovation throughout the Union by increasing funds for research and encouraging firms to innovate more. This was a milestone in EU research and innovation policies which started joint scientific research activities after the foundation of European Atomic Energy Community (EURATOM) in 1958. However, establishing research and innovation policies at Union level is a difficult task to accomplish. First of all, there are 25 member states, which mean 25 different systems, 25 different kinds of resources, 25 different levels of science and technology. Moreover, research and innovation are merely based on an intangible asset: knowledge, unlike tangible goods, such as coal, steel, and nuclear energy,

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[5] ibid.

[6] European Commission, *Green Paper on Innovation, COM(1995) 688* (Brussels: European Commission, 1995), 5.

around which solidarity is required to achieve common goals.[7] The absence of common rules and regulations for research and innovation policies forces EU to depend on the performances of member states in improving their research infrastructures and innovation capabilities, as well as harmonizing their policies with EU specifications.

The two major drawbacks of EU in research and innovation are fragmentation of research activities and lack of ability to transform the intangible asset knowledge to a tangible value: innovative products. EU produces largest amount of scientific publications, even in the most advanced sectors, but has the least number of patents with respect to its major competitors USA and Japan. European economies are losing ground in competitiveness and lagging behind USA and Japan in technology production and innovation capabilities.

Being aware of the situation, European Council agreed on a new strategic and ambitious goal: making EU "the most competitive and dynamic knowledge-based economy in the world by 2010", which was later known as the “Lisbon strategy” in March 2000.[8] Besides other policy areas, Lisbon strategy was also a turning point for EU research and innovation policies, where new policy tools and institutions have been introduced, and new strategies are being developed for the future of EU. In line with Lisbon strategy, EU decided to increase investment in R&D across the Union. It was agreed in 2002 Barcelona meeting of the European Council to increase R&D expenditures in member states to 3 percent of their GDPs by 2010.[9] Another significant item in Lisbon strategy is to achieve the establishment of joint research and innovation policies at EU level by “integrating” research efforts and capacities of

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[7] Ezio Andreta, “EU Strategies for Research and Development” in *Research and Technological Innovation: The Challenge for a New Europe*, eds. Alberto Quadrio Curzio and Marco Fortis, 181 (Heidelberg: Physica-Verlag, 2005): 175-183.

[8] European Council, *Presidency Conclusions, Lisbon European Council, 23 and 24 March 2000* (Lisbon: European Council, 2000), 2.

[9] European Council, *Presidency Conclusions, Barcelona European Council, 15 and 16 March 2002* (Barcelona: European Council, 2002), 4.

member states on a new ground: European Research Area (ERA), "common market" for research and innovation.[10]

Turkey, on the other side, has been developing its national science and technology policies since the beginning of 1980s, and has been trying to complete the institutional infrastructure in line with those policies, especially since 1990s. After releasing several science and technology policy documents, it is not possible to say that Turkey could fulfill the tasks described in them. Major reasons can be listed as lack of government support in science and technology policies, discontinuities in policies, insufficient interest of industry in research and development, poor relations among actors related to science and technology policy. However, the new millennium brought new trends and changes in this policy area.

Establishing a functioning national innovation system in Turkey has been gaining significance since 2000. In the Eighth Five Year Development Plan of 2001-2005 period, it was proposed to complete the framework of Turkish national innovation system.[11] However, the decision to prepare a "National Innovation Strategy and Action Plan",[12] which was taken in the October 2006 meeting of the Supreme Council of Science and Technology (BTYK) – the highest science and technology policy[13] body of Turkey – shows that Turkey could not manage to reach this goal yet. The lack of coordination among the stakeholders and awareness on the economic contributions of innovation can be regarded as the major reasons behind the failure.

Another noteworthy event of the 2000s is the launch of "Vision 2023" project in 2002. The objective of Turkey with "Vision 2023" is to become one of the leading countries in science and technology, which is capable of producing new technologies

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[10] European Commission, *Towards a European Research Area, COM(2000) 6* (Brussels: European Commission, 2000), 5.

[11] DPT, *Uzun Vadeli Strateji ve Sekizinci Beş Yıllık Kalkınma Planı 2001 – 2005* (Ankara: DPT, 2000), 128.

[12] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Ondördüncü Toplantısı, 12 Eylül 2006, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2006), 54.

[13] The term "science and technology policy" is used instead of "research and innovation policies" in Turkish official documents, such as development plans and BTYK decisions.

and converting technological progress to social and economic benefit by the year 2023, the 100th anniversary of Turkish Republic.[14] Within the scope of Vision 2023 project, a science and technology strategy document that defines policies to achieve the goals of the project is prepared as well. However, the outcomes of the project are yet to be seen, and Turkey is still showing a poor performance in research and innovation.

It can be concluded from the paragraphs above that both EU research and innovation policies, and Turkish science and technology policies are in transition. Both sides have undertaken huge tasks with ambitious goals and trying to adopt new arrangements in their policies. At this point, the launch of accession negotiations between the European Union and Turkey on October 3rd, 2005 gains more significance for Turkish science and technology policy. According to the "Negotiating Framework", accession means the acceptance of the rights and obligations of the Union system and its institutional framework. This implies that Turkey has agreed to improve its research and innovation capabilities, as well as complete its adaptation to EU policies at the end of accession period. Current performance of Turkey in R&D expenditure and innovation is very poor with respect to EU. Taking goals of Lisbon strategy and effort of EU to close the gap between USA and Japan into consideration, performance of Turkey should be considerably high to catch-up EU and adapt EU research and innovation policies during the accession period, which is likely to contribute to significant changes in Turkish science and technology policies.

The aim of this thesis is to analyze the adaptation of Turkey to the European Union research and innovation policies during the accession period. In this framework, this thesis compares Turkish science and technology policy and EU research and innovation policies from several aspects, such as institutional setup, performances in implementation of policy instruments, research and innovation capabilities, and contributions to the competitiveness of their economies at global

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[14] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Yedinci Toplantısı, 24 Aralık 2001, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2002), 10.

scale. In the light of this comparison, weaknesses of Turkish science and technology policy and necessary improvements to fulfill its obligations on the way to EU membership are explored.

For a better understanding, firstly the historical and theoretical background of research and innovation policies is analyzed in Chapter 2. The historical evolution of science and technology policies, the role of research and innovation in growth of today's leading economies are examined in this chapter. The theoretical background is based on the underlying economic theories and their approach to innovation and "innovation systems" concepts. Interaction between research and innovation, indicators showing the degree of resources devoted to R&D activities and the level of innovation capabilities of countries are other topics explored. The chapter is closed with several representations of "innovation systems", to be used while examining the organizational and institutional framework of Turkish and EU policies, and consecutively innovation systems.

Starting with the foundation of EURATOM, Chapter 3 analyzes the efforts in the European Union to establish research and innovation policies at Union level, and the recent trends in these policy areas after the launch of Lisbon strategy. Organizational and institutional framework of EU research and innovation policies, major policy instruments such as Framework Programs, and the existence of an EU innovation system are also explored in Chapter 3. After indicating the problems and challenges of EU research and innovation policies, the strategies of EU for the future, such as the completion of ERA and achievement of R&D targets are examined.

Chapter 4 examines the evolution of Turkish science and technology policy by mainly focusing on Five Year Development Plans and milestones in institutional infrastructure, starting with foundation of TÜBİTAK in 1963 as a result of a decision in the First Five Year Development Plan document.[15] Under the lights of development plans, BTYK decisions and policy documents, progress in science and technology indicators are analyzed, changes in research priorities are explored, and

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[15] DPT, *Birinci Beş Yıllık Kalkınma Planı 1963 – 1967* (Ankara: DPT, 1962), 88.

developments of institutions that play central roles in policy making and policy implementation are indicated. Common policy tools, such as incentives, R&D funding instruments and university – industry cooperation mechanisms are analyzed in this chapter as well. Finally, the strategies for the 100th anniversary of Turkish Republic – known as Vision 2023 – are studied, and the chapter is closed with the evaluation of the national innovation system of Turkey according to the framework representation introduced in Chapter 2.

Chapter 5 is where the answer to the research question is given. In this chapter, adaptation of Turkey to EU research and innovation policies during the accession period is examined. Firstly, the accession period is briefly analyzed in terms of the negotiation framework and obligations of Turkey within the scope of "Science and Research" chapter. Following this analysis, relations between EU and Turkey in scientific and technological research and progress of Turkey in integrating into the European Research Area are examined. Thirdly, a comparative analysis of Turkish and EU policies is done to indicate the areas where Turkey needs to show further policy improvements. Progress of Turkey during the accession period will be monitored and evaluated by EU via the developments in main science and technology indicators, as well as the steps taken towards developing a functioning national innovation system in Turkey. Therefore, the comparative analysis is done within this framework. The chapter is closed with policy proposals for Turkey to fulfill its adaptation to EU research and innovation policies and catch-up EU in science, technology and innovation.

Finally, the thesis is concluded with a summary of findings that come out as the results of analyses made throughout the chapters.

CHAPTER 2

HISTORICAL AND THEORETICAL BACKGROUND OF RESEARCH AND INNOVATION POLICIES

2.1 Introduction

Since the end of World War II, scientific and technological research has been a subject of national policies. The positive effects of technological development on national economies, such as increasing productivity and national income improved the significance of national research policies throughout the second half of the 20th century. With the astonishing developments in technology and the globalization of trade since 1980s, competitiveness has become the main prerequisite for the growth of national economies. Consequently, the term "innovation" gained central role in national policies since it was seen as the key of competitiveness.

The main aim of this chapter is to provide historical, conceptual and theoretical background information about research and innovation policies for a better understanding in following chapters. The historical background starts with the industrial revolution after which the first evidences of organized and professional research and development activities were seen, but focuses on the emergence and evolution of research and innovation policies in the period after the World War II. After analyzing the trends and changes in research and innovation policies, the concept of innovation and its relation with research is examined.

The last section of the chapter includes the economic theories related to innovation, and analyzes their approach to innovation, as well as their effects on research and innovation policies. The chapter is concluded with a summary of the recent developments in research and innovation policies, and contributions on the following chapters.

2.2 Evolution of Research and Innovation Policies in Historical Perspective

Technology has been an integral part of production process since the industrial revolution that started to change the world in the second half of the 18th century. Mechanization of the industry boosted productivity in several industries, such as textile and iron smelting, especially in Britain. The new level of productivity made Britain the production center of the world in a short period of time, and it contributed to a significant economic growth that provided British economy overtake other European economies and USA.[16] However, the leadership of British economy did not last long. The revolutionary transformation in British industry was followed by other European economies, especially Germany, and USA in the 19th century, and both countries caught-up Britain in the second half of 1800s.[17]

According to Freeman, the main inspiration behind the success of especially German industry was the professionalized R&D activities of the large companies. Germany was the first country that introduced in-house industrial R&D departments in 1870.[18] In fact, research and development activities were not new to industry. One of the main technological developments behind the industrial revolution was the steam engine of James Watt, which he invented in 1774. Moreover, there was a large population of "inventors" in Britain in the late 18th and early 19th centuries, who were continuously introducing new gadgets to the market.[19] The main difference of Germany – and of USA later on – than Britain was realizing that it could be profitable to rearrange the business of researching new products and developing more efficient processes on a regular, organized and professional basis.

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[16] Thomas S. Ashton, *The Industrial Revolution, 1760-1830* (New York: Oxford University Press, 1961), 26.

[17] Chris Freeman, "The 'National System of Innovation' in Historical Perspective," *Cambridge Journal of Economics*, vol. 19, no. 1 (1995): 5-24.

[18] ibid.

[19] Charles P. Snow, *The Two Cultures* (Cambridge: Cambridge University Press, 1993), 122.

The idea of in-house R&D activity was generally accepted by the majority of national industries, and specialized R&D labs became characteristic features of most large companies in manufacturing industry in industrialized countries during the first half of the 20th century.[20] The significant point is that, R&D activities were mainly driven by manufacturing industry as a result of market conditions, such as increasing competition among manufacturers. Although scientific research activities were also performed at universities of public labs, it is not possible to state that fostering research and "innovation" for economic growth was an objective of government policies until the World War II.

In the World War II period, combatant countries focused on strengthening their war power, which had two major outcomes: a considerably increased production of warfare equipment and significant amount of government funded R&D projects. During the war, the manufacturing capabilities were mainly used for military purposes. Countries reached a huge amount of production capacity and the manufacturing industry grew so rapidly that the total amount of capital stock in countries near the end of World War II surpassed the pre-war levels,[21] which would form a strong basis to recover their economies afterwards.

The latter, but more significant effect of World War II was felt in scientific research and technological development in participating countries. One of the characteristics of the war was new achievements in science and technology. Huge military projects were undertaken on both sides of the war, most of which needed significant scientific research performance. The outputs of government funded R&D projects were advanced technologies such as rocketry, radars and computers.[22] Although they were used to increase firepower, gather and process information during the war, each technology mentioned above contributed to great achievements

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[20] Freeman, op.cit.

[21] Nicholas Crafts and Gianni Toniolo, *Economic Growth in Europe since 1945* (Cambridge: Cambridge University Press, 1996), 67-80.

[22] The Atanasoff-Berry Computer was the world's first electronic digital computer. It was built by John Vincent Atanasoff and Clifford Berry at Iowa State University during 1937-1942.

of the 20th century, such as space flights, geographical research, and information and communication technologies (ICT).

The most significant research project of the war was the Manhattan Project[23] of USA which showed the power of science to the world, and the relation between research and invention in a clear but very dramatic way. Production of the Atom Bomb as a result of the Manhattan Project was an outcome of successive activities: basic knowledge on nuclear physics, research on application of theories, which was followed by experiments in large-scale labs, and production of the bomb. After the war, this sequential relation between research and *invention* was named as the 'Linear Model', or 'Linear Process' and it was used as the fundamental approach in research policies.[24]

With the increased prestige of R&D, "national research policy" topic started to enter national policy agendas after the World War II (post-war period). The first evidence of developing a national research policy for social and economic purposes is seen in USA. In 1944, the president of the USA, Franklin Roosevelt wrote a letter to Vannevar Bush, the head of Office of Scientific Research and Development.[25] After stating the success of the office during the war, Roosevelt asked for his recommendations on how this scientific accumulation, and R&D capacity be used in the days of peace for the improvement of the national wealth, the creation of new enterprises bringing new jobs, and the betterment of the national standard of living. Bush prepared the well-known report '*Science: The Endless Frontier*', [26] which was

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[23] The Manhattan Project was launched in 1942 by the United States to develop the first nuclear weapons to be used in the World War II. The project succeeded in developing and exploding two atom bombs in Hiroshima and Nagasaki, both in Japan.

[24] D. Allan Bromley, "Technology Policy," *Technology in Society*, vol. 26, no. 2-3 (2004): 455-468.

[25] The Office of Scientific Research and Development was an agency of the United States federal government created in 1941 to coordinate scientific research for military purposes during World War II. It was given almost unlimited access to funding and resources, and was run by Vannevar Bush, who reported only to President Franklin Delano Roosevelt.

[26] Vannevar Bush, *Science: The Endless Frontier* (Washington: Government Printing Office, 1945), 4, available at, http://www.nsf.gov/about/history/vbush1945.htm (accessed October 23, 2005).

used as the guideline of the research policy of the United States throughout the second half of the 20th century.

It would be useful to define the economic conditions after the World War II to understand the evolution of national research policies during the post-war period. The end of the war declared the absolute superiority of the United States over the rest of the world. Besides being the winner of the war, USA had a geographical advantage. It survived the war without getting any physical damage on its industry. However, same conditions were not true for Europe and Japan. Destruction of manufacturing and production facilities had a serious negative effect on the European economies. Cities, transportation facilities, industrial districts were severely damaged, and ports were destroyed due to air raids, bombings and battles on the ground. The production – especially of Germany – nearly came to an end.[27]

The Japanese side was not hopeful at the end of the war, either. As a "late comer" industrialized country, Japan reached a considerable amount of capital accumulation at the beginning of the World War II like European countries and USA. However, being devastated by two atomic bombs and forced to eliminate its military power, Japan was in a dramatic position after the war. It lost 40 percent of its industrial plants and infrastructure,[28] which led to the same diminishing capital stock situation as it happened in Europe.

The post-war period, especially with an uninterrupted economic growth until the oil crisis in 1973, had been a successful recovery period for the economies of European countries and Japan. It was time for those countries to regain the prior power, as well as to "catch-up" USA by rebuilding their economies and growing rapidly in a sustainable way. The institutional framework and strong background of industrialization in Europe – e.g. heavy machinery and chemistry in Germany, engineering in the United Kingdom – helped European economies recover rapidly, although the national industries especially in continental Europe had collapsed.

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[27] Crafts and Gianni Toniolo, op.cit.

[28] Ronald E. Dolan and Robert L. Worden, eds. *Japan: A Country Study* (Washington, D.C.: Library of Congress, 1992), 284.

The defeat of Japan, on the other hand, changed the power-structure in Japanese society with the elimination of military and the family-owned business groups, named the Zaibatsus. The bureaucracy took on the challenge of gearing up the economy and encouraging the society at large towards economic catch-up with the West.[29] Elimination of the military let Japan use its millions of former soldiers as reinforcements of the national workforce, and save the military spending in state budget. With a greater role of government at first, and the later emergence of private businesses receiving considerable amount of incentives, Japan could rebuild its business sector for international competition.

The effect of national research policies on economic growth of countries during this recovery period cannot be denied. The increased prestige of professional and structured R&D activities during the World War II resulted in a trend which is seen in the form of establishing research councils, scientific institutions, and research labs in the industrialized countries during the 1950s and 1960s.[30] This institutional framework that lies under research policies still persists in USA and many European countries, and was formed during this period.[31] During 1950s and 1960s, research policies were shaped as follows: governments were the main client of R&D activity, launching large-scale national programs serving to fund the technologies which the state needed for its public or military sectors.[32] Programs were funded essentially out of the public budget. This approach also kept industrial R&D alive and industry started to contribute to funding of programs in the late 1950s.

National R&D policies in the post-war period had a positive effect on productivity of countries. The impressive productivity levels achieved on the way to

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[29] Jan Fagerberg and Manuel M. Godinho, "Innovation and Catching-up" in *The Oxford Handbook of Innovation*, eds. Jan Fagerberg, David C. Mowery and Richard R. Nelson, 521 (Oxford ; New York : Oxford University Press, 2005), 514-542.

[30] Freeman, op.cit., 9.

[31] Uğur Müldür and Paraskevas Caracostas, *Society, the Endless Frontier: A European Vision of Research and Innovation Policies for the 21st Century* (Brussels: European Commission, 1998), 18.

[32] ibid.

catch-up USA helped Europe and Japan regain their industrial strength, based on their scientific knowledge accumulation and technological know-how.[33] In 1950-1973 period bigger economies of Europe, Germany, France and UK reached 5.9, 5.0 and 3.2 percent of annual average productivity growth rates respectively, while USA reached a level of 2.5 percent. The top performance, on the other hand, belonged to Japan with a level of 7.6 percent, 3 times higher than USA.[34]

The oil crisis in 1973 hampered the increase in productivity rates and economic growth of countries around the world. Countries started to shift away from oil-intensive industries. As an example, the oil crisis was a major factor in Japan's economy redirecting investments into less oil-intensive industries like consumer electronics, which resulted in the spectacular industrial rise of Japan. The major economic features of the new era after 1973 were increasing global competition, the emergence of economic liberalism and globalization of markets in 1980s. Moreover, technological revolutions such as personal computers (PCs) and international communication facilities that introduced ICT shifted the established industrial norms and the attitude of general public towards commercialized high technology products, namely innovations.

Despite the negative effects of oil crisis, European countries and Japan sustained their higher productivity growth rates compared to USA. The diminishing productivity gap between USA, Europe and Japan was regarded as a 'convergence' among these economies.[35] According to Nelson and Wright, the *convergence* was a result of two factors. Firstly, the economic environment that firms faced had become similar as a result of increasing international trade and globalization of markets, as well as resemblance of internal economic conditions of countries, especially after the

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[33] Fagerberg and Godinho, op.cit.

[34] Angus Maddison, *Dynamic Forces in Capitalist Development: A Long-Run Comparative View* (Oxford: Oxford University Press, 1991), 63-65.

[35] Richard R. Nelson and Gavin Wright, "The Erosion of US Technological Leadership as a Factor in Post-war Economic Convergence" in *Convergence of Productivity: Cross-National Studies and Historical Evidence* eds. William J. Baumol, Richard Nelson and Edward N. Wolff (Oxford: Oxford University Press, 1994), 139.

collapse of the communist bloc in the early 1990s. The second factor was the huge investments of catching-up countries in scientific education and R&D activities.[36] Fagerberg and Godinho summarize the main factors supporting catch-up as capital accumulation and a sufficient manufacturing base in the 1960s and 1970s, whereas in the 1980s and 1990s, the accumulation of technological capabilities and specialization in services were more relevant.[37]

The conditions mentioned above also caused radical changes in research and innovation policies after 1973. Firstly, industrial competitiveness that is driven by technological advancement became the main determining factor behind research and innovation polices. One outcome of this factor was that R&D activities started to focus on new and better products and production mechanisms, rather than searching for fundamental scientific results. Secondly, role of governments in R&D activities has undergone a fundamental change. Governments became more of a "partner to industry" than "a client" to R&D activity. Projects to be funded were selected according to their impact on industry and contribution to competitiveness.[38]

The globalization of markets in 1990s was one of the driving forces of development, and scientific and technological advancement. However, the increasing opportunities for international trade as a consequence of globalization introduced a highly competitive business environment that countries should cope with. The productivity level of countries supported their competition capabilities to a certain extent, but they needed to adopt new technologies, and produce new and high quality goods and services to sustain their economic growth and development, as well as to catch-up more advanced economies. Therefore, the significance of research and innovation policies among other policy areas started to increase in the 1990s.

Keeping in mind the changes in research and innovation policies, in terms of the roles of governments and global trends in R&D, following question arises at this

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[36] ibid.

[37] Fagerberg and Godinho, op.cit.

[38] Müldür and Caracostas, op.cit.

point: "Does convergence mean that countries followed the same strategies in their policies during the catch-up process?" It is unlikely to give an affirmative answer to this question, when today's economic conditions, industrial structures and technological specializations, as well as capabilities of industrialized countries are analyzed. Different organizations of production in countries result in differences in organization of innovative activities. Therefore, each major country represents a different structure of trade specialization and comparative advantages, and these national differences increased, rather than diminished in the last decades.[39]

European countries and Japan developed their own models of development, and policies by concentrating their efforts on particular fields[40]. European countries followed the traditional policy approach; launching government funded large-scale programs, establishing institutions related to research and development, such as policy advisory bodies, improving independent scientific institutions, like Fraunhofer Institute (founded in 1949), Max Planck Institute (founded in 1948) in Germany. In Europe, research and innovation policies were mainly focused on institutionalization, strengthening of scientific and technological bases and increasing cooperation via joint research projects, rather than concentrating on forming a continuously innovating industry.

Japan, on the other hand, focused on improving its production skills and specializing in high technology areas, such as electronics. It established its own production system[41] in close relation with research and development of technological

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[39] Paolo Guerrieri, "Technology and International Trade Performance in the Most Advanced Countries" (January 31, 1991). *Berkeley Roundtable on the International Economy*. Paper BRIEWP49., 1-22,
http://repositories.cdlib.org/brie/BRIEWP49 (accessed November 15, 2005).

[40] Daniele Archibugi and Mario Pianta, *The Technological Specialization of Advanced Countries* (Dordrecht: Kluwer, 1992), 128.

[41] "Lean manufacturing" and "just-in-time production" are effective production methods developed by Japanese companies. The idea is to improve quality, and reduce costs and production time by eliminating wastes in production process. Sources of wastes were defined as: Over-production, waiting time, transportation, processing, inventory, motion, and scrap in manufactured products or any type of business. Both methods aim to establish flow processes by linking work centers, so that there is an even, balanced flow of materials throughout the entire production process, similar to that found

products, and rapidly improved its technological capabilities. As a result, Japan became one of the most advanced countries in high technology, especially in consumer electronics. Japanese style of production and research policies were based on creating an environment where certain actors, such as government, public research labs, universities and financing institutions undertake certain roles and collaborate with the industry to foster innovation skills that would contribute to an increase in global competitiveness of the country. The strategy of Japan was later on named as the 'National Innovation System' (NIS) which has triggered a new approach in national research and innovation policies since 1990s.

2.3 Conceptual Background

Before going into details of the new approach in national research and innovation policies, it would be useful to analyze the conceptual background of innovation and its relation with research. Introducing new products to the market, improving the product with adding new features or modifying it to create a difference, or finding new methods for better production are all included in the verb "to innovate". In spite of its increasing role in global competitiveness and economic growth of countries, innovation has been a difficult term to understand. Can every new product be called as an innovation? Is innovation a different term than invention? Under what circumstances is a firm regarded as an innovating organization?

The roots of the term innovation go back to the Latin word "innovare", which means "to renew, to make new".[42] A review of the literature on innovation yields multiple definitions, most of which are focusing on similar points, looking from different perspectives. The common base of definitions points to products and processes that attempt to distinguish their uniqueness. OECD defines innovation by

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in an assembly line. To accomplish this, an attempt is made to reach the goals of driving all inventory buffers toward zero and achieving the ideal lot size of one unit.

[42] Maria M. Clapham, "The Development of Innovative Ideas Through Creativity Training," in *The International Handbook on Innovation,* ed. Larisa V. Shavinina, (London: Pergamon, 2003), 366-376.

relating it to technological developments in the Oslo Manual, the foremost international source of guidelines for collecting and interpreting technological innovation data. According to OECD:

> *Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). TPP innovations involve a series of scientific, technological, organizational, financial and commercial activities. The TPP innovating firm is one that has implemented technologically new or significantly technologically improved products or processes during the period under review.*[43]

The definition of OECD is accepted by the majority of member countries as a basis for their legal innovation definitions. A broader definition of innovation is introduced by EU as:

> *The renewal and enlargement of the range of products and services and associated markets; the establishment of new methods of production, supply and distribution; the introduction of changes in management, work organization, and the working conditions and skills of workforce.*[44]

According to the above definitions, innovation can take place in two major milestones of production life-cycle: the product itself, or the production process. The introduction of a new or improved product is called “product innovation”. Henry Ford used internal combustion motor instead of a horse to carry people on wheels and produced the first automobile, which is a real case study for product innovation. Ford’s innovation did not only open a new market, but also started a new era in transportation and provided the creation of the huge automotive industry in the long term.

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[43] OECD and European Commission, *Proposed Guidelines for Collecting and Interpreting Technological Innovation Data: The Oslo Manual* (Paris: OECD, 1997), 31.

[44] European Commission, *Green Paper on Innovation, COM(1995) 688* (Brussels: European Commission, 1995), 1.

On the other side, innovation can also take place as developing a new production method, which is called process innovation. Remembering Henry Ford again; using assembly lines and interchangeable parts to boost the production of the famous Model T automobiles is an example of process innovation.[45] With this new production method, Ford Motor Company succeeded a considerable reduction in production time per automobile and produced 15 million Model Ts from 1914 to 1927.[46] This had been a world record until broken by Volkswagen Beetle in 1972.

As an answer of the first question asked at the beginning of this section, every new output or procedure cannot be called as innovation. According to the OECD definition, it should contribute to a considerable technological improvement in either products or processes.

However, it cannot be deduced that every technological improvement or invention is an innovation. Innovation differs from invention in several aspects. First of all, an invention cannot be considered as innovation unless it is introduced to the market and commercialized. The famous example used to explain the difference more clearly is the story of vacuum cleaner. The first portable electric vacuum cleaner was invented by James Murray Spangler in 1907.[47] However, the commercialization of the machine was succeeded by William H. Hoover, who gave his name to the well-known brand. Secondly, every innovation does not have to be an invention, a totally new product. Relatively small extensions or new facilities added to a product can also be regarded as innovation. As an example, the introduction of computer mouse by Apple for Macintosh computers was an invention and also an innovation among computer input devices. On the other hand, replacing the ball under the mouse by optical sensors and developing the optical mouse is not an invention, but an innovation.

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[45] Ford's new production process was also the starting point of mass production and introduced a concept known as Fordism.

[46] Daniel Gross et al., *Forbes Greatest Business Stories of All Time* (New York: Wiley, 1996), 75-89.

[47] William R. Griffin, "Vacuuming to Victory," *Health Facilities Management,* vol. 15, no. 5 (May 2002): 33.

The nuance and constraints in the definition of innovation lead to the emergence of several classifications for the term. In a broader sense, innovation is classified as technological and non-technological. The definition of OECD and the examples given above for product / process innovations belong to the technological innovation group. However, service sector is as significant as manufacturing sector, and as the EU definition states, new services which are introduced to the market can also be regarded as innovation. Non-technological innovation includes improvements in managerial activities, new services, and any activity where technology is not the main actor. To clarify the definition, new strategies in consumer credits, such as accepting and processing applications via mobile phone can be given as an example of non-technological innovations. The focus of this thesis will be on technological innovation.

Another classification of innovation is made in terms of their impacts technological on development and the degree of dependence on the previous product or service. This approach categorizes innovations as “radical” and “incremental”. Radical innovations mean a technological leap which makes the previous technology or product obsolete, or introduces a brand new technology. Remembering Henry Ford once more, the invention of automobile was a radical innovation, which not only replaced horses as transportation instruments, but also brought in the internal combustion motor technology for the first time. Incremental innovations, on the other hand, contribute to improvements on an existing product or service. Continuing examples from the automotive industry, each improvement that has been done on cars since the Ford’s Model T are incremental innovations. Although modern cars do not have any resemblance with Model Ts, they still base on the same principle: four-wheeled motor vehicle on the road used for transportation.

What makes a firm an innovating organization, is in fact hidden in the definitions and examples given above. A firm is considered to be innovating if it introduces a new product, or realizes enhancements in its product or production processes that contribute to new outputs, and consecutively expands its market and improves its competitiveness skills. However, creating something new and making a difference is not a simple task. It depends on several factors that interact in a complex nature.

First of all, innovation is heavily based on absorption, generation and application of knowledge,[48] which requires qualified and specialized human capital, as well as developed learning skills of the organization. Due to the significant developments in science and technology in the second half of the 1900s, there has been an enormous knowledge accumulation in the world. Absorption and application of knowledge needs higher qualifications gained by specialized education, and sustained by life-long learning. However, the knowledge needed for innovation is not always explicit and has to be produced. Research is the major process of producing knowledge

The second factor behind innovation is research activities which can be performed by the firm itself (in-house research) or in cooperation with research institutions (universities and other public or private research labs). Firms can also make use of the outputs generated by research institutions, without taking part in research activity. Research activities have been showing a shift towards a more complex structure and a great diversity of organizations having an explicit goal of producing knowledge by doing research.[49] Nevertheless, research is a risky process with high uncertainties and costs. Every research may not give the desired output. In some cases, costs can be too high to be afforded by the firm before reaching its goals.

The interdependencies among innovation, learning, knowledge creation and research, represent a complex nature that should be seen as a system of relations and interactions. A thorough understanding of this system and establishing an environment that enhances effectiveness of interactions helps to increase innovation capabilities of firms. At national level, the system – namely the 'National Innovation System' (NIS) – covers a wide range of institutions and organizations, such as higher education and life-long learning mechanisms providing the skilled labor, public and

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[48] Jan Lambooy, "Innovation and Knowledge: Theory and Regional Policy", *European Planning Studies*, vol. 13, no. 8 (2005): 1137-1152.

[49] Luc Soete and Bar ter Weel, "Innovation, Knowledge Creation and Technology Policy in Europe", *De Economist*, vol. 147, no. 3 (1999): 293-310.

private R&D labs for knowledge creation, and incentives or funds to help firms to undertake high costs of research and innovation. A functioning NIS has considerable effects on improving the competitiveness of a country, which contributes to economic growth. Hence, innovation is seen as an economic, rather than technological concept by economists and entered in economic theories as well. At this point it will be useful to discuss the economic theories behind innovation and the NIS concept in detail.

2.4 Theoretical Background and Systemic Approach to Innovation

Joseph Schumpeter is the first scholar who used the term innovation in his studies. According to Schumpeter, economic development should be considered as an evolutionary process that depends on *preceding total situation*, rather than previous economic conditions alone.[50] Refusing the classical approach which sees economic change as a path to equilibrium, Schumpeter states that economic development is a "creative destruction",[51] meaning the replacement of the old by the "better" new. He suggests that the tendency to equilibrium is always broken by "new combinations of productive means" – which can also be interpreted as innovation – and concludes: "Development in our sense is then defined by the carrying out of new combinations (innovations)".[52] In Schumpeter's studies, those new combinations or – in other words – innovation cover five actions, which are included in the formal definitions of innovation: The introduction of a new good, the introduction of a new method of production, the opening of a new market, the conquest of new sources of new materials or half-manufactured goods to be used in production of the existing good, and the development of the new organization of the industry.[53]

[50] Joseph A. Schumpeter, *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle* (Cambridge, Massachusetts: Harvard University Press, 1934), 58.

[51] ibid.

[52] ibid., 66.

[53] ibid., 66.

Depending on the roots planted by Schumpeter, evolutionary theory (also known as Schumpeterian) started to become dominant in economics especially after 1980's, due to its sufficiency in explaining the place of technology and innovation in economic development.[54] Another significant point in evolutionary theory is that, the relation between research, invention and innovation is not considered to be a linear process as stated in section 2.1, but rather to have a more complex nature where each of the mentioned phases may overlap.[55] Moreover, innovation is seen as the motor of economic development in the long term,[56] and performance of an economy is bound to the characteristics and abilities of its individual firms and other organizations dependent on its institutions.[57]

Due to its complex nature and relations with its environment, evolutionary theorists claim that the innovation process can only be understood and managed by a systemic approach. The "innovation system" concept was introduced by Lundvall,[58] and used as the basis of the term "National Innovation System" (NIS), which was introduced by Freeman in his study on the success of Japanese economy.[59] A National Innovation System is mainly composed of two parts: actors and relations among them. The actors define formal institutions and organizations where the relation concept includes user producer relationships, supply chains, collaborations, other formal bonds that are formed by legislations, laws, traditions etc.

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[54] Erol Taymaz, *Ulusal Yenilik Sistemi Türkiye İmalat Sanayiinde Teknolojik Değişim ve Yenilik Süreçleri* (Ankara: TÜBİTAK, TTGV, DİE, 2001), 5.

[55] ibid., 14.

[56] Richard R. Nelson and Sidney G. Winter, *An Evolutionary Theory of Economic Change* (Cambridge, Mass: Harvard University Press, 1982), 10-18.

[57] Manfred M. Fischer, "A Systemic Approach to Innovation," in *Regional Development Reconsidered*, eds. Manfred M. Fischer and Gündüz Atalık (Berlin; New York: Springer, 2002), 15-31.

[58] Bengt-Åke Lundvall, *Product Innovation and User-Producer Interaction* (Aalborg: Aalborg University Press, 1985), 30-38.

[59] Chris Freeman, "Japan: A New National Innovation System?," in *Technology and Economic Theory,* eds. Giovanni Dosi et al. (London: Pinter, 1988), 330–348.

There are two main definitions for NIS, depending on different approaches of scholars: narrow definition and broad definition. The narrow definition, used by Nelson, encompasses the set of formal institutions which are directly involved with scientific and technical activities.[60] On the other hand, the broad definition of Lundvall includes the narrow definition and adds more actors and relations on it. The broad definition takes NIS as a composition of "all" institutions and structural factors which somehow affect the introduction and diffusion of new products, processes and systems in a national economy.[61] Lundvall's broad approach on institutional framework of NIS is represented graphically in Figure 2.1. Lundvall put firms at the center of the system considering them as the innovating force. The supporting actors, such as universities, research labs, intellectual property mechanisms, which provide a suitable environment for innovation, surround the center with necessary links and flows set. All the actors are interacting with each other and providing firms knowledge needed to innovate and protect their innovations. On the outermost shell lie the macro regulations such as monetary policies and organization of financial system needed to fund research and innovation activities of the firms, as well as the micro level linkages and organizations such as internal organization of firms and user-producer relationship.

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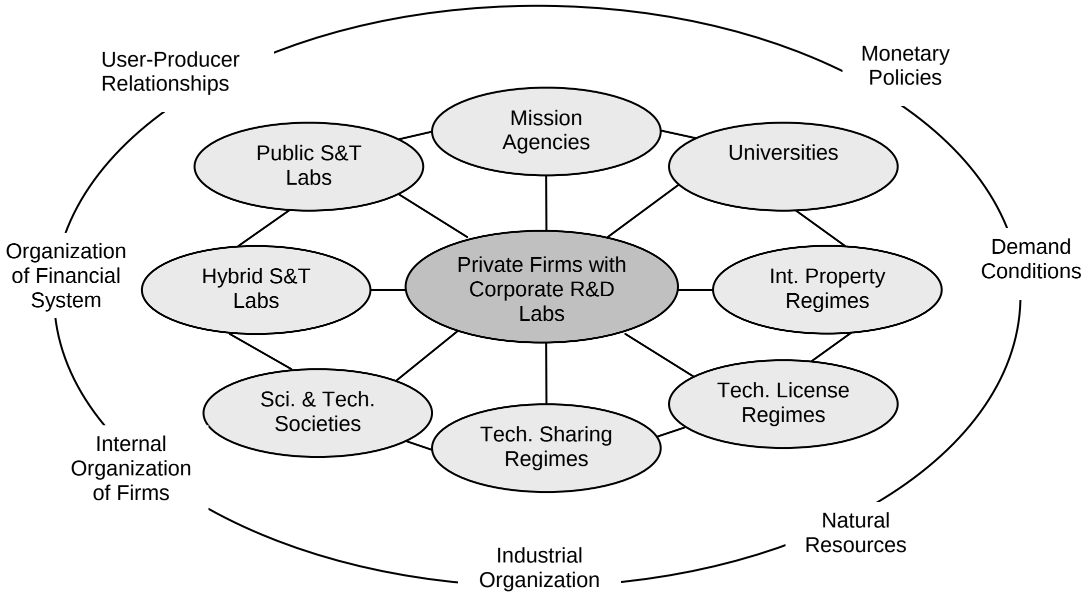
[60] Jacqueline Senker et al., "Literature Review for European Biotechnology Innovation Systems (EBIS)," *Sussex University SPRU* (1999), 15. http://www.sussex.ac.uk/spru/documents/litrev1.pdf (accessed July 2, 2005).

[61] ibid. More detailed information for both definitions can be found in Appendix A.



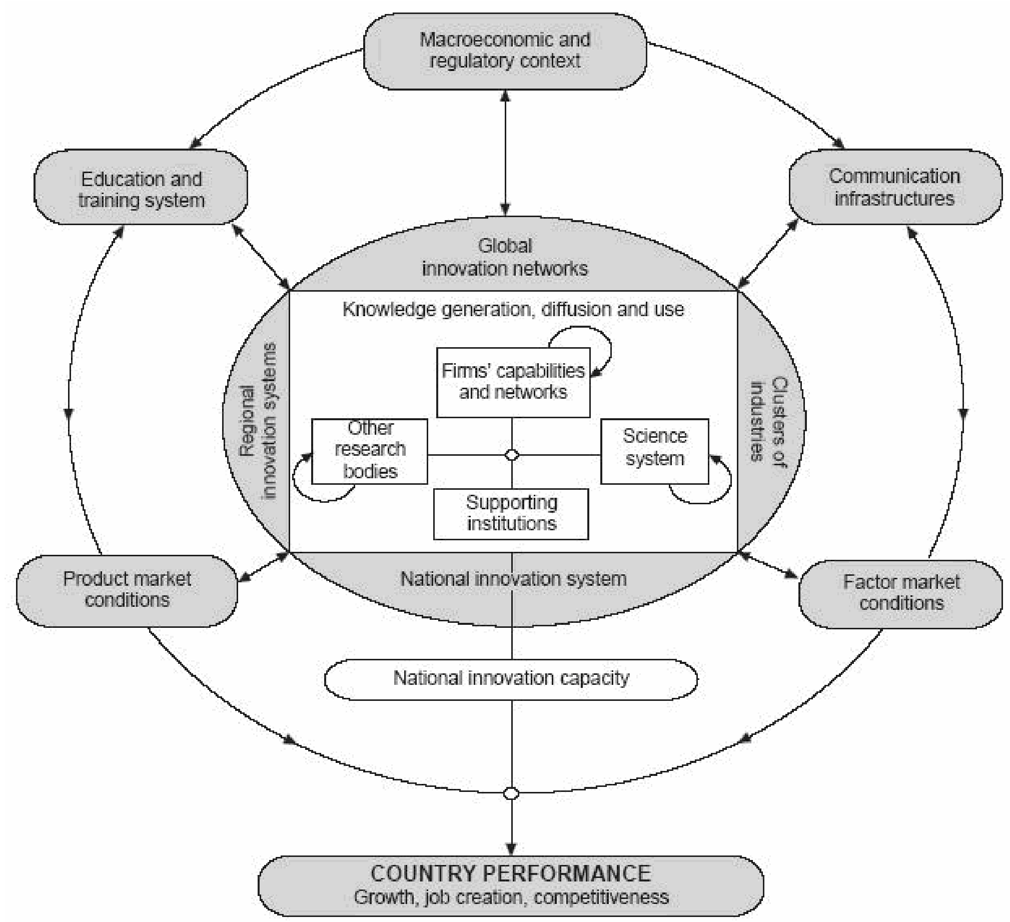
Source: Crow, 2005.

Figure 2.1: Institutional Framework of NIS in Broad Sense.

The most common representation of NIS is the one that is used by OECD. The OECD representation of NIS, as illustrated in Figure 2.2, is based on the national innovation system definition of Metcalfe:[62]

> *Set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies.*

[62] Stan Metcalfe, "The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives," in *Handbook of the Economics of Innovation and Technological Change*, ed. Paul Stoneman (Oxford, UK ; Cambridge, Mass. : Blackwell, 1995), 462-463.



Source: OECD, Managing National Innovation Systems, 1999.

Figure 2.2: Actors and Linkages in the Innovation System

In the OECD representation of NIS, differing from Lundvall's approach, all the organizations and institutions that are involved in knowledge creation and innovation processes are considered as the central bodies of the innovation system, not only the innovator firms. The bodies at the center of innovation process form up different innovation systems at different levels, starting with clusters of industries at the lowest level, regional systems at intermediate level, up to national innovation systems, and even global innovation networks driven by multinational companies. Similar to Lundvall's representation, regulations and market conditions interact with the center of the system. The noteworthy point is that, OECD represents the sources of skilled human capital explicitly by "Education and training system" box. Finally, OECD expresses that the system shows the national innovation capability of a country which contributes to its performance in growth and competitiveness, as well as creating more jobs.

The third representation of NIS is the model prepared by Durgut, Akyos, Göker, and Arıkan.[63] This model, which is represented in see Figure 2.3, shows the institutional structure in detailed, hierarchical manner; putting policy making bodies at the topmost layer. There is an analogy between "Layer I" of this model and the central box of OECD representation. The "Layer I" can be seen as the core of OECD representation, where firms and knowledge creation bodies are illustrated together at the same level.

The final model represents NIS as composition of five layers:

- **Layer 0:** Includes the basic education institutions and lifelong education system in order to plant the scientific notion in society.
- **Layer I:** Includes innovating firms making R&D, other production firms, higher education institutions (universities), public R&D institutions in order to provide the necessary scientific infrastructure (by basic and applied research etc.) needed for innovation. Almost all of the elements have relations with each other.
- **Layer II:** All incentives and especially financial support mechanisms are positioned in this layer. Information centers and networks that provide innovating actors necessary information about their activities are also parts of this layer. Agglomerations, clusters, and other actors needed for the dissemination / diffusion of knowledge and information, such as technoparks, incubators, and labor mobility mechanisms are other important elements of the layer, as well as mediators and consultants. Layer II, has close relations with Layer I as expected.

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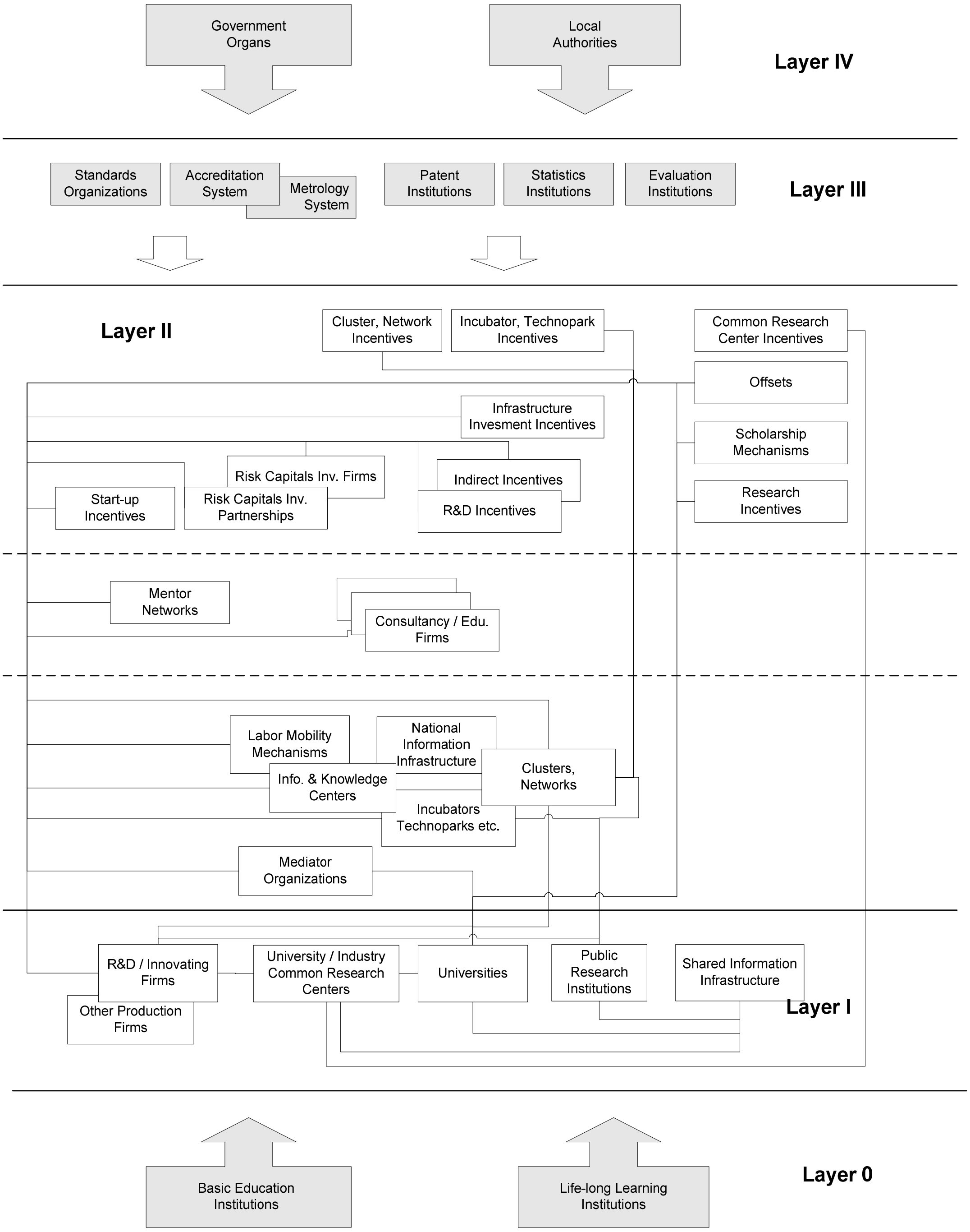
[63] TÜSİAD, *Ulusal İnovasyon Sistemi: Kavramsal Çerçeve, Türkiye İncelemesi ve Ülke Örnekleri* (İstanbul: TÜSİAD, 2003), 67.



Source: TÜSİAD, 2003.

Figure 2.3: Institutional Structure of NIS

- **Layer III:** Layer III is working both as an information provider for policy makers that are placed in Layer IV, as well as a mechanism for monitoring and evaluation of Layer I activities. Statistics institutions for information gathering process and accreditation mechanisms for evaluation of innovation activities are sample institutions of this layer.

- **Layer IV:** The highest Layer in the system is composed of policy making institutions.

The systemic approach to innovation has gained central role in research and innovation policies since 1990s. All models of national innovation systems see the firms as carriers of technological innovation. In the new millennium, the level of science and technology increased the complexity, costs and risks in innovation more than ever. The major goal of research and innovation policies today is to create an environment that removes the obstacles in front of innovation, and to encourage firms to increase their innovation capabilities that would eventually improve the competitiveness of the country and result in economic growth. A functioning innovation system, that has the features described in this section, provides such an environment by offering funding mechanisms for innovation to reduce the costs, easing knowledge flow and creation that would help firms to overcome the complexities, and making necessary regulations to reduce the risks.

Being aware of its significance, the European Union (EU) placed innovation at the center of their research and innovation policies in 1995.[64] Since the ratification of the "action plan" on innovation, EU is trying to create such a system at Union level.[65] First of all, the domain of scientific and technological research was defined as the entire EU with the introduction of European Research Area initiative in 2000,[66] which was a significant step towards the "European Innovation System". As a second issue, the launch of Lisbon Strategy in 2001 with the aim of making EU the

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[64] European Commission, *Green Paper on Innovation, COM(1995) 688* (Brussels: European Commission, 1995), 5.

[65] It is more likely to call it a "regional", rather than a "national" innovation system, where the "region" represents the entire EU area.

[66] European Commission, *Towards a European Research Area, COM(2000) 6* (Brussels: European Commission, 2000), 7.

most competitive economy in the world by the end of 2010 speeded up the completion of a functioning innovation system in EU.[67]

From Turkey's point of view, discussions on establishing a national innovation system have started in 2000.[68] Before that, research and innovation policies – named as "Science and Technology Policies" in Turkey – were focusing on determination of areas to direct research activities and targets for research funding, rather than explicitly increasing the innovation capabilities of the country. After reaching a consensus on the significance of systemic approach to innovation, the most significant step towards the completion of Turkish national innovation system could be taken in 2006, with the start of preparations of a "National Innovation Strategy and Action Plan".[69]

During the analysis of organizational and institutional frameworks of Turkish and EU research and innovation policies, in Chapter 3 and Chapter 4, the existence of innovation systems in both sides will also be explored. Within this framework, the analysis will be made in the light of definitions and NIS representations mentioned in this section. The most appropriate representations for EU and Turkish innovation systems are seen as the OECD representation, which is illustrated in Figure 2.1, and hierarchical representation, which is illustrated in Figure 2.3, respectively.

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[67] Even though global processes became more important in the last decade, the importance of regional processes is gaining significance as well. At first sight, the two processes seem to create a paradox, but in fact, they feedback each other. Globalization confronts countries with many challenges that can be handled more effectively through cooperation with other states. Therefore regional cooperation strengthens the position of individual states as they strive to secure their national interests in an integrating world economy.

[68] DPT, *Uzun Vadeli Strateji ve Sekizinci Beş Yıllık Kalkınma Planı 2001 – 2005* (Ankara: DPT, 2000), 126.

[69] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Ondördüncü Toplantısı, 12 Eylül 2006, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2006), 54.

CHAPTER 3

EUROPEAN UNION RESEARCH AND INNOVATION POLICIES

3.1 Introduction

Since the publication of the “Green Paper on Innovation” in 1995 and “First Action Plan for Innovation in Europe” in 1996, innovation became one of the major policy topics of the European Union. European Commission has set the goals of EU research and innovation policies as to support an increase in the quantity and efficiency of innovative activities across the Union, and to contribute to an increase in competitiveness of European firms in the long run.[70]

The aim of this chapter is to examine the evolution of EU research and innovation policies, and recent trends in policy implementations and to analyze the future goals of the Union. The evolution of EU research and innovation policies is studied in three periods. The first period starts with the foundation of European Atomic Energy Community (EURATOM) in 1958 as the first intergovernmental organization for joint research activities. Development of intergovernmental R&D programs, entrance of “research and technological development” topic to the Treaties of the Union, first attempts and efforts towards a common research policy are analyzed in this period. The second period starts with the ratification of “Green Paper on Innovation” in 1995, with which innovation was explicitly accepted as the driving force of economic growth, and policies of the Union were restructured. Finally, third period starts with the launch of the Lisbon strategy of the Union in 2000:. “to become the most competitive and dynamic knowledge-based economy in the world (by 2010)”. Recent trends in EU research and innovation policies, and future goals of the Union are also analyzed in this section.

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[70] European Commission, *Innovation Policy in a Knowledge-Based Economy* (Brussels: European Commission, 2000), 4.

After examining the evolution of EU research and innovation policies, and the changes in this policy area in the light of the Lisbon strategy, the organizational and institutional structure is analyzed from innovation systems point of view, trying to find out whether there is an innovation system at EU level. Policy implementations, especially Framework Programs as the main policy instruments and cooperative research programs within the institutional framework are examined in a separate section. Finally, the chapter is closed with evaluation of EU research and innovation policies, including the problems and challenges for the Union.

3.2 Evolution of European Union Research Policies: 1958 - 1995

Scientific research has always been a significant item in the European Union agenda. During the post-war period, the major aims of European countries had been firstly to recover their economies, and secondly to catch-up the US economy. Establishment of European Coal and Steel Community (ECSC) by the Treaty of Paris of 1951 was an outcome of these aims.[71] Steel had played an important part in production of warfare goods in World War II and was a fundamental resource of the western European states. The aim was therefore a common program of post-war production and consumption of steel and coal, by pooling resources of the member states. There was also a desire to unite the countries by controlling steel and coal by the Community which were fundamental to war industries. The ECSC introduced a common free steel and coal market, with freely set market prices, and without import/export duties or subsidies, which was an important incentive towards common usage of industrial resources.[72]

Although it was foreseen in the Treaty of Paris, the European joint scientific research activities started with the EURATOM, which was established in 1958. European countries had their own research policies, and they were capable of

[71] First members of the ECSC were France, West Germany, Italy, Belgium, Luxembourg and the Netherlands.

[72] Derek W. Urwin, *The Community of Europe: A History of European Integration since 1945* (New York: Longman Publishing, 1995), 46.

sustaining scientific and technological development with their own resources to a certain extent. In addition, the accumulation of scientific knowledge especially in basic sciences[73] and strong industrial infrastructure seemed to be an asset for them. On the other hand, several problems, such as different levels of national scientific know-how and research capabilities of countries, redundant research activities that were causing unproductive usage of both human capital and technological infrastructure, the limited transfer of knowledge and high rate of failure of individual research projects played crucial role in establishing joint research activities among European countries. The objective of EURATOM was to accomplish what the countries could not do by themselves in the atomic energy area.[74] In accordance with this objective, the task of "promoting research and providing the diffusion of technical information among member states",[75] and establishment of the Joint Nuclear Research Centre can be regarded as the start of intergovernmental research activities.

Despite the initiation of intergovernmental research programs, it was not until the 1970s that Research and Technological Development (RTD) became a policy issue that would be considered as an area of activity for the Community linked with industrial policies.[76] The industrial rise of Japan, which had operated a science and technology policy focusing on improving its technological development and competitiveness, and the increasing technological dominance of USA together with its economic power were the two significant factors that triggered the formation of a research policy.[77] These factors motivated the idea that European countries needed a

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[73] e.g. chemistry, physics, mathematics, biology.

[74] Luis Sanz and Susana Borrás, "Explaining Changes and Continuity in EU Technology Policy: The Politics of Ideas," *in The Dynamics of European Science and Technology Policies*, eds. Simon Dresner and Nigel Gilbert (Aldershot: Ashgate Publishing), 33.

[75] Treaty Establishing the European Atomic Energy Community, Mar. 25, 1957 [hereinafter Euratom Treaty], *as amended in* Treaties Establishing the European Communities (EC Official Publications Office 1987), art. 4-11.

[76] Luke Georghiou, "Evolving Frameworks for European Collaboration in Research and Technology," *Research Policy*, vol. 30, no. 6 (2001): 891-903.

[77] Sanz, op.cit.

greater degree of technological interdependence amongst them by joining their "scientific" resources and technological capabilities.[78]

At the beginning of 1970s, joint research activities were institutionalized by the establishment of European Cooperation in the Field of Scientific and Technological Research (COST). COST was established in 1971 as an intergovernmental program for the coordination of nationally-funded research at a European level, and joint research projects have been undertaken since then. Right after the foundation of COST, first signs of forming a common RTD policy for the Union were seen at the Paris Summit in 1972, and the leaders of EU came to an agreement on "coordination of national policies and the definition of projects of Community interest in the areas of science and technology".[79] In 1974, European Council adopted a resolution which focused on: harmonizing national science and technology policies and research procedures, establishing an action program, and preparing forecasting and assessment methodologies in the field of science and technology.[80] The resolution was a big step towards an EU RTD policy. [81] Creation of Directorate General for Research, Science and Education (DG XII) in the European Commission in 1973 as a governance actor and Scientific, and Technical Research Committee (CREST) as the advisory body to the European Council and the Commission in 1974 to oversee the coordination of national policies were the two noteworthy actions for building up an organizational framework. On the other hand, due to the recessions in mid 1970s, because of 1973 oil crisis, EU could not manage real coordination or harmonization among its members.[82]

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[78] Keith Pavitt, "Technology in Europe's Future", *Research Policy*, vol. 1, no. 3 (1972): 210-273.

[79] Luca Guzetti, *A Brief History of European Union Research Policy* (Luxembourg: OPOCE, 1995), 52.

[80] Georghiu, op.cit.

[81] Thomas Banchoff, "Institutions, Inertia and European Union Research Policy," *Journal of Common Market Studies*, vol. 4, no. 1 (2002): 1-21.

[82] ibid.

After waiting for nearly a decade for harmonization of national research procedures and institutionalization activities in cooperative research approaches, European Union research and innovation policies could fully start in the mid-1980s.[83] The major policy instruments of the Union – Framework Programs – also started in this period. The first three Framework Programs were initiated in response to a situation where individual R&D activities were uncoordinated, in which joint research activities were supported between 1984 and 1994 without using any constraints like priority areas.

In EU history, Single European Act (SEA) was a milestone for further integration of Europe, establishment of a Single European Market and building up regional and social policies.[84] Signed in 1986 and entered into force in 1987, SEA revised the Treaty of Rome and added significant items about R&D and related policies to the Treaty. The new title, named "Research and Technological Development"[85] was the most significant addition to the Treaty from scientific and technological research point of view. With this new title, it was aimed to strengthen the scientific and technological basis of European industry and to encourage it to become more competitive at international level[86] and the framework of research policy was defined. Promoting joint research activities via framework programs, providing dissemination of knowledge created by R&D projects, and encouraging the training and mobility of researchers were significant topics which were stated in "Research and Technological Development" title in the SEA.

[83] Paraskevas Caracostas and Uğur Müldür, "The Emergence of a New Europan Union Research and Innovation Policy," in *Research and Innovation Policies in the New Global Economy: An International Comparative Analysis*, eds. Philippe Larédo and Philippe Mustar, 160 (Cheltenham, UK: Edward Elgar Publishing, 2001): 157-204.

[84] Caracostas and Müldür, op.cit., 202.

[85] European Community, "Treaty Establishing the European Economic Community, Part Three - Policy of the Community, Title VI: Research and Technological Development, Article 130f," *Official Journal of the European Community*, 29 June 1987, 10.

[86] ibid., art. 130f.

Although SEA had positive effect on forming a firm infrastructure for EU policy making and institutionalization, member states had difficulties with harmonizing their national research policies. In addition, they could not succeed to catch the wave of new technological developments, especially in information technologies (IT) sector. One of the major factors behind the failure was that EU concentrated its effort on supporting collaborative scientific research, rather than promoting technological development and innovation.[87] While European countries were dealing with scientific excellence issues, USA and Japan became globally leading economies as a result of their success in IT and new economy, which was introduced by the intensive usage of IT in production and services. Japan, and later on other Far Eastern countries, such as South Korea, Taiwan and China became dominant in hardware, where USA became number one in software development.[88]

Europe did not show poor performance only in IT sector, but also in majority of high technology spectrum. Major problem –named as the "European Paradox" – is that, although European countries were in a leading position in terms of scientific research and output, they were lagging behind the ability of converting this strength into wealth-generating innovations.[89] Scientific output as measured by the number of publications per million population, and patent-to-population ratio[90] is considered to be an indicator of innovative activity directly related to technological enhancements. According to OECD, the number of scientific publications per million population in EU15 was 32.5, where USA and Japan published 30.9 and 8.8 scientific articles per million population, respectively.[91] On the other hand, patent-to-population ratio of

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[87] Georghiu, op.cit., 894.

[88] Daniele Archibugi and Alberto Coco, "The Technological Performance of Europe in a Global Setting," *Industry and Innovation*, vol. 8, no. 3 (2001): 245:266.

[89] Giovanni Dosi et.al., " Science-Technology-Industry Links and the 'European Paradox': Some Notes on the Dynamics of Scientific and Technological Research in Europe," in *How Europe's Economies Learn: Coordinating Competing Models*, eds. Edward Lorenz and Bengt-Åke Lundvall, 261 (New York: Oxford University Press, 2006): 258-291.

[90] Patents per million population which are registered at the US, European and Japanese Patent Offices.

[91] OECD, *Science, Technology and Industry Scoreboard 2005* (Paris: OECD, 2005), 41.

EU15 was the lowest compared to its competitors with 43 patents, where USA had 58 patents and Japan showed the highest performance with a patent-to-population ratio of 92.[92]

Regarding that poor performance in innovation and underachievement in intergovernmental approach to RTD policies of the Union, the Research Commissioner Antonio Ruberti argued in 1993 that EU should establish a "truly European Research Policy", rather than keeping it as a "simple juxtaposition" of national programs and intergovernmental research projects,[93] to catch-up USA and Japan. EU was not only lagging behind its competitors in technological and innovative efforts, but also in R&D expenditure. Europe needed to increase its R&D expenditures and turn more of the knowledge created by those programs/projects into innovations, and contribute to their economic growth.

With Maastricht Treaty in 1993, the objectives of the EU research policy were reshaped to coordinate with other EU policies at supranational level,[94] and the European Commission was charged with coordination of research policies across Europe.[95] The concerns for coordination, further integration and closing the gap between USA and Japan contributed to the emergence of a new policy term added to EU research policies: innovation.

3.3 Emergence of Innovation in EU Research Policies: 1995-2000

The lack of sufficient actions in support of innovation has been recognized by the Commission itself which produced a well defined analysis of the situation in its Green Paper on Innovation. The release of "Green Paper on Innovation" in 1995 is

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[92] ibid., 69.

[93] Antonio Ruberti, "The Future of the Community Research", speech at The European Institute, Washington, May 20, 1993, Cordis News Service, May 24, 1993.

[94] Caracostas Müldür, op.cit.

[95] European Commission, *Future Directions of Innovation Policy in Europe* (Luxembourg: Office for Official Publications of the European Communities, 2004), 46.

considered as the milestone of EU Innovation Policy, where innovation was accepted as the driving force behind the entire business policy.[96] Regarding the European Paradox, problems with turning technological research into competitive results and innovation were determined, and a detailed framework for an innovation policy was prepared with the document.

The “First Action Plan for Innovation in Europe” was released in 1996 as a thorough implementation plan for the Green Paper on Innovation. The main areas for action were determined as fostering an innovation culture, establishing a framework conducive to innovation, and better articulating research and innovation.[97] Each action area was detailed into subsections with several programs under each subsection. The action plan focused both on the short-term actions such as revising regulations on incentives, and long-term issues such as creating a Union wide infrastructure with all links and institutions that would make it a favorable environment for innovation.

The Action Plan was in fact prepared by a “systemic” approach to innovation concept, in which innovation is seen to be taking place as a result of complex interactions between many individuals, organizations, institutions and environmental factors. This approach was related to the Innovation Systems concept mentioned in previous chapter, and it was in fact pointing to a European Innovation System, a supranational restructuring of National Innovation Systems of member states. Another important point in the plan was that it was agreed to monitor innovation performance of EU by using main science and technology indicators, such as R&D intensity (the amount of R&D expenditures as a percentage of GDP) and researcher statistics periodically.

However, the first attempt to create a complete innovation policy framework for EU did not produce desired enhancement in R&D activities. EU made 346 ECUs of

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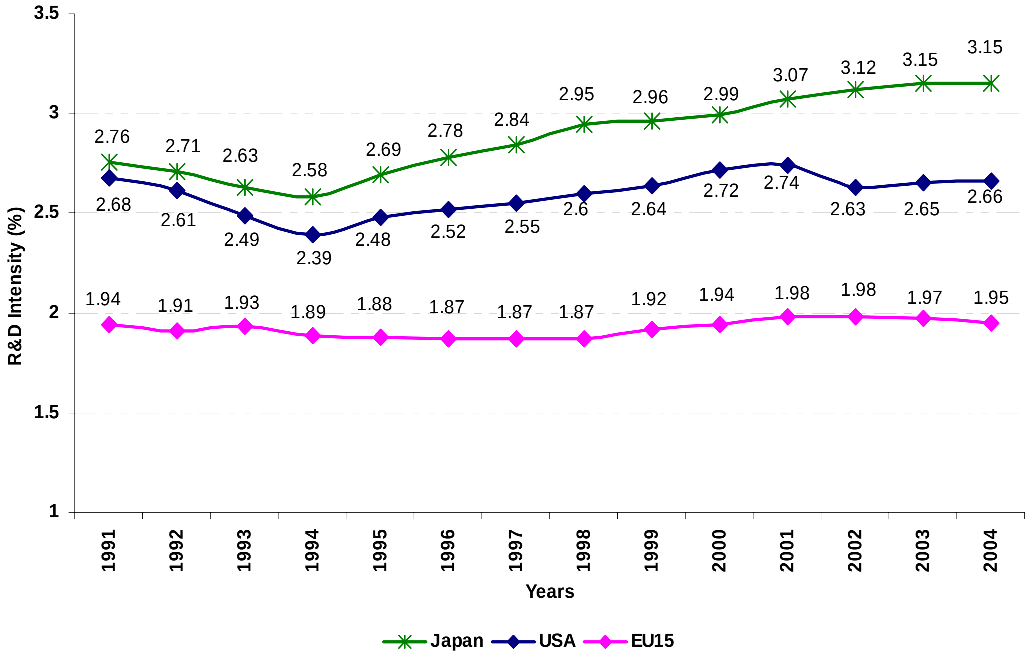
[96] European Commission, *Green Paper on Innovation, COM(1995) 688* (Brussels: European Commission, 1995), 5.

[97] European Commission, *The First Action Plan for Innovation in Europe: Innovation for Growth and Employment* (Brussels: European Commission, 1996), 3.

R&D expenditure in EU in purchasing power standards (PPS), where USA and Japan were investing 752 and 648 respectively by the end of the 1990s.[98] Moreover, R&D intensities of EU, USA and Japan were 1.92%, 2.64% and 2.96% respectively, showing a huge gap. Indeed, the gap was even wider with respect to the first half of 1990s. Figure 3.1 shows the R&D expenditures per GDP of EU compared to USA and Japan in this decade.[99] The gap that tended to narrow in the first half of the decade was not because of increasing EU investment in R&D but decreases in the amounts of USA and Japan. Throughout the second half of the decade, R&D intensities of USA and Japan increased considerably, where this amount decreased in EU – except the gradual increase between 1999 and 2002.



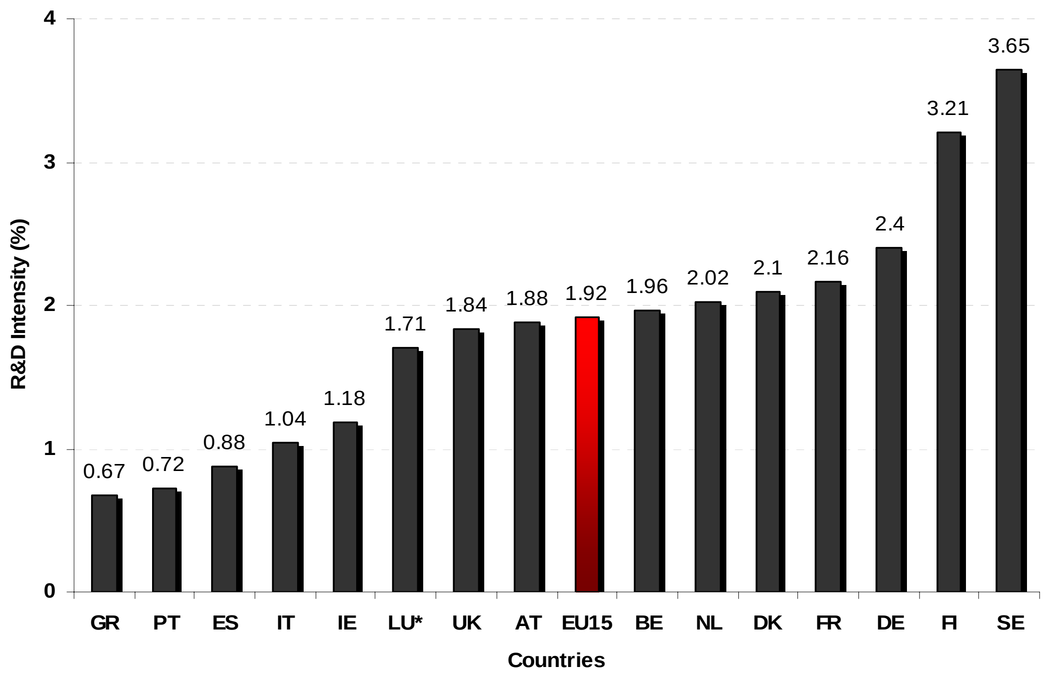
Source: Eurostat, NSF, 2006.

Figure 3.1: R&D Intensities (%) of EU15, Japan and USA (1991-2004)

[98] Caracostas and Müldür op.cit., s. 165.

[99] No data is available for EU15 before 1991.

Besides the low overall R&D intensity, member states had considerable differences in levels of national R&D expenditures. Figure 3.2 shows R&D intensities of 15 EU member states in 1999. Greece had the lowest rate of R&D intensity among the member states with 0.67%, where that rate reached top with 3.21% in Finland and 3.65% in Sweden. The significant difference between lowest and highest levels, and the high variance of R&D intensity among member states shows that coordination of research and innovation policies could not be succeeded. In addition, the continuity of dominance of national R&D activities over transnational activities at EU level, and low level of knowledge flow that caused fragmentation of R&D among member states remained as a crucial problem. As a result, it was hard to talk about harmonization and cohesion – in the means of reducing disparities among member states – of national policies towards an EU innovation policy.[100]



Source: Eurostat, 2006.

Figure 3.2: R&D Intensities (%) of EU15 Member States, 1999

[100] Georghiu, op.cit., 894.

3.4 Lisbon Strategy and EU Research and Innovation Policies in 2000 and Beyond

The new millennium started with considerable changes in the European Union approach to research and innovation policies. Firstly, European Commission redefined the scope of EU research and innovation policies by "European Research Area" (ERA) concept in its communication "Towards a European Research Area" released in January 2000. ERA was significant for being a big move of EU to manage the transition of research and innovation policies of the Union from an intergovernmental to a supranational level. The Commission admitted in this communication that the European research effort was no more than the simple addition of the efforts of the 15 Member States and the Union, and the fragmentation of research efforts would only serve to compound the impact of lower investment in knowledge.[101] It seemed that there had been no improvement towards establishing a European level policy in research and technological development since Ruberti's assertion in 1993. ERA initiative focused defining a European research policy in broader terms than research programs and projects such as, renovation of European research infrastructure, completing the integration of national research policies with a European level policy, increasing the mobility of researchers and rate of knowledge diffusion, and having a standardized European patent system.[102] One of the major ambitions behind ERA was to make the research sector what single market has been for commercial exchanges.[103]

After the declaration of ERA initiative, European Council held a special meeting in March 2000 in Lisbon. The Council agreed on a new goal in this meeting, which would reshape EU research and innovation policies – together with ERA – during the

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[101] European Commission, *Towards a European Research Area, COM(2000) 6* (Brussels: European Commission, 2000), 7.

[102] Paraskevas Caracostas, "Sharing Visions: Towards a European Area for Foresight", *Paper Presented at The Second International Conference on Technology Foresight,– Tokyo, 27-28 Feb. 2003*.

[103] Álvaro de Elera, "The European Research Area: On the Way Towards a European Scientific Community?," *European Law Journal*, vol. 12 no. 5 (2006): 559-574.

upcoming years: *to become the most competitive and dynamic knowledge-based economy in the world* (by 2010)*, capable of sustainable economic growth with more and better jobs and greater social cohesion.*[104] One of the strategies to reach that goal was determined as to prepare the transition to a knowledge-based economy and society by enhancing R&D and information society policies, as well as by stepping up the process of structural reform for competitiveness and innovation.[105] Enhancing R&D and information society policies included developing mechanisms for networking of national and joint research programs that would be based on a voluntary participation of both public and private sectors without being bound to priority research areas.[106] The main idea behind the approach was to let market conditions and technological trends lead research activities, and speed up the conversion of knowledge created during research into innovations.

However, rapidly changing technological trends in the new millennium and emergence of new industries based on high technology appears as a challenge that European countries should overcome. Europe held the comparative advantage in moderate technology and traditional industries after recovering their national economies in the post-war period. Adapting existing technologies and making incremental improvements seemed sufficient to preserve the international competitiveness of firms and to increase the living standards of European citizens. The inertia in shifting away from such traditional industries and dedication of countries to the sustainability of mature industries slowed down the response of Europe to technological shifts.[107] On the other hand, Lisbon strategy was a milestone to take action towards a more innovative environment supported with enhanced R&D activities.

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[104] European Council, *Presidency Conclusions, Lisbon European Council, 23 and 24 March 2000* (Lisbon: European Council, 2000), 2.

[105] ibid.

[106] ibid.

[107] Paul J.J. Welfens et.al., *Technological Competition, Employment and Innovation Policies in OECD Countries* (Berlin, Heidelberg: Springer – Verlag, 1998), 165.

Within the scope of Lisbon Strategy,[108] European Council set an ambitious target in its meeting in March 2002 in Barcelona and agreed to increase overall spending on R&D and innovation in the Union to 3% of GDP by 2010, where two-thirds of this new expenditure was expected to come from the private sector.[109] Council also agreed to improve the implementation of intellectual property rights across Europe, to further develop and strengthen the use of risk capital in research, and consecutively increase networking between business and the science.[110] The goal of 3% percent R&D intensity was very high compared to the 2001 rate of 1.98%, therefore the entire research and innovation policies were based on the target of 2010 and the Council decided to focus on implementation, rather than on debates and elaborations of guidelines.

Both Lisbon strategy and Barcelona target made ERA the major achievement for the future goals of the Union. Initially, the aim of ERA was to integrate the research environment of the Union in 2000. In addition to be a "Single Market" of researchers, it was intended to construct the core of the European Innovation System with ERA. EU plans to complete the construction of ERA – together with European Innovation System – and provide full functionality by the end of 2010. The major research and innovation policy instrument of EU are the Framework Programs, which will be examined in detail in Section 3.6. In this context, the Seventh Framework Program (2007-2013) plays crucial role in completion of ERA.[111]

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[108] The agreement in Lisbon meeting is called as the Lisbon Strategy.

[109] European Council, *Presidency Conclusions, Barcelona European Council, 15 and 16 March 2002* (Barcelona: European Council, 2002), 4.

[110] ibid.

[111] European Union has several policy implementation tools other than Framework Programs, which will be analyzed in the "3.6 Policy Implementation and Framework Programs

" section.

As shown in Table 3.1, FP7 has four specific programs, namely Cooperation, Ideas, People and Capacities, and each of these programs has its own objectives.[112] The classification of specific programs in FP7 shows the change in EU research and innovation policies.

Table 3.1: Specific Programs and Objectives in Seventh Framework Program

Specific Program	**Objective**
Cooperation	To support all types of research activities carried out by different research bodies in trans-national (within EU member states) cooperation, as well as international (with third countries) cooperation with non-EU countries.
Ideas	To encourage production of new ideas and creation of knowledge by supporting frontier scientific and technological research. Founding an independent European Research Council is a topic of this program.
People	To provide support to researchers, supporting their career development and mobility by means of an expansion of the existing 'Marie Curie' exchange program.
Capacities	To improve research capacities throughout Europe. The main actions include support to research infrastructures, research for the benefit of SMEs, regional research-driven clusters, help for convergence regions to unlock their full research potential, 'Science in Society' (activities aimed at strengthening the link between science and society in general) and horizontal activities of international cooperation.

Source: CORDIS, 2006.

First of all, international cooperation with non-EU countries is explicitly identified to provide knowledge flow towards the Union and enhance the absorption of new technologies by EU member states. According to Edler and Meyer-Krahmer,

[112] CORDIS, "The main objectives of FP7: Specific programmes", http://cordis.europa.eu/fp7/objectives.htm, (accessed June 27, 2006).

[113] increasing international cooperation is an appropriate approach, but should not only remain in industrial cooperation level. They assert that, in the globalization era, not only the know-how produced in the national innovation systems of countries, but also other issues, such as education and training, are increasing their significance in the international exchange of knowledge. Therefore, it is not enough to encourage the mobility of higher education and graduate students, researchers or technical staff within the EU, but they should also be supported to improve their skills and accumulate their knowledge in non-EU countries. Secondly, the "ideas" – not only solid activities – that would contribute to innovations are supported. Thirdly, researchers are encouraged to work in different places that would help them both to develop their careers and to diffuse their knowledge around the Union, and help the formation of the "Single Market" of researchers.

Thematic research areas that are chosen as the future priorities of EU are handled under the specific program of 'Cooperation'. There are ten themes in FP7: Health; food; agriculture and biotechnology; information and communication technologies; nanosciences and nanotechnologies; materials and new production technologies; energy; environment (including climate change); transport (including aeronautics); socio-economic sciences and the humanities; security; and space. The structuring of research areas shows that EU is defining its priorities according to developments and trends in the world.

In addition to the new trends in FP7, the budget of the program is considerably increased to reach the Barcelona target. European Council agreed the budget of FP7 to be 50.521 billion Euros in 2006 prices,[114] which is nearly three times of the budget of FP6. However, the huge amount of increase in the budget of FP7 maybe misleading without paying attention on two significant points. First of all, the

[113] Jacob Edler and Frieder Meyer-Krahmer, "How International are National (and European) Science and Technology Policies?" in *Innovation Policy in a Knowledge-Based Economy: Theory and Practice,* eds. Patick Llerena and Mireille Matt, 330 (Berlin,Hidelberg: Springer-Verlag, 2005), 319-337.

[114] European Council, *2747th Council Meeting, 24 July 2006: Competitiveness (Internal Market, Industry and Research)* (Brussels: European Council, 2006), 7-9.

duration of FP7 is longer than the previous Framework Programs. FP7 will last seven years, from 2007 to 2013, where durations of Framework Programs have been specified as five years, on the average. Comparing the average annual budgets of FP7 and FP6 will make it easier to see the real increase in the budget of FP7. With 17.5 billion Euros gross budget and five years duration, the average annual budget of FP6 is 3.5 billion Euros, where the average annual budget of FP7 can be calculated as 7.22 billion Euros by dividing its gross budget of 50.521 billion Euros by the seven years duration. As a result, the increase in FP7 budget turns out to be around two times.

Second significant point that would affect the real increase in FP7 budget is the enlargement of EU. The budget of FP7 is prepared by the enlarged Union with 25 instead of 15 members, which means an increase of two thirds in the participants of the Program.[115] In other words, share of each country will decrease in the budget of FP7, compared to FP6, and it also reduces the rate of increase per country. Therefore it can be concluded that the real increase in FP7 budget is far less than two times of the budget of FP6, due to enlargement and extended duration of the upcoming Program.

Finally, increasing the budget of Framework Programs did not always contribute to same amounts of increase in R&D intensities. As an example, the budget of FP4 was more than two times higher than the budget of FP3. However, R&D intensities in 1994-1998 period did not increase, but decreased, compared to the period of FP3 (see Figure 3.1). Moreover, EU needs to achieve an average annual growth rate of 7.5 percent in R&D intensity to reach the Barcelona target of three percent R&D intensity from the 1.95 percent of 2004, which is an ambitious rate according to the trend of R&D intensities since the beginning of the 1990s. R&D intensity of EU had an average annual growth rate of only 0.048 percent in 1991-2004 period.

In the light of the above calculations, the insufficient contributions of Framework Programs on R&D intensity of EU and the trend of R&D intensities in the new

[115] Participants out of the Union such as Turkey are excluded to simplify the calculation.

millennium, the overall opinion of authorities and specialists is that it is nearly impossible to reach Barcelona target by the end of 2010.[116] After the release of Kok report, which was prepared by the High Level Group of experts stating the likely failure of Barcelona target and proposing new methods to achieve the goals of Lisbon, EU re-launched Lisbon strategy in 2005.[117] However, the outcomes of the re-launch are yet to be seen.

3.5 Organizational and Institutional Setup

Veugelers pointed out that, there is a need for close cooperation at various levels in society, like cooperation involving the political leadership, educational organizations, research institutes, venture capitals, as well as the industry. Such cooperation can be managed by high levels of collaboration among policy makers, both in terms of action at the EU level, and sharing good practice and understanding at the national level, which in fact implies the "systemic approach" and developing an EU innovation system where knowledge flows connect and network all member states.[118]

At this point, it would be useful to analyze the current organizational and institutional setup of EU research and innovation policies in the light of Innovation Systems theory. Due to the complex and systemic nature of innovation, which is discussed in Section 2.4., it can be said that research and innovation policy is a "horizontal" policy linking traditional areas such as economic, industrial and

[116] Iain Begg, "How to Get the Lisbon Strategy Back on Track," *Intereconomics*, vol. 40 no. 2 (2005): 56-73, see also Wim Kok, *Facing the Challenge: The Lisbon Strategy for Growth and Employment. Report from the High Level Group chaired by Wim Kok, Luxembourg 2004* (Luxembourg: Office for Official Publications of the European Communities, 2004), 20.

[117] European Commission, *Working Together for Growth and Jobs: A New Start for the Lisbon Strategy, COM(2005) 24* (Brussels: European Commission, 2005), 17.

[118] Reinhilde Veugelers, "Assessing Innovation Capacity: Fitting Strategy, Indicators and Policy to the Right Framework," *Paper Presented at Conference of Advancing Knowledge and the Knowledge Economy, Washington 10-11 January 2005.*

educational policies.[119] Hence, organizational and institutional setup of EU will be analyzed in this context. In addition, European Union has a unique research infrastructure that represents a jigsaw of different national research and innovation policies of its member states within ERA and under multilevel governance of both the European Commission and member state governments. Therefore, it is not easy to apply one of the innovation system models studied in Section 2.3 to fully represent the organizational and institutional setup of EU. On the other hand, the representation in Figure 2.1 in Chapter 2 would be the most appropriate model for the EU innovation system, which is also used by the European Commission to illustrate the European Research Area.[120] Figure 3.3 illustrates the applied framework of EU innovation system.

The major policy making body of EU is the European Commission.[121] There are two Directorate Generals which are responsible for the development of EU research and innovation policies: DG for Research, and DG for Enterprise and Industry. Under the responsibility of the Commissioner for Science and Research, DG for Research works as the developer of the European Union's policy in the field of research and technological development. DG for Research also coordinates European research activities with those carried out at the level of the Member States and supports the Union's policies in other fields including R&D activities, such as environment, IT, energy and regional development.[122] The instruments used for the implementation of research and innovation policies of EU, such as the Sixth

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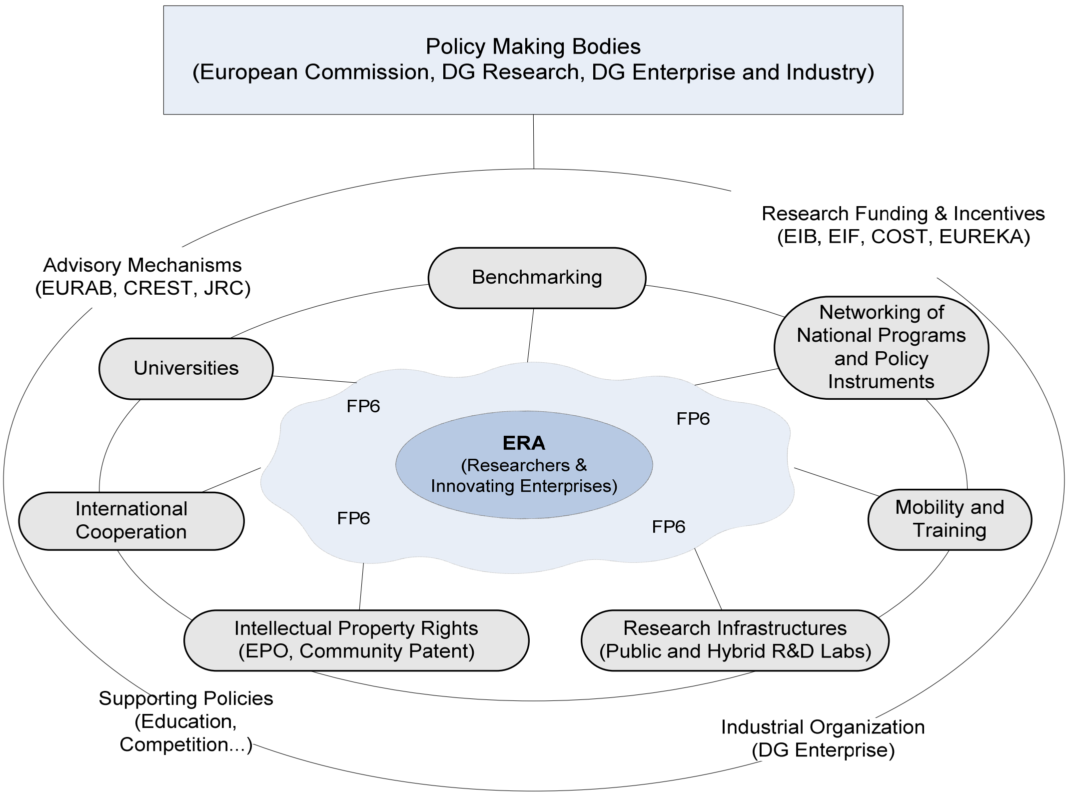
[119] European Commission, *Innovation in a Knowledge Driven Economy, COM(2000) 567* (Brussels: European Commission, 2000), 7.

[120] European Commission, "European Research Area," http://ec.europa.eu/research/era/index_en.html (accessed November, 2, 2006).

[121] The European Commission is made up of representatives (Commissioners), one from each member state, and is divided into 26 directorates-general (DGs) and nine services. Each DG deals with certain policy areas. There is a corresponding Commissioner responsible for one or more policy areas, to whom related DGs are connected. Commission prepares and proposes legislations on which the European Parliament and the Council decide as the highest governing structure of the Union and applies them after they are adopted.

[122] European Commission, Research Directorate-General, "The mission of Research Directorate-General", http://ec.europa.eu/dgs/research/index_en.html, (accessed June 20, 2006).

Framework Program, are also managed by DG Research. Last but not least, DG for Research is the main actor in the ERA initiative. These tasks and duties undertaken show the dominance of this Directorate-General in development of research and innovation policies.



Source: DG Research, 2006.

Figure 3.3: Organizational and Institutional Setup of EU Research and Innovation Policies

Innovation side of European research and innovation policies is identified as a topic under the responsibility of DG for Enterprise and Industry.[123] DG for

[123] European Commission, "European Innovation Policy - The Main Activities of Directorate-General for Enterprise and Industry in Support of Innovation", http://ec.europa.eu/enterprise/innovation/index_en.htm, (accessed June 30, 2006).

Enterprise focuses on innovation policy development and implementation, as well as monitoring activities. Within the scope of Lisbon strategy and Barcelona target, and the mission of "structuring the European Research Area", the main activities of the Directorate-General can be summarized as innovation policy development, policy analysis, sectoral innovation stimulation, and technology transfer support.[124] Innovation policy development and implementation somehow overlaps with policy development task of DG for Research due to the closed relation between research and innovation. On the other hand, DG for Enterprise focuses on the implementation part of the policy and takes fostering of innovation among innovators (entrepreneurs and enterprises, especially SMEs) as its responsibility in the field. It coordinates and provides support services for industry via networking agencies within ERA, such as Innovation Relay Centers[125] (IRCs) and Network of Innovating Regions in Europe (IRE).[126] DG for Enterprise also analyzes the information on innovation throughout the EU to benchmark the innovation performance of the Union.

EU uses a variety of advisory mechanisms, which are created by the European Commission, during policy development and implementation processes. There are mainly three advisory bodies that EU cooperates for research and innovation policies: European Research Advisory Board (EURAB), Scientific and Technical Research Committee (CREST), and Joint Research Center (JRC).

First and the most significant of them is EURAB. Created in 2001 by a decision of the European Commission, EURAB is a high-level, independent advisory committee made up of experts coming from various academic and industrial

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[124] ibid.

[125] The IRC Network assists companies and research organizations with technology transfer, license agreements, intellectual property rights (IPR) and identify sources to finance innovation. There are 71 IRCs in 33 countries, including Turkey. There are two IRCs in Turkey. IRC-Ege is located in Ege University, Science and Technology Centre, İzmir and IRC-Anatolia is located in METU Technopolis, Ankara.

[126] The Innovating Regions in Europe (IRE) network is a joint platform of regions that are developing or implementing regional innovation strategies. Member regions are encouraged to collaborate and exchange their experiences, access tools and inter-regional learning opportunities on innovation. There are currently 235 member regions in 32 countries. Turkey is participating in IRE with two regions; Eskişehir and Mersin.

backgrounds. It provides consultancy services to the Commission on the design and implementation of EU research policy, or delivers advice and opinions on specific issues either at the request of the Commission or on its own initiative.

The second advisory board is CREST, which is composed of representatives nominated by the member states (two per country). Besides its monitoring and evaluation activities on national R&D policies, CREST assists the Council and the Commission by issuing reports upon request of either of the two bodies or its own initiative, on subjects relating to scientific and technical research.[127]

The third advisory body of the Commission is the JRC, which is a Directorate General. JRC, under the responsibility of the same Commissioner as DG Research, is established to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. JRC works as an "internal" advisory body of the Commission and its policy-making Directorates-General (DGs), as well as the Council, European Parliament and Member States.

Funding of research and innovation, incentives and other supporting mechanisms in EU show a complex structure. European Investment Bank (EIB) acts as the EU's financing institution that supports public and private sector R&D activities. European Investment Fund (EIF) is another financing institution which acts as a venture capital for entrepreneurs and SMEs. Both EIB and EIF are financially autonomous institutions. There are several other research and innovation funding mechanisms through Framework Programs and intergovernmental research programs / projects, such as COST. Member states also have their own funding and incentive structures. Tax exemptions, the common incentive mechanisms, are under the authority of national governments. Member states have local institutions to provide financial support for research and innovation, such as Tekes in Finland, and Anvar in France. EU currently enjoys a wide innovation friendly environment at the supranational level, but according to Borrás there is not enough information at hand to assert

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[127] CORDIS, "Scientific and Technical Research Committee", http://cordis.europa.eu/spain/24032002.htm, (accessed June 25, 2006).

whether it is the same at the national level in member states or not. [128] The clearest evidence is the diversity of R&D expenditures of member states, but it is not right to conclude that the main reason is the lack of funding or incentives.

Lisbon strategy and Barcelona target can be seen as the vision of EU research and innovation policies, where the scope of these policies is the ERA. The Sixth and Seventh Framework Programs are designed as the main supporting actions to form the structure of ERA. Therefore, it will be appropriate to see ERA at the center of the system surrounded by complementary institutions such as national programs, patenting regulations and other supporting policies.

Combination of the structure of ERA with policy making bodies and related actors makes EU Innovation System organizationally complete according to the definitions of Innovation Systems mentioned in Chapter 2. However, the dynamics and the efficiency of the linkages between organizations and institutions, and how well they stimulate innovation are not investigated enough to come to a conclusion that EU has a fully-functioning innovation system.[129] Edquist asserts that, it is not possible to say that the EU Research and Innovation System is rudimentary after all the efforts on institution building at EU level,[130] but according to Borrás it is early to define it as a fully-structured system either.[131] Moreover, ERA is still under construction and yet to be completed until the end of the upcoming Framework Program. Although the mid-term evaluations on the Lisbon strategy are pessimistic about the success of the strategy and ERA, the outcomes on EU research and innovation policies for 2005 and 2006 are still unknown and the effects of FP7 as the major policy implementation tool on the performance of the Union is to be observed.

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[128] Susana Borrás, "Systems of Innovation Theory and the European Union," *Science and Public Policy*, 431, vol. 31, no. 6 (December 2004): 425-433.

[129] ibid.

[130] Charles Edquist, *ISE Final Report: Scientific Findings and Policy Implications of the 'Innovation Systems and European Integration' (ISE) Research Project* (Linköping: Linköpig University, 1998), 36.

[131] Borrás, op.cit., 432.

3.6 Policy Implementation and Framework Programs

Within the context of the organizational and institutional setup of European Union research and innovation policies which is analyzed in the previous section, the main task of the Union was to promote the harmonization of national policies among the member states and, consequently to achieve the convergence of their research and innovation capabilities. In addition, it was needed to prevent redundant research activities, and to maximize beneficial results by uniting knowledge and researcher inventories of countries.[132] Research and innovation policies of EU have been implemented via cooperative intergovernmental research projects and programs financially supported by the Union. Several research programs have been launched by the Union to reach those objectives, as well as to promote cohesion of research and innovation policies of member states. Main policy tools, such as COST, ESPRIT, EUREKA and the Framework Programs will be discussed in this section.

COST is the oldest intergovernmental program of the European Union. Started in 1971 and still running, COST has been focused on coordinating basic and not market-oriented research projects at European level.[133] With 34 member states and an annual project budget turnover of 2.0 billion Euros,[134] COST has developed into one of the largest frameworks for research cooperation. Turkey is also a member of COST since the beginning of the program. One interesting feature of COST is that a COST project can be initiated in any subject within the research domain[135] by

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[132] Paul Diederen et.al., *Innovation and Research Policies: An International Comparative Analysis,* (Cheltenham, UK: Edward Elgar, 2000), 10-24.

[133] European Science Foundation, *About COST: 2005* (Brussels: COST, 2005), 7.

[134] ibid.

[135] COST actions should fall in any of the following areas (domains):
Biomedicine and Molecular Biosciences
Food and Agriculture
Forests, their Products and Services
Materials, Physical & Nanosciences
Chemistry and Molecular Sciences & Technologies
Earth System Science & Environmental Management
Information & Communication Technologies
Transport & Urban Development
Individuals, Society, Culture & Health

individual scientist from any of the COST countries or by the European Commission. This "bottom-up" approach gives flexibility and comfort for action, but projects are expected to be international, in cooperation with a number of countries and of public concern in which society has a particular interest.

ESPRIT (European Strategic Program of Research and Development in Information Technology) was born as a result of concerns about the lagging of European countries behind USA and Japan in IT sector. The main idea behind ESPRIT was to develop European IT industry further to compete with leading countries and gain new markets worldwide.[136] ESPRIT program was launched in 1984, became a part of EU's Fourth Framework Program that ran from 1994 to 1998 and stopped accepting new projects in 1999.

Created in 1985 – shortly after ESPRIT – as an intergovernmental program, EUREKA (European Research Coordination Agency) is a pan-European network for market-oriented, industrial R&D.[137] EUREKA has 38 members, including Turkey as the founding member. EUREKA financially supports high technology R&D activities within the thematic areas[138] and oriented by the market with the aims to increase the competitiveness of European industry worldwide and to encourage production of high quality goods and services. EUREKA focuses on especially promoting SMEs, encouraging cross-border cooperation and industry-research institution collaboration. According to July 2006 data, EUREKA supports 700 projects in progress with a total budget of 1.7 billion Euros. There are 2760 organizations involved in running projects. As seen in Table 3.2, SMEs have the majority with a 43% of share in total number of organizations. Considering the

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Topics falling outside domains are supported under a "Interdisciplinary Exploratoria" heading.

136 Wayne Sandholtz, *High-Tech Europe: The Politics of International Cooperation* (Berkeley: University of California Press, 1992), 167.

137 EUREKA, "About the Initiative-Mission and Objectives", http://www.eureka.be/about.do#content, (accessed June 03, 2006).

138 Thematic areas of EUREKA are: Medical and Biotechnology, Information Technologies, Industrial Processing, Communication, Transport, Energy, and Environment.

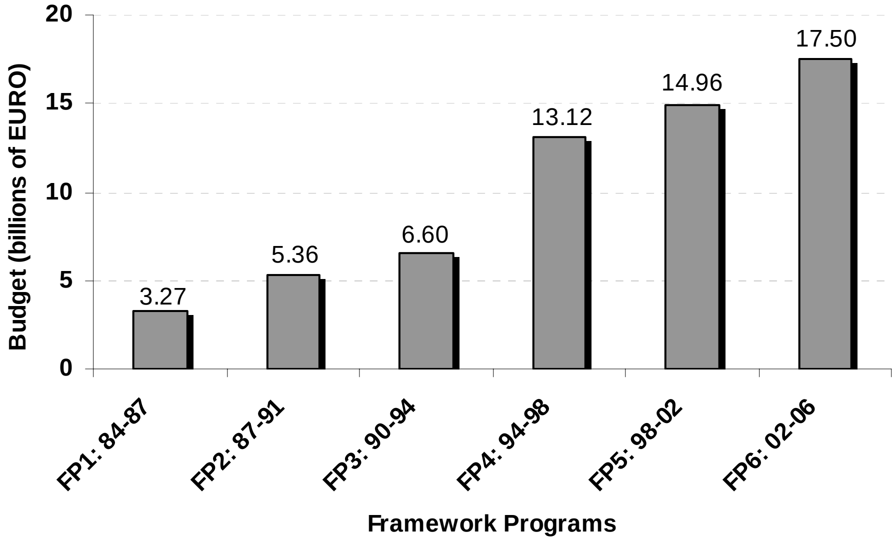
number of universities and research institutes, it can be said that there is a fair distribution in attendance of different bodies other than SMEs to projects, which makes EUREKA a successful initiative for cooperation and collaboration.

Table 3.2: Organizations Involved in EUREKA Projects, July 2006

Type of Organization	**Number of Organizations**	**Share (%)**
Business Enterprises	1,770	64.13
Large companies	*583*	*21.12*
SMEs	*1,187*	*43.01*
Research Institutes	491	17.79
Universities	435	15.76
Government/National Administration	64	2.32
Total	**2,760**	**100.00**

Source: EUREKA, 2006.

Among the R&D programs launched by EU, the most significant policy applications have been the Framework Programs (FPs). These multi-annual programs were started in 1984 with FP1, as a financial support mechanism planned to support collaborative RTD projects throughout the Union, and have evolved into the main policy application instruments aimed at improving the Union's economic competitiveness, as well as research and innovation capabilities. FPs became the main funding instruments for projects, especially after the Third Framework Program. Figure 3.4 shows the budgets of Framework Programs in billions of EURO. Started with 3.27 billion Euros, the budget of Sixth Framework Program reached 17.5 billion Euros.



Source: CORDIS, European Council, 2006.
Figure 3.4: Budgets of Framework Programs (Billions of EURO)

The First FP (FP1: 1984-1987) was intended to provide a wider framework within which individual programs could find a place and interact with each other.[139] The Second FP (FP2: 1987-1991) was designed to act within the scope of Single European Act, to promote research related to the needs of industry and realization of the Single Market.[140] Preserving the principles and aims of FP2, the Third Framework Program (FP3: 1990-1994) focused on selecting the proposed R&D actions according to their contribution to the implementation of Community policies. In addition, it was particularly aimed to strengthen the scientific and technological basis of European industry – including SMEs – in strategic "high technology fields", and encourage it to become more competitive at international scale.[141]

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[139] Yellow Window Consulting and European Commission, DG Research, *Identifying the constituent elements of the European Added Value of the EU RTD programmes: conceptual analysis based on practical experience-Final Report* (Antwerpen: Yellow Window, 2000), 5.

[140] ibid., 6.

[141] ibid.

Reflections of Ruberti's arguments, where he emphasized the need for an integrated research policy at Union level and the emergence of the "new economy" mentioned in Chapter 2 can be seen in the Fourth Framework Program (FP4: 1994-1998). Due to the gap in R&D intensities between EU, and USA and Japan, the Union agreed to increase the budget of FP4 from 6.60 to 13.12 billion Euros. The scope of FP4 was enlarged with an additional aim of encouraging research actions which contribute to the mobilization of researchers to improve co-ordination among national RTD programs, and among Community programs.[142] As seen in Table 3.3, projects to be supported in FP4 were classified in 11 activity areas. One noteworthy detail in FP4 was that, innovation concept was handled via a special program called "INNOVATION Programme" under "Dissemination and Exploitation of Results" activity. The main aim of the "INNOVATION Programme" was to promote an environment favorable to innovation and the absorption of new technologies by enterprises.[143] Another significant point is that, due to the rise of ICT industry and its significant contribution to economies, ESPRIT was included in FP4 and became a sub-program of "ICT" activity within the Fourth Framework Program.

After the addition of Innovation Policy to EU agenda with the release of "Green Paper on Innovation" and defining innovation as the driving force of economic growth and development, the contents, structure and approaches in the next Framework Program had changed. The main aim of the Fifth Framework Program (FP5: 1998-2002) was to create an environment to stimulate innovation process across Europe. Integrating the "innovation" and "SME" dimensions was one of the issues in the Action Plan for Innovation[144] that goes in line with that aim. As a result, a program named "Promotion of innovation and encouragement of SME participation" entered FP5, shown in Table 3.3. With FP5, EU introduced a new way

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[142] ibid, 7.

[143] CORDIS, "The European Commission's INNOVATION Programme", http://cordis.europa.eu/innovation-fp4/, (accessed June 05, 2006).

[144] European Commission, *The First Action Plan for Innovation in Europe: Innovation for Growth and Employment* (Brussels: European Commission, 1996), 8.

of organizing EU research activities: the “key actions”. The structure of FP was also reorganized. Unlike previous FPs that addressed research titles by names of scientific and technological disciplines, FP5 grouped research activities under “thematic programs” and “horizontal programs” titles. Both thematic and horizontal programs were defined as policy-oriented activity areas, such as renewable energy, and environment, and concentrated on reaching socio-economic goals by R&D and innovations, like increasing quality of life and improving human research potential. In addition to the new approach, it was intended to increase linkages between research and innovation policies and other EU policies.[145]

The latest of the Framework Programs is the current Sixth Framework Program (FP6: 2002-2006). FP6 was mainly planned as an instrument to contribute to the creation and completion of ERA by improving and coordination or research in Europe.[146] FP6 has three major priorities and they form the main components of the program: focusing and integrating European research, structuring the ERA, and strengthening the foundations of ERA. Research areas to be supported are grouped into seven “thematic areas” as illustrated in Table 3.3. Nanotechnology as a new topic of high technology area and sustainable development and global change as socio-economic fields show the multi-priority structure of FP6. Activities to support SMEs so that they can increase their technological and innovation capabilities, to encourage international cooperation by letting third country participation and to improve research activities of Joint Research Centers are included as actions complementing thematic areas. Mobility of researchers under “Marie-Curie Actions” subprogram, stimulating the coherent development of research and technology policy in Europe and developing a society closer to science and increasing the attraction of society to innovation concept are noteworthy actions planned under ERA-related components.

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[145] Caracostas and Müldür op.cit., 203.

[146] European Commission, *The Sixth Framework Programme in Brief* (Brussels: European Commission, 2002), 3.

Table 3.3: Activity Areas and Priorities in Framework Programs[147]

Framework Programs	**Activity Areas**
FP4	Activity Areas: • ICT • Industrial Technologies • Environment • Life Sciences and Technologies • Energy • Research & Training in the Nuclear Sector • Transport • Targeted Socio-Economic Research • Cooperation with Third Countries and International Organizations • Dissemination and Exploitation of Results • Stimulation of the training and mobility of researchers
FP5	Thematic Programs: • Quality of life and management of living resources • User-friendly information society • Competitive and sustainable growth • Energy, environment and sustainable development Horizontal Programs: • Confirming the international role of Community research • Promotion of innovation and encouragement of SME participation • Improving human research potential and the socio-economic knowledge base
FP6	Thematic Areas: • Life sciences, genomics and biotechnology for health • Information society technologies • Nanotechnologies and nano-sciences, knowledge-based multifunctional materials and new production processes and devices • Aeronautics and space • Food quality and safety • Sustainable development, global change and ecosystems • Citizens and governance in a knowledge-based society

Source: CORDIS, 2006.

[147] FP1, FP2 and FP3 are not shown in table since the activity area and priority concepts are used since FP4. First three Framework Programs were used to trigger cooperation among member states on any subject.

3.7 Problems and Challenges for EU Research and Innovation Policies

Besides the efforts to establish European research and innovation policies at supranational level, there are several challenges that EU has to face. Problems and challenges of EU research and innovation policies can be summarized as, enlargement, low R&D expenditure, discrepancies among R&D expenditure and innovation capabilities of member states, fragmentation of R&D activities among member states, ageing population, insufficient interest in young population to science and technology, and lack of Community patent.

In May 2004, EU experienced its latest and largest enlargement with the entrance of 10 new members[148] to the Union. Despite their high performance during the accession period, limited human and financial resources for implementation of innovation initiatives in firms, as well as limited capacity among firms for absorption and application of knowledge keep new member states behind EU15. In addition, the R&D intensities in all of new members are below the EU average. According to 2004 data seen in Figure 3.5, R&D intensity of enlarged EU25 is 1.9%, where this value is 1.95% for EU15. Besides the decrease after enlargement, the discrepancy of R&D intensities among member states has become more severe. As seen in Figure 3.5, R&D intensities of four of the 10 new member states are even less than the least of EU15, Greece. This picture triggered concerns about reaching the Barcelona target of 3% R&D intensity by 2010. The Commissioner for Research, Potočnik estimates that EU will only reach 2.5% by 2010, which means a big failure.[149]

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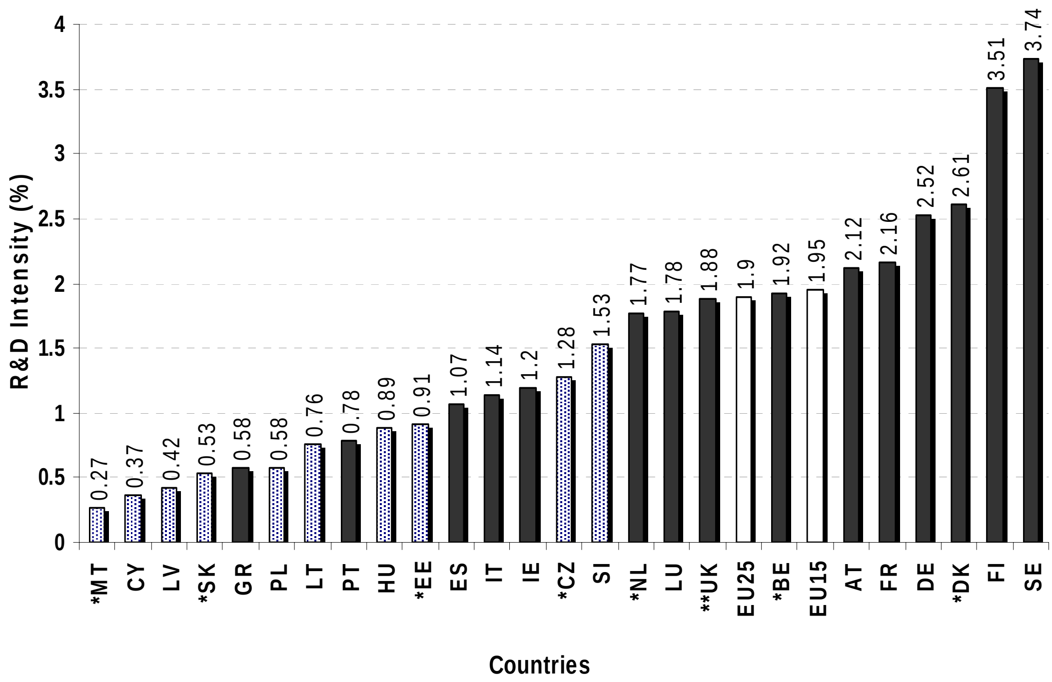
[148] Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia.

[149] Janez Potočnik, "Current Efforts to Meet Barcelona Goal are not Enough," *Cordis Focus*, February 2005, 18.



Source: Eurostat, 2006.
*: 2003 values, **: 2002 value

Figure 3.5: R&D Intensities (%) of EU25 Member States, 2004

It will not be fair to blame enlargement as the only challenge of Barcelona target. In fact, the discrepancy of R&D investments among member states has always been a problem, and the overall performance of EU in the new millennium is not satisfactory. Related to the discrepancy problem, "European Paradox", which is mentioned in the Green Paper for Innovation still remains as a trouble in front of the EU. EU countries play a leading global role in terms of top-level scientific output, but lag behind in the ability of converting this strength into wealth-generating innovations.[150] As an example, the comparative analysis of innovation performances in the latest European Innovation Scoreboard (EIS) shows that the overall innovation

[150] Giovanni Dosi et.al., *Science-Technology-Industry Links and the "European Paradox": Some Notes on the Dynamics of Scientific and Technological Research in Europe* (Strasbourg: Bureau d'Économie Théorique et Appliquée, 2005), 2.

index[151] of EU25 (0.42) is still lagging behind the USA (0.60) and Japan (0.65).[152] The only EU members with greater innovation index than USA and Japan are Finland (0.68) and Sweden (0.72).

Research and innovation are closely related with the skilled labor. Well trained people, equipped with required skills and directed to relevant fields are the main source of research activities. It requires a considerable investment on human capital, including education and training. The skilled labor force in Europe is another problem, and it is likely to become a chronic issue in the future. There is a brain-drain towards USA, and Europe cannot replace them enough neither with youngsters nor by immigration from third countries.[153] Young population feels reluctant to work on scientific and technological subjects. Indeed, women are still underrepresented in research, especially in industrial R&D, although they constitute the majority of graduates and 40% of PhD students.[154]

The ageing population of the Union is another challenge. Low population growth, combined with ageing makes it difficult to create required labor force of researchers and innovators. Demographic trends show that the proportion of older staff in enterprises will increase in Europe. In most Member States, the working age population (15-64 years) will begin to decrease before 2012. EU estimates that 700,000 new skilled researchers are needed to reach 3% target of Barcelona.[155] This shows how crucial the skilled labor problem is for the Union.

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[151] Innovation index is used to measure the innovation performance of countries. Several indicators, such as R&D intensity, number of patents per million population, and innovation expenditures are used as inputs to calculate the index.

[152] European Commission, *European Trend Chart on Innovation-European Innovation Scoreboard 2005* (Brussels: European Commission, 2006), 45.

[153]Kok, op.cit.

[154] European Commission, *Innovate for a Competitive Europe: A New Action Plan for Innovation* (Luxembourg: Office for Official Publications of the European Communities, 2004), 17.

[155] European Commission, *Investing in Research: An Action Plan for Europe, COM(2003) 226* (Brussels: European Commission, 2003), 11.

Besides the major problems, challenges like the lack of Community Patent, inadequate amount of venture capitals, the continuing need for coordination of innovation policies with other policy areas, and cohesion and integration of national research and innovation policies at EU scale are other challenges for the EU. As an evidence of public belief, a typology analysis based on the attractiveness to innovative products or services was made within the latest EIS studies in 2005. The analysis covered EU25 and candidate countries' citizens. At the end of the analysis, 11% of citizens were enthusiasts towards innovation, where 39% turned out to be attracted by innovation, 33% to be reluctant to innovation, and 16% were anti-innovation.[156] The results indicate that Europe is evenly divided between those who are attracted by innovation and those somehow reluctant or opposed to the issue.

Finally, the lack of a common patent system at EU level is a problem for the "Intellectual Property Rights" (IPR). Intellectual Property Rights concept plays a crucial role in innovation policies, and the only patent organization at European level is the European Patent Office (EPO). However EPO is neither an organization of EU nor legally bound to the Union. EPO was set-up by the European Patent Convention signed in 1973 as an intergovernmental organization that grants European patents. The idea behind is to provide a single patent grant procedure that would be applicable to all member states. In other words, an application made to EPO is counted as an application made to patent offices of each member state, which is a time and money-saving procedure for applicants. However, despite the name of the office is "European Patent Office", the patents granted are not regarded as European Community patents. In addition, high patenting costs may cause inventions to be sold off to someone who can afford costs rather than being developed in Europe.[157] There is an ongoing debate about a patenting mechanism at EU level: the "Community Patent" that would replace all the national patents and become the only patenting

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[156] European Commission, *European Trend Chart on Innovation- European Innovation Scoreboard 2005* (Brussels: European Commission, 2006), 27.

[157] Astrid Bårgrad, "The European Research Council and Seventh Framework Programme," *Cordis Focus*, February 2005, 17.

system of the Union. Three decades after the Community Patent Convention[158], EU has re-launched Community Patent studies in 2000 as an action item agreed in Lisbon summit. Although the European Council has not succeeded to reach an agreement on legislation to create Community Patent[159], it is still a hot topic in EU agenda and tried to be realized in 2007.

All the problems and challenges that the European Union has to face increase the significance of the European Research Area and FP7 as an implementation tool both to achieve Barcelona target and to realize the Lisbon strategy. It is obvious that EU has undertaken an extremely difficult task of building up research and innovation policies at supranational level and constructing a European Innovation System. Unlike other policy areas, such as agriculture and environment, it is not possible in research and innovation policy area to apply strict rules and regulations, and obtain the results as expected. Moreover, constructing a well organized and functioning innovation system is bound to many other factors and requires a strong interaction among different policies, as described in Chapter 2. It is difficult to build up such a system even at national level, yet – for EU – at supranational level. However, EU has to achieve this task to close the increasing technological gap between itself and competitors, USA and Japan, as well as to improve its global competitiveness.

The Lisbon Strategy and ERA initiative have triggered significant changes and emergence of new approaches, which are pointing that EU is experiencing a transition in research and innovation policies. Such a transition will inevitably be reflected to the candidate countries during their accession period. As a candidate country, Turkey will be influenced as well. Therefore, it will be useful to analyze science and technology policy in Turkey before determining the reflections of EU's transition on Turkish science and technology policy, and the policy improvements

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[158] The Community Patent Convention held in 1975, aimed to introduce the "Community Patent" concept and reduce patenting costs in Europe to levels in USA and Japan, but it has still not entered into force because of delays in its ratification.

[159] European Commission, *Results of the Competitiveness Council of Ministers, Brussels, 11th March 2004 Internal Market, Enterprise and Consumer Protection Issues*, *MEMO/04/58* (Brussels: European Commission Press Room, 2004), 1-4.

needed to adapt EU research and innovation policies. The next chapter examines the evolution of Turkish science and technology policy, current organizational and institutional framework of its national innovation system, and future goals in a similar methodology which is used in this chapter.

CHAPTER 4

TURKISH SCIENCE AND TECHNOLOGY POLICY

4.1 Introduction

Science and technology policy of Turkey has been an evolving and developing process for over 40 years. The first significant steps to develop a national science and technology policy in Turkey were taken in the first planned economic period of 1963-1967.[160] The Scientific and Technical Research Council of Turkey (TÜBİTAK), which played crucial role in fostering scientific research in the country, was founded in this period as well. Promoting basic and applied research in natural sciences as the main policy of the 1960s and the 1970s was expanded to include technology development and encouraging industrial research in the 1980s and the first half of the 1990s. Finally, establishing a national innovation system and planning the future became the main focuses of science and technology policy in the late 1990s and the 2000s. With the launch of Vision 2023 project in 2002, three ambitious objectives were set for the 100th anniversary of the Turkish Republic: to become a leading country in science and technology; to gain technology production capability; and to convert technological progress into social and economic benefit.[161]

This chapter analyzes the evolution of Turkish science and technology policies from a historical perspective, explores the recent trends in the 2000s, and examines the current national innovation system in the light of national innovation system (NIS) theory mentioned in Chapter 2. The basic information sources for this chapter are selected as the Five Year Development Plans and BTYK decisions, since major policy framework, targets, implementation tools and proposals towards

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[160] DPT, *Birinci Beş Yıllık Kalkınma Planı 1963 – 1967* (Ankara: DPT, 1962), 88.

[161] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Yedinci Toplantısı, 24 Aralık 2001, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2002), 10.

organizational structure were foreseen in these documents. In addition, the limited amount of publications and academic literature about the science and technology policy of Turkey increases the significance of development plan documents and BTYK decisions.

The evolution of Turkish science and technology policy is analyzed in four periods, each of which starts with a milestone in policy measures. The first period (1963-1983) starts with the foundation of TÜBİTAK in 1963, and covers the first attempts for policy formulations on science and technology.

The second period (1983-1996) starts with the ratification of the first official policy document in 1983: "Turkish Science Policy: 1983 – 2003", which is a milestone in Turkish science and technology policy history. 1983 is also significant for being the year in which the highest policy making body, the Supreme Council of Science and Technology (BTYK) was founded. Institutionalization of science and technology policy, attempts to promote scientific and technological development of the country with new policy documents are other noteworthy developments which are examined in 1983-1996 period.

The third period (1996-2000) starts with the launch of "The Project for Impetus in Science and Technology", which was foreseen in the Seventh Five Year Development Plan. According to Tümer, [162] Turkey made a shift from promotion of science at national scale towards an attempt in welfare creation through science and technology ventures with the Seventh Five Year Development Plan, which he considers as a turning point in Turkish science and technology policy. The other significant event of this period is the BTYK meeting in 1997, where competence in technological innovation was considered to be the driving force of economic development, and the need for a national innovation system in Turkey was stated for the first time. Attempts of policy development towards encouraging the cooperation among the stakeholders and further developments in institutionalization are the other topics which are studied in this period.

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[162] Turgut Tümer, "Rationale, Scope and Methodology of the Technology Foresight in Turkey – Vision 2023 Project" in *Technology Foresight for Organizers*, 192 (Ankara: UNIDO, 2003): 192-199.

The last period (2000s) starts with the new millennium, during which new R&D funding mechanisms and incentives for research have been introduced, and the first decisions for shaping the future of Turkish Republic were taken. Vision 2023 project was prepared for this purpose at the beginning of the new century. Forming up a full functioning NIS and integrating with EU in scientific and technological research area with the full participation of Turkey in FP6 are other important developments of this period.

In the last section of the chapter, the current situation and the organizational and institutional structure of NIS of Turkey are examined. The chapter is closed with an evaluation of Turkish science and technology policy. Relations with EU and integration with EU in science and technology areas are also mentioned, but the detailed study on these subjects are left for the next chapter.

4.2 First Significant Attempts of Policy Formulations: 1963–1983

The first significant attempts towards developing a national science and technology policy in Turkey started with the planned economy period in Turkey in the 1960s. The First Five Year Development Plan (1963-1967), in which the establishment of TÜBİTAK was foreseen, determined the basic principles of the policy of Turkey in science and technology as organizing, coordinating and promoting basic and applied research.[163] In the 1950s and the 1960s, the general trend in national science and technology policies was to conduct scientific and technological research based on a strong institutional framework of research councils, scientific institutions and research labs.[164] According to Türkcan, [165] foundation of TÜBİTAK in 1963 was an early response to the global trend of the institutionalization of national science and technology policies. For over a decade

[163] DPT, op.cit.

[164] Chris Freeman, "The 'National System of Innovation' in Historical Perspective," *Cambridge Journal of Economics*, vol. 19, no. 1 (1995): 5-24.

[165] Ergun Türkcan, "TÜBİTAK'ın 35. Kuruluş Yıldönümünde Türkiye'de Bilim Politikası," *Bilim ve Teknik*, no. 371 (1998): 76-78.

after 1963, the primary function of TÜBİTAK was confined to supporting basic research in the universities through its grant scheme.[166] Over the years, TÜBİTAK undertook various missions itself, such as contributing to the development of Turkey's science and technology policies, being the highest public R&D institution, monitoring and evaluating the scientific and technological advance of the country, as well as supporting and funding both public and private R&D activities. In addition to its central role in natural sciences, TÜBİTAK enlarged its mission area by funding research in social sciences and humanities after the establishment of Social Sciences and Humanities Research Grant Committee in 1999.

The other significant event of the 1960s was the Pilot Teams Project of OECD, which was started in 1962. Turkey participated in the project alongside the least developed OECD countries at that time, which were Greece, Spain and Portugal.[167] The main target of the project was to examine the level of scientific and technological research activities and their contribution to sustainable economic growth in those countries.[168] Requirements and constraints to establish a national science and technology policy in each participating country were analyzed in this project, as well. According to Göker, the project was in fact the first attempt to define strategies and policy framework for Turkey, but the results of the project were not used.[169]

The final event of the First Five Year Development Plan Period of 1963-1967 was the initiation of the first national R&D survey by TÜBİTAK. The aim of the survey, which was started in 1964, was to find out the scientific and technological infrastructure of the country, including the number of researchers, the level of basic research in universities, and the density of industrial R&D activities.[170] The results of

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[166] Tümer, op.cit.

[167] TÜBA, *Geçmişten Geleceğe Türk Bilim ve Teknoloji Politikaları* (Ankara: TÜBA, 2005), 132-134.

[168] Nimet Özdaş, *Bilim ve Teknoloji Politikası ve Türkiye* (Ankara: TÜBİTAK, 2000), 30-31.

[169] Aykut Göker, *Türkiye'de 1960'lar ve Sonrasındaki Bilim ve Teknoloji Politikası Tasarımları. Niçin [Tam] Uygula[ya]madık?* (Ankara: ODTÜ, 2002), 2-5.

[170] Özdaş, op.cit.

the survey indicated that Turkey had around 4,000 researchers – most of which were the academic staff at universities – and R&D intensity was as low as 0.37 percent.[171] Moreover, Turkey had neither industrial research nor technology development capabilities, and research institutions were mostly doing agricultural research, rather than technological research.[172] According to Türkcan, [173] the lack of industrial R&D and technology development can be explained by underdeveloped industry, and lack of demand for industrial R&D. He asserted that the newly developing industry in Turkey was trying to improve its manufacturing capabilities by importing the technology needed for production, which was the cheapest and the easiest way.[174] Moreover, insufficient resources for research, in terms of human capital, scientific knowledge and funds, were the main obstacles that hampered the creation of demand for industrial R&D.[175]

The basic policies of Turkey in the 1960s can be summarized as promoting basic and applied research, and increasing the number of researchers. The similar trend in Turkish science and technology policy continued in the 1970s, and there had been no noteworthy developments until 1979. In the Second (1968-1972) and Third Five Year Development Plans (1973-1977),[176] the significance of technological development and technology transfer have been mentioned, but no policy tools or precautions were foreseen in any of the documents. "Technology Policy" concept was explicitly used – for the first time – in the Fourth Five Year Development Plan (1979-1983), and *"integration of the technology policy with the industry, employment and investment policies and enhancing the technological abilities of*

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[171] ibid.

[172] ibid.

[173] Türkcan, op.cit.

[174] ibid.

[175] Özdaş, op.cit.

[176] DPT, *İkinci Beş Yıllık Kalkınma Planı 1968 – 1972* (Ankara: DPT, 1978), 23-24.
see also DPT, *Üçüncü Beş Yıllık Kalkınma Planı 1973 – 1977* (Ankara: DPT, 1972), 36.

certain industrial sectors" have been envisaged.[177] In accordance with the above statement of the Fourth Five Year Development Plan, Turkey documented its first detailed science and technology policy in the 1980s.

4.3 Policy Formulations and Evolution of Organizational Framework: 1983–1996

The "Turkish Science Policy: 1983 – 2003" document, which was prepared by TÜBİTAK, in close cooperation with DPT and with the contribution of over 300 scientists and specialists, was a milestone in the history of Turkish science and technology policy. The document was based on a detailed study and included two major topics. The first topic was the R&D infrastructure of Turkey. Under this topic, R&D human capital and R&D expenditures – the two major indicators used in science and technology policy evaluations – were determined. The second topic, which was more significant than, but related to the first one, was long-term scientific priority areas of Turkey, which were determined as electronic engineering, computer science, instrumentation[178] and telecommunication. R&D human capital and priority areas are related with each other in two ways. First of all, profiling and keeping track of the R&D human capital of a country shapes the national scientific and technological priority areas in the long-run. Secondly, defining the priority areas on the other hand, contributes to specifying the characteristics of R&D staff needed to achieve new strategic targets. Therefore, the document had a crucial importance in national science and technology policy of Turkey.[179]

The "Turkish Science Policy: 1983 – 2003" document led the establishment of a new institution: BTYK in 1983. BTYK was established as the highest policymaking body in science and technology area, and aimed *to develop, implement, elaborate,*

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[177] DPT, *Dördüncü Beş Yıllık Kalkınma Planı* 1979 – 1983 (Ankara: DPT, 1978), 48-49.

[178] Instrumentation is the technology of creating, constructing, and maintaining the measuring and control devices and systems that equip the manufacturing plants and research institutions.

[179] Özdaş, op.cit.

coordinate and direct the scientific and technological R&D policies of Turkey in accordance with the economic development, social improvement and national security goals.[180] However, BTYK held its first meeting in 1989, six years after its foundation, although it should be convening at least twice a year according to the law. According to Özdaş, the main reason behind the six years of delay and discontinuities in BTYK meetings was the lack of government's interest in science and technology.[181] BTYK has convened 14 times until March 2006, as can be followed from Table 4.1, which shows the meeting schedule of BTYK. It can also be seen in Table 4.1 that, BTYK has started to convene twice a year only since its 10th meeting in 2004.

Table 4.1: BTYK Meeting Schedule

Meeting #	Date of Meeting
1	October 9, 1989
2	February 3, 1993
3	August 25, 1997
4	June 2, 1998
5	December 20, 1999
6	December 13, 2000
7	December 24, 2001
8	April 15, 2002
9	February 6, 2003
10	September 8, 2004
11	March 10, 2005
12	September 8, 2005
13	March 8, 2006
14	September, 2006

Source: TÜBİTAK – BTYK Meeting Reports, 2006

The Fifth Five Year Development Plan of 1985 – 1989 period included a chapter named "Science – Research – Technology", where R&D and technological

[180] T.C. Resmi Gazete, Bilim ve Teknoloji Yüksek Kurulu Kurulmasına İlişkin 77 Sayılı Kanun Hükmünde Kararname, Decree No. 77, Enacted: 16.08.1983 (Official Gazette No. 18181, dated 04.10.1983).

[181] Özdaş, op.cit., 52.

development was stated as the guiding and impulsive force of economic development for the first time.[182] Taking necessary precautions and developing policies to encourage production of new technologies in accordance with the priority areas determined in the "Turkish Science Policy: 1983 – 2003" document, and promoting university – industry cooperation were major topics that were foreseen in the "Science – Research – Technology" chapter of the plan. The major precaution which was foreseen in the plan was the preparation of a long-term science and technology master plan based on the "Turkish Science Policy: 1983 – 2003" document.[183] The plan was expected to include long-term strategies for the priority areas, coordination mechanisms for ongoing R&D activities, and promoting basic and applied research. However, the Turkish Science Policy: 1983 – 2003 document was also prepared as a master plan, and Göker[184] states that there was no need for a new one. The proposed plan was not prepared and the science policy document was shelved until the preparation of Sixth Five Year Development Plan.

The last decade of the 20th century was a very active period for the Turkish science and technology policy, in terms of legislation and institutional framework. New instruments and targets for Turkish science and technology policy were foreseen in the Sixth Five Year Development Plan (1990 – 1994), such as to set short-term targets for main science and technology indicators, to support R&D activities in both public and private sector, to use technology transfer as the main method of acquiring necessary high technology to increase the quality of products and global competitiveness of national industry, and to establish a patent organization for the protection of intellectual property.[185] Statements in the Sixth Five Year Development Plan can be regarded as milestones of Turkish science and

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[182] DPT, *Beşinci Beş Yıllık Kalkınma Planı 1985 – 1989* (Ankara: DPT, 1988), 159.

[183] ibid.

[184] TÜBİTAK, *Türk Bilim ve Teknoloji Politikası 1983 – 2003*, 12.

[185] ibid., 310.

technology policy, and they triggered foundation of institutions each of which played a crucial role in Turkey's National Innovation System framework.

First of all, the Sixth Five Year Development Plan set precise targets for scientific research and development to be reached by the end of 1994. These targets were depending on the main science and technology indicators, and it was aimed:[186]

- To double the number of researchers, where the latest value was 33,000,
- To increase the number of researchers per thousand economically active people, known as the researcher ratio to 1.5,
- To reach an R&D intensity of 1 percent.

According to the statement in the Sixth Five Year Development Plan about R&D support, Turkish Technology Development Foundation (TTGV) and TÜBİTAK Industrial R&D Funding Directorate[187] (TİDEB) were established as the major R&D funding mechanisms. TTGV – a non-profit organization – was founded in 1991 with the funding of the Undersecretariat of Treasury from the resources of the World Bank in order to support technology development by Turkish industry, and to support technological research and innovation in private sector.[188] TÜBİTAK-TİDEB – founded in 1995 – has been organizing and regulating the state support for R&D activities of the industry, by reimbursing up to 60 percent of R&D expenditures of companies, regardless of their size.[189]

The most significant development in the policy target of "increasing the quality of products and global competitiveness of national industry" took place with the establishment of Small and Medium Industry Development Organization (KOSGEB) under the body of the Ministry of Industry and Trade. The history of KOSGEB goes

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[186] DPT, *Altıncı Beş Yıllık Kalkınma Planı 1990 – 1994* (Ankara: DPT, 1989), 309 – 311.

[187] Renamed as Technology and Innovation Support Programs Directorate – TEYDEB in 21.01.2006.

[188] TTGV, "TTGV Mission", http://www.ttgv.org.tr/eng/03_vision/32.htm (accessed February 8, 2006).

[189] TÜBİTAK, "TÜBİTAK – Industrial R&D Promotion", http://www.tubitak.gov.tr/english/rd_funding/index.htm (accessed February 8, 2006).

back to 1973 as being a pilot project in Gaziantep under the name of Small Enterprise Development Center (KÜSGEM). After reconsidering the role of SMEs in a national economy, KÜSGEM was restructured as an organization at national level and KOSGEB was founded in 1990. The mission of KOSGEB was to develop and support the mechanisms which would increase the competitive capacity of Turkish SMEs both in national and international markets, to provide new job opportunities in the market and technology oriented, high value added production fields, and to encourage entrepreneurship and to realize all of the above mentioned activities in accordance with the previously determined program targets and planned priorities.[190]

The outcome of R&D activities and innovation are new products and / or processes which improve production. At this point regulations for intellectual property rights are needed both to protect the innovator's ideas and prevent the unauthorized replication of products. Turkish Patent Institute (TPE) was founded in 1994 to fill the institutional gap in intellectual property rights area.[191] However, the aim of establishing TPE was foreseen in the Sixth Five Year Development Plan as to keep track of technological developments in the world and to promote the dissemination of new technologies, rather than encouraging innovation in Turkey by providing requiring protection mechanisms.

Besides the developments in policy targets which were stated in the Sixth Five Year Development Plan, the most significant event in this period was the preparation of a new policy document by TÜBİTAK. After the failure of the "Turkish Science Policy: 1983 – 2003", "Turkish Science and Technology Policy: 1993 – 2003" document defined new policy instruments and set new targets in a more detailed manner. Preserving the targets set for science and technology indicators in the Development Plan document, new priority areas for R&D activities were defined. Priority areas in the previous policy document: electronic engineering, computer

[190] T.C. Resmi Gazete, Küçük ve Orta Ölçekli Sanayi Geliştirme ve Destekleme İdaresi Başkanlığı Kurulması Hakkında Kanun, Law No. 3624, Enacted: 12.04.1990 (Official Gazette No. 20498, dated 20.04.1990).

[191] T.C. Resmi Gazete, Türk Patent Enstitüsü Kuruluş ve Görevleri Hakkında Kanun Hükmünde Kararname, Decree No. 544, Enacted: 19.06.1994 (Official Gazette No. 21970, dated 24.06.1994).

science, instrumentation and telecommunication, were combined under "Information and Communication Technologies (ICT)" title.[192] With the addition of new research titles, priority areas of Turkey were redefined as ICT, advanced materials, biotechnology, nuclear technology, and aerospace technology. [193]

Apart from defining R&D priorities; R&D support mechanisms, and university – industry cooperation issues were discussed in more detail, and building of technoparks was stated as a target. Increasing the number of international scientific publications of Turkey, strengthening Turkey's academic and researcher infrastructure by supporting the allocation of scientists from former Soviet Union States and Eastern European countries in Turkish universities, updating intellectual property rights legislation, and forming a national science academy consisting of high-level academics were other topics of "Turkish Science and Technology Policy: 1993 – 2003" document. Within the scope of the last topic mentioned above, Turkish Academy of Sciences (TÜBA) was founded in 1993 to arouse scientific curiosity throughout the public, to awaken interest in research and spread scientific thinking.[194]

Despite all the encouraging events of this period, neither the targets of the Sixth Five Year Development Plan could be achieved, nor could the strategies on research priority areas mentioned in the policy document be implemented. Legislation for intellectual property rights was not completed either. At the end of the Sixth Five Year Development Plan period, R&D intensity of Turkey was 0.36 percent and researcher ratio was 0.84,[195] where the targets for those indicators were set in the plan document as 1 percent and 1.5, respectively. The reason for the failure, especially in R&D intensity, can be explained by the macroeconomic conditions of

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[192] TÜBİTAK, *Türk Bilim ve Teknoloji Politikası 1993 – 2003* (Ankara: TÜBİTAK, 1993), 25.

[193] ibid., 5.

[194] T.C. Resmi Gazete, Türkiye Bilimler Akademisinin Kurulması Hakkında Kanun Hükmünde Kararname, Decree No. 497, Enacted: 13.08.1993 (Official Gazette No. 21686, dated: 02.09.1993).

[195] TÜİK, *Haber Bülteni – 2003 ve 2004 Yılları Araştırma ve Geliştirme Faaliyetleri Araştırması, Sayı:129* (Ankara: TÜİK, 2006), 2.

the 1990s that hampered the formation of a suitable environment to encourage long-term investments in high technology areas and to foster industrial R&D activities.[196] The budget deficits, and consequently increasing concerns about the domestic debt payments restricted resources that would have contributed to technological development and funding of research activities. In addition, high inflation rates, negative effect of high interest rates on investments and the general trend in investing savings in financial instruments, such as bonds also kept industry away from investing in technology and research.[197] As a result, R&D expenditures of Turkey decreased in the first half of the 1990s. The decline of R&D expenditures stopped in the second half of the 1990s with the start of incentives and launch of R&D funding programs by TİDEB, and the increasing trend continued until the economic crisis in 2001.

4.4 New Approaches in Science and Technology Policy: 1996-2000

The rise in R&D expenditures was not the only significant development in the second half of the 1990s. Unlike in the 1980s and the first half of the 1990s, cooperation among the stakeholders and efforts towards the implementation of policies increased in this period.[198] Moreover, science and technology policies started to focus on promoting competence in technological innovation started and encouraging scientific and technological research. Tümer[199] describes the developments in Turkish science and technology policy in the 1990s as a paradigm shift from "building a modern R&D infrastructure" to "innovation oriented" national policies.

[196] Yusuf Işık, *Türkiye'nin Gelişme Sürecinde Teknoloji ve Teknoloji Politikaları* (İstanbul: Friedrich Ebert Stiftung, 2001), 24.

[197] ibid.

[198] Göker, op. cit., 10.

[199] Tümer, op.cit., 193.

Within this context, the Seventh Five Year Development Plan (1996-2000) introduced a new policy instrument to promote scientific and technological research and innovation in Turkey: "The Project for Impetus in Science and Technology".[200] The project, which formed the "Science and Technology" chapter of the Seventh Five Year Development Plan document, was based on the strategies defined in "Turkish Science and Technology Policy: 1993 – 2003" document and indicated a substantial action plan for those strategies. Within the scope of The Impetus in Science and Technology Project, new targets for science and technology indicators were set and specific fields of investment[201] were proposed. It was aimed to reach an R&D intensity of 1.5 percent and researcher ratio of 1.5 by the end of 2000.[202]

The aim of specifying fields of investment was to determine the certain areas of specialization and to encourage industry to focus on these areas by providing incentives for scientific and industrial research. Majority of the investment fields listed above were consistent with the priority areas for R&D activities defined in "Turkish Science and Technology Policy: 1993 – 2003" document. Some of the fields, such as upgrading the existing railway system and process R&D in manufacturing industry were pointing out the areas where the industry should focus its research and development activities. However, guiding the industrial R&D should have been supported with laws and regulations that would allow transforming the outcomes of R&D into economic and/or social benefit. Encouraging R&D in renewable energy technologies, as an example, could not be backed up with legislative arrangements until the ratification of the "Law on Utilization of

[200] DPT, *Yedinci Beş Yıllık Kalkınma Planı 1996 – 2000* (Ankara: DPT, 1995), 71-77.

[201] Specific fields of investments were defined as: Construction of the national information infrastructure; process R&D; high-speed train technologies; aviation industry; gene engineering and biotechnology; environmentally sound technologies and renewable energy technologies; advanced materials.

[202] ibid.

Renewable Energy Resources for the Purpose of Generating Electrical Energy" in 2005.[203]

Within the scope of R&D incentives, it was also proposed in the Impetus in Science and Technology Project that the contribution of private sector to R&D should be encouraged by creating demand through public procurement.[204] It was stated in the project that, the aim of increasing science, technology and innovation skills would be taken into consideration in public procurement policies. It was an encouraging development for private sector companies especially in ICT sector. Besides, the majority of public institutions were in need of investments to renovate their ICT infrastructures.[205] However, only a few of them such as the Ministry of Finance within VEDOP Project[206] made such procurements in line with the aforesaid statement in the plan.

The last significant policy tool mentioned within the Impetus for Science and Technology Project was about the establishment of venture capitals.[207] Many high-technology companies are established upon new ideas. Many of them failed because of insufficient finance, rather than the uniqueness and marketability of their ideas. In order for those fledgling companies to grow up and come up with innovations, they

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[203] T.C. Resmi Gazete, Yenilenebilir Enerji Kaynaklarının Elektrik Enerjisi Üretimi Amaçlı Kullanımına İlişkin Kanun, Law No. 5346", Enacted: 10.05.2005 (Official Gazette No. 25819, dated 18.02.2005).

[204] DPT, *Yedinci Beş Yıllık Kalkınma Planı*, 75.

[205] ibid., 76.

[206] VEDOP is the abbreviation for *Vergi Daireleri Tam Otomasyon Projesi* (Tax Office Complete Automation Project) of the Ministry of Finance. Started in 1998 and completed in 2000, VEDOP was the greatest IT project in the history of Turkey. During the first part of the project, all the duties of 153 tax offices (collecting ~85% of the taxes) countrywide was transferred to an online platform and it became possible for citizens to pay their taxes in any tax office, apart from the one where they are registered. In addition to this office free tax payments, citizens began to perform some of the actions, such as calculating the amount of tax to be paid via the "Internet Tax Office", an internet portal of the General Directorate of Revenues. VEDOP won the grand prize of "e-government" awards in the category of "From Government to the Individual" in CeBit Eurasia 2002, the world's largest trade fair showcasing ICT solutions. The second part of the project, which covers the rest of the tax offices, will be completed in 2006.

[207] DPT, *Yedinci Beş Yıllık Kalkınma Planı*, 77.

needed investors that would support their ideas and take the risk of investment. This is where the concept of "venture capital" arises. Venture capitals and business angels are crucial organizations for the development of technology and innovative skills in a country. They undertake the risk when government incentives are not enough. Recognizing the importance of venture capitals, it was proposed that necessary regulations should be made, policies should be defined to prepare suitable environment for such organizations. After the completion of legal arrangement about venture capitals in 1993,[208] Vakıflar Bankası founded Vakıf Girişim Venture Capital Investment Co. in 1996, which holds being the first national attempt on the subject. Vakıf Girişim was followed by three noteworthy venture capitals, İş-Risk and iLab until the end of 2000.

The "Regulatory Reform and SMEs: Interim Report" of OECD, which was published in 1998, gave a remarkable picture of the evolution of science and technology policy in Turkey until the end of 20th century.[209] The report summarizes the implementations of technology and innovation policies in several countries, and grades each policy implementation as "best", "need for improvement" or "weakest", which is illustrated in Table 4.2. The institutional framework, incentives towards the creation of new demand, scientific foundations, policy evaluation mechanisms and establishment of firms showing high global performance were declared as the weakest policy implementations in Turkey, where R&D support mechanisms and polices for diffusion of knowledge showed a little improvement but still needed more.

[208] SPK, Communiqué Regarding the Principles of Venture Capital Investment Partnerships, prepared by the Capital Markets Board of Turkey (SPK), Series: VIII, No: 21, Enacted: 01.07.1993 (Official Gazette No. 21629, dated 06.07.1993).

[209] OECD, *Regulatory Reform and Small and Medium-Sized Enterprises (SMEs): Interim Report* (Paris: OECD, 1998), 17.

Table 4.2: Policy Applications in Technology and Innovation Policies

Country	Institutional Framework	Evaluation	Scientific Foundations	R&D Support	Diffusion Policies	Support for New Technology Base Companies	Incentives to Create New Demand		High Perform. Firms
							Internet	Environment	
Turkey	O/O	O/O	O/O	Δ/Δ	Δ/Δ		O	O/O	O/O
Korea	Δ/Δ	O/O	O/O	Δ/Δ	*/O	O	Δ	O/O	Δ/Δ
Japan	O/O	Δ/Δ	*/O	O/O	*/Δ	O	*	*/*	*/O
EU	*/O	*/O		*/Δ	*/O	Δ	*	*/*	*/*
USA	O/O	*/Δ	*/Δ	*/Δ	*/Δ	*	*	*/O	*/O

*: the best policy application; Δ: need for policy improvement; O: the weakest policy

Source: OECD, Regulatory Reform and Small and Medium-Sized Enterprises (SMEs): Interim Report, 1998, p. 17.

South Korea and Turkey were two similar countries both in scientific and technological level and economic performance in the beginning of 1980s.[210] Both countries prepared science and technology policy documents in the same decade, but South Korea could manage to implement its policy document where Turkey failed. As a result, South Korea had a better institutional framework, more efficient diffusion policies and most important of all, could create high performance firms at global scale, such as Samsung, LG and Daewoo. The result of weak policy implementation showed that Turkey still had a long way to go in the new millennium in spite of the policy formulations which are foreseen in the last couple of Development Plans and steps taken during the last two decades of the 20th century.

4.5 New Millennium Goals and Vision 2023 Project: 2000 and Beyond

The evolution of Turkish science and technology policy accelerated with the beginning of the new millennium. It can clearly be seen that technology production and the concept of "technological innovation" were positioned at the center of national policies. Moreover, building up a national innovation system was explicitly

[210] Özdaş, op.cit.

stressed in the Eighth Five Year Development Plan (2001 – 2005).[211] In addition to NIS, increasing the support for R&D activities of SMEs, establishment of new technology start-up companies, Technoparks and Technological Development Zones within the scope of university – industry cooperation, directing R&D activities to specific areas and setting new targets for science and technology indicators were other significant topics in the Eight Five Year Development Plan being the first plan of the new millennium. The science and technology indicators of Turkey in 2000 were once again below the targets set in the Seventh Five Year Development Plan. Turkey could reach an R&D intensity of 0.64 percent and researcher ratio of 1.25, where targets were 1.5 percent and 1.5 respectively. After the failure in R&D intensity, but progress in researcher ratio, the new R&D intensity target remained the same, where researcher ratio target was revised as 2.[212]

In the new development plan, priority areas for R&D activities – named as "the fields of advanced applications" – to be supported were also revised.[213] New research and development priorities of Turkey were revised as ICT, new materials, aerospace and space technologies, oceanography and technologies on utilizing and exploiting sea and underwater riches, mega science and clean energy technologies, and biotechnology and gene engineering.[214]

The ratification of "The Law of Technology Development Zones" in 2001[215] was a late but huge step towards the incentives for R&D activities of SMEs and university – industry cooperation. According to the law, technoparks and technology development zones which are established by universities and KOSGEB would provide incubators for start-up companies, office areas for SMEs and big companies.

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[211] DPT, *Uzun Vadeli Strateji ve Sekizinci Beş Yıllık Kalkınma Planı 2001 – 2005* (Ankara: DPT, 2000), 126-128.

[212] ibid., 140.

[213] ibid.

[214] ibid., 141.

[215] T.C. Resmi Gazete, Teknoloji Geliştirme Bölgeleri Kanunu, Law No. 4691, Enacted: 26.06.2001 (Official Gazette No. 24454, dated 06.07.2001).

In addition, technoparks are aimed to create the suitable environment for companies and universities to cooperate. It would help to maintain knowledge spillover, and foster technology production and innovation. To increase the attraction of technoparks and incubators for companies and entrepreneurs, several benefits such as tax exemptions were provided as well.[216]

The new millennium is also important from the BTYK point of view. BTYK became a more active organization in 2000s. At least one meeting was held each year on a regular basis, crucial decisions were taken in these meetings – which was a significant improvement. One of the crucial decisions of BTYK was about the proposal in the Eight Five Year Development Plan; "orienting the state procurement policy towards improving the scientific, technological and industrial potential of the country.[217] In its meeting held in December 2000, BTYK proposed that 1% of the amount of state procurements made according to the Public Procurement Law should be used to support R&D.[218] Being aware of the great role that governments play in the development of technology in a country by ordering high technology products to companies on purpose,[219] BTYK's decision was a radical movement in R&D support concept. Unfortunately, this decision could not be put into practice and could not find a place in the latest Public Procurement Law.[220]

Integrating with Europe in research and innovation policy was another major issue in the agenda of BTYK meetings in 2000s. In 2002 meeting of BTYK, it was proposed that it would be beneficial for Turkey to fully participate in the 6th

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[216] Companies and their R&D personnel in technology development zones are exempt from income tax for 5 – 10 years. Companies are also exempt from VAT. They can sell their products without adding VAT to their prices, which gives them price advantage. However, they cannot buy inputs without paying VAT. Therefore, this price advantage may turn into extra expenditure in their balance sheets in some cases.

[217] DPT, *Uzun Vadeli Strateji ve Sekizinci Beş Yıllık Kalkınma Planı,* 127.

[218] TÜBİTAK, *Altıncı Bilim ve Teknoloji Yüksek Kurulu Toplantısı, 13 Aralık 2000, Kararlar ve İlgili Dokümanlar* (Ankara: TÜBİTAK, 2001), 36.

[219] ibid.

[220] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Sekizinci Toplantısı, 15 Nisan 2002, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2002), 10.

Framework Program (FP6). Turkey, in fact, has been participating in EU research programs, such as European Co-Operation in the Field of Scientific and Technical Research (COST) since 1971, and European Research Cooperation Agency (EUREKA) since 1985 at country scale and 4th and 5th Framework Programs at individual firm or institutional level, as project partners. The 17.5 billion Euros budgeted FP6, on the other hand, seemed to be a huge opportunity to take part in the European Research Area (ERA) as an active member, to improve cooperation skills with foreign partners, and to benefit from the knowledge spillovers in order to improve innovation capabilities and competitiveness. Turkey paid about 250,000,000 Euros as an entrance fee for FP6 and assigned TÜBİTAK as the coordination point where the proposals would be gathered and candidates would be guided.[221] However, it is hard to say that neither the number of projects that Turkey attended, nor the percentage of accepted applications from Turkey are at adequate levels after four years of active participation. According to the EU FP6 project database, Turkey is participating in 55 of 5,467 projects either as a partner or as the main contractor, which contributes to a 1.01 percent of total FP6 projects.[222] Moreover, only 15.3 percent of the applications from Turkey were accepted by EU, which is a low amount of success rate.[223] The FP6 performance of Turkey will be analyzed in detail, while examining the EU-Turkey relations in Chapter 5.

In addition to all the significant issues, one of the most important decisions taken by BTYK was towards the preparation of "National Science and Technology Policies: 2003-2023 Strategy Document".[224] The strategy document was used as an

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[221] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Onuncu Toplantısı, 8 Eylül 2004, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2004), 9.

[222] CORDIS, "Search for FP6 Projects" http://cordis.europa.eu/search/index.cfm?fuseaction=proj.showadvform&CFID=4551806&CFTOKEN=8df7e385cbc782e2-C76DAFAA-DC79-8510-57FF560F65BAD32E (accessed November 15, 2006).

[223] TÜBİTAK, *TÜBİTAK'ın 7. Çerçeve Programı Hazırlıkları ve Türkiye'nin 6. Çerçeve Programı Performansı* (Ankara: TÜBİTAK, 2006), 8-10.

[224] TÜBİTAK, *Altıncı Bilim ve Teknoloji Yüksek Kurulu Toplantısı,* 13.

outline for the project named Vision 2023, which was launched in 2002.[225] The aims of Vision 2023 Project were to assess current status of Turkey in the field of science and technology, to identify the strategic technologies required for achievement of said targets, to assess the long termed scientific and technological developments in the world, and to recommend policies aiming at development and/or acquisition of said technologies. The project team was built up with huge participation of public institutions, NGOs, chambers, universities and Higher Education Council (YÖK), under the supervision of TÜBİTAK. Vision 2023 Project was decomposed into four sub-projects:[226]

- Technology Foresight Project
- National Technology Competence Inventory Project
- Researcher Information System Project (ARBİS)
- TUBITAK National Research Infrastructure Information System Project (TARABİS)

Within the scope of Technology Foresight Project, it was aimed to figure out where technology would lead during the next two decades and determine the areas on which Turkey should focus. "Information technologies" was the only priority area that had been kept since the Turkish Science Policy: 1983 – 2003 document. Biotechnology and gene technologies, and materials were also in Turkey's priority list, where oceanography and clean energy topics in previous list of priority areas were combined under energy and environmental technologies topic. With the addition of four new priority areas to the list at the end of Technology Foresight Project, priority areas of Turkey for the next 20 years were determined as information technologies; biotechnology and gene technologies; materials; energy

[225] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Yedinci Toplantısı, 24 Aralık 2001, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2002), 10.

[226] TÜBİTAK, "POLICY/ Vision 2023", http://www.tubitak.gov.tr/english/policy/index.htm (accessed February 15, 2006).

and environmental technologies; nanotechnology; design technologies; mechatronics; production methods and machinery.[227]

The aim of the National Technology Competence Inventory Project was to determine the level of national technological competence in accordance with international norms, whereby technological competence was understood to comprise of the abilities to effectively use existing technologies (production capability), choose the most appropriate technology under given circumstances (investment capability) and to develop new technologies (innovation capability). This project was implemented by collecting data via questionnaires, planned to reach a total of about 2500 firms in the manufacturing industries.[228]

ARBİS and TARABİS projects were started in order to build up an R&D human and capital stock of the country. With ARBİS, it was planned to create an always up-to-date database for the research personnel in universities, public and private sector establishments in Turkey and the Turkish researchers abroad.[229] Similar to ARBİS, TARABİS aimed to create a database for the machine / system / device stock and R&D project accumulation related with research, experimental development, test / analysis and diagnosis activities.[230]

Realizing the fact that Turkey could not reach its science and technology targets (R&D intensity could reach only to 0.67 percent, and the researcher ratio to 1.83 by the end of 2004)[231] and Turkey's problems with catching-up developed countries in technology production and innovation capabilities, Vision 2023 was a late but crucial move in the history of Turkish Science, Technology and Innovation Policies. In 2004, BTYK took a decision to prepare a mid-term plan, named "National Science

[227] TÜBİTAK, *Research, Development and Innovation in Turkey* (Ankara: TÜBİTAK, 2004), 13.

[228] TÜBİTAK, "POLICY/ Vision 2023", http://www.tubitak.gov.tr/english/policy/index.htm (accessed February 15, 2006).

[229] ibid.

[230] ibid.

[231] TÜİK, op.cit., 2.

and Technology Policies Implementation Plan 2005-2010 (BTP-UP)" for the application of Vision 2023.[232] BTP-UP, which was released after the meeting of BTYK held in March 2005,[233] included strategies aiming to strengthen the scientific and technological research infrastructure of Turkey.[234]

First impact of Vision 2023 and BTP-UP were seen in upcoming BTYK meetings, in terms of determining targets for the two science and technology indicators to be reached by the end of 2010. BTYK set targets for researcher ratio as 2.3, and R&D intensity as 2 percent, where latest values were 1.36 and 0.67 percent respectively.[235] Turkish government allocated 456 million YTL in 2005 year budget to support R&D activities and to achieve the R&D intensity target.[236]

Another impact was the acceptance of new science and technology performance indicators that are used by EU member states, Japan and USA to evaluate the policies in a better and more quantitative way. BTYK took the decision towards the usage of main science and technology indicators, which are listed in Table 4.3 in its 12th meeting in September 2005. Table 4.3 shows the list of science and technology indicators decided to be used, their current values in 2005 and targets set for them for 2010.[237] The first noteworthy point is that R&D expenditures started to be analyzed in more detail. Shares of business enterprises, government, and higher education were also measured. Another significant detail is the measurement of SME innovation performances. Last but not least, global competitiveness rank of Turkey is monitored by global competitiveness index, which was one of the crucial indicators

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[232] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Onuncu Toplantısı,* 12.

[233] BTYK has started to convene two times a year since 2005.

[234] quoted from TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Onbirinci Toplantısı, 10 Mart 2005, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2005), 105.

[235] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Onuncu Toplantısı, 8 Eylül 2004, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2004), 13.

[236] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Onikinci Toplantısı, 8 Eylül 2005, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2005), 30.

[237] ibid., 227.

showing the progress in scientific and technological development, and innovation capabilities of Turkey in a global scale. Using new science and technology performance indicators meant adapting generally accepted methodologies to collect meaningful data and calculate values of these indicators.

Table 4.3: New Science and Technology Indicators and 2010 Targets of Turkey

Indicator	2002 Values	2010 Target
R&D intensity (%)	0.67	2
Gross Expenditure on Research and Development (GERD) per capita population (2005 PPP dollar)	43.3	124
Total researchers (Full Time Equivalent)	23,995	40,000
Total researchers per thousand total employment (‰)	1.36	2.3
Business Expenditure on Research and Development as a percentage of GERD (%)	28.7	50
Government Expenditure on Research and Development as a percentage of GERD (%)	7.0	12
Higher Education Expenditure on Research and Development as a percentage of GERD (%)	64.3	38
Number of Triadic Patents*	7	100
Number of Scientific Articles per million population	200	400
Number of Scientific citations per million population	60	150
SMEs innovating in-house (% of all SMEs)**	24.6	40
SMEs involved in innovation cooperation (% of all SMEs)	18	20
Sales of "new to the market" products (% of total turnover)	9.4	10
Share of manufacturing value-added in high-tech sectors (%)	6.6	10
Labour participation of graduates with tertiary type A*** and advanced research qualifications (men)	83	90
Labour participation of graduates with tertiary type A and advanced research qualifications (women)	65	80
Rank in the global competitiveness	48	35
Global competitiveness index: infrastructure	51	45
Rank in global competitiveness: Legal environment affecting R&D in Turkey	41	35

*: Patents registered at the American, European and Japanese Patent Offices.
**: SMEs innovating by themselves and using their own resources.
***: Tertiary type A programs are mostly offered at 4-year institutions and lead to bachelor's degrees.

Source: TÜBİTAK, 2005

The third and final impact was the acceptance of Frascati, Oslo and Canberra Manuals[238] of OECD as references for R&D statistics collection and standardization.[239] It was aimed to use a standard methodology for both evaluation of science and technology policies and collection of data for performance indicators, and to obtain quantitative results in evaluation of R&D activities that would be consistent with other countries that are using the same techniques, such as EU member states, USA and Japan.

4.6 Current Organizational and Institutional Framework and Evaluation of Turkish Science and Technology Policy

It has been over four decades since the first significant attempts to establish a national Science and Technology Policy of Turkey. Recalling the eight five year development plans, policy documents, targets and priorities, institutional arrangements, legislations and regulations, it sounds that a lot have been done for this purpose. This section provides an evaluation of Turkey’s current situation under science and technology policy and NIS topics.

With the Sixth Five Year Development Plan (1990 – 1994), Turkey started to use two major science and technology indicators, namely researcher ratio and R&D intensity showing the R&D commitment of the country, and major policy targets were to increase the number of researchers per thousand full time employees and the share of R&D expenditures in GDP. Such indicators are used worldwide to see how a country approaches to science and technology concept. Science and technology indicators are also used to evaluate a country’s science and technology policies in addition to several evaluation methods. Figure 4.1 and Figure 4.2 show the

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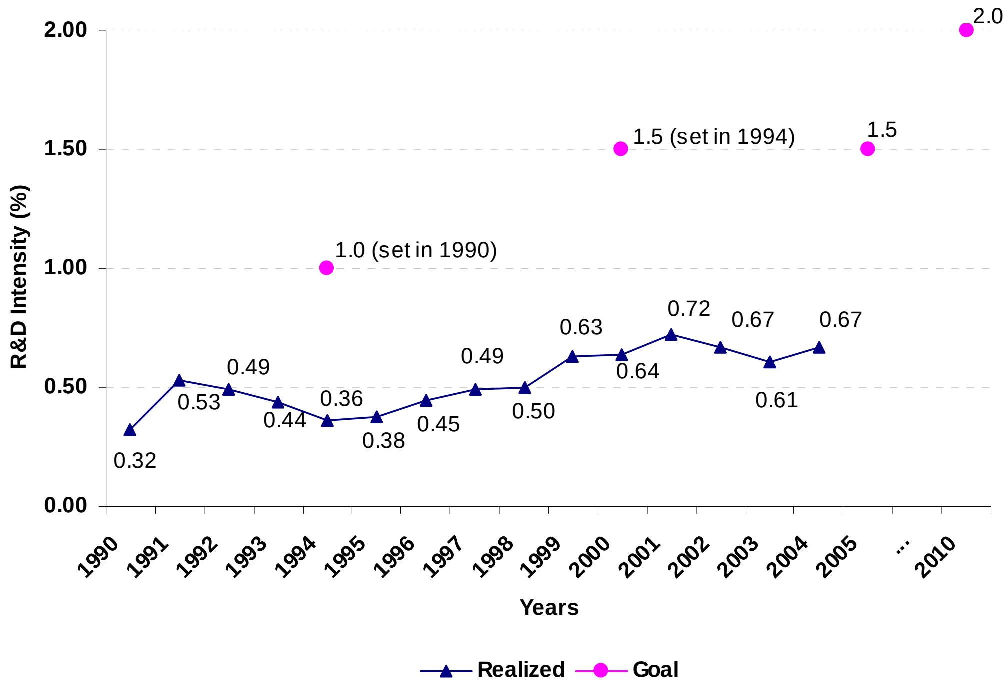
[238] The Frascati Manual is a document specifying the methodology for collecting and using statistics about R&D in countries that are members of the OECD. The document primarily deals with measuring the resources devoted to R&D. The Oslo Manual is a source of guidelines for the collection and use of data on innovation activities in industry. Canberra Manual is intended to provide guidelines for the measurement of Human Resources devoted to Science and Technology and the analysis of such data.

[239] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Onbirinci Toplantısı,* 60.

performance of Turkey and the targets set in development plans and BTYK meetings. Latest realized values of both indicators belong to 2004. Target values show the rates that were aimed to reach in the year they are placed at. The notes in parenthesis state the years in which these values are set as targets. As an example, the goal value shown in 2000 was set as a target in 1994 in Figure 4.1.



Source: TÜİK, 2006

Figure 4.1: R&D Intensity (%) of Turkey, 1990 – 2004

Figure 4.1 represents the R&D intensity performance of Turkey. The first point that deserves attention is how pretentious these targets have been, such as aiming to reach an R&D intensity of 1 percent by 1994 where the 1990 value was only 0.32 percent. The second significant point is the unstable nature of R&D intensity trend. Fluctuations due to the macroeconomic conditions that hampered R&D expenditures, which were mentioned in section 4.3, between 1990 and 1994 turned into an increasing trend after 1994 with the start of incentives and launch of R&D funding programs. However, the upwards trend was not sufficient enough to reach the 1.5

percent target of 2000. Moreover, the economic crisis in 2001 caused a considerable shrinkage in high-technology and ICT sectors in Turkey, and slowed down the technological investments in both public and private sector, which resulted in a decreasing trend of R&D expenditures as well. The R&D intensity of Turkey declined in 2001 and 2002, and decreased to 0.61 percent, even lower than the R&D intensity of 0.63 percent in 1999. 2004 R&D intensity value of 0.67 percent shows an increase, and it is likely to continue in 2005 and 2006 with the budgetary arrangements of the government.

Examining the growth rates of R&D intensity values also reveal interesting results. The average annual growth rate of R&D intensity of Turkey was 7.02 percent for 1990 – 2004 period. If Turkey can achieve the average annual growth rate in the years after 2004, it will reach an R&D intensity of 0.72 percent in 2005 and 1.01 percent in 2010, which are again much lower than 1.5 percent target of 2005 and 2 percent target of 2010. To reach the 2010 target, Turkey should achieve an average annual R&D intensity growth rate of 20 percent in 2004-2010 period, which is nearly three times more than the average annual growth rate of 1990-2004 period. Turkey could exceed 20 percent growth rate in R&D intensity only two times in 1990-2004 period. First one was in 1991, with a 65.63 percent increase from 0.32 percent to 0.53 percent, and the second one was in 2001, with a 26 percent increase from 0.5 percent to 0.63 percent.

Another calculation would clarify whether the 2 percent target is achievable. Assuming that the average annual GDP growth rate of 4.34 percent achieved in 1968-2005 period is sustained until 2010,[240] it can be forecasted that the GDP of Turkey will reach 558,121 million YTL in 2010. This indicates that Turkey should spend 11,166 million YTL on R&D during the 2005-2010 period to reach the 2

[240] GDP was 430,511 million YTL in 2004. See TÜİK, "İstatistikler - Üretim Yöntemiyle Gayri Safi Yurt İçi Hasıla, 1968-2005", http://www.tuik.gov.tr/PreIstatistikTablo.do?istab_id=492 , (accessed November 8, 2006).

percent of R&D intensity target. [241] A simple calculation shows that Turkey should increase R&D expenditures by 1,378 million YTL each year during the 2004-2010 period, which is not easy to realize. As a result, it can be concluded that the 2 percent R&D intensity target of Turkey for the year 2010 is not realistic.

On the other hand, Turkish government made a crucial move to reach the R&D intensity target by allocating 456 million YTL in 2005 budget for R&D funding and increased this amount by 20 percent to over 535 million YTL for 2006 budget. Both values are all time high in the history of Turkey, but their contributions to the R&D intensity are yet to be seen.

Figure 4.2 represents the researcher ratio performance of Turkey. This graph shows a brighter picture than the previous one. Researcher ratio targets were more realistic compared to R&D intensity targets. It was targeted to reach a researcher ratio of 1.5 by 1994 when the 1990 value was 0.75. Figure 4.2 shows a steady increase in researcher ratio, except slight falls in 1994 and 1998. The increasing trend indicates that the targets may be attainable for this indicator. The average annual growth rate of researcher ratio is 6.93 percent for 1990 – 2004 periods. If it is assumed that this growth rate is achieved for the years after 2004, Turkey will reach a researcher ratio of 1.71 in 2005 and 2.39 in 2010, which means that final target of 2.3 is accessible.

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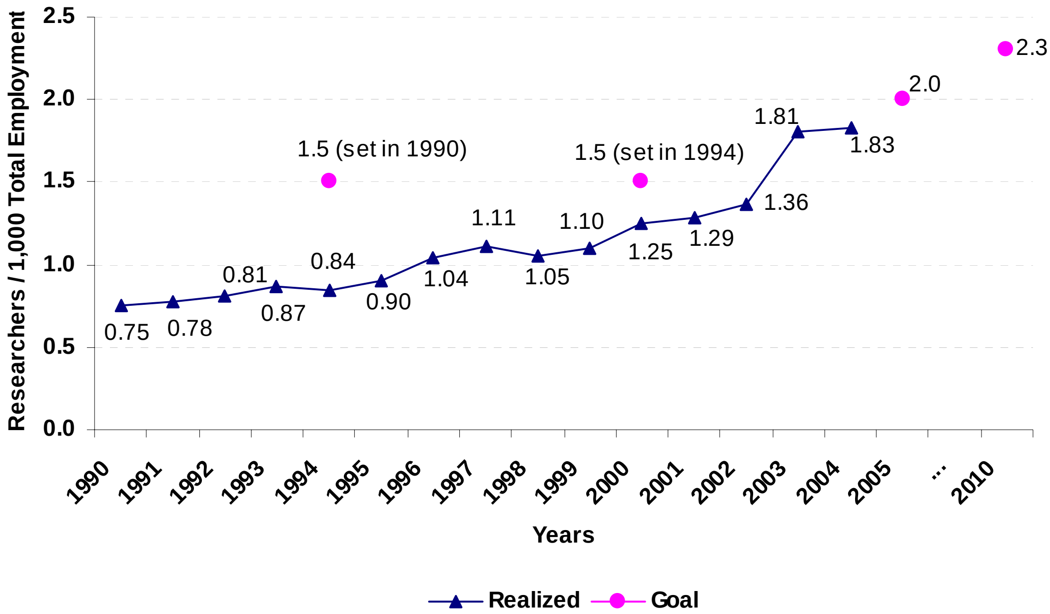
[241] The gross domestic R&D expenditure of Turkey was 2,898 million YTL in 2004. See TÜİK, *Haber Bülteni – 2003 ve 2004 Yılları Araştırma ve Geliştirme Faaliyetleri Araştırması, Sayı:129,* (Ankara: TÜİK, 2006), 2.



Source: TÜİK, 2006

Figure 4.2: Researcher Ratio (researchers per 1000 Employment) of Turkey, 1990–2004

The above graphs illustrate Turkey's efforts to reach its own targets, but it is hard to understand what these targets mean without comparing with other countries. Table 4.4 gives a clear picture of Turkey's current position among EU, OECD and several selected countries. Table shows the latest values of each indicator and it is easily seen that Turkey still has a long way to go. From R&D intensity perspective, the net amount of R&D expenditures is at minor levels compared to other economies. Turkey has lower GDP than the countries / country groups listed in the table, and the low level of R&D intensity means Turkey is spending much lower amounts for R&D activities. Comparative data on researchers, on the other hand show a worse picture than R&D spending. The rate of researchers per thousand full time employees in listed countries /country groups are more than three times higher than Turkey. Turkey has a higher researcher ratio than China, but it should not be forgotten that China has the second highest number of researchers, following USA. Moreover, the distribution of researchers according to sectors of employment yields even more pessimistic results for Turkey. Industrial research and development, which is mainly performed by business sector, is the most significant factor behind the development of technology and innovation capabilities in a country. Researchers employed in business sector are holding the majority in the countries listed in Table 4.4 and EU15. The ratio of business sector researchers varies from 52 percent in EU15, to 68 percent in Japan and 80 percent in USA.[242] On the contrary, only 22 percent of researchers are employed in business sector in Turkey, where the rest of researchers are either working for government institutions or employed in universities.[243] In the light of these statistics, it can be stated that industrial research in Turkey is at minor levels, and consequently, causes the poor performance in researcher-ratio.

Table 4.4: Science and Technology Indicators in Selected Countries, 2004.

Country	**R&D Intensity (%)**	**Total Researchers (Full Time Equivalent)**	**Researcher Ratio (per thousand employment)**
OECD *	2.26	3,600,000 (ss)	8.3 **
EU-15	1.99	1,095,777 (s)	5.9 (s)
EU-25	1.93	1,217,523 (s)	5.6 (s)
USA	2.68	1,300,000	9.6 **
Japan *	3.15	675,330	10.4
South Korea	2.63	141,917	6.8
China	1.44	862,000	1.2
Turkey	0.67	39,960	1.8

(s): Eurostat estimation, (ss): OECD estimation *: 2003, **: 2002.

Source: TÜİK, 2006; EUROSTAT, 2006; OECD Factbook 2006

[242] UNESCO, "UNESCO Institude for Statistics – New S&T Statistics", http://www.uis.unesco.org/ev.php?URL_ID=5218&URL_DO=DO_TOPIC&URL_SECTION=201, (accessed November 6, 2006).

[243] TÜİK, op.cit.

After examining the figures and tables above, it will be useful to analyze the current institutional and organizational structure of Turkey from the "National Innovation Systems" perspective. Establishing a national innovation system in Turkey has been in the agenda of government since the late 1990s,[244] and it has been stressed both in BTYK meetings since 1997, and the Eighth Five Year Development Plan.

Figure 4.3 shows the schematic representation of Turkey's national innovation system, which is based on the institutional framework discussed in Section 2.3. The representation is in fact the modified version of the framework structure mentioned in Figure 2.3. For nearly every box represented in the framework structure, Turkey has a corresponding institution or organization devoted to same tasks and duties. The institutions mentioned in previous sections, such as TÜBİTAK and UME are placed in appropriate positions. Since the theoretical background of the model is mentioned in Chapter 2, the organizational, mission specific and implementation dimensions of the structure will be evaluated in this section.

The first significant point in the system is the complex and crowded structure of the policy making layer and its complementary institutions (Layer IV and Layer III), which can be considered as a necessity since almost every component of the government and public institutions are somehow involved in policy development process. The problem here is that, the institutions – especially the ones which are directly related to policy making process – are affiliated to different ministries.[245] As an example, SPK and TÜİK are affiliated to different ministers of state, where TÜRKAK is linked to the Ministry of Industry and Trade, and TÜBİTAK is linked directly to the Prime Minister. This situation increases the risk of orchestration problems, and lack of coordination among these institutions, which can be eliminated by BTYK as the highest policy making body according to the current legislation.

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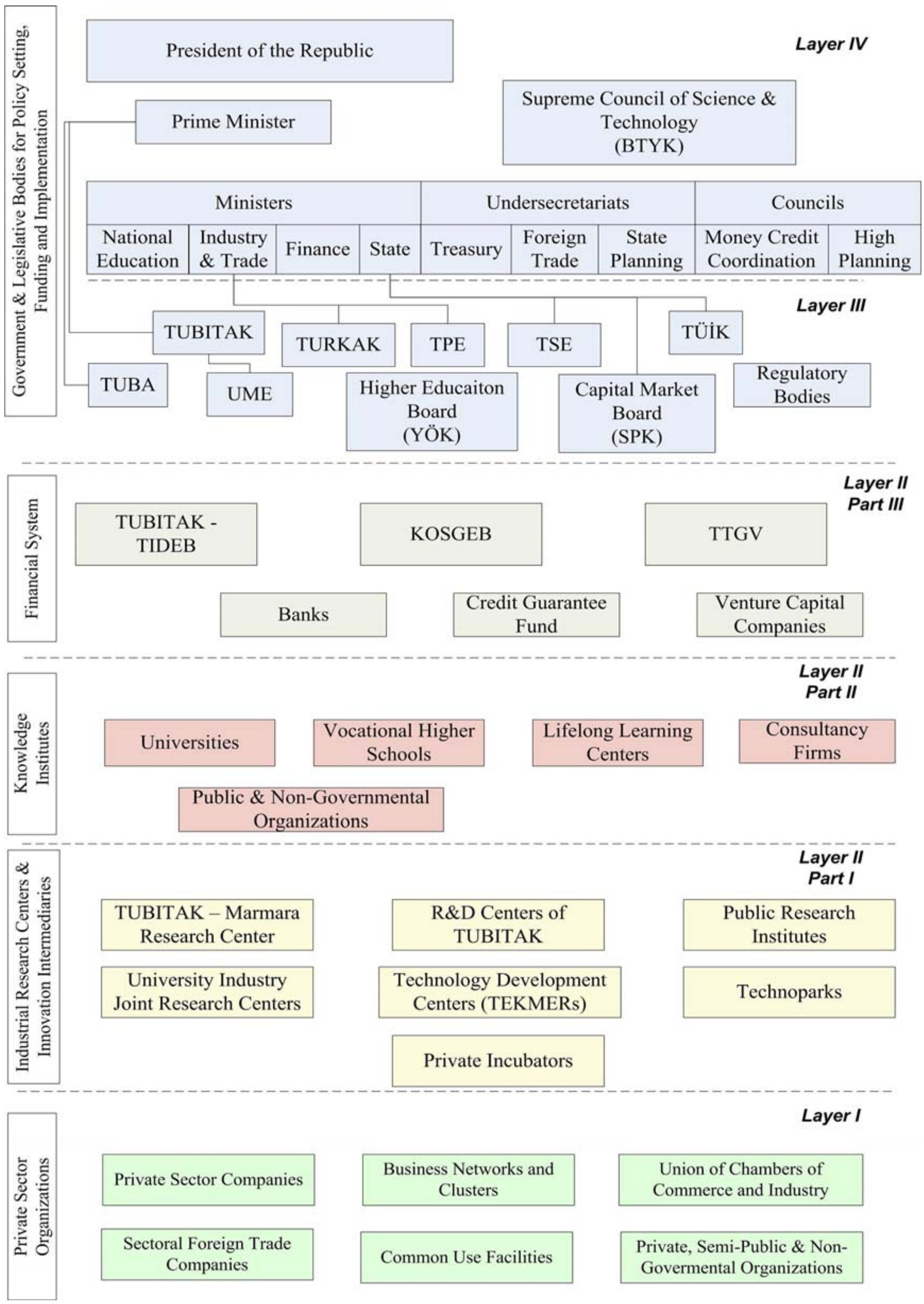
[244] Taymaz, op.cit., 6.

[245] TÜSİAD, op.cit., 79.



Source: European Commission, 2005

Figure 4.3: Institutional Structure of NIS of Turkey

However, BTYK could not manage the coordination among related institutions. and could not provide their involvement in policy making process. Moreover, BTYK has been experiencing difficulties in the efficient implementation of Turkish science and technology policy. The lack of government support and political willingness had been the main factor behind the insufficient performance and functionality of BTYK until 2004.[246] With the increase in government support since 2004, BTYK has started to convene regularly and it seems to be operating more efficiently, especially after the start of negotiations with the EU in October 2005. Despite this development, the policy making layer of Turkish national innovation system needs to be restructured to eliminate the risks mentioned above and to increase the efficiency of development and implementation of policies and long-term strategic plans, as well as to manage research and innovation at national scale.[247]

The financial system (Layer II / Part III) seems to be well organized by providing numerous types and levels of incentives and direct support for innovating firms. However, complex bureaucracy and long lasting application procedures for government R&D funds reduce the popularity of these incentives. The evaluation procedure of application can take up to one year, and firms lose so much time to finish their R&D or production phases, that their competitors may release the product before them, which is an unacceptable risk.

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[246] Özdaş, op. cit., 52.

[247] TÜSİAD, op.cit., 80.

Table 4.5: Venture Capitals of Turkey and Their Portfolios

Name	Year Founded	# of Projects/Companies in Portfolio
VakıfRisk	1996	3
iLAB	2000	7
İş Risk	2000	6
Turkven	2002	4
KOBİ A.Ş.	2004	1
TTGV Girişim Fund	2004	-

Source: Web sites of the listed organizations, 2006.
http://www.ilab.com.tr/tr/static/yatirimlarimiz_sigortam.html
http://www.isrisk.com.tr/turkce/portfolio.htm
http://www.vakifgirisim.com.tr/yatirimlarimiz.htm
http://www.turkven.com/investments.html
http://www.ttgvgirisim.com/eng/portfoy.htm
http://www.kobias.com.tr/

The complementary mechanism of government funds is the venture capital structure. However, Turkey has insufficient number of venture capital companies, and they provide very limited support to start-up companies. Well known venture capitals, years they are founded in, and their project portfolios are listed in Table 4.5. Table indicates that venture capital is a new concept in Turkey. Except VakıfRisk (1996), venture capital companies were founded in 2000s, and the total number of projects supported by them could barely reach 21.[248] It seems that Turkey still needs time for the venture capital concept to be better established and applied.

The Knowledge Institutes Layer (Layer II / Part II) of Turkey is also well organized with its strong formal education infrastructure and complementary learning mechanisms such as private courses. The major weakness of this layer exists in the consultancy mechanism. Consultants play an important role in guidance and coordination of institutions and organizations. Majority of public institutions and

[248] Burhan Karaçam Partnership and TTGV Girişim Fund did not declare the number of projects / companies in their portfolios.

private sector organizations do not tend to make use of consultants. Besides, there are not enough independent consultancy firms either. From the technology consultancy point of view as an example, most of the so called consultants are representatives or solution development partners of multinational technology enterprises, such as Microsoft, and it may keep them from providing optimum solutions for their clients.

Public and private research centers, university-industry cooperation mechanisms, and private sector companies form the operational sub-layer (Layer II / Part I) of a national innovation system. TÜBİTAK is the major public R&D organization of Turkey. TÜBİTAK runs the biggest R&D complex of the country, namely Marmara Research Center, which includes a technopark, and six research institutes working on specific areas.[249]

Technoparks are the major instruments for university – industry cooperation, as well as technology and knowledge spillovers among companies. They can be built by universities, public and private research institutes and even by the private sector itself. As indicated in Table 4.6, there are 23 technoparks in Turkey, 21 of which were founded by universities. The Ericsson Mobility World is the only example of technoparks initiated by private sector in Turkey. Founded in 2001 as a branch of worldwide Mobility World centers, Ericsson Mobility World provides know-how, equipment, marketing and sales support to ICT companies which are developing mobile internet solutions.[250] Marmara Technopark – the first technology development zone of Turkey – was founded in 1999 within the TÜBİTAK – Marmara Research Center, and has been offering companies a strong research infrastructure especially in ICT, environment, energy and biotechnology areas. Both technoparks are focusing on clustering of companies of specified technology fields, and enhancing knowledge exchange among them. In addition, Ericsson Mobility

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[249] Research institutes within Marmara Research Center: Information Technologies Research Institute, Institute of Energy, Chemistry and Environment Institute, Food Institute, Materials Institute, Earth and Marine Sciences Research Institute.

[250] Ericsson, "Ericsson Mobility World Türkiye Hakkında," http://www.ericsson.com/tr/solutions/emw/hakkimizda.shtml, (accessed November 8, 2006).

World is encouraging targeted research on market-oriented subjects, which is one of the crucial factors for innovation.

Table 4.6: Technoparks in Turkey

#	Name	University / Company / Location	Year Founded
1	Marmara Technopark	TÜBİTAK-Marmara Research Center / Gebze	1999
2	METU – Technopolis	Middle East Technical University / Ankara	2001
3	Ericsson – Mobility World	Ericsson / İstanbul	2001
4	İzmir Technology Development Center	İzmir Technology Institute / İzmir	2002
5	Cyberpark	Bilkent University / Ankara	2002
6	Gebze Organized Industrial Zone Technopark	Sabancı ve Kocaeli Universities / Kocaeli	2002
7	İTÜ – Arı Technopolis	İstanbul Technical University / İstanbul	2003
8	Hacettepe – Technopolis	Hacettepe University / Ankara	2003
9	YTU – Technopark	Yıldız Technical University / İstanbul	2003
10	Eskişehir Technology Development Zone	Anadolu University / Eskişehir	2003
11	KOU – Technopark	Kocaeli University / Kocaeli	2003
12	Istanbul University Technology Development Zone	İstanbul University / İstanbul	2003
13	Konya Technopolis	Selçuk University / Konya	2003
14	Antalya Technopolis	Akdeniz University / Antalya	2004
15	Erciyes Technopark	Erciyes University / Kayseri	2004
16	Trabzon Technology Development Zone	Karadeniz Technical University / Trabzon	2004
17	Çukurova Technology Development Zone	Çukurova University / Adana	2004
18	Ata Technopolis	Erzurum Atatürk University / Erzurum	2005
19	Mersin Technology Development Zone	Mersin University / Mersin	2005
20	Göller Bölgesi Technology Development Zone	Süleyman Demirel University / Isparta	2005
21	Ulutek Technology Development Zone	Uludağ University / Bursa	2005
22	Gaziantep University Technology Development Zone	Gaziantep University / Gaziantep	2006
23	Ankara University Technology Development Zone	Ankara University / Ankara	2006

Source: Republic of Turkey, Ministry of Industry and Trade, 2006

Universities in Turkey started to establish technoparks in 1990s, but they have been hosting companies since 2001 as seen in Table 4.6. There were two technoparks in Turkey, METU-Technopolis and TÜBİTAK-Marmara Technopark, by the end of 2001. After the ratification of "The Law of Technology Development Zones" in 2001, there has been a boom in technoparks, and 20 new technoparks have been founded since 2002. Most of the technoparks that were founded after 2003 are still under construction, and they have not started to host companies yet. However, following drawbacks in the Law of Technology Development Zones and poor implementation of the law decrease the efficiency of technopark initiatives.

First problem arises in determination of companies that are eligible to move in technoparks of universities. According to the Law of Technology Development Zones, two groups of companies can be hosted in technoparks: technology companies performing R&D based production, and software development companies.[251] Defining software houses as a separate group caused an "over-crowded" population of companies, most of which develop "low-level" applications.[252] The increase in the number of such companies conflicts with the motives behind the establishment of technoparks.

Second drawback of the law is at tax exemption point. As stated in the law, the earnings derived from the software or products developed as a result of the research and development activities are exempt from corporate income tax until 31 December 2013. The problem is that, although it is clear for software, it is not easy to distinguish which earnings of technology companies are derived as a result of R&D activities. This situation ends up with paying higher corporate tax in some cases, and reduces the efficiency of the incentive.

Finally, the lack of prerequisites, such as the academic capacity and scientific research capabilities of the universities, as well as the potential of industry during the establishment of technoparks, and insufficient mechanisms for auditing both

[251] Stated in the article 4.i of the Law of Technology Development Zones.

[252] "Low-level" applications are computer programs, which can easily be developed by using basic programming know-how and require no R&D.

technoparks and the companies within, are the major problems for the implementation of the law.

After examining the NIS representation above and evaluating the layers of the system, it can be summarized that national innovation system of Turkey includes nearly all the necessary actors. However, linkages among the actors of the system are not strong enough and the lack of interaction, cooperation and collaboration hampers the progress towards a functioning system. The policy making layer, especially the legislation of BTYK,[253] needs to be restructured. Establishing a central governing body which develops policy tools, evaluates the implementation, provides harmonization and cooperation among the stakeholders, and coordinates all public funds and incentives for science and technology policy – or research and innovation policy for he future – can be a solution for problems of this layer. The situation was also admitted in 2003 report of BTYK with the statement: "National Innovation System of Turkey could not be formed completely with all of its components".[254] In addition, "Innovation Policy Profile" document of European Commission for Turkey states that, cooperation and coordination among institutions of the national innovation system should be enhanced and strengthened.[255] In addition clear roles and responsibilities should be defined for implementing bodies of innovation policy, and impacts and results of every policy action should be monitored and evaluated systematically and continuously.[256]

As a conclusion to the chapter, it can be stated that, Turkey's attempts towards developing science and technology policy have not progressed in a complete and continuous manner since the beginning of planned years in the 1960s. The policies

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[253] BTYK decisions are not compulsory by nature, and it has somewhat become an advisory board.

[254] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Dokuzuncu Toplantısı, 6 Şubat 2003, Toplantı Hazırlık Notları* (Ankara: TÜBİTAK, 2003), 19.

[255] European Commission, *European Trend Chart on Innovation, Annual Innovation Policy Trends and Appraisal Report: Turkey 2004-2005* (Brussels: European Commission, 2005), 83-84.

[256] European Commission, *Innovation Policy in Seven Candidate Countries: The Challenges Final Report Volume 2.7 Innovation Policy Profile: Turkey* (Brussels: European Commission, 2003), 83.

formulated in policy documents could not be implemented properly in spite of the efforts of bureaucrats who prepared them. [257] The main factor here is that, policies have not been adopted enough by neither governmental layer nor the industry. From the governmental layer perspective, the lack of political support behind science and technology policies, insufficient collaboration between stakeholder institutions and problems with building-up on the past knowledge and experience can be counted as the major reasons. The adoption of private sector to the science and technology policy and industrial demand are as significant for the successful implementation of policies as governmental support.[258] However, social awareness on the economic contributions of science, technology and innovation could not be raised. Finally, the insufficient development of the production-based economy in Turkey did not create sufficient demand for effective policies to be developed. Severe political and economic crises that Turkey had experienced had a significant role in the lack of this demand. Due to the political and economic instability in the country, business enterprises were not able to make long-term strategies, which was an obstacle for the contribution of industry to market oriented research and development.

In the new millennium Turkish science and technology policy has been developed in a research and innovation oriented manner. Recent developments, such as the launch of Vision 2023 Project, introduction of new incentive mechanisms and support tools for industrial research and innovation, and participation in EU Framework Programs indicate a transition towards a new policy approach. Therefore, the start of accession negotiations with the European Union gained more significance in this period. The "Science and Research" chapter of the negotiations is directly related to Turkish science and technology policies, and Turkey is obliged to adapt to the policies of the Union. In this framework, the reflections of EU research and innovation policies on Turkish science of technology policy and requirements of Turkey to adapt EU policies will be examined in the following chapter.

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[257] TÜBA, *Türk Bilim Politikasında Yeni Arayışlar ve Atılımlar Paneli* (Ankara: TÜBA Yayınları, 2001), 2.

[258] ibid.

CHAPTER 5

ADAPTATION OF TURKEY TO THE EUROPEAN UNION RESEARCH AND INNOVATION POLICIES DURING THE ACCESSION PERIOD

5.1 Introduction

The evolution of Turkish science and technology policy has come to a new milestone with the start of accession negotiations between Turkey and the European Union on October 3, 2005. To become a full member of the Union, Turkey must meet the three basic criteria: political, economic, and legislative.[259] Although negotiations with EU are mostly focusing on social and political criteria, economic cohesion with EU is as significant as the others. Economic criteria do not only include the existence of a functioning market economy, but also imply that Turkey should be able to cope with market forces in the Union.[260] Reminding the central role that EU gave to innovation in economic growth and competitiveness, this statement also implies that Turkey should improve its technology development, research and innovation skills.

As defined in the Negotiating Framework document, "accession means the acceptance of the rights and obligations attached to the Union system and its institutional framework, known as the 'acqui communautaire' – simply the *acquis* – of the Union".[261] The *acquis* is broken down into 35 chapters, each of which is representing a certain policy area to be held independently during the negotiations.[262]

[259] European Council, *European Council in Copenhagen, 21 – 24 June 1993, Presidency Conclusions* (Copenhagen: European Council, 1993), 7.

[260] ibid., 13.

[261] European Commission, *Negotiating Framework* (Luxembourg: European Commission, 2005), 4.

[262] ibid.

Accession period can briefly be divided into three phases. The first phase of negotiations is the screening process, where the related *acquis* is explained to Turkish side and the state of preparation of Turkey for the opening of negotiations is evaluated.[263] As soon as the European Council decides that Turkey managed to meet the requirements set for a specific chapter, the chapter is provisionally closed and negotiations start for it.[264]

Once negotiations are successfully completed on every chapter, an accession treaty[265] will be signed between EU and Turkey. Third phase of accession period will start after signing the accession treaty, during which Turkey will officially be referred to as the "acceding country". This phase will be completed when Turkey shows sufficient progress to become a member state.

Among the 35 chapters of the *acquis*, "Science and Research" chapter is directly related with the science and technology policy of Turkey. Negotiation topics within the scope of Science and Research chapter can be summarized as, the existence of a national innovation system in Turkey, participation of Turkey in EU Framework Programs, performance of Turkey in research and innovation, future targets of EU such as Barcelona target of 3% R&D intensity and Lisbon strategy, and integration of Turkey into European Research Area. Screening process for Science and Research chapter started on October 20, 2005 and ended on November 14, 2005. Negotiations for Science and Research Chapter are opened and closed on June 12, 2006.

Although the negotiation phase on Science and Research chapter is passed so quickly, Turkey needs to close the gap between EU in research and innovation performances. Taking the recent developments in EU research and innovation policies and 2010 targets of the Union, it can be said that Turkey needs to show spectacular performance to catch-up EU average.

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[263] ibid., 7.

[264] EU holds its right to reopen the chapters and restart negotiations due to changing requirements or the progress of Turkey.

[265] The Treaty sets out the conditions and arrangements regarding accession, including the rights and obligations of the new Member States as well as adaptations to the EU institutions.

The aim of this chapter is to analyze the requirements for the adaptation of Turkey to EU research and innovation policies in terms of scientific and technological research, innovation skills and technology development capabilities. Within this context, firstly the relations between EU and Turkey in the area of scientific and technological research are examined. After this examination, policies of Turkey and EU are compared in terms of legislation, organizational and institutional framework, funding mechanisms, targets and policy implementations. In addition to the comparison, current situation of Turkey with respect to EU is studied in the light of research and innovation indicators. Finally, the chapter is concluded with policy proposals for Turkey to achieve its integration with the European Research Area and close the gap between EU.

5.2 Relations with the European Union

Relations of Turkey and the European Union go back to 1959, when Turkey applied for associate membership to the European Economic Community (EEC). After the application, an association agreement, known as the Ankara Agreement, was signed in 1963 to take Turkey to Customs Union with an eventual aim of full membership.[266] Since then, Turkey has been ambitiously cooperating with the Union in several areas including scientific and technological research.

Cooperation of Turkey with EU in scientific research has progressed at institutional level, rather than being a government policy until the end of the 1990s. Although Turkey has attended EU's cooperative research programs, such as COST (1971) and EUREKA (1985) at governmental level, they were mostly results of efforts of individual institutions like TÜBİTAK and universities. TÜBİTAK played the role of national authority and contributor for EU's intergovernmental scientific research programs, and Turkey has been attending both COST and EUREKA since the launch of these two programs.

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[266] DPT, *Ankara Anlaşması ve Katma Protokol* (Ankara: DPT, 1993), 5-8.

COST projects are focused on basic and non-market-oriented research; therefore participation of Turkey has been limited with universities and public research organizations. Each COST project can be initiated by any individual curious researcher, as long as international partnerships are established and financial support is available. There is no strict approval mechanism for the projects proposed. On the one hand, it leaves researchers free to study on any subject in the scope of COST. On the other hand, project initiation process – both finding partners and obtaining financial support from the national authority – is left to individual efforts, which makes it difficult in countries having complex bureaucratic procedures like Turkey. Totally 607 COST projects have been launched since 1971 and Turkey has participated in 67 of them.[267] Turkey's poor performance in participating in COST projects cannot be explained merely by complex bureaucracy, but it is also a result of insufficient interest in collaborative scientific research.

Unlike COST, EUREKA is a program where projects are focused on market-oriented industry research and development. It is a network gathering companies, universities and research organizations from member countries. As the founding member of the network, Turkey has participated in 79 projects out of 2514 with a share of 3.1 percent, and is currently involved in 28 of 700 ongoing projects with a share of 4.0 percent.[268] The average performance of Turkey in EUREKA is moderate and higher than COST performance. However, the number of organizations involved, and participation of Turkish SMEs and large companies in EUREKA projects are below the overall EUREKA average. As indicated by Table 5.1, only 39 out of 2760 participant organizations are from Turkey, which contributes to a share of 1.41 percent of the overall participants. In addition, 46.15% of Turkish participants are represented by the industry, where this rate is 64.13% on the average. The analysis shows that both overall performance and industrial involvement of Turkey in

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[267] COST, "Action Signatures Overview, Country Information, Filter: Turkey," http://www.cost.esf.org/index.php?id=26&domain=all&country=TR&filter=all, (accessed July 27, 2006).

[268] EUREKA, "Project Portfolio Advanced Search, Country: Turkey," http://www.eureka.be/inaction/portfolioAdvancedSearch.do, (accessed August 2, 2006).

EUREKA is insufficient, and universities are more interested in R&D projects, though it is a market-oriented research program.

Table 5.1: Turkey's Performance in Ongoing EUREKA Projects

	Turkey (28 projects)		Total (700 projects)	
Type of Organization	**Number of Organizations Involved**	**Share (%)**	**Number of Organizations Involved**	**Share (%)**
Business Enterprises	18	46.15	1,770	64.13
Large companies	*7*	*17.95*	*583*	*21.12*
SMEs	*11*	*28.21*	*1,187*	*43.01*
Research Institutes	4	10.26	491	17.79
Universities	13	33.33	435	15.76
Government/National Adm.	4	10.26	64	2.32
Total	**39**	**100.00**	**2,760**	**100.00**

Source: EUREKA, 2006

Relations with the European Union were not restricted with scientific and technological research cooperation networks. Turkey has also been participating in Framework Programs since the Fourth Framework Program. Participation in Fourth and Fifth Framework Programs were limited with individual applications of especially universities as third party contributors to projects.

Sixth Framework Program (FP6) is the first framework program that Turkey has fully attended at governmental level.[269] It was a significant step towards integration with EU in R&D area. Turkey was the first "candidate country" that fully participated in an EU framework program.[270] However, Turkey showed a poor performance in the Sixth Framework Program at the beginning. It was stated in the

[269] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Onuncu Toplantısı, 8 Eylül 2004, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2004), 9.

[270] Serap Durusoy, "Avrupa Birliği Bilim ve Teknoloji Politikasına Türkiye'nin Uyumu", in *Avrupa Birliği Dersleri. Ekonomi-Politika-Teknoloji*, ed. İrfan Kalaycı, 439 (İstanbul: Nobel Yayın Dağıtım, 2006): 435-455

2004 progress report of EU on Turkey that, both the number of application from Turkey and the overall success rate[271] of these applications were very low, and it was urged by the European Commission that Turkey should take significant steps to increase both the quantity and quality of its participation in FP6.[272] Total number of Turkish participants in FP6 projects was 128 at the time the report was prepared, only 50% more than participants in FP5.[273] The 2004 progress report of EU has been a breakpoint for performance of Turkey in FP6. The participation of Turkey in FP6 was evaluated for the first time in this report and, critical assessments about its poor performance urged Turkey to take precautions towards improving the participation in FP6. TÜBİTAK started a program named "tr-access" to raise the awareness towards FP6 and encourage SMEs to participate in FP6 projects, and launched courses on FP application procedures.[274] As a result of all these efforts, Turkish participation has geared up significantly since 2004. Therefore, Turkey's performance in FP6 is examined in two different periods: before and after the 2004 progress report.

Figure 5.1 shows Turkish participation and success rates of applications between December 2002 and June 2006. To indicate the upwards trend after 2004 progress report, the two periods mentioned above are represented separately. In addition, the overall performance of Turkey in FP6 is represented at the rightmost side of the graph as well. Between December 2002 and April 2004, only 10.54% of Turkish applications were qualified as project partners, with 128 accepted applications out of 1,214. On the other hand, there has been a considerable increase in both success rates and number of participants in FP6 projects since April 2004. Turkey reached a success rate of 18.80% with 305 accepted applications out of 1,622. TÜBİTAK declared that the success rate of 18.80% that Turkey has reached in 2004-2006

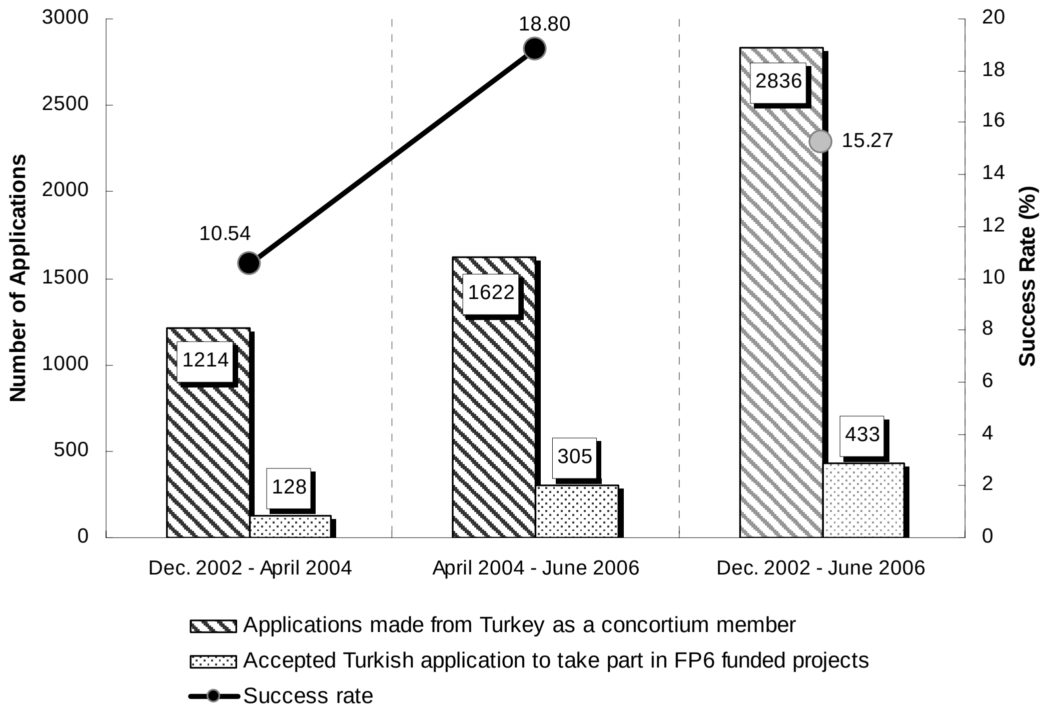
[271] "Success rate" term is used to represent the share of accepted application within total number of applications.

[272] European Commission, *2004 Regular Report on Turkey's Progress Towards Accession, COM(2004) 656 final* (Brussels: European Commission, 2004), 123.

[273] ibid.

[274] TÜBİTAK, "tr-acsess – AB Altıncı Çerçeve Programı Ulusal Koordinasyon Ofisi Bülteni," no. 1, (2004), 1-3.

period is around EU average for those years.[275] However, the overall performance of Turkey with 15.27% success rate does not prove that Turkey showed a sufficient performance in FP6. The 2006 progress report of the European Union about Turkey confirms the low performance of Turkey. It was stated in the report that Turkey had reached a success rate of 17% by the end of September 2006.[276] However, success rate of Turkey persisted to remain below the EU averages of 20% despite the gradual improvement after 2004.



Source: TÜBİTAK, 2006

Figure 5.1: Number of Turkish Applications in FP6 and Success Rate (%) of Applications

[275] TÜBİTAK, *TÜBİTAK'ın 7. Çerçeve Programı Hazırlıkları ve Türkiye'nin 6. Çerçeve Programı Performansı* (Ankara: TÜBİTAK, 2006), 8-10.

[276] European Commission, *Turkey 2006 Progress Report, COM(2006) 649 final* (Brussels: European Commission, 2006), 65.

In addition to participating in EU scientific and technological R&D programs, Turkey has close relations with the Union in institutional and organizational bases as well. Universities and public institutions such as TÜBİTAK, TURKAK, UMA and TPE are running joint activities with their equivalent institutions in EU member states, and representing Turkey in EU organizations. As an example, Turkey is a member of European Patent Office (EPO) and European Science Foundation (ESF). In both organizations Turkey is represented by TPE and TÜBİTAK respectively. KOSGEB has opened the first Euro Info Center[277] for SMEs in Turkey, in 1994, after reaching an agreement with the European Commission, and has been serving Turkish SMEs for better cooperation, collaboration and trade with their European equivalents.

5.3 Comparison of Turkey and EU within the Framework of Research and Innovation Policies

Relations with the European Union came to a new milestone with the start of negotiations on October 3rd, 2005. "Science and Research" chapter, one of the 35 chapters into which the *acqui* is broken down, is where negotiations on Turkish science and technology policy took place. According to Göker,[278] Turkey needs to close the gap between EU in science, technology and innovation to reach a comparable level in international competitiveness, which he sees as one of the noteworthy factors behind the economic cohesion of Turkey with EU. At this point, adaptation to EU research and innovation policies gains more significance for Turkey.

In order to better analyze the adaptation of Turkey to EU research and innovation policies, and to determine necessary improvements for Turkish science and

[277] Euro Info Centers form a network of 300 centers in 45 countries, informing, advising, and assisting SMEs on businesses cooperation. They help companies evaluate their readiness to co-operate at international level and assist companies in defining the type of co-operation needed and searching for potential partners.

[278] Aykut Göker, "Bilim ve Teknoloji'de AB'yi Yakalamak," *Cumhuriyet Bilim ve Teknik*, no. 919 (30 October, 2004): 6.

technology policy, it will be useful to make a comparison of Turkey and the European Union within this particular policy area. In this context, this section briefly compares Turkey and EU policies in terms of legislations, organizational and institutional framework, R&D funding, targets and priorities and implementation of policy instruments.

Legislation in research and innovation policies implies regulatory arrangements that create a suitable environment to foster research and innovation, such as incentive regulations and intellectual property law. Turkey has already developed necessary legislations to support its policy as foreseen by EU and achieved by the member states. Although legislations that regulate the infrastructure of Turkish science and technology policy, such as protection of intellectual property, establishment of venture capitals, establishment of technoparks, and incentives such as tax exemptions are in force, there are several drawbacks that hamper the effective implementation of them. The most significant legislative arrangement of the last decade was the enactment of "The Law of Technology Development Zones".[279] As mentioned in Section 4.6., deficiencies in the law such as the ambiguities in the selection process of companies into the technoparks, and the lack of control mechanisms create significant problems that reduce the efficiency of technology development zones.

In terms of organizational and institutional framework as the second comparison topic, it was stated in Section 3.5 that EU is trying to develop a fully-structured innovation system, together with the European Research Area. The aim of EU is to complete the construction of ERA within the Seventh Framework Program by the end of 2013. Turkey, on the other side, has constructed the "skeleton" of its national innovation system, after the considerable developments in its organizational framework in the 1990s. However, it is not possible to assert that Turkey has a complete and functioning innovation system due to the problems as discussed in Section 4.6, such as the lack of linkages, interaction and coordination among the actors, underdeveloped relations among the layers of the system and the lack of a

[279] T.C. Resmi Gazete, Teknoloji Geliştirme Bölgeleri Kanunu, Law No. 4691, Enacted: 26.06.2001 (Official Gazette No. 24454, dated 06.07.2001).

central policy governing body, which is represented by a permanent organization in EU – DG Research of the European Commission.

As the third comparison topic, it can be stated the R&D funding in EU represents a multilayered structure with a plenty of support for research and development. As discussed in Section 3.6, Framework Programs are the major instruments of EU for the funding of scientific research and technological development at Union level. In addition to the Framework Programs, member states have their own R&D funding and incentive mechanisms to support local research and development activities as well. However, the attractive conditions for R&D funding at Union level could not be provided by all member states at national levels. Disparities in R&D expenditures among member states slow down the convergence of national research and innovation capabilities, and reduce the R&D intensity of the Union. Turkey has also developed its own incentive mechanisms and funding methods. TÜBİTAK-TİDEB and TTGV are the major organizations that provide financial support for R&D in Turkey. With the budgetary arrangements for research funding since 2005, Turkey has significantly increased its resources of R&D support. However, the contributions of these arrangements to research and innovation capabilities, and R&D intensity indicator of Turkey are yet to be seen.

As the fourth comparison topic, it is seen in Chapter 3 and Chapter 4 that both EU and Turkey have been determining priorities to encourage specialization in scientific research and technological development areas, and setting targets to foster research and innovation. EU has been determining its priorities since the launch of COST projects in 1971 and updating its thematic priority areas in Framework Programs in accordance with the global trends in scientific and technological development since the start of FP4 in 1994. Turkey has also been determining scientific technological research priorities since the ratification of "Turkish Science Policy: 1983-2003" document, and continuously revised its priorities nearly in every policy document and Development Plan since the 1980s. However, unlike EU, Turkey could not manage to develop policy tools to channel R&D activities in accordance with the priorities determined.

As a summary of the above comparison of EU and Turkey in terms of research and innovation policies, it can be concluded that the Turkey does not have crucial problems in developing policy formulations, and establishing legislative and organizational infrastructure, determining priorities, as well as constructing funding mechanisms. The major problem of Turkey arises in implementing its policy formulations efficiently, which results in poor performance in scientific and technological development, and improvement of innovation capabilities. Therefore, comparison of Turkey and EU, in terms of policy implementation, focuses on the gap between the European Union and Turkey in research and innovation.

One way of evaluating the performances of countries in research, technology development and innovation is to use science and technology indicators and related statistics. To give a brighter picture for the position of Turkey with respect to EU, selected member states and other candidate countries, a comparative table – as seen in Table 5.2 – is prepared by using the indicators and statistics mentioned above. The main idea behind this approach is to use a quantitative basis for the comparison and analysis of research and innovation capabilities of selected countries. The comparative table follows a logical sequence starting with the creation of intangible asset: knowledge, and ending with its transformation into tangible goods: innovations and its contributions to the economy in terms of exports.

Table 5.2: Comparison of Research and Innovation Capabilities of Selected Countries / Country Groups

	Scientific and Technological Research Performance (Knowledge Creation)				Innovation Performance (Transformation of Research into Tangible Goods)			
	Number of Scientific Publications per Million Population, 2003	**Number of Researchers per Thousand Employment (researcher ratio), 2003**	**R&D Intensity (%), 2004**	**Share of R&D Expenditure Financed by the Business Sector (%), 2004**	**EPO Patents per Million Population, 2004**	**Triadic Patent Families per Million Population, 2000**	**Export of High Tech. Products as a Share of Total Exports (%), 2004**	**EIS, Innovation Index (max 1), 2005**
USA	809	9.61	2.66	63.1	51.46	53.11	28.5	0.60
Japan	569	10.38	3.15	74.5	39.74	92.63	26.5	0.65
EU25	639	5.80	1.90	54.3	23.81	36.24	19.7	0.42
EU15	673	6.09	1.95	54.6	28.20	-	17.7	0.46
Finland	1,397	17.68	3.51	70.0	125.59	94.53	21.3	0.68
Sweden	1,642	11.01	3.74	65.0	62.81	91.40	17.8	0.72
Denmark	1,457	9.30	2.63	61.3	45.77	47.65	16.0	0.60
UK	1,086	5.49	1.88	43.9	25.67	30.59	24.3	0.48
Germany	772	6.95	2.49	67.1	44.04	70.29	14.7	0.58
France	773	7.75	2.16	50.8	33.08	35.10	22.5	0.46
Bulgaria	182	3.67	0.51	26.8	0.12	-	3.0	0.24
Croatia	-	3.80	1.14	42.1	0.81	-	11.0	-
Turkey	***180***	***1.81***	***0.67***	***37.9***	***0.19***	***0.08***	***2.0***	***0.06***

Source: compiled from OECD, Eurostat, TÜİK, NSF, 2006.

Although the main aim of table is to analyze the position of Turkey with respect to the EU, USA and Japan are also included in the table to express the significance of the Lisbon strategy for the European Union, as well as to emphasize that EU will also be trying to improve its research and innovation capabilities during the accession period of Turkey.

The major indicator that shows the scientific and technological research capabilities of countries is the number of scientific publications produced by them. In terms of total number of publications, as well as the share of these publications in the total publications in the world, EU maintained its leadership in 2003. EU25 produced 38.3 percent of the world's scientific publications whereas USA and Japan got shares of 31.1 percent and 9.6 percent respectively. Turkey, on the other hand, could produce only 2 percent of total scientific publications of the world. Dividing the total number of scientific publications by "million population" indicates the scientific output performance of the country more accurately. As can be seen in the first column of the table, EU loses its leadership to USA in this indicator. Comparing EU25, USA, Japan and Turkey in terms of scientific publications per million population, USA leads with 809, followed by EU25 with 639 and Japan with 569. Turkey showed a very low performance with 180 scientific publications per million population. Within Europe, the ratio is particularly high in three Nordic countries and the UK, with more than thousand publications. In Turkey, the ratio is less than one third of EU25 and around a quarter of the ratio in USA.

The number of researchers plays a significant role in scientific output of the countries, since publications are mostly the products of researchers' activities. Moreover, researchers are the major assets of a country in scientific and technological research, and knowledge creation. Therefore, the number of researchers per thousand employment is one of the crucial indicators that shows the significance of scientific research in a country. European Union is far behind its competitors with a researcher ratio of 5.80, where USA and Japan have researcher ratios of 9.61 and 10.38 respectively. A similar picture to scientific output can be observed in researcher ratio for Nordic member states of the Union. The researcher ratio of Turkey is again much lower than the EU average with a rate of 1.81, which shows that Turkey needs much further improvement in its human capital. Turkey holds the lowest rank within the selected candidate countries, as well. The 2010 target of Turkey is to reach a researcher ratio of 2.3, which is quite achievable according to the latest trends in Turkey. However, even the target itself is much lower compared to the EU average considering the 2003 values.

The second crucial indicator for scientific and technological research is the R&D intensity, which is analyzed both for EU and Turkey in previous chapters. 2004 values show that 0.67 percent R&D intensity of Turkey is nearly one third of the R&D intensity of EU25, which is 1.90 percent. The huge gap between Turkey and EU indicates that Turkey should considerably increase its R&D expenditures. The R&D intensities of USA and Japan, which are 2.66 percent and 3.15 percent respectively, explain the aim behind the Barcelona target of 3 percent R&D intensity of the European Union, which is set for 2010. The leadership of Nordic countries persists in this indicator as well. Finland and Sweden have already achieved the Barcelona target with 3.51 percent and 3.74 percent of R&D intensities respectively. However, rest of the member states should spend more for R&D activities to reach the target and catch-up USA and Japan by 2010.

Total R&D expenditure includes basic and applied research activities as well as the market-oriented research. Therefore, the contribution of business sector to research is an important indicator which forms a basis for innovation capabilities of a country. Business sector in EU accounts for 54.3 percent of R&D expenditures in EU25, which is again lower than the contribution of business sectors in USA and Japan. The leadership of Nordic countries persists in this indicator as well. Business sector in Turkey realizes 37.9 percent of total R&D expenditures, which is around two thirds of the EU average and less than Croatia. The poor performance in R&D intensity, combined with low business sector contribution concludes that the performance of business sector in market-oriented research is much lower in Turkey. The gap between Turkey and EU in research results in the lagging of Turkey behind the Union in terms of innovation as well.

The second part of the table can be defined as the performance of countries in turning research into innovation. The first two columns indicate the new technology or new product development capabilities of countries. EU25 countries registered 23.81 patents per million population to the European Patent Office in 2004, where the leadership of Nordic countries persist with a particular success of Finland with a ratio of 125.59 patents. However, USA with a patent ratio of 51.46 and Japan with 39.74 overcame EU member states average in their homeland. The low performance of EU in turning scientific output into innovations is known as the "European Paradox". On the other hand, Turkey experienced a much deeper paradox than EU, with only 0.19 registered patents to EPO per million population, which contributes to a negligible amount compared to 23.81 patents of EU. The ratio of EPO patents per million population of EU25 is 126 times, and Finland is 668 times higher than the patent ratio of Turkey. Among the candidate countries, performance of Turkey is slightly higher than Bulgaria, but much less than the performance of Croatia.

The situation is even worse in the ratio of triadic patent families, which refers to patent inventions for which protection has been sought at the three major patent offices: the European Patent Office, the US Patent and Trademark Office and the Japanese Patent Office. The extra protection is generally assumed to imply higher commercial returns.[280] In terms of triadic patent families per million population, Turkey achieved a ratio of 0.08, which is also negligible compared to the EU triadic patent ratio of 36.24. The enormous gap between Turkey and EU25 implies that Turkey has very little capability of yielding commercial outputs as a result of research compared to EU. The main reason of the low performance of Turkey can be related to the lack of market-oriented research. The dominance of EU in this indicator over Turkey does not conclude that EU is in a leading position, globally. Despite the spectacular performance of Finland and Sweden with triadic patent ratios of 94.53 and 91.40 respectively, the EU ratio of 36.24 lags far behind USA and Japan triadic patent ratios of 53.11 and 92.63.

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[280] European Commission, *Key Figures 2005, Towards a European Research Area – Science, Technology and Innovation* (Brussels: European Commission, 2006), 60.

Scientific and technological research performances of countries, combined with the capability of turning them into innovation, contribute to an improvement in competitiveness as well. The strengths of national industries can be assessed by their ability to produce goods that find demand in the global marketplace. Therefore, competitiveness of a country can be measured by examining the market shares of high-tech industries in international trade. The low performance of Turkish industrial research and innovation capabilities can also be observed in its total exports. High-tech industries in Turkey accounted for two percent of total Turkish manufacturing exports in 2004, which can be interpreted as a result of the presence of a few large, export led and technology-intensive companies such as Arçelik and Vestel. The two percent of Turkish high-tech export share was nearly the one tenth of the share of EU high-tech industries, which was 19.7 percent, and was the lowest value among the candidate countries. With a share of 19.7 percent, manufacturing exports were less technology intensive in EU than in USA and Japan with shares of 28.5 and 26.5 resepectively. However, there had been an increase in the export share of EU high-tech industries from 1997 to 2002, whereas the shares of USA and Japan followed downwards trends. The positive trend in EU seems primarily due to the development of high-tech production in the new member states.[281]

Finally the EIS innovation index sums up all the indicators, and reflects the innovation capabilities of countries. With an innovation index of 0.06 out of 1, Turkey once more had the lowest value among all other countries listed in the table. The huge difference between the innovation index of Turkey and the EU25 innovation index of 0.42 summarizes the significant gap in industrial research, scientific output, technology production, and innovation capabilities.

In the light of this comparative analysis, it can be concluded that there is a considerable gap between EU and Turkey in research and innovation areas, which Turkey is obliged to close during the accession period. The next section proposes policy instruments and developments for Turkey to catch-up EU in research and

[281] ibid., 66.

innovation capabilities, and to achieve the targets of Vision2023, which are mentioned in Section 4.5

5.4 Policy Recommendations for Turkey

In the light of the findings derived in previous chapters, several prerequisites for policy formulations of Turkey have appeared. As it is asserted in Section 4.6, where Turkish science and technology policy is evaluated, the lack of government support and political willingness had been the major obstacle of Turkey for both developing and implementing its policies. Therefore, although the prerequisites form a strong basis for the success of policy recommendations which are discussed in this part of the thesis, it should be kept in mind that the eagerness of the political authority is essential.

The first prerequisite is to develop “long-term” science and technology policies and strategies. Technological development, as well as its contribution to economic growth depends on accumulation of scientific knowledge, training of skilled labor force, and development of capabilities to transform knowledge into innovations, all of which need long lasting strategies. Turkey has been developing several policy documents, action plans and strategies since the 1980s, and had no deficiencies in policy making process. However, continuity of policies and their implementation could not be satisfied properly. Continuity of policies can be assured by setting common and fixed goals which can be adopted by the entire stakeholders, and kept by each successor government and bureaucracy.

As the second prerequisite, Turkey needs to determine its priorities by taking the capabilities, strengths, resources (both human capital and accumulated knowledge) of the country into consideration. Being short in time, scientific background and financial resources, determining priorities plays significant role in using resources efficiently.

Third prerequisite is to follow a systemic approach while developing and implementing science and technology policies, as mentioned in Section 2.3.

Recognizing these prerequisites as the sine qua non of implementation, policy recommendations for Turkey in science, technology and innovation areas are grouped in three categories:

- Organizational and institutional regulations
- Operational arrangements and policy implementation tools
- Integration with EU in research and innovation

5.4.1 Organizational and Institutional Regulations

In the current organizational framework of Turkish science and technology policy, TÜBİTAK has undertaken three significant missions: performing scientific and technological research as the main public research institute, coordinating public financial support for research and development activities, and finally developing national science and technology policies and strategies as the general secretariat of BTYK. However, each of the three missions is represented by distinct organizations in the organizational framework of EU, which is a more appropriate approach for specialization and efficiency. Separating the science and technology policy mission from TÜBİTAK and integrating it to BTYK, which is the highest policy making body of Turkey, will contribute to the solution of the "lack of a central governing policy body" problem, which is mentioned during the evaluation of the science and technology policy of Turkey in Section 4.6. BTYK should also be restructured in terms of legislative basis, authorization and organizational structure to become more active in policy development and implementation.

Establishing a functioning national innovation system is essential to construct an "innovation friendly" environment in Turkey, and consequently to foster research and innovation at national level. The main prerequisite to set up such an environment is to create an innovation culture among the stakeholders, from government to industry. Creating an innovation culture is a long-term and dynamic process, which depends on the attitudes of the people, organizations and institutions towards innovation, and the system of values and incentives including the ways they guide the collective and individual behavior. Therefore, social awareness of, and involvement into innovation is as significant as defining tasks of organizations and constructing linkages among the stakeholders. BTYK took a decision, in its 14th meeting on September 2006, for the preparation of "National Innovation Strategy and Action Plan".[282] The aims of the action plan are stated as to determine a thorough definition for the national innovation system of Turkey, develop strategies to establish a synergy among actors of the system and construct effective linkages among them. The decision of BTYK is a significant step towards the establishment of a functioning innovation system at national scale, but the strategy should also include the social perspective to build the system on strong bases.

5.4.2 Operational Arrangements and Policy Implementation Tools

In terms of operational arrangements, current R&D support mechanisms should be reorganized, new tools should be developed to promote the contribution of private sector to R&D, and implementation of policies should be monitored by effective evaluation methods.

Within the context of R&D support mechanisms the first proposal is to revise "The Law of Technology Development Zones". Incentives brought about by the law provide valuable opportunities both for research community and for business sector. However, the problems mentioned in Section 4.6, such as the criteria used to evaluate the applications of companies, and the lack of control mechanisms on technoparks carry the risk of reducing the benefits that could be obtained from technology development zones.

Firstly, the differentiation of software companies from other R&D based businesses should be eliminated during the evaluation of applications. According to the Law of Technology Development Zones, two groups of companies can be hosted in technoparks: technology companies performing R&D based production, and

[282] TÜBİTAK, *Bilim ve Teknoloji Yüksek Kurulu Ondördüncü Toplantısı, Gelişmelere İlişkin Değerlendirmeler ve Kararlar* (Ankara: TÜBİTAK, 2006), 54.

software development companies.[283] However, software companies perform R&D based production as well, and the current legislation allows non R&D based software companies to move in technoparks, which is against the nature of establishing "technology development zones". The recent developments in software industry, such as artificial intelligence and expert systems, have created its own fields of expertise and research areas. Therefore, same criteria of performing R&D and developing new technologies can be applied to software houses as well.

Secondly, explicit control mechanisms should be added into the Law of Technology Development Zones. Control procedures which include both the continuous auditing of universities that run the technoparks, and monitoring of companies by universities within those technoparks will contribute to the effectiveness of the law.

Thirdly, strict standards and constraints to evaluate of eligibility of universities to establish a technopark should be added into the law. Considering the role of technoparks in university-industry cooperation, basic scientific research capabilities of universities need to be at a sufficient level that can meet the requirements of the industry. Moreover, universities should offer a strong technological infrastructure which is not possible for start-up companies to achieve. Therefore, constraints such as the existence of a modern infrastructure suitable for research activities, sufficiency of academic background to provide the creation and diffusion of knowledge, as well as to perform advanced scientific research will contribute to the efficiency of university-industry cooperation and eliminate the risk of establishment of technoparks by "under-qualified" universities.

Second proposal for R&D support mechanisms includes regulatory arrangements – by revising the Law of Technology Development Zones or by the ratification of a new law – to encourage the establishment of technoparks by private sector initiatives to benefit the incentives, and consequently increase their involvement in industrial research and innovation. A private sector incubator, which can fulfill the

[283] Stated in the article 4.i of the Law of Technology Development Zones.

prerequisites mentioned above, should be considered as a technology development zone. The main aim behind this proposal is to support high-technology clusters, provide the diffusion of innovation, and as a result increase the competitiveness of companies within the clusters.

Third proposal for operational arrangements is aiming to contribute to the efficient usage of R&D funds. To reach the 2010 target of two percent of R&D intensity, Turkey has been allocating huge amounts of R&D funds in national budgets since 2005, which is mentioned in Section 4.5. The stable trend persisted in 2007 budget with the allocation of 670 million YTL for R&D funding.[284] Reflections of these arrangements have not been measured, but the 20 percent average annual growth in R&D budget matches with the related R&D intensity calculations made in section 4.6, and it is likely to result in a considerable increase in R&D intensity indicator. In fact, business sector R&D activities increased in 2005 and 2006. According to TÜBİTAK, there had been a huge demand towards R&D incentives and financial support instruments that were placed in national budget.[285] Number of applications for national R&D funds, most of which are SMEs, reached 3,968 by July 2006,[286] which can be seen as an increase in industrial R&D and innovation that would contribute to national economy. At this point, efficient spending of this fund gains significance. The long lasting evaluation process and the complex bureaucratic procedures are the main challenges that SMEs especially face when they intend to apply for support. Reducing the red tape and speeding up the evaluation process would increase the appeal of these funds among SMEs.

Fourth proposal is about activating the public procurement mechanism to increase the private sector R&D expenditures. As mentioned in Chapter 4 and indicated in Table 5.2, the R&D expenditures of the private sector in Turkey is

[284] CORDIS, "Trendchart Newsletter, October 2006 - Turkey: Government Makes Investment in Innovation and R&D a Priority", http://trendchart.cordis.lu/tc_article.cfm?ID=3475&NEWSID=20 (accessed November 15, 2006).

[285] TÜBİTAK, "Sanayi Ar-Ge Projeleri Destekleme Programı Hakkındaki Bilgiler", http://www.teydeb.tubitak.gov.tr/ (accessed August 8, 2006)

[286] ibid.

relatively low, compared to EU averages. An efficient way to increase the contribution of private sector to research and innovation is to operate the public procurement mechanisms towards R&D. In fact, it was proposed both in the Seventh Five Year Development Plan and in the third meeting of BTYK in 1997 that the private sector R&D activities should be supported by rearranging public procurement policies. However, there are no evidences, except in defense sector, that public institutions launched research projects to encourage private sector. Public procurement mechanisms, as foreseen in the Development Plan and BTYK decisions should be operated by encouraging public institutions to initiate joint R&D projects with the private sector in specific areas.

The fifth and final proposal within the operational arrangements category is about the evaluation of policy implementations. Science and technology policy can be thought as a closed loop consisting of policy development, implementation and evaluation processes. Policy development phase determines the basics of priorities, aims and targets of a country in science, technology and innovation, which is followed by implementation of these fundamentals. In accordance with the policy formulation, either the existing instruments can be used or new tools can be designed. At this point, policy evaluation process both fine-tunes the implementation with a solid feedback and constitutes invaluable input for the policy development process.[287]

As discussed within the examination of OECD Interim Report about Turkey in Section 4.4, Turkey does not have appropriate policy evaluation mechanisms. Policy evaluation process has three major benefits for policy makers and implementers. First of all it provides sound basis for strategic changes in policy formulation. Policy makers can make required revisions or updates on policies by the aid of feedbacks provided by evaluations. Secondly, policy evaluation assists the decision support in resource allocation. Amount of R&D funds and their distributions within sectors or

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[287] Abdullah Gök, *The Concept of Behavioral Additionality of Public Support for Private R&D and a Methodological Proposal for an Evaluation Framework in Turkey* (METU: Ankara, 2006), unpublished master thesis, 4-6.

among technology areas can be determined efficiently and more effective usage of resources can be managed by the results yielded by evaluations. Finally, policy evaluation supplies necessary information which can be used to enhance the accountability.[288] Hence, policy evaluation has significant contributions to the improvement of policies within a country. Therefore it is proposed that Turkey should develop methodological policy evaluation mechanisms, especially to measure the contribution of policy instruments to the performance of industrial R&D activities, and innovation capabilities.

5.4.3 Integration with EU in Research and Innovation

International cooperation is one of the essential methods of technology transfer and knowledge exchange between countries. It is also beneficial for business sector in terms of improving their research and innovation capabilities. Due to its obligations during the accession period, which are mentioned in Section 5.1 where the accession period is examined, Turkey is expected to integrate into the European Research Area (ERA). As a result of the long-term relations with EU via intergovernmental programs, cooperative industrial research projects, and Framework Programs (especially after the decision of BTYK towards full participation in FP6), Turkey has achieved progress in integrating into ERA. The progress of Turkey is confirmed by EU in the "2006 Progress Report" as well.[289] However, both the number of applications and the rate of accepted proposals are still below the EU average. Problems for Turkish industry such as inexperience in finding fundable project ideas, lack of necessary background knowledge about the application procedure, and high costs of finding an appropriate partner prevent Turkey from taking part in more projects. Increasing the efficiencies of Innovation

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[288] OECD, *Improving Evaluation Practices - Best Practice Guidelines for Evaluation and Background Paper, PUMA/PAC(99)1* (OECD: Paris, 1999), 12.

[289] European Commission, *Turkey 2006 Progress Report, COM(2006) 649 final* (Brussels: European Commission, 2006), 65.

Relay Centers and Euro Info Centers, and providing similar services via TÜBİTAK to especially SMEs, can ease the efforts of Turkish SMEs at finding project partners in Europe. To increase the number of applications and the quality of project proposals, TÜBİTAK should provide more information to companies about the benefits of the Framework Programs, and it should increase the number of training programs and consultancy services about the preparation of project proposals. Widening the range of financial support and organizing meetings to gather Turkish industry and their European equivalents will help reducing the costs of especially SMEs.

In the new millennium, where innovation is regarded as the driving force of successful growth and development, Turkey should develop and successfully implement its science and technology policy not only to fulfill its obligations during the accession period but also to achieve the targets of Vision2023. Therefore, policy instruments and developments proposed in this section are aiming to contribute to the long-term development of Turkey in science, technology and innovation, rather than limiting its scope to the accession period.

CHAPTER 6

CONCLUSIONS

This thesis aims to analyze the adaptation of Turkish science and technology policy to the European Union research and innovation policies during the accession period, and seeks to identify necessary policy tools to improve Turkey's performance in science, technology and innovation.

To provide a ground for this analysis, research and innovation policies of the EU and Turkish science and technology policy have been examined. Special emphasis has been given to the integration process of Turkey to the European Research Area because of its importance in improving research and innovation capabilities of Turkey. After a comparative analysis of policies of Turkey in relation to Europe, Turkey's needs to reassess its policy instruments and to improve the efficiency in policy implementation are highlighted.

The first main Chapter in the thesis gives thorough information about research and innovation policies from historical and theoretical perspectives. Firstly, the deliberate evolution of scientific and technological research into national policies, and the increasing role of R&D and innovation in national economies during the post World War II period are discussed in Chapter 2. National research policies in the post-war period had a positive effect on productivity of countries. With the rise of industrial competitiveness, which is driven by technological advancement especially in information and communication technologies and globalization of trade in the 1980s, the scope of research and national policies went under a transformation. In Chapter 2, this transformation is explained by the term "innovation". The new trend in national research (and innovation) policy formulations was to create a suitable environment to foster innovation, by providing financial support, and incentives to research activities.

Theoretical analysis of research and innovation policies is based on the underlying economic theories, and their approach to the interaction between research and innovation and its contributions to development. It is seen that there is a complex interaction between research and innovation, and this interaction can be managed by using a systemic approach to the innovation process. If is also found that, the systemic approach, which is defined by "innovations systems" concept, plays a crucial role in transformation of knowledge into new products and processes, and consecutively the implementation of research and innovation policies.

The Third Chapter focuses on the evolution of the European Union research and innovation policies from a historical perspective and analyzes the recent trends in policy formulations within the scope of the Lisbon strategy of the Union. The first finding of Chapter 3 demonstrates that, research has been in EU policy agenda since the establishment of EURATOM in 1958, and the attempts to develop research policies at Union level have been taking place since the Single European Act, which entered into force in 1987. Secondly, the examination of policy formulations, major policy instruments, and the organizational and institutional framework of EU research and innovation policies show that the EU has focused on the harmonization of national research policies of member states as the policy framework, and used joint research programs – such as COST, EUREKA, and the Framework Programs – as the main policy instruments. It is seen that EU has a strong organizational and institutional framework, consisting of dedicated institutions for policy making, such as DG Research and DG Enterprise of the European Commission as the policy making bodies, CREST and EURAB as advisory bodies, and other complementary institutions.

Third finding of Chapter 3 indicates that, after the ratification of "Green Paper on Innovation" in 1995, EU determined "fostering innovation" as the main aim of its policies and reshaped its major policy instrument – Framework Programs – to encourage joint R&D activities, with a final aim of improving innovation capabilities at Union level. The main reason behind this approach is seen as the lagging of EU behind its main competitors, USA and Japan in science, technology and competitiveness areas.

Finally, recent trends in EU research and innovation policies after the launch of the Lisbon strategy, and the attempts towards establishing the EU innovation system via the European Research Area initiative are explored in Chapter 3. EU gave a new start to its research and innovation policies after the launch of the Lisbon strategy in 2000 with the aim of becoming the most competitive and dynamic knowledge-based economy in the world by 2010.[290] In the light of Lisbon strategy, member states agreed to complete the integration of their research and innovation policies within the scope of European Research Area, and establish common policies at EU level. Moreover, an ambitious target of increasing R&D expenditures to 3 percent of GDP was set to catch-up major competitors of EU: USA and Japan.[291]

According to the findings of Chapter 3, it can be concluded that EU has not been able to develop research and innovation policies at supranational level. The absence of common rules and regulations for research and innovation policies causes difficulties in having member states harmonize their policies in line with EU specifications. Disparities among the performances of member states in improving their research infrastructures and fragmentation of research activities among the member states increased even more after the latest enlargement of EU in 2004. Together with the problems caused by the enlargement, drawbacks in skilled labor due to ageing population, lack of interest of young population in science and technology areas, brain drain especially towards USA, and lack of ability to transform the scientific knowledge to innovation, are seen as the main challenges for EU.

In the Fourth Chapter, the evolution of Turkish science and technology policy, current organizational and institutional infrastructure, and future strategies for

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[290] European Council, *Presidency Conclusions, Lisbon European Council, 23 and 24 March 2000* (Lisbon: European Council, 2000), 2.

[291] European Council, *Presidency Conclusions, Barcelona European Council, 15 and 16 March 2002* (Barcelona: European Council, 2002), 4.

scientific and technological development of the country are examined. The first finding of Chapter 4 demonstrates that the attempts towards developing a national science and technology policy in Turkey have been continuing since the beginning of the planned economy period in the 1960s. It is seen that Turkey has established its first public research institute, TÜBİTAK in 1963, which was as a quick response to the global trend of institutionalization of national science and technology policies, such as EURATOM of the European Union. Since the establishment of TÜBİTAK, focus of Turkish science and technology policy has been shifted from constructing a strong infrastructure for basic scientific research to promoting innovation. Main aim of science and technology policy of Turkey during the 1960s and the 1970s was to promote basic and applied research, and to increase the number of researchers. In the 1980s and the first half of the 1990s, the role of technology in development is recognized and policy formulations were focused on defining "critical technologies" for development, and encouraging the concentration of research activities on them. Since the second half of the 1990s, national policies of Turkey in science and technology areas have been developed in an "innovation oriented" approach, rather than aiming to build an R&D infrastructure. Incentives for technology companies, industrial R&D funding mechanisms and university – industry cooperation programs are the main policy instruments that have been used to promote industrial research and innovation in this period.

Secondly, examination of the organizational and institutional framework of Turkish science and technology policy shows that Turkey has established the majority of individual organizations which build up the national innovation system. However, deficiencies in the system such as the lack of a permanent central policy governing body, inefficient R&D funding mechanisms, problems with incentives, inadequate coordination and weak linkages among the actors of the system are pointed out as the major obstacles that hamper the completion and efficiency of the system.

Third finding of Chapter 4 indicates that despite its ambition in developing policy formulations and efforts towards institutionalization, Turkey was not successful at implementing its policies, in terms of achieving targets in main science and technology indicators, and encouraging the contribution of private sector R&D activities. Main reasons behind this handicap are seen as, discontinuity in implementation of policies, lack of political support, poor social awareness of innovation, and insufficient coordination and collaboration among the stakeholders.

In Chapter 5, accession period of Turkey to EU membership is analyzed from the perspective of research and innovation policies. During the accession period, Turkey is obliged to adapt EU policies, improve its research and innovation capabilities and complete its integration into the European Research Area. Moreover, economic harmonization of Turkey with EU, which is one of the membership criteria, includes the achievement of a comparable level in international competitiveness, which also depends on closing the gap between Turkey and EU in science, technology and innovation.[292] Therefore, the adaptation of Turkey to EU research and innovation policies is examined within three sections. Firstly, the relations between Turkey and the European Union in scientific and technological research are discussed. Secondly, EU and Turkish policies and their implications are compared. In accordance with the findings of this comparison, recommendations for the improvement of existing policy instruments are developed and new policy tools are proposed for Turkey to adapt EU research and innovation policies.

The initial finding of Chapter 5 demonstrates that Turkey has been participating in joint research programs of EU for over three decades. Turkey has been a member of both COST and EUREKA programs at governmental level since they were first launched in 1971 and 1984 respectively. Moreover, Turkish government fully attended FP6, which is the main research and innovation policy instrument of EU, in 2003 and is planning to attend FP7 as well. Despite the long term relations with EU in research, it is explored that the participation of Turkey in either of the programs is much below the EU averages. According to this finding, it can be concluded that Turkey needs to improve its performance in EU programs to complete its integration

[292] Göker, op. cit.

into the European Research Area, as well as to get benefit of the programs in terms of knowledge dissemination and diffusion of innovations.

The second finding of Chapter 5 indicates that Turkey is lagging far behind the EU average in generating scientific knowledge, R&D intensity, researcher ratio, contribution of business sector to research activities, technology development and innovation capabilities. It is seen that while Turkish science and technology policy has several drawbacks in terms of legislation, organizational structure, incentives and R&D funding mechanisms, and priorities, obstacles in efficient policy implementation are the main factors behind the existence of huge gap between Turkey and EU in science, technology and innovation areas.

In the lights of the findings in Chapter 5, it is highlighted that the success of policy implementations depends on fulfilling several prerequisites, such as developing long-term strategies by assuring the continuity of policies, determining priority areas to focus on, and following a systemic approach to innovation. Following these prerequisites, and in accordance with closing the gap between EU in research and innovation, key policy tools are recommended for Turkey. Policy proposals are focused on three major areas where Turkey experiences problems, which are institutional framework, effective usage of policy instruments, and integration into the European Research Area. Reorganizing the R&D funding and policy formulation activities of TÜBİTAK under the authorities of separate institutions and establishing a central policy governing body to improve the efficiency of policy making layer is emphasized within the proposals of restructuring institutional framework. Revising the Law of Technology Development Zones to increase the efficiency of technoparks, and developing policy evaluation mechanisms both to monitor policy implementation and to "fine tune" policies are major topics which are discussed within the effective usage of policy instruments category. Finally, it is proposed to exploit the participation in EU Framework programs by supporting business enterprises during the application and to encourage mobility of researchers to fulfill the integration of Turkey into the European Research Area.

The new millennium has been a turning point for Turkey in science, technology and innovation areas with the start of negotiations with the European Union. To cope with ambitious goals of the European Union within the scope of Lisbon strategy and Barcelona target of 3 percent R&D intensity, and to adapt EU research and innovation policies during the accession period, Turkey needs to show considerable performance in scientific and technological development, as well as transforming knowledge into innovation. As an overall conclusion, Turkey should focus on structuring and implementing its policy instruments in the light of the *sine qua non* of science and technology policies and policy proposals which are discussed in the above paragraph, to catch-up EU in science, technology and innovation, and to further integrate into the European Research Area. Reassessing its policies and improving its research and innovation capabilities are essential for Turkey not only to fulfill its adaptation to EU research and innovation policies, but also to achieve a sustainable development in science, technology and innovation to increase its competitiveness at global level.

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APPENDICES

APPENDIX A

Definitions of National Innovation System[293]

In the narrow definition, a National Innovation System is composed of:

i. institutions actively engaged in the production and diffusion of new technologies (e.g. private and public R&D labs, quality control and testing facilities, etc.)
ii. institutions regulating the production and diffusion of new technologies (e.g. national standards institutes, patent offices etc.)
iii. institutions supporting the access and dissemination of scientific and technical knowledge (e.g. scientific and technical information services, science parks, publications, libraries, universities etc.)
iv. institutions providing qualified people, and a variety of craft and technical skills (the educational system and the industrial training system)
v. institutions formulating and implementing science and technology policy (e.g. Ministries, national research councils, etc.).

In the broad definition of a National Innovation System, the following elements are also considered in relation to their impact on the process of technological change:

vi. the production system (inter-industry linkages and production structure)
vii. the marketing system (in-house departments, marketing organizations)
viii. users of innovation (firms, governments)
ix. the finance system (banks, stock markets)
x. labor markets (unions, industrial relations)
xi. institutions formulating and implementing antitrust and trade policies
xii. institutions regulating the use of innovations (e.g. regulations on pharmaceuticals) and their impact on the environment and natural resources
xiii. informal and implicit institutions (e.g. social norms, culture etc.).

[293] Senker, op. cit., 15-16.

APPENDIX B

Key conclusions on Turkey[294]

The following key conclusions can be drawn from the analysis:

Turkey has an institutional structure with a long-tradition of policy development and an "evaluation culture" in the field of technological development and innovation policy. However, a problem arises from weak implementation of the policies both due to lack of commitment by politicians and governments, and insufficient awareness about innovation among firms. Being aware of this fact, the Vision 2023 Project has been started to design science and technology policies that would include Turkish innovation policy as explained in the first chapter of this report. The aim is that the Vision 2023 project guarantees a shared vision, commitment and active involvement by all stakeholders in policy making. On the other hand, there is a need to focus on raising awareness on innovation. While doing that, it is important to develop a common understanding on the concept of innovation. In general, definition of innovation has been given a narrow perspective and is mostly linked with research and development (R&D). A broader definition of innovation should be established and disseminated. Above issues are also evident in the results of the opinion survey and innovation policy workshop implemented under this study. Only 22% of the respondents to the survey agreed that there exists an innovation policy in Turkey; although there is a fullfledged policy, which is very nearly coherent with the objectives set out in the 2000 Commission Communication on innovation. Considering the fact that the survey covers those private sector actors who are already aware of the concepts linked to innovation policy, it is imperative to establish a concept of what innovation and innovation policy mean and what they are for. As stated above, there are a large variety of institutions in Turkish innovation system, which have been long in existence. There is also a monitoring and evaluation system developed and applied for the main institutions of the innovation system. The results

[294] European Commission, *European Trend Chart on Innovation*, *Annual Innovation Policy Trends and Appraisal Report: Turkey 2004-2005* (Brussels: European Commission, 2005), 83-84.

of analysis and innovation workshop indicate that cooperation and coordination among institutions of the national innovation system should be enhanced and strengthened. In addition clear roles and responsibilities should be defined for implementing bodies of innovation policy actions, and impacts and results of every policy action should be monitored and evaluated systematically and continuously.

Although the current legal and administrative environment is not fully conducive for innovation there are recent efforts to improve the situation. The "Reform Programmed for Improvement of Investment Climate" is of crucial importance both for domestic and foreign direct investments as mentioned in the first chapter of this report. Increasing the level of FDI is seen as one of the solutions to prevent brain drain in Turkey as qualified human resources and researchers, which are the most important capital for innovation, prefer to leave the country. Therefore, mechanisms to increase the level of FDI and of innovative activities of such companies are important in this respect as well as encouraging establishment of start-ups and spin-offs by improving the investment environment. Moreover, special measures should be taken to increase innovation activities of foreign enterprises in the country and interaction and cooperation of them with domestic enterprises. To facilitate starting up and operating a business, one of the most important improvement action needed is to open one-stop-shops. It is also required to place innovation at the core of legal and regulatory reforms. There is no question that macroeconomic environment is a major disincentive for firms to innovate. In the same way, it also makes investors risk averse. As a result entrepreneurs face serious problems in terms of finance. Most importantly market conditions and regulatory framework are not conducive to creation and growth of innovative firms. It is imperative to revise venture capital legislation and to increase the level and number of venture capital and seed capital/start-up funds to enable establishment and growth of new technology based firms (NTBFs). Both the results of opinion survey and innovation workshop attest to the fact that access to finance is a major problem for small innovative firms and start-ups, and must be solved by improving the market condition and regulatory framework as well as implementing various financial support schemes. There are a remarkable number of training and education activities implemented to develop human resources for innovation. On the other hand, it is necessary to place innovation, creativity and innovative entrepreneurship at the heart of national education system. As a result of the analysis, important areas of development are identified as

a) establishing one-stop-shops where training needs of SMEs are identified, training plans are developed and information is provided on available initiatives and service providers;

b) training trainers to increase the number of qualified trainers and high quality consultants for some specific topics (e.g. business planning, technology management, innovation management, high-tech entrepreneurship, etc.);

c) delivering more specific and customized training and consultancy focused on change in culture, business practices and organization for innovation (such as value analysis, benchmarking, creativity tools, etc.);

d) reinforcing coordination and cooperation between various bodies responsible for training and education;

e) establishing a more widespread and structured lifelong learning system for continuously upgrading human capital across all industrial sectors (especially for SMEs);

f) designing and implementing subsidy schemes to reduce the cost of training and consultancy making it more widely affordable for start-ups and SMEs.

Although initiated in a top-down manner, there is an increasing tendency for co-operation and networking between research community and industry and "business-to-business" collaboration, as elaborated in the third chapter of this report. Further efforts are required to increase the level of co-operation through a change in culture both for the research community and for the business sector which must be achieved by education, training and awareness raising activities as well as some initiatives and legislative improvements to encourage such co-operations. Recent developments such as Turkey's participation in the EU's 6th framework programmed and incentives brought about by the technology development zones law provide valuable opportunities in this respect both for research community and for business sector.