STRUCTURAL ANALYSIS AND FUNCTIONAL DYNAMICS OF NATIONAL INNOVATION SYSTEM IN TURKEY AND GERMANY: LESSONS FOR TURKEY

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Approval of the Graduate School of Social Sciences

Prof. Dr. Meliha Altunışık

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Erkan Erdil
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science

Prof. Dr. Erkan Erdil

Supervisor

Examining Committee Members

Prof. Dr. Erkan Erdil (METU, ECON)

Assoc. Prof Dr. Serhat Çakır (METU, PHYS)

Assoc. Prof Dr. Teoman Pamukçu (METU, STPS)

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : AYŞEN ÖZTÜRK

Signature :

ABSTRACT

STRUCTURAL ANALYSIS AND FUNCTIONAL DYNAMICS OF NATIONAL INNOVATION SYSTEM IN TURKEY AND GERMANY: LESSONS FOR TURKEY

Öztürk, Ayşen
M.Sc., Science and Technology Policy Studies
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This thesis examines the structure of national innovation system by analyzing the functional dynamics. The institutionalization of national innovation system, programs and funding system are analyzed. Similarities and differences between two countries, namely Germany and Turkey, are examined. The advantages, strengths (inducement) and weaknesses (blocking) of the German and Turkish research system are discussed and examined by focusing on key policy differences. Key policy differences are explained with tools in the national innovation system. The answer to the question of whether it is possible to harmonize the advantages of German system with the existing research and incentive structure in Turkey is looked for. Finally, considering the solutions that are presented by the tools proposed in the study, the question of whether there are any lessons to be drawn for Turkey is answered.

Keywords: National innovation system, structural components, functions, key policies.

ÖZ

ULUSAL YENİLİKÇİLİK SİSTEMİNİN TÜRKİYE VE ALMANYA İÇİN YAPISAL ANALİZİ VE FONKSİYONEL DİNAMİKLERİ: TÜRKİYE İÇİN DERSLER

Öztürk, Ayşen
Yüksek Lisans, Bilim ve Teknoloji Politikaları Çalışmaları
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Mayıs 2012, 104 sayfa

Ulusal yenilikçilik sisteminin yapısı, fonksiyonel dinamikler ile analiz edilerek bu tezde incelenecektir. Ulusal yenilikçilik sisteminin kurumsallaşması, programları ve finansman sistemi analiz edilecektir. Benzerlikler ve bu iki ülke arasında farklılıklar incelenecektir.Alman ve Türk araştırma sisteminin avantajları, güçlü (teşvik) ve zayıf (engelleme) yanları politikalardaki temel farklılıklarına odaklanarak tartışılmış ve incelenmiştir. Temel politikalardaki farklılıklar, ulusal yenilikçilik sisteminin araçları ile açıklanmıştır. Alman sisteminin avantajları ile Türk sisteminin araştırma ve teşvik yapısı ile bağdaştırmanın mümkün olup olmadığı sorusunun cevabı sorgulanmıştır. Son olarak tezde önerilen araçların sunduğu çözümler doğrultusunda Türkiye için ders çıkarılabilir olup olmadığı sorgulanmıştır.

Anahtar Kelimeler: Ulusal yenilikçilik sistemi, yapısal bileşenleri, fonksiyonları, temel politikalar.

To my Daughter and my Mom,

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ABBREVIATIONS

AiF	German Federation of Industrial Research Associations
AoS	Academies of Science and the Humanities
BMBF	Federal Ministry of Education and Research
BMWi	Federal Ministry of Economics and Technology
BTYK	The Supreme Council of Science and Technology
CEA	Commissariat à l'Energie Atomique
DAAD	German Academic Exchange Service
DFG	German Research Foundation
DWIHs	German Houses of Science and Innovation
EIF	European Investment Fund
EU	European Union
FhG	Fraunhofer Society
FTE	Full-time equivalent
GCRI	German Center for Research and Innovation
GWK	Joint Science Conference
HEIs	Higher Education Institutions
HGF	Helmholtz Association
HRST	Human resources in science and technology
HTS	High-Tech Strategy
IGF	Industrie Gemeinschaftforschung
IPR	Intellectual Property Rights
ITP	Industrial Technology Project
iVCi	Istanbul Venture Capital Initiative
KOSGEB	The Small and Medium Size Industry Development Organization
PROs	Public non University Research Organizations
States	Regional Governments
MARA	The Ministry of Agriculture and Rural Affairs
MAM	Marmara Research Center
MD	Ministry of Development
ME	Ministry of Economics
MPG	Max Planck Society
MoF	Ministry of Finance
MoFA	Ministry of Foreign Affairs
MoH	Ministry of Health
MoIT	Ministry of Industry and Trade

MoLSS	Ministry of Labor and Social Security
MoNE	Ministry of National Education
MoSIT	The Ministry of Science, Industry and Technology
NGO	Non-governmental Organization
NIS	National Innovation System
NQI	National Qualification Initiative
NRP	National Reform Program
PE	Turkish Patent Institutions
PMA	Patent Marketing Agencies
R&D	Research and Development
SANTEZ	Industrial Thesis program
SAVTAG	Defense and Security Technologies Research Group
SIS	Sectoral Innovation system
SOBAG	The Social and Humanitarian Sciences Research Group
SME	Small and medium-sized enterprises
SPK	Capital Market Board of Turkey
SPO	State Planning Organization
STHRCC	Science and Technology Human Resources Coordination Committee
STI	Science, Technology and Innovation
TAEA	The Turkish Atomic Energy Authority
TARAL	Turkish Research Area
Techno parks	Technology development zones (TDZ)
TEKMER	Technology Development Centers
TGNA	Turkish Grand National Assembly
TIS	Technological innovation system
TOBB	The Union of Chambers and Commodity Exchanges
TPE	The Turkish Patent Institute
TSE	Turkish Standards Institute
TUBITAK	The Scientific and Technological Research Council of Turkey
TUBITAK-ARDEB	Research Projects Support Directorate
TUBITAK-TEYDEB	Technology and Innovation Projects Support Programs Directorate
TUBITAK-BIDEB	Scientist Support Directorate
TUBA	Turkish Academy of Sciences
TURKAK	Turkish Accreditations Agency
TURKSTAT	Turkish Statistical Institute
TTGV	Technology Development Foundation of Turkey
TTO	Technology Transfer Offices

UAK	Inter-University Council
UFT	The Undersecretariat of Foreign Trade
UME	National Metrology Institute
USAMs	University–Industry Joint Research Centers
UT	The Undersecretariat of Treasury
UZAY	Space Technologies Research Institute
VC	Venture Capital
WB	World Bank
WGL	Leibniz Association
WR	The German Science Council (Wissenschaftsrat)
YOK	The Council of Higher Education
YPK	High Planning Council
ZIM	Central Innovation Program SMEs

CHAPTER 1

INTRODUCTION-THE STARTING POINT FOR THE ANALYSIS- THEORETICAL BACKGROUND

In recent times, Turkey has settled a great improvement in science and technology. Although it is still behind numerous OECD countries with regard to science and technology, and research and development indicators, it has completed big changes in institutionalization of research system and incentive system in recent years.

Germany, on the other hand, is one of the leading science and technology producers in the world, and it is the leading technology supplier in Europe. Well-developed research infrastructure, innovative power and flexibility of firms and industries, considerable cooperation between the institutions are important factors of technological advantages in Germany. German policies, programs and research systems are quite different from Turkey. However, there are still lessons to be learned from German experience. Since the emergence of an innovation system is a process that usually takes at least a couple of decades, and decision makers face a great deal of uncertainty about this process (Bergek et al. 2005), this study can be used by policymakers to identify the key policy issues and set policy goals with the new restructuring of National Innovation System (NIS) in Turkey.

Considering the recent changes in Turkish science, technology and innovation policy, and in the institutionalization of research system and incentive and funding system, similarities and differences between these two countries will be examined.

Based on the above stated main research topic, this thesis is organized around the following research questions:

1) What are the advantages, strengths (inducement) and weaknesses (blocking) of the German research system?
2) What are the policy differences?
3) Is it possible to harmonize the advantages of the current German system with the existing research and incentive structure in Turkey and what can be the lessons for Turkey?

In order to find answers to these questions, the research strategy that will be employed is the case study method. Comparative case study with multiple cases (Turkey and Germany) will be applied. The mode of inquiry will be inductive approach. The inquiry will be from a

set of specific observations and analysis to general. This study is a descriptive and an explanatory study due to the use of both quantitative and qualitative data.

Bergek et al. list major innovation systems. These are national systems of innovation, (Freeman, 1987; Lundvall, 1992a; Nelson, 1992), regional innovation systems (Asheim and Isaksen, 1997; Cooke et al., 1997), sectoral system of innovation and production (Breschi and Malerba, 1997; Malerba, 2002) and technological systems (Carlsson and Stankiewicz, (1991) (2008). The goal of innovation system is to develop, diffuse and utilize innovations[1]. Bergek et al (2008) state that actors, networks and institutions work together to achieve this goal deliberately or in an unplanned manner. They have analyzed the functional dynamics of technological innovation system (TIS) (2008) and sectoral Innovation system (SIS) (2005) by adopting the scheme of analysis from Oltander and Perez Vico (2005). By analyzing their methodology, national innovation system of Germany and Turkey was analyzed in this study. Moreover, national innovation system concept was focused on through research system and research policy.

Adopting the case study method and considering the research questions, a manual called "Analyzing the Dynamics and Functionality of Technological System: A Manual" will be widely used (Bergek et al., 2005).

[1]This definition has been inspired by Bergek (2002), Carlsson and Stankiewicz (1995) and Galli and Teubal (1997) cited in Bergek 2005 pp 4.

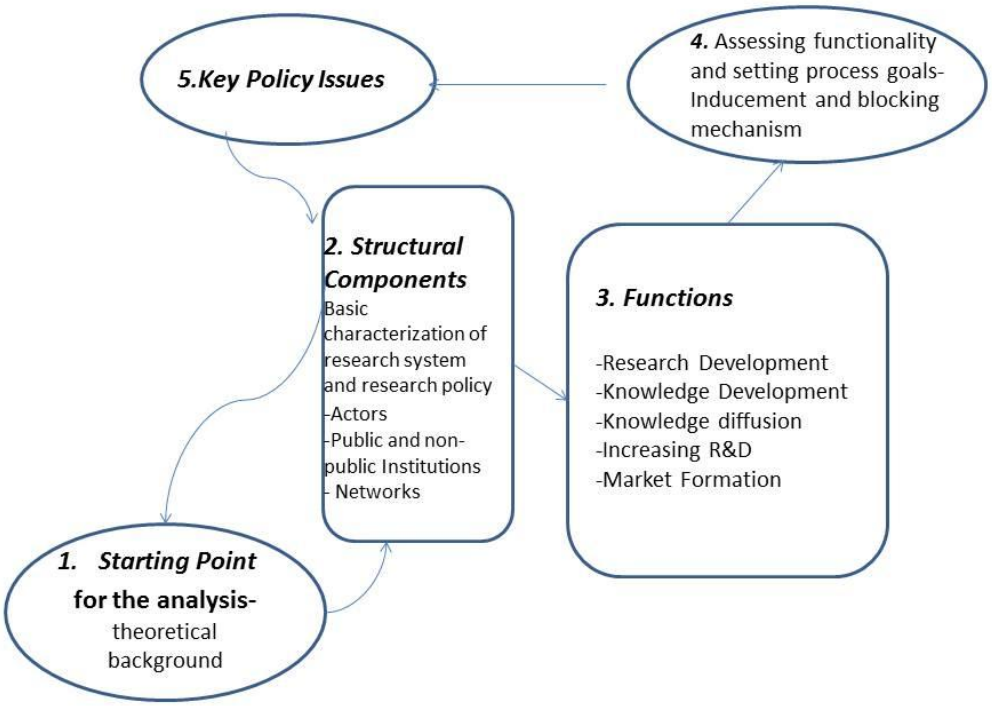

Figure 1 The scheme for analysis (Adopted from Bergek et al.,2005)

As indicated in Figure 1, this thesis **first** presents the starting point for the analysis and theoretical background in Chapter 1**.** The structural components (actors, networks and institutions) were identified as the **second step.** After focusing on NIS, Carlsson and Stankiewicz (1991) identify and analyze the structural components of the system as actors, networks and institutions. According to Bergek et al. (2005 and 2008), actors are universities, research institutes, public bodies, influential interest organizations (e.g industry associations, noncommercial organizations), venture capitalists, organizations deciding on standards and so forth.

The second structural component is networks. The form of network can be informal or formal. Some of the networks come together to manage specific tasks like standardization networks, technology platforms, public private partnership or supplier group networks for a common customer.

The third structural component is institutions. Institutions may come in a variety of forms and may influence TIS and SIS. Culture, norms, laws, regulations and routines need to be identified (North, 1994) for institutions. The laws and regulations will be examined in each chapter of the thesis.

By taking into consideration the above mentioned structural components of NIS, universities, research institutes, public bodies, institutions were widely used to examine the structural components in Germany and Turkey.

The key areas of government role have been emphasized by Link and Leyden (1992). The funding of R&D performed in private sector, funding of laboratory research activities and the effective transfer of that technology to the private sector; and the funding of basic research (specifically at universities) and encouragement of industry-university research relationship were the basic criteria for their studies. The reason why these governmental efforts have been so successful is that they are all related to the building of nation's technology infrastructure through investment activities. This is important because research facilitates the entire R&D production process, and it is one type of innovation-related activity that private sector firms are least willing to undertake alone (Link and Leyden, 1992). In the current thesis, the role of government will be strongly emphasized by focusing on the role of the government institutions and actors in detail.

By considering the above mentioned approaches, in Chapter 2**,** the basic characterization of research system and research policy with a special emphasis on the structural components (actors, public and non-public institutions, networks) in Germany and in Turkey will be explained. Both countries will be discussed separately.

In the **third step,** structure moved to functions. Bergek et al. (2008) report that,

"We need to supplement a structural focus with a process focus. Functions have a direct and immediate impact on development, diffusion, and use of new technologies. The functions approach to innovation system implies a focus on the dynamics of what is actually achieved in the system rather than the dynamics in terms of structural components only".

The process described in this quotation was categorized into a list of eight functions by Johnson (1998). Empirical application also put forward similar approaches, and accordingly the process categorization list has been revised and refined. Edquist (2004) identified a number of activities defined as development, diffusion and use of innovation. Later, Bergek et al. (2005) described the scheme of analysis and six steps were defined for TIS by adapting the scheme of analysis from Oltander and Perez Vico (2005). The same method was used to define sectoral innovation systems (SIS) in Bergek et al. (2005). Seven key processes which are knowledge development, resource mobilization, market formation, influence on the direction of search, legitimation, entrepreneurial experimentation, development of external economies were described in the studies of Bergek et al. (2005 and 2008). As stated by Bergek et al. (2005), there is no one-to-one connection between function and structural components, and each type of components

may influence several functions. The functions may influence each other through various positive and negative feedback loops.

By taking into consideration the above mentioned points, key processes in the evaluation of research systems and functions are shaped in Chapter 3. While designing the functional analysis, research system dynamics were considered. In addition to the previously mentioned "Analyzing the Dynamics and Functionality of Technological System: A Manual", the report by TUBITAK (The Scientific and Technological Research Council of Turkey) named "Science, Technology and Innovation in Turkey 2010" and also Erawatch country reports were extensively used to shape the functional dynamics After analyzing these documents, research development, knowledge development, knowledge diffusion, increasing R&D and market formation were chosen as country specific functional dynamics and key processes.

Research development: There is a complex interface between research and innovation. Research institutes and organizations will overlap with innovation organizations and institutes. National innovation system covers both of them. When focusing on research development, main actors, institutions and programs, policy and strategies, funding instruments and some research statistics will be explained briefly.

Knowledge development: Development and production of knowledge is one of the main functions of the research system. According to Edquist (2005:7*),*

"The System of Innovation approach places innovation and learning process at the center of focus. This emphasis on learning acknowledges that innovation is a matter of producing new knowledge or combining existing (and sometimes new) elements of knowledge in new ways."

When learning process is considered, two important policies named education and human resources are also considered as sub-functions of knowledge development. Since the measurement criteria is quite important, quality and excellence of knowledge production and policies will also be explained.

Knowledge diffusion: How the knowledge is diffused and combined in the system is in the center of NIS, which provides an assessment to allow for an efficient flow of knowledge between different R&D actors. Knowledge diffusion can be measured with numerous criteria and approaches. After checking country specific reports, the following criteria's were decided to be used for analysis in the thesis:

- Promoting the establishment of new indigenous R&D performing firms
- Stimulating greater R&D investment in R&D performing firms

- Attracting R&D performing firms from abroad
- Knowledge circulation between the universities, PROs and business sector
- Cross border knowledge circulation

Increasing R&D: Other policies in research and instruments that are not mentioned in the previous section are explained in this section.

Market formation: Customer profile, demand, price, new technologies, institutional change, formation of standards are important factors to form the market.

"*Market places may not exist, potential customers may not have articulated their demand, or have the capability to do so, price / performance of the new technology may be poor, uncertainties may prevail in many dimensions. Institutional change, e.g., the formation of standards, is often a prerequisite for markets to evolve"* (Hughes, 1983).

As Hughes state, it is difficult to analyze what drives the market. To form the market, the analyst needs to have in depth knowledge of product portfolio and all actors in NIS. Therefore, the multitude of factors that may drive or hinder market formation will be illustrated in the current study.

The fourth step is normative; the answer of the question how well the functions are fulfilled is assessed in Chapter 4. As Bergek et al. says,

"The functional pattern doesn't always tell us whether the TIS is well functioning or not; that a particular function is weak does not always constitute a problem, nor is a function always an important asset. In order to assess system functionality – i. e. not how, but how well the system is functioning- we need ways to evaluate the relative "goodness" of a particular functional pattern" (2008).

In this explanation, the answer to the question of whether NIS is well functioning or not will be limited with the function that was chosen for this thesis. In this same chapter, the way the functions and key processes are performed and developed will be emphasized. Functions will be analyzed with respect to the requirement of each phase.

In the fifth step, as a sub-section of Chapter 4**,** inducement and blocking mechanism towards desirable functional pattern is explained. In the case of Biocomposites (Bergek et al., 2005), there are two inducement mechanisms, which are belief in growth potential and government R&D policy. There are six blocking mechanisms, namely, lack of actors and resources, poorly articulated demand and uncertainty regarding application, lack of vision, definition and focus, lack of integration between subsystem and lack of platforms and meeting places, secrecy of some of the large firms.

In the final step, key policy issues with tools are specified. The advantages, strengths and weaknesses of the German and Turkish research system are examined by focusing on key policy differences. Chapter 5 will be the chapter to propose a research policy. This Chapter is devoted to find answer to the question of whether it is possible to harmonize advantages of German system with existing research and incentive structure in Turkey. This chapter will also try to reveal the lessons that can be drawn for Turkey.

As Edquist argues (2005:7),

"The SI (System of Innovation) approach employs historical and evolutionary perspectives, which makes the notion of optimality irrelevant. Process of innovation develop over time and involve the influence of many factors and feedback processes, and can be characterized as evolutionary. Therefore, an optimal or ideal system of innovation cannot be specified. Comparisons can be made different real systems (overtime and space), and between real systems and target systems but not between real systems and optimal ones. Although this is a complex view of the innovation process, it is far richer and more realistic than its alternatives".

This analysis is limited with the steps chosen in the study. The aim of the current thesis is not optimization since it is believed that it is not possible to rank desirability list, to specify all possible outcomes, and to list all the possible policy alternatives. Therefore, in the following chapters, optimal, desirable and ideal system of research will not be proposed or questioned. A comparison will be clarified between different real systems of Germany and Turkey, and accordingly, lessons that could be drawn for Turkey will be inquired.

CHAPTER 2

STRUCTURAL COMPONENTS (ACTORS, NETWORKS and INSTITUTIONS)

2.1 STRUCTURAL COMPONENTS OF GERMANY

According to the Edquist (2005:7), the behaviors of organization are shaped by institutions including laws, rules, norms and routines that constitute incentives and obstacles for innovations. These organizations and institutions are components of system for the creation and commercialization of knowledge. Lundvall argues that structure of production and institutional set up are the most important dimensions that jointly define a system of innovation (1992:1). Nelson and Rosenberg emphasize that the R&D supporting organizations promote the creation and dissemination of knowledge as the main source of innovation (1993: 5, 9-13). Edquist says that innovation processes are not influenced by the components of the system but also by the relations between them. Innovative firms normally interact with other organizations through complex relations that are often characterized by reciprocity and feedback mechanism in several loops. That makes system of innovation interdependence and non-linearity. (2005:7)

As stated above mentioned studies, organizations and institutions are often considered as the main components of system of innovation. To shape the thesis subject, basic characterization of research system and NIS system will be explained by actors, networks, institutions and organizations in this chapter. Much of the discussion in this chapter is relevant for generic approach, and based on the different variants of system of innovation and research.

2.1.1 BASIC CHARACTERIZATION OF RESEARCH SYSTEM

In the Erawatch Germany country reports it is stated that Germany has federally governed structure. There are 16 states in Germany. Due to the federal structure of German political system, political responsibility for research policy and funding is shared between Federal government and 16 states (Version: 1.6). The division of competencies and responsibilities between the federal government and states is seen as a key factor of German innovation system. All German States have a science and technology policy of their own, often shared between two ministries BMBF (Federal Ministry of Education and Research) and BMWi (Federal Ministry of Economics and Technology). The structures of states are similar to the structure at the national level. States have constitutional right to legislate on education, including higher education and they have right to apply programs in research and innovation policy at the federal level and joint funding from the federal government and the states is also possible.

Key actors for research and research infrastructure in Germany can be summarized as follows:

BMBF and **BMWi** which are the key actors at Federal level

Regional Governments (states)

Public non-university Research Organizations (PROs)

Private sector which is responsible for the private R&D investments

Main actors and institutions in research governance is BMBF, BMWi, GWK (the Joint Science Conference), DFG (German Research Foundation), AiF (German Federation of Industrial Research Associations) and the main research performer groups are Max Planck Society (MPG), Fraunhofer Society (FhG), Helmholtz Association (HGF), Leibniz Association (WGL)**.**

In the Erawatch Germany country reports it is stated that **BMBF** carries main responsibility for federal research policy at federal level (Version: 1.6). BMBF's basic aim is to improve the coordination of strategic research policy, planning and share the responsibility between the federal and the state level (BMBF, 2012). Institutional funding for large research associations and organizations is provided by BMBF jointly with state governments. Participation of foresight processes is one of the basic responsibilities. BMBF is responsible for the international dimension of R&D policy in Germany. BMBF has grants-in aid programs and thematic R&D programs which forms the national policy. The BMBF has introduced important measures to strengthen education, research and innovation in Germany under the High-Tech Strategy (HTS) and National Qualification Initiative (NQI). The basic aim of HTS is continuous monitoring and evaluation stable and predictable policy framework. In July 2010, the new HTS 2020 was launched. The new element of HTS is mission-oriented approach based on a number of future projects. The new strategy has five key priority areas of research. Those are climate and energy, health and nutrition, mobility, security and communication. Under the NQI there is Higher Education Pact, as well as the continuation of the Initiative for Excellence for the promotion of world class university research and the Joint Initiative for Research and Innovation with non-university research establishment. These are the activities of BMBF to initiate the science in federal and state level. They are offering every generation the opportunity to develop their full potential independent from their ages. The Initiative for Excellence aims to promote cutting-edge research at universities and covers all German universities and funded by federal government and states. Beside these, the Pact for Research and Innovation aimed at intensifying support for major science and research organizations.

The Higher Education Pact 2020, aim to create additional capacities for students and to reinforce excellent research at higher education institutions. The federal government and the states have decided to continue the Higher Education Pact until 2020.

The other important actor at federal system is BMWi. As Erawatch Germany country pages says that BMWi is responsible for innovation and technology policy and some areas of R&D policy. The main goal of the technology policy of the BMWi is to focusing more on technology in education and training and orienting applied research and development to the needs of companies. BMWi offers technology-specific programs oriented to the markets of the future. BMWi also execute innovation-oriented programs, most of them includes R&D and innovation. Most of these programs are not thematic but horizontal and bottom up although there are mission-oriented programs in the field of energy research, aerospace and transport research specifically for SME(Small Medium Enterprises) and deals with issues regarding an innovation-friendly environment (version: 1.6). Central Innovation Program (ZIM) for SMEs is the basic program by the BMWi for market-oriented technology funding of innovative SMEs in Germany. To increase SMEs innovative capacities and to work closer together with research establishments is the basic goal of BMWi under ZIM program. (BMWi, The Technology Campaign, March 2011)

To this end, BMWi has also programs including the High-tech Start-up Fund and EXIST. The basic aim of the program is to see considerably more knowledge-based business start-ups in the future. Start-ups from academic institutions are encouraged through the EXIST program. While the program is basically an initiative to improve framework conditions for entrepreneurship at universities, it also contains a small grant aid scheme (EXIST Gründerstipendium) which funds academic start-up projects. Promotion of tech-based start-ups also takes place through special sub-programs in the thematic R&D programs (e.g. biotechnology, nanotechnology, multimedia).

In the Erawatch Germany country reports it is stated that some ministries have their own research institutes in addition to BMBF and BMWi. Some ministries have dedicated sectoral research programs. The federal Ministry of Environment, Nature Conservation and Nuclear Safety has its own research programs mainly in the fields of sustainability and radiation protection. The Federal Ministry of Defense is suitable to his tasks related with R&D in defense application. The ministries are provided with their own research facilities. (Erawatch Germany, 2010)

On federal level, only the German parliament has a permanent committee on education, research, technology assessment and has to approve the research budget. The Joint

Science Conference (GWK) coordinates the research policy between federal and state government. To advise on and decide how to improve German science and research is its responsibility. The support the competitive standing of the country's science and research bodies is one of its objectives. GWK has member from among the representatives of the federal government and from among the representatives of state governments, which alternate in the presidency a year and represent each other" (GWK, 2012).

As Erawatch Country reports says that **The German Science Council** (Wissenschaftsrat-WR) is an advisory public body to the federal government and the state governments for research policy. WR is funded by federal governments and states jointly. Its function is to draw up recommendations on the development of higher education institutions, science and the research sector as regards content and structure, as well as on the construction of new universities. These recommendations involve considerations concerning quantitative and financial effects and the implementation of such considerations; they must be in line with the requirements of social, cultural and economic life. The WR issues statements, recommendations and prepares reports which primarily concern the two major fields of science policy, namely: the scientific institutions (universities, universities of applied sciences and non-university research institutions), in particular their structure and performance, development and financing, and general questions relating to the system of higher education, selected structural aspects of research and teaching as well as the strategic planning and assessment of specific fields and disciplines.(Erawatch, Country Pages, 2011)

Beside federal structure **Regional Governments (states)** are also key actors for research and research infrastructure in Germany. States are partly sovereign constituent states of the federal republic of Germany. The states are parliamentary republics and the relationship between their legislative and executive branches mirrors that of the federal system. Unlike in other countries, there is no strategic policy council to coordinate research and/or innovation policies. The responsibilities of governments of the states are to finance research and teach at the public universities. However, non-university research institutions also carry the large share of basic research. Non-university research institutions are financed jointly with federal government and states. (Erawatch Germany, 2011)

The research governance structure has also research organizations and foundations with different status. DFG one of this organization. He is an independent, publicly funding agency for basic research in Germany, complementing the institutional funding for basic research with project-type funding. Main task of the DFG is the funding of collaborative research centers in universities in general. The research centers aim to create core

research areas in universities by establishing temporary centers of excellence, to promote interdisciplinary cooperation and to advance young researchers. DFG is also funded by the federal government and the federal states. Most publicly funded R&D programs are administered and managed by a range of implementation agencies which are mostly located in large research. Together with the MPG and the FhG, the DFG make a considerable contribution towards the strengthening and integration of research in Germany and also to international co-operation. Support for the next generation of scientists is also of prime importance. The DFG is the self-governing organization for science and research in Germany. In organizational terms, the DFG is an association under private law. Its membership consists of German research universities, non-university research institutions, scientific associations and the Academies of Science and the Humanities (AoS) (Research at a Glance-BMBF, 2007).

The other research organization funded by the federal government and the federal states is AiF. The central concern of AiF is the promotion of applied R&D for the benefit of small and medium-sized enterprises (Erawatch Germany, 2010). AiF is one of the private sector industry associations. As a registered nonprofit association, AiF promotes research and development (R&D) in all industrial sectors in favor of small and medium-sized enterprises (SMEs). The association acts at federal as well as European level. AiF is organized by industry and is particularly involved in increasing the competitive strength of SMEs by supporting the efficient usage and advancement of R&D programs. These include a variety of applied research fields, e.g. process control, building industry, medical technology, food science and agricultural science. The AiF has a unique infrastructure, comprising an industry-based innovations network covering over 100 industrial research associations, with approx. 50,000 SME, and about 700 associated research institutions.

At the moment, there are 409 Higher Education Institutions (HEIs) in Germany, of which 104 are universities and 203 are universities of applied sciences. The remainder consists of specialized universities (e.g. theological, pedagogical, and school of arts) and a few private HEIs. German rector's conference (HRK) is an umbrella organization of HEIs. HEIs governed by state ministries of science and receive basic funding from state Government (Erawatch Germany, 2010).
Overview of German Research system is presented by Figure 2.

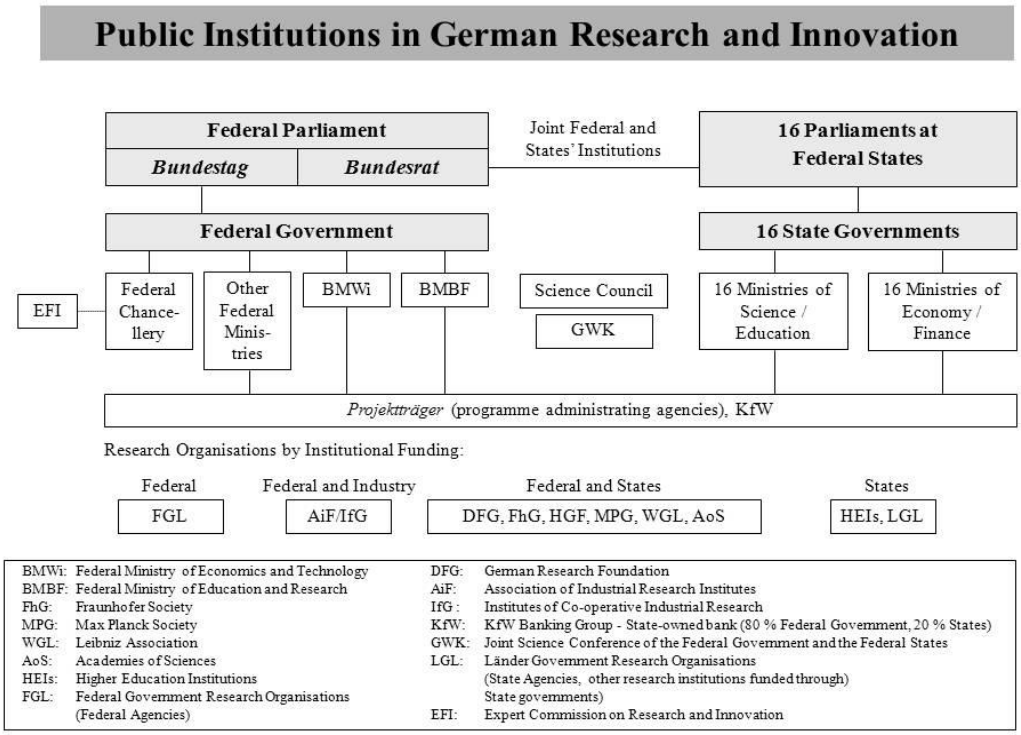

Figure 2: Structure of German Research System (Source: Erawatch Research Inventory report 2012, Version: 1.6)

There have been no major changes in the past years with regard to governance of the research system in Germany. Beside government structure, research organizations cover the huge part of the national research and innovation system.

For public research, there are four important public non-university research organizations (PRO) institutionally funded by federal or state governments or both. They consist of numerous different organizations and institutions with different roles and models by focusing on industry cooperation.

Main 4 large research performers groups with a number of Institutes are as follows:

Max Planck Society (MPG): MPG focuses on research fields that are particularly innovative, or demanding in terms of funding or time requirements. MPG currently maintains 80 institutes, research units and working groups mainly in the field of basic research. The MPG conducts free basic research in new fields of importance for the future. It sets priority areas for top-level research and performs a complementary function, in particular for university research. In addition to the grants provided by the German federal

government and its states for institutional support, the MPG and its institutes receive project funding from the German government and state ministries from EU grants and from private individuals, in the form of membership fees, donations and remuneration for services rendered (MPG, 2012).

Fraunhofer Society (FhG): The FhG concentrates on applied research and its principal objective is to translate the results of research into new and innovative products, processes and services. FhG is application oriented research organization. FhG offers scientific and technical expertise on the market for research and development services, in particular for SME. Basic research subject is health, security, communication, energy and the environment. FhG has 7 groups. These are information and communication technology, life sciences, microelectronics, light &surfaces, production, materials and components, defense and security. The FhG carries out research in hundreds of technology fields and makes the results available as patents, licenses, further training opportunities, and particularly in the form of research projects commissioned by industry. Two thirds of the research revenue is derived from contracts with industry and from publicly financed research projects. Only one third is contributed by the German federal and state governments in the form of institutional funding. Collaboration with the Max Planck institutes helps to bridge the gap between applied and basic research (Research at a Glance, 2007).

Helmholtz Association (HGF): The HGF is Germany's largest scientific research community. It performs research which contributes substantially to answering the major challenges facing science, society and industry. HGF has 17 major research centers with large scale. They work on complex technical questions and cross-disciplinary tasks, operate large scientific and technical apparatus and develop systematic solutions. The major research establishments receive 90% of their funding from the Federal Government and 10% from the federal state or states in which they are situated. Helmholtz Centers perform top-class research in strategic programs in six core fields: Energy, Earth and Environment, Health, Key Technologies, Structure of Matter Aeronautics, Space and Transport. Helmholtz Association uses program oriented funding. This means that they focus the scientific work on research programs and accordingly, they restructure the financing. After restructuring the financing program, funding goes to scientific programs rather than to the centers. Cooperation across institutional and disciplinary borders and competition for research funds are two principles for their policies. Leading scientists evaluate the basis for research program funding (Erawatch, 2007).

Leibniz Association (WGL): WGL is working at the interface of problem-oriented basic research and applied research. WGL differ greatly according to their tasks, size, location and legal form. Most of the institutes focus on application-oriented basic research. WGL are subject to a scientific quality evaluation implemented externally on a regular basis, the effects of which are unique in Germany. WGL has 86 research Institutions (Erawatch, 2007).

These Institutes are non-university R&D Institutions. Most of the basic research is performed outside the universities. The above mentioned organizations differ with regard to the degree of their organizational integration. While MPG and FhG are integrated organizations with a strong headquarters, HGF and WGL are comparatively loose umbrella organizations of legally independent institutes. Four of these organizations operate independently outside the university sector. Although some research project partnership they have, there are no organizational and administrative linkages between these organizations. Four of them are funded by federal government and states and they perform R&D activities with institutes and laboratories.

Below table 1 is prepared to summarize the functions of the organizations.

Table 1 Functions of the organization (Source: Author's construction)

	Public	Industry Assosiation	Non profit organization	funded by	Basic research	Applied research	Self-governing organization	provides funding to who and what	R&D activities
DFG	√			the Federal Government and states	√		√	collaborative research centers in universities	
AiF		√		the Federal Government and states				applied R&D for SME	
MPG	√			the Federal Government and states	√	√	√	project funding and institutional funding	√
FhG	√			the Federal Government and states beside these receives funding both from the public sector (approximately 40%) and through contract research earnings (roughly 60%) private sector		√	√	contract resaerch and independent research projects.	√
HGF	√			90% from the Federal Government and 10% from the federal state	√	√	√	funding goes to scientific programmes and to the centers.	√
WGL	√		√	the Federal Government and states	√	√	√	project funding and institutional funding	√

Beside PROs last important actor in research system is **Private Companies (PC).** PC has the majority of national R&D expenditures. Most of the basic research is performed outside the universities since there is huge amount of individual, non-university research institutes. Multinational enterprises became the important part for R&D performers. German business sector invests highly in R&D.

Most of the federal thematic programs form the national policy. HTS which launched in 2006 and updated 2010 cover the thematic R&D programs including space and energy and horizontal programs, and later on 2010 seven technology sectors have been covered like bio, nano and production technology in particular targeting SMEs. The other thematic programs are ZIM for SME's and industrial collective research program. (Industrie Gemeinschaftforschung- IGF) which provides funding for cooperative industrial research organized through a network of more than100 sector specific research associations (in the framework of AIF organization)

As stated before, it was observed that there are numerous funding instruments for R&D projects. Thematic R&D programs, project oriented programs are the strengths of the system. Scientific collaboration with other countries is a long tradition. Numerous institutes for example MPG, FHG, WGL, and HGF have worldwide international offices. Strong international cooperation in science and technology is the strength of the system. There was also permanent increase in bilateral agreements on corporation in education and research with other countries: new energy technologies between French organization CEA (Commissariat à l'Energie Atomique) and HGF. (CORDIS)

The most important institution for supporting international exchange of students and researchers is the **German Academic Exchange Service (DAAD).** DAAD is the German national agency for the support of international academic cooperation. DAAD offer programs and funding for students, faculty, researchers and others in higher education, providing financial support to over 55,000 individuals per year. They also represent the German higher education system abroad, promote Germany as an academic and research destination, and help build ties between institutions around the world. DFG runs a number of programs. These are to strengthen international research cooperation with a large number of bilateral programs. The basic aim of DFG is to encourage outstanding young students and academics from abroad to come to Germany, to fund of joint research projects and the to participate of German researchers in international conferences.

Moreover, there are Institutions for example, German Center for Research and Innovation (GCRI). It was established as one of five German Houses of Science and Innovation

(DWIHs) worldwide and is part of the German government's strategy for the internationalization of science and research.

Public private partnership among several actors as consortium is also well applied cooperation between R&D actors mostly with participation of SMEs. Moreover, this collaboration is one of the corner stone of German research policy mix. At regional level there are various private R&D investments often co-financed by European structural funds.

2.1.2 RESEARCH POLICY

National Reform Program (NRP) is the main document for research policy. NRP aims to shift the German research system towards achieving the same goals. The goals of R&D is to strength the education system and strength the research and development by promoting innovation and advanced technology, to increase the sustainability of public finances and to improve the quality of public financing, to foster the knowledge society through lifelong learning and improvements and reforms of the education system.

HTS for Germany is the other one of the important policy documents. The aim of the Federal Government is to build bridges between research and the markets of the future. Coordination of innovation and research polices, science-industry links, internationalization of R&D, improvement of the conditions for start-ups, increasing the speed of technology diffusion were the main issues of High-Tech Strategy. HTS was launched in August 2006. As stated in HTS document, it was the first national concept to collect the key stakeholders involved in innovation around a common idea. On 14 July 2010, the Federal Cabinet decided to continue along this successful path. The new HTS 2020 was launched by aiming to ensure the continuity of the overall approach and set new priorities. As described in HTS 2020, it focuses on science and technology based solutions in the areas of climate/energy, health/nutrition, mobility, security, and communication. HTS identified forward-looking projects in some areas and this will be the focus of future research and innovation policy. The HTS has formulated the followings as projects: CO_2-neutral, energy-efficient and climate-adapted cities, the intelligent restructuring of the energy supply system, renewable resources as an alternative to oil, treating illnesses more effectively with the help of individualized medicine, better health through an optimized diet, living an independent life well into old age, a million electric vehicles in Germany by 2020, more effective protection of communication networks, increasing internet use whilst making it less energy consuming that makes global knowledge digitally available and accessible.

The general conditions for innovation including setting up businesses, the special circumstances of SMEs, sufficient funding for innovations and the provision of venture

capital are being developed with HTS. Furthermore, research and innovation depend on an intensive dialogue with society. As mentioned in HTS, new dialogue platforms are being created to involve the general population for bringing its own ideas into the debate about emerging technologies and research results (HTS).

The other main aim of BMBF is to strengthen education, research and innovation under the HTS and the National Qualification Initiative (NQI). Under NQI, there is Higher Education Pact, as well as the continuation of the Initiative for Excellence for the promotion of world class university research and the Joint Initiative for Research and Innovation with non-University research establishment. These are the activities of BMBF to initiate the science in federal and state level. They are offering every generation the opportunity to develop their full potential independent from their ages. In 2009, the federal and state governments agreed on the second program phase of the "Higher Education Pact 2020" as well as the continuation of the "Initiative for Excellence" and the "Pact for Research and Innovation". Total funding volume for the three measures will be €18b until 2019" (Erawatch Germany, 2010).

The Initiative for Excellence is a program by German federal and state governments to promote top level research at universities and to provide scientific excellence. To strengthen research at German universities by organizing a competition and to raise international ability were the goals set by politics and science. It promotes of world-class university research. This initiative provides funding for Universities to establish centers of excellence to promote cutting edge research, graduate schools to promote young scientists and researchers, institutional strategies on projects to promote top level research and to deepen cooperation between disciplines and institutions. DFG is responsible for running the initiative together with the German Science Council. As the sub program of the Initiative for Excellence, the aim of the Cluster of Excellence is to contribute the university strategic planning and to accelerate the process of setting thematic priorities at universities. Interpenetration between research and education policy can be found in the Initiative for Excellence. Some criteria and some changes in governance and priority setting were developed since the evaluations of the main PROs in the early 2000's indicate that there is a lack of strategic planning and programming and there is inadequate culture of exchange and cooperation (Excellence Initiative at a Glance, 2011). The Initiative for Excellence is conducted by DFG together with the German Council of Science and Humanities (WR). There are three lines of funding. First line of funding is the establishment of 39 graduate research schools for young scientists and PhD candidates, which will receive one million €'s each per year. Second line of funding is the creation of cluster which connects universities with leading German research institutes and businesses. Annually, 37 clusters

will receive around 6.5 million €'s each to fund their work. Third line of funding is the selection of Universities of Excellence, which will be funded highly for their future concepts, i.e., institutional strategies to promote top-level university research. Particularly this third line of funding has drawn international attention, both in academia and media. Altogether €1.9 billion of additional funds will be distributed over the coming five years, most of this coming from the federal and state governments to fund the selected projects (Excellence Initiative at a Glance, 2011). The German Council of Science and Humanities is responsible for the third line of funding, and the DFG is responsible for the first and second lines of funding. These funds are to be available in the first instance for the universities and their partner institutions until 2012.

Beside these the **Pact for Research and Innovation** agreed in June 2005 is an initiative which is financed by the federal government and the states to foster research excellence in PROs by providing additional funding which is allocated through specific programs. (MPG, FhG, HGF, WGL), (Erawatch Germany, 2010). On 4 June 2009, **Joint Initiative for Research and Innovation** is designed to give financial planning security to institutions that are jointly funded by the federal government and the states (FHG, WGL, MPG, HGF) as well as the DFG (as a research funding organization). Their funding is to increase by 5 percent every year between 2011 and 2015. (BMBF)

The Higher Education Pact 2020 (EFI, 2011) aimed to create additional capacities for students and to reinforce excellent research at higher education institutions. In 2009, the federal and state governments agreed on the second program phase of the Higher Education Pact 2020 as well as the continuation of the Initiative for Excellence and the Pact for Research and Innovation.

As stated before research policy of Germany depends on the thematic programs which are **Competence centers (clusters) and competence networks.** These are supported by government initiatives and self-sustaining cluster and network structure. Cluster strategy becomes new research policy developments. The goal of the Cluster is collaboration and interaction between industry and science leading to higher innovativeness and competitiveness and another goal is to link academic research and industrial application by bringing together academic organizations with private firms. The government has developed cluster strategy by covering all ministries. Clusters are designated thematic areas (networks) and/or regional clusters. Starting with major initiatives in biotechnology, the competence centers and network approach were enlarged into other areas including optical technologies, medical technologies. There is a program called as Leading Edge Cluster Competition program under BMBF. This program provides support up to € 200

million and this amount will be available to up to five Leading-Edge Clusters over a period no longer than five years. This program also emphasized strategic alliances between business and science.

There is also cooperation programs under BMWi called as ZIM SMEs. ZIM is the basic program by BMWi for market-oriented technology funding of innovative SMEs in Germany. It requires cooperation of SMEs or SMEs and PROs. The basic aim of that program is increasing the involvement and cooperation of SMEs in R&D and innovative networks by reducing the technological and economic risks of R&D projects. There are cooperation projects, network projects, individual projects under ZIM program. This program requires the cooperation between SME's.

Furthermore, a number of support measures aim at increasing the absorptive capacity of industry with regard to drawing commercial benefits from scientific research results. In 2007, a new program called SME innovative was introduced to ease access to research funding for SMEs engaged in world-class research in important future areas.

2.2 STRUCTURAL COMPONENTS OF TURKEY

The organizations and institutions, actors and networks are also the components of existing NIS system in Turkey. In this section, basic characterization of research system and the structural components of Turkish national innovation system will be explained.

2.2.1. BASIC CHARACTERIZATION OF RESEARCH SYSTEM

Turkey is a unitary state where all policy fields, including research, are under the responsibility of the central government. The Turkish regional administrative hierarchy consists of provinces, counties, towns and villages which have all been equal in power and responsibility.

"*Provinces and counties have a two-tier governance system: local governors appointed by central government are the first tier; mayors who are voted in for a five-year period at local elections are the second. Local councils and chairmen are responsible for physical planning, infrastructure and, to some extent, economic and social development, in collaboration with the agents of central departments operating under the provincial governor. As far as local public services are concerned, ministries having branches or representatives at the provincial level (and, in some cases, at the regional level) have acted independently on the basis of their own schedules and budget. Regional administrative structures do not have responsibility for regional R&D policy. On the other hand, the regional development agencies take actions on regional R&D policies."* (Erawatch Turkey, 2010)

Turkish Grand National Assembly (TGNA) is the main actors of science and technology policies. Apart from TGNA and the Council of Ministers, the other actors in the formulation of science and technology policies in Turkey are the Supreme Council of Science and Technology (BTYK), the Ministry of Science, Industry and Technology (MoSIT), TUBITAK, Ministry of Development (MD) and the Council of Higher Education (YOK), and Universities. (World Bank, 2009)

BTYK is the highest body for designing, coordinating and monitoring science and research policy and highest level policy coordination body for R&D and it provides advisory support to the government in the formulation of long-term innovation strategy policy. Its meetings take place semi-annually and are chaired by the prime-minister and composed of representatives of the government, universities, industry and NGOs (World Bank, 2009).
An important recent development in research policy is the creation of MoSIT. This decision is taken in June 2011 by Turkish Government. This new ministry take the place of the existing Ministry of Industry and Trade. The development, implementation and coordination of the science, technology and innovation policies, and the promotion of the R&D and innovation projects, activities and investments defined as duties of the MoSIT. General Directorate of Science and Technology of MoSIT implements the science and technology-related duties. The coherence for the **Ministry of Industry and Trade (MoIT)** to (MoSIT)

was in progress before by assigning of Techno parks (the so-called technology development zones (TDZ) as defined by the Law), support of industrial R&D and the establishment of Industrial Estates and Organized Industrial Zones. After last regulation, MoSIT became the solely responsible authority from whole Turkish science, technology and innovation policies (Erawatch Country pages Turkey, 2011)

The MoSIT (through its Directorate-General of Science and Technology which also implements the TDZ scheme) manages the Industrial Thesis (San-Tez) Projects Program. The MoSIT also implements the R&D Law to support Industrial R&D enacted in February 2008 together with the MoF as well as the schemes including Technopreneurship Support and Precompetitive R&D Support under this legislation. It is also in the process of starting R&D support program for the private sector which will be operational in 2009. The new programs include R&D investment support, marketing and promotion support and patent support. The MoSIT implements studies to stimulate cluster development activities in Turkey and designs a cluster support program which will be initiated in 2009. MoSIT is an affiliated ministry of autonomous institutions Turkish Patent Inst. (PE), Turkish Accreditations Agency (TURKAK), Turkish Standards Institute (TSE), the Small and Medium Size Industry Development Organization (KOSGEB), Turkish Academy of Sciences (TUBA) and TUBITAK.

TUBITAK also manages the Turkish Research Area (TARAL), a platform for public, private and non-governmental organization (NGO) stakeholders to coordinate future R&D priorities and collaboration, and to integrate it with the European Research Area (ERA). TUBITAK own and operate a network of public R&D institutions and other organizations: Marmara Research Center **(MAM),** National Metrology Institute **(UME),** Electronics Institute and others. TUBITAK also act as national coordination office for Turkey in the EU Research Framework Programs.

Science and Technology Policies Directorate of TUBITAK performed the science and technology policy formulation role. Research and innovation support programs are executed by its three departments, namely the TUBITAK-ARDEB (Research Projects Support Directorate), TUBITAK-TEYDEB (Technology and Innovation Projects Support Programs Directorate) and TUBITAK-BIDEB (Scientist Support Directorate). Grants for R&D and innovation activities of the private sector are implemented by TUBITAK-TEYDEB (World Bank, 2009).

TUBITAK has also initiated new policy instruments for human resources in science and technology that are geared towards particular priorities so that it is possible to bundle policy instruments with a particular thematic focus PhD Scholarship Program. TUBITAK has also initiated Technology platforms activity in order to provide sectoral dimension to current

science and technology policy. However, there is no evidence on how much prioritization is given in these efforts for the thematic fields.

High Planning Council (YPK) is the highest-level body for the preparation and implementation of the development plans which are the highest level policy documents. The basic aim of the documents is to link research and innovation to other policy areas. MD is the secretariat for the YPK. The YPK is chaired by the prime minister and composed of the ministers appointed by the prime minister and the under-secretary of the MD.

Ministry of Finance (MoF) is responsible for the implementation of the R&D tax postponement and tax exemption schemes and the tax exemptions provided to the companies located in Techno parks The MoF co-operates with the MoSIT in implementation of tax exemptions in Techno parks and in the implementation of the R&D Law No.5746. (World Bank, 2009)

Ministry of National Education (MoNE) and the the Higher Education Council (YOK*)* are the key players in the NIS for the development of the human capital for innovation and resesrch. Designing and implementing the education and training policies and coordinating policy implementation are their main tasks. The Inter-Universities Council connected to the YOK is liable for the coordination and evaluation of research activities of universities and advising the YOK on the subject. (World Bank, 2009)

Other important actors are Technology Development Foundation of Turkey (TTGV), the Turkish Patent Institute (TPE), the Turkish Standards Institution (TSE), the Ministry of Agriculture and Rural Affairs (MARA), the Undersecretariat of Foreign Trade (UFT); the Undersecretariat of Treasury (UT); the Ministry of Finance (MoF), the Small and Medium-Sized Enterprises Development Organization (KOSGEB); the Turkish Atomic Energy Authority (TAEA); and the Turkish Academy of Sciences (TUBA)(World Bank, 2009). These institutions have sector-specific policy roles (as in the cases of MoSIT and MARA), implement certain support programs (MoF, UT and TTGV) while TUBITAK also performs R&D activities through its four Institutes.

TUBITAK-MAM is the largest public research center. It consist of seven institutes in the center, name: Energy Institute, Environment Institute, Materials Institute, Chemistry Institute, Environment Institute, Food Institute, Genetic Engineering and Biotechnology Institute, and Earth & Marine Sciences Research Institute. There is also a techno park in MAM. In service center several services are offered for example, contractual research, testing, training, consultancy, analysis and certification services in its research centers. MAM creates an environment for the generation and growth of high-tech firms in its techno park. TUBITAK's institutes including UZAY (Space Technologies Research Institute), UEKAE (Bilgem), GMBAE (International center for genetic engineering and biotechnology**)**

conduct research in their fields of specialization and are they are active research organizations (Erawatch 2010, Turkey).

The Turkish NIS also includes technology intermediaries including incubators, techno parks, venture-capital funds, other knowledge institutions and the enterprise sector. The Turkish Academy of Sciences (TUBA) identifies and advices the priority areas of science and suggest legislation to the government on issues related to scientists and researchers. TUBA also arranges and applies programs to encourage scientific studies. TUBITAK, TTGV and KOSGEB implement state supports.

KOSGEB, an affiliate of the MoSIT, deals with the design and implementation of small and medium-sized enterprise (SME) policies which also cover aspects of research and innovation which increase the competitiveness of companies. KOSGEB asists to create an environment for university–industry cooperation in its technology development centers (Erawatch 2010, Turkey).

According to new restructuring of ministries, responsibility of State Planning Organization (SPO) was transferred to the **Ministry of Development (MD).** SPO was one of the main actors in the system. One of the institutions that provide public funding for research and innovation was the SPO through Regional Development Agencies. Now, all responsibility regarding regional development agencies will be carried by MD. According to the medium term program of ministry 2010-2012, increasing the effectiveness of regional development policy at the central level will be main strategy for development agencies.
The main functions of the development agencies are focusing on competitive sectors at the regional level and highlighting local initiatives; clustering policies which support innovations, increase employment and efficiency; provide national and international competitive advantage and collaboration.

According to the Council of Higher Education (YOK) statistics, at present, there are 164 universities in Turkey, 61 of which have foundation status. Almost all universities aim to improve their quality in education and research in line with the Bologna Process. According to provisions in the Constitute on (Articles 130 and 131) and the Higher Education Law (Law No. 2547), YOK is a fully autonomous supreme corporate public body. Planning, coordinating, governance and supervision of higher education are the main responsibility of YOK. It has no political or governmental relationship. YOK confirmed the fields of education and programs under National Qualification Framework in January 2011 as part of the Bologna process.

The Turkish government has clarified strong efforts to strengthen the key institutions of the NIS in recent years. In the past decade, the Government has modernized several NIS institutions including the Turkish Standards Institution, TUBITAK's Marmara Research Center and National Metrology Institute, the Turkish Patent Institute and TTGV.

The Marmara Research Center, the largest public sector R&D organization. It has been restructured and now is one of the most active contract research centers in the country. It provides 4 extensive services (both R&D and other services) to industry and currently earns 50-60% of its expenses from contract work. However, a majority of its work is focused on the public sector.

TUBITAK also has five more R&D Institutes in the areas of information technologies and electronics, defense, cryptology, bio-technology, and genetics. These Institutes including Marmara Research Centers are non-university research centers. These Institutes financed with government.

Technology platforms were also established under the leadership of TUBITAK in 2007.With the initiatives of TUBITAK 5 platforms was established. These are: Textile, electronic and electric platforms, automotive, metal and marine.

The Turkish Patent Institute (TPE) is an autonomous affiliate of MoSIT. The responsibility of TPE is to manage the procedures related to industrial and intellectual property rights and to inform and advice researchers, industrialists and R&D institutes on Intellectual Property Rights (IPR) related issues. The Turkish Accreditation Agency (TURKAK) is also an affiliate of MoSIT and performs increasing the competitiveness of industry by accrediting organizations and laboratories. It ensures the operations in accordance with national and international standards. National Metrology Institute (UME) is one of the institutes. It was established as an autonomous structure of TUBITAK. UME caries out scientific metrology activities and supply measurement, training, consultancy, information dissemination and infrastructure services. And the other institute for nuclear research activities is the Turkish Atomic Energy Institute. It is the main task is to prepare strategies and for conduct research activities.

In addition to above mentioned institutes, there are six university–industry joint research centers (USAMs). They established jointly by universities, TUBITAK and at least three companies or an umbrella organization with mixed funding and they are private R&D performers in Turkey. The USAM can execute contract research for a partner company. In addition to that main activity is pre-competitive research. There are no private research

centers carrying out contracted research. However, some companies have established their R&D departments as separate entities in the newly established techno parks. Their main goal is to provide R&D services for other organizations (Erawatch Turkey, 2010).

2.2.2 RESEARCH POLICY

Research policy in Turkey is based on innovation support programs. BTYK is the highest body for designing, coordinating and monitoring science and research policy. As seen in German example, there were not comprehensive programs that can be the milestone of research policy and no ministry is responsible from research policy.

Since 1960's Turkey has had science and technology policy-making and well-developed institutional framework. But this is far behind the traditional German science and technology policy making and variety of funding instruments for R&D projects. Turkey generally follows the rules of EU instruments, targets and strategies. The European Research Area (ERA), The Turkish Research Area (TARAL) which has parallel objectives with Lisbon objectives of the EU, Framework Program 6 and 7 are the main strategy-related activities.

Turkey is also a member of EURAXESS networks, European Enterprise Network (EEN), Joint Programming Initiatives (JPI) and numerous thematic EU programs including Innovative Medicines Initiative (IMI), Nanoelectronics Technologies 2020 (ENIAC) and Fuel Cells and Hydrogen (FCH) Joint Technology Initiatives through the Turkish universities and TUBITAK.

The innovation and technology programs/policy measures in Turkey are provided by TUBITAK, TTGV, KOSGEB, MoSIT, MoF, Undersecretariat of Treasury and MD. These programs are as follows: (ERAWATCH Country Pages, Turkey, 2012)

- The Support Program for Scientific and Technological (Academic) Research Projects implemented by TUBITAK
- The Support Program for Industrial R&D Projects by TUBITAK
- The Support Program for Technology Development Projects by the Technology Development Foundation of Turkey (TTGV)
- The Support Program for R&D and Technological Innovation by the Small and Medium Industry Development Organization (KOSGEB)
- The Law on the Establishment of Technology Development Zones implemented by the Ministry of Industry and Trade (MoSIT)

- SME Funding Program TUBITAK-TEYDEB carries out a scheme for non-R&D performing SMEs
- Technopreneurship Capital Support Program, the establishment of new indigenous R&D performing/innovative firms is mainly promoted through seed finance provided under the implemented by the MoSIT.
- The Support Program for Industrial R&D Projects (SAN-TEZ) by MoSIT
- R&D Tax Exemption by MoF
- The support for R&D investments by the Treasury.
- MD Funding for R&D Infrastructures

In addition to above mentioned programs, the development of technology entrepreneurs through its R&D, innovation and industrial application support program are stimulated by KOSGEB. Techno-entrepreneurship funding program serves also for the same purpose and implemented by TUBITAK.

These programs are applied by different ministries and institutions. These programs have national coverage in Turkey as applied in national reform program and HTS strategy in Germany. All policy measures are in cooperation with EU Progress report for science and technology policy.

Beside these programs, in December 2010, BTYK approved two strategy documents: the National Science Technology and Innovation Strategy 2011-2016 and the National Science and Technology and Human Resources Strategy and Action Plan (2011-2016)
The main goal of Turkish research policy, as defined in the National Science, Technology and Innovation Strategy (2011-2016), are as follows:

- Developing human resources for science, technology and innovation;
- Stimulating the transformation of research results into commercial products and services;
- Diffusing a multi-actor and multi-discipline R&D cooperation culture;
- Strengthening the role of SMEs in NIS
- Increasing the contribution of R&D infrastructures to knowledge production of the Turkish Research Area (TARAL)
- Activating international science, technology and innovation cooperation for the benefit of the country.

The resolutions of the BTYK and various documents providing detailed analysis and recommendations with the aim of improving Turkey's research and innovation performance imply the following main challenges facing research policies in Turkey:

To increase R&D spending in the country by achieving a research and development (R&D) intensity of 2% by 2013 from 0.53% in 2002 (calculated using new GDP series) half of this share being funded by the private sector. With the increase in the public funds allocated for R&D activities, GERD/GDP increased to 0.73% and the share of business financed R&D reached 47.3% in 2008.

- To develop human resources for research by increasing the number of full-time equivalent R&D personnel to 150,000 by 2013, from 23,995 in 2002. According to the latest figures, the number of full-time equivalent (FTE) R&D personnel increased to 67,244 in 2008.
- To improve collaboration and communication between universities, firms and research centers in R&D.
- To increase awareness of science and technology across society.

In addition to above mentioned targets, the national R&D and innovation strategies for the areas of energy, water and food will be managed under the co-ordination of TUBITAK according to the BTYK decision held on June 2010.

R&D investments in each of these areas are promoted under the prime minister's initiative. Although there are research priorities, no programs with special budgets for any one of the above-mentioned thematic or technological fields exist. All of the programs currently running are generic in nature. TUBITAK announced a new program called the **Technology Transfer Support Program for SMEs** in May 2011. The program aims to stimulate the commercialization of research results of universities and public research organizations by SMEs. KOSGEB initiated a new program to support R&D and innovation in June 2010. The program aims to promote R&D activities and their commercialization in small and medium enterprises in all sectors. TTGV announced a new program, **Advanced Technology Project Supports-ITEP** in 2010 in order to support technology fields that are important for Turkey.

On the policy implementation side, there are the programs stimulating the creation of technology parks. Support for establishment of technology parks (**the Law on Technology Development Zones** implemented by the MoSIT, and the program aiming to establish technology incubators in co-operation with universities **(Establishment of Technology Development Centers (TEKMERs))** by the Small and Medium Enterprises Development Organization (KOSGEB) create linkage between research and innovation.

To establish strong linkages between the private sector and the research community the **Law on Technology development Zones Law No. 4691** came into force in 2001. According to the Law, Techno parks was established in higher education institutes and/or research centers to improve knowledge circulation. As indicated in Science, Technology and Innovation in Turkey, most of the R&D projects as implemented in the zones are mostly in the field of ICT followed by electronics, advanced material technologies, industrial design, nanotechnology, medical/bio-medical research, automotive industry, sustainable energy and environmental technologies (Science, Technology and Innovation in Turkey, 2010). Development of special investment areas for investments involving high technology is one of the objective of Technology Development Zones Law. To regulate the support of research and development activities as sources of innovations in production is the another aim of the law. This law came into force on July 6, 2001. Technology Development Zones Law No.4691 issued in 2001 and 6017 issued in 12.03.2011 defines TDZs as the area or region which integrates academic, economic, and social structures. They are mostly located at near the campus of certain universities or advanced technology institutes or an R&D centers, institutes or the region that they have sufficient R&D, industry and financial competences. They are involved in activities which transform a technological innovation into a commercial product, method or service and by this means contribute to the development of the region. The Law provides special benefits to firms located in the zones including several tax incentives. In the same way, the Law on Supporting Research and Development Activities (No. 5746 issued in 2008), is a policy tool that primarily aims at addressing the need of creating R&D centers with a critical mass. The Law embrace technology centers and R&D centers in Turkey, R&D projects, pre-competition cooperation projects and support and incentives with respect to technoprenurship capital. The support that are provided in the framework of the Law no. 5746 include R&D allowance, income tax withholding incentive, insurance premium support, stamp duty exemption and technopreneurship capital subsidy.

For the policy implementation side, above mentioned legislations have a significant impact on research policy and development. Germany regulates research policy by programs and strategies but in Turkey some laws and regulations has similar effect on research development. By issuing the Technology Development Zones Law, Turkey has a great progress in research indicators. Although Turkish Government does not provide high budget for programs, tax incentives provided with this law has an additional effect to decrease the cost of research.

On the R&D and innovation support program implementation side, TUBITAK itself is the main body managing research programs. The Technology and Innovation Support

Programs Directorate of TUBITAK (TUBITAK-TEYDEB), the Technology Development Foundation of Turkey (TTGV) and KOSGEB are the main agencies implementing industrial R&D and innovation support programs. Both TUBITAK-TEYDEB and TTGV use government and own resources for stimulating R&D and innovation in private sector companies (TUBITAK-TEYDEB provides subsidies whereas TTGV provides loans). TUBITAK-TEYDEB also manages EUREKA program. The R&D project support activities of TUBITAK-TEYDEB are partly funded by ME. TTGV manages programs to support technology development activities in industry through the finance provided by ME. There is also targeted or thematic research funding mainly under TUBITAK organization.

As Erawatch report stated that there are targeted research funds. The research budget is allocated for the programs implemented by the Defense and Security Technologies Research Group (SAVTAG), the Social and Humanitarian Sciences Research Group (SOBAG) and the Public Research Group (KAMAG) of the TUBITAK. The funds allocated to the programs of SAVTAG and KAMAG in 2007 were nearly €106m in total. The total amount of funds allocated for social and humanitarian sciences research was approximately €14m for the six years between 2000 and 2006 whereas the total disbursement was €7.4m. All these three groups are the sub-units of the Research Support Program Directorate (ARDEB) and their schemes are implemented under the Scientific and Technological Research Projects Support Program. KAMAG executes the Support Program for Public Institutions Research Projects and SOBAG runs the Rapid Support Program and the National Young Researcher Career Development Program and International Researcher Programs (EVRENA), for projects from the field of social and humanitarian sciences. KAMAG covers the research areas include agriculture, health, earthquake, energy and natural resources and environment and forest. Consortiums formed by the universities, research institutes and the private sector operate the projects (Erawatch Turkey, 2010).

In the concept of regional research policies, the government established 26 regional development agencies (RDAs) at NUTS II level in order to accelerate regional development through enhanced co-ordination and co-operation between all stakeholders. The first two pilot RDAs in Cukurova and Izmir regions have included stimulation of R&D and innovation in their regional development strategies. As stated earlier regional administrative structure does not have responsibility for regional R&D.

2.2.3 CONCLUDING REMARKS

Germany has a long tradition of research system and there have been no major changes with regard to the governance of the system in the past years. The system is well-defined but rather complex. Federally governed structure is the key factor of German research system and all German states have science and technology policies of their own often shared between the two ministries, BMBF and BMWi. States have constitutional right to practice their own regional policies and innovation systems. The actors in German NIS system are autonomous in their own dynamics organization. Because of the federal and state structure, Germany has horizontal and thematic programs interlinking the NIS system, thus providing an opportunity for all German states, PROs and other institutions to apply these programs. Since these programs include priority areas of research and national government strategies, the alignment of research and innovation policy with states and institutions are well structured.

As for the NIS system in Turkey, it is not as structured as in Germany. There are numerous programs and incentives supporting innovation and research. Turkey has centrally governed structure. For the first time, the decision that Turkish government held on June 2011, the MoSIT were established. This is the first time that research, science, innovation and technology was represented at ministerial level. Since then there have been institutional rearrangement in hieratical connections. For instance, TUBITAK used to report to prime minister now it reports to MoSIT. These institutions are mostly located in the universities. Except MAM and TUBITAK, there are no active PROs and nationwide PROs, industry associations and nonprofit research organization as seen in the German example. There were not comprehensive programs aligned with BTYK decision and applicable at the national level that can be the milestone of research policy and no ministry is responsible for research policy. TDZ provide special benefits to firms located in the zones which accelerate public private partnership.

CHAPTER 3

FUNCTIONS

3.1. FUNCTIONS OF GERMANY

The aim of this chapter is to assess the functions of the research system and linkages between research system and innovation systems by means of governance and policy. The functions are chosen as research development, knowledge development, knowledge diffusion, increasing R&D and market formation. There will be no one to one connection between the function and structural components and each type of component may influence and dominate several functions. The functions may influence the other functions through different positive and negative feedbacks. The analysis of this section builds upon mainly Erawatch Country Reports and other documents in the appendix.

3.1.1 Research Development

When explaining research development, main actors and institutions and programs, policy and strategies, funding instruments and some research statistics explained briefly.

Main actors and Institutions and programs, policy and strategies are explained in Chapter 2. Importance of the BMBF, BMWi and other actors coordinated and funding programs highlighted. Institutions in research system play crucial role in research development. BMBF, BMWi, GWK, DFG, AiF and as the main research performer groups MPG, FhG, HGF, WGL, DAAD are the main actors and institutions for research governance and development. The coherence between these institutions provided by the ministries at federal level. Thematic programs run by ministries play significant role in research development.

Universities, Competence centers (clusters) and competence networks are also quite important for research development. Government initiatives have also significant impact on research development. In short, Germany has a large portfolio of funding instruments for R&D projects. Research development depends on the strong focus on scientific excellence. The excellence initiative will be explained in detail in knowledge development part. The government has in recent times changed policy regarding public deficits. Reducing public deficits is one of the aim of government. However, there is no cut in research, innovation and education policy in federal budgets last year. Reports also says that in some federal states, science and education budgets have been cut. Beside these, institutional funding for universities has stagnated (Erawatch Germany, 2010).

In terms of R&D expenditures, Germany has the largest research system in EU. In the last decade, R&D expenditures in Germany (GERD) increased steadily Gross domestic expenditure on R&D (GERD) at 2000 prices and purchasing power of parity was about 82 million $ (2010). R&D intensity (measured as a percentage of GDP) was about 2.82 % in 2010. R&D intensity in Germany is significantly above the EU average (estimate 2009) of 2.01% (OECD 2011/2). Table 2 summarizes science and technology indicator for Germany and Turkey. Gross domestic expenditure on R&D (GERD) at current prices per capita for the year 2010 is $ 131 in Turkey compared to Germany with 1054 $.

This table is a summary of the all statistics that will be used for the thesis.

Table 2 Science and Technology Indicators (Source: OECD Main Science and Technology Indicators Volume 2011/2)

	GERMANY	TURKEY
Expenditure of R&D (% of GDP)	2,82 % (2009)	0,85% (2010)
Gross domestic expenditure on R&D (GERD) per capita at current prices	1 054 $ (2010)	131 $ (2010)
Gross domestic expenditure on R&D (GERD) and milliion current PPPs	82 209 m (2010) $	9 582 m (2010) $
Industry-financed BERD (Gross domestic expenditure on R&D) as a percentage of GDP	1,9 % (2010)	0,36 % (2010)
Government-financed GERD (Gross domestic expenditure on R&D) as a percentage of GDP	0,41 % (2010)	0,1 % (2010)
Percentage of Gross domestic expenditure on R&D (GERD) financed by industry	66,1% (2010)	45,1% (2010)
Percentage of Gross domestic expenditure on R&D (GERD) financed by government	29,7% (2010)	30,8% (2010)
Percentage of Gross domestic expenditure on R&D (GERD) financed by other national sources	4,2% (2010)	24,1% (2010)
Percentage of Gross domestic expenditure on R&D (GERD) performed by industry (BERD)	67,3% (2010)	42,5 % (2010)
Percentage of Gross domestic expenditure on R&D (GERD) performed by the higher education sector (HERD)	18 % (2010)	46 % (2010)
Percentage of Gross domestic expenditure on R&D (GERD) performed by the government sector (GOVERD)	14,7 % (2010)	11,5 % (2010)
Total researchers in headcount	484 568 (2010)	124 786 (2010)
Women researchers as a percentage of total researchers	24,87% (2009)	35,8% (2009)
Total R&D personnel in full-time equivalent	550 300 (2010)	81791 (2010)
Full Time equilavant Researcher(TZE)	327 500 (2010)	64 341 (2010)
Total researchers in full-time equivalent per thousand total employment	8.09 (2010)	2.85 (2010)
Business enterprise expenditure on R&D (BERD) million PPPs $	58 016 mil $ (2010)	4076 mil $ (2010)
Business enterprise expenditure on R&D (BERD) at million 2005 $ constant prices and PPP	51 830 mil $ (2010)	3261 mil $ (2010)
Business enterprise sector total researchers headcount	210 995 (2010)	29 800 (2010)
Business enterprise researchers in full-time equivalent	187 000 (2010)	25 341 (2010)
Higher education expenditure on R&D (HERD) as a percentage of GDP	0,51 % (2010)	0,4 % (2010)
Higher education expenditure on R&D (HERD) million 2005 $ constant prices and PPPs	13 901 (2009)	3526 (2010)
Higher education researchers in full-time equivalent	89 600 (2010)	32 912 (2010)
Number of triadic patent families	5 585 (2009)	24 (2009)

3.1.2 Knowledge development

Bergek et al. says that knowledge development and knowledge diffusion are the functions that are normally at the heart of a SIS. The function captures the breadth and depth of the knowledge base of the SIS and how well that knowledge is diffused and combined in the system (2005). The generation of knowledge is always the first step of innovation and research. It can only be achieved if scientific insights are put to commercial use both quickly and efficiently. For this reason, the federal government intends to continue improving the links between science and industry with HTS 2020.

In that section education policy, human resources policy, quality and excellence of knowledge production and policies will be highlighted. In this section beside High-Tech strategy, Higher Education Pact, the Initiative for Excellence, the Joint Initiative for Research and Innovation will be emphasized. According to Bergek et al, the functions may influence each other through various positive and negative feedback loops (2005). The functions and components in education policy and human resource policy have influence on each other.

3.1.2.1 Education policy

In this chapter, education policy in Germany will be questioned in terms of programs that federal government supports and supports of other structural components. As we stated in Chapter 2, the other main aim of BMBF is to strengthen education, research and innovation in Germany. German government support education with different programs including under the HTS and the National Qualification Initiative.

Under the National Qualification Initiative, there are Higher Education Pact, the Initiative for Excellence and the Joint Initiative for Research and Innovation. They are offering every generation the opportunity to develop their full potential independent from their ages.

The Initiative for Excellence includes graduate schools as main elements and aimed at promoting cutting-edge research at universities. The Initiative for Excellence has given rise to structural changes and shaped developments at German universities. To create research-friendly structures and promote interdisciplinary cooperation in universities are the main aim of the initiative. This cooperation will be provided between different universities, and between universities, non-university research institutions and the private sector. Particularly, young scientists have benefited from the Initiative for excellence. The Initiative has also provide equal opportunities and measures to assist balance work and family life. The another important contributions of the initiatives are to the internationalization of German universities and improve their attractiveness to students and scientists from Germany and abroad. Approximately 4,200 scientists have been used in the

funded projects, about 25% of them from other countries. It brought extraordinarily positive results after a relatively short period of time. The results were announced by the report that was issued by the Joint Commission of the DFG and German Council of Science and Humanities in November 2008. (Erawatch Germany, 2010)

The other program under HTS is **Higher Education Pact 2020.** The aim of the Education pact is to create additional capacities for students and at reinforcing excellent research at higher education institutions.

"Selected higher education institutions are funded by €1.9b through federal and state funds between 2006 and 2012. The Pact for Research and Innovation provides additional funds to non-university research institutes through federal and states funds of around €2.3b between 2006 and 2010. In 2009, the federal and state governments agreed on the second program phase of the Higher Education Pact 2020 as well as the continuation of the Initiative for Excellence and the Pact for Research and Innovation. Total funding volume for the three measures will be €18b until 2019 (Erawatch Germany, 2010)

In addition to above mentioned programs there is a **foundation** called **as Alexander von Humboldt** (AvH). The main aim is to increase the number of international researchers at German universities. Postdoctoral research programs, programs for junior research group leaders, programs for experienced researchers and programs for internationally recognized cutting-edge researchers are the example of the programs. The AvH provides equal opportunities for men and women in research. Furthermore, the scholarship provided by foundation contains longer or shorter stays in abroad. Scholarship provided by Humboldt foundation has prestige and generally pays more in compare to other scholarships provided by institution's for example MPG. In terms of education policy, the scholarships are the main incentives. In addition to AvH foundation, the institutes including the DFG and the MPG provides scholarship and grants to a certain extent. There are also several initiatives program in order to improve postgraduate education in Germany. Since 2001**,** DAAD and DFG have been performed together the initiative named Promotion a Hochschulen in Deutschland (Doctoral Studies at German Universities). To make German universities a more attractive place to do a PhD, to standardize the highly diversified programs and to improve their transparency are the basic aim of the program. The doctorate degree was provided only by universities, degree cannot be obtained from the institutions. The research performed in the institutions. As stated before, in 2005, initiative for excellence was launched. It provides funding for a selection of excellent universities in order to maintain and strengthen high-level research in Germany. Another part of the initiative is the funding of about 39 selected graduate schools in Germany with special research oriented programs. English has become the main teaching language in structured doctoral programs. In order to benefit from researchers, experiences abroad there are some existing initiatives. The main aim is to regain German researchers working abroad.

“Initiative Zukunft Wissenschaft” is the program to avoid a brain drain, specifically to the USA.

In addition to above mentioned programs, as Erawatch report states that national experts recognized that deficiency of entrepreneurship education in primary and secondary school as well as in post-school (e.g., in higher education) exist in entrepreneurship education in Germany. Therefore, in 2010 the BMWi activate the initiative country of founders Germany (Gründerland Deutschland) in order to strengthen a culture of entrepreneurship. Knowledge on business start-ups and management should be start and intensive in school. Based on this, the new competition university of founders has been launched in the federal program EXIST (EXIST-Gründungskultur – Die Gründerhochschule) in which higher education institutions compete with new strategies for entrepreneurship education at their institution (Erawatch Germany, 2010). Exist program will be explained in detail in Knowledge diffusion section.

Generally, there is considerable integration of research, innovation and education policies. However, allocation of competencies between federal and state level complicates policy making.

3.1.2.2 Human Resources

An Erawatch report says that the need for adequate human resources for R&D has been determined as a key challenge since the launch of the Lisbon Strategy in 2000. The assessment of human resources is done for R&D. Germany has a well-established higher education system which traditionally supported by a strong human resource base for R&D. In 2009, the share of human resources in science and technology (HRST) was 44.8% in compare to economically active population. This is above the EU-27 average (40.1%) (Erawatch Germany, 2010).

In the Erawatch reports, it is stated that human resources are playing an increasingly important role in R&D-related policies. The federal and states governments agreed on the **Qualification Initiative** for Germany in 2008. This initiative covers all areas of education from early-childhood education through to continuing vocational training. A number of initiatives exist also in **Initiative for Excellence** as mentioned in education policy. This excellence will provide funding for 40 graduate schools for junior scientists **The Pact for Higher Education 2020** provides students favorable conditions for their studies and research. Many organizations in Germany promote highly talented students in recent times. Germany needs an inflow of scientists and specialist workers from other countries in order to meet its needs for highly skilled workers including researchers. Therefore in early 2005 the Immigration Act came into force. It will be supported by the implementation of the EU's

Third-Country Researcher Directive. It facilitates the residence permit process for research institutes hiring researchers from other countries (Erawatch Germany, 2010).

Beside these, **BMBF** has initiated a program which provides equal opportunities for women in education and research. Its task is to apply gender mainstreaming with the help of a budget item of its own under the heading “Strategies for Implementing Equal Opportunities for Women in Education and Research”.

In order to increase the attractiveness of jobs for young researchers in science, the federal government introduced a new career path for post-docs towards a professorship (called Juniorprofessur) in 2002. As Erawatch report says that implementation by universities does not meet the expectations, and career prospects after completion of the junior professorship are still uncertain. By promoting top-class university research in the framework of the Initiative for Excellence, the main of the federal government is to establish internationally visible research places in Germany and increase its attractiveness.

Global budgets for public research institutions were introduced with the Academic Freedom Act (Wissenschaftsfreiheitsgesetz). With this law, institutions allow to offer more flexible contracts to researchers. The basic objective of this law is to improve Germany’s attractiveness in international competition for scientific systems and innovative centers. The federal government provided the states under €1b a year until 2013 for the further development of the infrastructure at higher education institutions in order to develop and improve German research infrastructure.” (Erawatch Germany, 2010).

In general, there are attractive working conditions for researchers. Nevertheless to gain a permanent position is difficult. Therefore there is a big concern about brain drain in particular to the US (Erawatch Germany, 2010).

3.1.2.3 Quality and excellence of knowledge production and policies

German capacity of knowledge production based on well-established university system and a large and unique non university public research sector called as PROs MPG, HGF, WGL, FhG.

As mentioned in earlier sections, the focus on research excellence became important in the context of the **Initiative for Excellence**. The initiative for excellence is the main federal instrument to forward scientific excellence at universities. Some criteria and some changes in governance and priority setting were developed since the evaluations of the main PROs in the early 2000’s indicates that there is a lack of strategic planning and programming and there is inadequate culture of exchange and cooperation. **Pact for Research and**

innovation agreed in June 2005 also help to response governments commitment to increase funding, afterwards public research organizations have clarified commitments to increase quality and performance of their R&D activities (Erawatch Germany, 2010).

Quality and excellence in academic research of the public research system are measured by DFG, WR and PROs. (Erawatch, 2010)

DFG set up specific institute for evaluation and quality assurance. DFG uses scientific excellence and quality criteria based on peer review. In addition, DFG utilizes a number of instruments to strengthen the scientific quality of the university system. DFG offer grants for non-oriented basic research on a competitive basis according to the peer criteria. Excellence in research is encouraged by regular evaluations of public research organizations and university faculties. DFG also publishes a university ranking based on the support received every three years (DFG, 2009).

WR is the other institution with regular evaluations and recommendations which monitors the quality and excellence of the public research system. Council evaluated all federal institutions with R&D responsibilities and research institutions which applied for joint federal and state funding through WGL.
Research quality of universities were ranked as an additional quality control mechanism which is a fairly recent phenomenon. It has been particularly fostered **by private non-for profit organizations** and the **university rector conference** (Erawatch Germany, 2010).

The **MPG** uses scientific excellence as its main criteria. The **FhG** uses contracts from private sector. The **HGF and WGL** apply different criteria for example the contribution to evidence-based policy making and the provision of a large state of art research infrastructure. In addition to these organizations, universities also perform evaluation of research performance.

For the evaluation measure, patent policy is an important instrument to measure the knowledge production. The federal government will continue to promote activities for the utilization of research results obtained at universities and R&D institutions and support SMEs in filling patents and utility models. There is considerable research performance in terms of publications and patents. Recent findings from patent analyses tells that many PROs have clarified substantial progress and were able to increase their research productivity particularly at the Helmholtz centers and the Leibniz institutes (Polt et al., 2010). Business enterprise sector is also a strong R&D performer. The business enterprise sector performs 67,3% of GERD.

Table 3 GERD performed by sector in 2010 in Germany Science and Technology Indicators (Source: OECD Main Science and Technology Indicators Volume 2011/2)

GERD performed by sector in 2010	%
Business (BERD)	67,3
Government (GOVERD)	18
Higher Education (HERD)	14,7

One of the measurements for producing new scientific knowledge can be considered as the Nobel prizes that German researchers have. In the past 25 years, 20 German researchers have been awarded Nobel prizes in Chemistry, Physics and Medicine.

3.1.3 Knowledge Diffusion

3.1.3.1 Promoting the establishment of new indigenous R&D performing firms

In the Erawatch Germany country reports it is stated that **Federal Technology Venture Capital (VC)** program provide finance support. Direct equity investment (seed stage) through co-financing of private investment (early stage) to re-financing and guarantee mechanisms for later stages is the financing methods. There are number of programs for innovative start-ups provided by state governments. These programs include VC measures (similar to the individual measures offered under the federal VC programs), spin-off measures and funding of R&D projects in high-tech start-up. BMWi and the European Investment Fund (EIF) have doubled the size of the ERP/EIF fund of funds by € 500 million to € 1 billion. This funds are available for young, innovative, technology-oriented companies. Fund of funds is a joint initiative between the federal government and EIF and primarily target German firms in the early and growth phase. It was established in 2004 with € 500 m capital. Following six years of activity, the ERP/EIF fund of funds has invested approximately € 430 m in 16 funds. A further € 26.4 m will be committed in the near future. At the same time, mostly private-sector investors have injected € 1.6 billion into these funds (Erawatch Germany, 2010).

The **High-tech Start-up Fund** is another important element for funding seed and start-up stages of high-tech-based start-ups. The fund is available specifically for academic spin-offs. As a special component, a coach is necessary for high-tech start-ups (i.e. an

experienced entrepreneur) in order to receive equity investment from the fund. The fund was established in 2005 and financed from federal government and by a small number of large enterprises. It has a total volume of €272 million. In addition to the kick-off funding, the fund also provides capital for business development, helps build the team, and arranges contacts to other funded enterprises. Investor of the fund is BMWi, KFW Bank groups and private companies (Erawatch Germany, 2010).

Creating a favorable regulative environment in order to stimulate start-up activities is important. Therefore, recent measures focused more on this subject . In 2008, a new law on VC has been launched as part of the Law on the Modernization of Framework Conditions for Private Equity. To improve tax regulations for investments into young technology companies and the financial situation of business angels are the main aims. Only 0.04% of GDP is used for venture capital investments. A need for a long-term improvement in the framework conditions for the provision of company equity is necessary (Erawatch Germany, 2010).

Another program for start-ups is the EXIST program which academic institutions are encouraged. The funding program is an initiative of the BMWi and part of the HTS for Germany. The project is co-funded by the European Social Fund and comprises three parts: “The EXIST program line **Culture of Entrepreneurship** supports projects at universities to build up an infrastructure for providing skills and support for technology and knowledge-based innovative ventures. In support of these activities, universities receive an allowance from the BMWi over a three-year period. EXIST **Business Start-Up Grant** supports the preparation of innovative business start-up projects at universities and research institutions. The grant aims to help scientists, university graduates and students developing their business ideas into business plans and to advance their ideas for products and services. To cover their living expenses, the entrepreneurs receive a grant between € 800 to 2,500 per month for a maximum period of 12 months. In addition, they receive materials and equipment, funding for coaching and child benefit. The university or non-university research institution offers them infrastructure during the pre-start-up phase and provides technical and start-up-related assistance. EXIST **Transfer of Research** promotes technology-based business start-up projects in the pre-start-up and the start-up stage. EXIST Transfer of Research complements the broadly targeted EXIST Business Start-Up Grants with an excellence-oriented measure for high-tech start-ups. The purpose of the first funding phase is to support research teams at universities or research institutes so as to enable them to provide proof for the technological feasibility of their product idea and to prepare the business start-up. The funding includes staff expenses for up to three staff members and €60,000 for materials and equipment. After one year, funding is available for

another person with managerial skills to become a member of the start-up team later. The maximum funding period is 18 months in the pre-start-up phase. During the second funding phase, the newly founded technology-oriented companies can be supported with up to €150,000 to continue the product design, for instance up to the prototype realization and to be able to solicit external funding for their company."(EXIST, 2010).

3.1.3.2 Stimulating greater R&D investment in R&D performing firms

In addition to the public sector, R&D performing firms are one of the most important target groups in the national policy. Most of the federal thematic R&D programs aim is to stimulate R&D investments. The main programs are as follows:
HTS, 2020 increased collaborative thematic R&D programs of BMBF and BMWi programs, including aerospace and energy, and horizontal programs, in particular targeting SMEs. In 2007 a new program called **SME innovative** was introduced to ease access to research funding for SMEs engaged in world-class research in important future areas. Since 2010 seven technology sectors have been covered in this scheme, for example bio, nano- and production technology (Erawatch Germany, 2010).

Public-private collaboration is also quite important tool for stimulating increasing R&D investment. Cooperation among several actors as consortium is often required or participation of SMEs is often preferred. The expected impact of the consortiums with different actors is the mobilization of additional R&D investment from businesses. "Main funding instruments are the thematic R&D programs, including the SME-specific measure SME Innovative, and cooperative R&D programs targeted at SMEs in the ZIM for SMEs. A further important program in this field is the IGF program (2008 budget: €123m) which provides funding for cooperative industrial research organized through a network of more than 100 sector-specific research associations (in the framework of the AiF organization). The actual research work is assigned to a research institute and results of this cooperative research are available for all SMEs in the respective sector." (Erawatch Germany, 2010).

At regional level, there are also many measures to stimulate private R&D investment which might primarily benefit existing R&D performers, often co-financed by **European Structural Funds**. In addition, human resource policies including the **Pact for Higher Education** and the **Qualification Initiative** may stimulate greater R&D investment in R&D performing firms.

Beside all of the above mentioned programs, almost each university and principally owns a TTO (technology transfer offices) which supports technology transfers between university and industry. Germany is one of the Countries that are experimenting with regional or

sector- based TTO (OECD, 2003). There is at least one Patent Marketing Agencies (PMA) in each federal state which is collaborating with the universities. Regional or sector-based TTOs according to field of research/technology and manages technology transfer activities for many PROs. TTOs have an arm's-length relationship to the PRO and may manage technology for several organizations. The majority appears to be dedicated on-site institutions and integrated into the university or research institution (OECD, 2003). There is no one size fits all approach to technology transfer. There are important differences among PROs that shape TTO structures and affect patenting and licensing strategies. TTOs in Germany provide a range of services which are case-by-case consultancy and training for scientists on IP issues and the evaluation of the patentability and commercial potential of new technologies.

3.1.3.3 Attracting R&D-performing firms from abroad

According to Erawatch country reports, since there is a large market and excellent research infrastructure, attracting foreign R&D performers has been considered as a historical strength of the German system. As a result of being huge market, numerous foreign companies perform their research in Germany. Therefore there is no specific policy focusing on attracting R&D-performing firms from abroad. Nevertheless German subsidiaries of foreign-owned companies can fully participate in all existing programs (Erawatch Germany, 2010). Considering the structure of the programs, there is diversity of R&D funds and comprehensive international collaboration and EU funds. There is no need to a program that focus on attracting R&D-performing firms from abroad.

3.1.3.4 Knowledge circulation between the universities, PROs and business sector

There is an increasing industry and science links by cluster strategy, collaborative projects, campus models, technology transfer institutions both in public and private sector (Erawatch Germany, 2010). Strong ties between businesses and academia can be explained by the high share of industry funding of research in universities and PROs and as shown by BERD figures. Fostering knowledge circulation has been a policy priority in German research and innovation policy since many decades, and for that reason a large number of programs have been implemented. Lately, the following initiatives may be regarded to maintain and further to increase industry-science links.

As mentioned in Chapter 2, there is a program called as Leading Edge Cluster Competition program under BMBF. This program provides support up to € 200 million and this amount will be available to up to five Leading-Edge Clusters over a period no longer than five years. The implementation envisages a matching level of financial participation on the part

of businesses and private investors. According to Horizon 2020, clusters and cluster policies play a vital role in creating a competitive and innovation-based economy. (Innovation Union" Speech by Máire Geoghegan-Quinn, EU Commissioner for research, innovation and science, Berlin 23. February 2012). Therefore, Cluster policy plays a vital role for Germany and will continue for the future.

At federal level under BMWi, there are also program called as ZIM. ZIM requires cooperation of SMEs or SMEs and PROs. These programs are some examples of thematic R&D programs and they encourage the cooperative research projects involving universities, PROs and the business sector. Universities and PROs has dominant role in knowledge transfer to business sector. Technical universities has an important role linking basic to applied research in all fields of natural science and engineering. Universities of applied science are have significant role in supplying industry with highly skilled personnel in the field of engineering and offering consulting and R&D services to SME's.

As mentioned in knowledge development part, federal government launched campus model as a new model of a funding instrument. In the Proinno Europa, it is stated that BMBF has launched research campus – public-private partnerships for innovation, a competitive funding scheme to strengthen the cooperation between companies and research organizations. The idea is to bring together universities, non-university research institutions and commercial companies at a single location so that they can engage in collaborations on a medium to long-term basis. The BMBF competition aims to encourage the construction of models to support the research campus. The Ministry, with support of a high-level jury, will select 10 campus models out of the applications received. The campus and its research strategy, by the partners and themselves engage in a collaborative process to design. The up to ten winners of the contest promoted in their research and development - at least 5 years and up to 15 years in several phases. For the annual sum of project-based grants per research campus, an orientation of a frame is given to 2 million €. The model focuses on supporting strategic partnerships in application-oriented basic research. Totally, a selected research campus could receive funding of up to € 20 million and planned time period is to run for 10 years. A research campus, to be selected, must have a minimum duration of 5 years and shall be characterized by three main features. First is to bund of private and public sector research competencies at one location. Second is to have a research focus with a medium or longer-term perspective and third one is to have a contractual commitment to establish a public-private partnership (PROINNO EUROPA, 2011).

3.1.3.5 Cross-border knowledge circulation

In Germany, there is also a long tradition of scientific collaboration with other countries. However, an explicit government strategy to incorporate internationalization has been published in 2008. As Erawatch Research Inventory Report says that **Bilateral agreements on R&D cooperation** are in place with more than 50 countries. International scientific cooperation is coordinated by the International Bureau of the BMBF and supported by a web-based signposting and information service since 2002. It provides foreign researchers and scientists information about research opportunities in Germany (Erawatch Germany, 2010).
Many institutes for example **MPG, FHG, WGL, HGF** have worldwide international offices. Therefore, there is a strong international cooperation in science and technology. There was also permanent increase in bilateral agreements on corporation in education and research with other countries such as new energy technologies between French organization CEA (Commissariat à l'Energie Atomique) and HGF.

The most important institution for supporting international exchange of students and researchers is DAAD. DFG runs a number of programs aimed at strengthening international research cooperation, including a large number of bilateral programs. Instruments include encouraging outstanding young students and academics from abroad to visit Germany by funding of joint research projects and the participation of German researchers in international conferences.

Moreover, there are also institutions for example, German Center for Research and Innovation (GCRI). It was established as one of five German Houses of Science and Innovation (DWIHs) worldwide. It is the part of the German government's strategy to internationalize of science and research.

In the Erawatch country reports it is stated that **Internationalization of business R&D** has been a major trend in the business sector for decades. Almost all large R&D performing enterprises headquartered in Germany run R&D laboratories outside Germany. There is lot of cooperation in terms of personnel and joint R&D projects between R&D labs in Germany and abroad. Business can join R&D projects that are implemented internationally. In general, there is rather the fear of a too high internationalization of business R&D than concerns of too low cross-border knowledge exchange (Erawatch Germany, 2010).

3.1.4 Increasing R&D

One of the main actors to increase R&D is BMBF. Under the National Qualification Initiative, Higher Education Pact, the Initiative for Excellence, Joint Initiative for Research and Innovation provide considerable impact on increasing R&D under BMBF. Beside these, SME innovative program ease access to research funding for companies by, simplified credit risk assessment. BMBF also set up the Federal Research and Innovation Funding Advisory Service. The main task of this service is to contact for any questions concerning research and innovation funding.

New international cooperation strategies, the creation of dynamic and performance-enhancing networks in the science system, the establishment of sustainable partnerships between science and industry, and the submission of yearly progress reports are the main task of PROs and as well as DFG. Access to public support of research and innovation in businesses is available online. This also supports R&D activities. In contrast to many countries , there is no tax incentives for R&D in Germany, although there are lots of support programs, institutions and policies.

In addition, a funding instrument for new “campus models” is developed. The idea is to bring together universities, non-university research institutions and commercial companies at a single location so that they can engage in collaborations on a medium to long-term basis.

As Erawatch Country reports says that there is an **Innovation-oriented procurement policy** in public sector. According to estimates, the total volume of public procurement in Germany amounts to roughly €250 billion per year. This contains major potential for fostering innovation. This program was identified as a driver for innovation and designed by HTS in 2006. “In 2007, six federal ministries (Economics, Research, Transport, Defense, Interior and Environment) decided to focus on innovative solutions in public procurement (BMWi, 2007). As a result, procurement of innovative solutions were studied, accordingly working groups have been built in ministries. They ask for the possibility to integrate innovative elements in the procurement procedure. The first effect was seen in energy efficiency (for a complete list see BMWi, 2009). As part of the government's measures to protect the climate, the Federal Cabinet has adopted "General administrative rules on the procurement of energy-efficient products and services" and accompanying guidelines (available in German only) that are binding on all federal ministries. Furthermore, in 2009, the law against restraint of competition (GWB) was modified. Public authorities can also require innovative aspects apart from social and environmental aspects in the service

specifications. The public procurement approach to stimulate innovation and R&D is increasing in Germany, however a binding strategy for innovation-oriented procurement is not yet in sight and compared to other countries for example the UK, it is still underdeveloped (Erawatch Germany, 2010).

As Erawatch Country reports says that R&D investment is affected by other policies. Several other ministries have their own sectoral research programs and institutes. The Federal Ministry of Defense, the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, the Federal Ministry of Transport, Building and Urban Development and the Federal Ministry of Food, Agriculture and Consumer Protection contribute together to about 20% of federal R&D resources. Sometimes coordination of the various targeted R&D activities across the different ministries is restricted. BMBF have responsibility in formal procedures, information exchange like renewable energy appears to be considerable however in other subject it is limited (Erawatch Germany, 2010). To increase R&D, most of the public support programs provide relevant information online and applications can be submitted online. The market-oriented and technology-based cooperation and networking program of the federal government for SMEs have been pooled into the ZIM for SMEs in 2008 which streamlined the support programs and developed the transparency.

3.1.5 Market formation

BMBF is active in every step of the research. Federal government is aiming to build bridges between research and the markets of the future. As stated before, BMBF jointly with the state level is responsible for all kinds of research and science support. In addition to main functions, it is quite clear that scientific insights must be put to commercial use both quickly and efficiently. For this reason, the federal government intends to continue improving the links between science and industry with HTS 2020. Coordination of innovation and research polices, science-industry links, internationalization of R&D, improvement of the conditions for start-ups, increasing the speed of technology diffusion are the main issues of High-Tech Strategy.

In addition to BMBF, BMWi offers technology-specific programs oriented to the markets of the future. BMWi supports German companies to create an innovation-friendly policy environment and to promote market-oriented research, development and innovation projects. BMWi's Technology Campaign provides initiatives for managing and improving the technological progress of German companies in the future. To this end, the BMWi is

taking steps to improve the research and innovation capacity of SMEs and to developed of key technologies toward the most pressing challenges of the future.

BMBF and BMWi are seen as two important actors in market formation. There is a high level of interaction between industry and public research.
As stated before, there are no tax incentives for R&D or innovation in Germany.

As explained in section 3.1.3, BMWi has an innovation-oriented procurement policy. The government not only saves money and energy but also provides industry with the impetus to put innovative products and services on the market by purchasing cutting-edge products and new technological solutions. In doing so, the government can foster the diffusion of innovations. This procurement policy has also form the market.

In the market formation, the role of the BMWi, FhG, and private company's role is respectable and remarkable. Most of the actors in the NIS system affect market formation directly or indirectly. This stems from the strategic decisions of federal government and thematic and mission oriented programs.

The below figure presents a summary of the NIS actors in functional dynamics.

National Innovation System in Germany

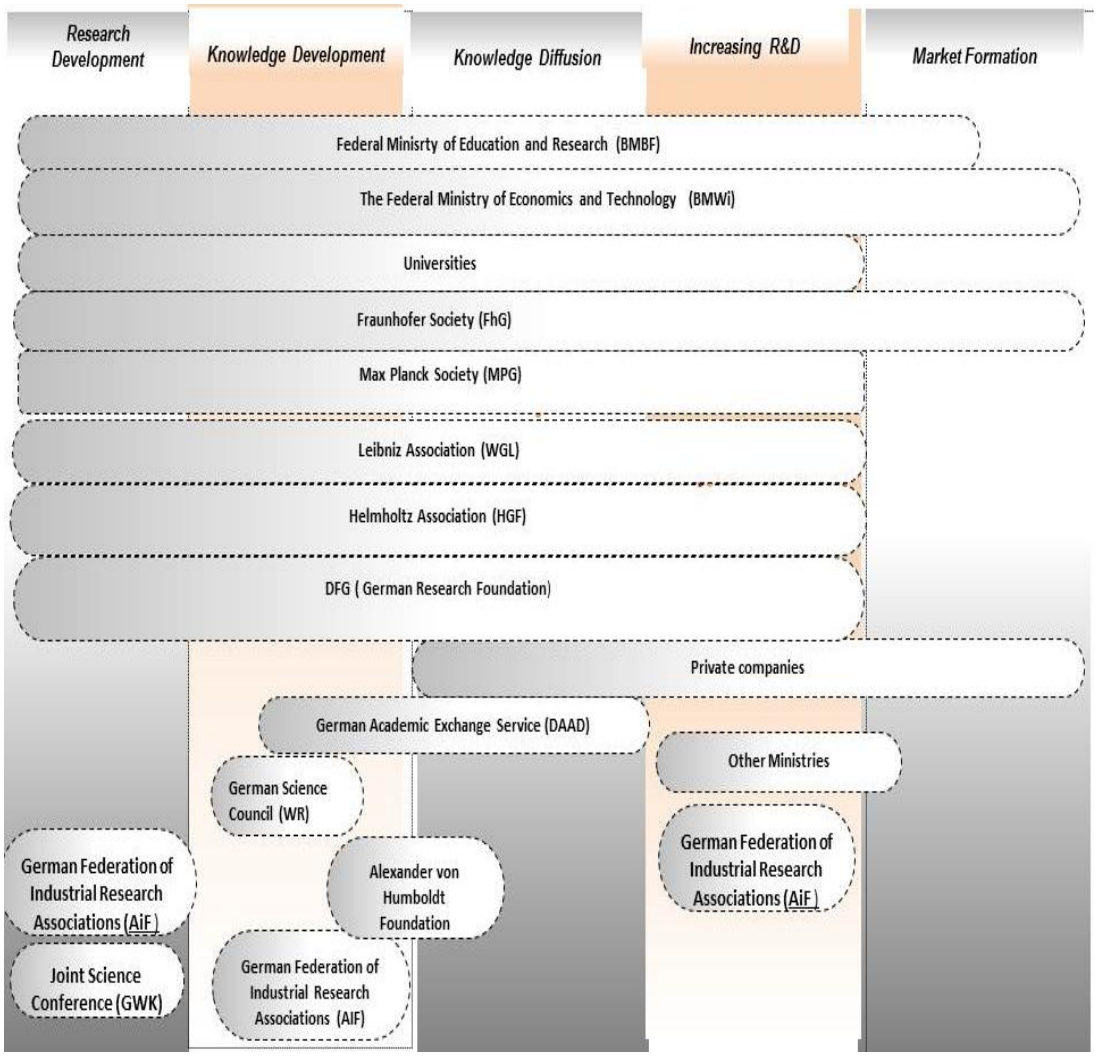

Figure 2 National Innovation System in Germany (Source: Author's Construction)

3.2 FUNCTIONS OF TURKEY

The aim of this section is to assess the functions of the research system and national innovation systems in term of governance and policy in Turkey. The analysis builds upon mainly Erawatch Country Reports 2010 and some other documents.

3.2.1 Research Development

Main actors, institutions and programs, policies and strategies have been explained in Chapter 2. The importance of the TGNA, the Council of Ministers, the BTYK, MoSIT, TUBITAK, MD and YOK, and universities and programs coordinated and funded by other actors are highlighted and emphasized since institutions in research system play a crucial role in research development.

MoSIT, TUBITAK, KOSGEB are the main actors and have institutions for research governance and development. As stated in Chapter 2, from the perspective of governance systems, Turkey has a tradition of science and technology policy-making (dating back to the 1960s) and a well-developed institutional framework at national level. However, this is far behind the traditional German science and technology policy making and a large portfolio of funding instruments for R&D projects. Turkey is at the negotiation stage for EU membership. Therefore, Turkey generally follows the rules of EU instruments, targets and strategies. According to the European Commission screening report Turkey, the acquis in Chapter 25 Science and Research chapter of EU, Turkey has reached a respectable level of alignment with and capacity to implement the acquis. The main points for improvement have been identified as encouraging the participation of industry in research projects and creating the necessary conditions to stimulate investment in research by private sector and undertaking actions to increase human resource capacities and to streamline research actions among universities.

Beside the EU targets, current research policies were determined as a result of the Vision 2023 Project. It was performed between 2002 and 2004 to formulate Turkey's science and technology strategies for the next two decades. Basic aim of this project is to achieve the widest possible participation with increased commitment around a shared vision.

In the light of the results of the vision 2023 project, the BTYK defined the Turkish Research Area (TARAL) in 2004 as a platform for the private and public sectors and NGOs (Non-Governmental Organizations) to strategically focus and collaborate in R&D. TUBITAK is responsible for the effective functioning of TARAL and its integration with the European Research Area (ERA) (ERAWATCH Turkey, 2010).

Moreover, government initiatives also have a serious impact on research development. Importance of the universities, competence centers (clusters) and competence networks is also recognized by Turkish government. Accordingly techno parks, technology platforms and cluster strategy were developed. There are no support schemes for cluster policies and regional growth pole policies. TUBITAK has announced in december 2008 that the ISBAP programs would also support Provincial Level Innovation Platforms. However there were no such projects supported as of June 2010. Moreover, in German example, thematic programs also run with ministries play significant role in research development. The Industrial Thesis Projects Program (San-Tez) of the MoSIT promotes university-industry linkages by partly financing research activities conducted by universities under thesis studies for a private sector company.

Between the years 1998 and 2009, there has been an increasing trend in GERD as a percentage of the revised GDP, which has risen from about 0.37% to 0.85%, more than doubled. In absolute terms, the increase is 2 billion to 6.7 billion $ (2009) (OECD, 2011/2). R&D intensity (measured as a percentage of GDP) was about 2.77% in 2009 (Table 2). Compared to absolute figure, Turkey is far from the German level, although Turkey has highest growth level among the OECD members.

According to the latest decision taken by the 23rd meeting of BTYK, 2013 target was increased. The measures put in place for increasing R&D intensity to 3%, private sector R&D expenditure/GDP to 2%, number of Researchers to 300.000 by 2023.

3.2.2 Knowledge development

As stated in German part, development and production of knowledge is one of the main functions of the research system.

The followings will be highlighted in this section.

- Education policy
- Human resources
- Quality and excellence of knowledge production and policies

According to the WB report 2009, Turkey's National Innovation System is fairly well developed by international standards. The most important purpose is to understand the obstacles for the transformation of knowledge into productivity gains and innovation. Therefore, Turkish government also intends to improve the links between science and industry.

3.2.2.1 Education policy

In the 23rd meeting of BTYK, promotion of science centers was announced. The aims of science centers are to bring people of all ages from different background to make science and technology intelligible and accessible for the community with an interactive teaching approach, to increase the importance of science and technology including experimental and practical works. In these guidelines, particularly in science interest and curiosity of children and young people will increase and technology will be used more accurately. The realization of the studies will be in cooperation with local governments. Science centers decided to set up as of 2016 in all of the metropolitan cities, and as of 2023 in all provinces.

In Science and Technology Human Resource Strategy and Action Plan 2011-2016, the strategy of directing R&D areas for young people was mentioned. Under this strategy, popular science activities for elementary and secondary education were increased. Technology and design course which works well in primary school is the part of the strategy.

According to the 20th meeting of Supreme Council of Science and Technology, there is a decision which names as training and development of the scientist. In that program, there is 1000 Student Project under the MoNE. MoNE program is still running. It was decided to send 1000 student to abroad for graduate and doctorate degree in 5 years as of 2006.

TUBITAK has undergraduate scholarships, graduate scholarships programs. Four types of university undergraduate scholarships are available: undergraduate basic science scholarships (students among the first 5000 in the general university entrance examination), and for students receiving medals from the National Science Olympiads, the International Science Olympiads and the National Secondary School Research Projects Contest. There are also graduate scholarships which are National Scholarship Program for MSc students, National Scholarship Program for PhDs students and International PhD Fellowship Program. PhD students who are registered in PhD programs in Natural Sciences, Medical Sciences, Social Sciences and Humanities, Engineering and Technological Sciences at universities or research centers in Turkey are also supported with the programs. The names of these programs are International Research Fellowship Program, PhD Fellowships for Foreign Citizens, Research Fellowships for Foreign Citizens, Summer School Support Program for Master and PhD Students (TUBITAK, 2012).

By increasing the R&D budget the programs including initiative for excellence and higher education pact 2020 can also be applied in Turkey. Moreover, in education policy support

programs provided only by ME and TUBITAK. However, the support amount is limited to have a convenient research environment. Therefore to improve the research environment, the amount of government support can be increased. In Germany, with programs universities and non-university public and private organization can use funds.

Moreover, there is also a program called as Industrial Thesis (SANTEZ) program which is implemented by MoSIT. It aims to stimulate co-operation between firms and universities by supporting masters and doctorate thesis written out by a number of graduate level students. The theses address research and innovation projects which aim to develop new technology-based products and processes, and to transform university research into innovative products and processes in line with the needs of the industry. Eligible projects are provided with grant finance up to 75% of the project budget.

In Turkey, it cannot be said that there is a considerable integration of research, innovation and education policies. But division of labor between institutions and national education programs matching with national research and innovation policy does not exist in Turkey.

3.2.2.2 Human Resources

As Erawatch Research Inventory Report says that human resource policies form a major element of the Turkish research policy. The development of human resources for science and technology is high in the agenda of the BTYK in Turkey. There is an increased focus on science, technology and innovation in the new curricula designed and implemented by the MoNE since 2005. In addition, TUBITAK, in cooperation with the MoNE, organises various schemes (for example, science olympiads) to promote science and research in schools.

Incentives and supports have also been provided for university researchers by TUBITAK in the form of project finance, scholarships and awards to develop human resources for science and technology. In 2007, TUBITAK launched a new support programme called the Science and Society Support Programme enabling teachers and academics to develop and implement projects to promote science in schools and universities (Erawatch Turkey, 2010).

According to WB report, scarcity of human capital is a critical bottleneck**.** One of the main reasons for this scarcity is a brain-drain that claims a significant share of Turkish researchers who reside abroad upon completion of their PhDs. To tackle this problem, TUBITAK, ME and the MoSIT have developed programs, and government efforts to modernize the higher education system."(World Bank, June 2009). TUBITAK has initiated new policy instruments for human resources in science and technology that are geared towards particular priorities so that it is possible to bundle policy instruments with a

particular thematic focus PhD scholarship program. But the career prospects after completion of PhD are still uncertain.

There are 2.85 researchers per thousand in 2010 of total employed in Turkey, which is much lower than 8.09 Germany researcher (see Table 2- Total researchers in full-time equivalent per thousand total employment). The number of the total researchers in headcount in Germany 484.568 (2009) and in Turkey 124.786 (2010). Women researchers as a percentage of total researchers is 24,87% (2009) in Germany and 35,8 % (2010) in Turkey. Total R&D personnel in full-time equivalent is 550.300 (2010) in Germany and 81.791 (2010) in Turkey.

In the Erawatch Germany country reports it is stated that in 2004, the government also set the target of increasing the number of full-time equivalent R&D personnel to 40,000 by 2010 from 23,995 in 2002. According to the latest figures, the number of full-time equivalent (FTE) R&D personnel increased to 67,244 in 2008, both due to the increase in the government funding to stimulate research and the revision of the FTE ratios by the Turkish Statistical Institute (TURKSTAT). In 2008, the BTYK replaced the target year of 2010 with 2013 for 2% target. The target for full-time equivalent R&D personnel to be reached by 2013 was revised as 150,000." (Erawatch Turkey, 2010).

Established at the 19th meeting of BTYK, the Science and Technology Human Resources Coordination Committee (STHRCC) is composed of the MoF, MoNE, Ministry of Health (MoH), MoSIT, Ministry of Foreign Affairs (MoFA), Ministry of Labour and Social Security (MoLSS), YOK, Inter-University Council (UAK), State Personnel Presidency, TOBB (The Union of Chambers and Commodity Exchanges of Turkey), and TUBITAK. Based on its five working groups, the committee has been working on important topics to improve the climate for researchers in Turkey. These are enhancing governance in higher education institutions, raising researchers' income, increasing the stock of qualified HRST and university-industry collaboration. Their recommendations is important to identify respective policies.

An International Researcher Committee was established according to the decision taken and at the BTYK 18th meeting on 24 December 2008 and worked until the the 20th BTYK meeting of 15 December 2009. To make Turkey an attractive destination for international researchers is the main aim of the the International Researchers Coordination Committee (IRCC) . The committee was composed of relevant authorities from the MoF, MoNE, MoH, MoSIT, MoFA, MoLSS, YOK, Directorate General of Population and Citizenship, Ministry of Interior, UAK, and TUBITAK. Regulatory issues for international researchers are the main task of the committee including work and residence permits, contract period, wage, retirement, academic promotion, education for researchers, children, learning Turkish, benefiting from health services, supports for scientific projects, and procedures for Turkish citizenship. The recommendations of this committee were feed-back into BTYK at its 19th

meeting in June 2009. BTYK designated relevant bodies to adopt their regulations for the issues recommended by the committee.
Some of the outputs of STHRCC and IRCC are to gain the right for receiving Project Incentive Bonus (PIB) from TUBITAK projects, to provide easy-access for work permits or preliminary permits to finalize their operations related to academic and professional qualification and to improve researchers income through removing deductions of revolving fund.

In general, there are no attractive working conditions for researchers in Turkey. However the attempts to create favorable climate for researchers and implementation of the decision with relevant authorities are in progress.

3.2.2.3 Quality and excellence of knowledge production and policies

There is no regular monitoring and evaluation mechanism for policies and programs in Turkey. On the other hand, as of 2010, various organizations in research and innovation system are acting on this subject. The first monitoring and evaluation exercise of research measures held on 1999–2005 period for the Industrial Technology Project (ITP). The funding was provided by the WB for research and innovation activities. However, this evaluation only applied to a small proportion of research schemes. In 2010, an independent evaluation of R&D support scheme of KOSGEB was initiated international norms along with the other SME support measures. In the same period, TUBITAK clarified process for the evaluation of its program by making a literature review, developing indicators and surveys for evaluation. In addition to these organizations, universities also conduct evaluation of research performance. 20th meeting of BTYK on 2009, the decision for the evaluation and impact analysis for TUBITAK R&D programs was taken. Working groups on the subject created an increased awareness and in-house studies in the literature were examined and international cooperation was laid. In this context, the pilot applications have begun. TUBITAK initiated impact measurement in 5 groups which are HR, TEYDEB, KAMAG and Bosphoruous and 1001 projects. These studies did not show continuity.

For the evaluation measure, patent policy is an important instrument to measure the knowledge production. **IPR and fiscal policies** mainly focus on increasing the level of awareness towards IPR in Turkey. At the end of 2006, a new support program was initiated in collaboration with the TPE and TUBITAK (the Program to Encourage and Support Patent Applications). In addition, TPE implements a promotion campaign jointly with related stakeholders (for example, TUBITAK, KOSGEB, etc.) to emphasize the importance of IPR. After these efforts, the number of patent applications increased from 633 in 2004 to 2,268

in 2008. But the number of the patents is still far behind German example. Compared to the German example, this increase in the number of the patents does not signify a respectable research performance.

Business enterprise sector is also a strong R&D performer. The business enterprise sector performs 70% of GERD in Germany but in Turkey this ratio is 42,5 %.

Table 4 GERD performed by sector in 2010 in Turkey Science and Technology Indicators (Source: OECD Main Science and Technology Indicators Volume 2011/2)

GERD performed by sector in 2010	%
Business (BERD)	42,5
Government (GOVERD)	11,5
Higher Education (HERD)	46

There has been a remarkable increase in the share of gross domestic expenditure on R&D performed by business sector (BERD) in Turkey, from 28.7% in 2002 to 42,5% in 2010.

As we stated before, one of the measurements regarding producing new scientific knowledge can be regarded as the Nobel prizes that researchers have. In the past 25 years, 20 German researchers have been awarded Nobel prizes in chemistry, physics or medicine. However there is no Nobel Prize in science in Turkey.

3.2.3 Knowledge Diffusion

3.2.3.1 Promoting the establishment of new indigenous R&D performing firms

Venture Capital (VC) program provide financing support. Direct equity investment (seed stage) through co-financing of private investment (early stage) to re-financing and guarantee mechanisms for later stages is its steps. However in Turkey, the first official legal basis for venture capital was set in place by SPK (Capital Market Board of Turkey) as the Communiqué on Principles of Risk Capital Investment Companies and published in the Official Gazette dated 06.07.1993 with the number 21629. According to the regulation by SPK, the risk capital has a threefold structure. These are risk capital investment funds, risk capital investment partnerships and risk capital management enterprises. The authority of identifying and supervising the working principles of all three is given to SPK by the law (KUĞU, 2004). TTGV- Teknoloji Yatirim A.S has Pre-Incubation, Risk Sharing Facilities and Start-up Supports. KOBI Venture Capital Investment Trust Inc. Co provides Venture Capital funding for companies. The stages of realized financial partnerships are classified

as seed money, set-up, early stage, development, bridge (mezzanine financing) and management purchase.

Beside these two companies, Istanbul Venture Capital Initiative (iVCi) is founded in 2007. It is Turkey's first applied fund of funds and co-investment program. The investors in iVCi are KOSGEB, TTGV, the Development Bank of Turkey (TKB), Garanti Bank, National Bank of Greece Group (NBG) and the EIF. EIF is the consultant to iVCi. iVCi is EU's specialized financial body for SMEs and the risk capital arm of the European Investment Bank Group (EIB Group). As at 30 November 2011, iVCi has signed seven commitments amounting to € 112.5 million. Two further contract valued € 32 million are planned during the first quarter of 2012 bringing the total portfolio to nine funds and € 144.5 million committed to Turkish private equity.

The importance of the venture capital also recognized by government. In the 23rd BTYK decision, venture capital needs was one of the subject. Startup companies, particularly in the first stages, need more public support. The role of public sector must be stronger than now. According to BTYK, TUBITAK institutions can be the partner of the venture capital funds. Initial outputs of firms will be helpful to the companies who have financial bottlenecks. Examples of country studies show that the public budget cannot exceed the 50% of total budget. If the necessary steps are taken, the role of high growth catalyzing entrepreneurship and innovative activities in firms will increase.

Risk capital, loans and equity guarantees do not exist for R&D investments. Although technology-based start-up companies are supported (mainly through technology incubators of KOSGEB, see Establishment of Technology Development Centers (TEKMERs), very little seed financing is available to stimulate the establishment of start-ups and spin-offs. Funding levels in most of the government-supported programs are insufficient, and the conditions for support, for example collateral requirement, discourage entrepreneurs. The only program providing seed finance as grants is the Technopreneurship Support Program implemented by the MoSIT under the Law on Supporting Research and Development Activities issued in 2008.

A lack of innovation finance due to the underdevelopment of the venture capital (VC) and business angel sector is another constraint to the promoting of new indigenous R&D performing firms. There are only three Venture Capital Investment Trusts in Turkey, with annual investments lower than US$ 100 million according to the WB report on June 2009. The regulatory framework and government incentives to the financial sector constrain development of these services. In addition, the demand (deal flow) for VC and business angel services is also low. This situation further constraints the development of the sector.

3.2.3.2 Stimulating greater R&D investment in R&D performing firms

To increase public–private collaboration is the Scientific and Technological Cooperation Networks and Platforms Support Program introduced in January 2007. Five pilot sectors were chosen by TUBITAK with the aim of establishing technology platforms for these sectors (textiles, electric/electronics, metal, automotive and marine sciences). TUBITAK encourage potentially interested individuals from industry, the public sector and universities to be active participant and coordinator of the meetings. First, temporary management boards had been selected for each of the potential platforms by the participants of the meeting and afterwards TUBITAK left coordination activity to these boards. As of October 2009, nine platforms have been established through this program with a total budget of €2.4m.

The last tool for collaboration between university and industry is the Industrial Thesis Projects Program (San-Tez) of the MoSIT where the research studies for masters and doctorate thesis that directly target solving the problems of private sector companies are supported by the MoSIT. This program was introduced in 2006 and 192 projects were selected for support as of May 2010. There are only 5 active TTO which is EBİLTEM (EGE University), Inovent (Sabancı University), HTTTM (Hacettepe University Technology Transfer Center), METUTECH TTO (Middle East Technical Office), YTTM (Yıldız Technical University). According to information of MoSIT as of 2011, there are 45 Techno Parks, 32 of which are actively working.

The manager companies in techno parks generally acting as TTO. In Turkey, there is no regulation for TTOs. But the existence of this office is extremely important for stimulating R&D investment and knowledge diffusion. TTOs in Turkey can be established under each university umbrella or each region can have their own organization. The TTOs should provide professional services to the universities, non-university research institutes and companies. They should provide a range of services, including case-by-case consultancy and training for scientists on IP issues and the evaluation of the patentability and commercial potential of new technologies should be the services of this offices. The agencies can be responsible for evaluation of invention disclosures and drafting, filing and managing patent applications. They can provide commercialization services. The TTOs can be responsible to negotiate, conclude and supervise the contracts in the commercialization period usually via licenses, sometimes via startups. Some of these actions are performed by PMA's in Germany since each university has its own TTO. But in Turkey all actions of PMA can be under the umbrella of TTOs. In recent times, TUBITAK and TPE have begun providing support to researchers for patenting, with the first, pilot Patent and TTO being established at Gazi University in Ankara.

3.2.3.3 Attracting R&D performing firms from abroad

Many foreign companies conduct research in Turkey. Thus, there is a specific policy focus on attracting R&D-performing firms from abroad. Foreign-owned companies can fully participate in all existing programs. Turkish Government provides tax incentives for R&D performing firms which are The Law on Technology Development Zones (TDZs) and Law on Supporting Research and Development Activities. Both laws are valid for international investors performing R&D in Turkey.

Tax incentives for R&D for the companies located in the techno parks were provided with the Law on TDZs since 2001. Incomes out of the R&D activities of companies in the techno parks designated by the MoSIT are exempted from income and corporate taxes, and income of the R&D staff working in those companies is exempted from all taxes until the end of 2023.

Another law named the Law on Supporting Research and Development Activities implemented by the MoSIT in cooperation with the MoF also provides tax incentives to increase the investments in R&D, to attract R&D functions of foreign companies in the country, to encourage collaboration on R&D and to stimulate the creation of new technology-based firms. This law issued in 2008 and according to the law in summary, there is an exemption of corporate income tax, if the companies employ more than 50 FTE researchers. If the companies employ 500 full time equivalent R&D personnel, there is additional income tax exemption. There is also an exemption from value added tax and customs duty for eligible firms conducting R&D. Public administrations can provide one time technopreunership capital support up to TRY100,000 without collaterals and university graduates can also benefit from this support. Half of the amount of social security payments which is required to be paid by the employer of R&D personnel is also exempted and covered by MoF for five years. Different preconditions exist in detail (INNO-Policy Trend Chart, Turkey, 2008).

As Erdil et.al says that principle of direct foreign investment policies should cover industrial, regional, and science and technology policies. In this process, investment promotion agencies become quite important if they are able to set close relationships with other actors in the national innovation system. In addition to these performance requirements, incentives and direct foreign investment policies related with techno parks are necessary and important. The role of investment promotion agency is to lobby politically and to attract the attention of public authorities for that region. Investment promotion agencies can serve

as a bridge between private and public sector (Erdil et.al, 2011). The role of the investment promotion agencies should increase in NIS in Turkey.

3.2.3.4 Knowledge circulation between the universities, PROs and business sector

The cluster strategy in Turkey is not well developed. According to Kalaycı (2011), there is a lack of financing options, high risk involved with bank loans for existing clusters. The venture capital concept is unheard in these regions. These clusters are literally on their own relying on accumulated savings. Moreover, there is a need to work on these clusters and present their potential capacity for growth and problems to the policymakers (Kalaycı, 2011). Although the aim of these clusters is not to be the innovative clusters, it indicates clearly how the clusters positioned in Turkey. Beside these studies, national Clustering Policy Development Project was prepared. The funds are allocated under the Pre-Accession Financial Assistance amounting 6 million € from European Union (EU) for two year period. Strategy Document forms cluster strategy of the country. Development of R&D and innovation, the importance of cooperation in eliminating barriers to SMEs is mentioned in the document. Sectoral clusters is also supported under the new incentive system, and awareness of the project created a significant platform for the creation of clusters. Since the awareness in regions is not well developed, the cluster strategy should be leaded centrally by government with providing incentives in Turkey. Since the clusters have problems in financing and using existing tools including VC, they will not be even able to make their own R&D by themselves. Developing support tools for clusters in regions will also be helpful for increasing R&D in regional context.

The objective in passing Technology Development Zones Law No. 4691 was the development of special investment areas for investments involving high technology. This law came into force on July 6, 2001. As compare to German system, this law provides considerable impact to increase the research ability of the companies. TDZ are involved in activities which transform a technological innovation into a commercial product, method or service and by this means contribute to the development of the region.

In short, as World Bank reports says that there is limited collaboration between public research institutes, universities and the enterprise sector. This cause to the low productivity of Turkish NIS system. Some of them are the regulatory framework that creates disincentives for researchers to offer consulting services to enterprises (university revolving fund regulations) and to establish start-ups, and for universities to commercialize research (distribution of royalty rights). In addition, the quantity and quality of many important NIS intermediaries including technology transfer offices, venture capital can be developed.

These intermediaries can facilitate collaboration between industry and research institutes. The Turkish government is making efforts in this direction, most notably with the expansion of TTO in major universities (Worldbank, 2009).

3.2.3.4 Cross border knowledge circulation

Bilateral agreements on R&D cooperation are also in agenda of TUBITAK. There is Bilateral and Multilateral Relations Division. This division is responsible for carrying out or monitoring the above-mentioned activities of bilateral cooperation and cooperation with international organizations.

1. Bilateral Cooperation: There are bilateral cooperation agreements with many countries at the intergovernmental or inter-institutional levels. Common research projects are supported and monitored with that cooperation. Financial support is given for different types of activities including common scientific meetings, exchange of scientists, scientific visits. TUBITAK is also supporting for the formation of documents at the intergovernmental meetings in the field of science and technology.
2. Cooperation with the International/Regional Organizations: Turkey is actively contributing the activities of a variety of European research program for example COST (European Cooperation in the field of Scientific and Technical Research), ESA (European Space Agency), ESF (European Science Foundation) and EMBC (European Molecular Biology Conference); regional organizations including Black Sea Economic Cooperation and Economic Cooperation Organization and international organizations including NATO, OECD and UNESCO. Turkish scientists can participate to the events organized by these organizations which are supported or monitored by TUBITAK.

In the framework of numerous current bilateral S&T cooperation agreements, TUBITAK has 27 bilateral S&T cooperation agreements with institutions from 23 different countries that are project based.

There are approximately 300 international projects going on as of the end of 2009 whereas the volume of these projects equals to more than € 7.9 million.

3.2.4 Increasing R&D

Several other ministries have also their own sectoral research programs and institutes in Turkey. Three research intensive ministries (the ministries of Agriculture and Rural Affairs, Health and Energy and Natural Resources) act as implementing ministries of the programs. These programs called as the Public Agriculture Research Program, the Public Health Research Program and the Public Research Program for Energy and Natural Resources.

Other ministries and public bodies (for example the Ministry of Environment and Forestry, State Water Works, etc.) also developed research projects in cooperation with universities, research institutes and the private sector. They submit their developed research project to TUBITAK. However, the coordination of the various targeted R&D activities across the different ministries is limited.

There is no regional approach to R&D policy in Turkey, although it would be quite important to have one. Ninth Development Plan prepared by MD (former State Planning Organization) has determined regional policy development in five important dimensions of sustainable economic and social development. As also highlighted in the same document, there are marked regional disparities in Turkey. The imbalances between the regions exists with respect to population structures, technical and social infrastructures, entrepreneurship, human resources, and education levels, availability of health services, environmental quality, employment and income levels. Turkish regional administrative hierarchy consists of provinces, counties, towns and villages which have all been equal in power and responsibility since 1925. In the 1950s, Turkey was divided into seven geographical regions, where each one contains about 10 provinces and does not have any governance component. The seven geographical regions are large in size and the provinces are too small to create an efficient regional policy, as a result of this, in 2002, a new regional distribution was created according to the NUTS classification . According to the new classification 81 provinces are grouped into 26 NUTS II clusters, provinces are considered as NUTS III level and 12 new adjacent province groups are labeled as NUTS I level.

KOSGEB is one of the agencies implementing R&D program which has regional branches which implement centrally designed policies and program for SME's. Some KOSGEB programs have similarities with SME innovative program in Germany.

In the Erawatch Germany country reports it is stated that an important development in this field is the adoption of new legislation for the decentralization of governance. The "Law on the Establishment, Coordination and Duties of Regional Development Agencies" was enforced in February 2006. The law incorporates significant details for the development and governance of regional innovation systems. The regional development agencies (RDA) take actions on regional R&D and innovation. The first two pilot RDAs in Cukurova and Izmir regions have included stimulation of R&D and innovation in their regional development strategies.

No regional research indicators are available for Turkey. Turkey was divided into seven geographical regions. The regional distribution of industrial enterprises is uneven and

concentrated in the Marmara region, which accounts for 51.8% of Turkey's total industrial value added. While there are no data available on the regional distribution of R&D, the breakdown of R&D project applications to state support programs indicates that R&D activities are concentrated in the Marmara region as well. Projects supported by the TUBITAK-TEYDEB between1995-2009 from Marmara region are almost 60% of all projects submitted to the department. Marmara is followed by Central Anatolia and Aegean regions, accounting for nearly 27% and 10% of total project applications, respectively (Erawatch Turkey, 2010).

There are various tax incentives in Turkey. As Link et al. says that tax incentives allow more private decision makers to retain autonomy. The advantage of tax incentives as compared to grant assistance is tax incentives entail less interference in the marketplace than grant assistance. Tax incentives require less paperwork and less bureaucracy. However, sometimes it is difficult to receive and should fulfill the requirement of assistance. Tax incentives have the psychological advantage of achieving considerable industry reaction. Tax incentives are more permanent and stable they do not require an annual budget review and they have high degree of political feasibility. However, tax incentives unlike grants assistance programs, often results in unfairness. Many new firms have no tax liability and are not profitable during the years in which they develop products and initially invest in R&D assets. Taxpayers in higher income level can benefit the high amount from tax incentives. Tax incentives can be harmful to the treasury since the tax rates reach higher than they would be. Tax incentives often weaken budget controls and public accountability. The effectiveness of tax incentives varies over the product life cycle during the stimulation of R&D. Although the permanency of the R&D tax credit will be viewed by many as a major technology step, Link and Leyden (1992) are skeptical of its effectiveness. In their study, there are pros and cons associated with any tax incentives. According to them the future attention should focus on R&D specific indirect policies, but rather on policies that have the ability to build the nations technology infrastructure. (Link and Leyden,1992).

Although there are lots of debate regarding tax incentives, Turkish government increase the amount of tax incentives by the law on Technology Development Zones and the Law on Supporting Research and Development Activities. Tax incentives exist for R&D personnel of companies located in Techno parks supporting research and development activities, implemented by the DG Industrial R&D of the MoSIT in cooperation with MoF, was enforced which also provides tax incentives for R&D personnel working outside the technology development zones. The law provides exemptions in income tax for R&D personnel employed in the private enterprise sector. Allowance is 90% for PhD holders, otherwise 80%. 30% additional funding is available for the costs of R&D personnel with doctorate degrees working in the R&D projects of the private sector if supported under the

state support for R&D program implemented by TUBITAK-TEYDEB. Law on TDZ and the law on supporting research and development activities implement by MoSIT in cooperation with the MoF.

Innovation-oriented procurement policy is in recent times in national agenda. According to estimates, the total volume of public procurement in Turkey amounts to roughly TL 54 billion in 2010. A sum like this contains major potential for fostering innovation. The improvement of elements of R&D and innovation by public procurement management system are strategy items. In the scope of public procurement law, a working group was decided to encourage innovation, technology transfer and localization for the priority fields in the decision was taken in The National Science, Technology and Innovation Strategy 2011-2016. This working group will be under the leadership of MoSIT with participation of ME, MD, Ministry of EU, MoF, Undersecretariat of Treasury, TUBITAK, and Public Procurement Authority. Proposals for legislative changes as a result of this study were presented to the meeting of the Supreme Council for approval on 23rd BTYK meeting. This decision was identified as a driver for domestic innovation and R&D in all public tenders. As seen in German example, working groups can build in ministries to check the possibility to integrate innovative elements in the procurement procedure to increase procurement of innovative products in particular with respect to priority fields including energy efficiency.

3.2.4 Market formation

According to the WB report 2009, under-investment in the commercialization of research activities is also reflected in the limited development of key institutional intermediaries including TTOs. TTOs can play an important coordination role during the commercialization stage of research, and in encouraging researchers and firms to initiate new collaborative projects. Researchers also need training and mentoring on business planning and other key topics including IPR management and commercialization. The lack of specialized institutions makes it difficult for firms to be aware of scientific and technological experts as well as research results and patented inventions produced at universities that could be useful to them. The absence of a specialized organization to deal with technology transfer and commercialization of R&D outputs also causes to problems in sharing and the use of IPR. Techno parks are aiming to build bridges between research and the markets of the future. Turkish government intends to continue improving the links between science and industry with Techno parks.

Coordination of innovation and research polices, science-industry links, internationalization of R&D, improvement of the conditions for start-ups, increasing the speed of technology

diffusion is important in market formation. In this process, investment promotion agencies become quite important, if they are able to set close relationships with other actors in the NIS system. In addition to these, as Erdil et al. says in performance requirements, incentives and direct foreign investment policies related with techno parks are necessary and important. In performance requirements, the best known policy tools are technology transfer and venture capital requirements. Most of the developed countries and an increasing number of developing countries use some forms of incentives to attract R&D. In many cases public support is provided on equal terms with domestic and foreign companies. However, multinational companies, unless the information is completely transferred to serve their own goals are not in favor of technology transfer. The basic logic behind the government's R&D subsidies is that if R&D decision is left to the market activity, firms will invest less to R&D due to problem of uncertainty. Therefore, incentives are meant to ensure socially optimal levels of R&D. Government supports for R&D are usually two types: which are financial and tax-related public support (Erdil, et al. 2011). Turkish Governments apply both of them. Decision of the BTYK is highly active in market formation. The applicability of the decisions should be followed-up.
Techno parks, MoSIT, private companies, R&D centers are the main actors for market development in Turkey.

Figure 3 indicates the role of institutions in the functions.

National Innovation System in Turkey

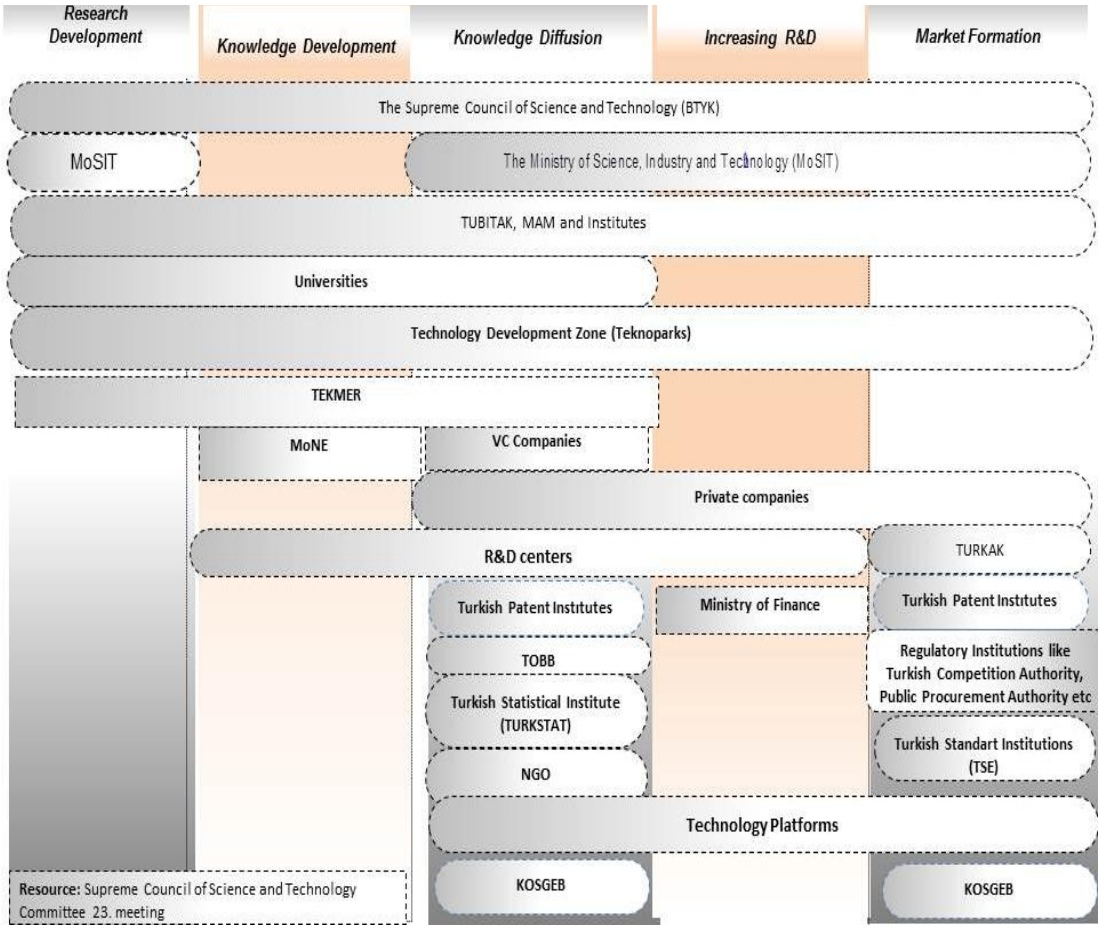

Figure 3 National Innovation System in Turkey (Source: Author's own construction- The 23rd meeting of Supreme Council for Science and Technology, Presentation, National Innovation and Entrepreneurship System, based on this presentation Prof. Dr. Yücel ALTUNBAŞAK, TUBITAK, 27 December 2011)

3.3 CONCLUDING REMARKS

The system of research governance in Germany is stable and large. Since the institutional structure is quite complex, the government supports research activities with thematic and mission-oriented programs. The figure 2 and 3 were designed to see the institutional structure in functions more practically. Institutional actors are not limited to the ones in figure 1. As can be recognized, the main actors: BMBF, BMWi, FhG, MPG, HGF, WGL, and DFG have strong roles in such functions as research development, knowledge development, knowledge diffusion and increasing R&D. In the market formation, the role of the BMWi, FhG, and private companies is respectable and remarkable. Most of the actors in the NIS system affect market formation directly or indirectly. This stems from the strategic decisions of federal government and thematic and mission oriented programs.

In Turkey, the structure is quite different. With the help of the restructuring of the MoSIT, it gains a more active role in functions including knowledge diffusion, increasing R&D and market formation. Techno parks are located closely to the public research institutes, universities and other private companies in order to create a favorable climate for activities. Therefore, Techno parks take part in all functions that were chosen for research and knowledge development, knowledge diffusion, increasing R&D and market formation. TUBITAK has an active role in each functional dynamic. MAM which is the biggest PRO in Turkey, is active in knowledge development and knowledge diffusion part. There are also attempts to increase the functions of R&D and market formation. In general, the institutions in Turkey do not have the effective role in the NIS system as seen in the example of Germany.

CHAPTER 4

ASSESSING THE FUNCTIONALITY AND SETTING PROCESS GOALS-INDUCEMENT AND BLOCKING MECHANISM

In this chapter, the way the functions are fulfilled and process and goals are set in terms of desired functional patterns will be examined. Moreover, functionality and the setting of process goals will be assessed. Functions can be analyzed considering the requirement of each phase. Assessment of strengths and weaknesses and how well the system is functioning will be evaluated and compared for each function on the country basis. Since chosen functions do not always tell us whether the NIS is well functioning or not, we will evaluate the functions with respect to the appropriateness and suitability of a particular functional pattern. NIS is a large system both in Turkey and in Germany, so the assessment of all the functions is not possible. Since programs and structures are not directly compatible in two countries, quantitative and qualitative comparison could be performed to a certain extent.

4.1 FUNCTIONS

4.1.1 Research Development

The basic difference between Germany and Turkey with regard to the innovation system results from the existing state structures of two nations. Germany has a federally governed structure, whereas Turkey is centrally governed. In Germany, BMBF carries the main responsibility for federal research and science policy, and BMWi is responsible for innovation and technology policy. There have been no major changes in the past years for the governance of the research system in Germany. The system of research governance in Germany is stable and large. Research, science, innovation and technology are represented at the ministerial level in the federal system in Germany as a tradition. However, in Turkey, in line with the decision Turkish government held on June 2011, the MoSIT were established. From that decision on, research, science, innovation and technology are represented at the ministerial level in Turkey as well. Yet, Turkey needs some structural arrangements in NIS actors since the significant changes and developments in the Turkish NIS have occurred in a relatively short period of time. In Turkey, such practices as institutional set-ups, procedures, practices and implementation of policies are still limited. The effect of ministries on R&D policy and implementation is relatively low compared to the German Ministries.

According to the World Bank report, regular monitoring and evaluation of institutions, programs and policies is quite important for communication and coordination between all

NIS actors. There are extensive scope of public programs supporting innovation and technology. Although there are some levels of fragmentation and overlap in institutions and programs, institutional improvements has been clarified in recent times. Independent evaluation and international benchmarking of institutions and programs is still developing. Following the EU experience, Turkey is now interested in increasing the influence of innovation policies on the development of regions (World Bank, 2009). The evaluation of World Bank regarding Turkey is still valid. The establishment of MoSIT is a serious institutional change; nevertheless, the changes in institutional structure in organizations and functions is still under progress including TUBITAK and its institutes like UZAY.

It was observed that nationwide self-governing organizations including DFG, MPG, FhG, HGF and WGL do not exist in Turkey. As in Germany, PROs must be in the NIS system of Turkey as well (TABLE 1). In addition to PROs, public institutions DFG and industry associations AiF is also a deficiency in the Turkish NIS system. In Germany, FHG has more than 80 research units; MPG maintains 80 institutes, research units and working groups; HGF has 17 major large scale research centers ; WGL has 86 research institutions; AiF has100 industrial research associations. As the above mentioned figures show, while the amount of individuals and non-university research institutes is high in Germany, the MAM is one of the biggest PROs in NIS system of Turkey. Institutes are mostly located in the universities, and 72 universities have research laboratories. Some of these laboratories are under construction (SPO, 2010).

In terms of R&D expenditures, Germany has the largest research system in EU. Gross domestic expenditure on R&D (GERD) at 2000 prices and purchasing power of parity was about 82 million $ (2010), but in Turkey, it was 9,5 million $ (2010). R&D intensity (measured as a percentage of GDP) was about 2.82% in Germany, and 0,85% in Turkey in 2010 (OECD, 2011/2). When these figures are taken into account, it is observed that Turkey is well behind Germany although it has the highest level of growth among the OECD members. According to the World Bank report, public expenditures are rising rapidly towards EU standards, and new policy initiatives are being designed and implemented in Turkey (World Bank, 2009). Yet, given the figures, it is seen that Turkish government allocates limited budget for gross domestic expenditure on R&D per capita at current prices is 131 $ (2010) but in Germany this amount is 1 054 $ (2010).

Budget to be allocated by Turkish government should certainly be increased in a short period of time. However, gross domestic expenditure on R&D is still limited. Due to the large budget that German government allocates, Germany has a large portfolio of funding instruments for R&D that makes it the largest research system in EU.

There are many funding instruments for R&D projects in Germany. Thematic, mission-oriented R&D programs and project-oriented programs are the strengths of the system. Most of the BMBF's funding is provided by thematic programs with a more or less narrow definition of the respective field of activities (i.e. initiatives in biotech for example Bio-Industry 2021); the BMWi, on the other hand, clearly favors horizontal approaches. However, no funding agency can be exclusively committed to one approach or the other. This mirrors that federal German research and technology policies have preserved a mission-oriented element and thematic focus in the way that they set priorities and fund research. Priority areas include ICT, life sciences, microsystems, nanotechnology, optical technologies, materials and production technologies, and energy and sustainable development.

The thematic and project-oriented elements also exist in Turkey, but they are not applied nationwide. Mission oriented programs do not exist in Turkey. Helmholz Association in Germany, for instance, uses program oriented funding. They focus on the scientific work on research programs and accordingly, they restructure the financing. However, in Turkey, funding goes to the institutes, and institutes spend that money considering their priorities. Sectoral or thematic programs do not exist for global NIS system.

The importance of universities, competence centers (clusters) and competence networks is also recognized by the Turkish government. Accordingly, Techno parks and technology platforms have been developed. Yet, there are no support schemes for cluster policies and regional growth pole policies. TUBITAK has announced ISBAP programs, but it is difficult to say that ISBAP will increase the R&D activities. The establishment of Techno parks certainly has a strong effect to increase the R&D projects and activities in Turkey.

In Germany, there are also programs including initiative for excellence. The Initiative for Excellence is a program by German federal and state governments to promote top level research at universities and to provide scientific excellence. To strengthen research at German universities by organizing a competition and to raise international ability are the goals of this program. It promotes of world-class university research. This initiative provides funding for universities to establish centers of excellence to promote cutting edge research, graduate schools to promote young scientists and researchers, institutional strategies on projects to deepen cooperation between disciplines and institutions. DFG is responsible for running the initiative together with the German Science Council. A total of € 1.9 billion of additional funds will be distributed over the coming five years, most of which come from the federal and state governments to fund the selected projects. To increase the competitiveness between the universities and to develop new ideas for scientists, this kind of funding will bring the scientist and researchers together to raise the profile of research. It

will also help to concentrate on research potential in both university and non-university research institutions.

Another program is called Cluster of Excellence. The aim of this program is to contribute to the university strategic planning and to accelerate the process of setting thematic priorities at universities. According to the thematic priorities of the universities, universities can have additional funding aligned with their strategic planning. The programs are approved by a joint commission comprising DFG and WR.

Beside these, Pact for Research and Innovation is a program under HTS that provides additional funding for PROs. This program serves a mission, and funding goes to the projects and programs that are applicable all over the nation and that match the specified criteria. This kind of a program does not exist in Turkey.

As stated in section 3.1.2.1, the amount of total funding is large. As stated in Erawatch report, total additional funding volume for the three measures (Higher Education Pact 2020, the Initiative for Excellence and the Pact for Research and Innovation) will be €18 billion until 2019 (Erawatch Germany, 2010).

4.1.2 Knowledge development:

Predictable policy framework in priority areas of research is supported with strong education and research policies in Germany. HTS and the NQI are the examples. With sub-programs including Higher Education Pact 2020 and the Pact for Research and Innovation**,** government creates additional capacities for students and reinforces research at higher education institutions (Higher Education Pact, 2020) and provides additional funds to non-university research institutes through federal and states funds (The Pact for Research and Innovation).

However, in Turkey, education policy has not been supported by policy framework in research and any priority areas of research. There are no programs that provide additional funds to non-university research institutes as seen in Germany.

Every kind of program and incentive exist in Germany. Increasing the number of international researchers at German universities, providing equal opportunities for men and women in research, improving postgraduate education, and developing entrepreneurship education in primary and secondary school as well as in post-school (e.g., in higher education) in Germany are some examples of these programs and incentives.

However, in Turkey, there are no widely used programs for education policy including the HTS and NQI as seen in Germany. In Turkey, the studies to provide young generation with

the opportunity to develop their potential are in progress, but the studies to offer every generation the opportunity to develop their full potential independent from their ages do not exist. There are no programs including the Initiative for Excellence to create research-friendly structures and promoting interdisciplinary cooperation in universities, between different universities, and between universities, non-university research institutions and the private sector. MoNE has funded only 5000 graduate students in the last 5 years all over Turkey and as of 30 October 2009, there are 6.893 doctorate students supported by TUBITAK according to the 20th meeting of BTYK. However, when compared to Germany, these figures are quite low since only the "Initiative for Excellence Program" in Germany funded 4.200 scientists. Young scientists in particular have benefited from the Initiative for Excellence. The Initiative has also promoted equal opportunities and measures to help balance work and family life. The Initiative for Excellence has an important contribution to the internationalization of German universities and increased their attractiveness to students and scientists from Germany and abroad. The other program under HTS is Higher Education Pact 2020. The aim of the education pact is to create additional capacities for students and to reinforce excellent research at higher education institutions.

There is limited variety of programs in Turkey. Only TUBITAK and MoNE provide funds for PhD Fellowships, Undergraduate scholarships, Graduate scholarships programs and International Research Fellowship. Beside these, entrepreneurship education in primary and secondary school does not exist in Turkey. This is also important for the functions of knowledge diffusion and market formation. By increasing the R&D budget, these kinds of programs can also be used in Turkey.

German Government also supports education and human resources policy with other programs including Qualification Initiative, which addresses all areas of education from early-childhood education through to continuing vocational training. Also, Immigration Act facilitates the residence permit process for research institutes hiring researchers from other countries, and Juniorprofessur introduces a new career path for post-docs towards a professorship. Vocational training is extremely important in Germany, but in Turkey, strategy for Vocational Training is not developed well enough for years and this is not the priority of the education policy, either. Generally, the amount of financial support is quite limited to have a convenient research environment. The need for adequate human resources for R&D has been identified as a key challenge since the launch of the Lisbon Strategy in 2000 also for Turkey. The assessment also includes the human resources for R&D. Turkey doesn't have a well-established higher education system which traditionally provided a strong human resource base for R&D. In 2009, the share of HRST of economically active population was 44.8%, which is above the EU-27 average (40.1%). The programs in education policy also serve the programs for human resources. Programs in R&D related policies and a number of initiatives concerning human resources have been

set up including the Initiative for Excellence, which will provide funding for 40 graduate schools for junior scientists, Qualification Initiative, which addresses all areas of education from early-childhood education through to continuing vocational training, and the Pact for Higher Education 2020, which offers a growing number of students more favorable conditions for their studies and research. However, in Turkey, there are no human resources programs as in Germany.

Only TUBITAK provides funding to support highly-talented students and highly-skilled researchers. There are no programs as seen in German example called “Equal Opportunities in Education and Research Division” in order to implement equal opportunities for women in education and research. Strategies for implementing equal opportunities for women in education and research will be a helpful model for Turkey to implement gender mainstreaming with the help of a budget item. International Researchers Coordination Committee (IRCC) acts as the Immigration Act in Germany. This act also facilitates the residence permit process for research institutes hiring researchers from other countries since inflow of the scientist and specialist workers from abroad is necessary. There are also attempts to improve the work climate for the researchers in Turkey, but these attempts are not at the desired level. There is a low share of students and graduates relative to OECD average, and there is also a low share of foreign professors and female researchers compared to the EU average.

Quality and excellence in academic research of the public research system are measured by many institutes in Germany for example DFG, WR, PROs (MPG, FhG, HGF and WGL), private nonprofit organizations and universities. Excellence in research is encouraged by regular evaluations of public research organizations and university and faculties. Scientific excellence, quality criteria, regular evaluations, evidence-based policy making, success of a process, sociological methods, statistical analyses, surveys or bibliometric assessments are some of the measurements that German institutions use.
Yet, as explained in Chapter 3, there is no regular monitoring and evaluation mechanism for policies and programs in Turkey. KOSGEB and TUBITAK have initiated to take steps for the evaluation of programs by conducting literature review, developing indicators and surveys for evaluation. Nevertheless, these activities should be more systematic and nation-wide. The impact on employment, productivity, technological development should be measured as well.

As a measure of quality and excellence of knowledge production, patent policy is taken as an important instrument. Since commercialization and technology transfer issues are well organized for years in Germany, its effect can be seen in the number of triadic patents. The

number of triadic patent is 5.764 (2009) in Germany and 24 in Turkey (2009). Turkey's IPR legislative framework is in line with the EU, but the IPR consensus in Turkey still needs to be strengthened.

4.1.3 Knowledge diffusion

As a sub-function of knowledge diffusion, firstly, **promotion of the establishment of new indigenous R&D performing firms** was chosen. The Federal Technology Venture Capital (VC) and High-tech Start-up Fund have an important role in promoting the establishment of new indigenous R&D performing firms. In Germany, Federal Technology Venture Capital (VC) program provides a broad range of financial support. The High-tech Start-up Fund is, on the other hand, an important element for funding seed and start-up stages of high-tech-based start-ups. The fund is particularly relevant to academic spin-offs. Another program for Start-ups is the EXIST program through which academic institutions are encouraged. EXIST Culture of Entrepreneurship supports projects at universities to build up an infrastructure to provide skills and support for technology and knowledge-based innovative ventures. EXIST Business Start-Up Grant supports the preparation of innovative business start-up projects at universities and research institutions. EXIST Transfer of Research promotes technology-based business start-up projects in the pre-start-up and the start-up stage.

In Turkey, Venture Capital (VC), pre-incubation, risk sharing facilities and start-up supports are quite important. The importance of the venture capital is also recognized by the government in recent times. In the last BTYK decision, venture capital needs was one of the topics for discussion. Startup companies, particularly in the first stages, need more support of governments. Another recent BTYK decision is that the role of public sector must be stronger than now. In Germany example, the BMWi and the European Investment Fund have doubled the size of the ERP/EIF Fund of Funds by € 500 million to € 1 billion. However, the fund allocated by Turkish government is quite small in comparison to the BMWi budget. At the same time, mostly private-sector investors have invested € 1.6 billion into these funds in Germany. Yet, in Turkey, private sector investors are almost invisible. Risk capital, loans and equity guarantees do not exist for R&D investments. Although technology-based start-up companies are supported by KOSGEB, very little seed financing is available to stimulate the establishment of start-ups and spin-offs. Funding levels in most of the government-supported programs are insufficient, and the conditions for support, including collateral requirement, discourage entrepreneurs should be developed. A lack of innovation finance due to the underdevelopment of the venture capital (VC) and business angel sector is another constraint to promote the new indigenous R&D performing firms in Turkey.

As a second sub-function of knowledge diffusion, **stimulation greater R&D investment in R&D performing firms** was selected.

High-Tech Strategy, SME innovative, and public-private collaboration are also important tools for stimulating greater R&D investment in Germany. Beside these, European Structural Funds, Pact for Higher Education and the Qualification Initiative may stimulate greater R&D investment in R&D performing firms. In Germany, there are federal thematic R&D programs, and these programs aim to stimulate R&D investments including HTS, which increased collaborative thematic R&D programs for example aerospace and energy, and horizontal programs targeting, in particular, SMEs. Cooperation among several actors as consortium is often required or participation of SMEs is often preferred. Main funding instruments in this respect are the thematic R&D programs called SME Innovative, ZIM for SMEs and IGF program. At the regional level, there are also many measures to stimulate private R&D investments, which might primarily benefit existing R&D performers, often co-financed by European Structural Funds.

In Turkey, tools developed by TUBITAK in order to increase public–private collaboration are the Scientific and Technological Cooperation Networks and Platforms Support Program introduced in January 2007. Another tool for collaboration between universities and industry is the Industrial Thesis Projects Program (San-Tez) of MoSIT, where the research studies for masters and doctorate thesis that directly target solving the problems of private sector companies are supported. The program that is seen in German example will be beneficial to stimulate R&D investments in Turkey as well.

As we also stated in German part, each university principally owns a TTO, which supports technology transfer between university and industry in Germany. There is at least one Patent Marketing Agency (PMAs) collaborating with the universities in each federal state.

In Turkey, there are only 5 active TTOs in 45 Techno Parks, 32 of which are actively working. The Manager companies in Techno parks generally act as TTO. As OECD reported in 2003, there is no one model for a technology transfer office. Individual countries and organizations are still learning about the costs and benefits of various approaches. Several countries are experimenting with regional or sectoral TTOs, recognizing that many individual PROs do not have the scale of research necessary for local TTOs. The number of new spin-off companies created to commercialize inventions is small but the phenomenon is widespread. TTOs also need to be free to hire high-quality technology transfer specialists with industry experience and governments may need to modify legal regulations to facilitate this (OECD, 2003).

In Turkey, there is no regulation for TTOs. Yet, the existence of these offices is extremely important for stimulating R&D investment and knowledge diffusion. According to the 2003 report of OECD, the main aim of TTOs is to facilitate the commercialization of publicly

funded research. TTOs can be subsidized in the initial stage of TTOs. In that stage, social returns might exceed private returns. In some cases, direct government subsidies to TTOs may be incompatible with national and supra-national legislation on government aid as well as with competition laws. Therefore, the Government support to TTOs should be limited (OECD, 2003). In parallel to this idea, the following decision was taken in ÜSİMP Workshop. Rather than the establishment of a single structure, a flexible model should be considered for TTOs in Turkey by taking into account the differences in local and regional needs and conditions. All stakeholders (the university, the city and the sector) should be a part of the system. According to the region's academic and industrial power, TTOs may be formed as central, regional, independent, commercial organizations, foundations / associations, or they may be affiliated with a university. Offices to be established should work together effectively with public, universities and private sector organizations. They can work effectively in a consortium initially; but the work to be performed in TTOs should be independent from university legislation and processes. After examining the existing models in the world, it is difficult to consider TTOs as revenue-generating structures in short and medium term. TTO's achievements should be measured with not only their licensing revenue but also a wide variety of services and benefits they provide to society. Therefore, the profitability of TTOs can be seen in long-term. It has been decided in USİMP workshop that TTOs should have administrative and financial independence, and that they must be non-profit organizations. After a certain period, TTOs may make a turnover according to the capability of region.

Attracting R&D-performing firms from abroad is the third subsection of the knowledge diffusion. In Germany, there is no specific policy focusing on attracting R&D-performing firms from abroad. However, German subsidiaries of foreign-owned companies can fully participate in all the existing programs. Germany has no tax incentives in R&D system at all.

In Turkey, foreign-owned companies can fully participate in all existing programs. Turkish Government provides tax incentives for R&D performing firms. The foreign owned and registered companies can also use all tax incentives according to Turkish trade law. We can say that there are some policies and incentives to attract R&D performing firms from abroad.

As fourth subsection of knowledge diffusion**, knowledge circulation between Universities, PROs and business sector** is quite important. There is an increase in industry and science links thanks to cluster strategy, collaborative projects, campus models, and technology transfer institutions in both public and private sector in Germany. Strong ties between businesses and academia is necessary for the high share of industry

funding of research in universities. Universities and PROs have dominant role in knowledge transfer to business sector. Federal Government in Germany launched campus model as a new model for a funding instrument. BMBF has launched Research Campus– public-private partnerships for innovation, which is a competitive funding scheme to strengthen the cooperation between companies and research organizations. The idea to bring together universities, non-university research institutions and commercial companies at a single location is necessary for knowledge circulation in that they can collaborate on a medium to long-term basis. “Leading Edge Cluster Competition Program” and “Campus Model” is a thematic program that German government applied. Campus model is a competitive funding scheme to strengthen the cooperation between companies and research organizations and this is a public-private partnership for innovation. Cluster support programs including Leading Edge Cluster Competition program not only help the restructuring of clusters but also develop and improve their technology and product-oriented innovation abilities.

Turkish Government developed Technology Development Zones called “Techno parks” in 2001 and these parks have a respectable impact on research and knowledge development in Turkey since there is an increase in BERD. Turkey has increased BERD figures from 28,7 % in 2002 to 42,5 % in 2010.

TDZ law helps increase the research ability of the companies. Techno parks are involved in activities that transform a technological innovation into a commercial product, method or service and these activities eventually contribute to the development of the region. However, limited collaboration between public research institutes, universities and the enterprise sector leads to low productivity in Turkey’s NIS. One cause of this limited collaboration is the regulatory framework that creates disincentives for researchers to offer consulting services to enterprises (university revolving fund regulations) and to establish start-ups, and for universities to commercialize research (distribution of royalty rights). To manage this problem, the quantity and quality of many important NIS intermediaries (technology transfer offices, venture capital) that facilitate collaboration between industry and research institutes can be raised. In fact, Turkish government is making efforts in this direction, most notably with the expansion of TTOs in major universities (World Bank, 2009).

As fifth subsection of knowledge diffusion **cross-border knowledge circulation** has important instruments in Germany. Bilateral agreements on R&D cooperation are signed with more than 50 countries. Many institutes including MPG, FHG, WGL, and HGF have worldwide international offices. Therefore, there is a strong international cooperation in science and technology. There is also a permanent increase in bilateral agreements on cooperation in education and research with other countries. Germany also funds joint

research projects and the participation of German researchers in international conferences. Internationalization of business R&D has been a major trend in the business sector for decades. Almost all large R&D-performing enterprises headquartered in Germany-run R&D laboratories outside Germany. Exchange between R&D labs in Germany and abroad is typically intense, including exchange of personnel and joint R&D projects. Many German enterprises conduct external R&D with partners from abroad. Bilateral agreements on R&D cooperation also exist in TUBITAK in Turkey. Such agreements and common research projects are supported and monitored; financial support is provided for several different types of activities including common scientific meetings, exchange of scientists, scientific visits and so forth. In the framework of numerous current bilateral S&T cooperation agreements, TUBITAK has 27 bilateral S&T cooperation agreements with institutions from 23 different countries. As seen in German example, joint R&D projects and exchange of personnel are also observed in Turkey. However, exchange between R&D labs is open to development in Turkey.

4.1.4 Increasing R&D

In contrast to many countries, there are no tax incentives for R&D in Germany, although there are several support programs, institutions and policies. In addition, a funding instrument for new “campus model” is to be developed. In public sector, there is an innovation-oriented procurement policy. Several other ministries have their own sectoral research programs and institutes. To increase R&D, most public support program relevant information is available online.

As seen in German example, several other ministries in Turkey have their own sectoral research programs and institutes. There is no regional approach to R&D policy in Turkey; adoption of new legislation for the decentralization of governance is published. The regional and sectoral research programs should be strengthened and given more importance in the strategic documents. Based on the capability of the region, new research programs should be settled.

In contrast to Germany example, tax incentives exist for R&D personnel of companies located in techno parks in Turkey. Within the scope of public procurement law, a working group was charged to encourage innovation, technology transfer and localization for the priority fields based on the decision taken in BTYKs 23rd meeting.

Many universities and companies have expressed their interests in Techno parks by establishing and joining Techno parks in Turkey, but collaboration between firms and research actors in the Techno parks and the creation of high-tech start-ups are low. In the case of Turkey, tax incentives have been provided to the Technology Development Zones by law. As a result, Techno parks seem to be dominated by the R&D departments of large companies seeking to take advantage of the additional tax incentives.

4.1.5 Market formation

Relationships and cooperation partnerships between companies are taken into account by German policy. The German system allows companies to work together on a consensus basis, and in many cases long-term cooperation partnerships are formalized by contracts between PROs universities and companies. The mission, thematic and project oriented programs are the outcome of the mutual dialogue between companies and business associations. Corporate governance in the German innovative system provides capacities for long-term R&D and innovation projects at a relatively low risk level and at the same time stable shareholding. As companies are monitored by banks and consultants who have the expertise to provide sufficient knowledge on technological opportunities, they are encouraged to engage in innovation strategies if risks and costs can be estimated. The consensus-based risk assessment reduces the likelihood of companies pursuing short-term radical innovation strategies.

Again in Germany, private companies have the majority of national R&D expenditures. Most of the basic research is performed outside the universities since there is a huge amount of non-university research institutes. Multinational enterprises have become the important part of R&D performers. German business sector invests highly in R&D.

Also, in Turkey, there has been a significant rise in the role of private sector in R&D activities lately. More than two thirds of the funds for R&D in Germany were spent by business enterprise sector (67,3 % in 2010 and 42,5 % in 2010). In Turkey, inductive approach can be used for the companies to measure what takes place inside firms in terms of innovation by considering sector specialization. To analyze the interaction between the companies with knowledge infrastructure and domestic and international linkages is also important.

As for Turkey, some R&D Institutes have been restructured (e.g., TUBITAK-MAM) to become market-oriented. However, for most of them, cooperation with the enterprise sector is limited. Cooperation between universities and the enterprise sector is also limited. R&D activity in Turkey is essentially performed by universities and public research institutes, and R&D intensity of affiliates of foreign firms is significantly lower.

As stated in knowledge diffusion section, TTOs can play an important coordination role during the commercialization stage of research, and in encouraging researchers and firms to initiate new collaborative projects. Since the researchers also need training and mentoring on business planning and other key topics including IPR management and commercialization, the lack of specialized institutions makes it difficult for firms to be aware of scientific and technological experts as well as research results and patented inventions

that are produced at universities and that could be useful to them. The absence of a specialized organization to deal with technology transfer and commercialization of R&D outputs in Turkey also leads to problems in sharing and the use of IPR. Lately, TUBITAK and TPE have begun providing support to researchers for patenting; Patent and TTO are being established at Gazi University in Ankara, Turkey. There are also attempts by a few Turkish universities to create technology transfer offices, as illustrated by Inovent, a company created at Sabanci University (in GOBS Technopark located in the Gebze Organized Industrial Zone) to undertake technology transfer and commercialization activities. Turkish Government has shown interest in supporting these efforts.

4.2 INDUCEMENT AND BLOCKING MECHANISMS

The mechanism that either induces (drives) or blocks a development towards the desirable functional patterns is investigated in this section of the study.

In the case of Biocomposites, there are two inducement mechanisms (Bergek et al., 2005): belief in growth potential and government R&D policy. There are also six blocking mechanisms, which are lack of actors and resources, poorly articulated demand and uncertainty regarding application, lack of vision, definition and focus, lack of integration between subsystems and lack of platforms and meeting places, secrecy of some of the large firms. The table below presents the inducement and blocking mechanisms that were chosen for the functions both in Turkey and in Germany.

Table 5 Inducement and blocking mechanism for Germany (Source: Author's construction)

GERMANY

FUNCTIONS	**INDUCEMENT**	**BLOCKING**
Research Development	-well defined institutional structure in NIS system -well-developed government strategy in every step with alliance of technology and research since it is ministries basic objective and tasks. -a dynamic and flexible system and extensive institutional framework including PROs -large portfolio of funding instruments for R&D projects -well-structured strategic programming and adequate culture of exchange and cooperation between the institutions	- allocation of competencies between federal and state governments complicates policy making
Knowledge development	-There is a considerable integration of research, innovation and education policies -There is a regular monitoring and evaluation mechanism for policies and programs. -There is nationwide thematic and mission- oriented programs	-There is a concern about brain drain

Table 5 (continued)

Knowledge diffusion	-strong international cooperation -each university has own TTO -extensive use of international cooperation	
Increasing R&D	-developed collaboration between firms, research actors and universities	-no tax incentives -less use of public innovation–oriented procurement.
Market Formation	-favorable investment climate	

TURKEY

Table 6 Inducement and blocking mechanism for Turkey (Source: Author's construction)

FUNCTIONS	INDUCEMENT	BLOCKING
Research Development	-new structural changes and improvements in Turkish NIS system	-needs of some structural arrangements in NIS actors since the significant changes and developments in the Turkish NIS are in a relatively short period of time -insufficient budget allocation from Turkish government
Knowledge development		-There is a concern about brain drain -There is no regular monitoring and evaluation mechanism for policies and programs. -There is no nationwide thematic and mission-oriented programs
Knowledge diffusion	-existence of Networks and Platforms Support Program, Industrial Thesis Projects Programs, TTOs, Techno Parks	-insufficient funding levels, underdevelopment of the venture capital (VC) and business angel sector -less tools to enhance public–private collaboration, -no long tradition of scientific collaboration with other countries -no regulation for TTOs -no policy priority for fostering knowledge circulation in NIS system. -low use of international cooperation apart from EU programs.

Table 6 (continued)

Increasing R&D	-existence of tax incentives -promising and developed collaboration between firms, research actors and universities	-no innovation oriented procurement policy -no sectoral and regional research programs
Market Formation		- mutual dialogue

4.3 CONCLUDING REMARKS

In this chapter, functions are assessed and analyzed. The evaluation of two countries indicates that the inducement and blocking mechanism for functions. Programs and structures are not directly compatible. NIS is a large system in both countries. There are many inducement mechanism which have numerous elements in NIS system. Inducements are not limited to the patterns stated here. Analysis of inducements and blocking mechanism could be clarified to a certain extent with the functions that were chosen. Blocking mechanisms are also analyzed according to the functions which were identified for Turkey. This mechanism will be used in next chapter as key policy differences. In the following chapter, tools will be proposed according to key policies.

CHAPTER 5

CONCLUSION KEY POLICY ISSUES

In this chapter, the key policy issues with tools are specified. The advantages, strengths and weaknesses of the German and Turkish research system are examined by focusing on key policy differences. Key policy differences are explained with tools. This chapter will be the chapter to propose a research policy and to find an answer to the question of whether it is possible to harmonize advantages of German system with existing research and incentive structure in Turkey. This chapter will also try to reveal the lessons that can be drawn for Turkey.

As Lundvall says, innovation is shaped by institutions and institutional change. Institutions have a strong impact on technical change. However, institutions, themselves, are normally quite rigid and do not change easily. The capability of national economies to cope with this problem (i.e. to learn about, adapt to and change their institutional framework) to engage in institutional learning is important from the development of their international competitiveness (Lundvall, 1992). As Lundvall states, changing the structure of institutions is not easy, thus firstly, the structure of institutions should be taken into account.

As a result of the analysis done on **research development** function and the examination of the institutional set-up, it was recognized that German institutional set-up is extremely different from the Turkish system. Specifically, the activities of non-public organizations, industry associations and non-profit research organizations are well-structured in Germany. Germany develops its government strategy in every step in compliance with technology and research since this is the basic objective and task of the ministries. The scope of federal and regional responsibilities is clearly spelt out in the constitution and other agreements, and the impact and implications of their strategies are negotiated continuously. However, in general, the NIS governance process in Germany should be regarded as a dynamic and flexible system. As seen in figure 2, the main actors including BMBF, BMWi, FhG, MPG, HGF, WGL, and DFG have strong role in the functions like research development, knowledge development, knowledge diffusion and increasing R&D. Actors in the system are also well-developed in Turkey. Yet, there was no effective ministry on research and technology policy in Turkey until 2011.

MoSIT was established in June 2011. Structural arrangement in Turkey executed after that period, which means significant changes and developments in Turkish NIS are realized in a relatively short period of time. Therefore, institutional set-ups and implementation of policies are still limited. Although the decision was taken on 2011, with the help of the restructuring of MoSIT, it has an active role in functions like knowledge diffusion, increasing

R&D and market formation as seen in Figure 3. Science, industry and technology have come together on ministerial level. The main tasks of MoSIT are to follow the technological developments in the industrial sector and stimulate the industrialists to do the same thing, to manage the transfer of the appropriate technologies to the industrial establishments, and to clarify the necessary measures for the technological integration among industrial establishments and to implement the appropriate ones. The merging of science, industry and technology is a respectable decision. There is also Strategy Development Department in MoSIT. The department sets the policies and objectives in accordance with the development plans and programs. Implementation of the plans should be regularly controlled, and application of the strategies should be checked. Strategies and actions should always be in alignment with BTYK decision.

As explained in chapter 4, the amount of individuals and non-university research institutes is high in Germany. PROs in Germany have large research and science community. Institutions that they have focus on research fields including basic research, applied research, and core fields for example energy, earth, environment, health, space, security, communication. These institutes act under PROs. On the other hand, it was observed that nationwide self-governing organizations like DFG, MPG, FhG, HGF and WGL do not exist in Turkey. In addition to PROs, public institutions like DFG and industry associations like AiF are also a deficiency in the Turkish NIS system. Institutes are mostly located in the universities which have research laboratories. According to SPO reports, in Turkey, 72 universities have research laboratories.

MoSIT is an affiliated ministry of autonomous institutions like PE, TURKAK, TSE, KOSGEB, TUBA and TUBITAK. TUBITAK has an active role in each functional dynamics. As an institute of TUBITAK, MAM is one of the largest PROs in NIS system of Turkey. There are seven institutes in MAM center as stated in section 2.2.1. MAM is active in knowledge development and knowledge diffusion part. There are also attempts to increase R&D in the market. However, in Germany only MPG has 80 institutes, research units and working groups mainly in the field of basic research. Therefore, the structure, expertise of the institutions of Turkey should be examined. While the institutions in Turkey are under Universities, in Germany they are mostly located under PROs. However, based on Germany example, it can be stated that in Turkey also these institutes can be under PROs. According to their field of research, these institutions can work even under the same organizations.

In addition, as seen in German example, PROs should be independent, autonomous and self-governing bodies. However, in Turkey, institutions and research laboratories are located mostly under universities. While universities are active in knowledge development and knowledge diffusion function, PROs and industrial associations may be more involved

in functions including research development and market formation. Activities, structures and organizations of PROs and nonprofit research organizations should be restructured to have a more effective role in the NIS system and research development and market formation in Turkey.

Furthermore, BTYK is the highest body for science and technology policy-making, coordination and advice in Turkey. It is effective in terms of setting polices and strategies. Different sub-systems need to be integrated into Turkish NIS system so that experiences and knowledge may be shared. In German system, GWK advises on and decide how to improve German science and research and WR is advisory public body to the federal government and the state governments for research policy. Both advisory public bodies in Germany can be analyzed by policy makers in Turkey. Moreover, in addition to BTYK, independent counsels that advice government separately should be in the system.

As indicated in Chapter 3 and 4, gross domestic expenditure on R&D (GERD) in Turkey is only 11,6 % of German expenditure as seen in Table 2. Gross domestic expenditure on R&D (GERD) and million current PPPs was about 82 million dollars (2010), but it is only 9,5 million dollars in Turkey (2010). Gross domestic expenditure on R&D (GERD) at current prices per capita for the year 2010 is $ 131 in Turkey as compared to Germany with 1054 $. This is not promising for the overall picture for Turkey, and this situation implies that more resources should be allocated to R&D. Budget to be allocated by Turkish Government should certainly be increased. This is a major bottleneck that Turkish Government faces. A strategic approach for R&D expenditures should be applied with scarce sources.

Another observation is that in Germany, institutions receive money from federal and state budget and also they are able to fund their projects with thematic, mission and project oriented funding. The funding goes generally over BMWi and BMBF. The pact for research and innovation which provides additional funding allocated through specific programs to foster research excellence in PROs is an important example for Turkey. The programs to provide additional funding to PROs should be developed. In Turkey, there are no funds allocated for thematic or mission oriented programs. The government should allocate funds for projects. The funds can be distributed over the ministries. The MoSIT, MoNE, and MD can be the ministries to organize thematic or mission oriented programs. The budget of these ministries should be increased for research, development, technology and innovation.

When **knowledge development** function is examined, it was observed that education and human policy and assessment of the research components are quite important. When the

analysis was done, it was observed that every kind of program exists in Germany. And there is a considerable integration of research innovation and education policies. To increase the number of international researchers at German universities, to provide equal opportunities for men and women in research, to improve postgraduate education, to develop entrepreneurship education in primary and secondary school as well as in post-school, to continue vocational training, to improve education from early childhood, and to offer every generation the opportunity to develop their full potential independent from their ages are the programs for the education policy. In Turkey, education policy has not been supported by policy framework in research and any priority areas of research. In addition, entrepreneurship education in primary and secondary school does not exist in Turkey. This is also important for the functions of knowledge diffusion and market formation. The attempts to organize entrepreneurship education in primary and secondary school should be organized. A considerable integration of research innovation and education policies is a must for Turkey. MoNE and MoSIT should work actively on this matter. By increasing the R&D budget, these kinds of programs can also be applied in Turkey. Entrepreneurship education should be widened in primary and secondary schools. The thematic and mission-oriented programs in Germany increase the coordination of all NIS actors. There are numerous funding instruments for R&D projects. Thematic R&D programs and project-oriented programs are the strengths of the system. Most of the thematic programs form the national policy in Germany. Existence of such programs as “Initiative for Excellence” and “Joint Initiative for Excellence” are important. The thematic and mission oriented programs. Thematic and mission oriented programs for human resources and education policy should be developed.

Vocational training is also one of the important subjects. To improve education from early childhood according to their ability and capability is highly important. The improvement can be done by MoNE. Moreover, as seen in Germany example, the program to offer every generation the opportunity to develop their full potential independent from their ages is extremely important for Turkey since the retirement age in Turkey is rather early, and program will help numerous people to integrate into the economic system.

The total number of researchers in Germany is 484.586 (2009), while it is 124.786 (2010) in Turkey. Women researchers as a percentage of total researchers is %24,87 (2009) in Germany and 35,8 % (2010) in Turkey. In absolute number, the number of women researchers is 120.516 in Germany and 44.673 in Turkey. It is far from the desired level. The number of full time equivalent researchers is 327.500 (2010) in Germany, while it is 64.341 (2010) in Turkey (Table 2). The number of researchers, female researchers and full time equivalent researchers should be increased in Turkey.

Monitoring and evaluation, and assessment criteria are another subject to focus on. In Germany, system evaluations of the main PROs were clarified in 2000. It was executed for each organization separately. The review confirmed that there was an inadequate culture of exchange and cooperation and a lack of strategic planning and programming. Following the findings of these evaluations, some changes in governance and priority setting were clarified. One further response was the Pact for Research and Innovation, which was agreed on in June 2005. In exchange for the government's commitment to increase funding, public research organizations have clarified commitments to increase the quality and performance of their R&D activities. These activities mainly cover the benchmarking of strengths and weaknesses with regard to excellence, and explore new research fields including risky and non-conventional research (Erawatch, 2010). The system evaluations brought new approaches to German Research system. As stated in Erawatch 2010 report, quality and excellence in academic research of the public research system are measured by DFG, WR, PROs, private non-profit organizations. The varieties of actors are in charge in German research system. Scientific excellence, quality criteria, regular evaluations, evidence-based policy making, success of a process, sociological methods, statistical analyses, surveys or bibliometric assessments are some of the measurements that German institutions use.

However, as explained in chapter 3 and 4, there is no regular monitoring and evaluation mechanism for policies and programs in Turkey. In the 20th meeting of BTYK in 2009, the decision for the evaluation and impact analysis for TUBITAK R&D programs was taken. KOSGEB, TUBITAK and universities initiated to take steps for the evaluation of its programs by managing a literature review, developing indicators and surveys for evaluation. Working groups on the subject created an increased awareness and in-house studies on the literature were examined and international cooperation was laid. Until now, the results of the working groups have not been announced or published officially.

Findings of these evaluations should result in some changes in governance, priority and strategic settings of government. In addition, the impact on employment, productivity, technological development and financial impact of the incentives should be measured. Another proposal is to investigate the structure of the WR as the public body which is active in monitoring and evaluation mechanisms. The monitoring and evaluation should be performed by each NIS actor separately and there must also be assessment institutions in Turkey as DFG in Germany. Private actors should also be in the system. As stated in the 20th meeting of BTYK, with a monitoring and evaluation mechanism, whether the funds provided by government are used efficiently to increase R&D activities can be understood.

NIS is regarded as a dynamic and flexible system in Germany. The German system is a rather complex one. The bottom-up, top-down and horizontal approaches are quite strong

all over the system. Although the analyses of the system seem chaotic initially, the dynamism between actors and programs is recognizable. Yet, in Turkey, there is a problem specifically in top-down approaches. There are deficiencies in the implementation of the strategies set by policy makers.

In knowledge development section**,** it was observed initially that in Germany, there is well-structured strategic planning and programming, and there is adequate culture of exchange and cooperation between the institutions. Since Germany recognized inadequacy of culture between the institutions in the early 2000, they have taken the necessary steps by designing the thematic and mission-oriented programs. However, after analyzing the NIS system of Germany, it is not easy to say that there is an adequate culture of exchange and cooperation between the institutions and a well-structured strategic planning and programming in Turkey. It was recognized that reconciliation and cooperation between the institutions need to be developed. in Turkey. During the preparation of strategies, adoption and participation of all stakeholders are necessary to establish an eco-system between NIS actors for Turkey. The strategies can be developed with the involvement of MoSIT, Ministry of Rural Development and other relevant ministries, universities, private sector representatives, and coordination mechanisms. The proposal is to set ecosystem between all the NIS sub-systems. To achieve this eco system, all stakeholders should be involved in the system. The government should invest financially in this issue.

As for **knowledge diffusion,** it is the biggest gap in Turkey. The fostering of knowledge diffusion must be a policy priority in Turkish NIS system.

There are tools to increase public–private collaboration and knowledge diffusion including TTOs and Techno Parks, Networks and Platforms, and VC in Turkey. Among these tools, specifically TTOs and VC need to be developed in Turkey.

Primarily, the goal of TTOs is to facilitate the commercialization of publicly funded research where social returns might exceed private returns. Although the existence of TTO offices is extremely important for stimulating R&D investments and knowledge diffusion, there is no regulation for TTOs in Turkey. A flexible model for TTOs in Turkey should be considered by taking into account the differences in local and regional needs and conditions. All stakeholders (the university, the city and the sector) should adopt and accept the needs and conditions. According to the regions` academic and industrial power, TTOs may be formed as central, regional, independent, commercial organizations, foundations/associations, or may have a structure affiliated to a university. Offices to be established should work together effectively with public, university and private sector organizations. They can work effectively in a consortium structure initially. However, the jobs to be performed in TTOs should be independent from university legislation and processes. It is quite difficult to consider TTOs as revenue-generating structures in short

and medium- term. The profitability of TTOs should be seen as a long-term target. TTOs must be the non-profit organizations. Subsidizing the creation of TTOs at least in the early stages, will be a feasible solution for Turkey.

In addition to TTO, insufficient funding levels and underdevelopment of the VC are the main problems. The importance of the VC is also recognized by government. In the 23rd BTYK decision, VC needs was one of the important subjects. According to BTYK, TUBITAK institutions can be the partner of the venture capital funds. Startup companies, particularly in the first stages, need more public support. The role of public sector must be stronger than now. In addition to VC funds, technology-based start-up companies are supported by KOSGEB. Limited seed financing is available to stimulate the establishment of start-ups and spin-offs. Funding levels in most of the government-supported programs are insufficient and the conditions for collateral requirement discourage entrepreneurs. As seen in German case, public and private sector should inject money into VC funds. The laws and regulations should be settled for TTOs, start-ups and VC.

The most important element in knowledge diffusion in Germany are thematic and mission oriented programs. These programs in human resource and education policy were emphasized in knowledge development section specifically with the programs like “Initiative for Excellence” and “Higher Education Pact”. These programs can also be seen as active elements in knowledge diffusion. In addition to these programs, the programs including HTS, SME initiative, ZIM and IGF program have an active role in knowledge diffusion as well. These programs stimulate the R&D investment in R&D performing firms and increase public–private collaboration.
In fact, in Turkey, SAVTAG, SOBAG, KAMAG, EVRENA are considerable examples of mission and thematic oriented programs. These programs are funded mainly under TUBITAK organizations. The funds allocated for these projects should be increased. Nevertheless, these programs do not form the national R&D policy. More programs should be developed. For instance, KOSGEB has mission oriented programs including SMEs initiative. However, KOSGEB does not have additional funding under a program to increase SMEs innovative capacities and to work with research establishments. Programs provide additional funding to increase SMEs innovative capacities should be developed. Market-oriented technology funding of innovative SMEs should be arranged.

As for cluster strategy, it can be said that the MoSIT implemented studies to stimulate cluster development activities in Turkey and designed a cluster support program which was initiated in 2009. However, Cluster support program can be further developed in Turkey and should be leaded centrally by government by providing incentives. Additional fund from

government is necessary to develop and improve technology and product oriented innovation abilities. The implementation of the strategies should be followed by each NIS actor separately for clusters.

Another important element in knowledge diffusion is cross border knowledge circulation. In Germany, numerous institutes like MPG, FHG, WGL, HGF have worldwide international offices. Therefore, there is a strong and long tradition of international cooperation in science and technology with other countries. Most of the R&D programs in Germany favor the support of cooperation, mainly between public (or private) research institutions, HEI and companies. Moreover, there are such Institutions as German Center for Research and Innovation (GCRI). It was established as one of five German Houses of Science and Innovation (DWIHs) worldwide and is part of the German government's strategy for the internationalization of science and research. In Turkey, there is no long tradition of scientific collaboration with other countries. Turkish firms follow and attend the EU funded projects, but there is no such international institution as part of the Turkish government's strategy for the internationalization of science and research. An institution which presents Turkey to the international market as a land of research and innovation, which enhances the dialogue between academia and industry, and creates an atmosphere for enhancement of international projects by providing an information platform for Turkish research and innovation landscape is necessary. Strong international cooperation and bilateral agreements in science and technology must be developed with other countries. The creation of new international cooperation strategies and dynamic and performance-enhancing networks in the science system must be the basic aim of Turkish Government. TUBITAK has numerous bilateral S&T cooperation agreements with institutions. However, joint R&D projects and exchange of personnel should increase and exchange between R&D labs should be open to development.

Other policies in research and instruments that are not mentioned in the previous sections of the current study are explained in **Increasing R&D** function section. The most important policies are innovation-oriented procurement policy and the absence of regional or sectoral approach.

Innovation-oriented procurement policy should also be applied in Turkey. Proposals for legislative changes were presented in the meeting of the Supreme Council 24th BTYK meeting. The decision taken in this meeting should be active in implementation. This decision has been described as a driver force for local innovation and R&D in all public tenders.

The other factor in increasing R&D function is absence of regional or sectoral R&D approach. Several ministries in Turkey have their own sectoral research programs and

institutes. There is regional approach toward the regional development in Turkey but there is no regional R&D. According to the capability of the region new research programs and strategies should be settled.

Finally, the last function chosen for the current study is **market formation**. The role of the BMWi, FhG, and private companies is remarkable in Germany. Most importantly, most of the actors in NIS system affect market formation directly or indirectly. This comes from the strategic decisions and the federal government and mission oriented thematic programs. The analysis for Turkey is quite different. As explained in chapter 4, there are numerous actors and tools to form the market. Mutual dialogue between companies and business associations can be increased by mission, thematic and project oriented programs. As stated, long term R&D projects is possible with the help of the corporate governance in German innovative system. R&D companies are monitored by financial institutions including banks and consultants who have expertise to provide knowledge on technological opportunities. In Turkey, mutual dialogue between companies and business associations is getting better each year. The share of the business sector increased in years. While BERD is % 42,5 (2010) in Turkey, it is % 67,3 (2010) in Germany. The contribution to business enterprise sector in R&D is subject to improvement. HERD is % 46 (2010) in Turkey, but % 18 (2010) in Germany. The research performed in Turkey is mostly located in universities. Universities have impact on knowledge development and a certain extent of knowledge diffusion, but no effect on market formation. The private, public and non-university research institutes should be integrated into the NIS system. The market oriented institutes like TUBITAK- MAM should be in the system.

Techno parks are one of the most important solutions to increase market formation in Turkey. Techno parks are located closely to the public research institutes, universities and other private companies in order to create a favorable climate for activities. Therefore, Techno parks have a role in all functions for research and knowledge development, knowledge diffusion, increasing R&D and market formation as seen in figure 3.

As stated in introduction, it is difficult to analyze what drives the market. To form the market, the analyst needs to have in depth knowledge of product portfolio and all the actors in NIS. Therefore, multitudes of factors that may drive or hinder market formation are illustrated. The tools that were described in all functions including VC, programs providing additional fund for SMEs, and entrepreneurship education and vocational trainings are also tools for market formation.

As a result of the thesis, Table 7 is prepared as a summary to see functions, blocking mechanisms, the key policy differences and tools. Tools that are described here will constitute our proposal for the research policy.

Table 7 Key policy differences and tools (Source: Author's construction)

FUNCTIONS	BLOCKING	KEY POLICY DIFFERENCES	TOOLS
Research Development	-needs of some structural arrangements in NIS actors since the significant changes and developments in the Turkish NIS are in a relatively short period of time.	-institutional set up	-Activities, structures and organizations of PROs and nonprofit research organization should be restructured to have effective role in NIS system. -Strategies and actions should be in alignment with BTYK decision. -The number of PROs should be increased. PROs should be independent, autonomous and self-governing bodies. -The programs that provide additional funding to PROs should be developed. -The structure, expertise of the institutions should be examined and the institutions that have similar research field can work under the same organizations. -In addition to BTYK, independent counsels that advice government separately should be in the system.
	-insufficient budget allocation from Turkish government	-budget allocation	-Budget to be allocated in Turkish Government should be increased. -Thematic and mission oriented projects with alignment of Turkish research and innovation strategies should be funded. -No funds allocated for thematic or mission oriented programs. The MoSIT, MoNE, MD can be the ministries to organize thematic or mission oriented programs

Table 7 (continued)

Knowledge development	-There is a concern about brain drain	-programs for education and human resource policy	-A considerable integration of research innovation and education policies is a must for Turkey. MoNE and MoSIT should work active. -Programs for education and human resource policy should be developed.
		-entrepreneurship education	-Entrepreneurship education should be widened in primary and secondary schools.
		-vocational training	-The improvement can be done by MoNE for vocational training
		-the number of researcher	-The number of researcher and the number of female researchers and full time equivalent researcher should be increased.
		-monitoring and evaluation mechanism	-The monitoring and evaluation should be performed by each NIS actors separately and there must also be assessment institutions in Turkey and private actors should also be in the system.
	-There is no regular monitoring and evaluation mechanism for policies and programs.	-thematic and mission-oriented programs	-Thematic and project-oriented elements exist but not applied in nationwide in the alignment of the strategic plan. There were deficiencies in the implementation of the strategies set by policy makers. The roles of research and research actors and thematic and mission oriented programs should be designed.
	-There is no nationwide thematic and mission-oriented programs	-culture of exchange and cooperation between institutions	-The reconciliation and cooperation between the institutions need to be developed in Turkey. All stakeholders should be involved in the system. The government should invest financially in this issue.

Table 7 (continued)

Knowledge diffusion	-no regulation for TTOs	-technology transfer offices (TTO)	- TTOs may be formed as central, regional, independent, commercial organizations, foundations / associations, or may have a structure affiliated to a university. Regulation and legal infrastructure should be prepared.
	-Insufficient funding levels, underdevelopmen t of the venture capital (VC) and business angel sector	-Venture capital	-Public and private sector should inject money into VC funds
	-less tools to enhance public - private collaboration	-SME	-Programs that provide additional funding to increase SMEs innovative capacities should be developed. Market oriented technology funding of innovative SMEs should be arranged.
	-no policy priority for fostering knowledge circulation in NIS system	-Cluster strategy	-Cluster strategy should be leaded centrally by government by providing incentives
	-no long tradition of scientific collaboration with other countries	-Scientific collaboration with other countries	-The institution which presents Turkey to the international market as a land of research and innovation and enhance the dialogue between academia and industry and creates an atmosphere for enhancement of international projects by providing an information platform for Turkish research and innovation landscape is necessary.
	-low use of international cooperation apart from EU programs.	- Knowledge circulation between R&D labs and bilateral agreements	-Joint R&D projects and exchange of personnel should increase and exchange between R&D labs should be open to development

Table 7 (continued)

Increasing R&D	-no innovation oriented procurement policy -no sectoral and regional research programs	-Innovation oriented procurement policy - Sectoral and regional research programs	-The decision taken in BTYK meeting should be active in implementation. - According to the capability of the region new research programs and strategies should be settled.
Market Formation	-mutual dialogue		-Mutual dialogue between companies and business associations can be increased by mission, thematic and project oriented programs. -Private, public and non-university research institutes should be integrated to the NIS system. The market oriented institutes should be in the system.

To summarize, the answer to the question of whether NIS is well functioning or not is limited with the functions that were chosen for this thesis. Functions are analyzed with respect to some sub-functions that are inherent in those functions. By comparing two countries, blocking and inducement mechanisms influencing the functions are explained. The key policy differences are analyzed. According to these key policy differences, tools have been developed. Tools that were chosen for one function are quite related with other functions. A tool for institutional set-up is also a tool for another function in NIS system.

When identifying key policy differences, it should not be forgotten that complexity of functions is quite high; numerous different policies may influence the innovation and research process; each policy has influence on several functions and functions have influence on each other. It is quite difficult to assess relative strengths, inducement, advantages and blocking mechanism for each function for the NIS system as a whole.

As the final remark, there is a research system and research policy in Turkey, but the research policy should be strengthened with the tools that are described. The tools mentioned in this study are the lessons for Turkey. Harmonization with the German system is always possible to a certain extent because of the differences in NIS system of both countries. This thesis would only be valuable if evaluation attempt is considered to be taken into account by policy makers and implementation authorities. The tools can be the action items. Turkish Government can concentrate on key policies and find solution for tools. Otherwise, it would be nothing more than an intellectual exercise.

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APPENDIX

TEZ FOTOKOPİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : ÖZTÜRK
Adı : AYŞEN
Bölümü : BİLİM TEKNOLOJİ POLİTİKASI ÇALIŞMALARI

TEZİN ADI (İngilizce) : STRUCTURAL ANALYSIS AND FUNCTIONAL DYNAMICS OF NATIONAL INNOVATION SYSTEM IN TURKEY AND GERMANY: LESSONS FOR TURKEY

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. ☐
2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐
3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐

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