The Republic of Turkey's Model of Instigating an STI Impetus

I. Introduction

The Republic of Turkey has long been and continues to be an advocate of raising science and technology to new heights, and has recently been engaged in a significant science, technology and innovation (STI) impetus. Such an advocacy is rooted in the advancement of a dynamic ideal based on continuous renewal and modernization under the guidance of science, technology, and knowledge.

Around the world, harnessing R&D and innovation as a driver of renewal and sustainable economic growth has also become an urgent need of the present times to attain a more prosperous and welfare-oriented society. In this pursuit, seeking alternative models to launch dynamics of change has been of interest to developed and developing nations alike. Hence, this policy brief presents a Turkish model as the set of characteristics that are instigated to accelerate the systemic dynamics of STI to reach fast-paced levels of increase in STI indicators and set forth a perspective towards future-oriented goals.

The Turkish model is all the more significant given that the low levels of public R&D funds, industrial R&D, and demand for innovation alongside rising global competitive pressure on sectors with high exports were overcome by the instigation of an STI impetus. With similar conjectures still being valid in many developing countries, the Turkish model provides useful insight to address these challenges.

In particular, many developing countries are characterized by an "innovation shortfall" that is attributable to low productivity and growth levels.[1] However, for a successful "catch-up," it is imperative that R&D and innovation is effectively bolstered to improve economic development, find solutions to societal challenges, and enhance welfare; and the most prominent way is to build-up an effective innovation system.[2] Moreover, a significant and robust statistical relationship exists between the level and change of GDP per capita on the one hand, and the level and change of the innovation system on the other.[3] On such a vital issue as R&D and innovation, the Turkish model is thus put forth to provide guidance.

This policy brief is organized into three main sections, namely long-term visions, strategies and targets for STI driven growth, major instruments in the STI policy mix, and achievements. With regards to the Turkish model, this paper emphasizes the conceptualization of the Turkish Research Area (TARAL) in triggering a particular kind of mobilization, both in the sense of resources and in guiding system actors towards socio-economic goals. It then underlines the policy mix that has invigorated the STI activities of the TARAL actors and the state of STI indicators, all of which indicate the perpetuation of STI as a motor for the advancement of society towards the Republic of Turkey's 100th anniversary and beyond.

As a policy brief written by the Department of Science, Technology and Innovation Policy at The Scientific and Technology Research Council of Turkey (TÜBİTAK), general comments and/or further inquiries regarding this brief is welcomed through the contact information provided on the last page.

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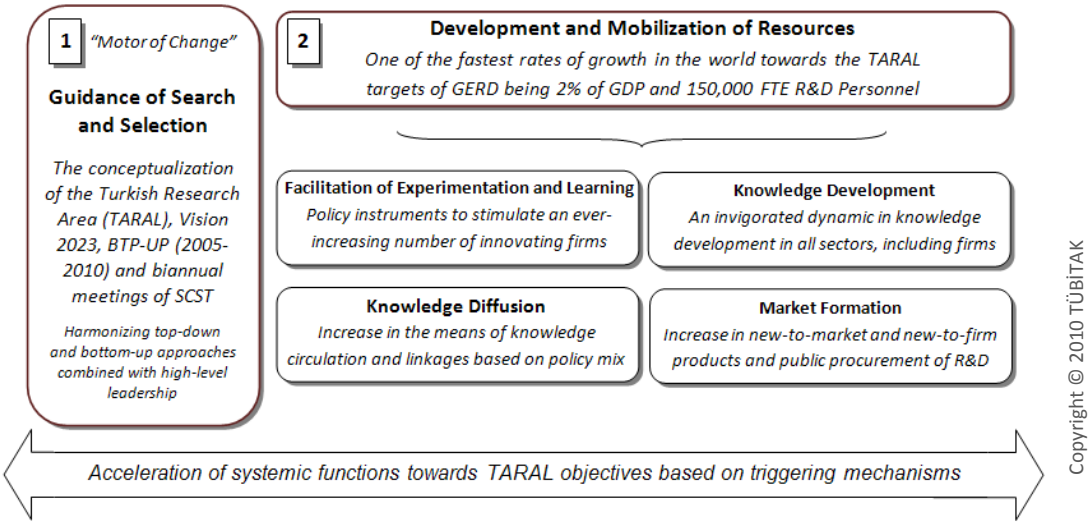
[1] Maloney, W.F. and Rodríguez-Clare, A. (2007) Innovation Shortfalls, *Review of Development Economics*, 11(4), 665–684.
[2] Nelson, R.R. (2004) The Challenge of Building an Effective Innovation System for Catch-up; Oxford Development Studies, Vol. 32, No. 3.
[3] Fagerberg, J. and Srholec, M. (2008) National innovation systems, capabilities and economic development, *Research Policy* 37,1417-1435.

II. Long-Term Visions, Strategies, and Targets for STI-Driven Sustainable Growth

Within the Turkish model, the establishment of long-term visions, strategies, and targets with the aim of guiding, aligning, and putting forth mobilizing expectations for its actors characterizes the initial set of triggers instigated to accelerate the functions of the S&T and innovation system (see Figure below). When combined with the actual development and mobilization of resources and a diversified policy mix to promote STI, this trigger effectively put into place a "motor of change" to bolster STI towards the said expectations. The ongoing results of the Turkish model indicate that Turkey exhibited and continues to exhibit a swift impetus in the field of STI with one of the fastest rates of increase in the world (section IV). With an urgent need of our times being the ability to harness the potential of STI to address a multitude of challenges for sustainable growth, the Turkish model provides insight with regards to the means of accelerating the functions of the STI system towards furthering this objective.



a. Vision 2023: Science and Technology Strategies

In an aspect of long-term visions and strategies for STI-driven, sustainable growth, "Vision 2023: Science and Technology Strategies" sets forth the aim of creating an ever-more innovative society in 2023, which marks the 100th anniversary of the foundation of the Republic of Turkey. Together with three other projects that collected and evaluated data on the STI capacity of the country, Vision 2023 included a technology foresight project. Based on the Delphi method as a systemic, meta-instrument, the results produced over 90 technology activity fields of which the main domains deemed most vital to secure the attainment of an STI-driven, welfare society are grouped under core socio-economic goals:

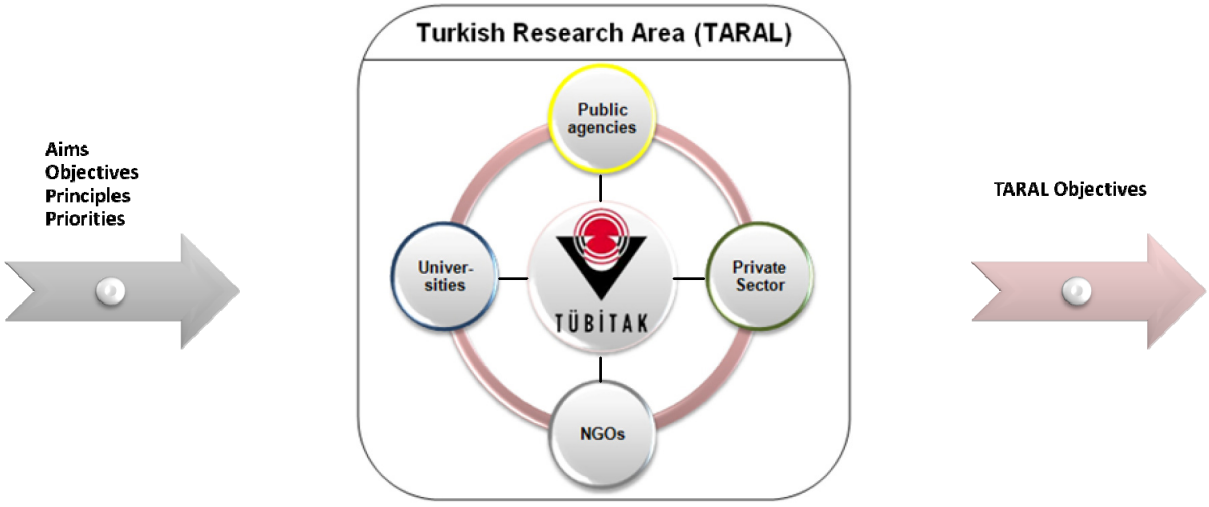
The Linkage of STI to Socio-Economic Goals	
Competitive Advantage in Industrial Production	*Innovative manufacturing systems, clean production processes, knowledge-intense, high value-added products as a global center of production, and advancement of competences for space technologies, material technologies, and agricultural production.*
Advancement of the Quality of Life	*Food security, innovative technologies in health and life sciences, healthy and environmentally-friendly urban infrastructure, next-generation transportation systems.*
Attainment of Sustainable Growth	*Energy and environmental technologies, including the better utilization of natural resources.*
Advancement of a Knowledge-Based Society	*Technology fields that further a dynamic, knowledge-based society.*

Furthermore, eight, cross-cutting strategic technology areas that were seen as common anchor points for achieving socio-economic goals were determined as: ICT, biotechnology and gene technologies,

energy and environmental technologies, material technologies, mechatronics, nanotechnology, design technologies, and production process technologies. Being one of the criteria in the peer-review phase of projects, public institutions provide priority to these areas during the utilization of their resources for R&D and innovation, which allows for the better linkage of STI with future-oriented, societal goals.

b. Establishment of the Turkish Research Area (TARAL)

Launched in 2004, one of the subsequent triggers in the Turkish model is the conceptualization of the Turkish Research Area (TARAL). TARAL set into motion a mobilization with which the private and public sectors, together with NGOs, strategically focus and collaborate on R&D and innovation. The TARAL objectives that are to be achieved are to *(a)* enhance the quality of life, *(b)* find innovative solutions to societal needs, *(c)* increase the competitiveness of the country, and *(d)* foster and diffuse S&T awareness in society. To make such a mobilization possible, the TARAL targets were determined as bolstering *(i)* the share of R&D expenditures in Gross Domestic Product (GDP), *(ii)* the demand for R&D, and *(iii)* the number of qualified R&D personnel. A critical stimulus was the formulation of a new, additional public investment TARAL budget for the utilization of the RDI activities of TARAL actors. Hence, TARAL triggered a particular kind of mobilization, both in the sense of resources and in guiding system actors towards socio-economic goals, which continues to be instrumental in the Turkish Model.



c. *National Science and Technology Policies Implementation Plan for 2005-2010*

As the first plan aimed to springboard the country towards the long-term goals and expectations that are foreseen for the year 2023, the National Science and Technology Policies Implementation Plan (BTP-UP) was established for the five year strategy timeframe between the years 2005-2010. Based on seven strategic objectives, BTP-UP (2005-2010) consists of a multitude of actions prescribed in line with the objectives, principles, performance measurements, and targets within the national STI system.

- **Strategic Objectives of BTP-UP (2005-2010)**: Increase S&T awareness in society and improve STI culture; Advance the quality and quantity of human resources for S&T; Support high quality, result-oriented research; Enhance the effectiveness of STI governance; Boost the S&T performance of the private sector; Improve the research climate and research infrastructure; Further the effectiveness of national and international networks.

BTP-UP (2005-2010) was instrumental in diversifying the policy mix that is being utilized by the TARAL actors for RDI capacity-building. Programs for human resources for science and technology (HRST) and science and society, in addition to defense and space research programs were also put under the auspices of the Prime Minister. According to recent developments, the targets of TARAL in consensus are, to *(i)* increase GERD as a percentage of GDP to 2% and (*ii*) raise the number of full-time equivalent (FTE) R&D personnel to 150,000 by 2013. The combined effect of this initial set of triggers effectively acted as a "motor of change"[4] to propel the functions of the STI system and instigate an STI impetus. The second implementation plan with regards to Vision 2023, namely the National Science, Technology and Innovation Policies Implementation Plan (BTYP-UP) for 2011-2016, is in preparation.

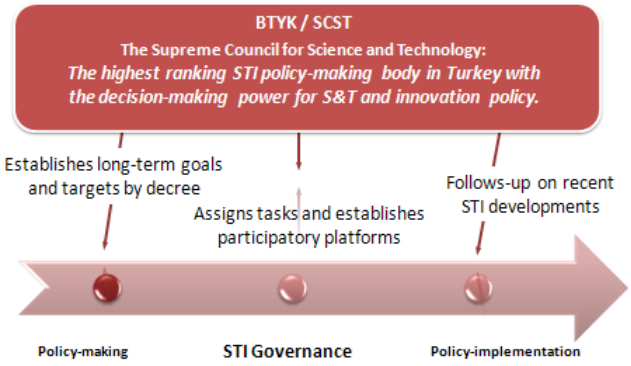
[4] The term "motor of change" is used in the functional dynamics approach to innovation systems. It refers to the functional domain that is instigated to accelerate the other functions of the innovation system (see Hekkert et al. 2007, pp. 413-432).

III. Major STI Institutions and Policy Instruments in the STI Policy Mix

All of the above-mentioned visions, strategies, and targets for STI-driven, sustainable growth have been resolved by decree of the highest-ranking STI policy-making body in Turkey with the decision-making power for S&T and innovation policy, namely the Supreme Council for Science and Technology (BTYK/SCST). By its very structure that is inclusive of an increasing broad-base of stakeholders, especially since the biannual meetings beginning in 2004, SCST contributes to diffusing developments on STI policies while increasing commitments for policy implementation. Moreover, there are individual organizations that are continuously contributing to the S&T policy-making process, namely the State Planning Organization (DPT) and the Scientific and Technological Research Council of Turkey (TUBITAK). Together with other institutions that uphold various roles in STI policy implementation, there exists a diverse policy mix to foster STI-driven objectives and contribute to the achievements of the TARAL actors.

a. Supreme Council for Science and Technology (BTYK / SCST)

SCST is granted the role of identifying, monitoring, and coordinating policies in S&T areas in accordance with national goals for economic and social development and national security. Based on twenty permanent members chaired by the Prime Minister, over one hundred different actors from governmental bodies, higher education and private sectors are represented in SCST meetings. Hence, SCST meetings culminate in governmental and non-governmental stakeholders from across Turkey.



SCST is an asset for S&T governance provided its role in establishing expectations that steer the Turkish system forward while guiding and framing policy intervention. SCST further assigns tasks to stakeholders for the implementation of the adopted decrees. As necessary, ad hoc committees have allowed stakeholders to identify specific problems and generate policy recommendations that feed-back into the policy-making process at the SCST level. SCST also contributes to make R&D and innovation more visible in the societal agenda with a unity in jargon so that actors from all levels of society have reached a common understanding on the vitality of R&D and innovation. The participatory platform of SCST further contributes to diffusing developments on recent STI policies while increasing commitments for policy implementation. This provides a more effective participation of stakeholders on STI issues, i.e. in ad-hoc committees regarding human resources for science and technology and public institutions that have been mobilized to deploy public research programs. Other assets for coordination and coherence include technical committees and technology platforms involving SCST permanent members and stakeholders as other venues of identifying challenges and formulating recommendations.

b. State Planning Organization (DPT)

The State Planning Organization (DPT) prepares, monitors, and evaluates the National Development Plans, and mid-term/annual programs, with the ninth National Development Plan having been issued for 2007-2013. Furthermore, DPT prepares the Technological Research Sector Investment Budget within the public investment budget, which is the main source for public (government) funding of R&D. This Budget includes the financial resources that are allocated to universities, the Turkish Research Area (TARAL) under the coordination of TUBITAK, and governmental institutions for the support of R&D activities, human resources for science and technology (HRST), and R&D infrastructure projects.

c. The Scientific and Technological Research Council of Turkey (TUBITAK)

TUBITAK is an autonomous and independent institution that is governed by the Science Board. In its advisory capacity, TUBITAK reports to the government on developments in STI policy and acts as the secretariat of SCST. Since 2004, SCST has assigned TUBITAK as the bridging institution between public agencies, higher education institutions, and the industry in TARAL in light of Vision 2023.

According to the roles assigned in the SCST decrees, TUBITAK has further facilitated the formulation of participatory platforms in policy design. As the coordinator of the preparation and realization of BTP-UP (2005-2010), the ongoing National S&T Human Resources Strategy, and International STI strategy, TUBITAK is actively engaged in policy-making for TARAL in support of an STI impetus.

d. Policy Instruments and Triggering Mechanisms in the STI Policy Mix

The policy instruments and triggering mechanisms in the STI policy mix of the Turkish model have been diversified following the "motor of change" as propelled forth by the launch of long-term visions, strategies and targets and subsequently, the swift reaction to develop and mobilize resources in support of the other systemic functions, which characterizes the Turkish model of instigating an STI impetus (Figure on p.2). The major triggering mechanisms to accelerate the systemic functions towards the TARAL objectives in a policy mix approach to instigate an STI impetus are provided in **Box 1**.

Box 1: *Some of the Triggering Mechanisms utilized in Turkey in a Policy Mix Approach*

Promoting entrepreneurship and technological or innovation-driven research

- An invigorated emphasis on new funding programs to increase the number of innovating SMEs and to encourage the creation of new, technology-based firms and early stage funding, e.g. SME RDI Grant Program and Techno-Entrepreneurship initiatives.

Expediting knowledge circulation for R&D and cooperation networks

- New programs to expedite cooperation networks and knowledge circulation for STI, e.g. Technology Development Zones (Techno-Parks), Industrial Thesis Projects, Funding Program for Initiatives to Establish Scientific and Technological Cooperation Networks and Platforms, Technology Platforms (ISBAP), Project Brokerage Events Grant Program.

Legal framework stimulating R&D activities

- New programs to raise awareness for the increased utilization and stimulation of the legal framework supporting R&D activities, e.g. tax incentives in favor of R&D activities.

Strengthening demand for R&D and innovation through public procurement

- Utilization of public procurement of RDI as a demand-side measure, e.g. Funding Program for Research Projects of Public Institutions to address the R&D needs of public institutions.

Promoting curiosity-driven academic research to sustain innovation

- Within the conjecture of substantially increased direct public support for R&D, achieving to maintain an emphasis on curiosity-driven basic research to sustain the future of innovation.

Enhancing infrastructures within the STI system

- New programs to enhance R&D infrastructures aiming at the development of thematic expertise centers with national and international significance.

Fostering a culture that embraces STI in society

- New programs to sustain the emphasis on igniting a dynamic awareness and appreciation for STI in society, e.g. Science Centers and an array of science and society activities.

Sustaining the development of human resources for science and technology

- New programs to sustain the development of human resources for science and technology, e.g. PhD fellowships, National Young Researcher Career Development Program, programs to lure global talent (Global Researcher Support Program EVRENA).
- New ad hoc committees to establish Turkey as an attractive destination for HRST and improve the climate for researchers, e.g. Human Resources for Science and Technology Coordination Committee and the International Researchers Coordination Committee.

Enhancing international S&T cooperation

- Enhancing better utilization of global knowledge networks through international strategies, e.g. new STI cooperation agreements, active participation in European research programs.

Another aspect that supported almost all aspects of the policy mix as provided above was the unity in jargon regarding R&D and innovation, which is a prerequisite to construct a consensus on STI issues at all levels of society. Following the translation of the Oslo and Frascati Manuals into Turkish and its free distribution by TUBITAK, the unity in jargon was assured. The Manuals also composed a reference point in funding programs and policy-development, thus complimenting a strategic approach to STI.

Promoting entrepreneurship and technological or innovation-driven research

As indicated in Box 1, the promotion of entrepreneurship and technological or innovation-driven research is invigorated through several, complimentary programs that act as triggering mechanisms to accelerate the dynamic of innovating firms.[5] This is reaffirmed by the increasing number of innovating firms that have largely undertaken technological innovation, and most recently, diversified to non-technological innovation as well, reaching 41% in the manufacturing sector and 31% in the services sector in 2008, respectively.[6] The private sector is also taking fast-paced strides to increase its absorption capacity, becoming the driving force behind many of the fast-paced increases in the total number of FTE R&D personnel in Turkey and BERD, which is significant for the target of a 60% share of GERD by 2013.

With an aim to increase technology development capability, innovation culture, and competitiveness of Turkish companies, the **Industrial R&D Grant Program** (TUBITAK/DTM) provides competitive, project-based grants to trigger R&D expenditures in the private sector. Between 2000 and 2009, the Program provided over 1 billion $ in grants and triggered about 4 billion $ in R&D expenditures as the largest program to stimulate the R&D activities of the private sector. The sectors that upheld the largest share of the grants during the timeframe 1995 to 2009 was machinery and manufacturing, including the automotive sector, followed by information technologies and electronics. For example, the Industrial R&D Projects Grant Program has facilitated the machinery and manufacturing sector to increase its RDI capacities. In 2008, the exports of the manufacturing sector reached 10 billion $ in close correspondence to the substantial increase in R&D expenditures that climbed to about 250 million $. Thanks to R&D supports, the automotive sector has also become Turkey's leading sub-sector performer of R&D in the manufacturing sector and largest export sector, which obtained a net export surplus of over 5 million $ in 2008 whereas there had been a net export deficit during 1996-2000. The other programs to increase the RDI capabilities of the private sector include the **Technology Development Project Funding Program** (TTGV/DTM) based on soft loans and the **R&D and Technological Innovation Funding Program** (KOSGEB) to better manage cash flows.

There is also an invigorated emphasis on new funding programs to increase the number of innovating SMEs, to encourage the creation of new, technology-based firms, and to stimulate existing firms to be included in the stock of firms that perform RDI. Such programs are designed to enable innovative business ideas, including those of candidate entrepreneurs, to be transformed into high value-added enterprises. In this respect, the **SME RDI Grant Program** (TUBITAK) is an SME-oriented funding program that is directed to invigorate SMEs productivity, their role in the economy, and international competitiveness by putting forth competitive, project-based grants for the first two RDI projects of SMEs. The Program is geared to support those projects that aim at developing new products, improving an existing product, increasing the product quality or standards, and/or developing new techniques and

SME RDI Grant Program is structured to serve the following five goals: *(i)* to enhance the competitiveness of SMEs by increasing their technological and innovation capabilities; *(ii)* to increase their propensity to prepare more projects; *(iii)* to develop high value-added products; *(iv)* to further the RTD culture in SMEs; and *(v)* to allow SMEs to participate more actively in national as well as international funding programs.

[5] The funding institutions are TUBITAK, which provides by far the largest funding for the RDI activities of the TARAL actors based on its grant programs, the Ministry of Industry and Trade (MoIT), Small and Medium Enterprises Development Organization (KOSGEB), and the Technology Development Fund of Turkey (TTGV). The Directorate of Foreign Trade (DTM) provides contributions to some of the programs in this policy mix domain.

[6] Source: Turkish Statistical Institute (TUIK), the Community Innovation Survey (CIS) 2006-2008. In addition, almost all of the innovating firms in Turkey cooperated with other domestic firms, which corresponded to 95.4% and 99.7% of innovating firms in the manufacturing and services sectors, respectively. Intra-firm linkages at the international level have also risen around the world, including those USA, EU, China, India and other countries.

new production technologies that will decrease costs to stimulate more SMEs to be vibrant actors in RDI. This program effectively allowed SMEs to put forth a vibrant participation in RDI projects as the number of SMEs with first time project proposals drastically increased with the launch of this Program in 2007. In particular, there was a surge in the number of project proposals submitted by the industry in recent years, bringing their percentage to over 70% of total firms of which the lion share was composed of SMEs with first time project proposals.

In another aspect, the **Techno-Entrepreneurship Grant Program** as initiated by TUBITAK and implemented by the Ministry of Trade and Industry (MoIT) aims to steer the issue of entrepreneurship towards technology and innovation based enterprises. The program encourages young entrepreneurs (undergraduate, graduate, post-graduate and doctorate students) lacking sufficient financial resources to transform their knowledge and research into marketable and high value-added products. The **Start-up Support** (TTGV) also invests in talented entrepreneurs with creative, unique and advanced-technology ideas and vision.

Expediting knowledge circulation for R&D and cooperation networks

In the knowledge-based economy, national systems of higher education are a strategic asset provided that links with the industry are strengthened and the transfer of technological knowledge is accelerated. Some of the on-going measures that act upon the importance of establishing strong linkages between the private sector and the R&D community at large include the following measures.

The Law on Technology Development Zones fosters the establishment of technology parks in higher education institutes and/or research centers to expedite knowledge circulation. Currently, there are 21 active technology parks across Turkey, which stimulate the mobility of human resources between the host research institution and the Techno-park as academicians and/or R&D personnel are encouraged to work with and/or become (co)founders of new firms located in the Techno-park. In addition, **Technology Development Centers** (TEKMERs) are incubators that are established in cooperation with universities to support the start-up of new, technology-based firms. There are 18 TEKMERs across Turkey whose tenants are provided with services for *(i)* promotion and marketing services, *(ii)* information services, *(iii)* consultancy services, *(iv)* laboratory and workshop services, *(v)* equipment and material support. Beyond the specialized structures of Techno-parks and TEKMERs to expedite knowledge circulation, the **Industrial Thesis Projects** (San-Tez) program provides funding to graduate students who develop new, technology-based products and processes in their graduate (M.S./PhD) theses. The Program seeks to transform graduate research into innovative products and processes that engages in and addresses the needs and requirements of the industry. As a public-private partnership, MoIT funds up to ¾ of the project and the firm partner to the project the remainder.

Broader networks for cooperation in RDI is facilitated through the **Funding Program for Initiatives to Establish Scientific and Technological Cooperation Networks and Platforms** (ISBAP), which was designed as a competitive, match funds program where TUBITAK matches the contribution of the network or platform members. The Program was also designed to be the funding mechanism of the Technology Platforms that was triggered by TUBITAK in the most export and import oriented sectors. ISBAP aims to *(i)* encourage mutual policy learning and networking between policy-making at local, national and international levels, *(ii)* intensify co-operation among public or higher education research organizations and/or enterprises on R&D activities, *(iii)* facilitate the development of collaboration between enterprises and other actors with a view to joint innovation activities and knowledge exchange, *(iv)* increase the rate of commercialization of the results of innovation activity in enterprises.

The **International Industrial R&D Grant Program** (TUBITAK) was also launched to encourage the involvement of Turkish firms in international projects, which is another means of knowledge circulation. The participation of Turkish industrial firms in international programs, such as EUREKA, has increased in parallel with their performance in nationally funded projects. Moreover, this program is instrumental to capture more benefits from knowledge that is generated at the international level.

Legal framework stimulating R&D activities

In parallel to programs geared to maximize absorptive capacity in the private sector and the utilization of R&D and cooperation networks to expedite knowledge circulation, there is another major triggering mechanism. The **Law for the Promotion of R&D Activities** provides multiple incentives in favor of

R&D activities, such as R&D tax allowance, income tax withholding incentive, insurance premium support, stamp duty exemption, and technopreneurship capital subsidy. Moreover, one particular aspect of the new R&D tax law should also be highlighted such that the law fosters the employment of R&D personnel by the industry, and hence diversifies the employment opportunities for researchers. As of September 2009, 60 private research centers were certified under the Law in sectors led by the automotive sector, automotive supplier industry, defense, and durable consumer/white goods sectors. In addition, about 2000 firms and 11,000 R&D personnel in the private sector were beneficiaries of the incentives provided in accordance with the income tax withholding. The total R&D tax allowance was about 2 billion USD. In addition to the direct project-support that is provided for RDI projects, the stimulated legal framework for R&D activities, including the R&D tax allowance, contributes in providing a desirable environment for the private sector to boost its R&D activities.

Strengthening demand for R&D and innovation through public procurement

Both technology-push and demand-pull forces are considered to act as catalysts for innovation since the process through which innovations are successfully introduced and diffused to the market is rather complex. Hence, as one of the three TARAL targets, fostering demand for innovation becomes important. In line with this strategic view, SCST resolved by decree that public institutions are to develop research programs to satisfy the R&D needs of public institutions and to foster R&D demand at societal level. The public R&D programs launched by public institutions include those in **Box 2**.

Box 2. Public Research Programs

1. National Health Public Research Program
2. National Agriculture Public Research Program
3. National Environment and Forest Public Research Program
4. National Earthquake Public Research Program
5. National Energy and Natural Resources Public Research Program
6. National Justice Public Research Program
7. National Family and Social Research Public Research Program
8. National Transportation Public Research Program
9. Foundations Public Research Program
10. National Work and Social Policies Public Research Program
11. National Culture and Tourism Public Research Program
12. National Education Public Research Program
13. National Security Public Research Program
14. National Population and Citizenship Services Public Research Program
15. Public Works and Settlements Public Research Program

The public R&D programs are facilitated by the **Funding Program for Research Projects of Public Institutions** (TUBITAK), which funds projects that address public institutions' R&D needs. The public institutions themselves decide on the R&D performer that can fulfill their needs while partnerships between the industry, academia, and public research institutions are encouraged. For the closure of a project, it is essential that the end results are utilized by the consumer, stimulating market formation.

Enhancing infrastructures within the STI system

Infrastructure is an essential element for R&D activities. Establishing, maintaining and updating high quality research infrastructure in an efficient way is a challenging task given the number of universities and their distribution across Turkey. DPT funds research infrastructures of higher education and public research institutes on a project basis. The proposed projects are examined by whether they are in line with priorities, respond to the needs of public and private sectors, can run basic, applied and multi-disciplinary R&D activities, build up the environment supporting qualified researchers, and their collaboration. In addition to joint laboratories, thematic expertise centers are funded in prioritized technology fields, including nanotechnology, ICT, food security, innovative food processing, hybrid vehicles, biotechnology, and clean technologies.

Fostering a culture that embraces STI in society

Raising public awareness on science and technology is one of the strategic objectives of BTP-UP (2005-2010). Hence, several initiatives and activities are ongoing under science and society programs, such as the **Science and Society Project Funding Program** and establishment of Science Centers. TUBITAK Solar and Hydrogen Car Races can also be given as examples of activities aiming to raise awareness on alternative energy usage and to encourage university students' capability to put their knowledge into practise and develop green technologies in the future.

Sustaining the development of human resources for science and technology

The development of human resources for science and technology (HRST) has been a vital priority in S&T policy and one of the strategic goals of BTP-UP (2005-2010). HRST is both a contributor to technological advancement and is a transmitter of RDI-relevant knowledge to the future generations.

New instruments and programs have been designed in this area based on the target of 150,000 FTE R&D personnel by 2013 towards which Turkey has taken some of the fastest-paced strides in the world. The funding programs directed at fostering HRST at each age cohort assist a prospective researcher from childhood to his/her early research career (TUBITAK). These include the **Overseas Research Fellowship Program** in support of PhD students who are registered in domestic doctoral programs in basic and applied science fields to perform research abroad. The **PhD Fellowships for International Students Program** grants highly qualified students who intend to complete their PhD studies in Turkey. The **Postdoctoral Research Scholarship Programs** are provided for both incoming and outgoing researchers, i.e. from Turkey to abroad and from abroad to Turkey. The **Visiting Scientists Fellowship Program** funds scientists working at universities or research centers abroad to attend conferences and lectures organized in Turkey, and/or short-term R&D and innovation assignments. In addition, the **National Young Researcher Career Development Program** is designed to capture the potential of young researchers while the **Global Researcher Support Program** (EVRENA) enables researchers who reside outside of Turkey to partake in brain circulation.

Select Policy Instruments to Sustain Human Resources for Science and Technology

The National Young Researcher Career Development Program supports young, PhD holders at the early stages of their research career. By supporting the R&D projects of young researchers who will hold the academic leadership in the 21st century, this program allows young scientists to pursue their career as a researcher and to further develop the level and role of S&T in Turkey.

The **Global Researcher Support Program** provides a venue for national researchers to include international experts in their research. In particular, TUBITAK supports the international expert's expenditures during their stay in Turkey provided that the expertise of the "global researcher" in a specific research area is critical for the success of the project and does not duplicate those of qualified researchers in Turkey. Regarding the term "global researcher," the only requirement is to be residing abroad so that Turkish researchers living abroad may also benefit from this program.

The diverse array of national programs as given above provide an attractive destination for researchers when taken together international grant programs to promote brain circulation, such as the Marie-Curie tool of FP7. Therefore, the consideration of the scholarship and grant programs that scientists can benefit in Turkey as a package enhances being an attractive destination for researchers.

Beyond financial instruments, meta-instruments and regulatory instruments are also effective means to develop and mobilize HRST. In this respect, the **Researcher Information System** (ARBIS) as one of the sub-projects of Vision 2023 facilitates the compilation of data on S&T fields and activities of any researcher in universities, the public and private sectors of Turkey and Turkish researchers living abroad. As a dynamic database, ARBIS contributes to monitor the sectoral distribution of the R&D personnel and provides a pool for the panel system in the peer-review phase of project-based funding.

Furthermore, new ad hoc committees to establish Turkey as an attractive destination for HRST and improve the climate for researchers were established by SCST. The **Human Resources for Science and Technology Coordination Committee** has worked to improve the climate for researchers in

Turkey, such as enhancing governance in higher education institutions, raising researchers' income, and further increasing the stock of qualified HRST and university-industry collaboration. The **International Researchers Coordination Committee** has worked on regulatory issues for international researchers, i.e. 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. A synergy to create the Turkish portal in the EURAXESS network was also established to provide information on visas, work permits, social security, accommodation, language courses, and other social and cultural issues.

In preparation of the **National S&T Human Resources Strategy**, a total of 12 workshops were organized with the participation of more than 500 research personnel from all stakeholder sectors, such as international and national academicians, private sector R&D managers, and public sector lab managers. Each of the workshops had a different participant profile including those exclusively organized for the business enterprise sector with R&D directors and researchers. In these workshops, TUBITAK made use of its consultation technique, Common Mind Platform (Ortak Akıl Platformu®).

Enhancing international S&T cooperation

Another strategic view is to conceive policies, design tools, and build relations in order to improve and highlight the STI capability of Turkey on a global scale within the perspective of international relations. In this regard, the **International STI strategy** aims to *(i)* increase the effectiveness of international relations, *(ii)* to develop international linkages for STI, *(iii)* human resource development and mobility of researchers, (iv) to enhance governance and coordination and (v) informing and follow-up. Turkey also actively participates in European research programs or schemes, such as the Framework Programs, and has agreements with international organizations, such as NATO, OECD, UNESCO, ICSU. Furthermore, by taking part in over 23 ERA-NET projects, Turkey enhances its linkages and level of cooperation with the European Research Area. Via INCO-NET projects, Turkey also increases its collaboration with countries on continents around the world, including countries not party to FP7.

IV. Achievements of TARAL in Accelerating Systemic Functions

Following the "motor of change" as provided by the launch of the conceptualization of TARAL, Vision 2023, and BTP-UP (2005-2010) with a harmonization of top-down and bottom-up approaches combined with high-level leadership, the swift mobilization of financial resources for TARAL and the triggering mechanisms were successful in accelerating systemic functions. In the present global financial crisis, the mobilization of financial resources for TARAL also continued with an additional budget of 130 million $, putting into place a springboard out of the crisis towards a sustainable, economic future based on STI-driven growth. Based on key STI indicators, this section provides some of the achievements of TARAL in accelerating systemic functions and becoming an ever-more dynamic system towards TARAL objectives in view of long-term visions to be a welfare society based on STI by 2023. The high levels of STI-related growth rates allude to ongoing results of the Republic of Turkey's model of instigating an STI impetus.

In the decade between 1998 and 2008, Turkey has been engaged in a swift STI impetus by all means based on top-level rates of growth as consistently exhibited across all of the STI indicators. As a summary of the swift STI impetus in the decade between 1998 and 2008, The Republic of Turkey:

Investment in STI:

- Increased GERD from 2 billion to over 7 billion in PPP $, which has been spurred forth by the launch of the conceptualization of the Turkish Research Area (TARAL) in 2004, and exhibited a growth rate in GERD at 250%, which is almost quadruple the OECD and EU27 averages.
- Doubled the level of GERD as a percentage of GDP from 0.37% in 1998 to 0.73% in 2008. This puts forth a significant catching-up dynamic towards taking sustained strides to reach the target of raising the share of GERD to 2% of GDP by 2013.
- Exhibited a fast rate of growth in GERD as a percentage of GDP based on the growth rate at 97.3%. These rates are by far above the 5.9% for the OECD and 7.7% for the EU27 averages.
- Fostered a business enterprise sector that outperformed the higher education sector in 2008 for the first time as the biggest performer of R&D at 44.2% after a rapid climb and emerging dynamic.
- Fostered a business enterprise sector that outspent the government to become the leading sector to fund R&D for the first time in 2005, reaching a share of funding at 47.3% of GERD in 2008.
- Fostered a business enterprise sector as the biggest investor in R&D with a self-funding that reached 38.8% of GERD in 2008 in addition to the transfer of funds for R&D to be performed in the higher education sector, which the industry also funded.
- Sustained a manufacturing sector as the leading performer of R&D in the business enterprise sector based on its share of business expenditures on R&D (BERD) at 64.1%, which is nearly double that of the service sector at 34.8%. Within the manufacturing sector, the automotive sector is by far the leading sub-sector performer of R&D with a leading exporter status to the present.

STI Human Resources:

- Nearly tripled in quantitative terms the stock of FTE researchers to about 53,000 in 2008 (being 80% of the total stock of FTE R&D personnel), especially after 2003, and represents a fast-paced increase of over 180% based on 1998 values of FTE researchers.
- Met its target of 40,000 FTE researchers for the year 2010 much earlier after which SCST resolved for 150,000 FTE R&D personnel by 2013, which contribute to technological advancement and the transmission of scientific and technological knowledge to future generations.
- Increased the number of FTE R&D personnel and researchers per 10,000 total employment in 2008 to 32 and 25, respectively, in which the presence of a relatively young population is considered as a future asset.
- Put forth noteworthy dynamics in the distribution of HRST by the main performing sectors of R&D activities, i.e. higher education, private enterprises, and governmental sectors. These dynamics

strike the balance of 44% for the higher education and 41% for the private enterprise sectors with 15% for the government sector as shares of the total stock.

- Remarkably increased the stock of FTE R&D personnel in each sector in which the private enterprise sector increased to five-fold in one decade reaching to 28 thousand. This shows a parallelism with the dynamics of R&D investment.

Scientific Publications and Patents:

- Increased its value on scientific publication to 22 thousand in 2007 namely a 305% increase between 1998 and 2007 with an exponential rate of increase.
- Is found to be the most dynamic sizeable country leading the catch-up process together with South Korea based on an average relative annual growth rate in S&E publications and a share in world total S&T publication output.[7] Furthermore, Turkey was the only exception among the BRICs and South Korea cluster, such that the share in world publications was greater than the share in world PhD degrees awarded,[8] which confirms the role of S&E productivity in Turkey as a driving force behind the catching-up process.
- Experienced a boom in the total number of utility model and patent applications being filed to TPE, namely an increase of about 950% in one decade reaching to 5217.
- Increased the number of international patent applications being filed to PCT as well as to the USPTO, EPO, and JPO.

Ranking in the World:

Furthermore, when a world ranking is calculated in terms of the growth rate more specifically between the years 2002-2007[9], the Republic of Turkey takes place in:

- 2nd rank in terms of growth rate in GERD, moving from a position at 25 to 23,
- 4th rank in terms of growth in GERD as a percentage of GDP, moving from 38 to 35,
- 2nd rank in terms of growth in FTE R&D personnel, with a position from 26 to 18,
- 2nd rank in terms of growth in FTE researchers, with a position from 25 to 18,
- 3rd rank in terms of the growth in scientific publications, with a position from 26 to 18.

All of these dynamics and others regarding performance in STI within the decade between 1998 and 2008 indicate that Turkey has been accumulating important assets with regards to mustering the necessary resources to increase its national capability, all of which is vital for a successful, sustainable economic catch-up. Furthermore, such an impetus is all the more significant given that the strongest and most robust statistical relationship between the level and change of GDP per capita has been attributed to the level and change of the innovation system. Currently, it is known that Turkey is ranked the 17th largest economy in the world based on GDP,[10] and 18th in most of the STI input and output indicators. Based on the sustainable growth that the STI impetus will further bring, Turkey will most certainly transform itself into an even more significant and innovative economy in the near future while leading toward the target to be a welfare society in the year 2023.

In sum, the trends in the STI indicators of Turkey allude to an STI impetus across the board from fast paced increases in GERD and the total stock of HRST to S&E productivity. As provided in **Table 1**, such an impetus based on the STI indicators provides a momentum to reach the targets as resolved by the SCST and drive a greater convergence towards the EU27 and OECD averages.

[7] Glänzel, W, Debackere, K, and Meyer, M. 'Triad' or 'tetrad'? On global changes in a dynamic world. Scientometrics, Vol.74, No.1 (2008) 71-88.

[8] Veugeler, R. "Towards a multipolar science world: Trends and impact." Department of Managerial Economics, Strategy and Innovation (MSI), Katholieke Universiteit Leuven, OR 0808.

[9] The 2002-2007 interval is used for comparison as most countries do not have values for the year 2008 although Turkey has.

[10] The World Bank: World Development Indicators database, 1 July 2009. Gross domestic product (2008).

Table 1. Science, Technology and Innovation Indicators

Indicator Number	Indicator Name	TURKEY								EU27 Total (2007)	OECD Total (2007)
		2002	2003	2004	2005	2006	2007	2008	Target 2010		
1	GERD as a percentage of GDP (by 1987 base GDP)	0.66	0.61	0.67	0.79	0.76	-	-	2	1.77	2.29
	GERD as a percentage of GDP (by 1998 base GDP)	0.53	0.48	0.52	0.59	0.60*	0.72*	0.73*	2**		
2	GERD per population (PPP$)	46	43	53	67	77*	97*	98*	124	530.1	747.6
3	Total Researchers (FTE)	23,995	32,659	33,876	39,139	42,663	49,668	52,811	-	1,360,332	3,997,466***
	Total R&D Personnel (FTE)	28,964	38,308	39,960	49,252	54,444	63,377	67,244	150,000**	2,317,698	-
4	FTE Researchers per 1000 total employment	1.1	1.5	1.7	2.0	2.1	2.4	2.5	5	6.0	7.4
	FTE R&D personnel per 1000 total employment	1.4	1.8	2.0	2.5	2.7	3.1	3.2	-	10.3	-
5	Private Sector R&D expenditures (% of GDP)	28.7	23.2	24.2	33.8	35.6	41.3	44.2	60**	63.4	69.6
6	Public Sector R&D expenditures (% of GERD)	7.0	10.4	8	11.6	11.2	10.6	12	14**	13.7	11.1
7	Higher Education Sector R&D expenditures (% of GERD)	64.3	66.3	67.9	54.6	53.2	48.2	43.8	26**	21.8	16.8
8	Triadic patent	7	8	12	17	19	24	-	100	14,831	49.974

Source: TurkStat, OECD-MSTI 2009/1

* Gross salaries are used for the calculation of R&D labour cost in higher education sector after the year 2006

**These targets are for the year 2013 because of the revision that was done in 17th meeting of SCST.

***For the year 2006

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