TECHNOLOGY DEVELOPMENT FOUNDATION OF TURKEY

ODTÜ TEKPOL

Research and Innovation Outlook of Turkey

RIOT 2020

TECHNOLOGY DEVELOPMENT FOUNDATION OF TURKEY

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“A copy of the introductory, cannot be sold with money.”

#TechnologyDevelopingTurkey

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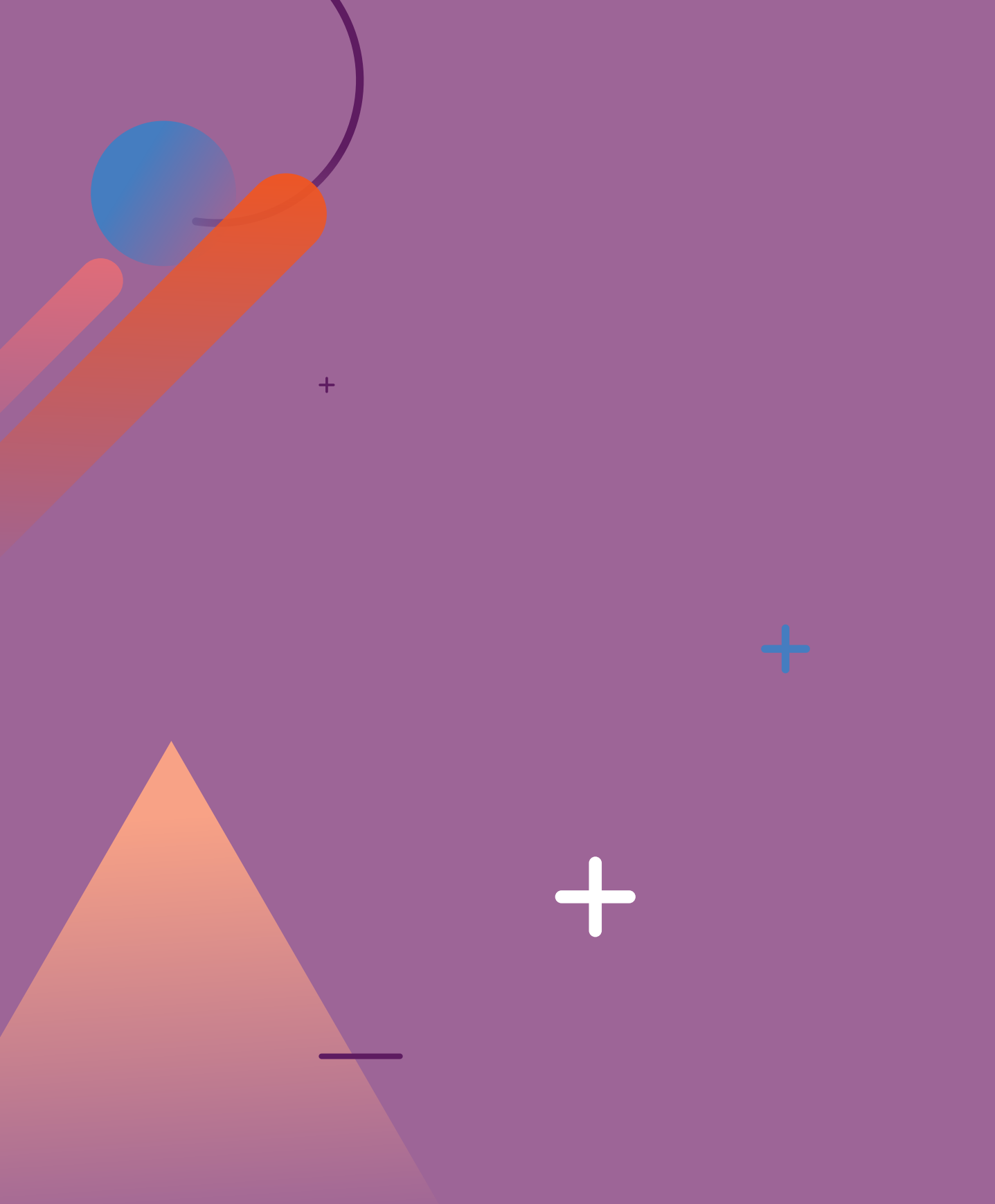
This report is an initial attempt to generate periodical reports on Turkish Science, Technology and Innovation (STI) system as detailed as possible, yet it may suffer some limitations mainly because of the unavailability of the data and transparency in policy-making processes. We thank our network and the alumni of TEKPOL who assisted us in finding data and information regarding the Turkish STI system. Without such assistance writing this report would not have been possible. This report builds on the 2015 Research and Innovation Observatory (RIO) Country Report and the 2012 and 2013 ERA-WATCH Country Reports of the European Commission.



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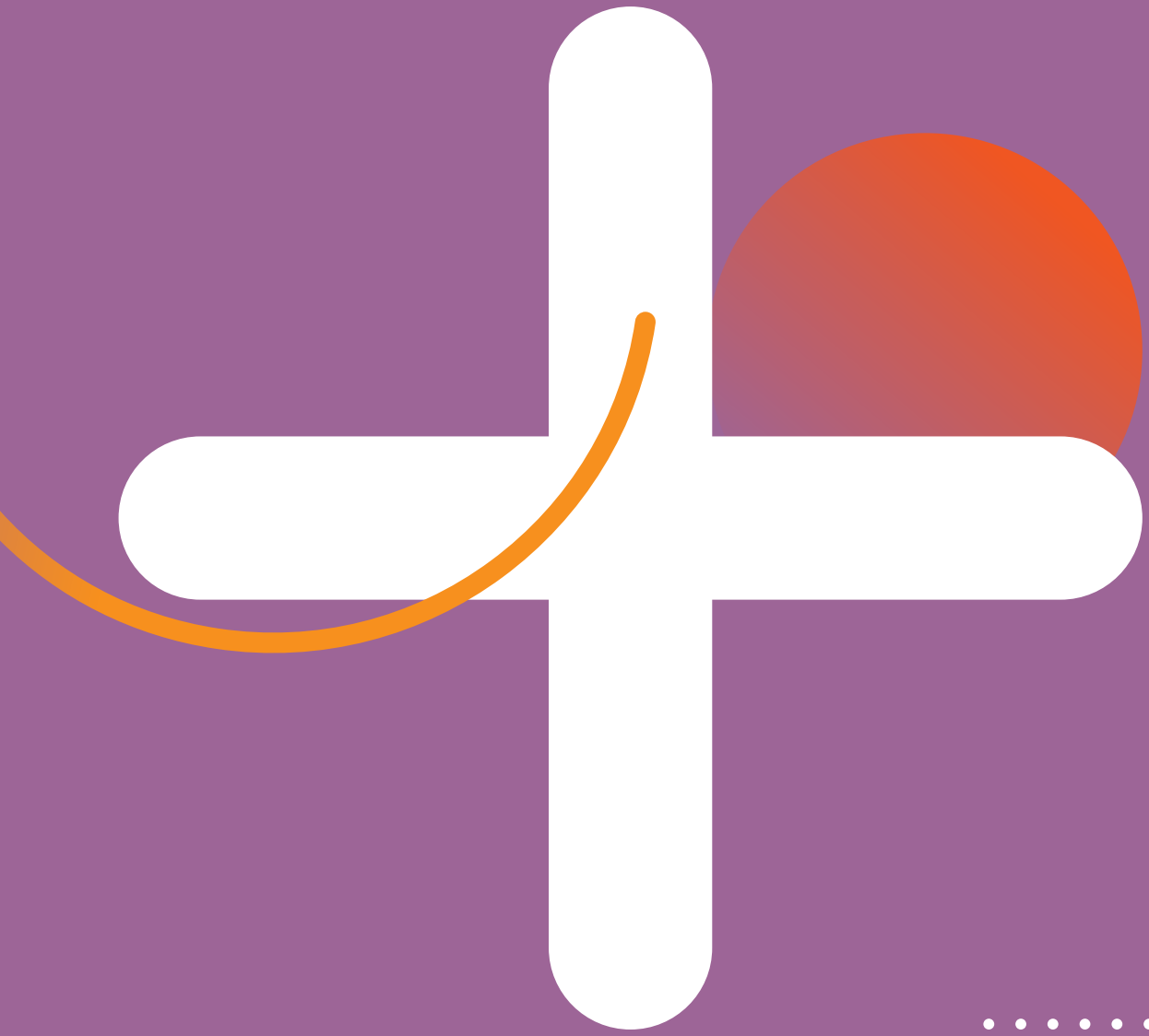

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Preamble

Technology Development Foundation of Turkey (TTGV) was established in 1991 in cooperation with public and private sectors with a mission to improve the international competitive capacity of the private sector and promoting the technology and innovation activities in Turkey. Through its activities, TTGV, aims to ensure that the diversity in the ecosystem is well comprehended; brings together different players and specialties to ideate in concert and enrich the ecosystem by means of common interests; identifies the common problems as well as the genuine needs and seeks solutions to these problems and needs. For further information on TTGV activities and publications, you can get an insight at https://www.ttgv.org.tr/

In line with TTGV's #TechnologyDevelopingTurkey mission, we carry out selective studies in the subjects aligned with the needs and objectives of the technological innovation ecosystem. In this context; we present Research and Innovation Outlook Turkey 2020 (RIOT) as TTGV Policy Level Publication which has been compiled by Middle East Technical University (METU) Science and Technology Policy Studies (TEKPOL). RIOT aims to shed light on Science, Technology and Innovation (STI) policies in Turkey after 2015 and analyze funders as well as performers in the field of R&D and innovation. We wish RIOT to be useful and insightful to anyone who is interested in the dynamics of Turkish innovation ecosystem.

Executive Summary

Turkey witnessed important changes in its governance structure in the last decade. Transition from the Parliamentary to the Presidential system occurred in a period of rapid technological change that creates opportunities for firms and countries. The COVID-19 pandemic even further accelerated this process of technological change both in terms of using science and technology to tackle problems that we face and the pace of how governments adapt to such changes. In such a narrative this report aims to shed light on the changes in science, technology and innovation (STI) policy in Turkey by focusing on the changes from 2015 onwards. The performers and the funders of Research and Development (R&D) and innovation are analyzed in detail. This report also assesses how Turkey responds to recent trends in STI policy-making around the world.

STI system under the new governance structure

Turkey's last 20 year of STI policy-making mostly focused on creating actors of the STI system. R&D tax benefits, subsidies and other forms of horizontal support schemes available for technology-based firms aimed at increasing the STI performance of these actors. Part of the actor generation process included creating new actors such as Technology Development Centers (TEKMER), Technology Development Zones (TDZ), Technology Transfer Offices (TTO) and changing the role of already existing actors, like how The Scientific and Technological Research Council of Turkey (TÜBİTAK) is transformed from supporting science and scientific research to supporting R&D and innovation processes of both universities, individual researchers, firms and entrepreneurs. Turkey's current per capita Gross Domestic Product (GDP) of $28,133 (purchasing power parity) is about 58% of the EU average and its R&D/GDP ratio is 1.06% compared to the EU average of 2.20%. Looking at employment in knowledge-intensive activities as a share of total employment (22.8%), exports of high technology products as a share of total exports (2.4%), industry value added per worker ($43,453 in 2010 constant prices) Turkey is still short of the EU average. As of 2020, Turkey is a moderate innovator in the European Innovation Scoreboard.

In 2018 the governmental system of Turkey changed from the Parliamentary to the Presidential system which also brought changes in the governance structure of the

STI system. Turkey's STI policy has long been devised by the Supreme Council for Science and Technology (BTYK), the Ministry of Industry and Technology (MoIT) and the State Planning Organization (SPO, continued later as Ministry of Development). This structure significantly changed in 2018. Ministry of Development and the highest STI policy-making body BTYK ceased to exist in the new system. The highest STI policy-making body is now the Council of Science, Technology and Innovation Policies (CoSTIP) established in July 2018 under the Presidency. This new structure is slowly penetrating into the STI actor network where the most noticeable change is the increased role of TÜBİTAK in both making and applying policy. It is too early to assess how the Presidential system will affect the STI system and the actor network in Turkey.

Policy-making and new policy tools

Looking at the strategy documents, reports and the recent behavior of MoIT and TÜBİTAK, there are six recent trends in Turkish STI policy-making.

1. It is observed that the policy-making mindset and the new policy tools are more inclined from sector-specific to technology-specific policies.

2. There is an increasing focus on indigenous and national (technology) production.

3. Looking at the new policy tools, there is a shift from supporting knowledge creation to commercialization activities.

4. New policy tools for both the existing Small and Medium-sized Enterprises (SMEs), big firms and the entrepreneurs focus on producing high-tech and high-value-added goods and services.

5. With the effect of COVID-19 pandemic, there is an increased awareness of what digital transformation will bring and how we can cope with the changes.

6. Increased attention on "co-creation" in performing STI activities where "co-creation" sometimes "forces" actors to come together.

If a taxonomy to classify policy tools as economic and financial benefits, regulation and soft tools is used, it is observed that there are quite a number of new tools that gives economic and financial benefits to firms and actors in the STI system organized both under TÜBİTAK and KOSGEB. The initiation of Industry and Innovation Network Mechanism Call (SAYEM), Technology Focused Industrial Movement Program (HAMLE), Commissioned R&D call, Patent-Based Technology Transfer Support Program organized under TÜBİTAK are important in the sense that the government signals change in policy mindset (more selective, focused, technology specific aiming successful commercialization). Of course, there has been unprecedent changes in the regulations. A new policy council has been established as the highest authority of policy-making (CoSTIP) under the Presidency. Apart from these, there has been amendments in Law no. 5746, now Promotion of Research, Development and Design Activities, that now includes "design" in the activities that are entitled for financial support and tax benefits. There has also been changes in Law no. 4691 on Technology Development Zones and Industrial Property Law no. 6769. The changes in Law no. 6698 on Personal Data Protection (KVKK) is also worth mentioning, because for the first time digitally collected data is accepted to be "personal data" and is subject to the rules for the protection of personal data. Turkey has never been rich in terms of soft tools that do not give direct monetary benefits to firms. The last decade is not an exception in this sense.

Who performs STI activities?

There are three main performers of R&D according to the Organization for Economic Co-operation and Development's (OECD) Frascati Manual; the business, higher education and government. The role of business in Turkey as a performer and funder has gradually increased in the last decade at the expense of government and higher education sectors. In 2015, about half of the R&D activities was conducted by the business sector. This number has reached to 64% in 2019, but it is still short of many European countries. One particular observation is the increased role of business in funding higher education sector research. Though the number is still small, there is an increasing trend in the past 10 years. The share of labor costs in R&D expenditures of the business sector is almost half of its total expenditure and the increase in labor costs has been at the expense of capital costs. On the human capital side of R&D, the increase in business sector R&D personnel from 2015 onwards reflected as a

fall in R&D personnel in higher education. Especially in terms of Full-Time Equivalent (FTE) statistics, about 60% of the R&D personnel has been employed in the business sector as of 2019. According to Turkish Statistical Institute (TÜİK) Innovation Survey 2016-2018, 36% of the enterprises in Turkey are innovative. The patent applications have also increased by 25% reaching to about 23,000 in 2019. When we look at the actor side, we see that most of the STI activities has been executed in TDZs (i.e., the technology parks), R&D and Design Centers. There are currently 72 active technology parks sheltering 6,364 firms with 66,615 employees, about 85% of which are R&D personnel. There are 1,244 R&D centers that employ 66,469 R&D personnel and 364 Design Centers that employ 7,861 personnel. When we look at the international indices, we see that Turkey ranks 61st among 141 countries in Global Competitiveness Index 2019 where Turkey's innovation capability is ranked better (49th) based on its position in commercialization and R&D activities. In Global Innovation Index 2020, Turkey ranks 51st out of 80 countries and lost ground compared to 43rd in 2017. Doing Business Index ranks Turkey in 33rd place out of 190 countries and Global Entrepreneurship Monitor 44th out of 137 countries. As mentioned earlier, Turkey is a moderate innovator in the European Innovation Scoreboard. All these statistics show that Turkey is more or less a middle-ranked country in STI activities.

On the higher education side, Turkey also gained ground in terms of increasing the number of R&D personnel (though its share in total has fallen). Percentage of population aged 25-34 having completed tertiary education has increased and converged to the EU average. However, in terms of efficiency and the quality of the workforce, Turkey has still a long way to go. New doctorate graduates per 1000 population is slowly increasing but Turkey's performance is lower than EU average (in terms of growth). The story is pretty much the same when we look at scientific publications among top 10% most cited, international scientific co-publications and foreign doctorate students. Thus, in terms of a "research system" Turkey still needs to invest in resources to increase both the quantity and the quality of R&D employees.

Though the role of government as a performer and funder of STI activities is increasing in absolute terms, its share within total R&D expenditures has been declining since 2011 and is currently about 9% of total R&D expenditure. It is difficult to draw the line between the roles of the government as a performer and funder of STI activities. The cases of the fully electric vehicle, Türkiye Otomotiv Girişim Grubu (Turkey's Automobile Initiative Group, TOGG) and the research infrastructures established under law no. 6550 are good examples. The initiation and the seed fund have come from the government in both cases, but in statistical terms government is not the

performer. Apart from few examples such as the Institute of Health Data Research and Artificial Intelligence Applications (TÜSEB) organized under the Ministry of Health and R&D Centers of Ministry of Agriculture and Forestry, almost all government activity in STI as a performer is organized under TÜBİTAK. There are 8 R&D Units and 3 R&D Support Units organized under TÜBİTAK. These units generate about $750 million revenue. Most of these R&D units are heavily funded by the government. Marmara Research Centre (MAM), Informatics and Information Security Research Centre (BİLGEM), Defense Industry Research and Development Institute (SAGE) and Space Technology Research Institute (UZAY) differentiate from others both in terms of scale, the amount of government funding they receive and the revenue they generate. At the end of 2019, Institute of Rail Transport Technologies was established as another R&D Unit under TÜBİTAK.

One of Turkey's weaknesses in terms of STI activities is cooperation and collaboration activities. Though there are various policies and mechanism of cooperation and collaboration under university-university, university-industry and industry-industry relations, several international indices (e.g., Global Innovation Index, Global Competitiveness Index, European Innovation Scoreboard) report a degrading position for Turkey (compared to other countries) in STI cooperation activities. Most policy tools in Turkey initiates and enables cooperation and collaboration, but do not really drive cooperation and collaboration. This also seems to be changing with new policy mechanisms like SAYEM of TÜBİTAK. The "co-creation" trend is slowly emerging.

One particular issue for Turkey that has taken great attention is the talent drain problem. World Talent Ranking 2019 shows that Turkey decreased by 7 places and now ranks 58th among 63 countries. According to this index, Turkey is losing grounds in all subindices that measures the investment in and development of home-grown talent, the extent to which a country taps into the overseas talent pool and the availability of skills and competencies in the talent pool. According to Turkish Statistical Institute (TÜİK) data, 1,085,807 people have left Turkey between 2016 and 2019, about 400,000 of whom are Turkish citizens. In 2019, foreign national emigrants constitute three fourth of the total emigration from Turkey. Two out of every five people who leave Turkey are in the 20-34 age range. What is more staggering is that, when emigration and immigration numbers are compared for the 20-44 age category within total, there is a difference of 10 percentage points almost every year (share of 20-44 age category in emigration is higher than immigration) indicating that three fifth of the immigrants are leaving Turkey for mostly work and education reasons, which is a rough indication of talent drain vis-a-vis immigration. There are only a few programs

that aim to reverse this trend, one of which is TÜBİTAK's International Fellowship for Outstanding Researchers Program with its new format announced in 2018. As a result of the first phase, 127 leading scientists and researchers from 21 different countries, 29 of whom are foreign nationals were supported.

Who funds STI activities?

It has been already stated that business sector increased its dominance in both performing and funding of R&D activities. Compared to 2015, the role of government as a funder has slightly increased (share in total funds rose from 27.6% to 29.4% in 2019). Business sector share as a funder has also increased and reached 56.3% in 2019. These numbers are very close to EU average, but the share of business is slightly higher and the share of government is slightly lower in EU. Central government budget appropriations and outlays on R&D (GBOARD) are almost four times higher today, compared to 2011 (in nominal terms. In US dollar terms it is stable around $3 billion). Direct and indirect R&D support was about 21 billion TL in 2019. The average GBOARD in Turkey (about 0.35 of GDP) is lower than EU average (about 0.65 of GDP). In terms of euro values, direct government budget allocations to R&D have increased by 15% since 2011 and indirect supports have increased by 175%. Turkey is catching up especially in terms of indirect R&D supports. Turkish government started to increasingly use public procurement to support innovation activities. According to TÜİK Innovation Survey statistics (2014), about 2% of firms undertake innovation activities required as a part of public procurement contract which places Turkey in the 4th position after Norway, Iceland and Finland. Given the high-tech focus in niche areas and governments' defined role in official strategy documents, it is expected that the government's direct and indirect R&D support will increase in the future.

Total GERD funded by business enterprises are mostly performed by business enterprises – covering more than 98% of total GERD financed by business enterprises. Business has also increased its role in financing higher education research (though still very low). The top 5 firms (based on to R&D expenditure) spent €422 million in 2014. This number has been reduced to €328 million in 2019. The average R&D intensity of the big five has also been reduced. Of course, these numbers are very low compared to R&D giants in the world. To give an idea, the levels of the total R&D expenditure of Ford and TOFAS in Turkey is 1% of the total R&D expenditure of Volkswagen.

On the entrepreneurship side, the developments are much positive in terms of increased government funding, venture capital and angel investor funding. In 2020, 165 Turkish start-ups raised a record of $139 million. From 2011 on, angel investor and venture capital funding has reached a total of about $750 million. In the past five years, a total of 731 firms have raised on average about $700,000. The corporate venture capital investment has also increased. It has reached to about $15 million (average for 2018-2020) from nearly zero in 2012. The purchase of Peak Games by Zynga for $1.8 billion has produced the first Turkish unicorn in 2020 and short after getir has been announced the second unicorn from Turkey.

On the higher education side, the EU Framework Program will continue to be a funding source for research and innovation activities. In the FP7, Turkey received €196 million which accounts for 0.4% of total European Commission (EC) contribution. Turkey's Horizon 2020 performance was much better. Since 2014 Turkey has contributed €265,.8 million to EU H2020 programs and for the first time net EU contribution surpassed (€267,1 million) Turkey's contribution. There is less work on the side of non-profit sector as a funder, except Technology Development Foundation of Turkey (TTGV). TTGV has a variety of funding options on almost the entire process of innovation from R&D, seed-funds to commercialization and scaling.

Recent trends in STI policy-making

There are five recent trends in STI policy-making.

1. The policy tools are moving towards selecting technologies, niche areas, even products. Thus, the policies are more selective moving away from horizontal policies that aim a general stock of firms.

2. Since the problems are becoming complex, the technological solutions to such problems are also becoming complex and may encompass a wide array of sectors and disciplines of science. In such case, the policy mix that are composed of various policy tools are increasingly used.

3. Complex technological solutions and coping with grand challenges necessitate an active role for government in creating technologies and markets as opposed to a more regulative role.

4. Public procurement for innovation as a tool of demand side policies to spur innovation is increasingly being used by the governments around the world.

5. Mission-oriented as opposed to diffusion-oriented policies are in rise especially with the recent attempt of the EU in moving towards creating missions. The most recent example is the new FP 2021-27, Horizon Europe, that is designed and organized in a mission-oriented policy setting.

When the six recent trends in Turkish STI policy-making (see the section above, Policy-making and new policy tools) is analyzed together with the five recent trends in STI policy-making around the world, one can say that Turkey is following the trends towards using selective policies, policy-mixes and public procurement to support innovation. Turkey's STI policy has also become selective and policy mixes are increasingly being used (for instance, supporting technology production in renewable energy). Especially in the last decade, Turkey also engaged in public procurement for innovation trend but of course there is a long way to go. There are also signs for an active government in creating technologies and markets, the case of TOGG, the establishment of Turkish Space Agency, the research and innovation efforts of TÜBİTAK R&D Units and the establishment of Directorate of Indigenous Technology under MoIT could be examples towards a more active government. However, such attempts are not organized and currently relates to few products (e.g., TOGG, a number of defense industry products). It would not be wrong to say that Turkey has no organized attempts in terms of mission-oriented policies. Especially in the case of an active government, policy-mix and mission-oriented policies for spurring innovation and developing technological capabilities, the government has to pass to a new mode that requires huge research and innovation finance, sustainability in policy-making, coordination between government units and dynamic capabilities in the government. Turkey needs to develop in all of the four areas above.

Challenges of the Turkish STI system

The review of the recent policy initiatives shows that Turkey needs to take significant steps to enhance its STI capabilities. This is crucial for escaping from the mid-technology trap that prevents Turkey to produce and export high value-added products and services. The existence of relevant bodies that design and implement

policies towards STI and entrepreneurship is an important asset. However, the underperformance of Turkish STI system indicates that the allocation of roles among actors (particularly in governmental bodies) should be reviewed. Besides, the abundance of policy papers, which recite identical or very similar measures, and overlapping funding programs point to a lack of communication and coordination This should be improved and all stakeholders within the quadruple helix (university, industry, government and civil society) should be represented in policy-making. The lack of systematic policy assessments prevents the design of more effective and influential policies. The completed and ongoing policies and programs should be assessed, and the results of these studies should be shared with the public and used to shape both new and ongoing policy initiatives. In addition, STI policies should be prepared and implemented in coordination with other policy areas such as education, industry, and trade.

The need to improve human capital has always been on the agenda of the Turkish government. However, further efforts and diversified measures are needed to improve human resources in a way that the absorptive capacity of companies is enhanced, the quantity and quality of researchers are increased, and the changing demand of new technologies such as automation, AI, and biotechnology is met. The low quality of education at all levels should be addressed in parallel with the observed increase in enrolment rates.

The weak collaboration and interaction among the innovation system actors, particularly between university and industry, appear as one of the most important challenges. The creation and improvement of interface structures (TDZs and TTOs, etc.) were crucial steps in this regard and helped creating scale and awareness. Yet, the policies should move beyond creating interfaces and focus on creating collaborations. To cope with the cultural and institutional factors that hamper collaboration, specific policies should be designed to initiate or drive collaborations in priority (or niche) areas and create scale that such practices diffuse. Practices covering horizontal as well as vertical collaboration and open innovation applications should be encouraged. The establishment of research infrastructures open to all users, support for cluster activities, and shared labs in some TDZs are promising activities. Yet, this progress should be improved with other types of open innovation applications such as living labs and technology platforms that get all stakeholders including users and enhance interaction among them. In short, the mindset of “give me money to do innovation” should be transformed into “provide me the environment to do innovation”. The policy makers could start to signal such a transformation.

In addition to the problems regarding regulatory and business environment, the underdeveloped Venture Capital (VC) and business angel markets may negatively affect technology-based entrepreneurship. The private investments in VC markets are low, and most of the VC funds and business angels in Turkey invest only in the seed and Series A rounds of a start-up. There is now a stronger need from International Financial Institutions (IFI) to sustain funding to the VC funds that will invest in innovative start-ups. Moreover, the need for growth stage VC funds and Series B and later stage investment rounds to increase the scale of innovative start-ups should be addressed.

Turkey needs to increase not only the diversification of its exports, but also the number of sophisticated (or core) goods and services in its export basket. R&D and innovation capabilities of the private sector, particularly of Micro Small and Medium-Sized Enterprises (SME) needs to be increased. It is important to conceive and implement specific policies for enhancing learning capabilities and absorptive capacities of the firms. In addition to firms that operate in high-technology fields, the innovation capabilities of the firms in low- and medium-technologies should be escalated. In this regard, the non-technological innovation (organizational, marketing, etc.) needs should also be promoted.

Both the central government and local administrative units should apply well-defined technology adoption and diffusion policies for innovative products besides the tools used for public procurement of innovation to enhance the domestic demand for innovative products and services. The size and sophistication of the market are important factors for encouraging companies to innovate and attract Foreign Direct Investment (FDI). Although there has been an important progress towards the use of public procurement to promote innovation, these efforts should be supplemented by long-term plans. Research activities could be integrated with long-term procurement plans.

There is a need to enhance regional capabilities through focusing on regional strengths and weaknesses and paying attention to the role of low- and medium-technologies and non-technological innovations. In Turkey, the same menu of incentives and supports are presented in all regions. There should be specific supports in accordance with regional needs. The first step could be preparing mapping of needs and regional innovation strategies in accordance with the smart specialization framework.

Turkey's current story in STI policy-making is creating an environment (actors, financing, intermediate organizations, entrepreneurs, support personnel) that enables research and innovation activities to flourish. In accordance with this story,

in the last two decades the STI policy-making in Turkey created many nodes (actors: entrepreneurs, firms, intermediate organizations, new public institutions) but little interaction. Following complex policy trends such as an active government mode, policy-mixes and mission-oriented policy requires good interactions among actors as well as dynamic capabilities on the government side. In this manner, Turkey's STI policy-making needs a new story that focuses on creating interactions between the actors to sustain and further develop the STI system. The general policy prescription in this sense is to design and implement policies that aims at the interaction between actors rather than the actor itself.

1

1. Introduction

In the last decade Turkey has witnessed important changes in its governance structure. Transition from the Parliamentary to Presidential system occurred in a period where technological advancements created many opportunities for firms and countries and economic structure slowly adapts to such opportunities. The COVID-19 pandemic brought rapid change both in terms of using science and technology to tackle problems that we face and the pace of how governments and countries adapt to such changes. In such a narrative, this report aims to shed light on the changes in science, technology and innovation (STI) policy in Turkey in the last decade focusing on the changes from 2015 onwards. Viewing the network of STI-related actors, infrastructure, physical and human capital and investment as a system and using the OECD's Frascati and Oslo Manual framework of collecting and presenting R&D and innovation data, this report studies the performers and funders of STI activities as well as the recent changes in STI policy in Turkey.

This report is composed of 6 chapters. In the second chapter actors in the STI system in Turkey are analyzed focusing on the recent change in the governance structure and how the STI system is organized under Presidency. The following chapter investigates the recent STI policy changes in Turkey, providing details of new policy tools from 2015 onwards. Third chapter also includes a detailed account of the recent changes in STI-related laws and regulations. Fourth chapter investigates the performers of R&D and innovation activities in Turkey using the Frascati and Oslo Manual framework on actors (business, higher education sector and the government). This chapter also includes cooperation and collaboration activities among the performers and a short section on talent drain which is a burning issue in Turkey. Chapter 5 looks at STI activities from the funder's side and includes a detailed account of the government involvement in funding STI activities. Information on international funds focusing on EU Framework Programs as a funder of research activities in Turkey is also provided. The final chapter concludes by looking at the recent trends in science and technology policy around the world and how Turkey adapts to such changes. Chapter 6 also includes a short discussion on recent changes in Turkey's policy towards STI, drawing from earlier reports such as the Research and Innovation Observatory (RIO) country report for Turkey.

After a brief summary of the background and performance of the Turkish STI system,

especially in the last decade, Chapter 2 presents a list of national studies, reports and documents on STI. Then it gives a full account of the actors in the STI system focusing on the change in the government structure. The former and the new government structures are compared and the STI-specific actors are further detailed. This chapter includes a short description of governmental and non-governmental STI system actors under the Presidential system. The roles of these actors in policy-making, performing and funding R&D and innovation activities are discussed in the following chapters.

Chapter 3 discusses the recent changes in policy-making from both the governance angle and the mindset. Turkey's STI policy has long been devised by the Supreme Council for Science and Technology (BTYK), the Ministry of Industry and Technology (MoIT) and the State Planning Organization (SPO). This structure significantly changed in 2018. SPO, Ministry of Development and the highest STI policy-making body BTYK ceased to exist in the new system. The current highest STI policy-making body, the Council of Science, Technology and Innovation Policies (CoSTIP) is established in July 2018 under the Presidency. The chapter, then, discusses six recent trends in Turkish STI policy-making: sector specific to technology specific focus, indigenous & national (technology) production, policy shift from knowledge creation to commercialization, high-tech high-value-added focus, preparing for digital transformation and co-creation in performing STI activities. The chapter details new policy tools under three broad groups: economic and financial incentives, regulation and soft policy tools. This chapter also includes a very detailed discussion on the recent changes in laws and regulations related to STI policy-making.

Chapter 4 looks at the STI system from the performer side. There are three main performers of R&D and innovation activities in Turkey: the business, higher education and government. This chapter presents a detailed account and statistics on each of these sectors and especially actors in the business sector. It also includes a short discussion on Turkey's position in international indices such as the Global Competitiveness Report, Global Innovation Index, Doing Business Index and European Innovation Scoreboard. Chapter 4 includes separate sections on two other topics that are related with the performance and the performers of STI activities. The first one is the cooperation and collaboration activities of actors in the STI system. Various policies and mechanisms of cooperation and collaboration are discussed under university-university, university-industry and industry-industry relations. Secondly, talent drain and the migration of skilled labor force are burning issues in Turkey especially in relation to STI actors. Thus, this chapter also covers statistics regarding the current position of Turkey in relation to migration of skilled people and policies directed at the talent drain problem.

Chapter 5 investigates the funders of STI activities in Turkey. Business sector has become a major player in STI activities both as a performer and funder. However, the government, through direct and indirect supports, also plays a vital role in funding of such activities. This chapter includes information on the funding mechanisms in Turkey scattered around different government and non-governmental organizations such as the Scientific and Technological Research Council of Turkey (TÜBİTAK), MoIT, Small and Medium Enterprises Development Organization (KOSGEB) and Technology Development Foundation of Turkey (TTGV). Chapter 5 also includes a section on international funding to scientific activities where Turkey's performance in European Union's Framework Programs (especially FP7 and Horizon 2020) is discussed.

The final chapter briefly summarizes how Turkey responds to recent trends in STI policy-making around the world. Chapter 6 introduces five of such world-wide trends: more selective and focused policies rather than horizontal policies, use of policy-mix rather than policy tools, the increased role of government in supporting technology development, the importance of public procurement for innovation, and the rise of mission-oriented policies. For each of these trends Chapter 6 briefly discusses where Turkey stands. This final chapter also elaborates the findings of this report taking stock of earlier reports on the STI activities in Turkey such as the Research and Innovation Observatory (RIO) Country Report for Turkey and various others. In the light of existing analytical works and main indicators related to Turkish STI system, the following STI challenges have been identified:

- Skilled and sustainable human capital growing mechanisms
- Effective and efficient commercialization for university research output
- Increasing survival rates for high-growth innovative start-ups
- Increasing R&D and innovation capabilities of the private sector
- Increasing demand for innovation and improving the conditions for the uptake of innovations
- Fostering university-industry collaborations on priority and focused areas
- Strengthening the entrepreneurship ecosystem for VC and business angel industry

- Strengthening regional innovation capabilities and overcoming regional disparities
- Supporting open innovation ecosystems
- Improving coordination of innovation policies
- Scarcity of systematic and periodic studies for impact evaluation and enhancing the knowledge base for evidence-based policy making
- Adaptability of private sector to digital transformation, especially Micro SMEs
- The harmony among different innovation systems
- Policies regarding the nature and society


2

2. Actors and The Science, Technology and Innovation (STI) System

2.1. Background of Turkish STI System

Turkey is an upper middle-income country with a per capita income level of $28,133 (purchasing power parity, PPP) as of 2019, implying 58.8% of the EU average. Despite several geopolitical headwinds and a number of adverse shocks in the recent years, average growth rate was realized as 4.1% during the last five years (2015-2019). In this period, while the share of industry and services sectors in Gross Domestic Product (GDP) has increased, the share of agricultural sector has diminished gradually. While the share of agriculture was 6.4% in 2019, the shares of industry and service sector in GDP were 21.9% and 61.7%, respectively.

Turkey's population is 83 million with a median age 32.4, where working age population accounts for 67.8% (population between 15-64). The population growth rate has decelerated to 0.139% compared to previous years.

Turkey is highly integrated with the European Union (EU) market through trade and investments and has made progress to cope with competitive market forces within the EU. Some advances were realized in research and development (R&D) spending, education sector and physical capital infrastructure. On the other hand, R&D personnel, employment in high and medium-high technology manufacturing sectors and employment in knowledge intensive activities are still growing, yet they are still short of EU average. Full-time equivalent (FTE) R&D personnel in private sector increased 2.79 times since 2009. Important STI statistics for Turkey is presented in Table 2.1.

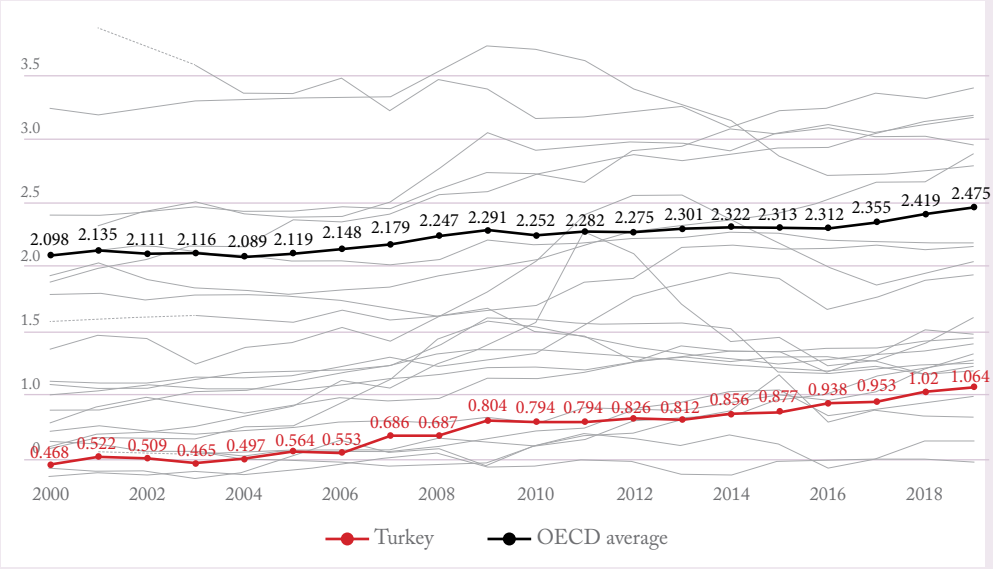
Table 2.1. R&I Indicators for Turkey

Indicator	2005	2010	2015	2016	2017	2018	2019	EU 27 avr. (2019)
GDP per capita (€)	5,897	7,972	9,906	9,852	9,409	8,148	8,287	31,279
GERD (million €)	2,287	4,642	6,814	7,370	7,245	6,752	7,228	307,845
GERD as % of the GDP	0.57	0.80	0.88	0.94	0.96	1.03	1.06	2.20
GERD (EUR per capita)	33.6	64.0	87.7	93.6	90.8	83.5	88.1	688.7
R&D personnel (FTE) as a percentage of active population	0.24	0.33	0.42	0.46	0.50	0.55	0.58	1.40
Employment in high and medium-high tech. manufacturing sectors as a share of total employ. (%)	---	3.0	3.3	3.3	3.3	3.5	3.6	6.2
Employment in total knowledge-intensive activities as a share of total employment (%)	---	18.3	20.5	21.6	21.2	24.2	25.8	39
Exports of high technology products as a share of total exports (%)	---	2.0	1.9	1.9	2.9	2.4	---	17.9
Manufacturing value added (% of GDP)	16.9	15.1	16.7	16.6	17.6	19.0	18	14.0
Industry value added per worker (constant, 2010 USD)	30,287	32,144	39,770	41,123	43,689	43,453	44,427	73,693

Sources: Turkstat, Eurostat, World Bank (World Development Indicators). GERD: Intramural R&D expenditures (all sectors). FTE: Full time equivalent. GERD: Gross Expenditure in R&D. FTE: Full time equivalent. GDP: Gross Domestic Product. GDP per capita is calculated as GDP in current prices (millions of €) divided by population 1st of January. The definitions of active population, human resources in S&T, high and medium-high technology and knowledge-intensive activities are available from Eurostat.

In 11th Development Plan, Turkey set its R&D expenditure on gross domestic spending target as 1.8 for 2023 (see Table 2.2). This ratio was 0.82 in 2013, which then was targeted to be 2.00 in 2023. Similarly, the expected R&D expenditure as a percentage of GDP in 2018 was 1.8 but it actually occurred as 1.03. Turkey has the largest gap between the target and the realized ratio compared with 35 OECD countries. Although the targets have not been achieved, it is an important milestone for Turkey to exceed the critical point of %1 GERD to GDP ratio and %50 of private sector share in total R&D expenditure. Figure 2.1. shows the gross domestic spending on R&D for Turkey from 2000 onwards (in red), where the black line indicates the OECD average and grey lines show various countries.

Figure 2.1. R&D Expenditure on gross domestic spending for Turkey



Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators

Table 2.2. 11th Development Plan 2023 targets

	2018	2023
R&D expenditure on gross domestic spending (%)	1.03	1.80
FTE R&D Personnel	172,000	300,000
PhD and above FTE R&D personnel per million people	352*	863

*Note: * denotes 2017 data*

When the R&D expenditure is analyzed in terms of sectors and financers in Figures 2.2 and 2.3 respectively, it is seen that the business sector constitutes the highest share in expenditure and finance (see also Table 2.3). R&D law put into action in 2008 and new government support and funding mechanisms, especially by The Scientific and Technological Research Council of Turkey (TÜBİTAK) may explain this trend. After the changes in the R&D law in 2016, this trend is expected to continue in favor of the business sector. Business sector's main R&D activity is on manufacturing technologies with 59% of total business R&D expenditures, followed by the ICT technologies with a share of 27%.[1]

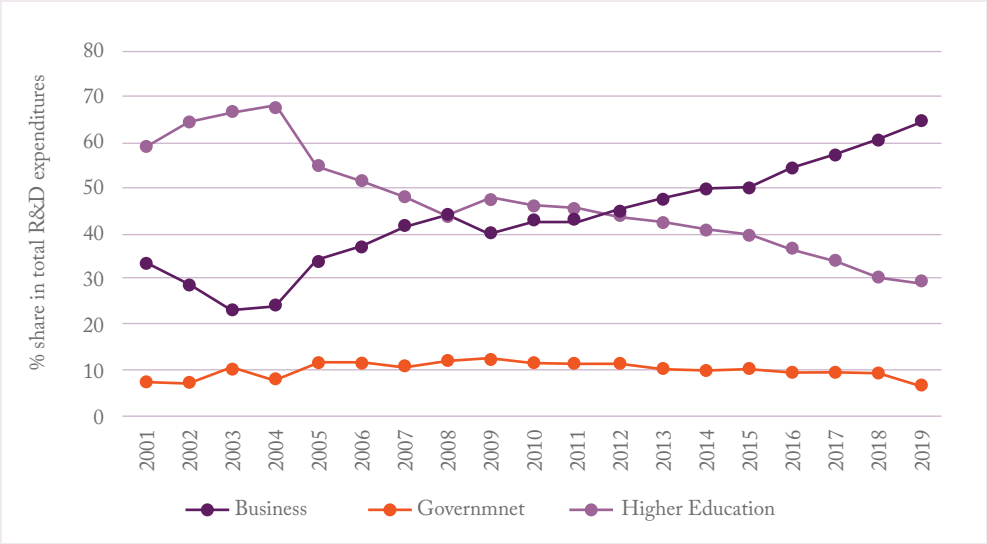
Table 2.3. R&D expenditure in sectors and by financers in 2019

	R&D expenditure in sectors		R&D expenditures by financers	
	Amount (millions of euro)*	%	Amount (millions of euro)*	%
Private sector	4,077.50	64.19	4,077.50	56.34
Higher Education Institutes	2,124.07	29.18	924.65	12.77
Government	729.98	6.62	2,124.07	29.35
Foreign	-	-	134.75	1.34

*Source: TÜİK. *Constant, 2019 average euro exchange rate: 6.35 TL*

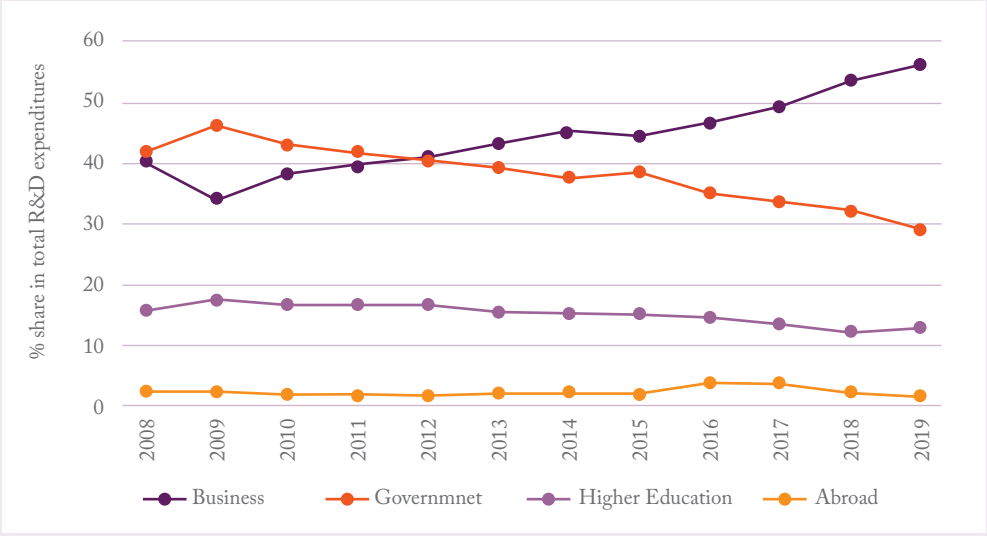
1. Calculated from the data available at www.tuik.gov.tr.

Figure 2.2. R&D expenditures by sector of performance



Source: TÜİK

Figure 2.3. R&D expenditures by source of finance



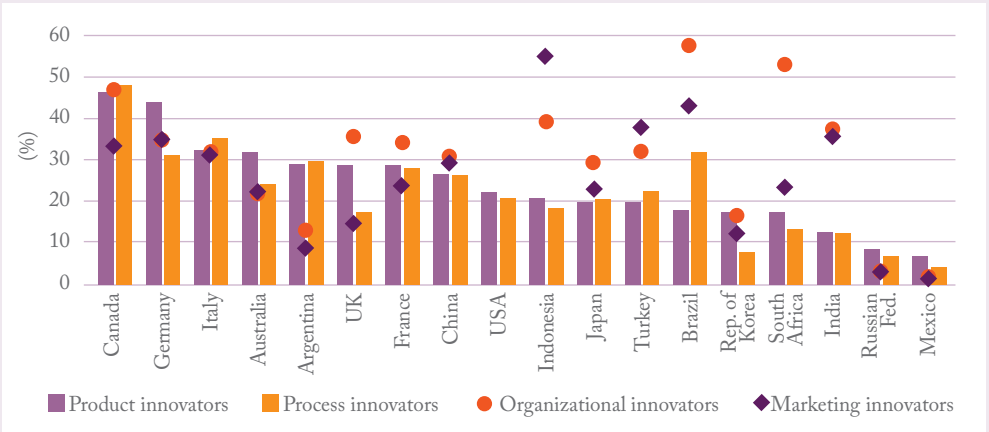
Source: TÜİK

2.2. Performance of Turkey's STI System

Turkey has made progress on STI capacity building in the last 10 years. As presented in section 2.1, R&D expenditure, FTE R&D personnel and business involvement in R&D has grown steadily. Increased entrepreneurship activities and finance options, use of ICT competency and skills in national education programs and encouraging broader participation in STI policy design are important highlights of the Turkish STI system.

According to European Innovation Scoreboard 2020, Turkey is regarded as a Moderate Innovator. The performance is better than that of in 2012. Turkey performs better compared to EU average in indicators measuring innovators, firm investments, and innovation-friendly environment which are the strongest innovation dimensions. Especially non-R&D innovation expenditures and SME's product/process, marketing and in-house innovation indicators are above EU average. This indicates a developing system for innovation in Turkey where SMEs constitute more than 99% of the private firms. However attractive research systems, intellectual assets and employment impacts are the weakest innovation dimensions of Turkey. As compared to 2012 scores, in 2020, Turkey underperformed in finance and support indicators and sales impact due to decrease in R&D expenditure in the public sector and decreased sales of new-to-market and new-to-firm innovations. There is also a decrease in the indicators of enterprises providing ICT training, the scientific publications among top 10% most cited publications worldwide and design applications compared to 2012. Detailed information about STI funders and performers are given in sections 4 and 5 respectively.

Figure 2.4. Innovators in G20 countries as a percentage of manufacturing firms



Source: UNESCO Institute for Statistics, April 2017

When the performance and structure of the economy is considered, as of 2018, service sector constitutes nearly one-third of the employment. Knowledge intensive activities' share in service sector is 25% (EU average 39%). The manufacturing activities' share of employment is 18% where employment in high and medium-high manufacturing technologies in total employment is 3.6% which is below EU average of 6.3%. Innovation is higher in organizational and marketing activities of manufacturing sector, which necessitates less R&D compared to product and process innovations. Figure 2.4 compares the share of manufacturing firms according to innovation types in G20 countries. Product and process innovators constitutes approximately 20% of all manufacturing firms in Turkey.[2]

Initiatives on Turkish Research Area (TARAL) and strategy documents which are introduced below are important to understand the background of current Turkish STI system.

2.3. TARAL and ARBİS (Researcher Database)

TARAL (Turkish Research Area) is a public investment initiative put into action in 2004 in order to gather the resources and strategically guide system actors (business enterprise and public sectors, together with Non-Governmental Organizations, NGOs) to collaborate in R&I activities. It is a conceptual integrity that enables science, technology and R&D activities to be carried out within a strategic framework to create synergies. Since TARAL, national STI strategy and implementation plans and budget are coordinated systematically. In 2017, more than half of the government expenditure on technology activities were used from TARAL budget. TARAL budget includes Scientist Training and Development Program, Industry R&D Support Program, Science and Technology Awareness Program, Academic and Applied R&D Support Program, Defense and Space R&D Support Program, Public R&D Support Program and EU Project Award, most of which are implemented by TÜBİTAK.

TARAL triggered a particular kind of mobilization, both in terms of resources and in guiding system actors towards socio-economic goals, which continues to be instrumental in Turkish STI system. To make such a mobilization possible, TARAL targets were determined as bolstering:

2. G20 Innovation Report 2016, OECD

- the share of R&D expenditures in Gross Domestic Product (GDP),
- the demand for R&D,
- the number of qualified R&D personnel.

Researcher Information System (ARBİS) is a web-based application designed by TÜBİTAK in order to create an up-to-date researcher database of Turkey. It has been in use since 2004. Researchers from public institutions, industry and academia, both in Turkey and abroad, register to the system and provide information on areas of interest, publications, patents, projects and other sorts of scientific activities. The main aim of ARBİS is to reach researchers working in various governmental and non-governmental organizations as well as private firms and universities. With the increasing number of researchers using the database, important statistical data is also collected which is then used for the design and even implementation of R&I policies.

TÜBİTAK Research Infrastructure Information System (TARABİS) is another web-based application designed by TÜBİTAK aiming to create a database for machine/system/device stock related to research, experimental development, test/analysis, diagnosis activities and R&D project. By means of TARABİS, it is possible to obtain coded information about features, location, and capacity of machine/system/device related to research, experimental development, test/analysis, diagnosis activities and industrial business line in which this potential could be used along with the products and technologies developed.

2.4. Important National Studies, Reports and Documents on STI

In this section of the report, a brief summary of important national STI strategy documents and main results from these documents are given. These documents not only explain the economic rationale of the policies implemented, but also show the capacity of the STI system in Turkey, its development and the trajectory. The documents are all interrelated and complement each other to accomplish predefined policy and aim. The details and the outputs of such strategy documents will further be discussed in chapter 3 when analyzing the STI policy changes in the past few years.

The most important STI document in Turkey is Vision 2023 Project, which was conducted in 2001. It is a big project composed of many sub-projects including human capital, research infrastructure and technology foresight studies.

In national STI strategy documents for the periods of 2005-2010 and 2011-2016, R&D and innovation capacity and need-oriented approaches are set for short-term targets with funding mechanisms and programs structured accordingly.

S&T Human Resources Strategy 2011-2016 is also an important study that was carried out to set policies for both increasing the number and improving the sectoral and occupational distribution of the R&D personnel.

Entrepreneurship activities constitute an important element of Turkey's STI system. A special study, the Entrepreneurial and Innovative University Index is carried out every year by TÜBİTAK. Also, Entrepreneurship Information System (GBS) is coordinated by Ministry of Industry and Technology (MoIT) to guide and monitor the rapidly developing entrepreneurship ecosystem.

Technology Prioritization Study 2019 reveals an important political change in the STI system that the sector-specific funding mechanisms are transformed to technology specific funding mechanisms (see section 3.1.1).

There are also special studies for industry and industry-government collaborations to accelerate the growth performance attained so far. The Technology Transfer Accelerator Turkey (TTA Turkey) - an initiative managed by European Investment Fund (EIF) – was another program aimed to commercialize applied research output of universities and scale up the technology transfer market in Turkey, with a particular focus on spillovers to less developed regions. The program, that launched in 2014 and ended in 2017, had capacity and business development studies that were put into action to create a working technology transfer system covering all stakeholders in Turkey. A non-exhaustive list of official documents that are relevant to the Turkish STI system for the last five years are presented below. Policy aim changes throughout this period can also be traced within these documents.

- Vision 2023
- National STI Strategies (UBTYS) 2011-2016
- 10th Development Plan 2014-2018

- 11th Development Plan 2019-2023
- The New Industrial Revolution: Smart Production Systems Technology Roadmap
- Turkey Public-University-Industry Cooperation Strategy and Action Plan 2015-2018
- Turkey Biotechnology Strategy Document and Action Plan 2015-2018
- Turkey Entrepreneurship Strategy and Action Plan 2015-2018
- National Cyber Security Strategy and Action Plan 2016-2019
- Turkey Software Strategy and Action Plan 2017-2019
- National Broadband Strategy and Action Plan 2017-2020
- 2023 Digital Turkey Roadmap
- Information Society Strategy and Action Plan 2015-2018
- Action Plan / National Employment Strategy 2017-2019
- Roadmap Document for The Protection of Critical Infrastructures 2014-2023
- Turkey Industrial Strategy Document 2015-2018
- Turkey Textile, Apparel and Leather Products Sectors Strategy Document and Action Plan 2015-2018
- National Geographical Indication Strategy Document and Action Plan 2015-2018
- National Intellectual Rights Strategy Document and Action Plan 2015-2018
- National Metrology Strategy and Action Plan 2015-2018
- Productivity Strategy and Action Plan 2015-2018
- Science and Technology Human Resources Strategy 2011-2016
- SME Strategy and Action Plan 2015-2018
- Technology Prioritization Study 2019

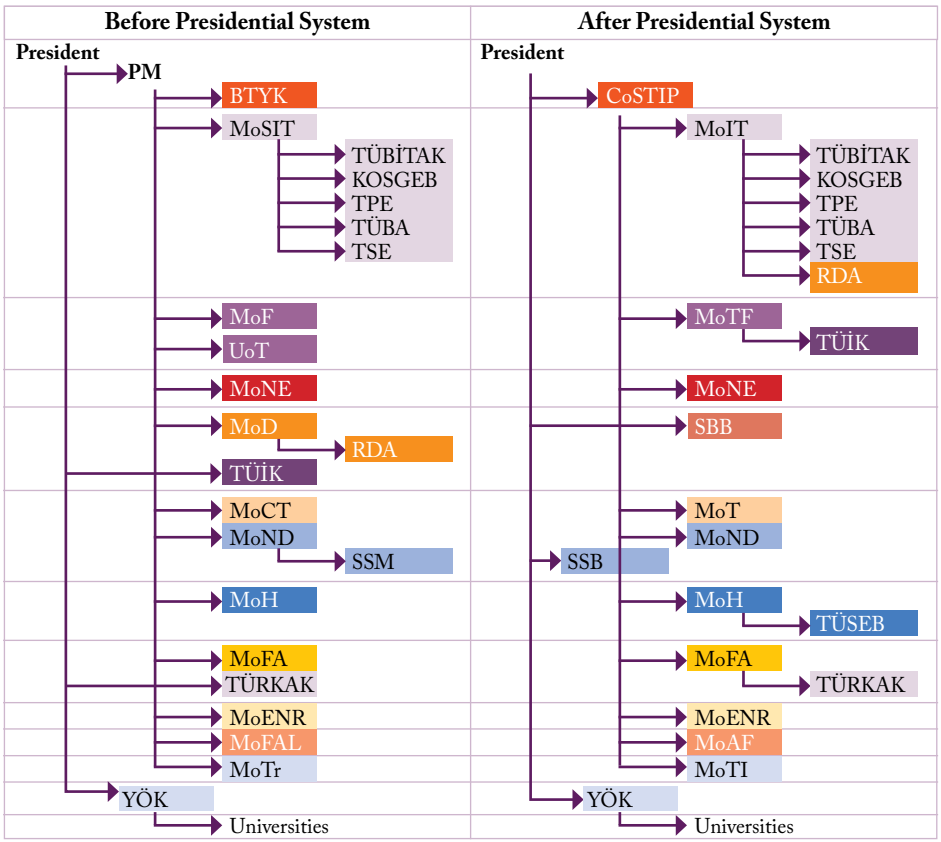
- Turkey Automotive Sector Strategy and Action Plan 2016-2019
- Turkey Software Industry Strategy and Action Plan 2017-2019
- Turkish Pharmaceutical Sector Strategy Action Plan 2015-2018
- National Recycling Strategy Document and Action Plan 2014-2017
- Design Strategy Document and Action Plan 2018-2020

After giving a brief information about the history, the capacity and the development of the system, the main actors and their roles in the STI system is discussed in the next section.

2.5. The STI System and its Actors in Brief

After the 2018 elections, the structure of the government has changed significantly from Parliamentary to Presidential system. The former and new government structure and changes on governmental bodies are shown in Figure 2.5. The change in affiliations of the organizations through Ministries and their relations are displayed in colors. The most important change is the formation of a new Council for STI policies which directly reports to the President and is responsible for the central coordination of all STI activities. The recent changes in STI policies are discussed in section 3.

Figure 2.5. The Former and New Governmental Structure

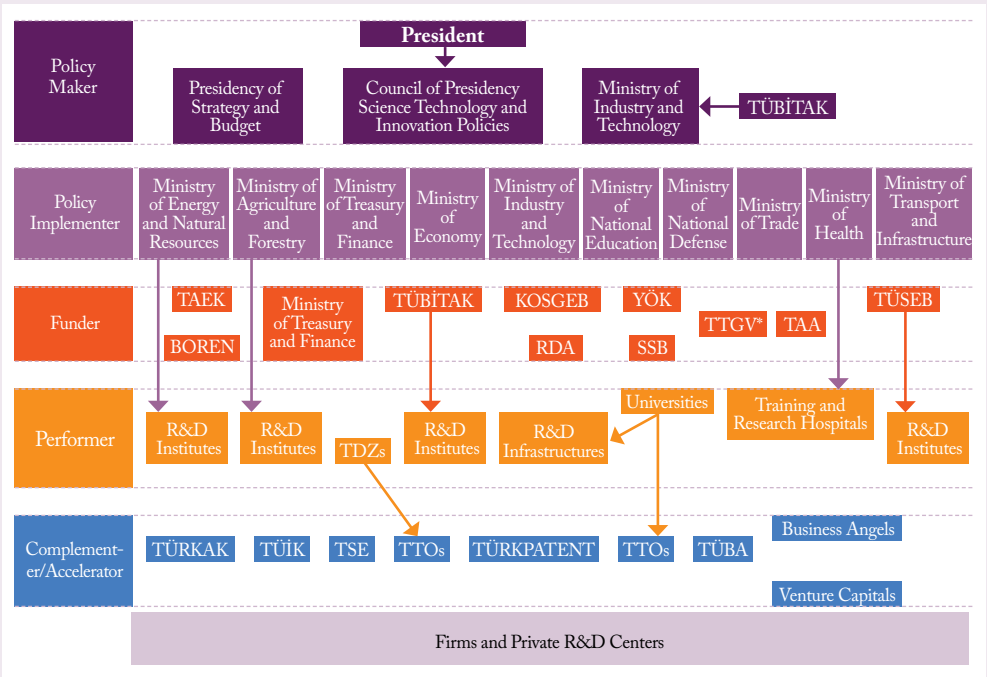


BTYK	Supreme Council of Science Technology and Innovation
CoSTIP	Council of Science Technology and Innovation Policies
KOSGEB	Small and Medium-Sized Enterprises Development Organization
MoAF	Ministry of Agriculture and Forestry
MoCT	Ministry of Customs and Trade
MoD	Ministry of Development
MoENR	Ministry of Energy and Natural Resources
MoF	Ministry of Finance
MoFA	Ministry of Foreign Affairs
MoFAL	Ministry of Food Agriculture and Livestock
MoH	Ministry of Health
MoIT	Ministry of Industry and Technology
MoND	Ministry of National Defence
MoNE	Ministry of National Education
MoSIT	Ministry of Science, Industry and Technology
MoT	Ministry of Trade
MoTF	Ministry of Treasury and Finance
MoTI	Ministry of Transport and Infrastructure
MoTr	Ministry of Transport
PM	Prime Minister
RDA	Regional Development Agencies
SBB	Presidency of Strategy and Budget
SSB	Presidency of Defense Industries
SSM	Undersecretariat of Defense Industries
TPE	Turkish Patent Institute
TSE	Turkish Standards Institute
TÜBA	Turkish Academy of Sciences
TÜBİTAK	Scientific and Technological Research Council of Turkey
TÜİK	Turkish Statistics Agency
TÜRKAK	Turkish Accreditation Agency
TÜRKPATENT	Turkish Patent and Trademark Office
TÜSEB	Health Institutes of Turkey
UoT	Undersecretariat of Treasury
YÖK	Higher Education Council

In Figure 2.6, national STI system of Turkey is presented. In this new structure, the main policy-making body on STI activities is the Council of Presidency Science Technology and Innovation Policies (CoSTIP), which works as an advisory board to the President. The Council is composed of representatives from public bodies, industry, academia and NGOs. The public bodies may also take part in policy-making through their representatives in the council. The council gives policy recommendations to the President and is also responsible for monitoring and reporting the implemented activities to the President.

TÜBİTAK, which provides technical support to the Council, Presidency of Strategy and Budget (SBB) and Ministry of Industry and Technology (MoIT) are the other important policy-making bodies working together with the Council.

Figure 2.6. Actors of Turkey's STI System



Source: Modified from the Expertise Thesis of Mehmet Cem Fendoğlu, Ministry of Development, July 2018.
**Technology Development Foundation of Turkey is an NGO.*

Note: See Figure 2.5 for abbreviations. BOREN: National Boron Research Institute, TAEK: Turkish Atomic Energy Authority

After approval by the President, the policies are put into action by the Ministries and their affiliated/associated institutions. Policies are implemented by the Ministries according to the duties and responsibilities assigned to them. Apart from the governmental bodies, there are also private business financers and NGOs that feed the system with complementary and acceleratory activities, especially for the formation of the system and commercialization of R&I activities.

The STI actors are categorized into five groups as policy makers, policy implementers, funders, performers and intermediate organizations (complementors) as depicted in Figure 2.6. In the next section, the responsibilities of these actors are summarized. The responsibilities presented below are only given in the framework of STI activities.

2.5.1. Council of Science Technology and Innovation Policies (CoSTIP)

After 2018 Presidential elections, the Council of Presidency Science Technology and Innovation Policies has become the highest governmental actor in Turkey's STI system. It has 5 permanent members from business, academia and government. The Council gives guidance to public institutions and organizations on STI policies, monitors the implementation of policies and prepares reports to the President. The Council first convened in September 2019.

There are offices working for the Council which conduct research before designing and implementing policies and prepare various policy and strategy documents. The Council develops policies and after the approval of the President, the ministries and their affiliated governmental organizations are responsible for the implementation of these policies.

2.5.2. Ministry of Industry and Technology (MoIT)

Ministry of Industry and Technology is one of the most important actors in Turkey's STI system, not only due to its role in policy-making, but also in implementation of the STI policies. Many of the support programs, including industry clusters, research infrastructures, R&D centers, design centers, technoparks (technology development zones, TDZ), techno-entrepreneurship, techno-investment, technology driven industry projects (HAMLE program) are implemented by MoIT. Considering also the coordination of government-

industry cooperation activities, MoIT is a major actor in the system, along with its affiliated organizations.

2.5.3. Presidency of Strategy and Budget (SBB)

SBB was established following the 2018 parliamentary election, after which the Ministry of Development was abandoned, with its duties being transferred to SBB and MoIT. SBB reports directly to the President and it designs national development plans and medium-term programs which includes the R&I strategies of the government. The other government bodies are responsible for implementing the approved programs and plans. SBB has also central role in allocating resources, therefore is important for R&I finance.

2.5.4. Scientific and Technological Research Council of Turkey (TÜBİTAK)

TÜBİTAK leads the R&D and innovation activities in Turkey at the operational level. It takes role in facilitation of policy experimentation and learning, knowledge development, knowledge diffusion, guidance of search and selection, market formation and mobilization of resources. It provides grants for R&D, innovation, R&D and innovation networks and science and society. These grants aim to facilitate experiments and learning as well as development and mobilization of resources. The support programs are for academia, industry, individual researchers, entrepreneurs as well as for intermediaries such as accelerators and TTOs. TÜBİTAK is an affiliated organization of MoIT.

TÜBİTAK also conducts R&D activities via its research units; Marmara Research Centre (MAM), Information and Information Security Advanced Technologies Research Centre (BİLGEM), Defense Industry Research and Development Institute (SAGE), Space Technologies Research Institute (UZAY), National Metrology Institute (UME), Rail Transport Technologies Institute (RUTE) and Basic Sciences Research Institute (TBAE).

There are 7 institutions in Marmara Research Centre; Materials Institute, Food Institute, Chemical Technologies Institute, Earth and Marine Sciences Institute, Energy Institute, Environment and Cleaner Production Institute, Genetic Engineering and Biotechnology Institute. Turkey Industrial Management Institute (TÜSSİDE) performs training, consulting, research and publication in the area of administrative sciences.

There are also R&D support units in TÜBİTAK. National Academic Network and Information Centre (ULAKBİM), operating a high-speed computer network enabling interaction within the institutional elements of the National Innovation System (NSI), also provides information technology support and information services to help scientific production. TÜBİTAK National Observatory (TUG) is a ground-based astronomical observatory, located in Antalya. Bursa Test and Analysis Laboratory (BUTAL) provides testing and analysis services with the aim of helping the industry, governmental and private research centers and institutions, service sector and scientists.

2.5.5. Ministry of Treasury and Finance (MoTF)

According to the R&D Law No.5746, MoTF regulates R&D tax incentives. Firms, having R&D activities, can benefit from tax exemption for personnel, goods and services and investments.

2.5.6. Ministry of Trade (MoT)

MoT supports export-oriented product development activities. Trademark, competitiveness and entrance to market supports are coordinated by MoT. It also conducts specific programs for niche areas like mobile gaming.

2.5.7. Other ministries

Besides the ministries mentioned above, some others also have their own research institutes like Ministry of Agriculture and Forestry (MoAF) and Ministry of Energy and Natural Resources (MoENR). Some of them have their own R&D support programs like Energy Sector Research and Development Projects Support Program (ENAR) and Productivity Increasing Projects (VAP) Support.

2.5.8. The Small and Medium-Sized Enterprises Development Organization (KOSGEB)

KOSGEB is a public institution established to increase the role and effectiveness of small and medium sized enterprises in the economy, increase their competitiveness and realize their integration in the industry

to enhance economic development. KOSGEB is an affiliated organization of MoIT. It has support programs on R&D, technology and domestic production, entrepreneurship, SME finance, incubation and laboratory services.

2.5.9. Technology Development Foundation of Turkey (TTGV)

TTGV was founded as a public-private partnership in 1991 with a mission to promote and support technology development and innovation activities of private companies. TTGV designs, develops and implements activities to provide reference and build capacity for value added operations, processes and products to support the vision of "Technology Developing Turkey". Founders' Committee consists of 56 reputable members that are representatives of public institutions, private sector companies, associations, foundations, chambers and private persons.[3]

2.5.10. Turkish Patent and Trademark Office (TÜRKPATENT)

Turkish Patent and Trademark Office carries out the procedures related to industrial and intellectual property rights. In the STI system, it has a role of supporting the technological development in Turkey through knowledge diffusion and of establishing and protecting of industrial property rights.[4]

2.5.11. Turkish Standards Institute (TSE)

Turkish Standards Institute is a public institution and the sole authorized body for standardization in Turkey. It operates in diverse fields of the quality infrastructure that includes certification, testing, training as well as surveillance and inspection activities. TSE has the responsibility of providing standardization, conformity assessment, test and calibration activities independently, effectively and reliably. Its role in the STI system is to increase Turkey's competitiveness and to facilitate trade at national and international levels.[5]

3. See the official website https://www.ttgv.org.tr/tr

4. See the official website https://www.turkpatent.gov.tr/TURKPATENT/commonContent/History

5. See the official website https://www.tse.org.tr

2.5.12. Regional development agencies

Development agencies have been founded in early 2000s to reduce inequalities between regions and to ensure regional development throughout Turkey. Its main task is to support the cooperation between the public, private sector and non-governmental organizations and to ensure that local potential is revealed. Currently, there are 26 development agencies in Turkey. The Ministry of Industry and Technology is responsible for the coordination of development agencies in Turkey. They are responsible for the implementation of development plans, including R&D activities. So far three agencies have adopted innovation strategies according to Research and Innovation Strategies for Smart Specialization (RIS3) which are Western Black Sea, Eastern Marmara and Ankara RDAs.[6] İzmir RDA is currently preparing innovation strategy according to RIS3.

2.5.13. Health Institutes of Turkey (TÜSEB)

TÜSEB is an affiliated institute of Ministry of Health, founded to conduct and fund domestic and international research and cooperation, contribute to scientific development and build an ecosystem for scientific research in the field of health sciences in Turkey. There are 7 institutes in TÜSEB; Turkish Cancer Institute, Turkish Biotechnology Institute, Turkey Mother, Child and Adolescent Health Institute, Turkey Institute of Public Health and Chronic Diseases, Turkey Traditional and Complementary Medicine Institute, Turkey Health Care Quality and Accreditation Institute and Turkey Institute of Health Policies. TÜSEB also has a clinical research center which aims to be the major body to conduct, coordinate and fund these studies.

2.5.14. Turkish Accreditation Institute (TÜRKAK)

TÜRKAK deals with the accreditation of organizations and laboratories.

6. Erdil, E. and Çetin, D. (2019), Smart Specialization and R&I Policy Framework in Turkey, in Casairo, N. and Santos, D. (eds). Smart Specialization Strategies and the Role of Entrepreneurial Universities, IGI Global, Hershey: USA. DOI: 10.4018/978-1-5225-6152-1.ch009.

2.5.15. Turkish Statistics Institute (TÜİK)

TÜİK is responsible for providing statistical information related to R&D, innovation and industrial activities.

2.5.16. Turkish Academy of Sciences (TÜBA)

TÜBA works as an advisory board for STI actors and gives recommendations on STI activities, makes investigations to determine the priority areas, proposes regulations to the President.

2.5.17. Council of Higher Education (YÖK)

The Council of Higher Education (YÖK) was established by Law No. 2547 dated November 6, 1981. This law commenced the restructuring process of academic, institutional and administrative aspects in higher education.

This report only provides brief information on the types of Higher Education Institutions and academic units all of which are actors in the STI system.[7]

Faculty (College): A division conducting higher education, scholarly research and publication. Various departments and programs may be connected to it. Students obtain a Bachelor's degree at the end of an educational program that lasts for at least four years.

Graduate School: An institution in universities concerned with graduate education, scholarly research and applications. Graduate schools award MA, MSc or PhD degrees.

Conservatory: An institution of higher education in which artists are trained for music and the performing arts. It lasts for eight semesters.

Post-Secondary Vocational School: An institution of higher education that is aimed at developing human capacity in specific professions and provides instruction lasting four semesters.

7. See for details: https://www.yok.gov.tr/Documents/Yayinlar/Yayinlarimiz/2019/Higher_Education_in_Turkey_2019_en.pdf

Research and Application Centre: An institution of higher education carrying out research and applied studies to meet the applied study needs of various areas and to provide preparatory and support activities for various professional areas, with the aim of supporting education in institutions of higher education.

2.5.18. Universities

There are 203 universities in Turkey as of 2020. 130 of them are state universities and 73 on them are non-governmental foundation universities. Every year YÖK publishes a report on the monitoring and evaluation performance of each university. The evaluation is based on 5 main criteria; education, R&D, project and publications, internationalization, budget and financing, community service and social responsibility. There are 96,199 PhD students, 394,174 master students and 4,420,699 undergraduate students enrolled in higher education programs.[8] There are also student exchange programs, research mobility programs and scholarship programs at the undergraduate and graduate levels.

As of 2013, a study is being performed by TÜBİTAK to measure the innovativeness and entrepreneurship activities of universities. TÜİK, Council of Higher Education, MoIT, TÜRKPATENT, TÜBA, KOSGEB and TTGV also contributed to the study. The entrepreneurial university Index, ranks universities according to their entrepreneurship and innovation performances, thus contributes to the entrepreneurship and innovation-oriented competition among universities, thereby improving the entrepreneurship ecosystem. The index has 5 sub-indices; scientific and technological research competency, intellectual property pool, cooperation and interaction, economic contribution and commercialization. There are 23 indicators under the index.[9] The study has been renewed every year since then and the methodology is shared with the public.

2.5.19. Research infrastructures

Considering the importance of the role it plays in scientific and technological development, and being compatible with national and regional priorities, in line

8. Council of Higher Education, Higher Education System in Turkey, January 2019 (www.yok.gov.tr)

9. For an academic analysis of the entrepreneurial university index see Gür, U., Oylumlu, İ.S. and Kunday, Ö. (2017). Critical assesment of entrepreneurial and innovative universities index of Turkey: Future directions. Technological Forecasting and Social Change, 123, 161-168.

with the needs of the public and private sector, establishment and development of "research infrastructures" are supported within the scope of investment programs by the Ministry of Development (ceased to exist as of 2019, see section 2.5, but now operates under SBB, see section 2.5.3.). For this purpose, approximately 6 billion TL (app. €1.4 billion) has been allocated in 2017 prices.

In 2014, a new law 6550, known as the "R&D Infrastructures Law", was put in action. The law mainly introduces a system approach to monitor and evaluate the performance of research infrastructures and to support them on a performance basis. Two types of research infrastructure supports are given under investment programs:[10] i) thematic research laboratories specializing on a certain scientific field, capable of carrying out research activities at national and regional levels, ii) central research laboratories where research infrastructures of different units in universities are shared.

There are 93 thematic research laboratories, 92 central research laboratories and 16 governmental research laboratories in Turkey. Their sectoral distribution is; 31 in Health, 19 in Food and Agriculture, 15 in Energy, 12 in ICT Technologies, 9 in Environment and Earth Systems, 7 in Machine and Manufacturing, 6 in Aviation and Space, 5 in Nanotechnology, 5 in Automotive, 4 in Materials Science, 3 in Basic Sciences, 2 in Defense, and 1 in Transportation, 1 in Metrology.

2.5.20. Technology Transfer Offices (TTO)

TTOs are organizations, usually in universities, which play an intermediary role in the STI system, by enabling the outputs of academic research to commercialize. They construct a bridge between academia, entrepreneurs, industry and private financial investors. In Turkey, TTOs supported by the TÜBİTAK grant program create, develop and support R&D projects within the framework of university-industry cooperation, register and protect intellectual and industrial property rights (IPR), involve in marketing, commercialization and venture capital support, provide incubation and accelerator service, business guidance, consultancy and training services, and organize and broadcast activities that raise awareness.

10. See for details: T.C. Kalkınma Bakanlığı Üniversite Ve Kamu Kurumları Araştırma Altyapıları", May 2017
http://www.sbb.gov.tr/wp-content/uploads/2018/11/Universite_ve_Kamu_Kurumlar%C4%B1_Arastirma_Altyapilari.pdf

A performance-oriented support process was designed to encourage the transfer of accumulated knowledge in universities to industry and enhance technology production capabilities and capacities of universities so that knowledge creates economic value. In the updated support mechanism of TÜBİTAK (as of 2019), TTOs have institutionalized their business processes and created revenue models which are expected to effectively protect inventions in higher education institutions (HEI) and manage their portfolio of intellectual rights. In this context, transferring the inventions of HEIs to the industry or commercializing them within the premises of the university are important performance indicators for TTOs.

TÜBİTAK has a support program for TTOs, titled "1513 - Technology Transfer Offices Support Program". There is also another call program for the TTOs which are in establishment phase; "1601 Capacity Building for Innovation and Entrepreneurship Grant Program". "Patent-Based Technology Transfer Funding Call – Patent Licensing" is another important tool, first launched in April 2020, stating that TTOs can take part as technology provider for the transfer of patented technologies acquired by the academia to private sector, to be used in product development and commercialization processes.

TÜBİTAK as an R&D performer (as well as its mainly acknowledged function, funding) also has its own TTO that was founded in 2016. Its main aim is to protect the IPR owned by the institution, determining the commercialization processes and managing the technology transfer processes within this context.

2.5.21. Continuing education centers

They are the centers in universities that are carrying out continuing education programs in all areas that the universities have specialization and knowledge. They satisfy life-long education and learning needs of the society, the government and business employees. There are 92 continuing education centers in state universities and 26 in non-profit foundation universities.[11]

11. See for details: http://www.tusemkonseyi.org.tr/

2.5.22. Technology Development Zones (TDZ)

Technopark concept in Turkey was introduced in the 1980s. Technology Development Centers (TEKMER) started to be established in the 1990s as a first step of creating technocities within the framework of cooperation between KOSGEB and universities. The legal framework on technocities was established in 2001 with the enactment of the law numbered 4691. Law No. 4691 uses the term "Technology Development Zones (TDZ)" instead of the concept of technocity or technology park. However, the term "technopark" is preferred to be used in this report. By January 2021, there are 87 TDZs, 72 of which are currently in operation and 15 of them are working on infrastructure establishment (see also section 4.1.3.3).

TDZs aim to produce technology and enhance R&D and innovation activities of firms by creating synergy within the zone and between the firms and the university.[12]

As of January 2021, the number of companies carrying out R&D activities in technoparks has reached 6,364. 45% of these companies operate in the software industry, 7% in Life Sciences (including agriculture), 3% in Computer Hardware and 3% in Biotechnology. There are also firms in Medical, Energy, Chemistry, Food, Defense and Automotive sectors. 66,615 personnel are employed in the TDZs and the technological product exports of the companies to the most developed countries of the world such as the USA, Japan, Israel, England and Germany have reached approximately $5.6 billion as of January 2021. There are 322 foreign/foreign partner companies in the Technology Development Zones. The number of patents registered by the companies operating in the zones is 1,262 and the number of patents whose application process is continuing is 2,775.[13]

12. See for details: https://www.tgbd.org.tr/

13. The statistical data is taken from the MoIT website https://www.sanayi.gov.tr/istatistikler/istatistiki-bilgiler/mi0203011501

2.5.23. R&D and Design Centers

According to the law no: 5746 (R&D Law) in 2008, private firms can establish R&D Centers and benefit from various government supports. With an update in the law in 2016, Design Centers was also included in the law (see also section 4.1.3.4 and 4.1.3.5). There are R&D, tax and employment incentives by the MoIT for R&D and design centers. The criteria to become an R&D or Design Centre are as follows:

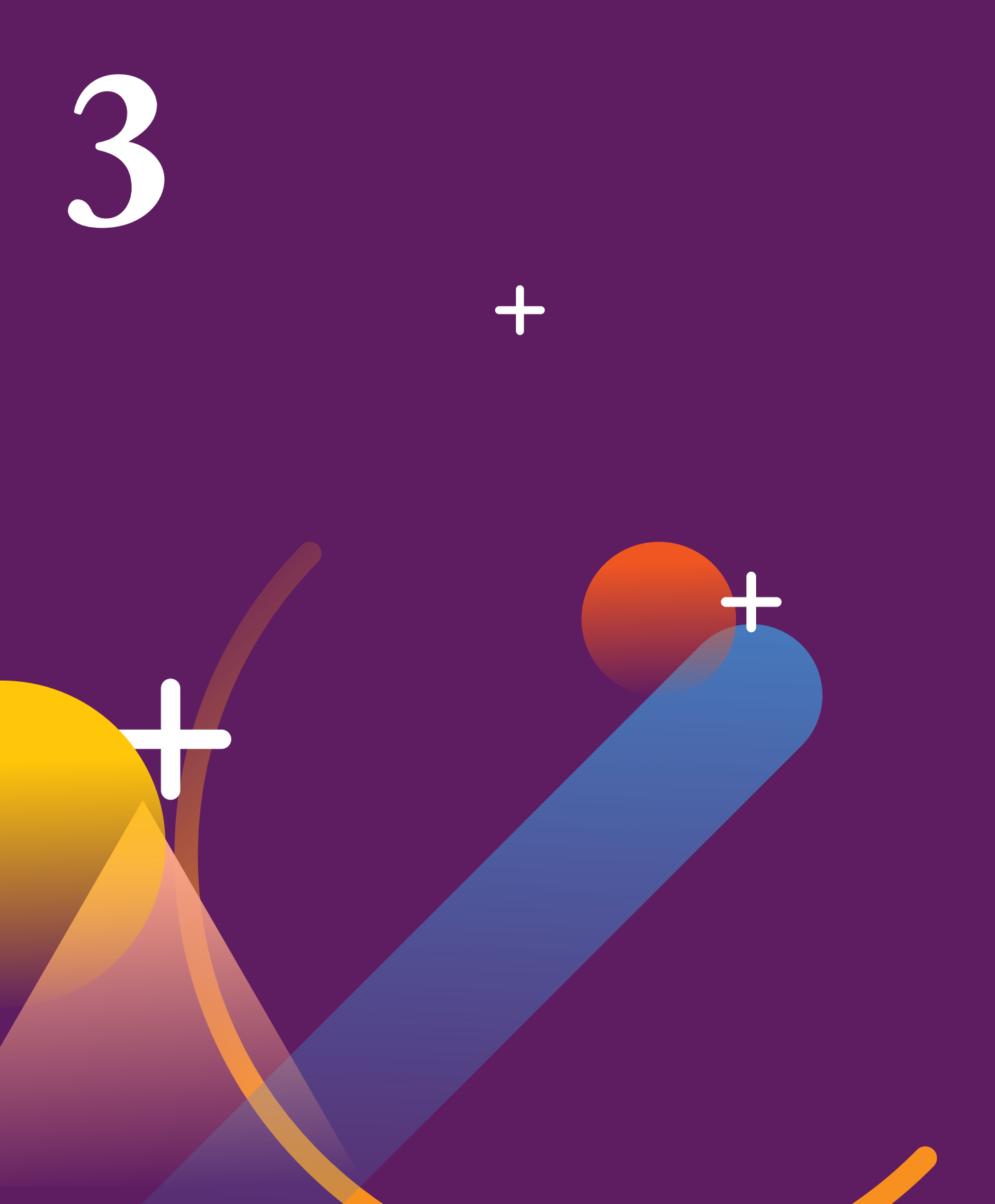
- For R&D Centre to employ minimum 15 FTE R&D personnel in researcher and technician positions, where this number is 10 for Design Centre
- to perform R&D activities in Turkey
- to have the facility to prove that the personnel is physically in the center
- The R&D center is organized as a separate unit and is located in a single campus or physical space

As of January 2021, there are 1,244 R&D Centers in Turkey. 67,007 personnel work in these centers, 1,122 of whom are PhD holders. There are 210 foreign/foreign partner companies. 7,058 patents registered and 17,476 patents are in evaluation process. Looking at the sectoral distribution, it is seen that 174 of the R&D centers are in the machinery sector, 127 are in automotive sub-industry, 113 in software, 83 in computer and communication, 78 in textile, 77 in electronics, 72 in chemical, 61 in food, 40 in defense and 34 in pharmaceuticals industry.[14] 80% of the R&D centers are located in 5 cities: İstanbul, Bursa, Kocaeli, Ankara and İzmir.

There are 364 Design Centers as of January 2021. Of the 7,861 personnel working in these centers, 24 hold PhDs. There are 29 foreign/foreign partner companies. 177 patents registered and 312 patents are in evaluation process. When a sectoral analysis is made, it is seen that 65 of the Design Centers are in textile sector, 46 are in engineering and architecture, 45 in manufacturing, 37 machinery and equipment, 19 furniture, 19 in automotive sub-industry, 19 in media and communication.[15] 78% of the Design Centers are located in 5 cities: İstanbul, Ankara, İzmir, Bursa and Kocaeli.

14. Data available on https://sanayi.gov.tr/istatistikler/istatistiki-bilgiler/mi0203011502

15. Data available on https://sanayi.gov.tr/istatistikler/istatistiki-bilgiler/mi0203011503


3

3. STI Policies in Turkey

State Planning Organization (SPO) established in 1960s made the first attempts to formulate Science and Technology (S&T) policies with the introduction of the First Five Year National Development Plan in 1963. TÜBİTAK was established in the same year for the purpose of organizing, coordinating and promoting basic and applied research, directing research activities to reach the targets of the national development plan and setting research priorities. During the 1960s and 1970s, the S&T policy in Turkey was mainly based on the promotion of basic and applied research in natural sciences. In this early phase, the S&T policies were formulated by TÜBİTAK without any official policy document through a tacit consensus with the government. The concept of technology policy and its integration within the industrial, employment and investment policies has been introduced in the Fourth Five-Year National Development Plan covering the period of 1973–1977. The first detailed S&T policy document in Turkey entitled, "Turkish Science Policy: 1983–2003", was prepared in 1983. This was the first time the role of technology for development was explicitly recognized and priority technology areas were suggested. Although this study was not a foresight exercise, it can be regarded as the first attempt towards defining "critical" or "priority" technologies in Turkey. Subsequently, the Supreme Council for Science and Technology (BTYK) was established.

As the highest S&T policy-making body, BTYK enabled designing policies with the participation of various actors. But BTYK had its first operational meeting only in 1989, six years after its establishment. In the mid-1990s, BTYK started to play an active role in formulating the national S&T policy to enhance the NSI. In its second meeting in 1993, BTYK approved the document titled "Turkish Science and Technology Policy: 1993–2003". This document paved the way for new policy initiatives, such as R&D support programs in the 1990s. This was a turning point in the history of S&T policymaking in Turkey as there was a paradigm shift from "building a modern R&D infrastructure" to "innovation-oriented national S&T policies". The policies formulated in this document were further elaborated in 1995 with "A Project for Impetus in Science and Technology", which formed the S&T chapter of the Seventh Five Year National Development Plan for the period of 1996–2000.

In its sixth meeting on December 13, 2000, BTYK underlined the fact that superiority in S&T is a must for the welfare of the Turkish society. Along these guidelines, BTYK

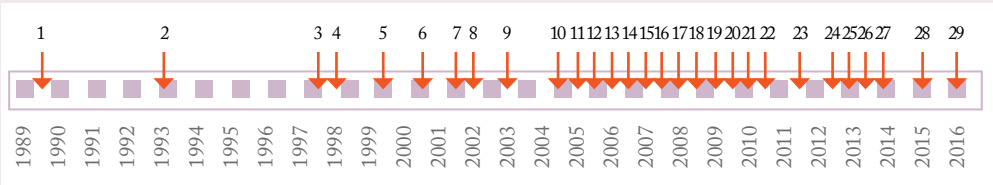
decided that new S&T policies should be formulated, and priority areas should be set for the time period covering 2002–2023. As the general secretariat of the BTYK, TÜBİTAK detailed the project accordingly, with the title "Vision 2023: Science and Technology Strategies". The project was approved by the BTYK a year later in its seventh meeting on December 24, 2001. The implementation of the project started in January 2002, and the draft strategy document was brought to the agenda of the 10th meeting of the BTYK held on September 8, 2004.[16]

The number and frequency of BTYK meetings can be seen in Figure 3.1. Nine meetings had been held during the first 20-year period (1983 – 2004) annual meetings on a regular basis held afterwards until the duties of the council were handed to the newly established Council of Science Technology and Innovation Policies (CoSTIP) in 2018 under the presidency.

The BTYK gathered on 17th of February 2016 for the 29th and the last time.[17] The two main decisions taken at this last meeting were:[18]

1. Studies to be carried out on smart production systems,
2. Development of a National Nuclear Development Plan 2016-2023

Figure 3.1. The number and frequency of Supreme Council of Science Technology meetings between 1986 and 2016.



Source: https://TUBITAK.gov.tr/tr/kurumsal/icerik-bilim-ve-teknoloji-yuksek-kurulu

16. Özcan Sarıtaş, Erol Taymaz, Turgut TÜMER, Vision 2023: Turkey's national Technology Foresight Program: A contextualist analysis and discussion, Technological Forecasting & Social Change 74 (2007) 1374–1393

17. https://TÜBİTAK.gov.tr/tr/kurumsal/bilim-ve-teknoloji-yuksek-kurulu/toplantilar/icerik-bilim-ve-teknoloji-yuksek-kurulu-29-toplantisi-17-subat-2016 (access date; May 15, 2020)

18. Information for some of the recent BTYK meetings (25th-28th meetings) can be found in RIO Country Report for Turkey 2015 https://rio.jrc.ec.europa.eu/country-analysis/Turkey/country-report.

Launching of the Turkish Research Area (TARAL) in 2004 to gather the resources and strategically guide research system actors is also one of the important milestones for S&T, as well as innovation policy (see section 2.3). The activities planned between 2005-2010 are documented under S&T Policies Implementation Program. 7 strategic goals were reported in the document and related course of actions was also determined for each goal.

- Development of science and technology awareness and culture
- Training and advancement of scientists
- Supporting result-oriented and quality research
- Activation of national science and technology management
- Strengthening the science and technology performance of the private sector
- Development of R&D infrastructure and environment
- Activation of national and international networks

Within the period of 2011-2016, disseminating the culture of multilateral and multidisciplinary R&D and innovation cooperation, stimulating sectoral and regional R&D and innovation dynamics, encouraging SMEs to become stronger actors within the NSI, and enhancing the contribution of research infrastructures to the knowledge creation capacity of TARAL are defined as the main focus points within the NSI and National STI Strategy (UBTYS) 2011-2016 document that was approved in the 22nd meeting of BTYK. To address these focus points, within the National STI Strategy (2011-2016), mission-oriented approaches in areas with strong R&D and innovation capacity, need-oriented approaches in areas with a demand for gaining acceleration and bottom-up approaches including basic, applied and frontier research have been identified.[19]

19. For further information see https://TUBITAK.gov.tr/en/about-us/policies/content-national-sti-strategy-2011-2016

3.1. A General Look on Policy Changes

In 2018, the parliamentary system ended as a result of a referendum and the presidential system came into force as mentioned earlier in section 2. As a consequence, science and technology policy actors, their responsibilities and relations between these governmental bodies have been reorganized accordingly (see section 2.3). The highest S&T policy-making body in Turkey, BTYK has been abrogated and Council of Science, Technology and Innovation Policies (CoSTIP) was established by a law decree (dated July 10, 2018, number 1) instead.

CoSTIP has been founded as one of the nine policy councils under the Presidential organization. Each council consist of minimum three members. The President is the head of the councils, assigns the members and appoints a deputy within these members. The first members of CoSTIP were assigned in October 2018.

CoSTIP is in charge of developing suggestions to the President on STI related issues and doing the required work (e.g., design policies, propose regulation) for the policies and strategies. Developing policy and strategies against unexpected changes caused by global competition, giving opinions to related public organizations, monitoring applied policies and reporting to the President, having extended meetings with ministries, institutions, experts and representative of NGOs, conducting studies on impact evaluations are some other tasks of the council.[20]

Although the policy-making actor BTYK has been reconstructed as CoSTIP, "National Science and Technology Policies: 2003–2023 Strategy Document" is still the top policy document which is an output of the Vision 2023 project; the first-ever national Foresight Program of Turkey. The program focuses mainly on determining the priority technology areas. This document has been prepared around three essential elements of focus:

1. Focusing on strategic (priority) technology areas
2. Increasing R&D expenditure (with specific targets for both public and private sector share)
3. Development of R&D human capital (with specific targets)

20. Akman Ç. (2019). Policy councils in the presidential government system: An evaluation through social policy councils, Route Educational and Social Science Journal, 6(3).

Vision 2023 process has mobilized a considerable number of people from industry, academia and public bodies. It also attracted the attention of mass media to a certain extent. In this way, some intangible outcome of the exercise, such as raising awareness and increasing commitment to S&T issues have been achieved during the process of implementation. However, this momentum was by no means sustainable, in the way that the current attitude of the stakeholders to STI issues is not significantly different from the past.

These observations constitute yet another example of the interrelatedness of context and the process of change. The fact that Turkey has mainly been a technology user rather than a producer has made the process susceptible to changing priorities and to the attitude of decision makers.

Although the initially envisaged outcome of the Vision 2023 project could not be fully realized, the process itself was instrumental for the accumulation of knowledge and capabilities regarding STI policy-making in Turkey. Part of this knowledge and capabilities were codified in the form of outputs of analysis (e.g., lists of strategic technology fields). Moreover, two on-line databases, one on the researchers in Turkey and the other on the research infrastructure, were prepared as a result of the project. These two databases ARBİS & TARABİS (see section 2.3) now provide information necessary for any further study on STI policies. Via the capabilities accumulated during the Vision 2023 process, TÜBİTAK was actively involved in the organization of UNIDO-led foresight training programs.

Finally, the Vision 2023 project in general, and the Technology Foresight Program in particular, constituted an important step towards harmonization of Turkish STI system with that of the European Union.[21]

Apart from National Science and Technology Policies: 2003–2023 Strategy Document, National Development Plans are important for STI policies in Turkey. The State Planning Organization (SPO) was responsible for preparation and implementation of Development Plans until 2011 and its mission proceeded as Ministry of Development thereafter. In 2018, within the scope of new organizational changes by the presidential system, Presidency of Strategy and Budget (SBB) was founded (see section 2.5.3) and become the responsible actor for the National Development Plans.

21. Sarıtaş, Ö., Taymaz, E., Tümer, T. (2007). Vision 2023: Turkey's national Technology Foresight Program: A contextualist analysis and discussion, Technological Forecasting & Social Change. 74, 1374–1393.

The 10th Development Plan (2014-2018) and the 11th Development Plan (2019-2023) are in the scope of this report. These two plans are examined for recent changes and also the 9th Development Plan (2007-2013) is taken into consideration to have an idea of the evolution of STI policies. Subject wise, 11th Development Plan is more specific and has detailed action items especially in comparison with the 9th Development Plan. The main targets of three development plans are shown below in Table 3.1. While the focus is on private sector in the 9th Development Plan, forming an ecosystem is prioritized in the 11th Development Plan. Another remarkable difference is that, STI policy targets shifted from increasing R&D expenditures to commercialization and supporting high value-added products.

Table 3.1. Main goals and targets of STI policy

9th Development Plan (2007-2013)	10th Development Plan (2014-2018)	11th Development Plan (2019-2023)
to design R&D activities intended for market in a way to produce innovation for competitiveness and efficiency. to increase the rate of R&D expenditure in GNP and to increase the weight of private sector in these expenditures. the main target is to increase innovation creation capability of private sector.	to enhance the power of competitiveness in a global scale to increase technology and innovation activities for benefit, focusing on the private sector to commercialize research results by creating an ecosystem based on innovation and with technology- intensive products with trademarks	to create an effective research and innovation ecosystem to increase research and innovation activities to a level that supports high value-added products and services to enhance the capability of knowledge production & use
no emphasis on commercialization	emphasis on commercialization	emphasis on high value-added products
no emphasis on creating an ecosystem	emphasis on both the private sector and creating an ecosystem	emphasis on creating an ecosystem compatible with new trends such as increasing collaboration, supporting interdisciplinary work, getting prepared for future technologies, industry 4.0

Creating an ecosystem has become a priority in the 11th National Development Plan as mentioned in Table 3.1. For this purpose, several Ad-Hoc Specialized Commissions were formed and out of these three were directly related to STI: Entrepreneurship, R&D and Innovation, and Economic Growth Dynamics. These commissions were in charge of examining the present ecosystem and making comparisons with developed countries and providing analyses, recommendations and tangible outputs in order to design, strengthen and manage an ecosystem producing technology and transforming it into one that produces high value-added.[22]

Industry and Technology Strategy 2023 by MoIT is also another major document for STI policy, which has been published in 2019. In this strategy document, a program that covers the fields of industry and technology with a holistic approach has been designed in order to accelerate the growth performance in previous years especially in the 2000s. It aims for a comprehensive development according to the dynamics of the country providing wide participation and reinvigorating the society. National Technology Act is the focus of the strategy that emphasizes the importance of indigenous and national technology production. The sub-components of the strategy are defined as high technology and innovation, digitalization, entrepreneurship, human capital and infrastructure.[23]

After reviewing the policy documents and programs/projects based on these policies briefly, some highlights of the recent changes in S&T Policies can be listed as follows:

- From sector specific to technology specific focus
- Indigenous & national (technology) production
- From knowledge creation to commercialization
- High-tech, high-value added focus
- Digital transformation
- Co-creation

22. http://www.sbb.gov.tr/wp-content/uploads/2020/04/Ar Ge_ve_YenilikEkosisteminiGuclendirilmesiOzelIhtisasKomisyonuRaporu.pdf (access date; June 30, 2020)

23. https://www.sanayi.gov.tr/assets/pdf/SanayiStratejiBelgesi2023.pdf (access date; June 30, 2020)

3.1.1. From sector specific to technology specific focus

Critical and prioritized technologies have been determined in recent STI policy documents as along with prioritized sectors. CoSTIP has conducted a study[24] in 2019 with a systematic approach to determine prioritized technology fields. Technologies have been assessed in terms of their impact and feasibility. Indicators for these two dimensions have been determined and weight of each indicator has been assigned as in Table 3.2.

Table 3.2. Evaluation Criteria for Prioritized Technology Field Determination of Turkey

Evaluation Dimensions	
Impact	**Feasibility**
financial impact (%50)	academic knowledge accumulation (%15)
social benefit impact (%15)	private sector project capability (%15)
national security impact (%35)	research infrastructures (%10)
	patent accumulation (%15)
	qualified human resources (%15)
	easiness of access to funding (%15)
	Technology Readiness Level (TRL) of related technology in Turkey (%15)

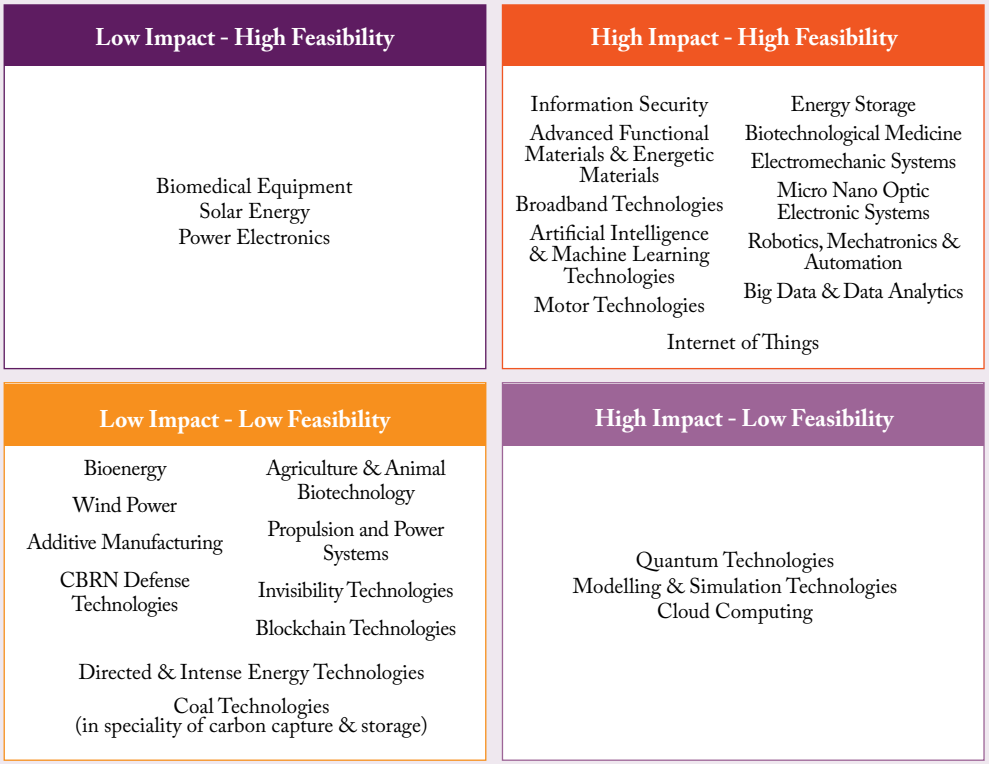
27 technology fields have been chosen for the assessment regarding national requirements and focused technology fields in international technology foresight studies for developed & developing countries. Numerous quantitative and qualitative analysis using statistical data and expert opinions have been used to determine high impact and feasible technologies to focus R&D and

24. https://www.sabanciuniv.edu/sites/default/files/ankaraprojeofisi/Hasan%20Mandal%20Sunum.pdf (access date; May 20, 2020)

innovation efforts on. 11 technology fields with high impact and high feasibility were determined as a result. These fields are; information security, energy storage, advanced functional materials & energetic materials, biotechnological medicine, broadband technologies, electro mechanic systems, artificial intelligence & machine learning technologies, micro-nano optic electronic systems, robotics, mechatronics & automation, motor technologies, big data and data analytics and internet of things (see Figure 3.2). It has been decided to prepare technology roadmaps, to provide education and scholarship priorities, production and incentive opportunities for these chosen technology fields. An official strategy document, including the method of the study, has not been published yet but studies in all selected fields have already started such as preparing a roadmap for advanced functional materials & energetic materials and artificial intelligence strategy.

The technology-based policies have also been included in recent National Development Plans. Prioritized sectors (Chemistry, Pharmacy & Medical Equipment, Machinery & Electrical Equipment, Automotive, Electronic & Rail System Vehicles) in 11th Development Plan has been chosen from middle-high and high technology fields as a sign of increased attention on technology specific policies. Critical technologies have been evaluated as a discrete section in the plan and action items to enhance these technologies have been mentioned in detail. Artificial Intelligence, Internet of Things, Big Data, Cyber Security, Energy Storage, Advanced Materials, Robotics, Micro-Nano-Opto Electronic, Biotechnology, Quantum Sensor Technologies and Additive Manufacturing Technologies have been determined as critical technologies. It has been suggested to prepare roadmaps, enhance infrastructure and human resources to improve these technologies. It has also been decided to intensify R&D and innovation supports on critical technologies as well as prioritized sectors.

Figure 3.2. Results of Technology Fields Prioritization Study of CoSTIP



Vision 2023 Strategy Document has also mentioned eight strategic technologies: Information and Communication Technologies, Biotechnology & Gene Technologies, Nanotechnology, Mechatronic, Production Processes and Technologies, Materials Technologies, Energy & Environment Technologies, Design Technologies. Subfields to be focused under each main field was also included in the document (for instance, boron technologies, composite materials, polymer technologies, smart materials, magnetic, electronic, optoelectronic materials, light and high strength materials under materials technology field).

Table 3.3 gives a summary of prioritized technology fields in the 11th National Development Plan, Vision 2023 and Technology Fields Prioritization Study of CoSTIP.

Table 3.3. Prioritized technology fields in National Plans & Studies

Vision 2023	11th Development Plan	CoSTIP Technology Fields Prioritization Study
Information and Communication Technologies	Artificial Intelligence	Information Security
Biotechnology & Gene Technologies	Internet of Things	Energy Storage
Nanotechnology	Big Data	Advanced Functional Materials & Energetic Materials
Mechatronic	Cyber Security	Biotechnological Medicine
Production Processes and Technologies	Energy Storage	Broadband Technologies
Materials Technologies	Advanced Materials	Electro Mechanic Systems
Energy &Environment Technologies	Robotics	Artificial Intelligence Machine Learning Technologies
Design Technologies	Micro-Nano-Optoelectronic	Micro-Nano Optic Electronic Systems
	Biotechnology	Robotics
	Quantum Sensor Technologies	Mechatronics & Automation
	Additive Manufacturing Technologies	Motor Technologies
		Big Data and Data Analytics and Internet of Things.

3.1.2. Indigenous & national production

One of the most prominent developments in STI policies is the emphasis on indigenous and national production. National Automobile, National Combat Aircraft, National Space Agency are some of the striking examples of this new policy orientation. Technology Focused Industrial Movement Program has been built and actualized as a large-scale incentive in order to promote indigenous production (see section 3.2.1 for details of the program). The establishment of Directorate of Indigenous Technology under MoIT in late 2020 is also a signal toward the importance of indigenous & national production.

The 11th Development Plan has handled national production in a separate title under which detailed action items were determined. Some of these action plans are as follows:

- A strong institutional structure to support indigenous production and technological transformation shall be formed.
- "Industrialization Executive Board" shall be established headed by the President to take higher level decisions for enhancing indigenous production and technological transformation.
- MoIT shall make middle and long-term needs analysis for public procurement and determine critical technologies and products that can be produced locally; prepare a specification pool and capability inventory; cooperate with firms in order to enhance product quality and prepare technology roadmaps.
- Public procurement shall be used as a leverage to increase indigenous production in priority domains.
- Local firms performing activities on high technology fields and having high growth potential shall be paired with international investors and their investments based on technology transfer shall be supported.

For instance, the State Supply Office has actualized "Techno Catalogue" application as a smart public purchase tool in 2017. Techno Catalogue is a peculiar sales channel for entrepreneurs who has Technological Product Practice Document, has completed TÜBİTAK TEYDEB projects, are registered

to Cyber Security Cluster, operate at TDZs and produce mid-high & high technologies locally.[25]

Other targets /studies for indigenous and national production in the 11th Development Plan can be listed as follows:

- Incentive mechanisms to be developed for indigenous automobile project.
- Manufacturing of national electric train series to be completed by 2020.
- Serial production of national electric locomotive to be started by 2022.
- Prototype of national high-speed train to be completed by 2023.
- 80% of indigenous production in all kinds of railway vehicles by 2023.
- 100% indigenous production to be provided in critical technologies of the defense industry.
- National Space Program, National Smart Network Management System (National SCADA) for Energy institutions, National Electronic Messaging Platform, National Open Data Portal for Public Data to be prepared.
- Indigenous Air Defense Systems and Sea Platforms to be provided.
- Indigenous production of high value-added aluminum products for aviation, defense and automotive industry to be encouraged.
- Indigenous production for 5G Technologies to be provided.
- Indigenous satellite technologies to be improved.
- Indigenous production of advanced materials to be encouraged.
- Use of indigenous composite materials to be encouraged in nuclear plant installations.
- National policy for the production and use of artificial intelligence to be generated.
- National solutions for cyber security to be provided.

National Space Agency has been established under MoIT in 2018 for the preparation and actualization of National Aerospace Plan. Rail Transport

25. https://www.dmo.gov.tr/Files/TeknoKatalog/ (access date May 20, 2020)

Technologies Institute has been established in 2019 by TÜBİTAK in compliance with the targets in the 11th Development Plan. Private sector companies have gathered as a consortium for manufacturing indigenous automobile in 2017 and the first use is planned to be in 2022 (The TOGG named after the Turkish abbreviation of Turkey's Automobile Initiative Group).[26] The newly established Institute of Artificial Intelligence by TÜBİTAK is in charge of uniting all ecosystem stakeholders in the field of artificial intelligence with common goals in line with the needs of the business sector.

3.1.3. From knowledge creation to commercialization

Although policies for supporting R&D activities progressed until 2014, the need of enhancing commercialization has been emphasized in the 10th Development Plan: "It is critical to create competitive, new semi and final technological products and brands by commercialization of R&D and innovation activities at the international level." There was no significant expression on commercialization and branding in the 9th Development Plan. However, as can be seen in Table 3.4, commercialization and branded technology products have become a main target for Turkish STI policies in the 10th Development Plan and a commercialization plan for prioritized areas (health, energy, aviation & space, automotive & rail systems, defense) has been included under the general coordination of MoIT in cooperation with Ministry of Economy.

26. https://resmigazete.gov.tr/eskiler/2018/12/20181213-1.pdf (access date; June14, 2020)
https://rute.TUBITAK.gov.tr/tr/kurumsal/tarihcemiz-0 (access date; June14, 2020)
https://tr.wikipedia.org/wiki/TOGG (access date; June14, 2020)

Table 3.4. Commercialization Program for Prioritized Areas (10th Development Plan-Section 1.11)

Main Targets	Indicators
To increase the number of technological products and trademarks in prioritized sectors.	The number of new products, trademarks and patents
To increase the share of prioritized areas for production and exports	The share of prioritized areas in production and exportation of manufacturing industry
To raise qualified researchers and to increase their employment in private sector	The number of researchers with a PhD degree
To increase the number of research, incubation, accelerator, technology and innovation centers	The number of accredited research, measurement and test centers
To render TDZs sector focused	The number of clusters in prioritized areas
To enhance innovative entrepreneurship	The number of entrepreneurs
To increase technology transfer interfaces	The number of technology transfer offices and the number of companies that take service from these offices, the amount of license income of the offices

There are also concrete action items in the 11th Development Plan including;

- Research projects with high commercialization potential of high-tech platforms, formed by research infrastructures in cooperation with private sector R&D centers and public R&D units, will be supported under the centers of Excellence Program.
- There shall be informative programs, especially for the researchers in universities on subjects such as government incentives and IPRs, in order to accelerate the commercialization process. Incentives and support shall be provided especially for transferring capability on defense electronic to civilian areas, signifying dual-use.
- The legal barriers reducing the efficiency of revenue sharing and commercialization stages, with regards to the industrial property rights developed within universities or through the cooperation of universities and other public institutions or private sector will be eliminated.

3.1.4. High-tech focus

In the 11th Development Plan, it was decided that firm consortiums shall be supported for high-tech products and commercialization with special focus on prioritized areas by the Industry Innovation Network Mechanism Program (known as SAYEM) which later was launched by TÜBİTAK (see section 3.2.1 for details of the program). This program is one of the most important and comprehensive policy tools for developing high technology products and processes. As a smart specialization study, TÜBİTAK-1004-Excellence Centre Support Program in which Higher Education Research Infrastructures in priority areas are supported to become excellence centers, is another noteworthy progress. (see section 3.2.1 for details of the program)

There are also other decisions for improving high technology in the 11th Development Plan.

- Institutional capacity and need-based monitoring of domestic companies with specific high technology capabilities will be developed and policies will be formed in accordance with economic security and self-sufficiency.
- Incentive programs shall be prepared to increase foreign direct investments (FDI) regarding indigenous production of high-tech products.
- R&D and innovation support system shall be transformed into a structure that comprehends all the process from focused research to commercialization, considering sector requirements and development potential.

Although in the Public Procurement Law, there was a 15% price advantage in favor of local producers, public procurement was not able to support technology transfer and development of industry at the desired level. Public procurement is a broadly used policy instrument that supports technology development and indigenous production in developed countries (and recently in developing countries). “Technology Development and Indigenous Manufacturing by Public Procurement Program” was included in the scope of the 10th Development Plan.

Table 3.5. Technology Development and Indigenous Manufacturing by Public Procurement Program

Main Targets	Indicators
To increase the share of local firms in public procurement for middle-high and high-technology sectors	The share of indigenous production in public procurement
To support trademarks in high technology fields at the international level and to increase products that have trademark.	The share of indigenous industry in foreign procurement by offset application
To increase R&D expenditure via public procurement	The share of indigenous production in public purchase guarantee in total purchase The share of SMEs in public procurement
To increase foreign direct investments by policies on public procurements	The number and value of offset agreements

Source: 10th Development Plan, Section 1.12.

The targets for the high technology industry in the 10th Development Plan are given in Table 3.5. Exports of high technology products as a share of total exports (%) is given in Table 2.1 (R&I Indicators for Turkey) whereas the rate of high-tech industry in manufacturing exports is given in Table 3.6.

Table 3.6. Targets of manufacturing Industry for High Technology

	2006*	2012*	2013*	2018**	2023**
The share of mid-high tech. industry in manufacturing export	30.8	31.4	31.4	36.4	44.2
The share of high technology industry in manufacturing export	5.6	3.7	3.7	3.2	5.8
The share of mid- high & high tech. sector in total credits	NA	NA	NA	4,8	13

**Data source: 10th Development Plan, ** data source: 11th Development Plan*

3.1.5. Digital transformation

While the focus was on e-government applications in former plans, digital transformation has become a subject of importance in the 11th Development Plan. The basic goal is enhancing productivity and competitive edge through accelerating digital transformation in prioritized areas. Some of the action items for digital transformation are;

- Forming industrial cloud platforms in the prioritized sectors to be supported.
- The development and use of required smart products and systems in industry's digital transformation process.
- Competence and digital transformation centers to be established in TDZs and Organized Industry Zones to provide consultancy services and bring technology providers and users together.

Targets for digital transformation in the 11th Development Plan is presented in Table 3.7.

Table 3.7. Digital Transformation Targets

	2018	2023
Number of SMEs getting service from Industrial Cloud Platform in prioritized areas (cumulative)	-	10,000
Number of competence and digital transformation centers (cumulative)	1	14
Number of digitalization projects developed by SMEs (operating in prioritized sectors) in cooperation with local product and service providers	-	20,000

Data source; 11th Development Plan

Moreover, 2023 Digital Turkey Roadmap was prepared under the leadership of MoIT with the contribution of all relevant public and private stakeholders. This roadmap aims to plan and realize digital transformation process effectively to increase the competitiveness of the manufacturing industry.

Organized Industrial Zones, Industry Regions, TDZs and private sector R&D centers will take on a leading role in the process of digital transformation affecting structure of the manufacturing industry.

The first two years of the roadmap are composed of short-term actions to be performed, and it consists of concrete steps to increase readiness for digital transformation. Medium term (3-5 years) vision of the roadmap is designated as closing the gap on digitalization primarily in prioritized sectors and in selected technologies. The long-term vision (6-10 years) is to be a regional or global leader in digitalization in specific sectors and technologies. This long-term vision is composed of six main components:

- Human: Education, infrastructure development and qualified workforce cultivation
- Technology: Technology and innovation capacity development
- Infrastructure: Data communication infrastructure development
- Suppliers: Supporting national technology suppliers
- Users: Supporting users of digital transformation
- Governance: Strengthening corporate governance"[27]

3.1.6. Co-creation

Co-creation holds real promise as a way to facilitate innovation in the public sector. In the traditional model of public sector, a public entity receives resources through budgetary allocation and then uses those resources to deliver services to stakeholders through a set of work processes—filing a form, responding to a customer request on the phone, and so forth. The people at the receiving end of those processes are largely passive. Co-creation starts from the experience of each actor and strives to discover new modes of interaction that will improve the experience for all actors simultaneously. The process often leads to a reconfiguration of roles: Recipients of services become service providers, and vice versa. To develop and sustain these new modes of interaction, participants typically create special platforms for community engagement (many of which incorporate supporting technology tools).[28]

27. https://www.gmka.gov.tr/dokumanlar/yayinlar/2023_Dijital-Turkiye-Yol-Haritasi.pdf (access date June 30, 2020)

28. https://ssir.org/articles/entry/co_creation_in_government (access date; November 2, 2020)

Co-creation as opposed to collaboration and exchange-based knowledge is a recent rising approach in Turkish STI policy. The importance that TÜBİTAK has given to the establishment of co-creation models has been represented in initiatives such as the TÜBİTAK 1004 Call for High Technology Platforms prior to the COVID-19 pandemic. The first phase of 17 High Technology Platforms that were already launched in the leadership of research universities and research centers with competence under Law 6550 on Support of Research Infrastructure, has already included platforms on drug and vaccine development. In particular, diagnostic kits, drug and vaccine development including those for influenza-based infections as well as bio-indicator and high technology drug products and prototype vaccines are among the focus areas for the research programs of these platforms.

As a fast-track option with a particular focus on COVID-19, a sub-platform under the coordination of TÜBİTAK Marmara Research Centre (MAM) Genetic Engineering and Biotechnology Institute has been established, namely the COVID-19 Turkey Platform. This sub-platform brings together projects and competencies that can be transformed for an effective response against the COVID-19 infection with a particular focus on medicine, vaccines, and innovative treatment approaches. Remarkably, the orchestration of researchers for the COVID-19 Turkey Platform and the time for the implementation of the projects have been completed in only 10 days.

Such a scientific coalition brings together researchers from universities, public R&D units, and the industry to work on drug repurposing, drug development, innovative treatment approaches, and vaccine development against COVID-19. The platform currently involves 7 different vaccine and 8 different drug development projects where both chemical and biotechnological methods are applied. Multiple methods that have the potential of enabling an effective response in support of combating the COVID-19 infection are undertaken. For the grand goal of supporting an effective, science-based response to the COVID-19 pandemic, hundreds of researchers from 24 universities, 8 public R&D units, and 8 private sector firms are working diligently. There are currently 225 researchers with tasks in the platform of whom 116 are from universities, 62 are from public R&D units, and 47 are from the private sector. Overall, the platform involves a total of 15 projects that are being supported for a duration of up to 9–12 months.[29]

29. Mandal, H. (2020), Mobilizing the research ecosystem for scientific advances towards positive impact in the context of the COVID-19 Pandemic, Turkish Journal of Medical Sciences, 50: 485-488.

TÜBİTAK commissioned R&D Call (section 3.2.1.1.6), Patent-Based Technology Transfer Support Call (section 3.2.1.1.7), Industry Innovation Network Mechanism Call (SAYEM) (section 3.2.1.1.1) and National& International Leader Researcher program are other important initiatives of co-creation models that have recently been designed.

3.2. New Policy Tools

There are three general categories of instruments used in public policy according to Borrás and Edquist[30] (1) regulatory instruments, (2) economic and financial instruments, and (3) soft instruments. The recent policy tools within this report have been categorized according to this taxonomy.

(1) Economic and financial instruments (hard tools) provide specific pecuniary incentives (or disincentives) and support specific social and economic activities. They may involve economic means in cash or forms of finance, and they may also be based on positive incentives (encouraging, promoting certain activities) or on disincentives (discouraging, restraining certain activities). Economic and financial instruments have been extensively used in the field of STI policy.

(2) Regulatory instruments, use legal tools for the regulation of social and market interactions. The logic behind this type of instrument is the willingness of the government to define the frameworks of the interactions taking place in the society and in the economy. Naturally, there are many different types, but common characteristic of these regulatory instruments (laws, rules, directives, etc.) is that they are obligatory in nature, meaning that actors are obliged to act within some clearly defined boundaries. Regulatory instruments using law and binding regulations are important in the field of STI policy, for example the regulation of IPR in particular, but not only, patent regulations, the regulation of research and higher education organizations like universities and public research organizations (most importantly the statutory nature of the organizations, and researchers' employment regulations), competition (anti-trust) policy regulations concerning R&D and innovative activities of firms in the

30. Borrás, S. and Edquist, C. (2013) The Choice of Innovation Policy Instruments, Technological Forecasting and Social Change, 80(8), 1513-1522.

market, bioethics and other ethical regulations related to innovative activities, and last but not least, some specific industrial sector regulations with effects on innovative activities.

(3) Soft instruments are characterized by being voluntary and non-coercive. With soft instruments, those who are 'governed' are not subjected to obligatory measures, sanctions or direct incentives or disincentives by the government or its public agencies. Instead, soft instruments provide recommendations, make normative appeals and offer voluntary or contractual agreements. Examples of these instruments are campaigns, codes of conduct, recommendations, voluntary agreements and contractual relations, and public and private partnerships. These instruments are very diverse, generally based on persuasion, mutual exchange of information among actors, but less on hierarchical forms of cooperation between the public and the private actors. These instruments have been increasingly used in STI policy-making for the past two decades. However, it is important to keep in mind that even if their relative importance is increasing, these instruments complement regulatory and economic instruments. Nonetheless, they might constitute important new forms and new approaches to public action with regards to STI policy.

The focus on instrument mixes (or "policy mix") has received considerable attention from policy makers in the past few years. Policy-mix can be defined as the specific combination of innovation-related policy instruments which interact explicitly or implicitly in influencing innovation intensities. Policy-mixes are specifically designed and implemented for specific problems and tend to follow distinct patterns of national policy styles. There are several instances where the government initiates mixed policy designs. The National Technology Act for instance involves many hard and soft tools, and regulations. A good example is TOGG that aims to produce a fully electric "Turkey's Automobile" by 2022. The TOGG initiative involves government regulations[31], massive government funding, promotional tools and infrastructure building and also has multiple aims such as producing indigenous technology, reduce trade deficit, enhance cooperation between government-university-industry. Likewise, there are many policy tools that support entrepreneurship (especially technology-based or innovation-based). Such policy tools under different organizations aim to create an entrepreneurial society complementing each other. This report reviews the recent attempts in STI policy design under economic and financial instruments, regulations and soft tools.

31. https://www.resmigazete.gov.tr/eskiler/2019/12/20191227-2.pdf

3.2.1. Economic and financial instruments

There are various mechanisms providing financial support for R&D and innovation activities of private sector, universities and other related actors of the STI system. TÜBİTAK, KOSGEB, SSB, and TTGV are the well-known institutions that execute financial support programs/projects for changing needs of the actors. Programs are revised in compliance with STI policies from time to time. Although there are many new economic and financial instruments, only the most effective and important programs that are developed recently is included in this section.

3.2.1.1. TÜBİTAK

TÜBİTAK has transformed two of the most applied industry programs so that there will be calls with specific budget two times a year. One of them is 1501 - Industrial R&D Projects Grant Program and the other is 1507 - SME RDI Grant Program. The purpose of this change was to provide better budget management, to select the best projects by competition, to use various tools in an effective and flexible manner at the project selection stage and to direct financial resource to projects in predetermined areas complying with national targets and needs. Additionally, at the evaluation stage of the proposals, the weight of "commercialization" has been increased.

3.2.1.1.1. Industry Innovation Network Mechanism Call (SAYEM)

TÜBİTAK has launched Industry Innovation Network Mechanism Call (known as SAYEM) in 2018 to develop high value-added products or product groups in compliance with national high technology targets exercised by forming innovation networks where government, universities and private sector cooperate. Only high technology areas that have been determined by NACE codes below are in the scope of the program;

- Manufacture of basic pharmaceutical products and pharmaceutical preparations (NACE 2 code21)
- Manufacture of computer, electronic and optical products (NACE 2 code 26)

- Manufacture of other transport equipment (NACE 2 code 30)

Only roadmaps for products or product groups with Technology Readiness Level[32] 5 (preferably TRL 6) and above (except TRL 8&9) are in the scope of this call.[33]

The main applicants of the consortium are either universities, public research institutions or private firms which are subject to some additional conditions (being an R&D Centre, having a weighty turnover in the sector, developing products and having a broad sales network, having noticeable IPR for the basic technology of the targeted product, having applied for TÜBİTAK 1004 Excellence Centre support program). Related TTOs, entrepreneurs, SMEs, start-ups, potential customer representatives could also join the consortium.

There are two phases of the call; first phase includes forming the network and cooperation, capacity building, preparing roadmaps and the second phase mainly involves making the product ready and prepare for manufacturing. The applications for first phase of the call were completed at the end of 2018. Among 47 applications, 28 projects were selected to be supported with 2.5 million TL budget for phase 1. In the second phase of the program, the projects of the selected roadmaps can apply to different calls of TÜBİTAK and Strategic Product R&D Support calls without providing application criteria. Thus, SAYEM aims to enhance production of high value-added goods and services by forming networks that are expected to cooperate on research, innovation and production.[34]

32. Technology Readiness Level (TRL) is a method for estimating the maturity of technologies during the acquisition phase of a program, developed at NASA during the 1970s. A comprehensive approach and discussion of TRLs has been published by the European Association of Research and Technology Organisations (EARTO).

33. NACE (Nomenclature of Economic Activities) is the European statistical classification of economic activities. NACE groups organizations according to their business activities. Statistics produced on the basis of NACE are comparable at European level and, in general, at the world level in line with the United Nations' International Standard Industrial Classification (ISIC). (Reference https://siccode.com/page/what-is-a-nace-code).

34. For more information on SAYEM see https://www.TUBITAK.gov.tr/sites/default/files/292/sayem_sunum_31102018_web_.pdf

3.2.1.1.2. Technology Focused Industrial Movement Program (HAMLE)

Technology Focused Industry Movement Program is a special program targeting increased value-added by managing the support and incentives of MoIT and related institutions from a single window, to focus on middle-high and high-technology fields. The main aim is to increase the manufacturing of products in middle-high and high-technology critical sectors determined as machinery, chemistry, pharmacy, computer technologies, electronic-optic technologies, electrical equipment and transportation vehicles. The mission of the program is to decrease the foreign dependency in these sectors, especially imported inputs, and to enhance limited or non-existing manufacturing capabilities in niche products and contribute to the development of industry through backward and forward linkages. The sectors and products that have significant impact on the current account deficit are prioritized. If R&D activities are required for the eligible projects, TÜBİTAK may provide R&D incentives for projects. If the applicant firm of an eligible project is an SME, the investment part of the project could also be supported by KOSGEB up to 5 million TL.

The first call of the program for the machinery sector has been announced and applications have started by 3rd of October, 2019 and evaluations are to be completed by June, 2020.[35]

3.2.1.1.3. 1514-Venture Capital Support Program (Tech-InvesTR)

The new Tech-InvesTR Venture Capital Support Program has been designed to add value to Turkish economy through providing capital to early-stage start-ups in the process of commercialization newly developed R&D products and technologies. The program entered into force along with the agreement signed between TÜBİTAK and The Ministry of Treasury and Finance on 14.06.2018 and Tech-InvesTR-2018 Venture Capital Support Program Call was launched on the same day

35. For more information about HAMLE see the Official Gazette https://www.resmigazete.gov.tr/eskiler/2019/09/20190918-7.htm

The application period for the call was completed on 30.09.2018. Within the scope of the call, 34 project proposals have been received from 23 institutions including; 13 TDZs, 9 TTOs and 1 research infrastructure.

It is planned that the ministry will commit a maximum of 400 million TL, to selected VC funds, within the next 5 years. After the Ministry of Treasury and Finance's evaluation, the participation protocols between the Ministry of Treasury and Finance and the VC funds will be signed. At the same time TÜBİTAK and TTO/TDZ/ Research Infrastructures will sign the project support agreements. Investments are aimed to start after the establishment of these funds, in order to commercialize the R&D results of early-stage technology-based enterprises established in Turkey. With the contribution of the domestic and international resources, Tech-InvesTR VC funds are expected to reach 980 million TL at the first closing and approximately 1.8 billion TL at the final closing. Within the scope of TÜBİTAK Tech-InvesTR Venture Capital Support Program, about 300 early-stage technology-based ventures are aimed for investment.

3.2.1.1.4. 1004-Excellence Centre Support Program

The purpose of the Excellence Centre Support Program is to support excellent scientific research with high commercialization potential in Higher Education Research Infrastructures in priority areas determined by TÜBİTAK in accordance with national priorities. In compliance with national targets, this program aims to create Excellence Centers cooperating with R&D/Design Centers and Public R&D units. There are two phases of the program. In the first phase, activities to form the research program are supported. Preparation of the strategic research program, roadmaps including key steps for the use of developed technology and management model of the cooperation platform are the expected outputs of this phase. In the second phase, R&D and innovation activities in line with the roadmap are supported. The activities shall be in high technology fields from TRL 3 to 6. The budget of the first phase is for service procurement, consumables and travel

expenses. Machinery, equipment, software publication purchase, consumption goods, consultancy & service procurement, travel, personnel, project output publication expenses are supported in the second phase.[36] Prioritized areas are biomedical equipment, drugs and vaccines, solar energy technology, nanotechnology, advanced material technologies, sensor technologies, RF technologies, Industry 4.0 Technologies, 3D Printers and regenerative/personalized medicine. 17 programs have been supported under phase one and 9 of them are eligible to apply to phase two. These 9 projects are under two NACE codes: Manufacture of basic pharmaceutical products and pharmaceutical preparations (NACE 21) and Manufacture of computer, electronics and optical products (NACE 26).

3.2.1.1.5. 1515-Frontier R&D Laboratory Support Program

The 1515 Program applies an integrated perspective that extends beyond a consideration of the initial, establishment phase of an R&D laboratory. Since R&D laboratories flourish with long-term commitments, the support of the 1515 Program extends to the phase of sustaining the activities of R&D laboratories in the long run. The 1515 Program offers an entirely grant-based financial model to cover up to 75% (for personnel expenditures, in some cases up to 100%) of the operating expenses of the R&D laboratory in Turkey with up to 10 million TL for each calendar year for a duration of 10 years at most.

The program is designed to “facilitate” the process of allowing leading firms to undertake frontier R&D activities in their laboratories in Turkey. The basic expectations after a positive evaluation are that the R&D laboratory puts into place a research plan to realize the following:

- Expand the boundaries of existing scientific understanding
- Bring new scientific understanding to natural phenomena

36. See for details: https://TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/icerik-1004-mukemmeliyet-merkezi-destek-programi

- Conduct research activities that are directed to providing solutions to existing scientific challenges or those that are probable in the future
- Conduct research that have the potential to influence new, emerging technological trends
- Perform basic and/or applied research for "proof of concept" activities and/or those that are directed to the establishment of new scientific frameworks.

The presence of the R&D laboratory in Turkey will further open the possibility of benefiting from TÜBİTAK's any other grant-based support mechanisms. These mechanisms, including call-based programs in areas of priority, are open for the application of all research entities in Turkey. In addition to the grant that is provided for the budget under the relevant R&D support programs, the R&D laboratory will qualify to receive a "Project Incentive Premium" for each R&D project.

3.2.1.1.6. Commissioned R&D Call

Commissioned R&D 2020-1 is a call to support partnered projects in which potential customers are ready and innovative products will be developed by SMEs through conducting R&D. R&D projects that can quickly turn into products and have high commercialization potential will be supported. There is no subject and sector limitation in the commissioned R&D call.

The selected firms/organizations will carry out R&D activities and the project output will be commercialized by the "customer" organization. The customer will contribute to the R&D costs, along with TÜBİTAK. The total of accepted budget of the projects will be 30 million TL maximum. The total budget of a project (funded by TÜBİTAK) will be 2.5 million TL maximum.

Project is planned in two stages 1) product/process development and 2) commercialization. The product/process development phase shall be 24 months maximum. The commercialization

phase uses the results of the first phase but expenses related to this phase would not be supported. The initial commercialization period for all projects will be 24 months maximum.

While the SMEs develop the product by conducting R&D, the customer organization will support the execution of the R&D project as intended. Thus, information will be shared, disseminated and quickly transformed into a product. It is expected that the culture of business cooperation will develop and become widespread with the supported R&D projects. The call opened on May 14, 2020 for project applications.

3.2.1.1.7. Patent-Based Technology Transfer Support Call

The program aims knowledge transfer and commercialization of patented technologies which are developed by HEIs, research infrastructures, public enterprises, public research centers and institutes, and early-stage technology-based firms to established firms located in Turkey through licensing or assignment methods.

Support rate is determined differently according to each patent licensed or assigned in the scope of the project. Base rate of the support is minimum 25%. There is a 15% additional support rate which will be provided in case the client is an SME, another 15% additional support if patent is a high-technology product or service and another 10% if the patent is registered to EPO, USPTO, JPO, CNIPA or KIPO. Finally, in case there is a bundle of patents in the license agreement, there will be an additional 10% support. Total budget of the project will be 2 million TL maximum.

For the patents subject to license or assignment, the application to TÜBİTAK could be made by the certificate of registration or the search report if not registered yet. License or assignment fees of the patents that are submitted with the search reports, will be supported after the patent is registered during support period. Patents subject to the project should have at least a 10-year protection time period.

3.2.1.2. Small and Medium Enterprises Development Organization of Turkey (KOSGEB)

KOSGEB has launched three new support programs.

3.2.1.2.1. R&D and Innovation Support Program

R&D and Innovation Support Program has been launched in 2020. The purpose of the program is to develop technology-based new ideas and inventions of SMEs and entrepreneurs and to support the projects about development of new products, new processes, information and/or services. Rent, machinery & equipment, hardware, raw materials, software and service procurement costs, staff cost, start-up capital, project development cost (consultancy, test, industrial & intellectual property, etc.) are supported by the program.[37]

3.2.1.2.2. Strategic Product Support Program

KOSGEB Strategic Product Support Program has been launched in 2017. The purpose of the Program, which is in the scope of Technology-Oriented Industry Movement Program conducted by MoIT, is to support the investment to the products that are identified in the MoIT's priority product lists, which consist of products within the medium-high and high-technology industries that has critical importance and future potential for Turkey. During investment project period, support up to 5 million TL (whereof 1.5 million TL is non-reimbursable and 3.5 million TL is reimbursable) with a support rate of 60% (whereof 30% is non- reimbursable and 70% is reimbursable) provided. Machinery & equipment, software expenses support, staff cost support (whereof support rate is 100% and all amount is non- reimbursable), reference specimen support, service procurement expense items are provided.[38]

37. See for more information https://en.kosgeb.gov.tr/site/tr/genel/destekdetay/1229/rd-and-innovation-support-programme.

38. See for more information: https://en.kosgeb.gov.tr/site/tr/genel/destekdetay/6492/strategic-product-support-programme

3.2.1.2.3. SME Technological Product Investment Support Program

SME Technological Product Investment Support Program has been launched in 2017. The production and commercialization of products resulting from R&D and innovation activities in the fields of low-technology and medium-low technology are supported up to 1 million TL. The production and commercialization of products in the fields of medium-high and high-technology that will contribute to the closing of current account deficit are supported up to 5 million TL. Machinery-equipment, production line design expenses, software expenses, staff expenses, training and consultancy, promotion and marketing expenses (reimbursable & non-reimbursable in different ratios) are supported.[39]

3.2.1.3. Technology Development Foundation of Turkey (TTGV) programs

Technology Development Foundation of Turkey (TTGV), a non-profit intermediary/implementing agency-not primarily prioritizing profit, gives support for strengthening the system with programs not only based on financial incentives but also using different tools for the changing needs of the innovation system.

Ideanest, the first donation-based crowd-funding platform of Turkey has been launched in 2017 by TTGV. The program was designed to support innovation-based projects to raise funds. Through Ideanest, project owners and researchers may aggregate necessary funding for their specific needs. Furthermore, project owners and researchers can boost their idea development process by using Ideanest as a hub to reach technical competencies and expertise. In 2018, TTGV's new "Xnovate" Program, new Investment Program called "HIT" and "Make Tomorrow Program" were launched. "Xnovate" Program aims at disseminating the best practices in innovation processes that will create competition in the fields of technology, product management and innovation, while raising

39. See for more information: https://en.kosgeb.gov.tr/site/tr/genel/destekdetay/6443/sme-technological-product-investment-support-programme

human resources. Xnovate offers environment and tools in which new ideas and methods will be discussed and implemented in a community that learn and develop together with innovators. Xnovate program consists of five sub-brands in total. Xnovate Circle is a community of practice that speak, share, raise issues, learn and try to develop solutions about technology and innovation. Xnovate Fellows is a one-year program that consists of 4 modules and 1 summit. The program is designed to train innovation leaders who will make a difference. Xnovate Lab is a platform that offers different and unique applications that support the development of innovation processes. Xnovate Havadis is a news channel where you can follow up information about innovative ideas from companies, different working techniques, examples from around the world and developments in corporate innovation. Xnovate Hands-on is a platform where new ideas, unique methods, innovation tools are discussed and shared by people who are involved in TTGV's target group, innovation and technology professionals.

TTGV's new investment program called "HIT" aims at accelerating start-ups or entrepreneurs that already has a working prototype (MVP) in the thematic field chosen and provide them with early phase investment. The thematic field of the first year is "health" and the program will soon extend to other priority fields. HIT as a venture development program in selected vertical technology markets contributing to new ventures securing their first market/customer. With direct participation of industry professionals, mentors and consultants, the program implements a TTGV proprietary venture development methodology. HIT program is a translational development/investment model where TTGV develops early access to promising new ventures for its investment programs. Qualified start-ups with a valid business plan will be accepted to "Initial Market Entry Program". The program finances business development activities up to maximum $50.000 for one-year period. In this context, if the accepted start-ups are funded by an independent investor within five years of acceptance to the program, TTGV has the right to join the investment as a co-investor based on the valuation of the investor, up to $1 million at a 10% discount rate. Throughout the operational processes of the program, TTGV will contribute directly to the cost of any business development product or service. During program implementation, TTGV team works together with sector professionals, consultants, mentors

and organizations who will be appointed for each start-up for various business development activities.

Make Tomorrow Program is a digital transformation training program for students. Lecturers who have previously worked on Arduino kits or a similar platform join the program voluntarily and prepare projects with their students. The volunteer groups start working on their project demos aimed at providing solutions for identified problems in the areas of health, environment and energy, and smart cities. The Exhibition and Award Ceremony of the first term finalist projects were held. This program, in its functioning, resembles the recently established Design Factory at the Middle East Technical University (METU).

3.2.2. Regulatory tools

Both Constitution-wise and STI regulation-wise; the legal setting of Turkey has gone through major changes in the last years. The complexity, dynamics and intricacy of the legal structure well-endowed with a plethora of policy tools may sometimes lead to confusion among stakeholders. The sheer purpose of this sub-section is to present clear-cut, timely and up-to-date information on regulatory tools and familiarize readers to the legal surroundings in Turkey. This sub-section consists of six parts:

1. Principle STI laws (consisting of five main sub-sections as Laws 5746, 6676, 6550, 4691, and 6769 including five sub-sections within);
2. Digital Regulations, cybercrime and Data Protection Law (KVKK);
3. Related STI Laws (consisting of five main sub-sections as Laws 4734, 7033, 4059, 6563 and 6493);
4. Presidential decrees, presidential decisions;
5. Statuary Rules, orders and communiqués;
6. Other legal observations.

Only the legal novelties and modifications of the last five years are examined within the purposes and scope of this report.

3.2.2.1. Principle laws on science, technology and innovation

3.2.2.1.1. Law no. 5746 for Support of Research, Development and Design Activities[40]

The Law No. 5746 provides the opportunity for businesses to write down their expenditures on R&D projects as expenses, as well as providing high income tax withholding support. Under the regulation, which also provides insurance premium support to employers, purchases made by businesses are exempt from all kinds of customs duties and fees. Moreover, employees working in these businesses do not pay stamp duty. In addition to all these advantages, the regulation also provides staff support to companies and a gross wage for two years to the salaries of basic science graduates to be employed in R&D centers established under the Law *intra vires* the MoIT.

With the amendments made within the scope of the R&D reform package which came into force on February 26, 2016, arrangements were made to improve the R&D and innovation ecosystem of Turkey, especially with the enactment of the *Law no. 5746 on the Promotion of Research, Development and Design Activities*. At the heart of these regulations, design activities are included in the same scope of support as R&D activities. Within the scope of this law, the concept of Design Centre has entered into legislation and many important supports have been introduced to design centers.

R&D center certificates started being issued with the Law no. 5746 in order to define the areas in which private sector organizations cannot benefit from infrastructures especially like TDZs; and to enable companies carrying out R&D to benefit from similar support. The purpose of the support in the law is to “create an economic environment that is focused on innovation, to develop highly-skilled workforce, to produce high added value products, that have high efficiency and competitive advantage”. Increasing the international competitiveness of Turkey, developing innovation

40. https://www.mevzuat.gov.tr/MevzuatMetin/1.5.5746.pdf

capacity and establishing industrial infrastructure suitable for keeping in tune with times in the verge of a new age. The Law also provides opportunities for foreign capital companies to develop new technologies by structuring their R&D units in Turkey.

3.2.2.1.2. Law no. 6676 on the Promotion of Research and Development Activities and Amending some Laws and Decrees[41]

Within the *Information Society Strategy*, the action "providing effectiveness in incentives and support for the IT sector" has been included. The impact analysis of the supports given by the MoIT has been carried out and the necessary improvements have been made with the Law no. *6676* to increase the effectiveness of the supports. On the other hand, there is still a need to coordinate, monitor and control the incentives, including the entire value chain, from R&D to production and exports.

3.2.2.1.3. Law no. 6550 on the Support of Research Infrastructures[42]

The *Law no. 6550* for the *Support of Research Infrastructures,* prepared by the Ministry of Development entered into force via its publication in the Official Gazette dated July 10, 2014. No recent changes are observed in the Law, but it still is a fundamental law designing research infrastructures.

Secondary legislation of the Law was published in the Official Gazette dated August 28, 2015. Three regulations entered into force regulating the general principles of the application of this law, procurement and tender processes and budget and accounting transactions.

Under the *Law no. 6550*, *for more effective use of research infrastructures established or developed within the institutions of higher education and to ensure sustainability;* proficiency

41. https://www.resmigazete.gov.tr/eskiler/2016/02/20160226-1.pdf

42. https://www.mevzuat.gov.tr/MevzuatMetin/1.5.6550.pdf

was given to 4 research infrastructures by the Board of Research Infrastructure, having acquired legal personality. Proficiency was given for a period of 5 years in accordance with the Decision No. 2017/1 of the Board of Research Infrastructures dated 16/08/2017. Middle East Technical University Micro-electro-mechanical Systems Research and Application Centre (METU-MEMS), Dokuz Eylül University İzmir International Biomedicine and Genome Institute (IBG), Bilkent University National Nanotechnology Research Centre (UNAM) and Sabancı University Nanotechnology Research and Application Centre (SUNUM) are the infrastructures awarded with proficiency. The evaluation process for other research infrastructures under the law is ongoing.

3.2.2.1.4. Law no. 4691 on Technology Development Zones[43]

Within the scope of Law no. 4691 on Technology Development Zones and *Law no. 6170 amending the Law on Technology Development Zones*, a large number of TDZs have been established and started to operate in Turkey. Some recent statistics on TDZs are presented in *Section 2.5.22*. There has been a recent amendment in *Technology Development Zones law* on 03.02.2021. With this new amendment subsidies and exemptions under l*aw 469*1 and *5746* are prolonged till 31/12/2028. The most important change within this recent amendment is that, from 01.01.2022 onwards, firms and R&D and Design Centers which report more than 1 million TL revenue must transfer 2% of their revenue to a venture capital fund that aims to fund local entrepreneurs or to invest in start-ups located in incubators.[44]

3.2.2.1.5. Industrial Property Law no. 6769[45]

The *Industrial Property Law* was adopted by the General Assembly of the Turkish Grand National Assembly on December 22, 2016 and entered into force upon publication in the Official Gazette on

43. https://www.mevzuat.gov.tr/MevzuatMetin/1.5.4691.pdf

44. https://www.resmigazete.gov.tr/eskiler/2021/02/20210203-11.htm

45. https://www.mevzuat.gov.tr/MevzuatMetin/1.5.6769.pdf

January 10, 2017. A participatory approach has been put forward by holding various workshops and meetings in order to take the views and suggestions of stakeholders and to reflect these views and suggestions into text during the legislative process of the law.

The main characteristic that distinguishes the *Industrial Property Law* structurally from the previous legislation is the consolidation and harmonization of issues that are similar to each industrial property component under the *Book of Common and Other Provisions*. In this way, a compact law has been introduced that constitutes integrity among all industrial property rights. Transactions related to industrial property applications made before the date of the entry into force of the *Industrial Property Law* are carried out according to the abolished Decree-laws within the scope of the *Provisional Article 1* of the Law.

The novelties introduced by the *Industrial Property Law* for each industrial property component are as follows:

i) Legal novelties under the Book of Trademarks

In order to shorten the registration processes, the period of announcement in the Bulletin has been reduced from 3 months to 2 months. With the aim of protecting the will of the applicants to co-exist in the market; if the previous trademark owner clearly consents to the registration of the application, the application shall not be rejected if the notarized permit is submitted to the institution. To ensure more effective use of registered trademarks in the market and to prevent the application of trademark registration for goods and services that are not intended to be used; a regulation has been introduced which allows the request for the submission of information and documents relating to the use from the party objecting to the publication. The cases of invalidation and annulment were arranged separately in parallel with EU legislation and international regulations.

ii) Legal novelties under the Book of Geographical Indication and Traditional Product Names

Regulation on the protection of registered traditional specialty names through registration has been introduced. The advertisement fees, which constitute the bulk of the registration cost, were eliminated by the publication of the application in the Bulletin. The announcement period was reduced from 6 months to 3 months and the registration process was shortened. It grants the right to oppose the institution's decisions. The frequency of inspection of geographical indications has been reduced from 10 years to 1 year. An arrangement to the emblem to be used together with the geographical Indication and the traditional product name has been introduced. Thus, it is aimed to increase awareness of geographical indications and to enable the control system. A regulation has been made that allows changes in product specifications to be recorded in the register in the cases of scientific and technological developments, development of new methods in production, climate change etc.

iii) Legal novelties under the Book of Industrial Designs

The phrase "industrial designs" in KHK No. 554 and related legislation has been replaced with the phrase "designs". Arrangements have been made to comply with the EU Community Design Charter. Regulation on the formal rejection of designs contrary to public order or general morality has been introduced. In order to protect the original design works by registration, the application for the formal rejection of the design applications, which are not understood to be new, has been introduced. The 6-month notice period for published design registrations has been reduced to 3 months and the registration process has been shortened. In accordance with EU legislation, the invisible parts of the combined product and the use of the combined product for repair are excluded from the scope of design protection. In order to uncover the current design potential in universities for economic use, the right ownership of the designs of the university members has been given to HEIs, with at least 50% of the revenue generated from the design being owned by the designer.

iv) Legal novelties under the Book of Patents and Utility Models

Regulations have been made in order to solve the problems encountered in practice and to simplify and speed up the process of patent issuance. The right ownership of the inventions of the university members is given to the HEIs, with at least one third of the income generated from the invention belonging to the inventor. This is done to uncover the existing invention potential in universities and to bring the inventions to the economy by using the institutional infrastructure of universities through patents. A framework regulation was introduced on the ownership of the inventions in projects supported by public institutions and organizations, with the goals of promotion of inventions, and encouragement of participation to R&D efforts supported by public institutions and organizations at a high level in order to encourage the cooperation between public institutions and commercial companies. The patent system without review, which causes serious legal problems in practice between the rights holders and the companies and is open to misconduct, has been abolished. The patents granted can be contested after registration. Thus, after the patent has been granted, the procedure of going to court only for cancellation has been changed and an appeal period of 6 months has been introduced. Application of research reports for utility model applications has been introduced. Thus, it is aimed to give a more robust right by preventing useful models from being given to inventions that do not meet the protection criteria. In order to prevent the loss of rights often experienced in annual fee payments, the application of compensatory time and fee has been introduced. Regulation on the reestablishment of rights has been introduced.

v) Legal novelties under the Book of Common and Other Provisions

Several Decree-Laws were organized as one single law. Topics such as public representative, legal processes, the infringement of industrial property rights, right to be judged by a competent court, persons authorized to act, the notification and fee provisions were

converted into Common Provisions. Arrangements were made to address the problems related to the storage and conservation of items subject to crime. In order to solve the problems experienced by the institution during the notification phase, a new notification procedure was envisaged. Due to the Constitutional Court's annulment decisions and the legal loophole caused by the failure to comply with the Turkish Penal Code, the defendants were forced to make legal arrangements regarding the suspected criminal items in question as a result of the criminal acts, the items confiscated as a result of these acts are occupied as items of crime and not returned.

3.2.2.2. Digital regulations, cybercrime and data protection

Existing Turkish digital policies are generally in line with international standards while implementation challenges still exist. Turkey as a general principle formulates its digital regulations in compliance with EU policies and international standards. Turkish intellectual property (IP) laws have been in line with international IP protection policies, and the law is regularly updated to comply with international standards. *WIPO Copyright Treaty* has been in force in Turkey since 2008. The law recognizes electronic signatures, which speed up administrative processes. The Information and Communication Technologies Authority (BTK) has issued a regulation and closely monitors the enforcement of maintaining net neutrality by the internet service providers.

Cybercrime is treated seriously in Turkey, as a signatory of the anti-cybercrime Budapest Convention, the Turkish Penal Code addresses many digital offenses, resulting in adequate legal enforcement.

3.2.2.2.1. Law no. 6698 on Personal Data Protection[46] (KVKK)

Some of the data collected digitally is "personal data" and is subject to the rules for the protection of personal data. In terms

46. https://www.mevzuat.gov.tr/MevzuatMetin/1.5.6698.pdf

of Turkish law, *KVKK* covers this area of application. Below are general novelties regarding the scope of *KVKK*:

- Procedures and principles to obtain, store and process personal data,
- Permission for processing personal data as long as data provider's consent is obtained,
- Fines up to $350,000 in cases of breaches,
- Introduction of a new Personal Data Protection Authority for law enforcement,
- Compliance with EU Data Protection Directive 95/46/EC.

Transfer of personal data abroad can only be made if the data subjects explicitly consent to such transfer or if processing of personal data does not require explicit consent because it may be adjusted with one of the exceptions in the legislation, the country that the personal data will be transferred to shall have an adequate level of protection.

Under *KVKK*, companies operating in financial services and telecom sectors cannot store customer data outside the country.

The regulations are not definitive on the application of *KVKK* in public activities. Therefore, sector experts indicate that start-ups working with the public sector refrain from using global cloud services and opt for more expensive and less efficient solutions in order to avoid discontinued operations or fines. Turkish private consumers on the other hand can utilize international cloud services without many restrictions or regulatory barriers.

In the 2018 OCC Report[47], it is argued by the ecosystem participants that arbitrary interventions reduce international confidence and increase perceived country risk, which influence the investment decisions of domestic and international investors in related technologies.

47. https://www.occstrategy.com/media/1302/turkiyeteknogisimcilikekosistem.pdf

Much anticipated regulation relating to electronic payments, e-commerce and personal privacy and data protection came into effect in 2015 and 2016. Timely guidance on how regulations will be implemented and enforced is critical to alleviate uncertainties and allow for sound business and investment decisions. Delays in Turkish digital laws enactments hold back entrepreneurs from experimenting in new areas and technologies until the appropriate policy framework is established.

3.2.2.3. Laws directly related to the legal STI setting of Turkey

3.2.2.3.1. Public Procurement Law No. 4734[48]

The application of price advantage in favor of domestic companies in public procurement is considered as a policy tool for the development and support of domestic products and services. However, it is useful to evaluate this application once again in a multifaceted way. The change in Article 63 of *Law no. 4734* in 2017 made it mandatory to apply a price advantage of up to 15% in favor of domestic firms. The 15% advantage approach for domestic–national product procurement has become an incentive mechanism that cannot be used in practice, especially as it increases the purchase costs of public institutions.

3.2.2.3.2. Law No. 7033 Amending Some Laws and Decrees with the Aim of Developing Industry and Supporting Production[49]

Grand National Assembly of Turkey adopted the law numbered 7033 on June 18, 2017. It was promulgated on July 1, 2017 in the Official Gazette numbered 30111. In Article 3, enterprises producing information technology and software were included in the definition of industrialists in the *Industrial Registry Law*[50]. By

48. https://www.mevzuat.gov.tr/MevzuatMetin/1.5.4734.pdf

49. https://www.resmigazete.gov.tr/eskiler/2017/07/20170701-21.htm

50. https://www.mevzuat.gov.tr/MevzuatMetin/1.3.6948.pdf

the regulation stated in Article 74 a provision in favor of bidders offering domestic software product, 15% price advantage has been introduced.

3.2.2.3.3 Law no. 4059 on Financial Stability and Certain Regulations[51]

For start-up or growth stage Capital Ventures who have difficulties in accessing finance, support program has been established by Law No. 4059 by the Under Secretariat of Treasury. This is a financial tool which supports individual participation, participation of angel investors and the persons, institutions and organizations subject to this clause and regulates their activities.

3.2.2.3.4. Law no. 6563 Regulation on Electronic Commerce[52]

Some of the main subjects treated by this law are as following; Obligations for e-commerce firms to provide clear information on products/services, terms and conditions, data storage and dispute resolution mechanisms, guidance on commercial communications via electronic communication devices (except e-mails for certain purposes), introduction of ETBIS (E-Commerce Information System) to collect certain data from e-commerce firms. With the adoption of Law no. 6563, compliance with EU distance selling regulations was also achieved.

3.2.2.3.5. Law no. 6493 on Payment and Securities Settlement Systems, Payment Services and Electronic Money Institutions [53]

This law stipulates obligation to deploy data servers in Turkey for banks and financial institutions to oversee the monetary operations and protect Turkish consumers. The regulations bear resemblance with related EU regulations.

51. https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=4059&MevzuatTur=1&MevzuatTertip=5

52. https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=6563&MevzuatTur=1&MevzuatTertip=5

53. https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=6493&MevzuatTur=1&MevzuatTertip=5

3.2.2.4. Presidential Decree, Presidential Decisions

3.2.2.4.1. Presidential Decree Amending the Presidential Decree No. 59 on the Organization of the Presidency[54] (dated Tuesday, April 14, 2020. Published in the Official Gazette numbered 31099).

For the first time, two new head offices were created within the MoIT, which are critical for carrying out national technology moves, strategic research and efficiency. The Directorate of Indigenous Technology and the General Directorate of Strategic Research and Productivity were established.

Thus, the "National Technology Act" entered into legislation.

The ministry will establish policy proposals and strategies for the digital transformation of individuals and firms and for the development of the digital economy at the national level, will take measures to establish cooperation and co-direction between stakeholders in implementing strategies (public, private sector, universities, etc.) and carry out programs and projects to develop the digital economy and digital transformation ecosystem.

In addition, in order to increase the economic benefit of digitalization, it will take the necessary measures in cooperation with relevant public institutions and organizations to develop digital economy practices and to grow the ecosystem in this area. The Ministry will contribute to the creation of legislation and carry out programs and projects for the development of digital economy infrastructures and applications in parallel with digital technologies and trends.

The MoIT will take measures to increase the competence of individuals and companies in the field of big data and artificial intelligence and implement support and incentive programs, carry out programs and projects to develop and disseminate intelligent applications based on these technologies. The Ministry will support and encourage the activities carried out in this field

54. https://www.resmigazete.gov.tr/eskiler/2020/04/20200414-15.pdf

to increase the production of scientific, indigenous and unique advanced technology products and systems, contribute to the creation of the necessary infrastructures, and determine the procedures and principles for the support.

3.2.2.4.2. President's Decision no. 2248 on the Procedures and Principles for Supporting Research Infrastructure Projects of Foundation Universities by the Strategy and Budget Presidency[55]

This *Decision* dated March 4, 2020, was prepared with the aim of supporting the research infrastructure projects of foundation universities and sustainment of research infrastructures already established by supporting them in order to increase the contribution of the scientific and technological accumulation in the universities that are established and funded by foundations for economic and social development of the country.

3.2.2.5. Statutory Rules, Orders and Communiqués

3.2.2.5.1. Secondary Legislation of Industrial Property Law

Following the *Industrial Property Law,* which came into force on January 10, 2017, regulation works were carried out. The following are the legislative regulations enacted in the process following the law:

i) *Regulation on the Application of Industrial Property Law*[56]

ii) *Regulation on the boards of the Turkish Patent and Trademark Authority re-examination and Evaluation Department*[57]

iii) *Regulation on Employee Inventions, Inventions made in Higher Education Institutions and Inventions made in Publicly Funded Projects*[58]

55. http://arastirma.sbb.gov.tr/wp-content/uploads/2020/04/2020-Vakif-Usul-Esaslari.pdf

56. https://www.resmigazete.gov.tr/eskiler/2017/04/20170424-5.htm

57. https://www.resmigazete.gov.tr/eskiler/2017/05/20170512-22.htm

58. https://www.resmigazete.gov.tr/eskiler/2017/09/20170929-6.htm

iv) *Turkish Patent and Trademark Authority Professional Rules and Disciplinary Statutory Rule of Patent Attorneys and Trademark Attorneys*[59]

During the preparation process of these regulations, a participatory approach has been adopted and the opinions of the parties have been taken. The outputs of the workshops with the stakeholders were reflected in the regulation, especially in the preparation process of the regulation on employee inventions which are closely related to many different sectors, inventions realized in HEIs and inventions arising from public-sponsored projects.

3.2.2.5.2. Statutory Rule for the Implementation of Industrial Cooperation Projects

With the *Law no. 6518*, "purchases of goods and services containing industrial participation practices aimed at ensuring innovation, decentralization and technology transfer in public procurement" were deployed to be an exception from the *Public Procurement Law*. With the *Law no. 7033*, the scope of this exception was expanded to include "construction works".

Regulations are needed in the directions of adoption for implementation of the industrial cooperation program by public administrations, the development of the middle and high technology production infrastructure, maximization of the use of opportunities and capabilities within the country, increase of the domestic production rate and the achievement of the sustainability of industrial and technology progress. In this context, legislation intended to develop a new implementation model for industrial cooperation programs was published in the Official Gazette of February 17, 2018 with the number 30335[60]. The new legislation sets forth:

- Application of a technology development and decentralization project management approach, where elements such as R&D, design, production, testing are

59. https://www.resmigazete.gov.tr/eskiler/2017/05/20170518-2.htm

60. https://www.resmigazete.gov.tr/eskiler/2018/02/20180217-2.htm

addressed holistically rather than the classic acquisition-oriented approach in high-tech purchases of the public, especially in transportation, energy and health sectors, which require a great deal of cost

- Focus on the development and decentralization of intersecting critical technologies, especially the key technologies that play a role in the development of many sectors

- It is aimed to make maximum use of the opportunities and capabilities in the country and to increase the participation of local companies, especially the subsidiary industry and SMEs, in the projects.

3.2.2.5.3. Communiqué on Principles of Implementing Technology-Oriented Industrial Action Program[61]

This Communiqué was published in the Official Gazette no. 30892 dated September 18, 2019. It states: "The Program is a special program aimed at intensifying the support and incentives provided by the Ministry and its affiliated/related institutions to medium and high technology sectors in order to increase the value-added production in Turkey. The program aims to improve the production capacity of products that are critical for Turkey and have high future potential in the country. Within this context, several criteria were determined by the Ministry such as reducing import dependency, the intensification of competition, domestic production capabilities, the development trend of the global demand and potential future. Investment incentives and TÜBİTAK and KOSGEB financial supports regarding the 'Product Priority List' will be re-organized under a single-window mechanism. It is aimed to implement investment projects that will contribute to the technological development that Turkey needs within the scope of the program with end-to-end governance and support model."

The Technology-Oriented Industry Action Program has been built on bureaucratic simplicity-convenience with the goal of removing

61. https://www.resmigazete.gov.tr/eskiler/2019/09/20190918-7.htm

all obstacles to the production and industrialization of technology in Turkey.

3.2.2.6. Other legal observations

- Amendments to the Turkish Commercial Code[62] have enabled smoother procedures for establishing a business. Recent reforms and digitization efforts have simplified various business procedures in order to stimulate the business environment, though some are not yet fully in effect. New reforms enabled individuals to set up "Joint-Stock Company" and "Limited Liability Company" as single owners, and allowed companies to have operations outside their field of activity.

- Turkish Commercial Code, which was enacted in 2011, enabled holding Board of Directors and General Assembly meetings online as well as carrying out commercial transactions through electronic signature. Furthermore, General Communiqué No. 397 of the Tax Procedural Law[63] enables Joint-Stock Companies and Limited Liability Companies to keep and present their invoices in electronic format.

- Paid-in capital requirements were also lowered to 25%, compared to 100% before the reforms passed. Some sectors, such as FinTech, require higher paid-in capital, but this is appropriate given the sensitivity of the sector.

- Regulations regarding foreign investments in Turkey such as Law on Foreign Direct Investment No. 4875[64] and Law on Encouragement of Investments and Employment and Amendment of Certain Laws No. 5084[65] welcome foreign investors and protect their rights by providing freedom of investment and equal conditions with local investors.

62. https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=6102&MevzuatTur=1&MevzuatTertip=5

63. https://www.gib.gov.tr/node/88067

64. https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=4875&MevzuatTur=1&MevzuatTertip=5

65. https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=5084&MevzuatTur=1&MevzuatTertip=5

- While professionals with adequate business experience and familiarity with procedures consider current company establishment procedures straightforward, less experienced individuals feel the need for better guidance.

- Compliance with the current regulatory obligations is proving burdensome for early-stage start-ups. Social security, VAT, and withholding tax obligations are concerns of ecosystem participants, as well as legal fees and bankruptcy procedures. Obligations increase start-ups' death and reduce their chances to survive for longer periods. Certain measures are being implemented to reduce burden of regulatory obligations.

- The Turkish Ministry of Trade in its "Entrepreneurship Strategy & Action Plan for 2015-2018" included plans to reduce burdens with grants to entrepreneurs in advance, removing regulatory obstacles, easing liquidation procedures in case of bankruptcy, and giving a second chance to failed entrepreneurs.

- The Ministry of Finance introduced a tax reduction law for entrepreneurs under 29 years old that allows first-time entrepreneurs to deduct TRY 75,000 from their profits before paying taxes for three years.

3.2.3. Soft tools

3.2.3.1. Public University Industry Cooperation (KÜSİ)

The MoIT initiated the Public University Industry Cooperation (KÜSİ) project in 2014 to enhance the synergy between the stakeholders in public-university-industry cooperation. A planning and development board was established within this regard. In addition to the incentives offered by the MoIT, KÜSİ specialized on public-university-industry cooperation aiming at increased cooperation and interaction and access of stakeholders to R&D funds, researchers, investors and information through a single point. Users who are members of the KÜSİ platform are regularly informed about cooperation and investment opportunities,

success stories, new incentives, R&D and innovation and events organized by ministries, TDZs, industrial parks, chambers of commerce and industry, universities and non-governmental organizations.[66]

3.2.3.2. Deneyap workshops

Within the framework of the first 100-day execution program of the presidency, 100 Deneyap (try-and-make) technology workshops were established in 81 provinces. Cooperation has been established between the MoIT, the Ministry of Youth and Sports, TÜBİTAK and the Turkish Technology Team Foundation (T3 Foundation). With the contributions of these four institutions that contribute to the development of young people in Turkey, especially in the field of technology, Deneyap Turkey has been implemented.

The main objective of Deneyap Turkey is to train young individuals who are capable of producing technology that will form the driving force of the National Technology Act. (see section 3.1).

The training model of Deneyap technology workshops is designed for students of two age groups to gain skills such as entrepreneurship, creative thinking, critical thinking, solving complex problems, effective communication and teamworking. In the experiments, young people starting secondary and high school receive 36 months of free training in 10 subjects such as design and manufacturing, robotics and coding, electronic programming and the internet of things, nanotechnology and materials science, and aerospace technologies. In this 3-year period, they gain both basic technology competencies, while deepening in special interest areas, and ability to produce ideas and projects.

The first phase study of Deneyap Turkey; Adana, Ankara, Antalya, Edirne, Eskişehir, Erzurum, Hakkari, İzmir, Konya, Manisa, Muğla and Trabzon provinces began in July 2019 and training continues with 1920 students.[67] In the second phase of the study, preparations are continuing to start training in 18 provinces including Adıyaman, Afyonkarahisar, Antalya, Ağrı, Çanakkale, Çorum, Elazığ, Gaziantep, Isparta, Kahramanmaraş,

66. See the web page of the platform for details: https://kusip.gov.tr/kusip/views/portal

67. See the web page of Deneyap for details: https://www.deneyapturkiye.org

Kastamonu, Malatya, Rize, Sakarya, Samsun, Şanlıurfa, Tokat and Yozgat as of spring 2020.

3.2.3.3. Teknofest

Turkey's largest technology gathering, the İstanbul Aviation, Space and Technology Festival (TEKNOFEST İstanbul), 2019, was held at Ataturk Airport on September 17-22. The event, led by MoIT and T3 Foundation received great attention with 1.7 million visitors and became the world's largest aviation festival. In the event, where 19 technology competitions were held in 44 categories, 17,373 teams and 50 thousand contestants competed. People from 122 countries and 81 provinces of Turkey attended the event. The event was held in Gaziantep in 2020. The event received more than 20 thousand applicants (teams, about 100 thousand people in total) from 81 cities and 84 countries.[68]

3.2.3.4. Cyber security emergency drill

One of the recent highlights in technology has been "cybersecurity" activities. A cyber security exercise was carried out under the coordination of the Ministry of Transport and Infrastructure and The Information Technology and Communication Authority (BTK), while measures against the growing threat of cyber-attacks were strengthened.

Cyber-attack vulnerabilities and malicious software were detected through the scenarios. The technical infrastructure and scenarios were prepared entirely by the National Cyber Incident Response Center (USOM) under BTK. A "cyber shield" has been strengthened against possible attacks that have the potential to affect many areas, from energy facilities to financial institutions, from military units to communications infrastructure.

3.2.3.5 E-government services

Opportunities in technology have also been reflected in the services offered via the e-government portal. With 944 new services integrated in

68. For more information see https://www.teknofest.org/en/

2019, the number of services in e-State reached 5,180, while the number of users reached 45,072,811. The number of entries to e-government, which was 5,747 in 2008, reached 3,825,074,210 in 2019. 2,600 of the services are provided by government agencies, 2,123 by municipalities, 403 by private institutions and 54 water and sewerage services. The number of services is scheduled to increase further in 2020 with concept, location, and process-based improvements.[69]

3.2.3.6. TÜBİTAK workshops

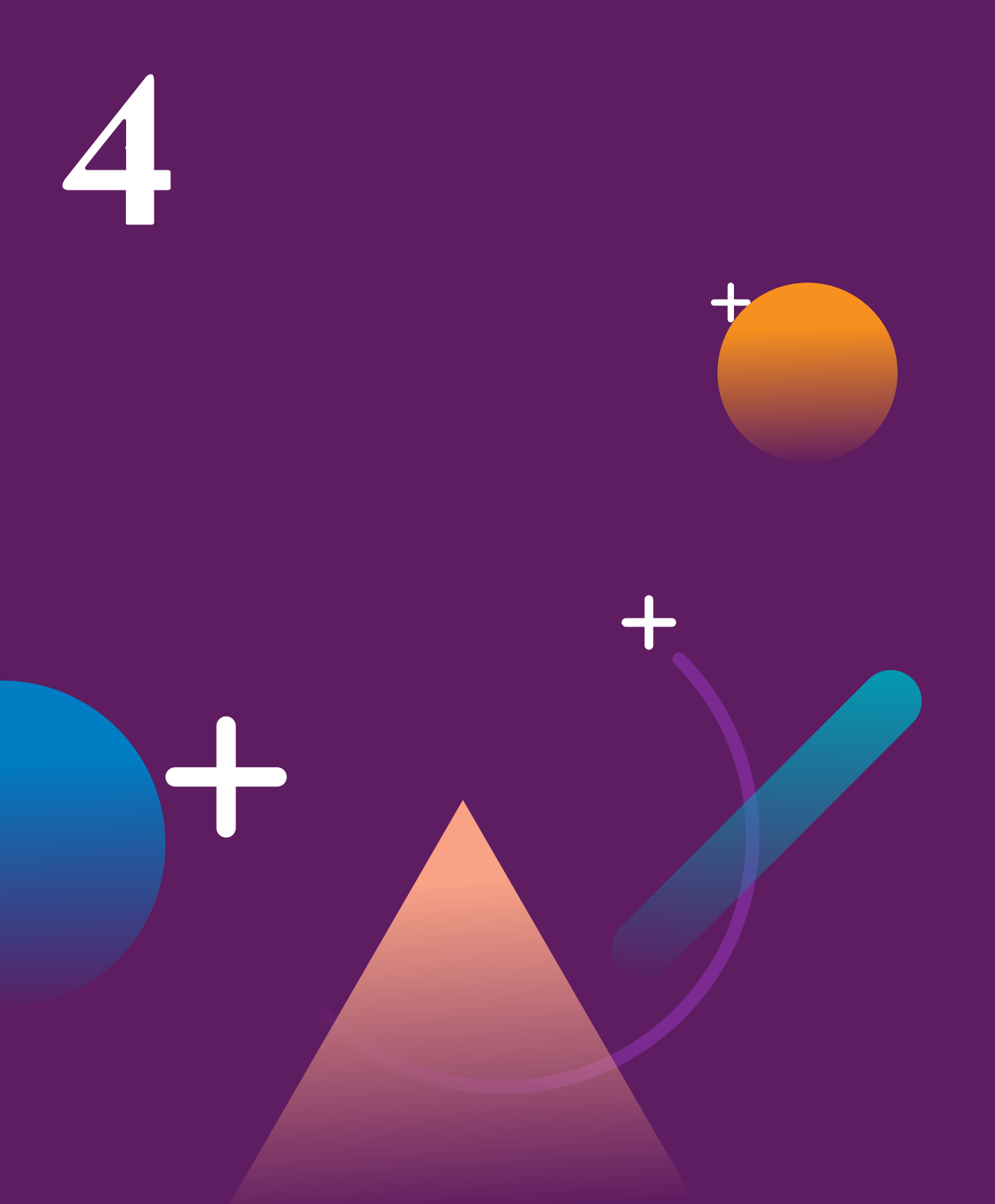
On-foot workshops are activities held in portable experiment stations. These experiment stations can be set up in exhibition galleries or anywhere in Science Centers.[70] Many experiments can be carried out at a station, as well as experiments associated with exhibitions when installed in the exhibition space. Any visitor can be involved in the experiments. One-to-one communication occurs between the visitors and the attendants, and the visitors perform the experiments individually. These stations are organized to cater to every age group and aim promotion of science and technology and different types of learning. The purpose of the on-foot workshops is to stir up excitement towards science and technology. TÜBİTAK also organizes travelling exhibitions. In 2019 Confronting Mars, Dinosaurs' Age, Sultans of Science and Earth Exploration exhibitions were organized in Kocaeli, Konya, Üsküdar, Kayseri, Bursa.[71]

69. https://www.aa.com.tr/tr/turkiye/e-devlet-te-2023-hedefi-53-milyon-kullanici/1693593

70. See the web page of Bilim Merkezleri for details: https://bilimmerkezleri.TUBITAK.gov.tr/Icerik/bilim-merkezi-nedir-140

71. See the web page of Gezici Sergiler for details: https://bilimmerkezleri.TUBITAK.gov.tr/Icerik/gezici-sergiler-167

4



4. Who Performs R&D and Innovation Activities?

4.1. R&D and Innovation Activities in the Business Sector

This section provides brief information and statistics on the performance of the business sector regarding R&D expenditures, R&D personnel, innovation activities and patents. Statistics on R&D expenditure can be used to determine who conducts and funds R&D, presenting a more actor centric approach. IPR statistics are also presented as an input indicator. Statistics from the TÜİK Innovation Survey (IS) and Community Innovation Survey (CIS) and European Innovation Scoreboard present a more output oriented look. This section also provides brief information on various indices such as the Global Innovation Index and Doing Business Index presenting data and rankings on sub-indices and indicators on innovation in general and the state of business sector in particular. In this way, one can see Turkey's position in the world when various indicators are considered.

4.1.1. R&D performance of the business sector

The business sector accounts for the largest share of R&D expenditures in industrialized economies. Turkey's pattern of both expenditure and funding of R&D by the business sector has a rising trend but is still short of industrialized countries. The Business Expenditure on Research and Development (BERD) in Turkey in 2019 reached €4.64 billion and BERD per inhabitant accounted for €56.6 (see Table 4.8). As can be seen in Table 4.1, the share of R&D expenditure of the business enterprise sector in all R&D expenditure doubled, from 33.74% to 64.12%, between 2001 and 2019. Unlike the business sector, the share of higher education has halved mirroring the increase in BERD. The share of government in overall R&D expenditure is relatively low around 10% but reduced about 3 percentage points from 2018 to 2019 which may seem contradicting with state attempts of indigenous technology production especially in the past 3 years.

Table 4.1. Sectoral distribution of R&D Expenditure (% in total)

	2001	2006	2011	2015	2016	2017	2018	2019
Business	33.74	37.03	43.19	50.01	54.21	56.88	60.44	64.12
Government	7.36	11.68	11.33	10.34	9.49	9.57	9.24	6.62
Higher Education	58.90	51.30	45.48	39.66	36.30	33.55	30.32	29.18

Source: TÜİK, R&D Statistics

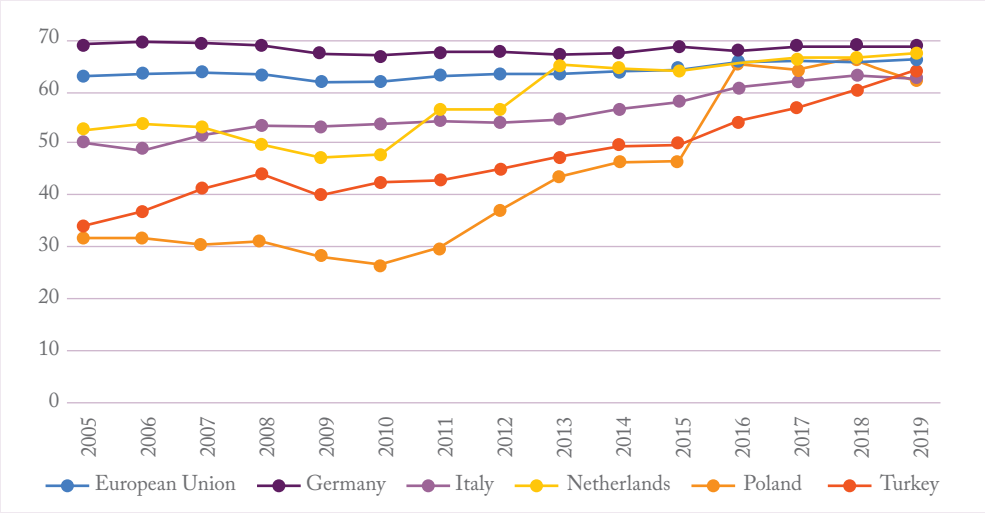
The share of the expenditure on R&D performed by the business sector has increased over time (64.1%) and caught other EU countries: 68.9% in Germany, 62.3% in Italy, 62.8% in Poland, 66.3% EU average (see Figure 4.1). Considering also the leading role of non-EU countries in R&D and innovation, the share of BERD is at a much higher rate: 80.2% in South Korea, 79.4% in Japan, 77.4% in China and 72.5% in the USA.[72]

The matrix, presented in Table 4.2, shows the R&D expenditures and sources of funds by sectors in 2011 and 2019. Besides the increase in the share of the business sector in both R&D expenditures and source of funds, there are some changes in terms of interaction by sectors of performance. For instance, compared to 2011, the contribution of the business sector in higher education in terms of funding increased five folds and now accounts for about 2% of total funding.

Additionally, the share of foreign funds in all R&D expenditures has been reducing and is now only 1.5%. The contribution of foreign funds in BERD rose from 0.76% in 2011 to 5% by 2017 and has been reducing since then (in 2019 only 1.5%) even though the private sector participation in international research programs (i.e., Horizon 2020) has increased over the years. There is not a notable change in foreign funds allocated to the government. Foreign funds allocated to the higher education sectors has been reducing since 2014 (from 2.8% to 1.7%).

72. Calculated from Eurostat Data on Research and development expenditure, by sectors of performance in 2017, Accessed June 12, 2020 https://ec.europa.eu/eurostat/databrowser/view/tsc00001/default/table?lang=en

Figure 4.1. Share of business sector in total R&D expenditure (%)



Source: Eurostat, Research and development expenditure- by sectors of performance

Table 4.2. Gross domestic expenditure on R&D by sector and source of funds, 2011 and 2019

Source of funds (millions of TL)							
	National						Abroad
Sectors	Total	Sub-total national funds	Business	Government	Higher education	Other	
2011							
Total	11,154.15	10,959.43	4,416.50	4,668.28	1,869.96	4.69	194.72
Business	4,817.27	4,780.43	4,347.22	429.31	1.42	2.49	36.84
Government	1,263.50	1,253.54	24.95	1,228.01	0.04	0.54	9.96
H. Education	5,073.37	4,925.45	44.34	3,010.96	1,868.49	1.67	147.92
2019							
Total	45,953.69	45,260.39	25,892.37	13,487.89	5,871.57	8.55	693.29
Business	29,500.71	29,053.11	25,582.78	3,460.98	4.11	5.25	447.59
Government	3,044.48	3,035.51	83.69	2,950.71	0.70	0.46	8.97
H. Education	13,408.29	13,171.76	225.89	7,076.19	5,866.84	2.84	236.73

Source: TÜİK, R&D Statistics

The distribution of R&D expenditures has been changed over the years. The type of R&D expenditure of the business sector can be seen below in Table 4.3. Labor costs, which was the smallest portion of R&D expenditures in 2001 now constitutes half of the R&D expenditures of the business sector. This trend is mirrored by the fall in capital costs from about half to less than 10% of the R&D expenditures. The dramatical drop of the share of capital cost in total may warrant optimal labor-capital allocations in R&D activities.

Table 4.3. Type of R&D expenditure of business (share within total Business R&D)

	2001	2006	2011	2015	2016	2017	2018	2019
Labor costs	19.55	37.24	47.97	51.15	48.27	52.67	49.08	49.90
Other current costs	34.54	50.49	36.95	39.55	43.58	40.82	42.20	42.78
Capital costs	45.91	12.28	15.08	9.30	8.15	6.51	8.71	7.31

Source: TÜİK, R&D Statistics

Regarding the human resources devoted to R&D activities, the weight of the business sector has increased through the years (Table 4.4). The share of the business sector has grown from 11.52% in 2001 to 42.44% in 2019 in terms of total number of R&D personnel, and from 20.24% in 2001 to 62.85% in 2019 in terms of total full-time equivalent (FTE) researchers.

In terms of the number, the majority of R&D personnel are employed by higher education. The great increase in the number of universities in Turkey in the last decade may explain this partially. However, considering the FTE researchers, which excludes the teaching and other related activities, the share of R&D personnel stock in higher education is much lower. One particular trend is that the share of the government in R&D personnel stock is continuously declining. It seems that the government is slowly departing from active involvement in R&D activities which is questionable given that Turkey is still a developing country in middle-technology trap and that the government is more willing to actively be involved in market creating rather than market fixing activities.[73]

73. Ye, L. and Robertson, P. (2016) Identifying prisonners of the middle-income trap, voxeu. https://voxeu.org/article/identifying-prisoners-middle-income-trap

Table 4.4. R&D Personnel (share in total, sectoral shares)

	2001	2006	2011	2015	2016	2017	2018	2019
Head count								
Business	11.52	21.34	33.49	34.58	34.63	38.05	41.02	42.44
Government	11.25	11.04	8.57	6.34	5.52	4.81	4.45	3.42
Higher Education	77.23	67.62	57.94	59.08	59.85	57.13	54.54	54.13
Full-Time Equivalent (FTE)								
Business	20.24	33.11	48.93	54.52	53.00	57.26	60.64	62.85
Government	19.11	17.82	12.66	10.08	8.62	7.39	6.61	4.86
Higher Education	60.65	49.06	38.41	35.40	38.39	35.36	32.75	32.28

Source: TÜİK, R&D Statistics

4.1.2. Innovation performance of business sector

According to the most recent statistics, the results of the TÜİK Innovation Survey (2016-2018), 36.0% of all enterprises are innovative in Turkey. The percent of innovative enterprises account for 39.0% in industry and 32.4% in the service sector (see Table 4.5).

According to NACE classification, scientific research and development (NACE 72) have the highest percentage on innovative enterprises followed by information and communication (NACE J: 58-63), manufacturing (NACE C: 10-33) and financial and insurance activities (NACE K: 64-66).

Table 4.5. Innovative enterprises and types of innovation activities (%)

	General	Industry	Service	Scientific Research
2016 – 2018				
Innovative enterprises	36.0	39.0	32.4	78.0
Ongoing innovation active enterprises	24.6	26.8	21.9	59.7
Product innovative enterprises	20.9	24.0	17.0	46.3
Process innovative enterprises	29.0	31.8	25.5	63.4
2008-2010				
Innovative enterprises	51.4	52.2	50.3	84.0
Ongoing innovation active enterprises	14.6	14.7	14.4	48.1
Product innovative enterprises	24.4	25.7	22.7	60.2
Process innovative enterprises	27.4	29.0	25.5	48.1

Source: TÜİK, Innovation Statistics

Compared to 2008-2010 period, it is observed that the values for the 2016-2018 period are much lower. However, it is highlighted by TÜİK that, there are radical changes in the types of innovation and questionnaires with the publication of the 4th version of the Oslo Manual in 2018.[74] A better comparison is provided in Table 4.7 that summarizes the business-related indicators and benchmarks in the European Innovation Scoreboard. According to this, Turkey performs better compared to 2012 EU average in SMEs product/process innovations and SMEs marketing/organizational innovations and SMEs innovating in-house (see section 4.1.4.6).

Among the innovative enterprises in general, 39.9% registered a trademark. This is followed by patent application (24.7% of the firms), utility model application (13.7% of the firms), copyright application 10.4% (of the firms) and industrial design registration (9.5% of the firms).[75]

74. http://www.tuik.gov.tr/PreTablo.do?alt_id=1039

75. TÜİK Press Release on Innovation Survey 2018, Accessed June 10, 2020 http://www.tuik.gov.tr/PreHaberBultenleri.do?id=30581

Table 4.6. Number of IPR applications received by TÜRKPATENT

Type of Application	2001	2006	2011	2015	2016	2017	2018	2019
Patent and Utility Model	3,874	7,616	12,313	15,622	19,307	17,621	19,110	22,885
Trademark	29,105	66,855	117,723	110,679	107,176	121,108	120,008	134,353
Industrial Design	13,902	31,321	41,536	46,413	46,500	46,853	42,345	46,188

Source: TÜRKPATENT, Patent Statistics

When the sectoral distribution of the patent and utility model applications is analyzed, pharmaceutical industry is leading (12.5%), followed by household equipment (7.1%), medical devices (6.5%), machinery (5.8%) and chemicals (5.6%).[76]

According to the WIPO Intellectual Property Indicators ranking (2019), in terms of intellectual property filing activity by origin, Turkey ranks 23rd in the global ranking of patent applications, 10th in trademark application and 7th industrial design applications.[77]

4.1.3. Actors of the business sector

The creation of intermediary actors to enhance R&D activities of the business sector started to be an important policy tool in the 1990s with the establishment of TEKMERs. In the 2000s, the legal infrastructures of intermediary actors were regulated by Law on the Support of Research and Development Activities No: 5746 and Law on the Technology Development Regions No. 4691. TDZs, R&D and design centers, technology transfer offices (TTOs), incubation centers and accelerators are vital elements of the NSI today together with the actual R&D and innovation performers (firms). Besides providing financial support,

76. TÜRKPATENT, Official Statistics, Accessed June 21, 2020 https://www.turkpatent.gov.tr/TURKPATENT/statistics/

77. WIPO, World Intellectual Property Indicators 2019, Accessed on June 20, 2020 https://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2019.pdf

these intermediary organizations contribute to developing R&D culture among different types of business actors, including corporate companies, SMEs, and start-ups. This section provides a non-exhaustive list of such intermediary organizations complementing the discussion in section 2.5 and Figures 2.5 and 2.6.

4.1.3.1. Technology Development Centre (TEKMER)

The public support programs for the entrepreneurs began with the establishment of Technology Development Centre (TEKMER) in the early 1990s by KOSGEB. TEKMERs are regarded as one of the forerunners of intermediary actors in the NSI. The main aims behind the establishment of TEKMERs were to create and support technology-based SMEs and academic start-ups by providing support for R&D and innovation and industrial implementation activities especially through university-industry collaboration. KOSGEB established TEKMERs in cooperation with universities and regional actors such as chambers of commerce and industry, and more recently regional development agencies. TEKMERs offer office space, physical infrastructure as well as consultancy services and education activities for capacity building. Easy access to government support programs for technology-based entrepreneurs is another benefit of TEKMERs.

The operations of TEKMERs continue in 41 centers.[78] However, compared to the 1990s, the establishment of the TEKMERs has slowed down in the recent years and even has stopped in the past few years due to “accelerator” trend and the entrepreneurship programs of TÜBİTAK. The KOSGEB Strategic Plan includes a series of actions to restructure the TEKMERs to increase their effectiveness and qualifications. KOSGEB has started to focus on the restructuring of TEKMERs by working on a new model to adapt them to recent conditions and to make them the center of attraction for SMEs again. This new model is based on outsourcing TEKMER

78. KOSGEB Strategic Plan 2016-2020, Accessed June 3, 2020 kosgeb.gov.tr/Content/Upload/Dosya/Mali%20Tablolar/KOSGEB_STRATEGIC_PLAN_(2016-2020)_.pdf

activities to universities but maintaining the KOSGEB financial supports for the tenants.[79]

4.1.3.2. Business Development Centre (İŞGEM)

Business development centers (İŞGEM) are a kind of business support platform in which entrepreneurs can benefit from low-priced office space, shared coaching, consultancy and administrative services, easy access to finance, and management support. The first centers in Turkey were established by the support of the World Bank in 1997. These centers had important missions in the 1990s to reduce unemployment after the privatization operations and to support female entrepreneurship.[80] Since 1997, total of 19 İŞGEMs have been established and 3300 personnel employed by 450 enterprises are located in İŞGEMs.[81]

4.1.3.3. Technology Development Zones[82]

Technology Development Zones Law No. 4691, enacted in 2001, forms the legal framework of the TDZs (technoparks). It fosters the establishment of technoparks in higher education institutes or research centers to enhance knowledge circulation and create synergy within technoparks and between firms and universities. Besides providing physical infrastructure and opportunity for being part of the R&D and innovation environment, firms in technoparks are provided with certain financial advantages:

79. For a recent review of TEKMERs see Akçomak, İ.S. and Koçak, K. (2020). Türkiye'de Kuluçkalar: Eski Yapılarla ve Yeni Yapılar Birarada Yaşayabilir mi? in Akçomak, İ.S., Beyhan, B., Çetindamar, D., Tandoğan, V.S. (eds), Türkiye'de Yenilik Tabanlı Girişimcilik, Bilgi Üniversitesi Yayınları in press.

80. KOSGEB Annual Report 2019, Accessed May 18, 2020 https://www.kosgeb.gov.tr/Content/Upload/Dosya/Mali%20Tablolar/Faaliyet%20Raporlar%C4%B1/KOSGEB_2019_Y%C4%B1l%C4%B1_Faaliyet_Raporu.pdf

81. Demirhan, D., Temel, S. and Durst, S. (2019). The Role of Public Entrepreneurship Programs in Fostering Technology-based Entrepreneurship: A Turkish Case Study, Dana, L.-P. and Ratten, V. (eds.) Societal Entrepreneurship and Competitiveness, Emerald Publishing Limited, pp. 5-28.

82. Accessed November 3rd, 2020 https://www.sanayi.gov.tr/istatistikler/istatistiki-bilgiler/mi0203011501

- Tax exemptions under the law are temporary and limited until 2028.
- Corporate tax exemption of the profits derived from the operations, exclusively from the software, design and R&D activities in the premises of technoparks,
- Value-added tax (VAT) exemption of deliveries and services in the form of system management, data management, business applications, sectoral, internet, mobile, and military command-control application software,
- Exemptions on half of the employer's share of social security premium for the employees who work in firms operating in the technoparks,
- Exemption on stamp tax and duties for the products imported for use in R&D, innovation, and design projects,
- The personnel of public institutions, agencies, and universities who serve as research staff for activities in technoparks, can be employed part-time or full-time, with the permission of their institution,
- Academic staff can establish firms, partner with a company and/or take part in the management of a company in the technoparks in order to commercialize the output of their academic research.

The number of technoparks has reached 87 as of January 2021. While 72 of the technoparks are active, 15 technoparks are under construction. The number of companies performing R&D in all technoparks has reached 6,364 with 66,615 employees. 54,562 of these are classified as R&D personnel. When the sectoral distribution of the companies is analyzed, ICT and software development is leading (45%), followed by natural science and engineering (7%).

There are 322 foreign firms or firms with foreign shareholders within the premises of technoparks. The number of patents received (national/international) by the companies located in the technoparks is 1,262. The total export of all companies in technology development zones has reached $5.6 billion.

4.1.3.4. R&D centre[83]

Law No. 5746 on Support of the R&D and Innovation Activities came into force in 2008. Unlike TDZs, R&D centers only receive financial support on tax deduction, income tax exemption, social security premium support, and stamp tax exemption.

R&D centers have an important role in the Turkish NSI. The number of R&D centers reached 1,244 as of January 2021. The total personnel employed in the R&D centers is 66,469, 13,269 of whom have master's and/or doctoral degrees. The number of completed and ongoing projects in all R&D centers are 53,863. The overall number of patents generated by R&D centers is 24,454; 7,058 of which are registered and 17,476 are in the application phase. From the viewpoint of attracting foreign direct investment (FDI), there are 210 R&D centers that belong to a foreign firm or a firm with foreign shareholders.

Considering the sectoral distribution of R&D centers in Turkey, the forefront sectors are machinery (174) and automotive supply industry (127), followed by software (113), computer and communication (83), textile (78), electric-electronic (77), chemicals (72), food (61), defense (40), pharmaceutical (34) and energy (28). A large number of R&D centers (420) are located in İstanbul, followed by the major manufacturing hubs Bursa (130) and Kocaeli (126), respectively.

4.1.3.5. Design center[84]

In 2016, the amendment on the Law on the Support of Research and Development Activities No: 5746 was extended to include design activities being eligible for incentives and supports granted to R&D centers. As of January 2021, the number of design centers reached 364 with 7,861 personnel employed in these centers. Master's and doctoral degree holders are about 9% of the personnel.

83. Accessed September 10, 2020 https://www.sanayi.gov.tr/istatistikler/istatistiki-bilgiler/mi0203011502

84. Accessed September 10, 2020 https://www.sanayi.gov.tr/istatistikler/istatistiki-bilgiler/mi0203011503

When considering the sectoral profiles, 65 design centers are in the textile sector, 46 of them are in engineering and architecture services, 45 design centers in manufacturing, 37 in the machinery and equipment sector, 19 in furniture, 19 in media-communication and 19 in the automotive supply industry. Depending on the sectoral distribution being predominant in the textile and manufacturing industries, design centers are concentrated in İstanbul, Ankara, İzmir, Bursa, and Kocaeli.

29 design centers are owned by foreign firms or firms with foreign shareholders. The number of completed and ongoing projects in all design centers are 9,538. The number of patent applications (national/international) by the design centers, is 489, 177 of which are registered.

4.1.4. International indexes: Position of Turkey in business related indicators

4.1.4.1. Global Competitiveness Report 2019[85]

In the 2019 edition of The Global Competitiveness Report, which is published by the World Economic Forum, Turkey, with a slight improvement compared to the previous years, ranked 61st among 141 countries. Turkey's performance was mixed, with significant progress in some dimensions while losing ground in some others. Considering business-related indicators, Turkey's position on innovation capability (49th) was relatively better than the overall performance. Under the innovation capability pillar, Turkey scored relatively well in commercialization (49th) and research and development (38th), but relatively bad in interaction and diversity (93rd).

4.1.4.2. Global Innovation Index

The Global Innovation Index determines and ranks the innovation capabilities of world economies by measuring 80 of innovation-related indicators. In 2020 according to the overall performance, Turkey ranked 51st out of 131 economies, which was 49th in 2019, 50th in 2018, 43rd in 2017.[86]

85. The Global Competitiveness Report 2019, Accessed April 3, 2020 http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

86. Global Innovation Index 2020, Accessed September 10, 2020 https://www.globalinnovationindex.org/userfiles/file/reportpdf/gii-full-report-2020.pdf

When the indicators are grouped into innovation inputs and innovation outputs, Turkey's performance is almost the same level in innovation outputs (53rd) and inputs (52nd). While Turkey performs the best in the pillars on market sophistication, human capital-research and creative outputs; institutions, business sophistication, and knowledge-technology outputs are the weaknesses of Turkey's innovation capabilities.

4.1.4.3. Doing Business Index

The World Bank's Doing Business Index provides a base of comparison for the general policy environment for businesses across 190 countries.[87] Turkey ranks 33rd among 190 economies. Turkey scores relatively well on protecting minority investors (21st), enforcing contracts (24th), paying taxes (26th) and registering property (27th). However, in "starting a business", one of the important indicators of the index, Turkey ranks only 79th.

4.1.4.4. Global Entrepreneurship Index

The Global Entrepreneurship Index is an annual index of the Global Entrepreneurship and Development Institute that measures the health of the entrepreneurship ecosystems in various countries. According to the Global Entrepreneurship Index 2019, Turkey ranks 44th out of 137 countries losing seven places compared to 2018.[88] The best rankings in the sub-indices are in product innovation, high growth and start-up skills, whereas Turkey performs relatively bad in risk acceptance, competition and networking.[89]

87. Doing Business 2020 – Economy Profile Turkey, Accessed May 16, 2020 https://www.doingbusiness.org/content/dam/doingBusiness/country/t/turkey/TUR.pdf

88. Global Entrepreneurship Index 2019, Accessed May 6, 2021 https://thegedi.org/wp-content/uploads/2021/02/2019_GEI-2019_final_v2.pdf

89. For an analysis of Turkey's position in the Global Entrepreneurship Monitor see Karadeniz, E. (2020), Türkiye'de girişimcilik faaliyetleri ve girişimcilik ekosistemi, in Akçomak, İ.S., Beyhan, B., Çetindamar, D., Tandoğan, V.S. (eds), Türkiye'de Yenilik Tabanlı Girişimcilik, Bilgi Üniversitesi Yayınları in press.

4.1.4.5. Legatum Prosperity Index[90]

Legatum Prosperity Index evaluates the strengths and weaknesses of the countries by sorting them under 12 economic and social indicators. According to the index in 2020, Turkey is 94th among 167 countries. Turkey performs most strongly in the investment environment and living conditions but is weakest in safety-security, personal freedom, and social capital. Comparing the overall performance, Turkey's position on business-related pillars is relatively better. Turkey ranks as 52nd in the investment environment, 54th in market access and infrastructure, and 58th in enterprise conditions. Turkey has moved down the rankings by 21 places since 2010.

4.1.4.6. European Innovation Scoreboard[91]

Turkey is classified as a moderate innovator country in the European Innovation Scoreboard 2020. Compared to 2020, Turkey's performance is better in the overall index. Innovators, firm investments and innovation-friendly environment indicators are the strongest innovation dimensions. However, Turkey is weak in scientific publications, employment impacts, and attractive research systems indicators.

90. The Legatum Prosperity Index 2019, Accessed May 23, 2020 https://prosperitysite.s3-accelerate.amazonaws.com/8115/8635/0367/The_Legatum_Prosperity_Index_2019.pdf

91. European Innovation Scoreboard 2020, Accessed September 10, 2020 https://ec.europa.eu/docsroom/documents/41900

Table 4.7. Comparison of Turkey's performance in European Innovation Scoreboard

	Relative to EU (2012)	Relative to EU (2019)
	Modest Innovator	**Moderate Innovator**
Summary Innovation Index	55.2	62.3
Business-related indicators		
Innovation friendly environment	85.8	69.0
R&D expenditure in the business sector	25.5	36.4
Non-R&D innovation expenditures	250.2	178.5
Medium and high-tech exports	43.2	55.4
Knowledge-incentive services export	16.5	37.6
SMEs product/process innovations	94.8	129.8
SMEs marketing/organizational innovations	106.2	164.4
SMEs innovating in-house	77.5	161.5
Intellectual assets	18.8	21.7

Source: European Innovation Scoreboard 2020. Country Profile: Turkey

Considering the EU average of business-related indicators in 2012 and 2019, Turkey's performance is relatively better on knowledge-incentive services export, intellectual assets and SMEs' innovating activities (see Table 4.7).

4.1.5 General performance

Table 4.8 summarizes some of the indicators discussed earlier and includes others to present a general understanding of the R&D and innovation performance of the business sector. In spite of the increasing trend, BERD is still low compared to the EU average, especially in terms of per capita spending. The share BERD in total R&D expenditure and the share of R&D employment in the business sector in total R&D employment is slowly converging to the EU average and expected to catch-up the EU average soon. In terms of output

indicators such as share of high-technology exports there is still a long way to go. Table 4.8 complement Table 2.1 in section 2.1.

Table 4.8. General Performance of Business Sector in R&I

	2006	2011	2015	2016	2017	2018	2019	EU27 average
Business expenditure on R&D (BERD)(million euro)	900	2,060	3,407	3,995	4,120	4,080	4,640	7,561
Business expenditure on R&D (BERD) per inhabitant (Euro)	11.4	27.2	43.9	50.7	51.6	50.5	56.6	456.3
Share of business expenditure on R&D in total R&D expenditure (%)	37.3	43.2	50.0	54.3	56.9	60.4	64.1	66.3
R&D personnel in business sector as a share of total R&D personnel (%)	33.1	48.9	54.5	53.0	57.3	60.6	62.8	59.5

Source: OECD, Main Science and Technology Indicators

4.2. Higher Education Sector

4.2.1. General performance of the higher education sector

Table 4.9 reveals the quality of the science and research base in Turkey compared to the EU, based on the methodology adopted by the European Innovation Scoreboard (EIS).

The EIS 2020 framework distinguishes between four major types of innovation performance indicators together with 10 related dimensions. Framework

conditions identify the main drivers of innovation that are external to the firm and define the basis for innovative activities. Two of these dimensions in the framework conditions are represented by human resources and attractive research systems.[92]

Table 4.9. Quality of the Science and Research Base

	Actual performance within the year							Relative to EU in 2012	
Human Resources	2012	2015	2016	2017	2018	2019	EU 28 (2019)	TR Change*	EU Change*
New doctorate graduates per 1000 population aged 25-34	0.35	0.41	0.48	0.48	---	---	2.1 (2017)	9.0	10.1
Percentage population aged 25-34 having completed tertiary education	23.8	26.5	29.4	30.5	32.1	33.5	40.5	80.2	27.3
Percentage population aged 25-64 involved in lifelong learning	3.9	5.5	5.8	5.8	6.2	---	11.1 (2018)	31.1	4.4
Research Systems									
International scientific co-publications per million population	86.4	104.9	117.4	118.1	123.9	142.8	1171.8	8.1	51.9
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	5.01	4.97	5.32	5.52	---	---	10.79 (2017)	-0.8	1.8
Foreign doctorate students as a % of all doctorate students	3.8	6.5	7.4	8.4	---	---	21.4 (2017)	38.2	14.6

Source: European Commission, European Innovation Scoreboard, 2020
** Change refers to difference in normalized scores between the most recent period and 2012.*

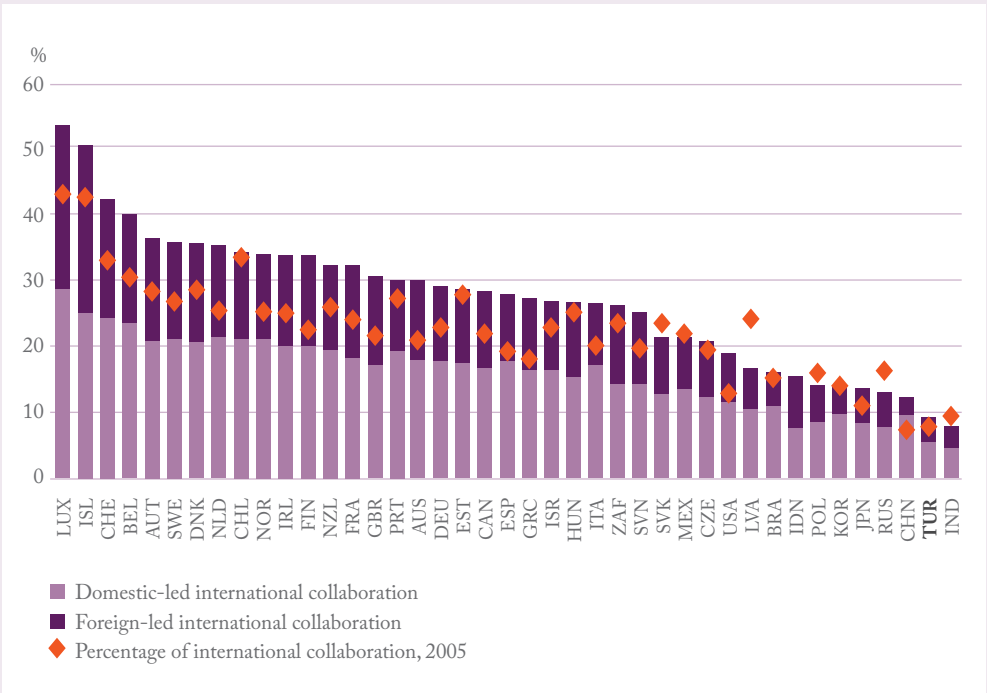
92. The third dimension in this framework is represented by innovation-friendly environment that evaluates the business environment in which firms operate and measures the degree of entrepreneurial activities. Two variables in this dimension are broadband penetration among enterprises and opportunity-driven entrepreneurship.

Human resources dimension has three indicators measuring the availability of a high-skilled and educated workforce using three variables: new doctorate graduates, population (aged 25-34) with completed tertiary education and population (aged 25-64) in education or training.

Second dimension is the attractive research systems composed of three indicators, which is a measure of the competitive strength of the science base in a country. This dimension also uses three variables: international scientific (co)publications, the quality of the publications proxied by scientific publications in the top 10% most cited publications and the number of foreign doctorate students.

As for human resources, Turkey has rapidly converged to the EU average by rising its high-skilled workforce implying a high potential for increasing living-standards in the long-term if human resources are conducive for innovation (see the last two columns of Table 4.9). However, the same performance is not achieved in increasing the new doctorate graduates that are regarded as more relevant in conducting basic and applied research activities. Lifelong learning programs has become particularly important in the age of digital technologies as the countries need to transform their active labor force to secure competitive strength and avoid unemployment. The EIS 2020 figures suggest that although the growth rate of the population aged 25-64 involved in lifelong learning is robust, it remains almost half of the figure for the EU in 2018. Therefore, Turkey needs to prepare its own roadmap and define the procedures on how to support firms and individuals to accelerate active education and training programs, which is now more important due to the increased pace of digitalization in the COVID-19 era.

Figure 4.2. International scientific collaboration, 2015



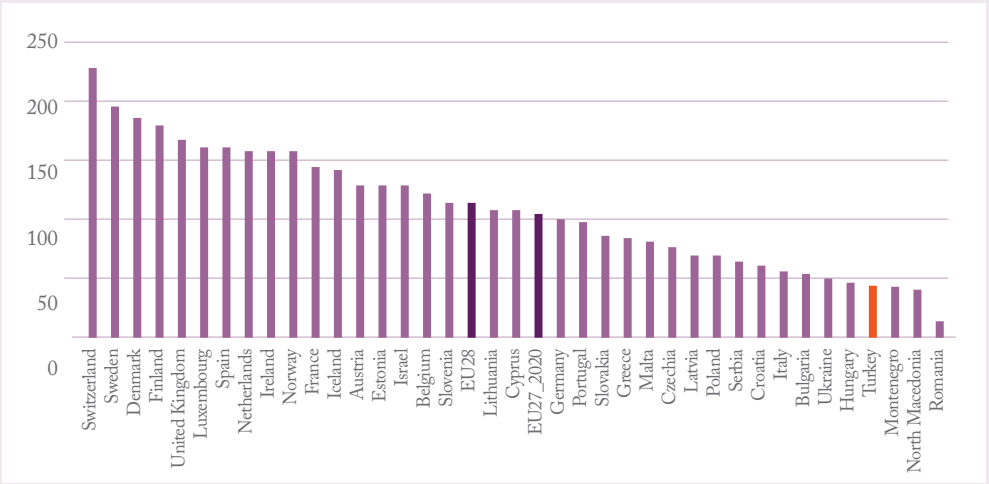
Source: OECD (2017)

Research systems dimension in Turkey displays a weaker feature compared to the EU. In addition, the development over time in respective indicators fell short of EU relative to its level in 2012. It is observed that the quality of scientific publications has declined relative to 2012, suggesting international competitiveness of scientific base measured as scientific publications among the top 10% most cited publications has decelerated. One explanation for having a low share in the quality publications might be that international scientific collaboration as a percentage of domestically authored documents was very low in Turkey as of 2015 and did not change much in the last decade (Figure 4.2). According to OECD (2017), scientific research collaboration is highly correlated with citation impact at the country level. Hence, participation more intensively in global scientific networks is suggested to enlarge the limited scale of the

most cited publications. Another explanation is that increases in the number of faculties and universities have not been met by the number of skilled and qualified researchers. One of the favorable developments was achieved in increasing the number of foreign doctorate students in Turkey as international mobility of highly educated people is accepted as a major driver of knowledge circulation between countries. As of 2015, the share of international doctoral students in natural sciences, engineering and ICT was about 40% and display a similar pattern for domestic doctoral students (OECD, 2017).

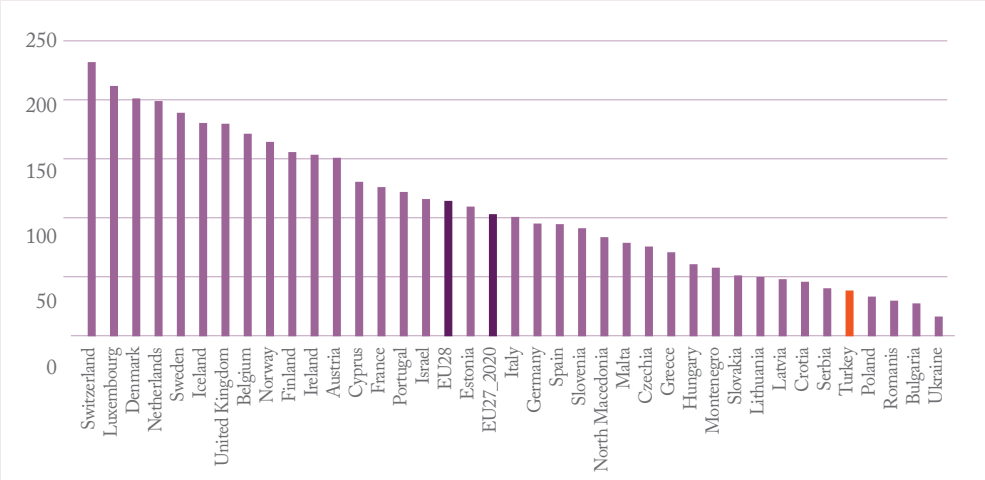
These two dimensions of framework conditions highly associate with each other, as countries with strong human resources are more likely collaborate with international counterparts and generate higher quality knowledge. One remarkable observation is that the countries that are the leaders in innovation as defined by EIS 2020 are the ones that have also improved their quality of science and research base much further than the moderate innovator countries (See Figure 4.3 and Figure 4.4). Turkey is classified as a moderate innovator country, nevertheless fell short of improving its performance relative to the 2012 level of EU compared to its counterparts regarding both dimensions, suggesting more emphasis on restructuring the higher education sector to strengthen the foundations of knowledge creation.

Figure 4.3. Change in human resources in 2019 relative to EU-28 in 2012 (%)



Source: European Commission, European Innovation Scoreboard, 2020

Figure 4.4. Change in research systems in 2020 relative to EU-28 in 2012 (%)

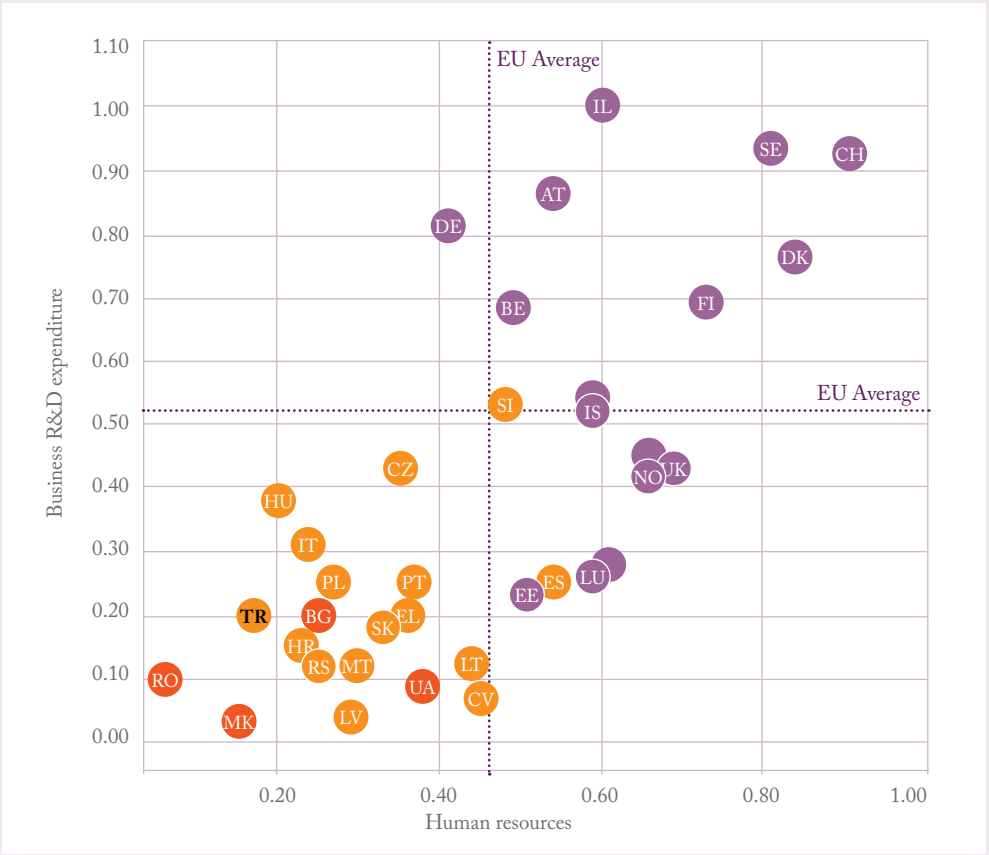


Source: European Commission, European Innovation Scoreboard, 2020

Quality of the science and research is also known as the basis for innovation activities of the business sector as implied by the strong correlation between framework conditions and invention and innovative activities of the business sector. The countries above the EU average on these dimensions have also outpaced in the scale of business R&D expenditures and intellectual assets for patent, trademark and design applications that are implied by human resources and attractive research systems at the country level (Figure 4.5 and Figure 4.6). Relative performance of the countries with respect to innovation activities invites policy intervention in Turkey aiming at constant improvement of the quality of the science and research base that sustains and stimulates R&I activities.

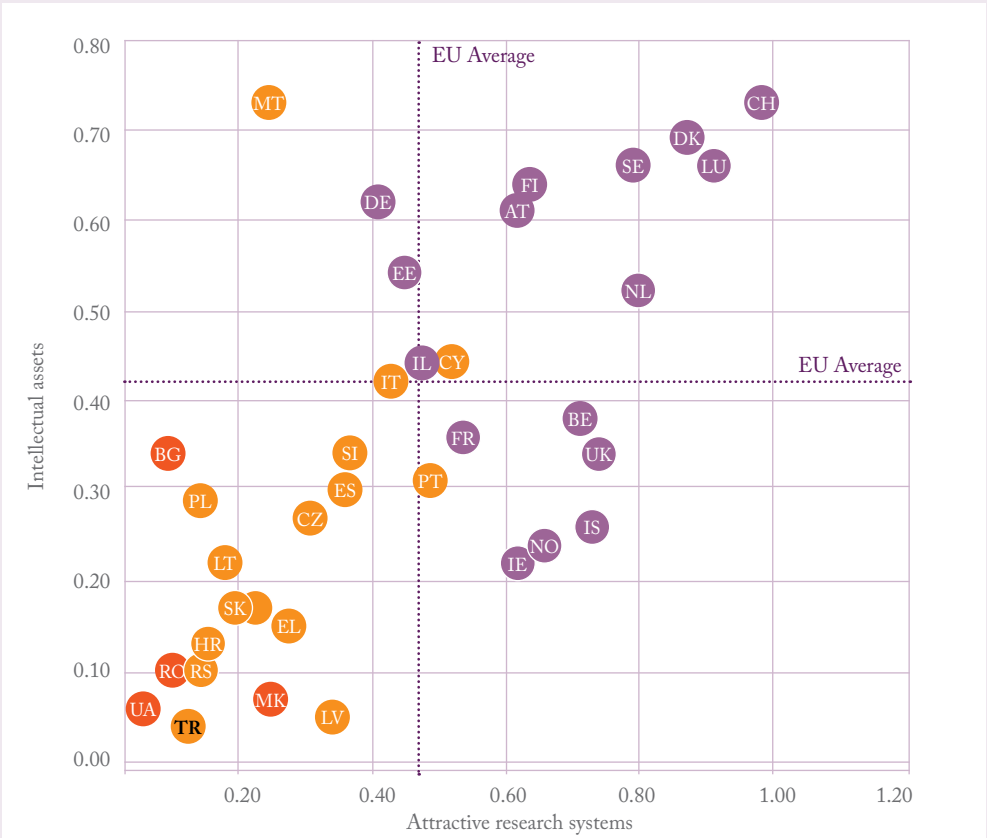
The indicators for research systems as defined by EIS 2020 may also reflect the performance of the countries' higher education systems in terms of governance, resource allocation and international attractiveness. Further, it is the key for improving the quality of the science and research base which provides a basis for the scale of business R&D expenditures as well as intellectual assets. Therefore, investing more in higher education is the key for Turkey to increase its international competitiveness. This is considered as a highly relevant instrument for realizing competitive production and high productivity objectives of Turkey, that have been emphasized in the 11th Development Plan.

Figure 4.5. Relationship between Business R&D Expenditures and Human Resources



Source: EIS 2019

Figure 4.6. Relationship between Intellectual Assets and Attractive Research Systems



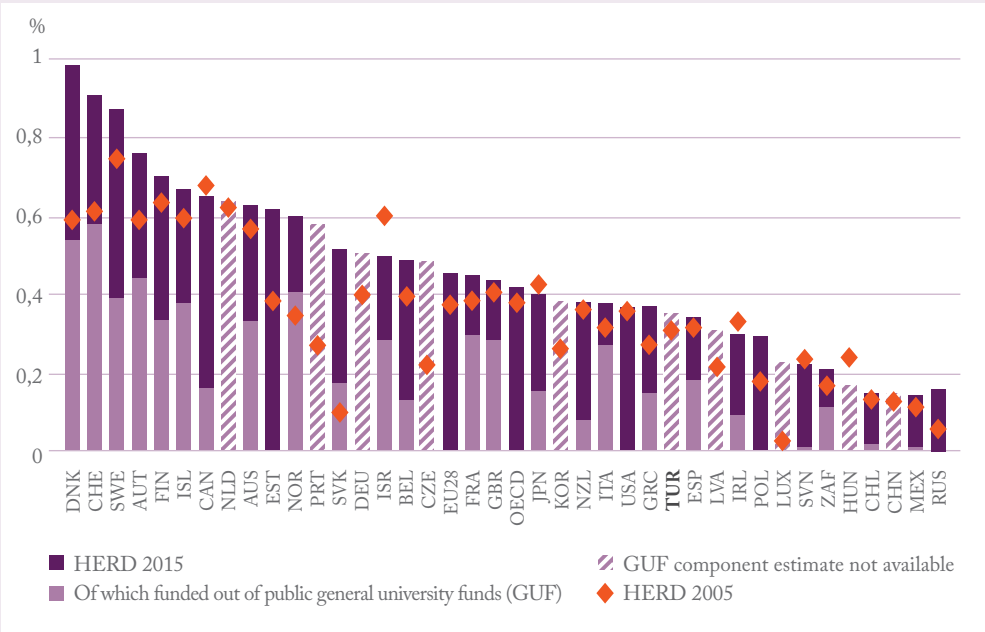
Source: EIS 2019

The HEIs cover all universities, colleges of technology and other institutions conducting formal tertiary education programs, as well as all research institutes and centers whose R&D activities are under the direct control of HEIs. Public general university funds (GUF) represent funding share granted to universities from the central budget to support research and teaching activities. Higher education sector R&D expenditures (HERD) is associated more likely with the basic research, which refers to experimental or theoretical work carried out mainly to generate new knowledge without a particular application of new findings. Hence, it opens a window for applied research to be undertaken by the private sector for technological innovations (OECD, 2017).

In OECD countries, R&D expenditures carried out by HEIs (HERD) account for 0.35% of GDP, which is similar to the level of EU28 as of 2015 (0.32% in Turkey as of 2017). However, higher education expenditure spending on R&D has risen more in EU than the OECD average compared to 2005 (Figure 4.7). HERD in Turkey accounts for approximately one third of total R&D expenditure. This implies that, slightly less than one third of resources are allocated to conducting basic research in Turkey. The target of doubling the total R&D expenditures at the end of the 11th Development Plan period has the potential to enhance R&D expenditure of the higher education sector.

On average, 70% of the resources for HERD are granted from central government budget in OECD countries (often through general university funds). In addition to this, HEIs also raise their own funds from tuition revenues or receive transfers from other HEIs to finance R&D activities. This is notable in Turkey, where 46% of R&D funds of HEIs are either covered by collaborating HEIs or universities' own funds (OECD, 2017).

Figure 4.7. Higher Education Expenditure on R&D, 2015 (as a percentage of GDP)



Source: OECD (2017)

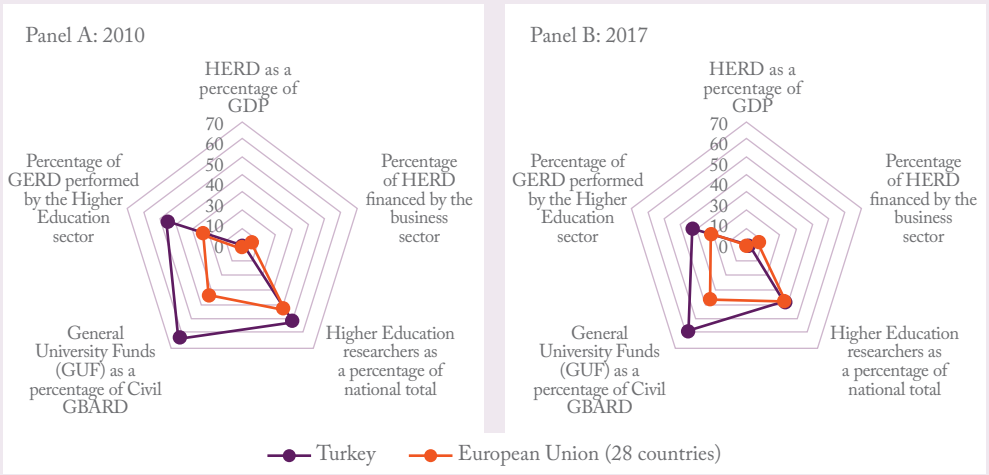
In addition to providing higher education and conducting basic research, HEIs have been undertaking an increasing role in applied research, innovation activities and diffusion of knowledge as private sector also begin to engage in financing of HERD, which is an indication of R&D collaboration between these two sectors (OECD, 2018; see also Figure 4.2).

Despite the wide dispersion among OECD countries, government funds have still been the main source of academic research activities. Although, it tended to decline after the global crisis in 2009, many economic and social challenges globally call for new technological and social innovations that require public funding. The earliest taxonomy for government funding for R&D distinguishes between competitive (i.e. funding research projects selectively) and non-competitive (institutional block grants) funding types. However, public funding has evolved recently in a way that more funds are allocated to competitive projects and non-competitive institutional funding are provided to HEIs based on certain performance-based variables. Turkey is not very different in this sense. Providing institutional funding based on strategic components, is no longer considered as non-competitive. With

the conditionality of public funds in some countries (i.e., Sweden, Norway), it is aimed a better alignment between research activities and national priorities, while preserving institutional autonomy (OECD, 2018).

Figure 4.8 compares the inputs and the performance of higher education sector in Turkey and the European Union with respect to 2010 and 2017. In both panels, general university funds constitute the main source of higher education research expenditures, while business sector funding increases slightly as of 2017. The figure implies that higher education sector is the main beneficiary from the central budget for R&D expenditure in Turkey. Business sector financing for higher education sector R&D expenditure is more than fivefold in European Union compared to Turkey. Higher education researchers as a percentage of national total researchers have both declined in Turkey and the EU that implies a rising research activity in the business sector. Policy implication follows that stronger network connections and collaborative mechanisms between higher education and business sector need to be built up in Turkey to generate more funds towards higher education sector that is assumed to increase the R&D performance. This also questions the impact of university-industry collaboration policy tools in Turkey that have been implemented for a long time. Strengthened collaborative mechanisms on the other hand is expected to favor research needs of business sector in technology development.

Figure 4.8. Resources and Performance of Higher Education Sector in Turkey and European Union (28 countries), Panel A (as of 2010), Panel B (as of 2017).



Source: OECD Stat, Main Science and Technology Indicators

4.2.2. Data, network and open access in HEIs

Turkish Academic Network and Information Centre (ULAKBİM) aims to manage a high-speed computer network that enables interaction between the institutional elements of the national innovation system and provide information technology support and information services to assist scientific production. ULAKBİM also provides technological facilities like computer networks, information technology support, and information/document delivery services, so that the information requirements of universities and research institutions can be met, and the efficiency and productivity of their end users can be increased.[93] ULAKBİM also manages the biggest scientific research support programs of Turkey, Incentive Program for International Scientific Publications Originating from Turkey (UBYT), where researchers receive certain amount of money from TÜBİTAK if they publish in web of science indexed journals. This support reaches up to 15,000 TL depending on the journal and its impact factor.[94]

Turkish National Research and Education Network (ULAKNET), conducted by Network Technologies Department of ULAKBİM ensures that network services are always one step ahead of the expectations of its users and today approximately 111,000 lecturers, researchers and over 2,500,000 university students benefit from this service. Moreover, Network Technologies Department also provides an R&D networking platform for innovative demands from the research elements of the innovation system.

Turkish National Science e-Infrastructure (TRUBA) is a national e-infrastructure that provides scientific research by promoting high-performance computing, grid computing, and data-intensive computing services to over 1300 researchers in 106 universities, and developing projects in cooperation with a variety of public institutions.

JournalPark Project, conducted by TÜBİTAK ULAKBİM, provides users with web-based publications of academic journals and an online journal management system. The project, aims to enable nationwide service to meet a variety of requirements within this context rapidly.

93. For more information see TUBITAK ULAKBİM. (2020). Ulusal Akademik Ağ Ve Bilgi Merkezi. Retrieved 21 May, 2020, from https://ulakbim.TUBITAK.gov.tr/

94. See more information at https://cabim.ulakbim.gov.tr/ubyt/

Thanks to the hosting service offered by ULAKBİM, the whole process starting from the submission of an article to its publication can be carried out in an electronic environment, with an infrastructure compatible to international standards.

Education Roaming (EDUROAM) aims to provide using the network for the users of Eduroam member institutions in other educational institutions. Owing to Education Roaming, users of Eduroam member institutions can be connected to the network from another institution (Guest Institution) which is a member of Eduroam with the username and password that they use to connect to the network in their institutions.

TÜBİTAK Open Science Policy was accepted recently in January 2019.[95] The policy constitutes the management, storage, archiving, compilation and digital preservation of the publications and research data produced by the projects carried out or supported by TÜBİTAK. The policy implementation started immediately in selected programs in 2019 and now covers all TÜBİTAK programs. Open Science Policy follows the Green Road Open Access requirement based on self-archiving.[96] To support the access of open science documents, all project related documents need to be uploaded to TÜBİTAK Open Archive (https://aperta.ulakbim.gov.tr/). Though it is recommended that research data and publications from the projects could be open access, there is no specific funding from TÜBİTAK and the HEIs for open access publications.

Open Science Policy is an important step of TARAL's compliance with European Research Area (ERA). It is expected that the policy will increase the visibility and impact of Turkey's scientific publications.

95. See for details https://ulakbim.TUBITAK.gov.tr/en/haber/TUBITAK-open-science-policy-accepted.

96. The Open Science Policy could be found at https://ulakbim.TUBITAK.gov.tr/sites/images/Ulakbim/TUBITAK_open_sciency_policy-eng.pdf

4.3. Government

Though the scale of government as a performer and funder of STI activities is increasing in absolute terms, its share within total R&D expenditures has been declining since 2011 and is currently about 7% of total R&D expenditure (see Table 4.1). As a funder, government's role has been degrading since 2016. Currently about 29% of available funds in R&D activities is government oriented (see Table 5.1). Direct government spending on R&D activities has doubled in the past five years (2015-2019) and indirect government allocations of the government has tripled (2015-2018) in nominal TL terms. But in terms of US dollars, the total government allocations to R&D activities is fixed around $3 billion (Figure 5.3).

It is difficult to draw the line between the roles of the government as a performer and funder of STI activities. Turkey's attempt to produce a fully electric car - Türkiye Otomotiv Girişim Grubu (Turkey's Automobile Initiative Group, TOGG) is a good case. The attempt, the initial organization and the early-stage investment is government led. In mission-oriented policy jargon the government is creating a market. However, in statistical terms, the performer is actually a firm: consortium of five industrial firms and the biggest NGO, The Union of Chambers and Commodity Exchanges (TOBB). Thus, most such government attempts and organizations are in fact covered in section 4.1 where business STI activities are discussed and in section 5.3.2 where the government's role as a funder is discussed. Another case is the recent government attempt of creating research infrastructures (see section 3.3.2.1.3 on law 6550) complementing university research. The funder and the initiator are the government but the performer in statistical terms is the HEIs or the business depending on the structure of the research infrastructure.

Apart from some few examples such as the Institute of Health Data Research and Artificial Intelligence Applications (TÜSEB) organized under the Ministry of Health almost all government activity in STI as a performer is organized under TÜBİTAK. There are 8 R&D Units and 3 R&D Support Units organized under TÜBİTAK.

R&D Units at TÜBİTAK

- Marmara Research Centre (MAM)
- Informatics and Information Security Research Centre (BİLGEM)
- Defense Industry Research and Development Institute (SAGE)
- Space Technology Research Institute (UZAY)

- National Metrology Institute (UME)
- Rail Transport Technology Institute (RUTE)
- Research Institute for Fundamental Sciences (TBAE)
- Turkish Institute for Management Sciences (TÜSSİDE)

R&D Support Units at TÜBİTAK

- National Academic Network and Performance Centre (ULAKBİM)
- Bursa Test and Analysis Laboratory (BUTAL)
- National Observatory (TUG)

R&D Units and R&D Support Units generate about 5.2 billion TL of revenue of which 90% is generated at the R&D Units. Revenues include projects, education, service and direct government transfers as well. Most of these R&D Units are funded by the government. 71% of the revenue of UZAY, 61% of the revenue of MAM and 97% of the revenue of TBAE comes from direct transfers of government. In total about 40% of revenues of R&D Units are direct transfer from the government. Among these R&D Units, three stand out in terms of scale: SAGE, MAM and BİLGEM. 34% of the generated revenue comes from these three R&D Units. In terms of the share of project revenue in total, two R&D Units stand out, SAGE and MAM.[97]

Among R&D Support Units, ULAKBİM stands out in scale. These support units are mostly funded by the government and ULAKBİM takes the lion's share (92% of direct government transfer goes to ULAKBİM alone).

57% of TÜBİTAK personnel is classified as R&D personnel (2,987 researchers as of 2019) and 26% is classified as R&D support personnel (1359 personnel as of 2019). In total, about 80% of TÜBİTAK personnel is either R&D or R&D support personnel.[98] Compared to 2009, both the absolute number and the share of R&D related personnel within the total has increased.

In the last decade there is only one recent addition to R&D Units at TÜBİTAK which is the Institute of Rail Transport Technologies, that was established at the end of 2019. The institute, established in TÜBİTAK Gebze campus, aims to follow the developments in the world and carry out R&D and innovation activities in the field of safe, fast and efficient rail transport technologies. Indigenous technology production within the field of rail transport technologies is a central focus of the institute.

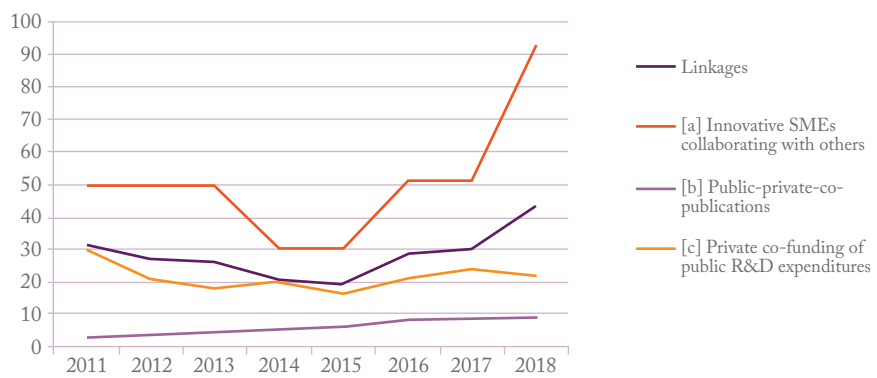
97. https://www.TUBITAK.gov.tr/sites/default/files/18842/TUBITAK_2019_yili_faaliyet_raporu.pdf

98. https://TUBITAK.gov.tr/sites/default/files/18842/2020-pp.pdf

4.4. Cooperation and Collaboration

Universities, industry and the government are three main actors that perform and fund STI activities by cooperating and collaborating with each other. It is essential that these three actors interact closely and collaborate effectively in the innovation process to promote economic development by both enhancing the environment for R&D and innovation activities and increasing inputs and outputs of the innovation process via transfer of technology and knowledge.[99]

Figure 4.9. Turkey's performance over time according to linkage indicators of EIS (in percentage)



Source: European Innovation Scoreboard 2019, 3. Innovation activities, 3.2. Linkages

The linkages dimension of European Innovation Scoreboard (EIS) measures the public-private cooperation and collaboration of countries. Turkey's cooperation and collaboration performance over time is demonstrated in Figure 4.9. Looking at the linkages dimension we can say that Turkey has an overall increase in collaboration. Both

99. Etzkowitz, H., Leydesdorff, L. (1995). The Triple Helix - University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development. EASST Review, 14(1), 14-19. Available at SSRN: https://ssrn.com/abstract=2480085; Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. Research Policy, 29(2), 109-123. https://doi.org/10.1016/S0048-7333(99)00055-4; Etzkowitz, H. (2007). University–industry–government: The Triple Helix model of innovation. EOQ Congresses Proceedings. 51st EOQ Congress, 22–23 May, 2007. Prague. Retrieved from http://www.eoq.org/fileadmin/user_upload/Documents/Congress_proceedings/Prague_2007/Proceedings/007_EOQ_FP_-_Etzkowitz_Henry_-_A1.pdf

public and private collaborations of SMEs have increased significantly ([a] in Figure 4.9), especially in the recent years. The amount of increase in academic publications resulting from collaboration of private sector and public sector researchers ([b] in Figure 4.9) is very low. Turkey is well below the EU average in the public-private co-publication activities. When private co-funding of public R&D expenditures is taken into consideration, Turkey's state is even worse ([c] in Figure 4.9), placed among the last three countries out of 36.

Other indicators demonstrating collaborations in STI are also included in the 2019 versions of Global Competitiveness Report and The Global Innovation Index. Table 4.10 summarizes some countries' scores and world rankings, according to indicators that measures STI cooperation in 2011 and 2019. As one of the sub-indicators of the innovation linkages dimension in The Global Innovation Index, "5.2.1 university/ industry research collaboration" represents countries' performance in terms of R&D cooperation between universities and the private sector. According to this indicator, Turkey is ranked 88th among 129 countries with a score of 37 out of 100 in 2019. Furthermore, as part of the innovation capacity pillar in the Global Competitiveness Report, the "12.04 multi-stakeholder collaboration" indicator shows the cooperative performance of countries' national stakeholders in activities ranging from knowledge production to innovation. Accordingly, Turkey scored 3.6 out of 7 in multi-stakeholder collaboration by ranking 86th among 141 countries in 2019. But most remarkably, according to both indicators, Turkey's ranking in STI cooperation has declined from 2011 to 2019.

Table 4.10. Country profiles according to STI collaboration indicators specified in Global Innovation Index 2011[100]-2019[101] and Global Competitiveness Report 2011[102]-2019[103]

	Global Innovation Index				Global Competitiveness Report			
	5.2.1 University/industry research collaboration				12.04 Multi-stakeholder collaboration			
	2011		2019		2011		2019	
	Score/ 100	Rank/ 125	Score/ 100	Rank/ 129	Score/ 7	Rank/ 142	Score/ 7	Rank/ 141
Israel	68.0	13	79.4	2	5.4	7	5.4	1
Netherlands	69.8	11	75.5	4	5.3	8	5.4	3
Germany	70.6	9	72.8	6	5.2	13	5.2	7
France	50.6	41	54.6	30	4.2	36	4.5	29
Italy	41.4	63	49.5	41	3.5	79	3.7	64
Spain	49.6	43	42.2	59	4.1	42	3.6	81
Turkey	39.5	75	37.0	88	3.5	74	3.6	86
Poland	43.8	57	35.1	92	3.6	65	3.2	116
Greece	33.8	102	25.6	122	2.9	120	3.1	123

Looking at both indicators demonstrated in Table 4.10, Turkey has a poor performance on STI collaboration, lagging behind the Netherlands as an innovation leader as well as strong innovators such as Israel, Germany, and France in 2019. Among moderate innovator countries, Turkey is left behind Italy and Spain relatively while in front of Poland and Greece in 2019 for both indicators.

100. Global Innovation Index 2011, Accessed June 25, 2020 https://www.wipo.int/edocs/pubdocs/en/economics/gii/gii_2011.pdf

101. Global Innovation Index 2019, Accessed June 25, 2020 https://www.globalinnovationindex.org/userfiles/file/reportpdf/gii-full-report-2019.pdf

102. The Global Competitiveness Report 2011-2012, Accessed June 25, 2020 http://www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf

103. The Global Competitiveness Report 2019, Accessed June 25, 2020 http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

4.4.1. National cooperation

In order to enhance STI activities in Turkey, the first steps towards developing collaborations and cooperation at the national level began with the 6th Five-Year Development Plan 1990-1994, aiming to create an active collaboration ecosystem. Especially since 1995, significant efforts have been made to improve cooperation and interaction between the university, industry and the government, and as a result, many applications and programs have been implemented.[104] In this section, the practices that emerge as a result of collaborations among the university, industry and the government with the aim of supporting and developing science, technology and innovation, will be summarized.

4.4.1.1. University-university

In this section, implementations aiming to increase knowledge exchange, knowledge production, and research activities by inter-university cooperation agreements or student and academician exchange programs, are briefly described.

4.4.1.1.1. Inter-University Collaboration Program (ÜNİP)

ÜNİP was established on 21 July 2006 with the initiative of Atatürk University, Cumhuriyet University, Erciyes University, Fırat University, Gaziosmanpaşa University, İnönü University, Kafkas University, Karadeniz Technical University, and Yüzüncü Yıl University. This project aims to promote scientific and technological research and development projects to be carried out by the member universities of the ÜNİP at the undergraduate and postgraduate levels and the protocol is renewed every 5 years. The objectives of the ÜNİP joint project commission are as follows; ÜNİP members provide privileges (low price, priority, etc.) to each other for R&D projects, integrate R&D projects into the R&D Data System and Communication Network created by Erciyes University via web services, give priority to BAP Projects to be

104. Kiper, M. (2010). Dünyada ve Türkiye'de Üniversite-Sanayi İşbirliği. TTGV. Retrieved from https://ttgv.org.tr/content/docs/ueniversite-sanayi-isbirligi-2010-11.pdf

made jointly among member universities, encourage members to actively use the “Scientific Research Projects Information Sharing Platform”, universities, whose experience and infrastructure are suitable, organize training programs on R&D Project Preparation and Project Management once a year for the researchers of the member universities.

4.4.1.1.2. Farabi Exchange Program

Farabi Exchange Program is a national exchange program for students and faculty members of universities and higher technology institutes among HEIs that provide education at undergraduate, graduate and doctorate levels. Farabi Exchange Program aims for students or faculty members to continue their education and training activities in a HEI outside their own institutions for one or two semesters. Non-refundable grants for students and additional course payments for faculty members who participate in the Farabi Exchange Program are provided. The main purpose of the Farabi Exchange Program is to contribute to the education and training, academic studies, social development processes and career plans of students and staff by placing them in a different academic environment.

Table 4.11. Numbers of incoming and outgoing exchange students of Farabi Exchange Program

Academic year	Incoming Students			Outgoing Students		
	Male	Female	Total	Male	Female	Total
2015 - 2016	1,226	2,035	3,261	1,237	2,047	3,284
2016 - 2017	967	1,659	2,626	967	1,659	2,626
2017 - 2018	980	1,616	2,596	980	1,616	2,596
2018 - 2019	787	1,249	2,036	1,297	1,882	3,179

Source: istatistik.yok.gov.tr

4.4.1.1.3. MEVKA Inter-University Cooperation Program

This program aims to activate the mediating role of Mevlana Development Agency in regional development and to strengthen the cooperation of universities in Konya and Karaman to create economic value from the scientific research and projects. The cooperation protocol was signed between Mevlana Development Agency and Selçuk University, Karamanoğlu Mehmetbey University, KTO Karatay University, Mevlana University, Konya Necmettin Erbakan University. The purpose of this protocol is to develop university-industry and university-city collaborations in Konya and Karaman provinces, contributing to regional development. University-city cooperation undertakes the mission of accelerating human and economic development in a comprehensive manner, including public, private sector, non-governmental organizations, and the public.

4.4.1.2. University-industry

In national STI system, the cooperation of universities and industry stakeholders is essential for the commercialization of scientific knowledge. Accordingly, agreements, implementations, and public support programs that promote the cooperation between universities, which are the source of scientific knowledge production, and the private sector, which is the source of innovation and high technology production, are introduced in this section.

4.4.1.2.1. University-Industry Cooperation Centers Platform (ÜSİMP)

Established on the structure of the discontinued University-Industry Joint Research Center Program (ÜSAMP), the mission of the University-Industry Cooperation Centers Platform (ÜSİMP) is to contribute to the establishment of interface institutions that serve university-industry cooperation by developing a national cooperation culture, improving the quality and performance of actors, and determining the policies and strategies for the

efficient execution of technology transfer applications. The objectives of ÜSİMP are as follows: development of university-industry cooperation activities in universities, research institutions and organizations, industrial organizations and non-governmental organizations; promoting the sharing of knowledge and experience between national and international institutions, public and private institutions and organizations; institutionalization of university-industry cooperation organizations, diversification of services, establishing a service standardization and recognition process for the interface institutions, improving the quality and performance of organizations; contributing to the processes of preparation of action plans, help designing policies and strategies on university-industry cooperation together with official institutions. Continuing its activities as a platform, ÜSİMP is managed by an executive board selected from the representatives of the member organizations. 50 workshops and seminars, 7 national TTO networks and 6 national business mentoring initiatives, 22 trainings organized with different stakeholders, 8 projects supported by national and international funds, active participation to 90 events, representation in 30 international events, 6 cooperation protocols, and 94 member organizations have been reached since 2007.[105] In the past five years, ÜSİMP coordinated a national patent exhibition and convention annually, organized about 30 workshops and symposiums, but more importantly organized regular education programs to become Registered Technology Transfer Professional (RTTP).

4.4.1.2.2. TÜBİTAK 1503 - R&D Project Brokerage Events Grant Program

This program is to support national or international "Project Market" events organized to bring representatives from universities, research and private sector organizations together, to introduce their projects to each other and to establish collaborations. The collaboration between at least one university and any one or more of the exporters' association, chamber of industry, and/or

105. http://www.usimp.org.tr/uploads/raporlar/kurulusumuzdan_gunumuze_usimp_2.pdf. For more information see the website of ÜSİMP http://www.usimp.org.tr

chamber of commerce is required and one of the participating organizations can apply for support to TÜBİTAK.[106] From 2001-2019 10.9 million TL (in 2019 prices) were provided to 310 project brokerage events.[107]

4.4.1.2.3. TÜBİTAK 1505 - University – Industry Collaboration Support Program

The purpose of this program is to contribute to the commercialization of the knowledge and technology produced at university / public research centers and institutes by transforming them into products or processes in line with the needs of SMEs or large-scale organizations. Universities, training and research hospitals, or public research centers and institutes performing R&D (as the executing agency) can apply jointly with SMEs or large enterprises (as client organizations) that guarantee to implement the project results in Turkey. Projects up to 1 million TL are supported and TÜBİTAK funds 60%-75% of the project budget depending on the size of the client. Client co-finance is 40% for large firms and 25% for SMEs. The budget may consist of personnel costs, travel costs, equipment, software and materials cost and service procurement.[108] From 2011 to 2019, 715 applications were made for this program and 267 of them were supported with a success rate of %37. The total amount funded by TÜBİTAK was 75.5 million TL (in 2019 prices).[109]

4.4.1.2.4. TÜBİTAK 1513- Technology Transfer Office Support Program

This program is to support TTOs, which operate to commercialize the knowledge and technology produced in universities, to

106. For more information about the program see https://www.TUBITAK.gov.tr/en/funds/industry/national-support-programmes/content-1503-rd-project-brokerage-events-grant-programme. See also a presentation on the program at https://www.TUBITAK.gov.tr/sites/default/files/1503-sunumu.pdf

107. https://www.TUBITAK.gov.tr/sites/default/files/21566/teydeb_guncel_sunum_0.pdf

108. For more information about the program see https://www.TUBITAK.gov.tr/en/funds/industry/national-support-programmes/content-1505-university-industry-collaboration-support-program

109. https://www.TUBITAK.gov.tr/sites/default/files/21566/teydeb_guncel_sunum_0.pdf

establish cooperation between universities and the private sector organizations, and to help the industry produce the information and technology needed by the industry. Universities, companies partnered with universities, technopark management companies, and companies partnered with technopark management companies are among the institutions that can apply for the program. This program consists of two phases, the "institutional capacity building" and the "target oriented growth", each supported for a maximum of five years. The former has an annual budget of 1.25 million TL, while the latter has an annual budget of 1.75 million TL. Project budget may consist of personnel costs, travel costs, equipment, software and service procurement.[110] Between 2013-2019, 53 TTO's benefited from TÜBİTAK funding reaching a total of 188.6 million TL (in 2019 prices).[111]

4.4.1.2.5. TÜBİTAK 1601 - Capacity Building for Innovation and Entrepreneurship Grant Program

This is a support program aiming to enhance capacity in innovation and entrepreneurship. This program aims to transform the research outputs carried out at universities into economic value, to provide university-industry cooperation, to benefit from the national and international support mechanisms of universities, to develop academic entrepreneurship based on the knowledge produced in universities, and to support TTOs that operate in universities for the commercialization of IPRs. Through new calls of 1601 every year, entrepreneurial initiatives targeting high-tech production in primary thematic areas (e.g., focusing on intelligent transportation, intelligent production systems, energy and clean technologies, communication and digital transformation, health and good life, sustainable agriculture and nutrition) and entrepreneurship trainings of universities are supported. Universities, TTOs, foundations established by law, and established capital companies that have successfully

110. For more information about the program see https://www.TUBITAK.gov.tr/en/funds/industry/national-support-programmes/content-1513-technology-transfer-office-support-program

111. https://www.TUBITAK.gov.tr/sites/default/files/21566/teydeb_guncel_sunum_0.pdf

carried out business idea evaluation processes by organizing at least one business idea contest in the field of entrepreneurship or experienced in the fields of acceleration, incubation etc. can apply to these calls.[112] 7 calls were opened from 2015 onwards. 149 applications were made from which 65 were supported, with a success rate of %43.[113]

4.4.1.2.6. TÜBİTAK 2244 - Industrial Thesis Program (SANTEZ)

This program mainly targets to meet the industry-based R&D needs on scientific knowledge production with university-industry cooperation and to reach the indigenous technology production mission. The objectives of this program are as follows; institutionalizing university-industry-government cooperation, supporting the development of high value-added technology-based products and production methods, enabling SMEs to acquire technology production and R&D cultures, ensuring that R&D, technology and innovation activities that SMEs cannot perform by their own assets are carried out with the support of both the university and the government, ensuring that the thesis subjects of the graduate students are determined according to the products, production methods and R&D based needs of SMEs based on new technologies for manufacturing industry, to help increase the number of qualified human resource by supporting graduate students in these projects, to pave the way for the thesis students working in these projects to be employed as R&D personnel in these companies in the future. Regardless of the sector and size, projects to be prepared in cooperation with established enterprises and universities that create added value at the firm level can benefit from this program. From its initiation as SANTEZ, 497 protocols were signed between universities and firms. In these projects, 517 PhD students have received funding.[114] At the moment 34 universities have at least one project

112. For more information see https://www.TUBITAK.gov.tr/en/funds/industry/national-support-programmes/content-1601-capacity-building-for-ie-grant-program

113. https://www.TUBITAK.gov.tr/sites/default/files/21566/teydeb_guncel_sunum_0.pdf

114. https://www.TUBITAK.gov.tr/sites/default/files/18842/TUBITAK_2019_yili_faaliyet_raporu.pdf

supported by the Industrial Thesis Program. According to the program, students receive 4500 TL (2020 value) for up to four years and may be employed by the contracted firm for three years after completing the PhD.

4.4.1.2.7. ASELSAN Academy

Established in 1975, ASELSAN is a company of Turkish Armed Forces Foundation. ASELSAN is the leading defense electronics company of Turkey and listed as one of top 100 defense companies in the world.[115] Within the scope of the project (signed by ASELSAN and YÖK in August 2017), ASELSAN personnel is trained and can conduct academic research at postgraduate level in the fields related to defense industry at Gazi University, METU, Gebze Technical and İstanbul Technical University in accordance with ASELSAN's mission and vision.[116] The Industrial Graduate Education Program aims to develop ASELSAN's technology and knowledge resources and ensure its continuity. ASELSAN Academy Program aims to increase the competitiveness of ASELSAN and Turkey, by ensuring its development in critical technologies. ASELSAN personnel participating in the program receive a postgraduate degree (MSc or PhD) by realizing the projects they work within the form of an industrial thesis. In 2019, the program involved about 380 engineers in the MSc, 65 in the PhD programs. About 80 courses are provided every year by about 60 academic personnel from the universities above.[117]

4.4.1.2.8. Vestel Technology Academy

Vestel is the leading electronic goods producer of Turkey and amongst the top 100 firms considering the number of patent applications to EPO. Vestel Technology Academy Program, initiated in 2010 with the cooperation of Özyeğin University in order

115. https://people.defensenews.com/top-100/

116. http://be.gazi.edu.tr/posts/view/title/gazi-universitesi-ve-aselsan-arasinda-%22aselsan-akademi-lisansustu-egitim-programi%22-protokolu-imzalandi.-203179

117. https://www.defenceturk.net/aselsan-akademi-3-yasinda-muhendisler-hem-okuyup-hem-calisiyorlar

to improve the technical infrastructure of Vestel engineers, aims to transfer the techniques developed in the electronic products and consumer durables sector to the engineers by scientific staff and expert professionals. The aim of the academy, which includes technical trainings, applications and projects specially designed for Vestel, is to increase the knowledge and skills of employees engaged in technical tasks such as R&D, quality and production. Employees attending the academy are also given the opportunity to obtain MSc and PhD degrees approved by YÖK in the fields of electronics, machinery, computer and industrial engineering within the framework of the program. The academy, which is the first in Turkey, has more than 170 graduates and about 250 students since 2015.[118]

4.4.1.3. Industry-Industry

In order to support the R&D, innovation and high technology production activities of the private sector, intra-industry cooperation support programs implemented by public institutions and non-governmental organizations are briefly introduced in this section.

4.4.1.3.1. KOSGEB (Collaboration Support Program/ İş Birliği Güç Birliği Destek Programı)

The aim of the program is to contribute to the development of a culture of collaboration in within SMEs or with large enterprises and to establish collaborations that provide mutual benefits and competitive advantage. Cooperation projects of enterprises with each other and/or with large enterprises providing mutual benefits, reducing costs and securing competitive advantage are supported. The objectives of the cooperation projects are as follows; joint manufacturing in order to increase capacity, efficiency, product variety and quality, joint design, product and service development in order to meet customer demands and market demand, joint laboratory to improve product and service quality, joint marketing in order to increase their market shares and to create a brand image, collaborations to improve their skills and abilities and to join value chains.

118. https://www.vestel.com.tr/tegepodulleri

4.4.1.3.2. TÜSİAD SD2

This program is designed (by the Turkish Industry and Business Association, TÜSİAD) with the mission of creating an ecosystem where the technology user and the technology supplier meet, revitalizing the technology supplier network and its competence, and creating good practice examples on digital transformation in Turkey. It is aimed that the technology supplier checks the suitability of the product or service, whether it has already customer verification or provides a solution to the problem, need, opportunity defined by the technology user. The applicant must be operating in one of the prioritized technology areas such as augmented reality, cloud, big data and analysis, robot and automation, cyber security, artificial intelligence and intelligent systems. The other main conditions are to be a micro firm or an SME and to have a product or service that has a working prototype that can provide a solution to the problem, need or opportunity defined by the technology user.[119]

4.4.1.4. University-Industry-Government

The active cooperation of the university, industry and government, which are the three key actors in national innovation systems, is one of the key elements of economic development. This section describes publicly funded support programs, practices, and agreements to improve both the active interaction and collaboration of key actors and the collaboration of various stakeholders arising from interactions of the universities, industry, and government aiming development of STI activities and knowledge and technology transfer.

4.4.1.4.1. Public-University-Industry Cooperation Portal (KÜSİP)

With the Public-University-Industry Cooperation Portal (KÜSİP)[120]; it is aimed to provide an easy and fast access to R&D funds, researchers, investors, and knowledge resources through a

119. For more information about the firms, partners, open calls see https://tusiadsd2.org/hakkinda

120. For more information: www.kusip.gov.tr

single virtual platform where cooperation and interaction between public, university and industrial enterprises, entrepreneurs and investors could be built. The main objectives of KÜSİP are bringing together the main actors of the NSI with the new stakeholders that emerged as a result of their interaction, creating a dynamic and connected network to promote sustainable high-value and innovative high-tech production, enabling easy access to activities such as news, events and announcements in the R&D and innovation ecosystem.

4.4.1.4.2. TÜBİTAK 1512 - Entrepreneurship Multi-phase Program

This new program is based on the former Techno-Entrepreneurship Program of MoIT. The purpose of the program, organized by TÜBİTAK, is to support the activities of individual entrepreneurs from the idea stage to the commercialization and marketing stages, to transform technology-based business ideas to products and services that can generate high value added and create qualified employment opportunities. Students who will be graduating from any undergraduate program of universities providing formal education within one-year-period, graduates, MSc and PhD students, or entrepreneurs who obtained one of their undergraduate or graduate degrees at most 5 years before the application date can apply. When the business idea is found appropriate by TÜBİTAK, the start-up business plan is prepared in the first stage of the accepted projects. In this first stage TÜBİTAK outsources most of its activities to about 40 different universities and firms. For those who are successful in start-up business plan application (the idea creation phase), techno-initiative capital support of 200,000 TL is provided in the second stage to the newly established firms as seed capital aiming technology validation of the idea. In this stage the entrepreneurs receive mentorship support for 18 months. In the third stage (R&D performing), the initiative's first R&D project is supported within the scope of 1507 SME R&D Initial Support Program for up to a budget of 600,000 TL. In the final step, the enterprise is expected to commercialize its products in no more than twelve months. TÜBİTAK provides project brokerage, easy access to

partner finding events, and increased networking opportunities with private equity firms. Between 2013-2019, 194.2 million TL was transferred to participants of this program. Out of 27,000 applications in phase 1, about 3,700 were selected and about 1,400 firms were established in phase 2. About 123 million TL were transferred to phase 3 firms through 1507 program, only in 2019.[121]

4.4.1.4.3. TÜBİTAK 1004 - Centre of Excellence Support Program

The aim of the 1004-Center of Excellence Support Program is the specialization of the research infrastructures of HEIs by collaborating with R&D centers, design centers and public R&D units, and to support research programs that have traceable targets, have scientific qualifications and high commercialization potential in the priority areas determined within the scope of national targets. 1004 program consists of two phases. Only 10 Research Universities declared by YÖK and Research Infrastructures supported under Law 6550 can apply to the first phase which is more related to establishing the working model of the Centre, its cooperation and collaboration potential and the basic strategy of creating knowledge and technology. Second phase consists of supporting R&D expenditures at TRL 3 to 6 levels. Between 2014-2018, there were 19 applications 18 of which were supported and about 1.4 million TL were devoted so far which only accounts phase one activities.[122] ODTÜ-MEMS, Sabancı University-SUNUM and Bilkent University-UNAM are few examples of the research centers funded under this program.

4.4.1.4.4. TÜBİTAK 1007 - Public Institutions Research Funding Program

With the 1007-Public Institutions Research Funding Program, it is aimed to provide procurement methods based on R&D, supply of technologically qualified products / systems from national resources, and transfer of foreign technology. R&D projects that

121. https://www.TUBITAK.gov.tr/sites/default/files/21566/teydeb_guncel_sunum_0.pdf

122. https://www.TUBITAK.gov.tr/sites/default/files/21566/teydeb_guncel_sunum_0.pdf

focus on solutions to problems of public and/or needs identified by public institutions are supported. In addition to the primary goal of meeting the R&D needs of public institutions, public, private institution and university collaboration is encouraged and knowledge and high technology industry production is targeted through the utilization of basic and applied research at universities. Three type of projects are funded according to determined output: i) prototype/system/pilot projects that basically target a working prototype, ii) model/process that target a working model, process to provide a service or produce technology, iii) technology accumulation in products where national capacity is limited. The project duration is maximum 48 months and there are no budgetary limitations.[123]

4.4.2. International cooperation

Since the 1950s, Turkey has experienced fundamental changes in terms of international cooperation.[124] Recently, Turkey has become a player in international cooperation thanks to new economic dynamics and an increasing sense of responsibility for promoting international relations to contribute to global development while pursuing its own interest. Turkey has developed several programs for presentation of Turkish researchers, institutes, universities, and industries on international platforms.[125] International Cooperation Department (UİDB) at TÜBİTAK whose main purpose is to develop international collaborations for STI activities has become responsible for conducting bilateral and multilateral programs. Thanks to these efforts, international cooperation in Turkey increased and it is ultimately expected that this will contribute to the development of the NSI, localize many sectors by supporting indigenous production capabilities, provide high value-added products in the long term.

123. For more information see program website https://www.TUBITAK.gov.tr/en/funds/academy/national-support-programmes/content-1007-public-institutions-research-funding-program

124. Ministry of Foreign Affairs (2020). Turkey's Development Cooperation: General Characteristics and the Least Developed Countries (LDC) Aspect. Retrieved 20 May, 2020. http://www.mfa.gov.tr/turkey_s-development-cooperation.en.mfa

125. Tanrıkulu, E. (2010). A Case Study of Impact Analysis: TÜBITAK Research Support Programmes. Retrieved 20 May, 2020. http://etd.lib.metu.edu.tr/upload/12611597/index.pdf

4.4.2.1. Bilateral cooperation

One of these international cooperation programs is the "Bilateral Cooperation Program" launched by TÜBİTAK. This program aims to increase the capacity of utilizing international research funds and international R&D cooperation programs. This international R&D funding program is designed for both academic and industrial R&D cooperation.[126]

Within the scope of bilateral cooperation agreements signed with a variety of countries at the inter-governmental or inter-institutional levels, joint project calls are opened and common research projects are funded. Moreover, different types of activities are also supported financially within this program such as common scientific meetings, exchange of scientists, scientific visits, etc.[127] TÜBİTAK has launched bilateral cooperation projects with many countries. Figure 4.10 depicts countries with whom bilateral cooperation was established (some of which are still continuing under open calls).[128]

Turkish scientists who want to propose a joint project should have an agreement with the researcher(s) in the country with whom they will carry out the project. Project partners in Turkey should submit the project proposal form that can be downloaded from TÜBİTAK's website, foreign project partners should submit the application form to their funding institution. Unilateral applications are not accepted. TÜBİTAK and the foreign counterpart institutions examine and evaluate project proposals according to their own criteria and only the projects approved by both parties are supported.

Within the program, cooperation activities, short-term scientist exchange, and joint scientific activities can be supported. For the scientist exchange within the scope of the project, unless a contrary

126. https://www.TUBITAK.gov.tr/TUBITAK_content_files//ICIM/ikili_coklu_iliskiler_brosur_1__3_ok.pdf

127. TUBITAK (2012). Uluslararası İşbirliği Daire Başkanlığı (UİDB). https://www.TUBITAK.gov.tr/sites/default/files/content_files/iletisim/uidb-baski.pdf

128. A full list of bileteral cooperation calls can be found at https://www.TUBITAK.gov.tr/tr/uluslararasi/ikili-proje-destekleri/icerik-diger-programlar

situation is stated in the relevant agreement, the receiving party covers the accommodation and food/beverage expenses, while the sending party covers international travel expenses. In addition to overseas travel support to bilateral cooperation projects, for the Turkish party, research support can also be provided by TÜBİTAK upon request. TÜBİTAK has 27 bilateral cooperation programs with institutions from 22 different countries (see Table 4.12).[129] The project applications to bilateral programs witnessed a sharp increase in 2013 and thereafter an average of 400 project applications have been made every year (before 2013 the average was about 150). The success rate is about 15%. The budget of bilateral programs increased continuously reaching about 25-30 million TL by 2018 annually.

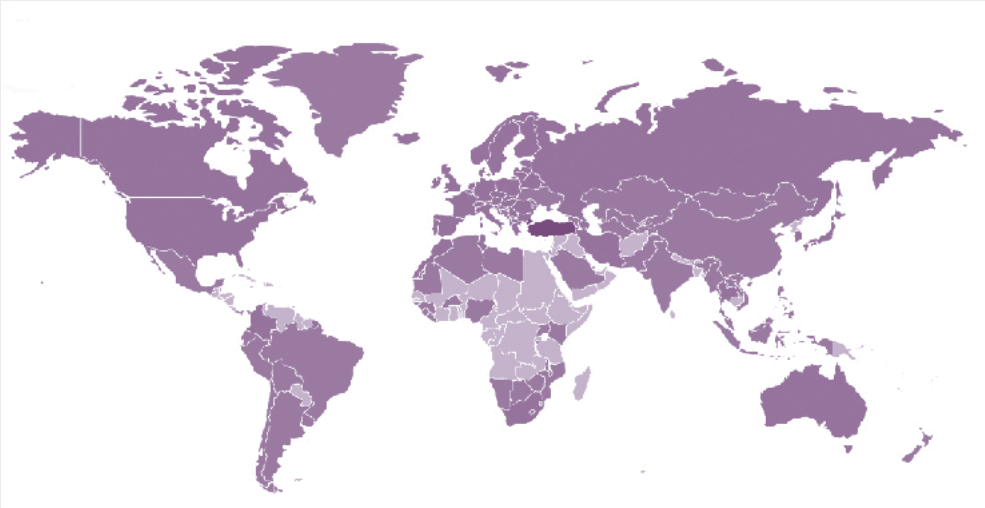
Table 4.12. The list of countries to cooperate with under the Bilateral Cooperation Programs

USA (NSF, NIH)	Mongolia (MAS)	Pakistan (MoST)
Bulgaria (BAS)	Italy (CNR, Ministry of Foreign Affairs)	Russia (RFBR)
Belarus (NASB)	France (CNRS, Bosphorus Program with Ministry of Foreign Affairs)	China (MOST)
India (CSIR)	Slovenia (ARRS), Ukraine (NASU, DKNII)	Czech Republic (AS CR)
Germany (DFG, BMBF)	Hungary (NKTH)	Belgium (FWO)
Slovakia (SAS)	Korea (NRF)	
Greece (GSRT)	Romania (ANCS),	

Source: https://www.TUBITAK.gov.tr/TUBITAK_content_files//ICIM/ikili_coklu_iliskiler_brosur_1__3_ok.pdf

129. The list of open calls (in Turkish) can be seen from this link: https://www.TUBITAK.gov.tr/tr/uluslararasi/ikili-proje-destekleri/icerik-diger-programlar

Figure 4.10. International Bilateral Cooperations - Interactive World Map



Source: https://h2020.org.tr/en/interactive-world-map

4.4.2.2. Multilateral cooperation

Multilateral Cooperation Program includes the active participation of Turkey in the activities of international organizations and the monitoring of the ongoing programs within such organizations. There are several aims of the program such as assisting Turkish researchers to utilize TÜBİTAK supports like international projects, scholarships, awards, etc.; monitoring the activities of the international organizations and informing the relevant people/institutions, following international STI policies, contributing to the arrangement important international organizations in Turkey, increasing Turkey's visibility in the international STI arena.[130]

Turkey is actively participating in the activities of various European research programs such European Cooperation in the field of Scientific and Technical Research (COST), European Space Agency (ESA), European Molecular Biology Conference (EMBC), regional

130. TUBITAK (2012). Uluslararası İşbirliği Daire Başkanlığı (UİDB). https://www.TUBITAK.gov.tr/sites/default/files/content_files/iletisim/uidb-baski.pdf

organizations such as Black Sea Economic Cooperation and Economic Cooperation Organization and international organizations like NATO, OECD, and UNESCO. The participation of Turkish scientists to such events organized and conducted by these organizations are supported or monitored by TÜBİTAK. Brief information about some of the programs under Multilateral Cooperation is given below.

4.4.2.2.1. PRIMA - Partnership for Research and Innovation in the Mediterranean Area

PRIMA Program (Partnership for Research and Innovation in the Mediterranean Area) aims to support international and multi-partner research and innovation projects to be carried out in the fields of water resources and food systems, provide participation of researchers from many countries in the north and south of the Mediterranean to the projects, and to deliver the outputs and innovative solutions within the scope of the projects to the end-users.

4.4.2.2.2. CORNET

Cornet Program aims to support projects that increase the pre-competitive capacities of SMEs. Project outputs are expected to be disseminated and to be useful for the SMEs. Stakeholders from at least 2 of the call member countries should come together. Member countries are Germany, Belgium, Brazil, Czech Republic, Netherlands, Switzerland, Japan, Canada, Peru, and Poland. Project topics need to be determined according to the needs of the SMEs.

4.4.2.2.3. COST - European Cooperation in Science and Technology

COST Association is an organization that aims to bring scientists who are experts in their fields together in an international scientific network called COST Action and to support scientists to bring their research to the international arena. Turkey is among the members of the program.

COST, whose main purpose is to provide researchers with only network support, is the most important structure in its field. COST offers important opportunities such as the meeting of Turkish researchers with international experts, reaching potential research consortiums which is important in EU Framework Program applications. Therefore, COST is an ideal start point for Turkish researchers who are conducting research mostly within the national borders but want to communicate their research in the international arena.

4.4.2.2.4. EMBO - European Molecular Biology Organization

EMBC, with an annual budget of approximately €15 million, is considered an important program among the European science support programs in terms of scientific activity level, efficiency, and interest from the non-European countries. Turkish researchers in natural sciences and medicine using molecular biology methods can utilize this support program. It is expected that through knowledge transfer and funding, this program will strengthen the scientific infrastructure of Turkey in the field of life sciences.

4.4.2.2.5. ICGEB - International Centre for Genetic Engineering and Biotechnology

ICGEB aims to support the establishment of the biotechnology infrastructure in developing countries and to increase the interaction and cooperation between these countries in the field of biotechnology. TÜBİTAK Marmara Research Centre Gene Engineering and Biotechnology Centre (MAM-GMBE) has been representing Turkey in this organization since 1989.

ICGEB's open several programs for researchers from Turkey:

- Doctorate Scholarships,
- Post-Doctoral Scholarships,
- Joint Research Projects,
- Course, Meeting and Workshop Organization Support

The deadline for all applications is on the 31st March of every year.

4.4.2.2.6. IRASME

IRASME is a self-sustaining international network that supports international research projects to increase the innovation capacities and capabilities of SMEs. Members of the IRASME network include countries such as Germany, Austria, Belgium, Czech Republic, Canada, Luxembourg, and Russia. The purpose of the network is to help SMEs acquire technological know-how through international projects, to have the necessary cooperation networks, and to improve their global competitiveness.

4.4.2.2.7. Framework Program

Framework Programs (FP) are conducted to strengthen the research and technology development capacity of Europe, to encourage university-industry cooperation, and to develop cooperation in various fields within the scope of EU policies with the EU Member States, associated countries and other countries with which the EU cooperates. National Coordination of Horizon 2020 Program is carried out by TÜBİTAK. Industrial organizations, SMEs, SME unions, individual researchers, universities, research centers, public institutions, non-Governmental organizations, international organizations can be supported by the FPs. Detailed information on FPs and especially H2020 (FPs 2013-2020) can be found in section 5.4.2.

4.4.2.2.8. ERA-NET

ERA-NET, designed within the framework of EU FPs, aims to support public-public collaborations in the member countries of the program, to ensure the coordination between national and regional research programs, and to increase international cooperation by developing and strengthening research and innovation programs. Within the program, the preparation phase, networking, design and implementation and coordination of joint activities of the public-public partnerships are supported.[131]

131. https://ec.europa.eu/programmes/horizon2020/en/h2020-section/era-net

4.4.2.2.9. EUREKA

EUREKA is an international cooperation platform established to promote the research and development of advanced technologies, products, and services, which will increase the competitiveness of industrial and research institutions in European countries. It aims to create and conduct joint projects between countries.

With the increasing influence and functionality of the EUREKA network, the number of member countries of the EUREKA program has increased to 44 with the participation of countries such as Canada, South Korea, South Africa, and Chile.[132]

Within the scope of EUREKA, there are 3 different support mechanisms: EUREKA Network Projects, Eurostars and EUREKA Clusters. If the project applications made through any of these support mechanisms are approved, the projects are supported by national funds.

The participation of SMEs and industrial organizations in Turkey to the projects carried out under the EUREKA Program is conducted by TÜBİTAK under Industry-Industry R&D and Innovation International Collaborations. While international collaborations are established in the program, projects are supported by national resources. TÜBİTAK supports the projects submitted to the EUREKA program with the 1509 program.

4.4.2.2.10. 1509 - TÜBİTAK International Industrial R&D Projects Grant Program

This program was designed to support international partner research and development projects offered to EUREKA and similar international programs. All organizations participating in such international programs can be supported by this program, provided that they operate in Turkey. This program aims to increase technical competence and knowledge in Turkey with such supports provided to the organizations located in Turkey by

132. http://www.eureka.org.tr/

internalizing the acquired technical knowledge and experience within the organization. Within the scope of this program, it is planned to support a maximum of 60% of the project expenditures of R&D projects of large-scale companies and 75% of the project expenditures of SMEs. In 2019, about 44 million TL was provided to fund the projects under the 1509 program, which is about 6% of the total Industrial R&D support schemes of TÜBİTAK.

4.5. Talent Drain

Globalization and the development of information technologies over the past two decades have created a knowledge-based economy. Classical definitions of input in economic models have now changed; knowledge, technology and human capital have become the most important factors of production. One of the four pillars[133] the World Bank has set within the Knowledge Economy Framework is educated and skilled workers who can continuously upgrade and adapt their skills, to efficiently create and use knowledge.[134]

Innovation and its constituent elements have major impact on the migration flows of highly skilled workers. In particular, a greater degree of innovation in a country and greater economic growth could boost the arrival of highly skilled immigrants (HSI). HSI should be considered by countries and companies as a source of resources and strengths which, together with other factors of innovation, make sustainable present and future growth possible. It is especially important in times of recession and global competition like we are currently experiencing.[135] Research demonstrates that a

133. Chen, D.H. and Dahlman, C.J. (2005) The Knowledge Economy. The KAM Methodology and World Bank Operations. World Bank Institute Working Paper No. 37256, Washington DC.

134. The other three pillars are: An economic incentive and institutional regime that provides good economic policies and institutions that permit efficient mobilization and allocation of resources and stimulate creativity and incentives for the efficient creation, dissemination and use of existing knowledge; an effective innovation system of firms, research centres, universities, consultants and other organizations that can keep up with the knowledge revolution, tap into the growing stock of global knowledge and assimilate and adapt it to local needs; a modern and adequate information infrastructure that can facilitate the effective communication, dissemination and processing of information and knowledge.

135.Bosetti, Valentina & Cattaneo, Cristina & Verdolini, Elena, 2015. “Migration of skilled workers and innovation: A European Perspective,” Journal of International Economics, Elsevier, vol. 96(2), pages 311-322.

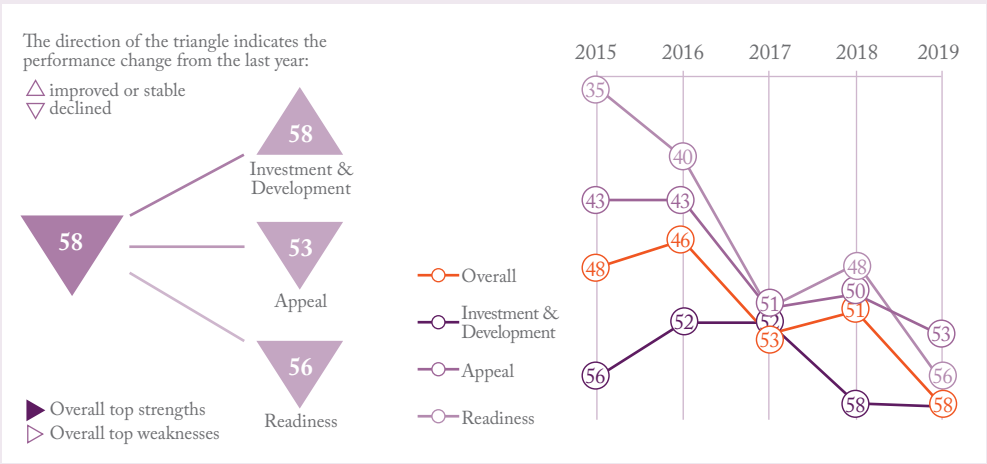
higher number of skilled immigrants increase the number of patents in United States and Europe. Migration is related to patents and innovative potential of the country by increasing the absorptive capacity of the sending country.

Disruptive innovations and higher productivity require time and talent. In this sense, those countries that can attract international talent will become first movers in a global and competitive market with important consequences for their level of development.

Turkey has been going through some difficult times in the last decade regarding its talent potential. There is a steady downfall considering several indicators and this trend seems to be routinized. IMD World Talent Ranking 2019[136] shows the overall performance of Turkey among 63 countries. Turkey experienced an acute decline, down 7 positions to 58th in 2019's rankings (see Figure 4.11). The ranking is structured according to three factors:

1. Investment and Development - The investment in and development of home-grown talent.
2. Appeal - The extent to which a country taps into the overseas talent pool.
3. Readiness - The availability of skills and competencies in the talent pool.

Figure 4.11. Turkey's performance according to IMD World Talent Ranking 2019



136. https://www.imd.org/wcc/world-competitiveness-center-rankings/world-talent-ranking-2019/

Turkey's performance is negatively affected by decreases within the readiness factor. The availability of finance skills drops to 48th and that of competent senior managers and managers with international experience both to 38th. In addition, the effectiveness of management education experiences a downturn (55th) as well as that of university education (57th), albeit to a lesser extent. In the availability of language skills, Turkey remains in the 50th position. Elsewhere, under appeal, executive opinions see a negative shift; placing brain drain down to the 55th rank and the prioritization of attracting and retaining talents to the 47th position. Employee training (59th) and the implementation of apprenticeship programs (52nd) also decline.

According to Turkish Statistical Institute (TÜİK) data[137], 1,085,807 people have left Turkey from 2016 to 2019, about 400,000 of whom are Turkish citizens. In 2019 foreign national emigrants constitute three fourth of the total number. Two out of every five people who leave Turkey are in the 20-34 age range. Among those who left, the proportion of women went slightly from 44% to 46%. In addition, the data shows that most of those who left are educated and urbanites[138]. According to data released in the 2020 Presidential Program[139], the number of citizens migrating abroad in 2018 increased by another 20% compared to the previous year, to 137 thousand people. However, when net numbers (immigration minus emigration) are taken into account, Turkey is still a net beneficiary. Table 4.13 shows the share of 20-44 age category in total immigrants and emigrants. There is a gap about 10 percentage points almost every year indicating that three fifth of the immigrants are leaving Turkey for mostly work and education reasons, which is a rough indication of talent drain vis-a-vis immigration.

137. TÜİK International Immigration Statistics http://www.tuik.gov.tr/PreTablo.do?alt_id=1067

138. CHP Brain Drain Report, November 2018, p.1. https://chp.azureedge.net/4e364a6dfa264acba3efa8626b513a19.pdf

139. http://www.sbb.gov.tr/wp-content/uploads/2019/11/2020_Yili_Cumhurbaskanligi_Yillik_Programi.pdf ,p.326

Table 4.13. Share of 20-44 age category within total immigration and emigration

	Share of 20-44 age within total immigration	Share of 20-44 age within total emigration
2016	0.51	0.62
2017	0.51	0.59
2018	0.49	0.61
2019	0.54	0.59

Source: TÜİK migration statistics. http://www.tuik.gov.tr/PreTablo.do?alt_id=1067

Among the emigrants abroad, educated urbanites constitutes a large portion. In the last 3 years, 13 thousand entrepreneurs and businesspeople have left Turkey.[140] According to a calculation done by the Turkish Economic Policy Research Foundation (TEPAV) in 2015, Turkey's migrant stockpile in 20 OECD countries amounts to a direct investment of $230 billion going abroad.[141]

ArfAsia Bank Global Wealth Migration Review Report 2019 report examines the highly skilled migration in three sub-categories: 1- Millionaires 2- Highly Educated Workforce, Businesspeople, Entrepreneurs 3. Academics, Graduate, Undergraduate and High School Students.

4.5.1 Millionaires

According to Table 4.14, Turkey is the worst performing country losing about 4000 net-worth millionaires, but more importantly, which constitutes 10% of the total net-worth millionaires residing in Turkey. These are quite alarming numbers as 2018 is the third straight year that over 4,000 High net worth individuals (HNWIs) have left the country. These outflows are concerning, as Turkey is not producing many new HNWIs to replace the ones that are leaving. As a result, the total number of HNWIs living in the country is declining over time.

140.CHP Brain Drain Report, November 2018, p.2. https://chp.azureedge.net/4e364a6dfa264acba3efa8626b513a19.pdf

141. https://www.tepav.org.tr/tr/blog/s/5287/Turkiye___nin+Insan+Sermayesi+Gocuyor

Table 4.14. Countries with large net outflows of High-net worth individuals (HNWI), 2018

Country	Net outflow of HNWIs	% of HNWIs lost
China	15,000	%2
Russian Federation	7,000	%6
India	5,000	%2
Turkey	4,000	%10
France	3,000	%1
United Kingdom	3,000	< %1
Brazil	2,000	%1
Saudi Arabia	1,000	%2
Indonesia	1,000	%2

Source: New World Wealth
Note: '% of HNWIs' (High-net worth individuals- in this ranking specifically, those individuals with wealth of US$1 million or more.) refers to the outflow divided by the total number of HNWIs living in that country. For instance, one could say that 10% of Turkey's HNWIs left the country in 2018.[142]

4.5.2. Highly educated workforce, businesspeople, entrepreneurs

Nearly 100 engineers from TÜBİTAK and Turkey's leading companies, ASELSAN, SAGEM and TAI who migrated to the Netherlands took attention of the media, but the big picture may be even worse than thought. A total of 1,020 academics and highly educated people from Turkey applied to the Netherlands in the 11-month portion of 2018, according to data from the Dutch Migration and Citizenship Authority (IND). According to figures released by the IND, 235 people from Turkey applied for asylum in the Netherlands in 2016, while this number reached 481 in 2017.[143]

142. New World Wealth, AfrAsia Bank Global Wealth Migration Review 2019, Full Report, April 2019. https://e.issuu.com/embed.html?u=newworldwealth&d=gwmr_2019

143. https://www.independentturkish.com/node/24501/haber/bir-beka-sorunu-olarak-beyin-g%C3%B6%C3%A7%C3%BC%E2%80%A6-t%C3%BCrkiye-%E2%80%9Cakl%C4%B1n%C4%B1%E2%80%9D-neden-kaybediyor-gidenler-ve

Thousands of Turks have applied for business visas in Britain or for golden visa programs in Greece, Portugal and Spain, which grant immigrants residency if they buy property at a certain level. Applications for asylum in Europe by Turks have also multiplied in the past years.[144] It is estimated that 10,000 Turks have made use of a business visa plan to move to Britain in the last few years, with a sharp jump in applications since the beginning of 2016.

BBC Turkish reported[145] that according to British immigration statistics, 7,607 Turkish nationals in 2017 applied for an Ankara Agreement visa, a specific type of visa for Turks who want to establish businesses or become self-employed in Britain. The Ankara Agreement signed in 1963 is an association created between Turkey and the European Economic Community. The agreement, also known as the ECAA agreement, permits Turkish nationals to work or set up business and attain residency rights in the United Kingdom. The ECAA applications to UK (completed only in the UK excluding the ones completed from Turkey) has doubled in four years rising from 3,135 in 2015 to 7,607 in 2018.

4.5.3 Academics, graduate, undergraduate and high school students

In 2019, 94% of those graduating from Alman Lisesi (German High-School) went abroad for university. İstanbul (Erkek) Lisesi (İstanbul High-School) is experiencing a first in its 135-year history: The proportion of those who went to university education abroad surpassed those who stayed in Turkey. Of the historic high school, where only 1.6% of graduates went abroad 10 years ago; 52.6% of 2019 graduates went to Europe. Their overseas preferences have increased exponentially over the past 4 years.[146]

According to a research done by International Education Fairs of Turkey (IEFT) at the beginning of 2019, almost 3 out of 4 young people studying abroad do not want to come back to Turkey.[147] In the survey, 72% of the students asked if they would like to return to the country after the end of their education said

144. https://www.nytimes.com/2019/01/02/world/europe/turkey-emigration-erdogan.html

145. https://www.bbc.com/turkce/haberler-dunya-47411662

146. https://tr.sputniknews.com/turkiye/201912201040880571-turkiyede-beyin-gocu-ilk-kez-lise-seviyesine-indi/

147. https://www.sozcu.com.tr/2019/egitim/yurtdisina-egitime-giden-gencler-turkiyeye-donmek-istemiyor-3634180/ , https://www.yenisafak.com/yazarlar/ozlemalbayrak/genclerin-gocu-2052415

"I would like to stay abroad". According to Kadir Has University Turkey Trends 2019[148] percentage of people who'd like to live abroad providing that they have the means has risen from 17% to 20% in the past three years.

Stephen Wordsworth, director of the UK-based Council for at Risk Academics, says applications to the institution in 2018 are up 300 percent compared to last year, with most of those applications coming from Turkey[149]. Scholar Rescue Fund also points at a similar situation in which 65% of all applications are from Turkey.[150]

An in-house statistic by the Federal Office for migrants and refugees (BAMF) revealed that one in two people applying for asylum from Turkey is a university graduate, Die Welt newspaper reported. In the first half of 2018, 48% of applicants from Turkey were university graduates, while in applications from other countries, the average of those with a university degree was 17%.[151]

The results of the British Council's study[152] on 4,816 university students aged 22-25 in 81 provinces of Turkey provide clue to the extent of the threat faced in terms of trained human capital loss. Research shows that 95 out of every 100 young people in Turkey want to do their undergraduate and graduate studies at universities abroad.

The number of foreign academicians coming to Turkey to teach short- or long-term courses in Turkish universities is also experiencing a decline. For instance, the number of foreign scholars and experts coming to Turkey with the ERASMUS+ mobility grant for academic staff was reduced by half in 2017 compared to 2016. This trend continues in almost all programs in ERASMUS+.

148. Kadir Has University Turkey Trends 2019, Published on Jan. 15, 2020. p.125. https://www.khas.edu.tr/sites/khas.edu.tr/files/inline-files/TE2019_TUR_WEB_15.01.20.pdf?fbclid=IwAR1M3qdhJeaWUBY97Jhm7QB2b9-GKv5GbfXEvBKXXb-9qM-Q_zIA-PA0UfU

149. https://www.independentturkish.com/node/24501/haber/bir-beka-sorunu-olarak-beyin-g%C3%B6%C3%A7%C3%BC%E2%80%A6-t%C3%BCrkiye-%E2%80%9Cakl%C4%B1n%C4%B1%E2%80%9D-neden-kaybediyor-gidenler-ve

150. https://ahvalnews.com/tr/beyin-gocu/tersine-beyin-gocu-tutmadi-gidenler-katlandi-yerlerini-ortadogu-ve-afrikalilar-aldi

151. https://www.dw.com/tr/t%C3%BCrkiyeden-almanyaya-iltica-ba%C5%9Fvurular%C4%B1nda-e%C4%9Fitim-d%C3%BCzeyi-y%C3%BCkseliyor/a-49985398

152. https://www.britishcouncil.org.tr/programmes/education/next-generation/turkey/report

When the numbers in 2016 and 2018 Annual Reports are compared, Turkey' position as a sender country remains stable (even increased in some programs) but as a receiver country, in KA101 (school education staff mobility) Turkey received about 55% less, in KA102 (VET learners and staff mobility) received about 65% less, in KA103 (higher education student and staff mobility) received about 50% less and in KA105 (youth mobility) received 30% less people from program countries.[153]

On the other hand, Iraq, Afghanistan, Syria, Azerbaijan and Turkmenistan were the countries where Turkey received the most migration from. Migrants who came to Turkey work mostly in construction, manufacture labor and domestic services.[154]

4.5.4. Policies directed at the talent drain problem

In December 15, 2018, the International Fellowship for Outstanding Researchers, announced by TÜBİTAK was launched with the official campaign. The aim of the program is to convince educated Turkish citizens abroad to return to the country reversing the brain drain, to highlight scientific studies in Turkey in medical, pharmaceutical, digital, software, IT and defense industries.

This program provides scientists up to 1 million TL research allowance, 750,000 TL research support will be given to the university or institutions, experienced scientists earn about 24,000 TL for 24 or 36 months (which is more than double the salary of a full professor in public universities), for young researchers with a doctorate, 20,000 TL of monthly payment was announced. The scientists who come to Turkey with their families would also receive a monthly family allowance of 2,250 TL. It was announced that facilities such as their families' round trip plane tickets, accommodation, health insurance, etc. would be provided.[155]

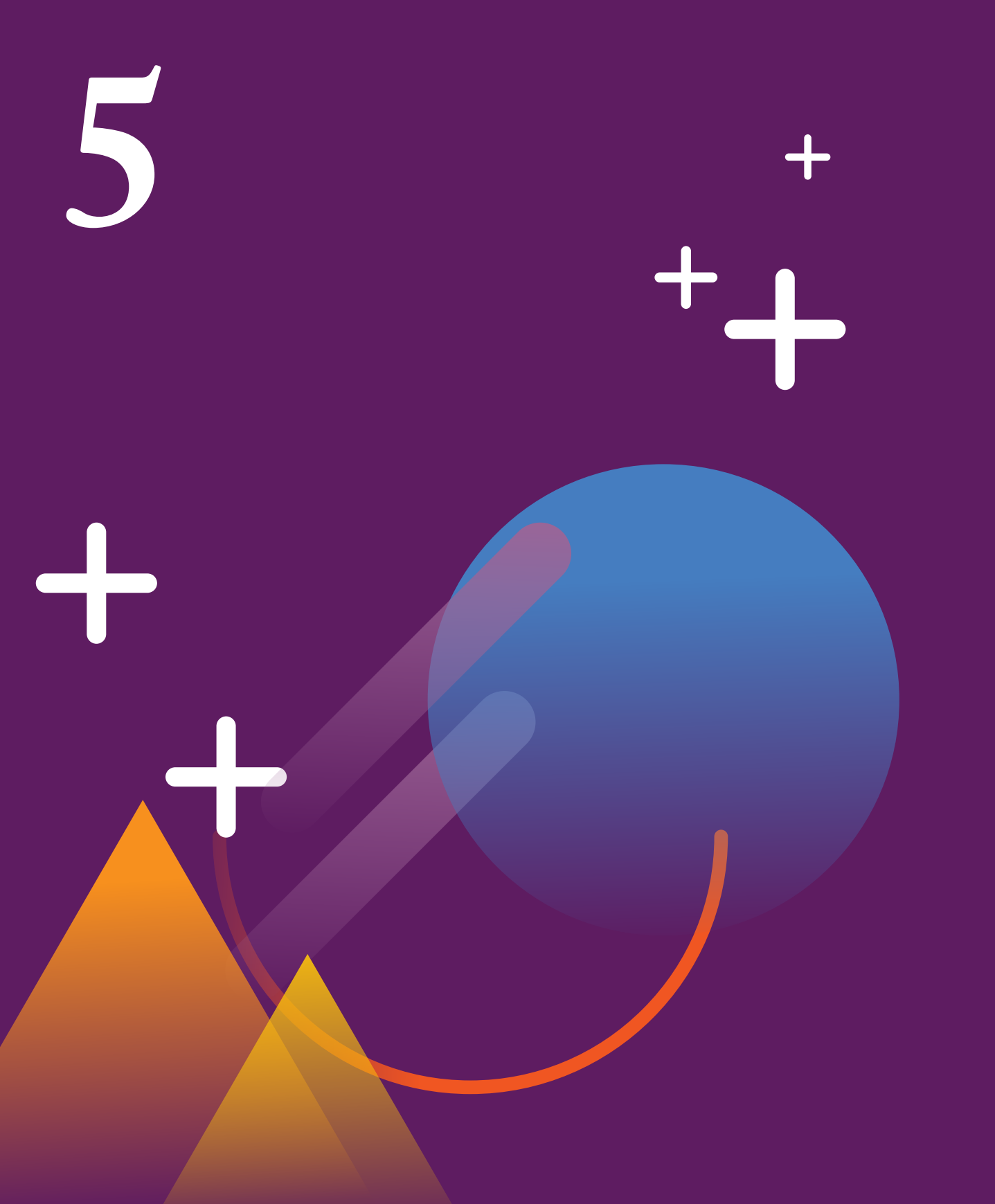
153. See Erasmus+ Annual Report 2016 https://op.europa.eu/en/publication-detail/-/publication/49350560-0d56-11e8-966a-01aa75ed71a1/language-en/format-PDF/source-search and 2018 https://op.europa.eu/en/publication-detail/-/publication/7985705e-41b7-11ea-9099-01aa75ed71a1/language-en/format-PDF/source-search

154. http://www.ufuk2020.com/haberler/turkiyenin-beyin-gocu-sorununa-kisa-bir-bakis.html

155. https://www.dunya.com/ekonomi/tersine-beyin-gocu-icin-proje-haberi-432275

From December 15, 2018, applications have started to be received, and the period ended on March 29, 2019. As a result of the evaluations, 127 leading scientists and researchers from 21 different countries, 98 of whom are Turkish and 29 foreign nationals, were eligible for the support.[156] It is too early to assess the implications (and impact) of this TÜBİTAK program.

156. https://t24.com.tr/haber/bakan-varank-acikladi-127-bilim-insani-tersine-beyin-gocu-yapti,831993


5

5. Who Funds R&I Activities?

Public accountability and systematic policy actions are based on assessment of both performers and funders of R&I activities. Analyzing trends and current state of R&I funders provide insight into the direction of policies and strategies dedicated to boosting R&I activities. This section uses a funder-based reporting approach and differentiates sources of funds as government, business enterprise, higher education and private non-profit sector.[157]

5.1. Changes and Trends in R&I in Turkey, Compared with EU

As indicated in Table 4.1., business enterprises have the highest rank as source of R&D funds both in Turkey and EU member countries. Table 5.1 further details annual changes in R&D funds based on three sources: Government, Business and Higher Education.

157. Reinhilde Veugelers. 2015. Is Europe saving away its future? European public funding for research in the era of fiscal consolidation. Policy Brief by the Research, Innovation, and Science Policy Experts. Available at: https://ec.europa.eu/research/openvision/pdf/rise/veugelers-saving_away.pdf; Bernanke, Ben S. "Promoting Research and Development The Government's Role." Issues in Science and Technology 27, no. 4 (Summer 2011); Gerben Bakker. Money for nothing: How firms have financed R&D-projects since the Industrial Revolution. Res Policy. 2013 Dec; 42(10): 1793–1814. doi: 10.1016/j.respol.2013.07.017. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4045395/; OECD. 2010. Measuring Innovation: A New Perspective. Available at: https://www.oecd.org/site/innovationstrategy/45188224.pdf

Table 5.1. Percentage of Gross Domestic Expenditure on R&D by Source of Fund

Years	Turkey			EU Average		
	Government	Business	HE	Government	Business	HE
2011	29.2	45.8	20.8	33.3	55	0.9
2012	28.2	46.8	21.1	32.8	55.1	0.8
2013	26.6	48.9	20.4	32.5	55.2	0.8
2014	26.3	50.9	18.4	31.9	55.5	0.9
2015	27.6	50.1	18.1	31.1	55.3	N/A
2016	35.1	46.7	14.4	30.2	57	1.2
2017	33.6	49.4	13.3	29.3	58.2	1.1
2018	32.3	53.6	12.1	29.8	58.9	N/A
2019	29.4	56.8	12.8	N/A	N/A	N/A

Source: Eurostat, Intramural R&D expenditure (GERD) by source of funds as percentage of total R&D expenditures. Available at: https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

While business sector has the highest R&D expenditures compared to government and HEIs, it's also the main source of R&D funds. Comparing this indicator with EU member country average, it can be seen that business sector is the main provider of R&D funds since 2011. Therefore, business (as a funder) in R&D activities has become more important compared to government and higher education.

It should be noted that HEIs usually are not acting as R&D funders, instead they co-fund R&D expenditures. There are also other co-funding options such as public R&D expenditures co-funded by private business enterprises. Turkey's private co-funding rate on public R&D expenditures is constant at 0.1% of its GDP since 2011. In EU this rate is also constant around 0.5%, between 2011 and 2016. However, such co-funding activities do not provide a significant difference in the big picture. The business sector is the biggest funder and its share is increasing over the years. R&D fund provided by both government and higher education is now less than half of what business sector provides.

In addition to basic indicators showing sources of R&D funds, innovation activities could also be measured by non-R&D expenses. These expenditures involve investments in equipment, machinery, patent and license acquisition costs, diffusion of new products or ideas. While, in terms of R&D expenditure per person, Turkey is below the average of EU, according to Innovation Union Scoreboard data, Turkey's non-R&D expenditure as per population aged 25-34 is higher than the EU member countries' average.[158]

5.2. Current Fiscal Policies

"*Medium Term Fiscal Plan for 2019-2021*[159]", is prepared by the Ministry of Treasury and Finance and the Presidency's Strategy and Budget Office. The main purposes of this fiscal plan are:

- maintaining financial stability in the short term,
- having a balanced economy and sustaining budgetary disciplines,
- sustainable growth in medium term while decreasing inequality

R&D and innovation relevant issues are addressed under public procurement practices indicating that the state will continue to contribute to R&D and innovation activities, to encourage localization and to promote technology transfer. Current public procurement practices are further detailed in section 5.3.2.

In accordance with the fiscal plan, "*Medium Term Fiscal Plan for 2020-2022*[160]" has also been prepared. The purpose of the new fiscal plan is quite in parallel with the previous one, but also focuses on industrial production, saving rates and efficient use of resources. By 2022, it is aimed to boost industrialization process, increase efficiency, augment national savings and productive investments, more importantly transform the production processes into an export-focused, innovative and less imported-input-dependent structure, all under the collaboration of public and private institutions. Regarding the of use of technology for fiscal policies, it is

158. https://knoema.com/EIUSCORE2020/innovation-union-scoreboard

159. https://www.resmigazete.gov.tr/eskiler/2018/10/20181011-12.pdf

160. http://www.sbb.gov.tr/wp-content/uploads/2019/04/OVMP_2019-2021.pdf; http://www.sbb.gov.tr/wp-content/uploads/2019/11/2020-2022-Donemi-Orta_Vadeli-Mali-Plan.pdf

aimed to improve and diffuse information and communication technologies to cope with unrecorded economy and to improve tax services.

Republic of Turkey Ministry of Treasury and Finance has also announced its "New Economy Program: Balance-Discipline-Transformation for 2019-2021[161]", reflecting its medium-term objectives. Focusing on science, technology, research and innovation, the program targets to achieve the following objectives:

- Technology and R&D investments to be executed with private-public partnership models emphasizing domestic production and global best practices, to reduce import dependency
- Energy technologies to be localized and to be supported through Renewable Energy Resource Aras (YEKA) model
- Tax collection process to be improved with new technologies, in specific, through Big Data Tax Analysis Centre
- Industry and technology zones using effective management models to be established to produce high-tech products
- Production of 20 biotechnical drugs to be encouraged
- Education to be enhanced through providing basic software skills, algorithms and industrial design programs
- Legal and technical infrastructure to be established where necessary to ensure financial stability and timely data flow in public services

161. https://ms.hmb.gov.tr/uploads/sites/2/2019/01/Turkey-NEP-2019-21.pdf

5.3. Sources of Funds, Statistics, Trends

5.3.1. Business enterprises

R&D expenditures of the business sector have surpassed the government and the higher education sector. In this manner, Turkey is slowly converging to the EU average regarding the share of business in GERD. In general, the business and innovation environment are getting better in Turkey. According Global Innovation Index[162], Turkey's business sophistication rank went up from 108 in 2013 to 57 in 2020.

Business sophistication and innovation environment are strongly linked to available infrastructure. Considering R&D expenditures of business enterprises in Turkey, Table 4.3 in Section 4.1.1 further details business enterprise R&D expenditures. Total GERD funded by business enterprises are mostly performed by businesses, covering more than 98% of total GERD financed by business enterprises, followed by higher education and government. Compared with the EU average, R&D expenditures of business enterprises as a percentage of GDP is increasing at similar rates. In summary, the Turkish business sector is increasingly funding its own R&D. While this is a sign of increased strength of the business sector, it may also show weakness, especially in government funding on early- stage R&D activities.

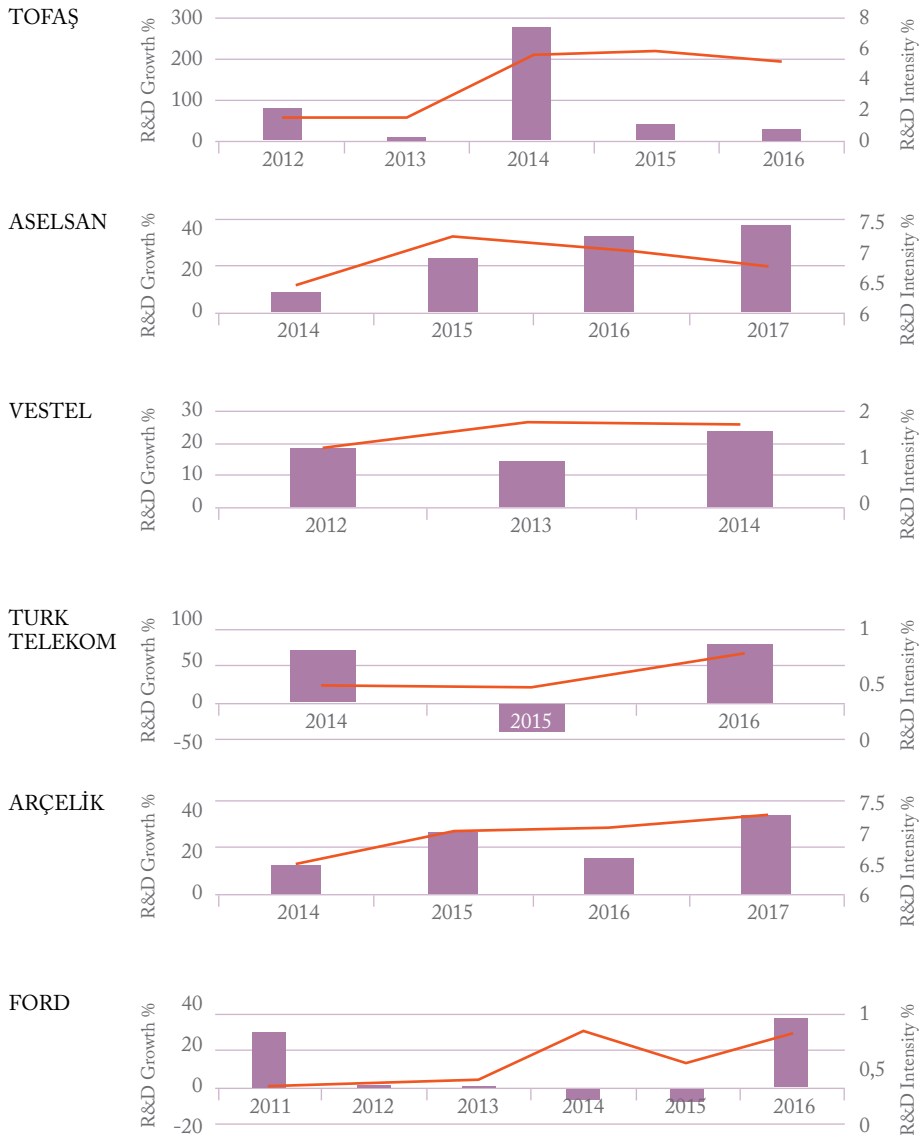
To observe business enterprise funds and investments on R&D and innovation, one can use the examples of big firms in Turkey such as TOFAŞ, TURK TELEKOM, ARÇELİK, FORD, VESTEL, ASELSAN. Even though there are some fluctuations in business enterprises' R&D expenditure, an overall increase after 2013 is a common observation (Figure 5.1). In general, automotive, support services and electronic equipment firms have higher R&D intensity rates compared to telecommunication, household goods, general industrials and technology hardware equipment. Since business enterprises are mainly funding inhouse R&D activities in Turkey, observations regarding R&D performance also gives an insight on R&D funds of business enterprises. We specifically used 2017 as a cut off because from mid-2018 the TL depreciated immensely which directly and indirectly affects R&D expenditures of firms.

162. https://knoema.com/GII2018Aug/global-innovation-index-2020

In general, R&D expenditures and R&D intensity defined by R&D expenditure divided by net sales have an increasing trend in all sectors and yearly R&D growth rates fluctuate in accordance with the level of R&D expenditure. Yet, some of the cases are worth observing in more detail such as ASELSAN where expenditures in R&D is increasing at a steady rate. In general, the R&D expenditures of big firms in Figure 5.1 are continuously increasing over the years till 2017. In 2014 the total R&D expenditure of TOFAŞ, FORD, KOÇ, ASELSAN and ARÇELİK was €422 million and the average R&D intensity was 1.18%. Both R&D expenditures and R&D intensity increased till 2017. Since then, there has been a decline. Of course, the depreciation of Turkish Lira explains the fall to a great extent (in 2017 the annual average exchange rate for Euro was 4.12 Turkish Liras, in 2019 it was 6.35, in 2020 it was 8.02). In 2019 the total R&D expenditure of the big-five was only €328.12 and the R&D intensity was 0.79%. It seems that the positive picture in the first half of the 2010s has changed. The fall in R&D intensity from 1.49% in 2017 to 0.79% in 2019 is a good indicator that reflects this change. If one excludes the big holding company (KOÇ) and calculate the average R&D intensity, the result does not change: average R&D intensity falls to 1.7% in 2019 from about 3% just within several years.

To compare Turkish and foreign top world ranked automobile firms, a considerable R&D growth seems to be the case for only BMW in Germany and FORD in Turkey for the 2018-2019 period. However, considering the overall R&D intensity rates, FORD and TOFAŞ in Turkey are relatively low compared to global top 5 automobile companies. The R&D intensities of FORD and TOFAŞ are about 1-1.5% in 2018 and 2019 whereas it is in the range of 5-7% in global automotive companies. To give an idea about the levels, the total R&D expenditure of FORD and TOFAŞ in Turkey is 1% of Volkswagen in 2019. Considering electronic equipment firms, again, R&D growth rate for 2018-2019 period is high for ASELSAN compared to SAMSUNG, SIEMENS, HIATCHI and MITSHUBISHI. But in terms of levels, 2019 R&D expenditure of ASELSAN is less than 1% of SAMSUNG. All in all, we can say that the current economic situation and the exchange rate (weak TL) in the past few years have damaged the positive trend in R&D expenditure of top firms in Turkey.

Figure 5.1. R&D Growth and R&D Intensity of Selected Business Enterprises



Source: The EU Industrial R&D Investment Scoreboard

Moving forward to firm collaborations, merger and acquisition (M&A) numbers in Turkey seem to have a decreasing trend since 2011. As Table 5.2 shows, main target sector in M&A in Turkey is information technologies. In weak innovation systems, M&A and foreign presence could be sources of new knowledge and technological upgrading if managed properly.

Looking into the deal values of M&A, financial services ranked first ($3,212 million) in 2018, followed by transportation ($1,192 million).[163] Number and values of M&As in 2018 show that even though information technologies cover most of the M&A activities, financial services are invested in the most. Given the weak TL and increased demand for funds (from the domestic firms) M&A activities topped in 2020 with about 300 transactions totaling $9 billion.[164]

163. https://www.statista.com/statistics/898230/value-of-merger-and-acquisitions-deals-in-turkey-by-sector/; https://www.statista.com/statistics/898187/value-of-merger-and-acquisitions-deals-in-turkey/

164. https://www2.deloitte.com/tr/tr/pages/mergers-and-acquisitions/articles/annual-turkish-ma-review-2020.html

Table 5.2. Number of M&A transactions in 2018[165]

Sectors	Number of M&A	Percentage
Services	17	9%
Healthcare	5	3%
Financial Services	10	5%
Energy	21	11%
Manufacturing	21	11%
IT	58	31%
Food and Beverage	22	12%
Automotive	2	1%
Transportation	6	3%
Retail	4	2%
Real Estate	5	3%
Media	4	2%
Chemicals	2	1%
Textile	2	1%
Tourism	7	4%
Construction	3	2%
Mining	1	1%
Telecommunication	1	1%
TOTAL	190	100

165. https://www.ey.com/Publication/vwLUAssets/Mergers_and_Acquisitions_Report_Turkey_2018/$File/EY%20Mergers%20and%20Acquisitions%20Report%20Turkey%202018%20(Web).pdf; https://www.statista.com/statistics/898179/number-of-merger-and-acquisitions-deals-in-turkey/, EY, Mergers and Acquisitions Report Turkey 2018.

5.3.1.1. Increased private funding options for start-ups

Regarding private finance for start-ups, there are 47 licensed angel investors as of 2019, mainly located in İstanbul. Investments made by licensed angel investors totaled as 11,889,206 TL, allocated to 35 applications, as of March 2019. Software development is the highest investment area, followed by e-commerce.[166] Venture capital investments, on the other side, are regulated by the Capital Markets Board of Turkey.[167] According to the most recent data, venture capital availability in Turkey increased at an average annual rate of 4.46% since 2017. There are currently 52 capital investment funds in Turkey, divided into several types, most important of which are listed in Table 5.3.

In 2017, total size of the early-stage investment made in Turkey recorded as $177 million, $103 million among which made by angel investors and venture capital companies. According to the Entrepreneurship Report of the 11th Development Plan, such an investment rate is not sufficient to fulfil the needs of the entrepreneurship ecosystem. In fact, Turkey ranks last among countries with $100 million early-stage investment in terms of entrepreneurship and ranks at 16th in overall entrepreneurship rate in Europe.[168]

Angel investor and venture capital investments in Turkey and number of funds are presented in Figure 5.2. The figure shows the trend starting from 2011 to 2020. Both the number of investments and the value of investments has steadily increased till 2017. Turkish start-ups have received more than $750 million from the venture capital and angel investors. In the past four years average investment per firm has been $700,000. In 2020, 165 firms have received about $139 million investment where health sector led both the deals and investment. Corporate venture capital investment is also on the rise. It has reached about $15 million (average 2018-2020) from nearly zero in 2012.[169] The purchase of Peak Games by Zynga for $1.8 billion produced the first Turkish unicorn.

166. https://ms.hmb.gov.tr/uploads/2019/02/BKS-İLERLEME-RAPORU-4.-Çeyrek.pdf; https://www.researchgate.net/publication/328065775_Turkiye'de_ve_Dunyada_Melek_Yatirimcilik

167. https://www.spk.gov.tr/Sayfa/AltSayfa/206; https://tracxn.com/d/investor-lists/Venture-Capital-Funds-in-Turkey

168. https://sbb.gov.tr/wp-content/uploads/2020/04/InternetGirisimciligiCalismaGrubuRaporu.pdf

169. Startups.watch. Turkish startup ecosystem 2. Quarter results.

Table 5.3. Capital Investment Funds by Type[170]

Investment Phase	Type	Name	Establishment Year[171]
Technology Accelerator Fund	Corporate VC/Company Builder	Inventram	2003
	Technology Commercialization Accelerator	Inovent	2006
	Venture Capital	ACT Venture Partners	2015
		DCP - Diffusion Capital Partners	2007
Seed	Accelerator Fund	Webrazzi Ventures	2006
	Corporate VC	Doğa Girişim	2010
		F+ Ventures	2015
		Sankonline	2014
	Early Stage Investor	YT Venture Partners	2016
	Gamebootcamp, Startupbootcamp İstanbul Fund	StartersHub Fund	2015
	Investment Firm	Aslanoba Capital	2006
	Micro VC	500 İstanbul	2010
	Seed Stage Investor	String Ventures	2013
	Venture Capital	LETVEN Girişim	2007
Seed and Early Stage	Corporate VC	Vestel Ventures	2015
	Seed Stage Investor	inventures	2009
Early Stage	Venture Capital	212	2011
		Buran Venture Capital	2012
		Earlybird	1997
		Hummingbird	2010
		Idacapital	2013
		Revo Capital	2013
		TRPE Venture Partners	2012
		AddVenture	2008
		STC Ventures	2019
		Wamda Capital	2014
Early & Growth Stage	Venture Capital	iLab Ventures	2000
Growth Stage	Corporate VC	Alesta Girişim	2012
		Verusaturk GSYO	2012
	Growth Equity	3TS	1998
		Arya Women Investment Platform	2013
		DGSK	2013
		iVCi	2007

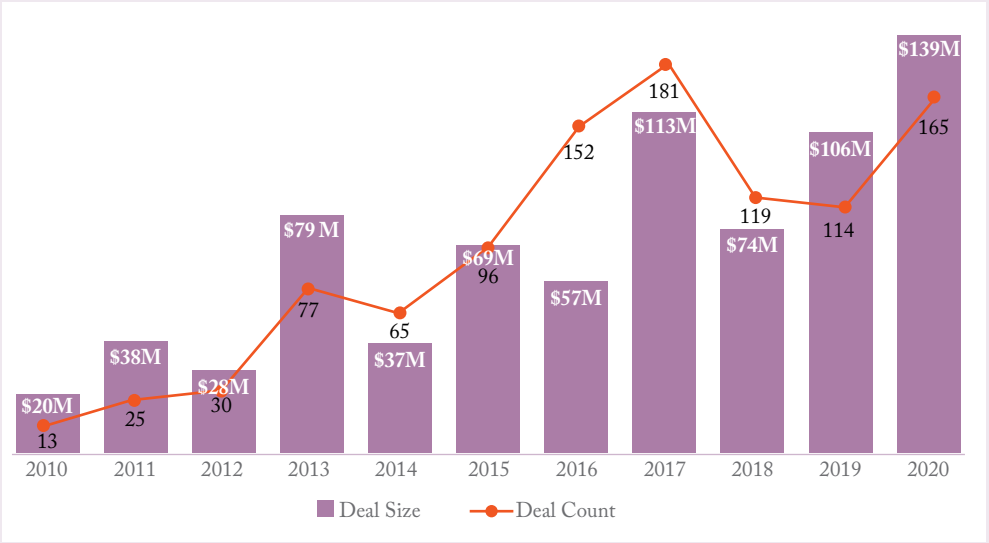
Note: İstanbul Venture Capital Initiative (iVCi) makes venture capital investments in with first time funds, established funds, experienced funds, small and medium enterprises and, high-growth companies.[172]

170. http://www.ttaturkey.org/34/venture-capital

171. https://www.crunchbase.com/

172. «İstanbul Venture Capital Initiative (Ivci)». Https://Www.Crunchbase.Com/, https://www.crunchbase.com/organization/istanbul-venture-capital-initiative-ivci#section-overview. Accessed 16 June 2020.

Figure 5.2. Venture Capital and Angel Investors Deals as of 2020

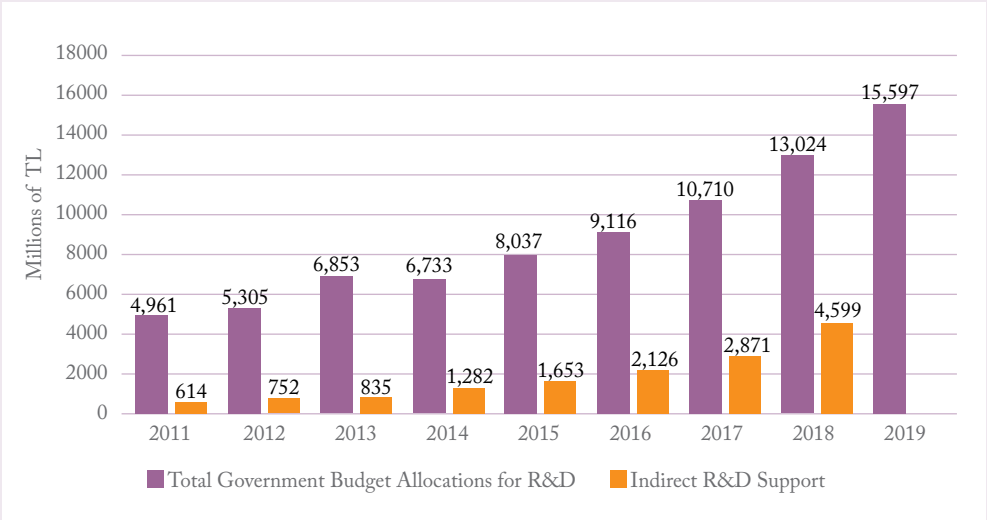


Source: Turkish Startup Ecosystem. 2020 Year in Review. Startups.watch

5.3.2. Government

Government budget appropriations and outlays on R&D in Turkey could be divided into two categories, including central government budget and indirect R&D support. Figure 5.3 shows the annual budget appropriations and supports on R&D from 2011 onwards.

Figure 5.3. Government Support for R&D, in national currencies

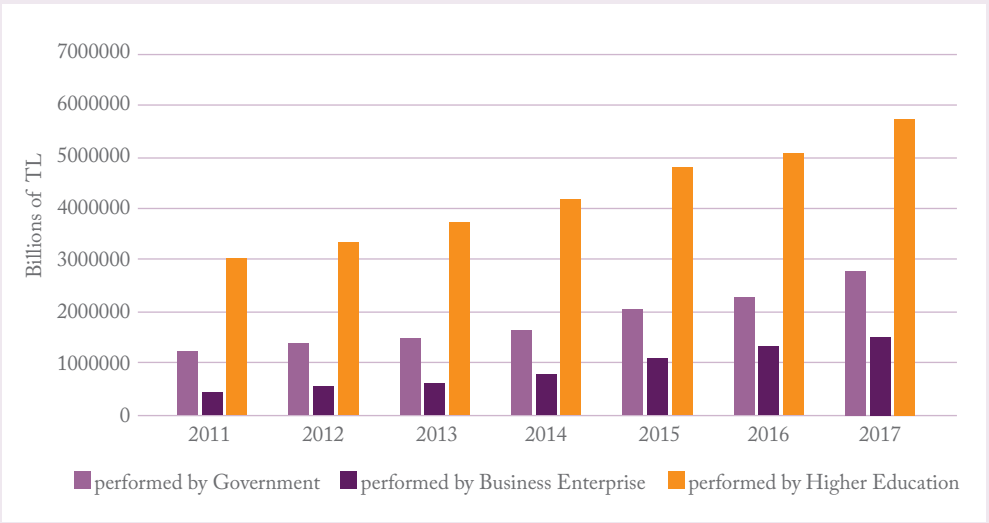


Source: TÜİK

Based on Figure 5.3, it can be seen that central government budget appropriations and outlays on R&D are almost four times higher today compared to 2011. Direct and indirect R&D support is about 21 billion TL. In comparison to EU averages, annual fluctuations seem to have similar patterns. Between 2011 and 2018, GBOARD as percentage of GDP in EU member countries is recorded as 0.65 on average (range 0.69 to 0.63). The same indicator for Turkey is 0.34 on average (range 0.38 to 0.33). Even though the average GBOARD in Turkey is lower than EU average, it seems that Turkey is catching up especially in terms of indirect R&D supports. Compared to 2011, indirect R&D supports have increased 8 times. In terms of Euro values direct government budget allocations to R&D have increased by 15% since 2011 and indirect supports have increased by 175%. Majority of the direct government allocations for R&D is transferred to institutions rather than R&D projects.

Figure 5.4 illustrates allocation of government funds among government, business enterprises and higher education since 2011.

Figure 5.4. GERD financed by Government

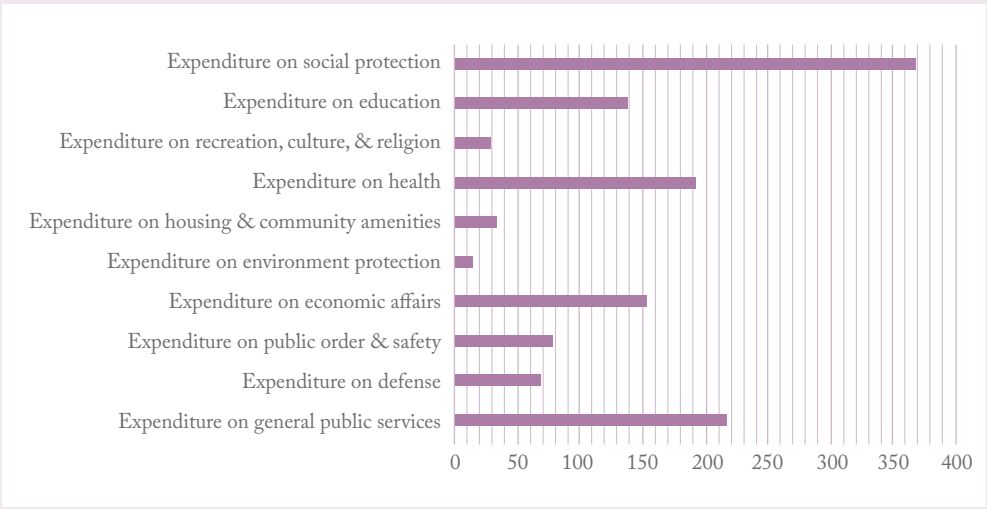


Source: UNESCO, Science, Technology and Innovation Statistics Data

Based on Figure 5.4, higher education sector in Turkey benefits to most from government funded expenditures on R&D. Different from business enterprises funds, government and higher education collaboration seems stronger than other collaborative funds which may explain why higher education sector consumes government R&D funds. Of course, the main reason for this is the fact that 65% of the universities in Turkey are state universities, in terms of scale (number of student and university personnel) their share within the Turkish university system is much higher. In fact, HEIs themselves are not major funders of R&D and innovation activities. Rather, HEIs benefit from government funds allocated to support education and research activities. However, if the shares are compared, the share of business and government actors in GERD financed by the government has increased over the years.

Government expenditures in R&D is not only divided by the performer institution, but also by sectors including general public service, public order and safety, economic affairs, environmental protection, housing & community amenities, health, recreation, culture, & religion, education and social protection. Figure 5.5 shows the allocation of government funds (either from central government or local government) allocated to those sectors in billions of TL (nominal, 2018).

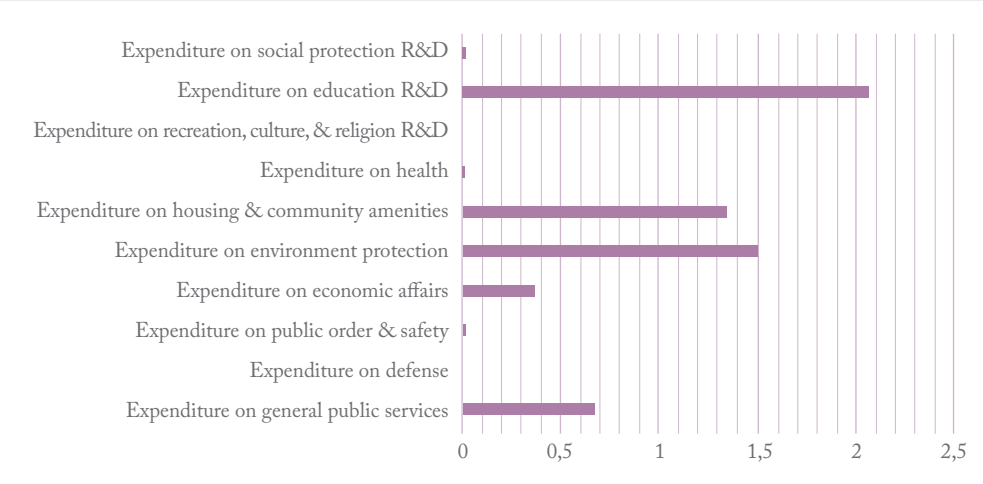
Figure 5.5. Government Expenditures by sectors 2018 (billions of TL, nominal)



Source: Government Finance Statistics (GFS), Expenditure by Function of Government (COFOG)

Largest government expenditures go to social protection followed by general public services and health. These 3 government sectors constitute 60% of total government expenditures in 2018 and about 20% of the GDP. R&D expenditures within the government expenses is only 0.43%, which is short of GERD over GDP (1.06% in 2019). The distribution of R&D expenditures to sectors varies. Figure 5.6 shows % share of government expenditures directed to R&D activities in each sector. Three sector stands out; education, housing and community amenities and environmental protection. In these sectors about 1.5-2.0 % of total expenditure is devoted to R&D activities. While government R&D expenditures in environmental protection and education show a rising trend from 2014 onwards, government R&D expenditures devoted to housing and community amenities have decreased by a great extent in the past 5 years.

Figure 5.6. Government expenditures directed to R&D in each sector 2018 (% share in total expenditure)



Source: Government Finance Statistics (GFS), Expenditure by Function of Government (COFOG)

For the case of government R&D expenditures on education, distribution of sources in R&D expenditures are given in Table 5.4. Central government expenditures on education R&D activities have increased over the years, the increase from 2017 to 2018 is worth mentioning. This is compatible with goals of increasing R&D personnel and number of doctorate graduates.

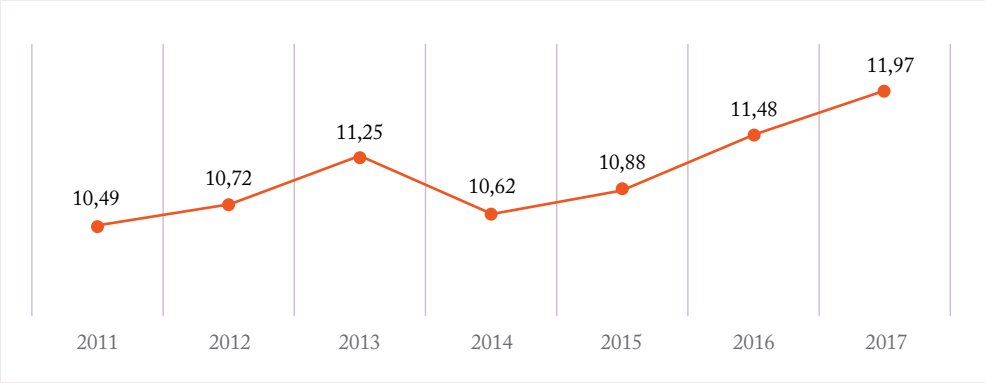
Table 5.4. Expenditure on education R&D (as percent of GDP)

Sector	2015	2016	2017	2018
General Government	0.04214	0.05176	0.04887	0.07677
Central government	0.04123	0.05078	0.04817	0.07609
Local governments	0.00093	0.00098	0.00070	0.00073

Source: Government Finance Statistics (GFS), Expenditure by Function of Government (COFOG)

In addition to government expenditures, public procurement for research and innovation is also gaining importance around the world.[173] General public procurement as percentage of GDP is given in the Figure 5.7. The sharp increasing trend of procurement is worth mentioning because the share of procurement activities towards innovation is important for supporting R&I activities.

Figure 5.7. General Government Procurement as a percentage of GDP



Source: Government at a Glance - 2019 Edition

Table 5.5. presents public procurement statistics for innovation for selected countries in 2014. According to the TÜİK Innovation Survey, 14.4% of the firms in Turkey have foreign or domestic contract which is below the average of 25 countries for which the data is available. Turkey ranks 20th among 25 countries. Within these firms, almost all have contract from the domestic public sector, Turkey is not an exception in this sense. Among the firms that has procurement contract from the domestic public sector only 1.6% undertake innovation activities which are not required as part of the contract. Turkey ranks 13th overall. But the most important indicator is the percentage of firms that undertake innovation activities required as a part of the contract which Turkey

173. https://www.oecd-ilibrary.org/governance/public-procurement-for-innovation_9789264265820-en;jsessionid=rEUjat8fwlYg5Trys-mlDHms.ip-10-240-5-85

performs quite well. Turkey ranks 4th after Norway, Iceland and Finland. This can be taken as an indicator that Turkey has started applying public procurement for innovation policies following the recent trend especially in Europe.

Table 5.5. Public procurement for innovation in selected countries, Community Innovation Survey, 2014

	Percentage of enterprises with procurement contract for domestic and/ or foreign public sector	Percentage of enterprises with procurement contract for domestic public sector	Percentage of enterprises with procurement contract for domestic public sector that undertake innovation activities not required as part of the contract	Percentage of enterprises with procurement contract for domestic public sector that undertake innovation activities required as part of the contract
Bulgaria	8.9	8.6	0.6	0.4
Czech Republic	18.2	17.9	1.1	0.8
Greece	25.0	24.7	1.5	0.8
Croatia	28.5	28.2	2.9	1.1
Italy	14.2	14.1	0.6	1.1
Hungary	16.5	16.3	0.7	0.7
Netherlands	14.6	14.0	2.2	1.6
Austria	33.6	32.7	2.4	2.1
Poland	6.3	6.2	0.9	0.3
Portugal	16.6	16.1	2.0	0.8
Romania	5.5	5.4	0	0.1
Finland	33.2	32.5	7.1	2.2
Sweden	28.9	28.1	3.2	---
Norway	30.3	29.9	3.9	2.9
Turkey	14.4	14.2	1.6	2.1
Average 25 countries	20.5	20.1	3.47	1.25
Minimum 25 countries	5.5	5.4	0.00	0.10
Maximum 25 countries	33.6	32.7	27.8	2.9

Source: Community Innovation Survey 2012-2014.

In accordance with the 10th National Development Plan[174], "Programme for Technology Development and Domestic Production through Public Procurement" has been initiated in 2013 for 25 primary transformation programs. Main objective was to use public procurement to promote innovation, technology transfer, entrepreneurship and domestic production. Main targets of the program could be summarized as following:

- To increase share of domestic firms in medium-high and high technology sectors
- To increase internationally branded products in high-tech sectors
- To increase R&D expenditures
- To reorganize public procurement system to boost R&D and innovation
- To increase innovation capacity of private sector

In the 11th National Development Plan[175], following objectives related to public procurement have been identified to support indigenous R&D and innovation activities and domestic production:

- To identify critical technologies and products that can be produced in Turkey
- To collaborate with companies to develop product quality and prepare technology roadmaps
- To enable international direct investment and technology transfer to Turkey through public procurement
- To accelerate the amount and diversity of the commercialization of new technological products through public procurement mechanisms
- To develop new investment models in renewable energy sector including domestic product/equipment use, R&D, technology transfer and public procurement

Various government institutions fund R&D and innovation activities and within different institutions there are also various forms of funds. Municipalities of big cities such as Ankara, İstanbul and İzmir also fund R&I activities but they

174. http://www.sbb.gov.tr/wp-content/uploads/2018/11/The_Tenth_Development_Plan_2014-2018.pdf

175. http://www.sbb.gov.tr/wp-content/uploads/2019/07/OnbirinciKalkinmaPlani.pdf

are in much smaller scale and not periodic. Table 5.6 summarizes overall R&I funds available from different public institutions. As a major funding institution TÜBİTAK is not included in Table 5.6. Specific information about TÜBİTAK programs can be found in sections 3.2.1.1 and 5.5.2.1. Small and Medium Sized Enterprises Development Organization (KOSGEB) supports can also be found in section 3.2.1.2 in more detail. Recently the government initiated an online platform (https://www.yatirimadestek.gov.tr) for all government subsidies, funds and supports including the ones for R&D and innovation.

Table 5.6. Comprehensive R&I funds available from different public institutions

Funder Institution	Relevant Public Institution	Fund Name	Amount of available/allocated fund
General Directorate of R&D and Incentives	Ministry of Industry and Technology[176]	Technological Product Investment Support Program	No calls since 2015. 204 supported applications. As of 2019 72.795.881,30 TL of the 131.060.670,83 TL overall budget is allocated.
General Directorate of EU and Foreign Affairs		Competitiveness and Innovation Operation Program	Total budget of 2014-2018 period was €260.1M. In 2019 €13,4M payment has been made.
Development Agencies		Financial Support Program for Improving Vocational Education in the Field of Advanced Technology Product Commercialization and Advanced Technology	Total budget of 10,000,000 TL for applications
		Financial Support Program for Social Entrepreneurship and Social Innovation	Total budget of 7,000,000 TL for applications
General Directorate of Industrial Zones		Support Program for Clustering	5-year budget is 82,121,722 TL. As of January 2020, clustering initiative budget was 4,235,260 TL half of which is allocated as grants to enterprises.
Small and Medium Enterprises Development Organization[177]		Support Program for R&D, Innovation and Industrial Design	Budget up to 600,000 TL including support for rent, equipment, machinery, human resource and project development

176. https://www.sanayi.gov.tr/destek-ve-tesvikler/sanayi-yatirimlari/md1203011615

177. https://www.kosgeb.gov.tr/site/tr/genel/destekdetay/1229/arge-ve-inovasyon-destek-programi

Ministry of Transport and Infrastructure[178]	R&D Support Projects in Electronic Communication, Space, Aviation Sectors	Total budget of 468,830,776 TL has been transferred to TÜBİTAK
Ministry of Energy and Natural Resources[179]	R&D Support Program for Energy Sector	N/A
Ministry of Food, Agriculture and Forestry[180]	R&D Support Program	Supports R&D in organic agriculture, fight with erosion, nature protection and national parks, polluted water, field crop, horticulture, plant health, agricultural economy, land and water resources, land management and plant nutrition. Total budget is 11,824,000 TL
Directory of Strategy and Budget[181]	Program for Researcher Resource and Project Support for Research Infrastructure	N/A
Ministry of Finance[182] Scientific Research Projects	Techno-Initiative Capital Support Program	Budget up to 100.000 TL for applications
	Budget transferred to TÜBİTAK	
Social Security Institution	Support for R&D and Design Activities	N/A
Ankara Development Agency	Social Entrepreneurship and Social Innovation Financial Support Program[183]	Support between 100,000 TL and 400,000 TL within the total budget of 7,000,000 TL

Source: Sanayi Yatirimlarina Verilen Destekler ve Teşvik Programlari, 2019; KOP Bölge Kalkınma İdaresi Başkanlığı, Ar-Ge, Yenilik, Girişimcilik, Ticarileştirme ve Yatirim Destekleri El Kitabi; official websites and annual reports of relevant ministries

178. https://www.uab.gov.tr/uploads/announcements/ulastirma-ve-altyapi-bakanligi-2019-yili-faaliyet/uab-2019-faaliyet-raporu.pdf

179. https://www.enerji.gov.tr/File/?path=ROOT%2f1%2fDocuments%2fFaaliyet%20Raporu%2fETKB%202019%20Y%c4%b1l%c4%b1%20%c4%b0dare%20Faaliyet%20Raporu-28.02.2020.pdf

180. https://www.tarimorman.gov.tr/SGB/Duyuru/91/Tarim-Ve-Orman-Bakanligi-2019-Yili-Faaliyet-Raporu-Yayimlanmistir

181. https://ms.hmb.gov.tr/uploads/2019/05/Hazine-ve-Maliye-Bakanl%C4%B1%C4%9F%C4%B1-2018-Y%C4%B1l%C4%B1-Faaliyet-Raporu.pdf

182. https://www.resmigazete.gov.tr/eskiler/2016/09/20160930-13.htm; https://ms.hmb.gov.tr/uploads/sites/2/2019/04/New-Economy-Program-2019-2021.pdf

183. https://www.ankaraka.org.tr/tr/2019-yili-mali-destek-programlari_4564.html

5.3.2.1. TÜBİTAK

TÜBİTAK remains the major funder for science, technology and innovation in Turkey. TÜBİTAK funds are divided into several categories applicable for different performers. Funding categories could be detailed according to the level of R&I activity: basic research, applied research, experimental research, pre-commercialization, commercialization and investment. Even though TÜBİTAK supports are not covering investment stage, public institutions and especially ministries have specific programs for the investment stage. Yet TÜBİTAK takes part in the evaluation process whether the investment includes technology development and/or R&D activities.

Universities generally benefit from basic, applied and experimental research funds, including supports numbered 1000, 1001, 1002, 1003, 1004 and 3501. There are also government funds transferred to TÜBİTAK, applicable for universities. These funds are Scientific Research Projects funded by Ministry of Finance and R&D Support Program for Energy Sector, funded by Ministry of Energy and Natural Resources. Funds for universities are generally for basic research but may cover up to pre-commercialization stage.

For university and industry collaboration, TÜBİTAK supports cover applied research, experimental research, pre-commercialization, commercialization and investments. Supports numbered 1005, 1007, 1503, 1505 and 1513 and 1601 are applicable for projects targeting university and industry collaboration. Ministry of Food, Agriculture and Forestry, Ministry of Transport and Infrastructure, Ministry of Industry and Technology and KOSGEB's R&D support programs are also supporting university and industry collaboration.

SMEs are supported by TÜBİTAK, 1507 and from 2019 onwards 1501 support programs. 1707 Commissioned R&D program can also be considered as an SME support program. In addition to TÜBİTAK, MoIT, KOSGEB, Ministry of Finance and Development Agencies have different supports and funds for promoting applied research, experimental research, pre-commercialization, commercialization and investment stages.

Industry supports in TÜBİTAK (programs 1501, 1509, 1511, 1515, SAYEM and HAMLE), on the other hand cover R&I costs from basic research to investment. In addition, Ministry of Finance and MoIT have several support programs targeting industry development. There are only a number of industry support programs in TÜBİTAK but in terms of the allocated budget it is almost the same as academic research supports.

1004 program for academic research and SAYEM for industrial research, both launched in 2018, target big consortiums (including all actors denoted in section 2.5) working collaboratively and specialize in high technology areas, to produce products that can not be produced in Turkey.

HAMLE program, which targets investment in predefined needs of the country is used as a prior stage investment tool where R&D is complemented with industrial investment at the end.

Apart from funding R&D activities, TÜBİTAK also funds other actors in the STI system like TTOs, venture capital, patent licensors and entrepreneurs.1513 program supports TTOs that contribute to the commercialization of research outputs in universities and technology produced in TDZs. Patent Based Technology Licensing Program launched in 2019 provides a maximum of 2 million TL per project enabling the commercialization of patents hold by universities and researchers. 1514 Tech-InvesTR Venture Capital Support Program was established to enable venture capital funds to invest in R&D intensive early-stage companies. Entrepreneurs are supported under 1512 BIGG program (200,000 TL per entrepreneur) to transform their technology and innovation-oriented business ideas into startups that have potential to create high value-added and jobs.

Last, but not the least, branding, marketing and investment related projects are supported at experimental research, pre-commercialization, commercialization and pre-investment stages. Ministry of Finance, KOSGEB, Turkish Patent and Trademark Office, Development Agencies and MoIT have 13 different support programs under this category.

Table 5.7. Maximum budget allocations of TÜBİTAK programs[184]

1000	Maximum support of 30,000 TL[185]
1001	Maximum support of 720,000 TL[186]
1002	Maximum support of 45,000 TL[187]
1003	Maximum support ranging between 750,000 TL to 3,750,000 TL depending on the project scope[188]
1004	No maximum budget is identified[189]
1005	Maximum support of 300,000 TL[190]
1007	No maximum budget is identified[191]
3501	Maximum support of 360,000 TL[192]
1503	Maximum support ranging between 30,000 TL to 40,000 TL[193]
1513	Maximum support ranging between 1,250,000 TL to 1,750,000 TL[194]
1601	No maximum budget is identified[195]
1507	Maximum support of 600,000 TL[196]
1501	No maximum budget is identified[197]
1509	No maximum budget is identified[198]
1511	No maximum budget is identified[199]
1515	Maximum support of 10,000,000 TL[200]

Note: The maximum supports are announced budgets in the last calls and may change in each call.

184.https://www.TUBITAK.gov.tr/sites/default/files/19970/ardeb_tanitim_sunumu_2020_0.pdf

185. https://www.TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/1000/icerik-1000-2015-1-universitelerde-ar-ge-strateji-belgesi-hazirlatilmasi-ve-uygulatilmasi

186. https://www.TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/icerik-1001-bilimsel-ve-teknolojik-arastirma-projelerini-destekleme-pr

187. https://www.TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/icerik-1002-hizli-destek-programi

188. https://www.TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/icerik-1003-oncelikli-alanlar-ar-ge-projeleri-destekleme-programi

189. https://www.TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/icerik-1004-mukemmeliyet-merkezi-destek-programi

190. https://www.TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/icerik-1005-ulusal-yeni-fikirler-ve-urunler-arastirma-destek-programi

191. https://www.TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/1007/icerik-destek-kapsami

192. https://www.TUBITAK.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/icerik-3501-kariyer-gelistirme-programi

193. https://www.TUBITAK.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/1503/icerik-destek-kapsami

194. https://www.TUBITAK.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/1513/icerik-destek-kapsami-0

195. https://www.TUBITAK.gov.tr/tr/icerik-destek-kapsami

196. https://www.TUBITAK.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/1507/icerik-destek-kapsami

197. https://www.TUBITAK.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/1501/icerik-onemli-hususlar

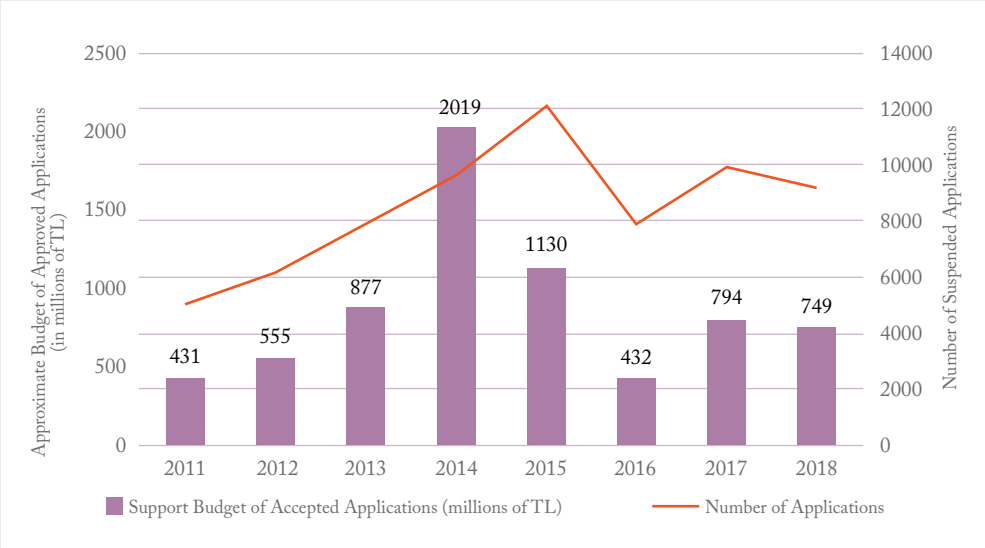
198. https://www.TUBITAK.gov.tr/tr/destekler/sanayi/uluslararasi-ortakli-destek-programlari/1509/icerik-destek-kapsami

199. https://www.TUBITAK.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/icerik-1511-TUBITAK-oncelikli-alanlar-arastirma-teknoloji-gelistirme-ve-yenilik-p-d-pteknoloji-odakli

200. https://www.TUBITAK.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/1515/icerik-destek-kapsami

TÜBİTAK Directorate of Academic Research Funding Programs (ARDEB) support statistics for 2011-2018 show that number of applications increased by 81% compared to 2011. The increasing trend in applications is not met by the budget. The average support budget of accepted projects topped 220,000 TL in 2014 and gradually declined to 85,000 TL in 2018. Given that these are nominal numbers, budget per applications has declined in real terms over the years. Figure 5.8 provides number of applications and number of allocated budgets for approved applications in more detail.

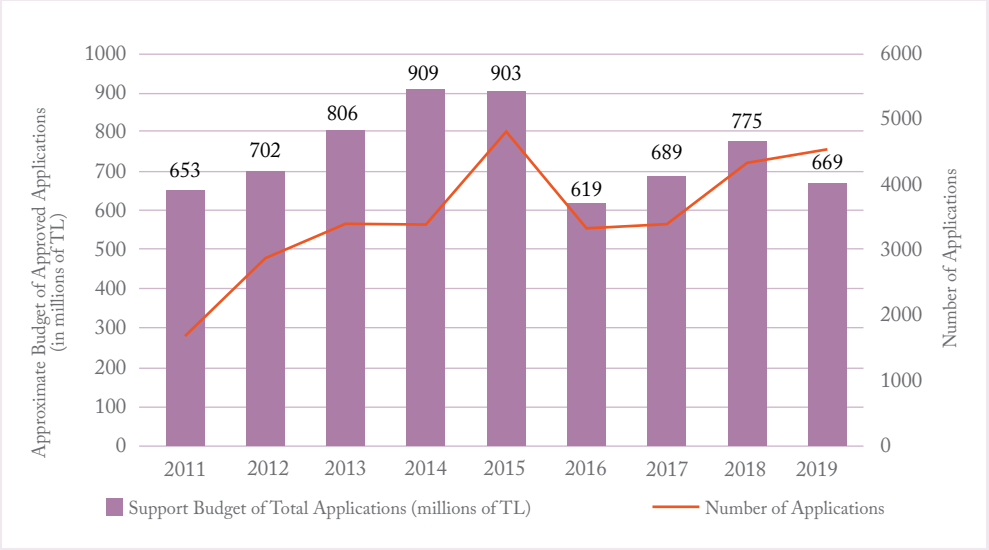
Figure 5.8. Number of applications to Academic Research Funding Program (ARDEB)



On the other hand, as of 2019, applications to Directorate of Technology and Innovation Support Programs (TEYDEB) are more than doubled since 2011 with an increasing trend over the years. Even though total amount of budget fluctuates each year depending on the applications, overall budget is rather stable over the years and in fact has declined gradually since 2015. Figure 5.9 provides further detail on the applications and

budget of accepted projects to TEYDEB. In TEYDEB projects the average support is about 1.5 million TL which in real terms have fallen gradually over the years.

Figure 5.9. Applications to Directorate of Technology and Innovation Support Programs (TEYDEB)



5.3.2.1.1 ARDEB

ARDEB, is a directorate in TÜBİTAK that provides various forms of support for in house and interinstitutional research and development activities. ARDEB functions as a bridge between research groups and universities, state institutions and organizations, natural and legal persons. The main aim is to assist the production of quality R&D activities mainly in universities. ARDEB provides funding for national support programs which are 1000, 1001, 1002, 1003, 1004, 1005, 1007, 3001 and 3501. ARDEB coordinates its activities under scientific area groups

that support, conduct and assist R&D projects. These groups are given below:[201]

- Research Support Group for Chemistry and Biology (KBAG)
- Research Support Group for Mathematics and Physics (MFAG)
- Research Support Group for Health Sciences (SBAG)
- Research Support Group for Electric, Electronic and Informatics (EEEAG)
- Research Support Group for Engineering (MAG)
- Research Support Group for Environment, Atmosphere, Ground and Marine Sciences (ÇAYDAG)
- Research Support Group for Agriculture, Forestry and Veterinary (TOVAG)
- Research Support Group for Social Sciences and Humanities (SOBAG)
- Research Support Group for Defense and Security Technologies (SAVTAG)
- Research Support Group for Community (KAMAG)

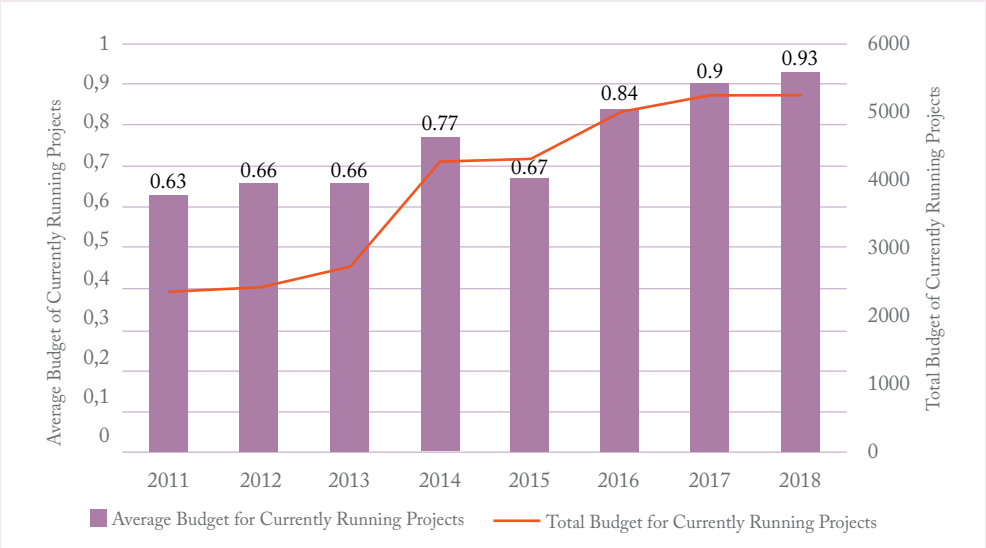
By 2019, the total number of supported projects through ARDEB has reached nearly 21,300.[202] Figure 5.10 shows total funding data for current running projects and average budget allocated for each project per year.[203]

201. "TUBITAK ARDEB Destekleri | Proje Destek Ofisi". Pdo.Metu.Edu.Tr, https://pdo.metu.edu.tr/TUBITAK-ardeb-destekleri. Accessed 18 May 2020.

202. TUBITAK.Gov.Tr, 2018, https://www.TUBITAK.gov.tr/sites/default/files/281/ardeb_stat_2018_1.pdf. Accessed 20 Oct 2020.

203. "ARDEB GENEL DESTEK VERİLERİ (2009-2018)". TUBITAK.Gov.Tr, https://TUBITAK.gov.tr/sites/default/files/18842/1_ardeb_genel_destek_verileri_2009-2018.pdf. Accessed 20 June 2020.

Figure 5.10. ARDEB funding over the years (million TL)



5.3.2.1.2 TEYDEB

TEYDEB, Technology and Innovation Funding Programs Directorate runs supporting programs within TÜBİTAK and provides funding for R&D project-based activities to improve R&I capabilities of the private sector, enhance innovation culture and indirectly competitive capacity of Turkey.[204] Supporting programs funded by TEYDEB are 1501, 1503, 1505, 1507, 1509, 1511, 1512, 1513, 1514, 1515, 1601 and 1602.[205] 1602 is Patent Support Program that provides funding for search and examination reports of the patent application process. Moreover, if patent is granted in Turkey, there is an award of 3,000 TL. If the obtained patent is either from US, Japanese or European Patent Offices then the award is 10,000 TL.[206]

204. "TEYDEB Teknoloji Ve Yenilik Destek Programları Başkanlığı - Özel Sektör Ar-Ge Ve Yenilik Destekleri". TUBITAK.Gov.Tr, https://www.TUBITAK.gov.tr/sites/default/files/teydeb_kitapcik.pdf. Accessed 19 May 2020.

205. «TÜBİTAK TEYDEB Proje Değerlendirme Ve İzleme Sistemi - PRODİS». Eteydeb. TUBITAK.Gov.Tr, https://eteydeb.TUBITAK.gov.tr/teydebmevzuat.htm. Accessed 9 May 2020.

206. "TÜBİTAK TEYDEB Özel Sektör Arge, Yenilik Ve Girişimcilik Destekleri". TUBITAK.Gov.Tr, https://www.TUBITAK.gov.tr/sites/default/files/teydeb-genel-100314.pdf. Accessed 14 May 2020.

There are six different Technology Groups and four Support Groups in TÜBİTAK TEYDEB:

- Information Technologies Group
- Biotechnology, Agriculture, Environment and Food Technologies Group
- Electric and Electronic Technologies Group
- Material, Metallurgy and Chemistry Technologies Group
- Transportation, Defense, Energy and Textile Technologies Group
- Machine Manufacturing Technologies Group
- Technology Transfer Mechanism Supporting Group
- Entrepreneurship Supporting Group
- Venture Capital Supporting Group
- Priority Areas Supporting Group

Between 1995 and 2018, total number of supported projects was 20,237 with 9 billion TL funding and 16.3 billion TL R&D volume.[207]

5.3.2.1.3 BİDEB

Directorate of Science Fellowships and Grant Programs (BİDEB) provides funds and supports for research events and fellowships for university students at any level of study. Table 5.8 summarizes support programs of BİDEB.[208]

207. Telifhaklari.Gov.Tr, 2019, http://www.telifhaklari.gov.tr/resources/uploads/2019/10/31/TUBITAK-TEYDEB-DESTEKLER.pdf. Accessed 17 May 2020.

208. "BİDEB". E-Bideb.TUBITAK.Gov.Tr, https://e-bideb.TUBITAK.gov.tr/giris.htm. Accessed 20 June 2020.

Table 5.8. Support and Fellowship Programs for Students and Research Events

For Undergraduate Students	Support
2205 Bachelor's Degree Scholarship Program	A monthly stipend of 1,000 TL and tuition fee up to 2,000 TL
For Graduate Students	
2211/A General Domestic Doctorate Scholarship Program	Scholarship ranging between 650 TL to 3,000 TL
2211/B Transition to Domestic Social Sciences PhD Scholarship Program	
2211/C Domestic Priority Doctoral Scholarship Program	
2211/E Direct Domestic PhD Scholarship Program	
2210/A General Domestic Graduate Scholarship Program	Scholarship ranging between 550 TL to 2,500 TL
2210/B Transition to Domestic Social Sciences Graduate Scholarship Program	
2210/C Domestic Priority Graduate Scholarship Program	
2210/D Graduate Scholarship Program for Domestic Industry	
2210/E Direct Domestic Graduate Scholarship Program	
2213-A International Ph.D. Scholarship Program	Scholarship up to $60,000
2213-B International Joint Ph.D. Scholarship Program	Monthly scholarship for Europe up to €1,700 and for US $1,900, travel expenses[209]
2214 International Research Fellowship Program (for PhD Students)	Monthly scholarship for Europe up to €1,500 and for other countries $1,800
ICGEB (International Center for Genetic Engineering and Biotechnology) Scholarship Program	Monthly stipends are: €1,300 for Italy, $1,020 for India, ZAR 12,500 for South Africa
TWAS (The World Academy of Sciences) Scholarship Program	Fellowship budgets, grants, prizes and awards vary
EMBO (European Molecular Biology Organization) Programs	Fellowship budgets, grants, prizes and awards vary
APSCO Scholarship Program	Scholarships vary
NAM S&T Centre Scholarship Program	Scholarships vary
For Postdoctoral Students	
2219 International Postdoctoral Research Fellowship Program	Monthly scholarship for Europe up to €2,100 and for other countries $2,500

209. KARACA, A. Mete. The Scientific And Technological Research Council Of Turkey. Head Of Bilateral & Multilateral Relations International Cooperation Department, 2019, https://eurieeducationsummit.com/uploads/presentations/2019/Mete-Karaca.pdf. Accessed 18 May 2020.

2247-A National Leading Researchers Program	Support for R&D is 1,000,000 TL Scholars (PhD): monthly 4,500 – 800 TL Scholars (Post-Doc): monthly 6,000 TL Project Director: monthly 5,000 TL
2247-B European Research Council (ERC) Support Program	Support for R&D is 500,000 TL Scholars (PhD): monthly 3,500 – 650 TL Scholars (Post-Doc): monthly 4,500 TL
2236 Co-Funded Brain Circulation Scheme2 (CoCirculation2)	Support for R&D: monthly €600 Scholars: monthly $4,167 – $4,792
2232 Postdoctoral Reintegration Fellowship Program	Initial Support: 500,000 – 1,000,000 TL Support for R&D: 720,000 TL Scholars: 20,000 – 24,000 TL
2221 Fellowship Program for Visiting Scientists and Scientists on Sabbatical Leave	Support varies between daily 165 TL with monthly $3,500
EMBO (European Molecular Biology Organization) Programs	Fellowship budgets, grants, prizes and awards vary
ICGEB (International Centre for Genetic Engineering and Biotechnology) Scholarship Program	Monthly stipends are: €2,000 for Italy, $1,590 for India, ZAR 18,750 for South Africa
NAM S&T Centre Scholarship Program	Scholarships vary
ESA (European Space Agency) Scholarship Program	Scholarships vary
For Foreign Researchers/Students	
2216 Research Fellowship Program for International Researchers	Scholarship monthly 2,250 TL
2221 Fellowships for Visiting Scientists and Scientists on Sabbatical Leave	Support varies between daily 165 TL with monthly $3,500
EMBO (European Molecular Biology Organization) Programs	Fellowship budgets, grants, prizes and awards vary
European Union Marie Curie Actions and European Research Council Program	Fellowship budgets and program funds vary
For Scientific Events	
2223-C Multi-Participation International Event Organization Support	Support up to 200,000 TL[210]
2237-B Project Training Activities Support Program	Support up to 6,000 TL
2224-C Program to Support Participation in Scientific Activities Abroad within the Framework of International Agreements	Scholarship varies

210. "TUBITAK 2223-C – Çok Katılımlı Uluslararası Etkinlik Düzenleme Desteği | BİLİM ŞENLİĞİ". Bilimsenligi.Com, https://www.bilimsenligi.com/TUBITAK-2223-c-cok-katilimli-uluslararasi-etkinlik-duzenleme-destegi.html/. Accessed 18 May 2020.

2224-A Program to Support Participation in Scientific Activities Abroad	Scholarship varies
ICGEB (International Centre for Genetic Engineering and Biotechnology) Supports	Monthly stipends are: €2,000 for Italy, $1,590 for India, ZAR 18,750 for South Africa
Travel Support for Consortium Building	Support varies
2223-D Support for Organizing Events in the Framework of Bilateral Cooperation Agreements	Support up to 50,000 TL
2242 University Students Research Project Competitions	Awards varying between 1,000 TL and 15,000 TL

By 2019, total number of supported students was 125,917 with about 2.1 billion TL total funding. Detailed annual funding data can be seen in Figure 5.11.[211]

Figure 5.11. BİDEB Funding over the years (million TL)

211. "BİDEB 2010-2019 YILLARINA AİT İSTATİSTİK RAPORU". https://www.tubitak.gov.tr, 2020. https://www.TUBITAK.gov.tr/sites/default/files/3835/bideb_istatistikler_07.05.2020.pdf. Accessed 21 June 2020.

With the comparison of Figure 5.8 to 5.11 it can be said that over the years share of TEYDEB has been increased compared to other TÜBİTAK support programs.

5.3.2.2. TTGV

One of the biggest funders of science, technology and innovation in Turkey is Technology Development Foundation of Turkey (TTGV) that provides support under various programs such as Technology Transfer Accelerator, Explore Investment Program, Hit Program, Ideanest Program, Green Technology Projects (YETEP) Support Program and TTGV1 Program. Detailed information on aims, budget limitation and duration of these funding programs are given below.

5.3.2.2.1. Explore Investment Program

This program aims to improve the diffusion of technology-based companies to the global marketplace increase market share and sustainability of sales performance. Entry strategies, and roadmaps of the companies are developed with experienced actors in the pre-exploration phase. After this assessment step, an equity investment up to $250,000 is available for selected companies to improve their market entering processes. As a third party, Teknoloji Yatırım's co-investment funding is available for up to $2 million.[212] Figure 5.12 depicts the Explore Investment Program.

212. https://www.teknolojiyatirim.com.tr/en/explore-en

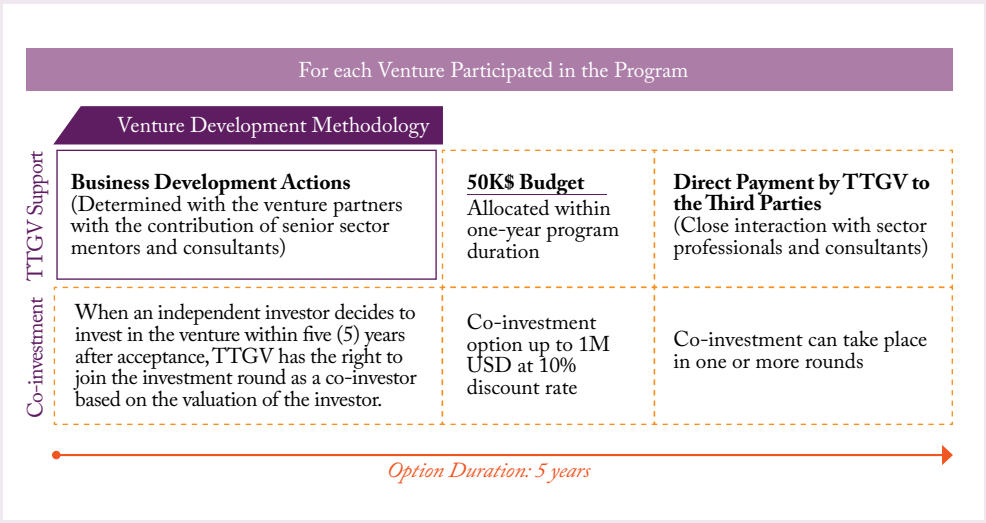
Figure 5.12. Explore Investment Program

Source: TTGV

5.3.2.2.2. Hit Program

For selected vertical technology markets the program aims to develop ventures and provide a first customer or a secured market for the ventures. Start-ups are selected according to their business plan and selected ones are part of the "Initial Market Entry Program". To develop the business activities, the program finances up to $50,000 (per start-up) for initial market entry process, for one-year period. Selected start-ups may be financed by independent investors within five years. Figure 5.13 depicts the Hit Program.

Figure 5.13. Hit Program



Source: TTGV

5.3.2.2.3. Ideanest Program

This program is designed as a crowdsourcing platform and the goal is to pair the beneficiaries with the funders in accordance with TTGV's strategies. The main motto of this program is "Technology Producing Turkey". To achieve this, the program provide supports for academic research projects and early-stage technology-based new product ideas while highlighting donation for technology. The target budget of crowdsourcing differs for each project.

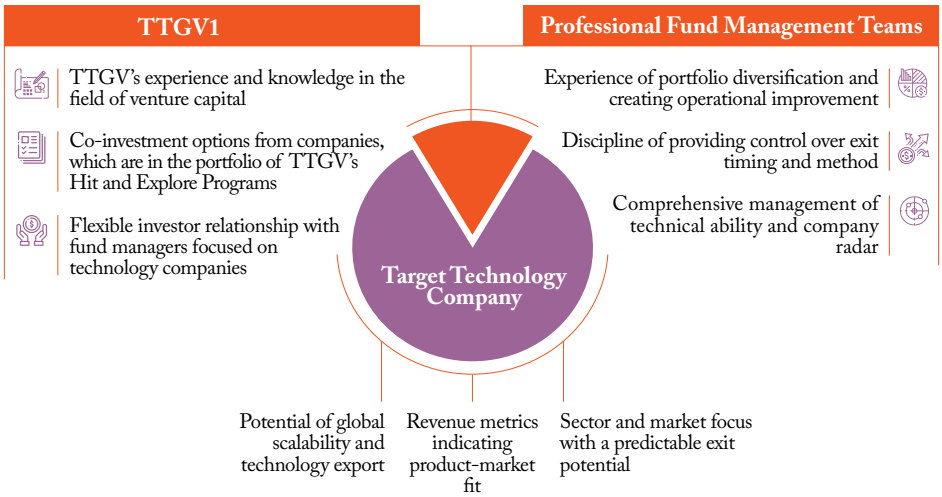
5.3.2.2.4. Green Technology Projects (YETEP) Support Program

The aim is to provide repayable financial support to organizations for the implementation of their projects. There are three different scopes of YETEP program which are "Climate-Friendly Technology Support", "Clean Production Technologies Support" and "Energy Efficiency, Renewable Energy and Other Energy Technologies Support". Selected projects can be supported for a maximum fifteen months with a budget ranging from $100,000 to $400,000.

5.3.2.2.5. TTGV1 Co-Investment and Follow-On Investment Fund

The aim is to make investments to companies at the growth stage and take the attention of professional investors so that selected companies receive investment. The program is explained in Figure 5.14 in details. Funding life is 10 years and the period of investment is five years with possible funding up to €20 million.

Figure 5.14. TTGV1



Source: TTGV

5.3.2.2.6. The Technology Transfer Accelerator - TTA Turkey

"The Technology Transfer Accelerator - TTA Turkey is an initiative designed by the European Investment Fund (EIF) in cooperation with the MoIT, the Delegation of the European Union (EU) to Turkey and the DG Regional Policy of the European Commission".[213] TTA Turkey Project is co-financed by the EU and the Republic of Turkey under the Instrument for Pre-Accession Assistance (IPA) funds and managed by EIF on behalf of the Ministry. One of the sub-components of TTA Turkey is the Advisory Services and Networking component which is implemented by the consortium of TTGV, Bpifrance Financement (FR) and VentureWell (US). TTA Turkey has an AdviSeNet project that aims to enhance the capacity of TTOs in Turkey, improve commercialization of the R&D capacity of TÜBİTAK and identify investment ready opportunities.

213. "TTGV". Ttaturkey.Org, http://ttaturkey.org/. Accessed 16 May 2020.

Selected TTOs are provided with capacity development services and business development services.[214] Furthermore, this project enables TTOs to exchange staff with paired relevant TTOs in France or the US for two weeks.

5.4. International Funds

5.4.1. The 7th EU Framework Programme (2007-2013)

The 7th EU Framework Programme (FP7) was the main financial instrument of the EU to build the ERA, aiming at enabling free circulation of researchers, scientific knowledge and technology. It was a tool to lift up the competitive strength of beneficiary countries.[215] Having accounted third largest share of the EU budget, FP7 provided a significant impetus to support investments in knowledge, innovation and human capital across the EU, the candidate, and associated countries.

FP7 was built on previous programs and went beyond by structuring the program strategically for better alignment of research priorities to meet the policy needs of the EU. The structure of the Program was based on four sub-programs, where FP7-Cooperation streamlined international cooperation in transnational research projects through themes, FP7-People aimed at developing human potential through training, and increasing mobility of researchers between sectors and countries. With the FP7-Capacities sub-program, funds were directed to strengthen research infrastructures, particularly enhancing the research capacities of the SMEs. One of the novel additions to this program was FP7-IDEAS, which provided project funding for exploratory and cutting-edge research in new and emerging fields of science and technology.[216]

214. "Services | TTGV". Ttaturkey.Org, http://www.ttaturkey.org/2/services. Accessed 16 May 2020.

215. European Commission (2015a), "Commitment and Coherence: Ex-Post-Evaluation of the 7th EU Framework Programme (2007-2013)" EU publications.

216. European Commission (2015b), "Seventh FP7 Monitoring Report: Monitoring Report 2013".

To realize the objectives of FP7, €55 billion budget was allocated over seven years, which represented a rise of 66% compared to the previous FP6 program. Within the FP7, approximately 25,000 projects involving 29,000 organizations were supported to realize research objectives. The bulk of the budget over the program period was allocated to cooperation, which represents 64% of total allowances. The rest was distributed to ideas, people and capacities. With respect to the type of organizations, higher education, private sector and research organizations were observed the main beneficiaries from the EU financial grants as the number of applicants and the figures for the requested EU contribution indicates.[217] FP7 monitoring results on the applications and success rates are presented in Table 5.9.

Table 5.9. FP7 Monitoring Results

2007-2013 (on average)	Success rates in applications	Success rates in EU financial contributions
Turkey	16.1 %	7.2 %
Cand. & Assoc.	21.9 %	18.7 %
EU countries	21.6 %	19.2 %
Third countries	20.3 %	17.1 %
All countries	21.8 %	19.1 %

Source: Adopted from European Commission (2015a), Commitment and Coherence: Ex-Post-Evaluation of the 7th EU Framework Programme (2007-2013).

The geographical distribution of FP7 participation and grants displayed in Figure 5.15 and Figure 5.16 suggest that Turkey's participation in this program was realized mainly by research institutions and private sector located in major cities, especially Ankara and İstanbul. During the program period, Turkey realized a success rate[218] comparable with the average of various country groups. However, Turkey fell short in acquiring financial contributions from EU budget even compared to its own group of candidate countries, indicating that most successful applications of Turkey was with small budget, compared to the other consortium members (Table 5.9). Notwithstanding, Turkey ranked 4th

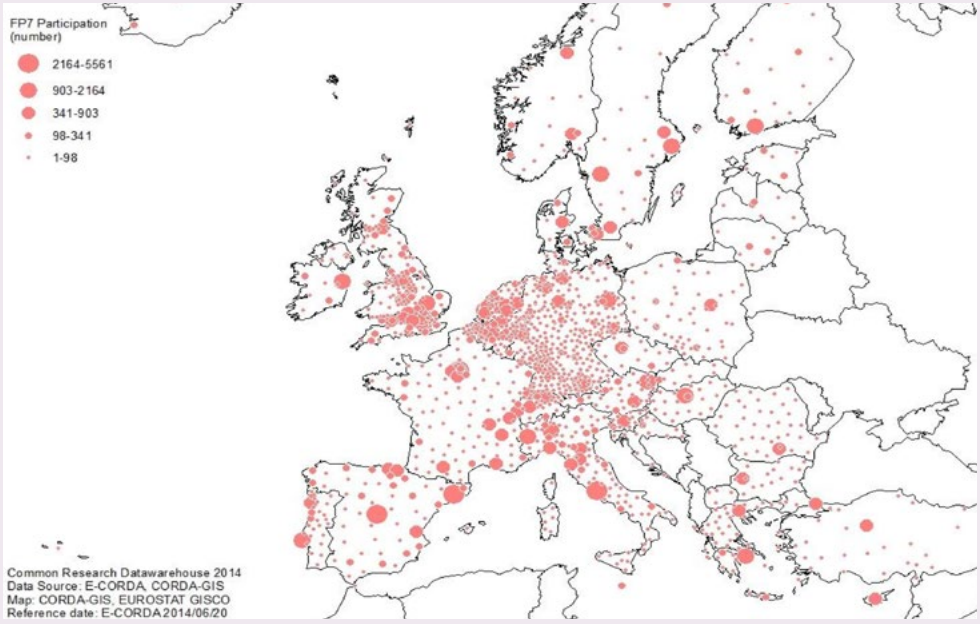
217. European Commission (2015a).

218. Defined as the ratio of retained proposals to eligible proposals that could be supported.

in candidate and associated countries in terms of total European Commission (EC) contributions of about €189 million (0.4% of total EC contributions).[219]

Among research institutions all over the EU, TÜBİTAK, ranked 24th (97th overall) as the sole research institution from Turkey that took place among the top 50 research organizations (in terms of participation numbers over the program period).[220]

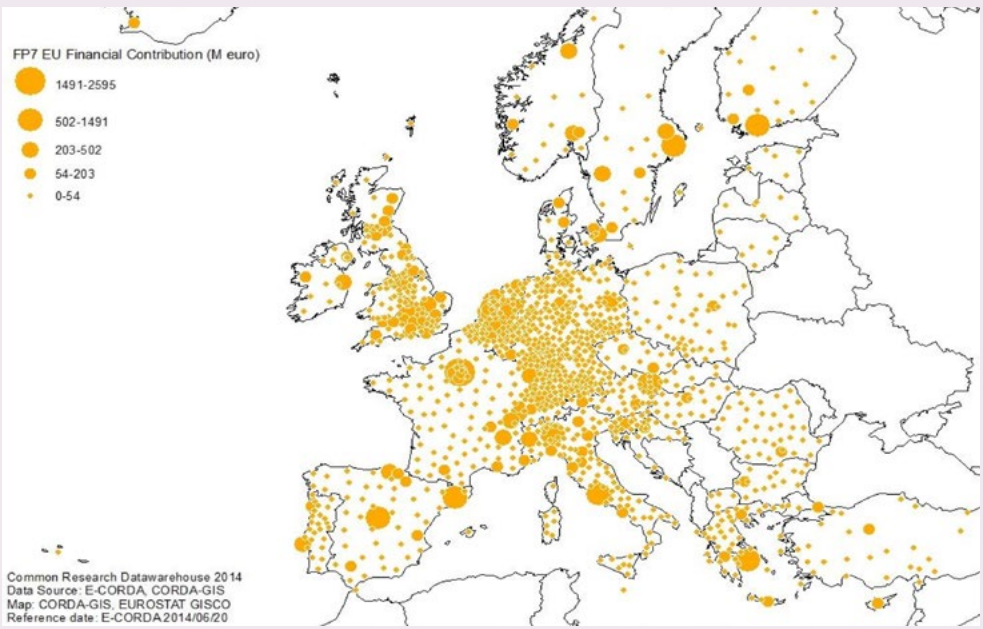
Figure 5.15. FP7 Participation (number)



Source: European Commission, 2015b; adjusted by the authors

219. European Commission (2015a) and European Commission (2015b).
220. European Commission (2015b).

Figure 5.16. FP7 EU Financial Contribution (million Euro)



Source: European Commission, 2015b; adjusted by the authors

5.4.2. Horizon 2020 (H2020)

After finalizing FP7, a new EU FP for R&I was launched in 2014, H2020, that steers the implementation within the frame of Innovation Union objectives. Having €80 billion budget over 7 years, the program is the biggest financial instrument aimed at ensuring the competitive strength of the EU and regarded as a key investment for the future to secure the EU's roadmap for achieving smart, sustainable and inclusive growth.[221]

H2020 had certain novelties in that it brings three separate programs

221. European Commission (2017), Interim Evaluation of Horizon 2020, Commission Staff Working Document, Directorate General for Research and Innovation. Horizon 2020 Official Standard Presentation https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/281113_Horizon%202020%20standard%20presentation.pdf retrieved on 17.05.2020.

together[222], supporting all types of innovations from research to retail, it puts societal challenges to the forefront (e.g., health, clean energy and transport) and finally, it provides a simplified access for everyone so as to ensure projects flourish quickly.

According to the final breakdown of H2020 budget among its three priorities, the bulk of the funds are allocated to the societal challenges (38.5%) including health, demographic change and well-being; securing clean and efficient energy, food security, sustainable agriculture and forestry, smart, green and integrated transport, climate action, Europe in a changing world and securing societies. Next, 31.7% of the funds is allocated to ensure excellent science, which is distributed among the European Research Council (ERC), Marie-Skłodowska-Curie actions (MSCA), future and emerging technologies and European research infrastructures. 22.1% of the budget is used to support leadership in industrial technologies, access to risk finance and innovation in SMEs. The rest of the budget is allocated among other initiatives that are brought together in H2020.[223]

Table 5.10 presents descriptive data of Turkey within the H2020. While the geographic distribution of Turkey's participation shows similar pattern compared to FP7, big cities, in particular, become more scattered spanning Eastern Anatolia, as well (Figure 5.17). Similar to FP7, TÜBİTAK is the top beneficiary in terms of both participation and EU contribution from H2020, which is followed by major universities and large private enterprises in the industrial sector (Figure 5.18). Based on net EU contribution, majority of the funds have been granted to the private sector (39.3%) followed by higher or secondary education (33.4%), research organizations (14.9%), and public bodies (10.6%).[224]

222. These 3 programs and initiatives include FP7, CIP (Competitiveness and Innovation Framework Program) and EIT (European Institute of Innovation and Technology)

223. European Commission (2013), Factsheet: Horizon 2020 Budget https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/Factsheet_budget_H2020_0.pdf retrieved on 17.05.2020.

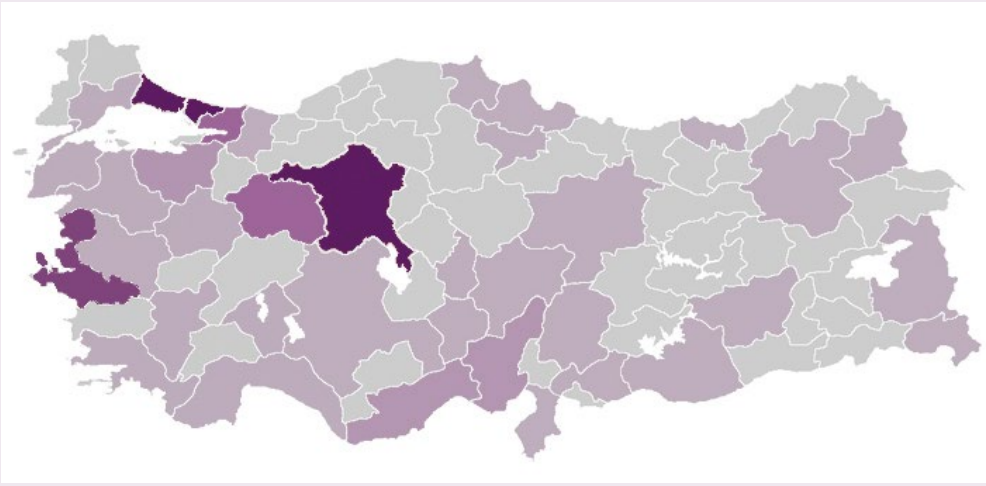
224. The data is retrieved from the European Commission Horizon 2020 Dashboard as of March 2020. European Commission Horizon 2020 Dashboard, H2020 Country Profile https://webgate.ec.europa.eu/dashboard/hub/stream/aaec8d41-5201-43ab-809f-3063750dfafd

Table 5.10. Horizon 2020 Monitoring Results for Turkey

	Figures for Turkey	Share of the associated countries, total
Participation	871	8.6 %
Net EU contribution	183.4 million €	4.3 %
Applications	7,556	12.0 %
Success rate	10.1 %	13.9 %
Signed Grants	609	10.2 %
ERC Principal Investigators	16	1.9 %
European Innovation Council (EIC) Participation	24	4.0 %
Experts, female	575 / 46.1 %	---
MSCA participation	145	12.6 %

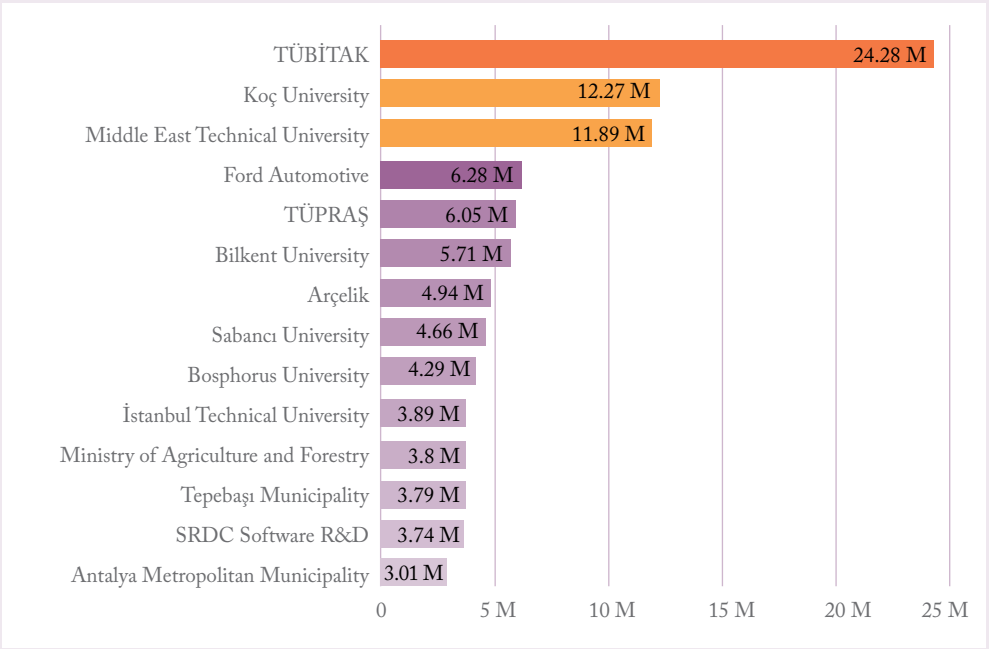
Source: European Commission, H2020 country profile (as of March 2020)

Figure 5.17. H2020 Participation by cities



Source: European Commission, H2020 country profile (as of March 2020)

Figure 5.18. H2020 Top Turkish Organizations



Source: European Commission, H2020 country profile (as of March 2020)

Figures 5.19 and 5.20 compares FP7 and H2020 in participation and funding. With regards to the member and associated countries in total, participation figures in H2020 tend to fall, while Turkey's share is declining in participation compared to FP7 (from 0.91% to 0.68%). On the other hand, EU contribution across programs has increased in H2020 in member and associated countries, while the funds granted and their share both have fallen in Turkey compared to FP7 (from 0.44% to 0.36%). While, Turkey secures its rank related to participation and funding in H2020 with respect to associated countries, Turkey started to lose competitive ground compared to member countries, suggesting a necessity for stimulating investments on R&I and effective steering of implementation depending on official policy documents for the upcoming period.

Figure 5.19. EU Participation to and funding from H2020

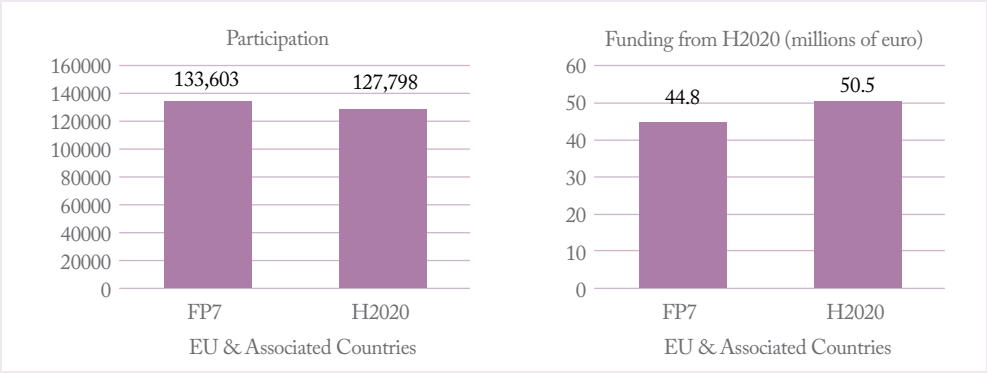
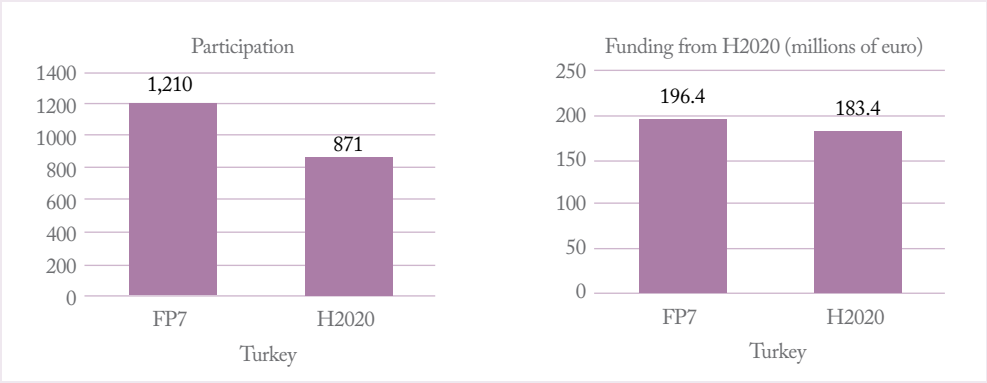


Figure 5.20. Turkish participation to and funding from H2020



Source: European Commission, H2020 country profile (as of March 2020)

5.4.3. Horizon Europe: The Next EU Research & Innovation Investment Program (2021-2027)

As of 2020, the previous program H2020 is making way for Horizon Europe after the provisional agreement endorsed by the European Parliament and the Council of the EU in April 2019. The Commission's proposal of €100 billion for R&I for the years between 2021-2027, is the most ambitious program ever and is aimed at strengthening innovation capability, providing lasting prosperity and preserving global competitiveness of Europe.[225,226]

Horizon Europe is based on the successes of and lessons learned from the H2020. While Europe is relatively strong in science and research base and accounts for 20% of global R&D investments, EU companies are lagging behind their competitors (i.e., in South Korea, Japan and the United States) on spending for innovation. Further, the overall amount of venture capital and the average size of funds in Europe is insufficient to allow start-ups to flourish. Public investment across the EU remains below 3% target and the R&D intensity is uneven across regions. Last but not least, 40% of the workforce in Europe needs digital upskilling (European Commission, 2019a). On the Turkish side, the above observations hold qualitatively. Turkey spends and involves more in R&D but less in innovation, the STI policy tools primarly funds R&D activities and the earlier phases of innovation process, entrepreneurship activities are mainly funded by the government, R&D spending as percentage of GDP is stabilized around 1% and most of the workforce needs digital upskilling. Thus, such characteristics of the Turkish STI ecosystem resembles the EU very much.

Considering these observations, a renewed agenda on R&I is put forward within Horizon Europe and the policy framework is expected to shift from diffusion-oriented to mission-oriented rationales.[227] This shift may be problematic for countries such as Turkey where policy rationale is mainly diffusion-oriented. Figure 5.21 summarizes the three pillars of Horizon Europe.

225. The budget proposal covers both Horizon Europe and Euratom research and training programme.

226. https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en .

227. European Commission (2019b), Horizon Europe: The Next EU Research & Innovation Investment Program (2021-2027)

The Open Science pillar (€25.8 billion) supports frontier research projects driven by researchers themselves through the European Research Council (€16.6 billion), funds fellowships and exchanges for researchers through Marie Skłodowska-Curie Actions (€6.8 billion) and invests in world-class research infrastructures.

The Global Challenges and Industrial Competitiveness pillar (€52.7 billion) supports research to address societal challenges, reinforces technological and industrial capacities, and determines EU-wide missions with ambitious goals to tackle some of the pressing problems.

The Open Innovation pillar (€13.5 billion) aims to make Europe a frontrunner in market-creating innovations via the European Innovation Council (€10 billion). Through this pillar, it is aimed to develop the overall European innovation landscape, including further strengthening the European Institute of Innovation and Technology (EIT) to reinforce the integration of business, research, higher education and entrepreneurship (€3 billion).[228]

Figure 5.21. The new program will be implemented through three pillars

Source: European Commission (2018), EU Budget for the Future: Horizon Europe.

228. European Commission (2019a), Press Release: EU budget for 2021-2027: Commission welcomes provisional agreement on Horizon Europe, the future EU research and innovation programme.

This program also brings about certain novelties. The first is the European Innovation Council, which will bring the most promising ideas from the lab to the real-world application and support the most innovative start-ups through two funding instruments, one for early stages and the other for development and market deployment. The second novelty is the EU-wide R&I missions that represent ambitious, bold goals to deal with the issues that affect citizens' daily lives. Horizon Europe emphasizes sustainable development, where 35% of the program budget is allocated to address the effects of climate change. In this framework, 5 mission areas are determined: (i) adaptation to climate change, (ii) fighting against cancer, (iii) soil health and food, (iv) developing climate-neutral and smart cities, (v) ensuring healthy oceans, seas, coastal and inland waters. The missions under these areas will be designed together with the citizens, stakeholders, the European Parliament and the member states. The third novelty is open science that goes beyond the open access policy of H2020 and requires open access to publications, data, and management plans.[229]

Horizon Europe was officially launched on 1 January 2021. The strategic planning process will particularly focus on the Global Challenges and European Industrial Competitiveness pillar of Horizon Europe.[230] The challenge will be to develop a financing window that is both inclusive (i.e. financing R&I of all types) and in line with specific missions that are linked to the key societal problems.[231] Hence, policymakers and the beneficiaries from the public, private and higher education sector in Turkey needs to adjust to mission driven project-portfolio approach by investing more in sustainable development, while pursuing to participating in R&I projects, where they can develop their competitive advantage through R&I Window, SME Window and the European Innovation Council's specific financial instruments.

229. European Commission (2018), EU Budget for the Future: Horizon Europe.

230. https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en

231. European Commission (2019b)


6

6. Concluding Remarks

In the midst of a new technological paradigm new ideas, inventions and prototypes emerge and the old paradigm fades away. Today, the world is experiencing such a process where scientific base is renewing. Technological solutions to grand challenges like climate change and the recent COVID-19 pandemic are bounded with what science and the scientific base can provide. The match between technological problems, solutions to that problems and the scientific base should also be assessed in terms of economic feasibility and societal reflections. What is the role of government in such a process? How do governments cope with the grand challenges? What kind of policy frameworks emerge and most importantly how does Turkey respond to them? This final chapter briefly discusses five trends in STI policy-making and reflect how Turkey copes and responds to such trends. It also pinpoints the challenges of the Turkish STI system.

There are five recent trends in STI policy-making.

1. The policy tools are moving towards selecting technologies, niche areas even products. Thus, the policies are more selective moving away from horizontal policies that aim a general stock of firms.

2. Since the problems are becoming complex the technological solutions to such problems are also complex and may encompass a wide array of sectors and disciplines of science. In such cases the policy-mixes (that are composed of compatible policy tools) are increasingly used compared to policy tools.

3. Complex technological solutions and coping with grand challenges necessitate an active role for government in creating technologies and markets as opposed to a more regulative role.

4. Public procurement for innovation as a tool of demand-side policies is increasingly being used by governments around the world.

5. Mission-oriented rather than diffusion-oriented policies are in rise especially with the recent attempt of the EU in moving towards creating missions, the most recent example is the new FP 2021-27, Horizon Europe, that is designed and organized in a mission-oriented setting.

Moving towards selective policy tools is, in fact, a long process. The neo-classical school as a theoretical base state that science and technology policy aim at supporting knowledge creation at the upstream assuming a representative firm. Once knowledge created by actors it is assumed that it will diffuse. But due to uncertainty in the R&D and innovation processes, firms will spend less than they should spend (market failure). Horizontal supports like R&D tax exemptions, R&D subsidies are generated with such a theoretical base. The evolutionary school posit, on the other hand, that knowledge is created by interactions of heterogenous agents. Technological knowledge is created in an innovation system and when an actor lacks or the interactions between actors lack, one can talk about a systemic failure. In such a framework, since firms are heterogenous the policy tools cannot be general. Thus, pushing all firms to a non-existing optimal level of R&D is not a good way to support STI activities. The policy should aim a "functioning" innovation system. Evolutionary theory necessitates a more selective approach in designing STI policy. In the last decades we see that policy tools are becoming much more selective based on the characteristics of the actors. It started by selecting sectors, certain areas within sectors, then technologies and now even technological products.

This report shows that Turkey follows this trend. Horizontal policies and more selective policies are used in tandem but especially most new policy designs are selective, selecting a sector, a group of firms, a geographical area, a technology or even a product (the case of TOGG, Turkey's Automobile Initiative Group). Selecting sectors has long been applied in policy-making in Turkey but even within that a "high-technology" focus is observed. Thus, for instance ICT, machinery or knowledge-intensive sectors are favored as opposed to textiles. But within those sectors there is also selection towards high-technology firms assuming that high-technology creates value-added. The trend in supporting technology-based entrepreneurship, but not necessity-based entrepreneurship could also be an example to such trend. In the recent years, it is observed that rather than broad technology groups niche technologies are selected. CoSTIP's recent attempt of prioritizing technology fields is also in line with the aim of selecting technologies as devised in the 11th Development Plan (section 3.1.1). In a similar manner, the new policy tool, Industry Innovation Network Mechanism Call (SAYEM), is focused on high-technology areas and even certain NACE codes. This behavior of selective design is present in many other new tools of TÜBİTAK such as HAMLE, Commissioned R&D Call and the 1004-Excellence Centre Support Program. These recent policy tools also reveal that the government wants to direct and accelerate the innovation activities with collaboration and co-creation efforts, both in business-to-business and university-industry side, with an emphasis on impact and output orientated model.

The second trend in STI policy-making is related with complexity. Our current problems, especially the grand challenges such as climate change, are becoming so complex for single-aimed policy tools to handle. Since it is difficult for one policy tool to cope with such complexity, new policy designs have multiple tools for one policy aim (for instance, support indigenous technology production).[232] There are many examples in this fashion, but the best ones are the policy-mixes that use both demand and supply-side designs and multiple tools to support eco-innovation and renewable energy technology production in the Nordic countries.[233]

Turkey follows this trend as well. If one looks at the policy designs some 20 years ago, one policy tool was burdened with several policy aims. The initiation of technology parks and the Technology Development Zones law is a good example. It is a policy tool with multiple hard-to-achieve and hard-to-asses policy aims (support technology production, increase patent applications, create synergy, substitute technology import by indigenous production, assist regional development etc.). Current policy designs are plainer, but many such policy tools are used to achieve one policy aim. The trend on indigenous and national (technology) production could be an example. There is one giant policy aim but there are many policy tools that one way or another support the aim of indigenous technology production. Policy-mix to support renewable energy technologies is also a good example in the case of Turkey. There is a policy-mix that is composed of many supply and demand-side policy tools (e.g., R&D tax exemptions, innovation support, public procurement, regulation, technology prioritization, creation of research infrastructures etc.). The most important problem for Turkey to design and implement policy-mixes is coordination among different public institutions and between public institutions, firms and universities.

Another trend in STI policy-making relates to the role of government in supporting research and innovation. Moving away from a passive state mode (government regulate) to an active state mode (governments create markets) is increasingly being observed. The seminal book of Mariana Mazzucato, The Entrepreneurial State, gives many examples from different countries and different technologies regarding how governments induce technological change by actively making markets rather than regulating the existing ones.[234] The argument is that radical technologies and scientific

232. Meissner, D., Kergroach, S. Innovation policy mix: mapping and measurement. J Technol Transf 46, 197–222 (2021). https://doi.org/10.1007/s10961-019-09767-4

233. https://www.nordicenergy.org/wp-content/uploads/2014/05/Renewable-Energy-Policies-in-the-Nordic-Region.pdf

234. Mazzucato, M. (2013) Entrepreneurial State, Anthem Press.

breakthroughs seldom emerge from firms. Governments create such technologies and the market until a risk-taking environment is set. The US missions, the recent attempt of EU moving towards mission-oriented policy[235], the roles of Chinese and South Korean government in technological development, the role of government in Brazil's renewable energy technology development and health sector[236] are just few examples around the world.

Turkey is somewhere between the passive and active state modes.[237] In some sectors, such as defense and energy, and specific technologies, such as unmanned aerial vehicle and now electric automobile, the government is more active. But we cannot say that there is a general trend of moving away from passive to active state mode. Automotive sector is a good example in this manner.[238] Especially after the Customs Union agreement with the European Union (EU) in 1996 the automotive sector almost completely was left to market forces and government mainly regulated the market. Now with TOGG this is changing. Even the investment decision and the current activities to produce a fully electric automobile led to sharp changes in other firms' attitude. Currently, several brands are advertising heavily about fully electric and hybrid automobiles much earlier than planned. Ford is establishing Turkey's first battery assemble plant.[239] Active state mode and creating markets needs huge research and innovation finance, macroeconomic sustainability, policy sustainability and coordination among government bodies and between the government and the firms. In all these areas Turkey has structural problems that are difficult to swiftly address.

235. https://op.europa.eu/en/publication-detail/-/publication/5b2811d1-16be-11e8-9253-01aa75ed71a1/language-en. See also the full acount of reports on mission-oriented policy: https://ec.europa.eu/info/horizon-europe/missions-horizon-europe/mission-oriented-policy-studies-and-reports_en.

236. https://publications.iadb.org/publications/english/document/The-Age-of-Missions-Addressing-Societal-Challenges-Through-Mission-Oriented-Innovation-Policies-in-Latin-America-and-the-Caribbean.pdf

237. Akçomak, I.S. and Emiroğlu, U. (2020), Devlet Kaynaklı Teknolojik Gelişme: Girişimci Devlet ve Doğurgan Devlet, in Tiryakioğlu, M. (eds) Devletle Kalkınma, İletişim Yayınevi: Ankara, 73-102.

238. Akçomak, I.S. and Bürken, S. (2020), Middle-Technology Trap: The case of Automotive Industry in Turkey, in Ferreira, J. J., Teixeira, S.J., Rammal, H.G. (eds). Technological Innovation and International Competitiveness for Business Growth, Palgrave, pp. 263-306.

239. https://blog.ford.com.tr/kategori/editors-picks/setting-up-turkeys-first-battery-assembly-plant

Another development in STI policy-making is the rise of public procurement as a policy tool as part of the great interest in demand-side policies.[240] All supply-side designs whether backed by neo-classical or evolutionary theories assume that firms' R&D and innovation activities should be supported providing that the demand is ready. Most of the time this is not the case. Public procurement is especially important in indirectly supporting early phase research and innovation activities and signal firms that the market is ready. When assessed together with the rise of active state mode, it is also used for creating (a market for) radical technologies. "Public procurement for innovation" as a phrase is stated as a specific innovation strategy of the EU (the Lisbon Strategy).[241] Since then, it is a rising trend especially in the EU.

In Turkey the wide scale use of public procurement of innovation is rather recent (less than 10 years). According to TÜİK Innovation Survey 2014 Turkey is in the last quarter (among 30 European countries) in % firms with public procurement contract. Turkey is in the third quarter in % firms that involve in innovation (not forced) with public procurement contract. But most importantly Turkey is in top-5 in % of firms that public procurement contract requires innovation (forced). This is a good indication that public procurement for innovation is used as an STI policy tool in Turkey. The recent Techno Catalogue of The State Supply Office can also be assessed as a movement towards demand-side policies and especially use of public procurement for innovation.

Finally, mission-oriented policy is increasingly being adopted by developing as well as developed countries as opposed to diffusion-oriented policy. US have been applying it for years. France and Germany already have moved towards mission-oriented policy. Italy's recent attempt is also worth mentioning. The statement that new FP of the EU, Horizon Europe, will follow mission-oriented policy principles even further enhanced the popularity of missions.[242] Horizon Europe with a budget of more than €100 billion will be the leading research and innovation fund of the EU for the next 7 years (2021-2027). New missions focus on "sustainability" thus differ from the old missions (e.g., man on the moon of US). Research and innovation efforts are organized around a bold clear aim (e.g., 100 carbon free cities in EU by 2030) defined by a mission.

240. Edquist, C., Vonortas, N. S., Zabala-Iturriagagoitia, J. M., & Edler, J. (Eds.). (2015, January). Public Procurement for Innovation. Cheltenham: Edward Elgar Publishing, 304 pp.

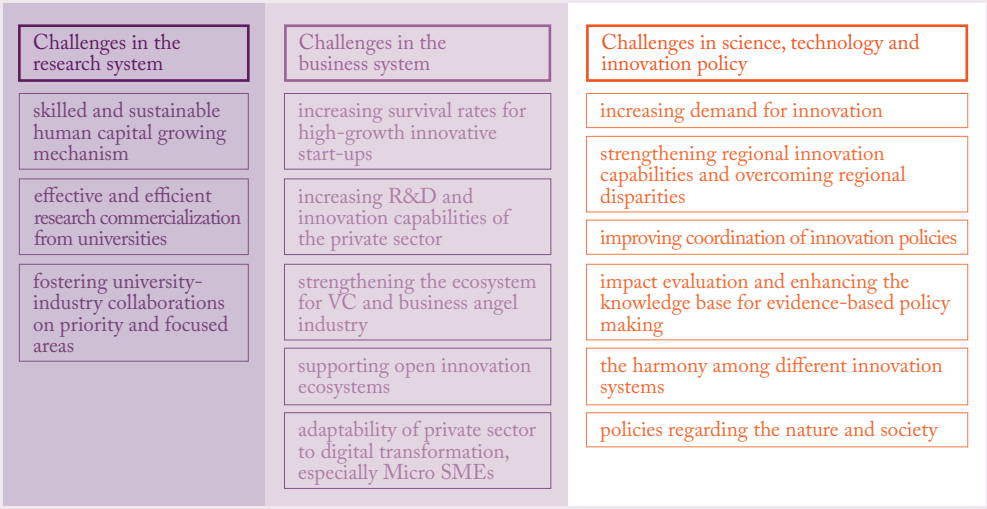
241. Edler J. (2012) Research and Innovation and the Lisbon Strategy. In: Copeland P., Papadimitriou D. (eds) The EU's Lisbon Strategy. Palgrave Studies in European Union Politics. Palgrave Macmillan, London. https://doi.org/10.1057/9781137272164_10

242. https://ec.europa.eu/info/horizon-europe/missions-horizon-europe_en

There are no clear attempts of moving towards mission-oriented policy in Turkey. How the TOGG electric automobile is publicized may sound like a mission (an indigenous electric car on the roads by 2022) but it cannot be said that all research and innovation efforts are organized around this mission. For this reason, it is difficult to say that TOGG can be considered a mission-oriented attempt.

In light of the existing analytical works and the main indicators related to Turkish STI system, several STI challenges have been identified depicted under three categories in Figure 6.1. Challenges in research, business and policy systems in Turkey are briefly discussed below.

Figure 6.1. Challenges in research, business and policy systems



Challenges in skilled and sustainable human capital growing mechanisms

The share of employment in knowledge-intensive activities in Turkey is very low as compared to the EU average. The need to improve the human capital base has always been on the agenda of governments in Turkey and emphasized in the policy documents. Although there have been some improvements such as increases in the number of researchers and R&D personnel, and in the number of scientific publications, further efforts and diversified measures are needed to improve human resources in a way that the absorptive capacity of companies is enhanced, and the quantity and quality of researchers are increased. The quality of the education at all levels needs to be improved in parallel with the observed increase in enrolment rates. The existing programs at various levels of the education system are not sufficient to meet the changing demand for human resources associated to new technologies (automation, AI, biotechnology, etc.) as experienced in the COVID-19 process. While the number of R&D personnel has significantly increased in the last decade, there are still issues related to employment of highly-skilled persons particularly of natural science graduates. The role of international cooperation programs such as EU Framework Programme may be important in improving quality in HEIs.

Challenges in effective and efficient research commercialization from universities

There has been significant progress in improving knowledge transfer from HEIs towards business enterprises in the last years. Almost all new instruments aimed at improving the collaboration between universities and private sector such as TTOs, TDZs, and research infrastructures (RI). However, the collaboration between these actors is not at the desired level. Most of the intermediate actors do not have fully skilled and experienced people who work on technology commercialization. It is needed to put more emphasis on relationship building to construct more capacity. The enrichment of policy mix with a variety of measures is needed to address this challenge, in particular via interface structures that conduct brokerage activities among actors and consulting and mentoring interfaces for technology-based ventures. Spin-offs should be encouraged both from universities and corporations to foster the commercialization of knowledge created in these organizations.

Challenges in fostering university-industry collaborations on priority and focused areas

Creating interfaces (technology development centers, technology parks, TTOs) have been used as a general initiative to support university-industry collaboration. However, a main challenge is going a step further from creating relations to creating collaborations. It was assumed that when firms and university are in proximity, they will automatically collaborate. The experience of the last two decades shows that this is not the case. Culture and unbinding formal institutions (the rule of law) are the two important factors that explain low collaboration in Turkey, where working in teams and collaboration is an exception rather than a rule. Therefore, university-industry collaborations have to be specifically supported. One such tool is to support university-industry collaboration in priority areas. Currently, supporting collaborations and priority areas are two aspects that seem to be detached. Thus, an important challenge is to design specific policies to support/force collaborations in priority areas and then create scale that such practices diffuse. There are several developments in this aspect. For instance, TÜBİTAK has announced a framework for several TEYDEB programs that directly supports the link (i.e., the collaboration) rather than the nodes (university, firms etc.). When funding is directed to a node, it enhances capabilities of that specific node (e.g., research funding to a university). However, when funding is directed to a link, it enhances exchange of knowledge between linked nodes and co-creation of knowledge which both parties benefit from. The organization of Direct Industry Supports (SADE) and Indirect Interface Supports (AYDE) has specific initiatives to support collaboration. However, SADE is currently inactive and SAYEM and Commissioned R&D Calls are the programs that drive collaboration. Firms, people and related nodes in the ecosystem are so used to getting funding for R&D and innovation activities that it created its own inertia. The government must transform the mindset of “give me money to do innovation” to “provide me the environment to do innovation”. Therefore, the government can push firms, universities and other related parties to involve in collaboration by increasing funding for collaborative activities. The slowly emerging co-creation movement can also be assessed in this manner.

Challenges in increasing survival rates for high-growth innovative start-ups

In addition to the weaknesses in the regulatory and business environment, the underdeveloped venture capital and business angel markets negatively affect technology-based entrepreneurship. Support programs implemented by MoIT,

TÜBİTAK, and KOSGEB have contributed to the creation of innovative start-ups. However, more efficient and effective policy measures and support mechanisms are needed to encourage educated and qualified human resources to see entrepreneurship as a career option. In addition, most of the Venture Capital (VC) Funds and Business Angels in Turkey invest only in the seed and Series A rounds of a start-up. There is a strong need for growth stage VC funds and Series B and later stage investment rounds to increase the expansion rates of innovative start-ups.

Increasing R&D and innovation capabilities of the private sector

Turkey needs not only to increase the diversification of its exports, but also to increase the number of sophisticated (or core) goods and services in its export basket which are strongly correlated with its competitiveness. In this regard, increasing low levels of absorptive capacity of private sector is an important challenge. This is also critical for upgrading its position in global value chains (GVC) as the interdependence among economies increases and the role of GVCs in determining the position of countries in the international division of labor becomes more important. A firm's ability to innovate is critical to retaining its competitiveness and even survival: in the long run, it is the capability to generate a stream of products and processes that matters. R&D and innovation capabilities of the private sector, particularly of Micro SMEs needs to be increased. Increasing knowledge transfers from universities and other research institutions to private sector is crucial. Consequently, to secure their position into the future, firms need to be able to develop, maintain and renew their "innovation management capability" which is not institutionalized in most SMEs and many large firms in Turkey. In addition to firms that operate in relatively high-technology fields, there is a need to increase the innovation capabilities of the firms in low- and medium-technologies. In this regard, non-technological innovations (organizational, marketing) also need to be promoted.

Challenges in strengthening the ecosystem for VC and business angel industry

As mentioned above, venture capital and business angel markets are underdeveloped in Turkey. A number of policy measures have been implemented in recent years in order to improve the framework conditions faced by the venture capital and business angels. There is a need to evaluate existing strategies and create a policy-mix to enhance the access to finance for innovative ideas of individuals and enterprises. The private investments in VC markets are low, which justifies the need for public

intervention. Government co-investment programs in VC Funds do not suffice as the funds still face the challenge of raising money from private investors. Role of International Financial Institutions (IFI) in the establishment of new VC Funds has been significant in the last decade (e.g., İstanbul Venture Capital Initiative (iVCi), Turkish Global Investment Fund (TGIF), European Bank of Reconstruction and Development (EBRD) and International Financial Corporation's (IFC) co-investments in VC Funds). However, most of these VC Funds have been fully invested and they are facing challenges in raising new funds, as there is little interest from the private investors and government co-investments will not be sufficient to establish new funds. There is now a stronger need from IFIs to sustain funding to the VC Funds that will invest technology focused, innovative start-ups.

Challenges in supporting open innovation ecosystems

Turkey has made significant investments in its universities and public research organizations to enhance the generation of knowledge. The knowledge base of industry has also been expanded as business sector has increased its R&D and innovation activities. However, the level of interaction between the actors is not at its desired level. Turkey's relatively lower scores in terms of innovation linkages (for instance in EU Innovation Scoreboard) show that there is room for government intervention. Public supports in Turkey are mostly designed to increase in-house R&D and innovation activities. On the other hand, collaboration efforts are mostly directed to enhance the vertical cooperation (such as university-industry cooperation or supplier-buyer interaction). There are specific programs to encourage clusters and support pre-competition research projects of firms, but their impact is not clear. One example for lack of horizontal cooperation could be the decline in the number and amount of allocated budget of KOSGEB's Cooperation Collaboration Support Programs which aims to support SMEs cooperating to meet their needs. In addition to the problems in the institutional framework including weak IPR protection, inefficiency of legal framework in settling disputes, and unethical behavior of firms, negative socio-cultural attitude towards cooperation and weak interpersonal trust in society are amongst the barriers to collaboration in Turkey. In this regard, open innovation approach that allows "firms to use external knowledge and external paths to market in order to advance and commercialize their technology" could be used to redesign the innovation system in a way to encourage cooperation besides competition. The creation of research infrastructures open to all users, supports for cluster activities, and shared labs in some TDZs are amongst the promising activities to encourage open innovation in Turkey in recent years. This progress should be improved with

other types of open innovation applications such as living labs and technology platforms that gather all stakeholders including users and enhance interaction among them. Besides the supports for cross-disciplinary R&D and innovation activities, the system must be strengthened by human resources with necessary skills to conduct these types of activities. Last but not least, adequate protection of IPR to improve the markets of technology should be on the agenda.

Adaptability of private sector to digital transformation, especially Micro SMEs

The unavoidable introduction of technological changes in the life of modern homo sapiens not only alters the humanity itself yet transforms societies and socio-economic structure dramatically. The recent discussions on the so-called industry 4.0 or digital transformation seems to have such a capacity. In this context, the current situation in Turkey seems to be promising for policy development and innovative sustainable policy-making. However, the most significant problem is the intensive participation of sub-tiers in the domain of these actors such as SMEs, university research centers, etc. in policy making and probable transformation actions. The late adaptation of the industry to possible changes may have detrimental impact on Turkish industry.

Challenges in increasing demand for innovation and improving the conditions for the uptake of innovations

Empirical studies show that companies are most sensitive to the needs of their closest customers. The more sophisticated and demanding the customers are, the more pressure is provided for innovation, productivity, efficiency, and for upgrading product and service quality. In these circumstances, firms will be eager to differentiate themselves from their competitors both in the domestic and international markets. The size of the market is also an important factor since it helps companies benefit from economies of scale. Another impact is on the introduction of innovative products in a more sizeable environment that enables firms to process market signals with a large amount of data. Lastly, existence of a sizeable market and increasing demand for innovation also have a potential to accelerate FDIs. In Turkey, although there is no official data on the sophistication of domestic demand, it can be weakly and intuitively claimed that the sophistication level of consumers is not far beyond the OECD average. Especially final consumers are keen to adopt innovative products and services as pointed by case studies related to e-commerce, mobile phones, health devices etc.

On the other hand, similar case studies show that the situation is almost the same for intermediate goods. Both central and regional governments should apply well-defined technology adoption and diffusion policies for the innovative products beside the tools used for the public procurement of innovation. Although there has been important progress towards the use of public procurement to promote innovation, these efforts are needed to be supplemented by long-term plans of public agencies. Research activities should be integrated in light long-term procurement plans. The studies by TÜBİTAK and TÜSİAD on digital transformation show that large industrial firms and technology suppliers also demand sophisticated innovative products and services.

Challenges in strengthening regional innovation capabilities and overcoming regional disparities

Turkey has made progress in preparing regional innovation strategies while they are in a laggard position with respect to monitoring and evaluation, policy-mix, and identification of priorities. There is a need to enhance regional capabilities through focusing on regional strengths and weaknesses and paying attention to the role of low- and medium-technologies and non-technological innovations. Regional policies aim to mitigate regional disparities and contribute to the equality of living conditions among citizens. It is needed to increase the innovation capacity of private and public sector together with NGOs via interaction in regional and/or local innovation systems. Improving the relations with the actors in the ecosystem may further contribute to eliminating regional disparities. Significant differences between the regions may have repercussions on their development capacity and create different responses to outward challenges caused by globalization of production and services. In turn, this further creates tensions in terms of their capacity and capability to respond to productivity and competitiveness pressures. What is striking in Turkey is the overwhelmingly centralized decision-making power of the government. Regional agencies seem to be effective on paper in regional decision making, yet they have strict limits in practice for designing novel regional innovation policies. Moreover, the innovation capacity needs of regions vary. However, the challenges of regional articulation to global value chains and development need simple solutions. As one moves to the upper ladder of innovation systems (national/sectoral), solutions become more complex to apply. Regional authorities usually are aware of the solutions, but they do not have the political and bureaucratic power to implement them. In Turkey, through national innovation system actions, the central authorities present the same

menu of incentives and supports to the firms, universities and other related institutions. This creates problems and puts barriers to mitigation of innovation challenges and innovation-related regional disparities. General supports should be complemented with specific supports that are more focused and tailored. The first step is to prepare mapping of needs and regional innovation strategies in accordance with smart specialization framework. This would enable regional authorities to design spatially targeted interventions.

Challenges in improving coordination of innovation policies

The coordination of and consistency between policies implemented by different public agencies is a challenge for Turkey. There is an abundance of STI policy documents in Turkey and, hence, there is need for a national R&D and Innovation Strategy Document. The number of policy documents increased especially after mid-2000s when public agencies almost feel obliged to prepare strategy documents. Although these policy documents are prepared with the help of experts, it is difficult to say that they are prepared with an evidence-based approach and that ex-ante policy appraisals are conducted to shed light on their content. While STI documents focus on specific issues, some are closely interrelated and may contain very similar actions, leading to coordination problems besides the bureaucratic burden for public agencies in reporting the developments for each strategy paper to related organization. In addition to policy-making, all support mechanisms should be integrated to prevent the waste of resources due to the duplications of public support schemes. An inter-organizational coordination council (BTYK) has been operating since 2011, now organized under the Presidency (CoSTIP). However, there is still lack of coordination between different governmental bodies when it comes to design and implementation of support programs.

Scarcity of systematic and periodic studies for impact evaluation and enhancing the knowledge base for evidence-based policy making

Lack of systematic and regular impact assessments is a major issue that should be improved upon without any delay. These impact evaluation studies may be ex ante, interim or ex post. If the results of the programs/policies are not in line with the targets, findings should be used to revise or even to abandon the policy instruments assessed. In addition, these exercises can be used to increase accountability of the funding process. Therefore, impact assessment studies should be made available to the public, showing data as well as methodologies used, and findings obtained.

The harmony among different innovation systems

Although one may observe various initiatives among different types of innovation systems (national, regional, sectoral and technological innovation systems) the existing coordination problems impedes the complementary relations of different initiatives among the innovation systems. Sometimes, these initiatives may produce counter acting impacts through conflicting initiatives rather than complementary. The dynamic capabilities embedded in each system is not utilized at the desired levels.

Policies regarding the nature and society

STI policies' sustainability and success depend on their degree of formulation to consider the relations of human society with their natural and social systems. However, the policy-making practices generally do not consider this challenge. Human-nature relations in STI policy-making often treated as a residual and is not considered endogenous to the systems of innovation. Although we observe some evidence of this struggle especially in some local/regional innovation systems, the general understanding is still far away from what is desired. Such an approach may have a potential to create sustainability problems in the medium- and long-term. Moreover, the policy-making processes should consider the various segments of stakeholders in the context of multiple-helix approach. The state of belonging and being an actor of policy-making co-generate the actors with the requirements of regulations and policies. However, the rising nepotism and clientelism in policy-making, on the other hand, makes the policy initiatives idle and/or inefficient.

Epilogue

Turkey's current story in STI policy-making is creating an environment (actors, financing, intermediate organizations, entrepreneurs, support personnel) that enables R&I activities to flourish. In accordance with this story, the STI policy in Turkey created many nodes (actors: entrepreneurs, firms, intermediate organizations, new public institutions etc.) but little interaction. Following complex policy trends, such as an active government mode, policy-mix and mission-oriented policy, necessitates good interactions as well as dynamic capabilities on the government side. In this manner, Turkey's STI policy needs a new story that focus on creating interactions among actors to sustain and develop the STI system.

List of Commonly Used Abbreviations

ARBİS	Researcher Information System
ARDEB	Directorate of Academic Research Funding Programs
BERD	Business Expenditure on Research and Development
BİDEB	Directorate of Science Fellowships and Grant Programs
BİLGEM	Informatics and Information Security Research Centre
BTYK	Supreme Council for Science and Technology
GBOARD	Central Government Budget Appropriations and Outlays on Research and Development
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
CIS	Community Innovation Survey
COST	European Cooperation in Science and Technology
CoSTIP	Council of Science, Technology and Innovation Policies
EC	European Commission
EIF	European Investment Fund
EIS	European Innovation Scoreboard
EPO	European Patent Office
ERA	European Research Area
EU	European Union
FDI	Foreign Direct Investments
FP	Framework Program
FTE	Full-Time Equivalent
GUF	General University Funds
H2020	Horizon 2020
HAMLE	Technology Focused Industrial Movement Program
HEI	Higher Education Institution
HERD	Higher Education Sector Research and Development
ICT	Information and Communication Technology
IPR	Intellectual Property Rights

İŞGEM	Business Development Centre
KOSGEB	Small and Medium Enterprises Development Organization
KÜSİ	Public University Industry Cooperation
KVKK	Law on Personal Data Protection
M&A	Merger & Acquisition
MAM	Marmara Research Centre
METU-MEMS	Middle East Technical University Micro-Electro-Mechanical Systems Research and Application Centre
MoAF	Ministry of Agriculture and Forestry
MoENR	Ministry of Energy and Natural Resources
MoIT	Ministry of Industry and Technology
MoT	Ministry of Trade
MoTF	Ministry of Treasury and Finance
NACE	Statistical Classification of Economic Activities in the European Community
NGO	Non-Governmental Organizations,
NSI	National System of Innovation
OEC	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parity
R&D	Research and Development
RIO	Research and Innovation Observatory
RTTP	Registered Technology Transfer Professional
RUTE	Rail Transport Technologies Institute
S&T	Science and Technology
SAGE	Defense Industry Research and Development Institute
SANTEZ	Industrial Thesis Program
SAYEM	Industry and Innovation Network Mechanism Call
SBB	Presidency of Strategy and Budget
SME	Small and Medium-sized Enterprise
SPO	State Planning Organization
STI	Science, Technology and Innovation
SUNUM	Sabancı University Nanotechnology Research and Application Centre

TARAL	Turkish Research Area
TARABİS	TÜBİTAK Research Infrastructure Information System
TDZ	Technology Development Zones
TEKMER	Technology Development Centres
TEYDEB	Directorate of Technology and Innovation Support Programs
TOBB	Union of Chambers and Commodity Exchanges
TOGG	Turkey's Automobile Initiative Group
TRL	Technology Readiness Level
TSE	Turkish Standards Institute
TTA	Technology Transfer Accelerator
TTGV	Technology Development Foundation of Turkey
TTO	Technology Transfer Offices
TUG	TÜBİTAK National Observatory
TÜBA	Turkish Academy of Sciences
TÜBİTAK	The Scientific and Technological Research Council of Turkey
TÜRKAK	Turkish Accreditation Institute
TÜRKPATENT	Turkish Patent and Trademark Office
TÜSEB	Health Data Research and Artificial Intelligence Applications
TÜİK	Turkish Statistical Institute
UBYTS	National STI Strategies
ULAKBİM	National Academic Network and Information Centre
UNAM	Bilkent University National Nanotechnology Research Centre
USPTO	United States Patent Office
UZAY	Space Technology Research Institute
ÜSİMP	University-Industry Cooperation Centres Platform
VC	Venture Capital
YÖK	Council of Higher Education

Notes

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