

Insights into Türkiye's Technology Development Journey

SERDAL TEMEL

Ege University, Türkiye

ORCID No: 0000-0002-6391-7372

ABSTRACT *Türkiye, an emerging economy, has been attempting to improve its socioeconomic strength through the promotion of research and development (R&D), innovation, and technological development activities. Most notably, since 2000 the government has been implementing programs and supporting schemes with a particular focus on improving the innovation capacity of small and medium-sized enterprises (SMEs) and universities. First, institutions were set up by the government to provide support to SMEs, and different support programs were then introduced by these institutions. The support programs subsequently diversified to include patenting, commercialization, and entrepreneurship support as well as support for ecosystem improvements. In this commentary, I provide a summary of these programs and how they have affected technology R&D and innovation capacity in Türkiye. Although it is clear that the programs have had an impact, we were not able to source any evidence delineating the size of their impact. Nevertheless, it would have been better if we, as a country, could have focused on measuring not only the financial contributions of the programs but also their social impact as well.*

Keywords: Türkiye, Technology Development, R&D, Innovation, Government Support

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Introduction

One of the main goals of all countries is to provide a better quality of life for their citizens. To achieve this, governments develop and implement different policies to enhance the competitiveness of firms, as they are the main drivers of job creation in society.¹ In modern economies, the main role of the government is not necessarily to be an entrepreneur itself but to provide a very efficient ecosystem in which companies and entrepreneurs can be more innovative and competitive. However, it is challenging for governments to do this because simply developing new policies and creating grant schemes, while necessary, are not sufficient. To achieve the desired outcomes, transformations are required in many areas of an economy.

By way of example, Türkiye, an emerging economy, has been working to enhance the technological development capacity in the country for more than a decade. Up until the 1980s, Türkiye had implemented an import substitution economy model, which limited foreign trade and access to goods and services developed in other countries.² This policy created a type of competitive 'comfort zone' for firms in Türkiye; they could sell their products to the local market and achieve high-profit margins as they had no pressure from international competitors. Firms also had little incentive to be creative and innovative to gain a competitive advantage. When Türkiye shifted its policy from import substitution to an export-led policy

in 1980, Turkish consumers were easily able to obtain goods and services developed in other countries, which harmed the Turkish manufacturing industry. At that time, firms started to compete with other innovative and technology-oriented firms in the world. However, it was very difficult for firms in Türkiye to compete because, until that time, they had not made innovation a priority, nor had they built their internal capacities.³

To help firms gain competitive skills, Türkiye created several mechanisms and schemes in the early 1990s and indeed continues to actively develop new strategies to improve the innovation levels of firms. With the help of the institutions that implemented such schemes, Turkish firms started to learn how to conduct R&D and innovate. The number of supportive institutions and mechanisms has increased since the 1990s, and the number of firms benefiting from them has grown. The resultant skills and capacities have also attracted many international firms, which have invested in Türkiye. Furthermore, the competitiveness of firms has improved in many areas, with an increasing number of new goods and services, patents, and startups. Notably, academic entrepreneurship has become a hot topic and the main target of universities and science parks. Universities are particularly focused on not only developing a high number of patents but also commercializing these patents. All these efforts have improved Türkiye's ranking in the Global Innovation Index. However, despite all its initiatives, Türkiye is

not at a sufficient level of innovation and R&D concerning impact. In this commentary, I provide a brief overview of the journey of technological development in Türkiye and discuss how Türkiye could improve its impact over the longer term.

Beginning of R&D and Innovation in Türkiye

R&D, innovation, entrepreneurship, and technology development support programs in Türkiye started later than those in most developed countries around the globe. At the beginning of the 1990s, some organizations were created by the government to enhance the R&D and innovation capacity of firms and help them increase their competitive power.

One of the first such organizations, which was established in early 1990 to support the R&D and innovation activities of firms, was the Small and Medium Enterprises Development Organization of Türkiye (KOSGEB). KOSGEB mainly helps small and medium-sized firms (SMEs) stay competitive by introducing new technologies and innovation. KOSGEB closely monitors firms, their performance, and needs and introduces new programs to not only improve the technology development capacity (i.e. R&D and innovation) of the firms but also to facilitate their access to international markets, their recruitment of talented staff, their digital transformation, and entrepreneurship. KOSGEB has been a crucial organization for firms for two rea-

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sons: first, it mainly provides grants, and second, it has centers in all the cities of the country, which makes it very easy for firms to access KOSGEB support programs.

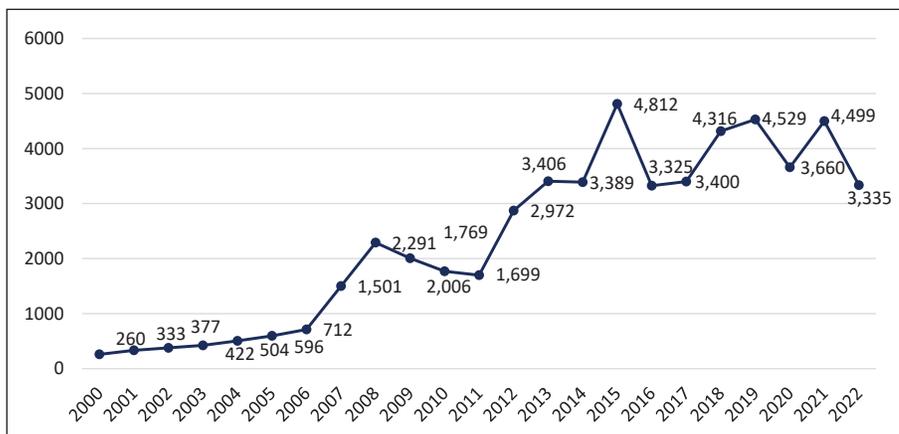
Shortly following its establishment, KOSGEB created Technology Development Centers (TEKMER), which aim to support technology-oriented small and new businesses, foster university-industry collaboration and create technology-based academic startups. KOSGEB established these centers in cooperation with local actors, such as universities and regional chambers of commerce and industry. TEKMERs are physical buildings that provide tax exemptions, free incubation, and easy access to government financial support for technology-focused entrepreneurs. By virtue of their structure, TEKMERs represented the first institutional implementation of the Triple Helix model in Türkiye. Between 1991 and 2017, 44 TEKMERs were established in 26 different cities across Türkiye.

A second organization that supports firms' R&D and innovation activities

in Türkiye is the TÜBİTAK Technology and Innovation Support Program Directorate (TEYDEB). Established in 1995, TEYDEB aimed to support the R&D and innovation activities of

As shown in Graph 1, the total number of project applications to TEYDEB for R&D and innovation purposes has increased over time but particularly since 2011. This means

Graph 1: Total Number of R&D Project Applications to TEYDEB from 2000 to 2022



Source: TÜBİTAK TEYDEB⁴

firms of all sizes, including large businesses. Since its launch, TEYDEB has been developing different programs to enhance the R&D, innovation, and technology development capacities of firms, including via the awarding of grants. Furthermore, TEYDEB aims to accelerate university-industry collaboration, and for this reason, a specific support mechanism, the University-Industry Collaboration Support Program, was created. This program has motivated numerous firms to conduct R&D projects in collaboration with universities and helped both parties develop new technologies. The advantages of TEYDEB's support programs also include the establishment of mutual understanding, the development of collaboration skills, and the setting of long-term targets.

that more firms have become involved in R&D activities and have developed more R&D and innovation projects, which was the initial purpose of the programs.

In early 2000, Türkiye started to implement the technopark model, which had seen success in the U.S. and many European countries. The aim was to develop new technologies and generate startups, especially technology-based startups. Technoparks were established on university campuses as private-public partnerships, and tax exemptions were provided for R&D activities conducted by companies operating in these technoparks. Given the advantages of tax exemptions, easy access to university resources, comparatively low rental costs, and the availability of mentoring services,

technoparks have become very popular in Türkiye since 2010. Currently, there are 97 technoparks in Türkiye; 82 of them are actively operating, and 15 are under development. As of today, around 9,000 companies and 91,000 employees are working on different R&D projects. Similar to other countries, technoparks have motivated researchers to commercialize their research results by forming startups. Consequently, university researchers have created over 1,800 academic startups.⁵

The R&D and innovation activities in technoparks to date have resulted in around 4,800 patents and 485 industrial designs and contributed to exports totaling almost \$8 billion.⁶ In addition, technoparks have accelerated university-industry collaboration on new technological developments and provided a better ecosystem for technology-based entrepreneurship. Although the number of outcomes seems to be low compared to developed countries, technoparks have had a remarkable impact on technology-based entrepreneurship and innovation in Türkiye.

Industrial Thesis Program

The goal of increasing the production and exports of high-value-added goods and services motivated the government to be creative about R&D support programs. In 2006, a new support scheme, the Industrial Thesis Program SanTez, was launched to encourage academics to collaborate with industry. The SanTez support

Technoparks have accelerated university-industry collaboration on new technological developments and provided a better ecosystem for technology-based entrepreneurship

scheme requires the development of university-industry joint research projects that lead to the awarding of postgraduate degrees, and the state covers 75 percent of the total project costs. This program obliges universities to maintain close contact with industry. Moreover, firms have found the cooperation model to be very attractive as it allows them to access financial grants and invest in young graduates to further their experience in the firm's specific field of operation. The firms mostly employ postgraduate students upon completion of their studies. The program has helped create a culture in which firms seek to maintain sustainable and long-term collaboration with universities to develop new technologies while benefitting from government financial support.

Universities: Places of Scientific Research

In addition to creating different programs to develop new technologies via R&D and innovation activities, knowledge transfer, and the com-

A techno-entrepreneurship (*Teknogirişim*) program was introduced by the Ministry of Industry and Technology in 2009 to transform innovative and technology-based business ideas into high-value-added startups

mercialization of research results, the number of universities in Türkiye increased rapidly from 77 in 2003 to some 205 by 2022. Setting up universities appears to be a good approach for conducting breakthrough research, creating new knowledge and technologies, and progressing innovative ideas for commercial purposes. While the number of universities (both private and public) has increased 2.6-fold, they have not created the expected contribution in the field of either science or technology. This indicates that to use universities as a strategic tool, a productive ecosystem for researchers and universities needs to be created, and setting up new universities may not be the answer. Accordingly, unless the Turkish higher education system were to transform, the existing university system would not be able to provide the necessary scientific and technological outcomes to improve socioeconomic development in Türkiye.

In an attempt to address this issue, in 2013, TÜBİTAK started to rank

all universities under the Entrepreneurial and Innovative Universities Ranking system based on their innovation and entrepreneurship activities.⁷ The main aim was to make the entrepreneurship and innovation activities of universities visible to society and to create a competitive environment for universities. Since 2013, universities have been ranked annually based on their performance. In addition, in 2018 the Higher Education Council of Türkiye launched the Research-Oriented University Index.⁸ Notwithstanding other indicators, this index aims to motivate universities to conduct breakthrough research and commercialize their research results.⁹ These policies have made universities visible in society and created friendly competition between academic institutions. However, this competition is based on quantitative indicators rather than quality. As a result, the number of universities has increased, and they are motivated to compete with each other, yet their international performance has not improved. In fact, the opposite has occurred as their international performance has decreased.

Internal R&D Activities in the Private Sector

In 2008, the government introduced a new support scheme, private R&D centers, aimed at firms that want to proceed with their own R&D activities on their premises instead of at technoparks. This program allows firms to benefit from tax exemptions as long as they conduct R&D and innovation ac-



tivities, and have the equivalent of 15 full-time R&D staff. This scheme has motivated numerous firms to focus on internal R&D and innovation activities and to hire skilled R&D staff to develop high-value-added goods and services. Based on the statistics of the Ministry of Industry and Technology, as of 2022, there were 1,257 private sector R&D centers employing over 75,000 R&D staff. Since 2008, these centers have conducted over 68,000 R&D projects and created 32,000 patents and a number of different goods and services.¹⁰ This program has motivated the private sector to become involved in R&D activities by using their resources, which is desirable in many developing economies.

Technology-Based Entrepreneurship Startups

As previously described, until 2008, Türkiye invested heavily in creating awareness and building capacity in firms for R&D, innovation, and technology development. However, it was clear that to increase the technology

development capacity of the country, the projects developed by firms were not enough. Alongside many other elements, the entrepreneurship piece of this complex puzzle was missing. To close this gap, a techno-entrepreneurship (*Teknogirişim*) program was introduced by the Ministry of Industry and Technology in 2009 to transform innovative and technology-based business ideas into high-value-added startups. For the first time, Türkiye focused on providing financial support specifically for technology-based business ideas. With the help of this program, around 2,000 technology-based startups were created with the support of \$37 million. In 2012, the program was reformed and currently operates under the name Individual Young Entrepreneur Support Program (BIGG) and is coordinated by TÜBİTAK.¹¹

The BIGG program has motivated numerous students, researchers, and young entrepreneurs to develop business ideas and form their own startups. In 2012, 360 business ideas were submitted to TÜBİTAK, and 112 re-

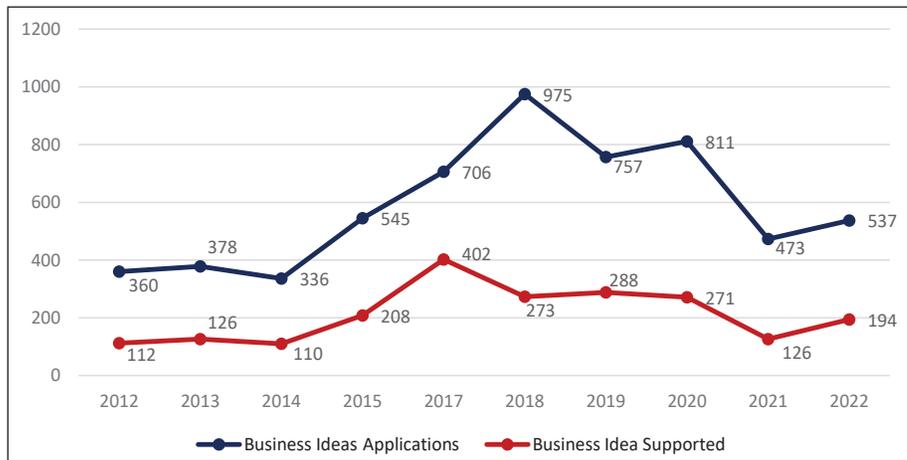
Technopark İstanbul is one of the biggest science parks in Türkiye. There are more than 300 local and international companies engaged in R&D research for high technology developments.

TEKNOPARK
İSTANBUL / AA

ceived grants (Graph 2). In 2018, the number of business ideas reached its highest level at 975, but since then, the number of business ideas has declined. One reason for this decrease is the program’s focus on specific themes, such as green and health businesses, which has minimized the number of applications. Second, the quality of the business plans has become important, and certain quality standards need to be met before they will be considered, which has further limited the number of applications.

versities closer to industry to improve the innovation capacity of firms and to facilitate the transfer of knowledge from universities to the private sector. To help universities translate research results into high-value-added goods and services, TÜBİTAK started the Technology Transfer Office (TTO) Support Program for universities that want to form TTOs and benefit financially from the support program. With this program, Turkish universities were introduced to the concept of structured TTOs that provide ser-

Graph 2: Technology-Based Startups Supported by TÜBİTAK (2012-2022)



Source: TÜBİTAK, TEYDEB Presentation

From Teaching-Oriented Universities to Entrepreneurial Universities

Despite a large number of universities in Türkiye, including those that have recently been launched, Türkiye has not obtained tremendous benefits from them as entrepreneurial accelerators. On the other hand, Türkiye has made a huge effort to draw uni-

vices under five different modules, namely, Awareness and Training, Project Support, University-Industry Collaboration, IPR and Licensing, and Entrepreneurship. Since 2013, 30 universities have received support to establish TTOs, with a total of around \$16 million.

The TTOs have worked hard to increase the number of university-industry collaborations, gain access to

research funds and submit patent applications for new technology development. In 2017, a new IP law was introduced which, similar to the Bayh Dole Act, gives ownership of the patents developed at the respective universities. Together with the support of TTOs, this new IP law has increased the number of inventions and patent applications of universities.

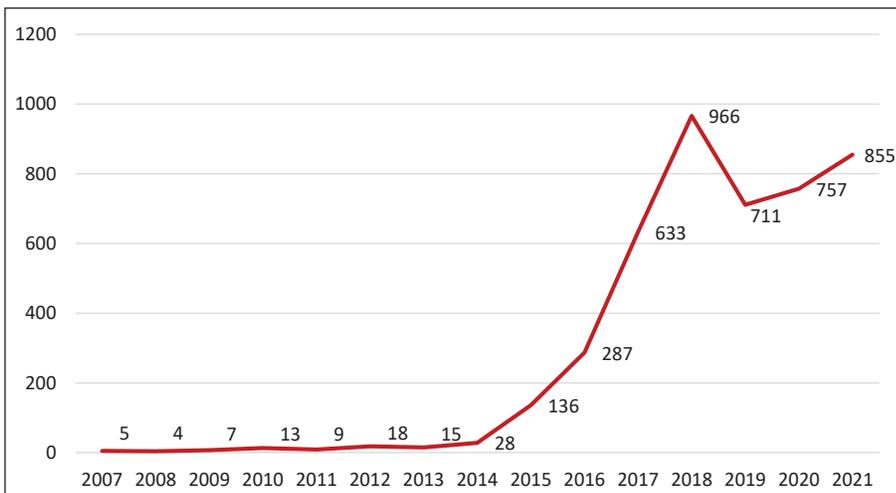
As shown in Graph 3, the number of university-originated patent applications started to increase from 15 in 2013 when the first TTOs were established to 996 in 2018 after the introduction of the new IP law in 2017. The support programs, aided by legislative changes, have thus provided results within a very short space of time.¹²

However, the commercialization of university patents was not straightforward for many reasons, including a lack of awareness, skills, and expe-

The main advantage of the National Technology Initiative is its sectorial orientation and focus on critical sectors and products so that companies can be directed to continue R&D on the defined critical products

rience. Accordingly, Türkiye introduced a support program in 2018 to create and support technology-based startups to accelerate the commercialization of value-added products. Under this program and in collaboration with TTOs, technoparks, and similar organizations, 10 venture capital funds were established to invest in promising technologies, especially in academic startups in

Graph 3: Number of University Patent Applications from 2007 to 2021

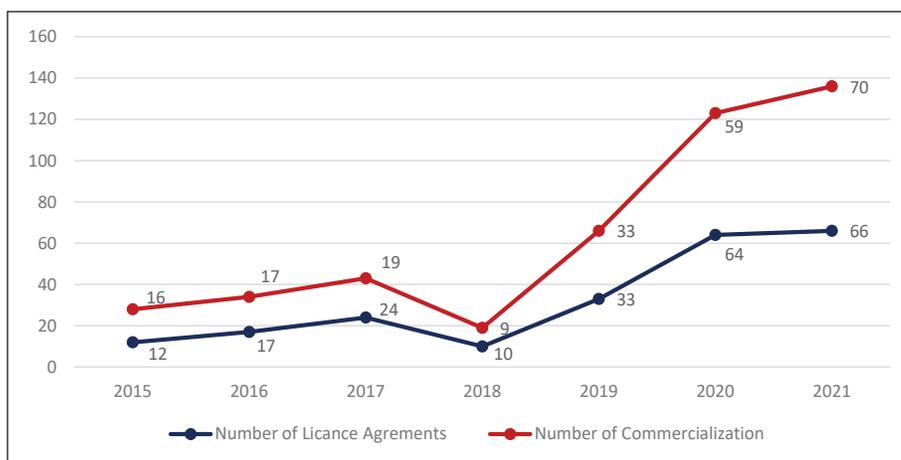


Source: Turkish Patent Report 2021, Patent Effect¹³

Türkiye. Furthermore, in 2020 a new support program, the Patent-Based Technology Transfer Support Programme, was introduced to help uni-

knowledge required to access funding. For this reason, Türkiye started the National Technology Initiative in 2019 to increase the production

Graph 4: Number of Commercialized University Patents (2015-2021)



Source: Turkish Patent Report 2021, Patent Effect¹⁴

versities commercialize their patents. Within this program, TÜBİTAK covers up to 75 percent of the royalty payment to any firm that intends to license a university patent.

A Framework Program: The National Technology Initiative

Providing a range of support programs to SMEs, large firms, universities, and other types of organizations to improve R&D and innovation results requires an appropriate strategy. Despite the availability of a variety of programs, the relevant target groups may not benefit from them. Occasionally this occurs because these groups lack awareness or the capacity to develop a project or prepare a proposal, and sometimes they lack the

of high-value-added products in Türkiye. For instance, KOSGEB Investment Support and the TÜBİTAK R&D and KOSGEB SME support programs were launched under this initiative. In addition, new calls for support have been introduced in the areas of mobility, structural transformation in production, health, and chemical sectors as well as digital transformation. The aim is to enhance the R&D capacity of firms in these sectors to develop value-added goods and services.

The main advantage of the National Technology Initiative is its sectorial orientation and focus on critical sectors and products so that companies can be directed to continue R&D on the defined critical products. For instance, Türkiye is mainly dependent

on imports of health and chemical products, and digitalization is a horizontal issue for all sectors as it affects efficiency. The other advantage of the initiative is that it enables easy access to grants. To achieve this, the National Technology Initiative brought all the support mechanisms and programs managed by different public organizations together under a single umbrella so that all funding and programs can be reached by firms without difficulty. Firms can thus access specific programs and benefit from less bureaucracy, accelerated procedures, and fast decision-making processes. Unlike other programs, the National Technology Initiative does not provide grant support; it is a framework that is focused on increasing the efficiency of the other grant schemes in parallel with Türkiye's technology production targets.

The National Technology Initiative's immediate objective is to create awareness about the different innovations, technology, and government supports. Second, it gives priority to critical sectors during grant distribution to improve their technological capacities. Finally, and most importantly, the National Technology Initiative provides a single point of access to all grant schemes. Notwithstanding, it is too early to assess the financial outcomes of the initiative or its effects on technology development.

Results

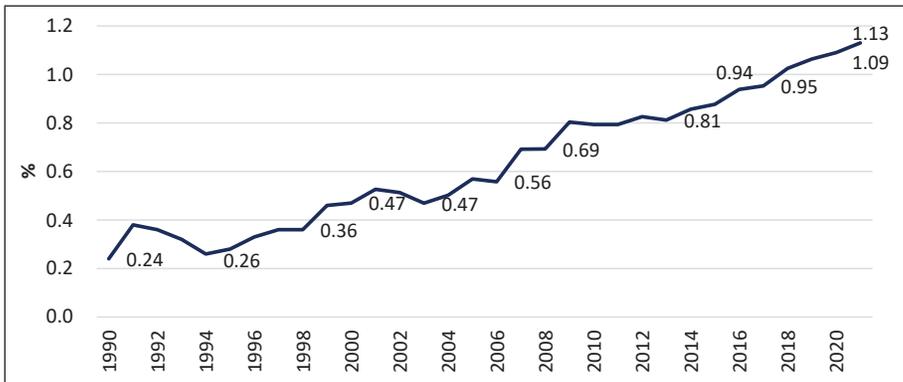
The main aim of the Turkish government has been to enhance the tech-

The main aim of the Turkish government has been to enhance the technology development capacity of firms and universities by introducing a range of mechanisms and programs

nology development capacity of firms and universities by introducing a range of mechanisms and programs. The government had set the objective for Türkiye to be among the first 10 large economies to achieve a gross domestic product (GDP) of \$2 trillion, an annual income per capita of \$25,000 per capita, 8 percent of total exports from high-tech products and 3 percent of the GDP spent on R&D by 2023.

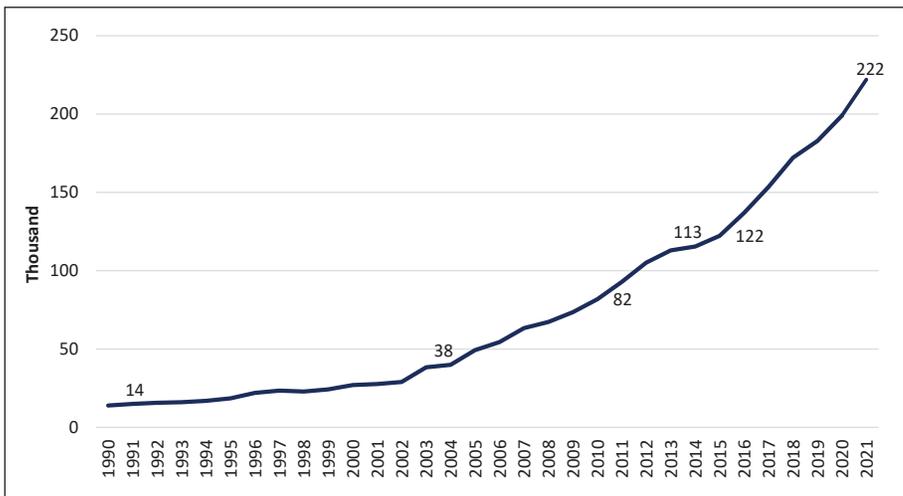
It is clear that all the programs have contributed to the achievement of these targets, and they have improved Türkiye's performance. However, the main question relates to the real effects of all the programs in terms of economic outcomes. It is difficult to discuss the real impacts as a detailed study has not yet been undertaken, but some numbers have shown that Türkiye has improved its R&D and innovation performance over the last 20 years. For instance, Türkiye has increased its R&D expenditure from 0.36 percent of its GDP in 2000 to 1.13 percent in 2021.

Graph 5: Percentage of GDP Allocated to R&D (1990-2021)



Source: Prepared by the Author by Using TurkStat R&D Statistics, 2022¹⁵

Graph 6: Full-Time Employment Rate of R&D Personnel (1990-2021)



Source: Prepared by the Author by Using TurkStat R&D Statistics, 2022¹⁶

Despite this increase, Türkiye remains far behind developed countries such as the U.S., Canada, France, and Germany. The Organisation for Economic Co-operation and Development (OECD) average percentage of the GDP allocated to R&D was 2.5 percent in 2021, which is considerably higher than the 1.13 percent R&D spent in Türkiye in the same year. Notwithstanding, the number of personnel in the R&D workforce,

which is one of the most important inputs for successful R&D, has increased, particularly since 2000. This (full-time equivalent) number increased from around 40,252 in 2005 to almost 222,000 in 2021. Notably, R&D center support programs and the higher prevalence of technoparks have contributed to this increase.

The public support programs have also motivated the private sector to

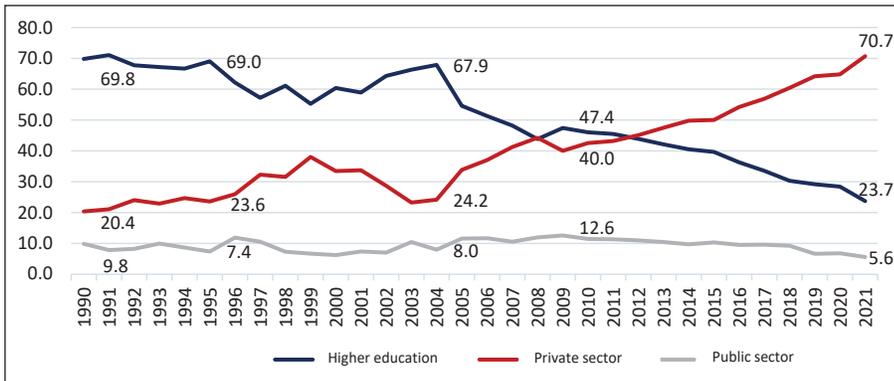
become involved in more R&D activities. Graph 7 shows that the share of the private sector R&D spending started to increase after 2004 when the majority of new programs were launched. This also reduced the proportion of public spending on total R&D expenditure. Graph 7 also demonstrates the effects of public R&D support programs.

The various programs also contributed to Türkiye's global innovation performance. According to the

WIPO Global Innovation Index, Türkiye jumped from its ranking of 54 in 2014 to 37 in 2022. This improvement is the result of the collaborative work of the government, firms, and universities to improve technology development in Türkiye.

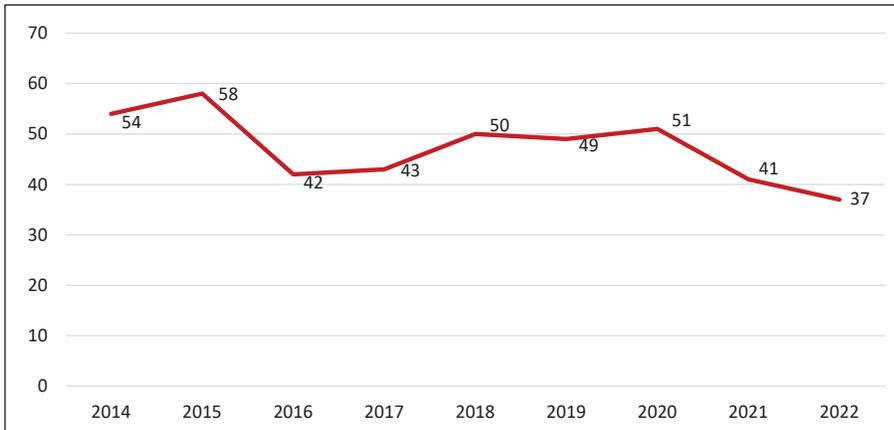
The other important question is: Has Türkiye reached its target of being among the large economies that not only use technology but also develop and export technologies given all the government's technology support

Graph 7: The Public and Private Sectors' Share of R&D Expenditure (1990-2021)



Source: Prepared by the Authors by Using TurkStat R&D Statistics, 2022, 2022¹⁷

Graph 8: Global Innovation Index of Türkiye from 2014 to 2022



Source: Prepared by the Authors by Using the Global Innovation Index, 2014-2022¹⁸

Türkiye has been implementing different programs and support schemes to reach its goal of developing high-value-added goods and services via R&D and innovation activities as well as university-industry collaboration

and programs? The answer is not yet, but the numbers are sufficient to be hopeful about the future. Nevertheless, Türkiye should not forget to focus on human resources and not only concentrate on inputs such as financial support. Although such investment is good, it is not enough. The country needs well-educated, trained, and skilled human resources, and to achieve this, a better education system is required, not only at a higher education level but starting from primary education. Furthermore, more quality than quantity is needed at universities. Second, the brain drain must be stopped, as emigration from Türkiye to international destinations has increased over the last 10 years. Last but not least, Türkiye must provide a better ecosystem, especially for the younger generations, so that the country can benefit from their endless creative ideas that will make Türkiye better, not only in terms of technology but also in other areas. If Türkiye does this, then I am positive that it will be-

come the location of choice for new technologies.

Conclusion

Despite starting late compared to many developed economies, Türkiye has been implementing different programs and support schemes to reach its goal of developing high-value-added goods and services via R&D and innovation activities as well as university-industry collaboration. Results show that many of those programs created results and contributed to the realization of targets. However, it is difficult to say which one was better.

Türkiye started first to improve the R&D and innovation capacity of SMEs and mainly created support for this purpose in the mid-1990s. Those support programs for SMEs, more or less under the same structure, have been implemented with the same purpose. However, the needs of SMEs are changing and expectations from them are shifting as well.

Therefore, implementing long-term grant support does not provide enough. Despite long-term R&D and innovation support programs, the R&D and innovation performance of companies is not at the desired level. Therefore, Türkiye should revise the entire support scheme according to the needs of companies, markets, and the country. Secondly, before the revision of grant schemes, it is necessary to conduct an assessment for each program. This will allow us to

see the real impact of the programs. Third, Türkiye only recently recognized universities as a source of innovation, which left the country lagging in many areas. It is crucial to use universities not only for teaching and research but also for developing new technologies and value-added goods and services. For this purpose, universities need to be transformed and that should start with a good governing strategy.

Prioritizing strategic goods and sectors for R&D and innovation grants is critical, and Türkiye has practiced it for the past 10 years. Still, the number of new products in the strategic sector is not at the level to create an impact on the Turkish economy. Therefore, we should be more creative in converting research results into value-added goods. For this reason, we could focus more on technology-based and academic entrepreneurship instead of supporting established companies. Support for young entrepreneurs with technology-intensive business ideas, in particular, would create an immediate impact on the social-economic performance of Türkiye. ■

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