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Enhancing Local and National R&D Competitiveness: Strategies for Improving Turkey's Innovation Landscape

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Abstract

In recent years, the literature has underlined the importance of industrial and innovative approaches in regional development and economic growth. The investments of R&D startups by giant international companies can inhibit national and local production capability and domestic competitiveness of developing countries. This study uses an innovative mindset to the innovation and R&D paradigms with a multi-disciplinary approach. It argues that since multinational companies can earn more value from their existing capacities and provide new ones in developing economies by investing more in R&D projects, developing countries can invest in and support to R&D startups on reverse engineering of existing innovation. Companies in emerging economies could theoretically learn from and catch up with investing multinationals and develop their capacities via venture capitalist fundings on corporate shares. Nevertheless, to do so, they need to build their innovative capabilities and move from a process to a product focus and from imitation to innovation, as Chinese global large firms do.

Keywords: *R&D, Innovation, Innovative Economies, Open Innovation, Product Development*

Yerli ve Ulusal Ar-Ge Rekabetçiliğinin Artırılması: Türkiye'nin İnovasyon Manzarasını İyileştirme Stratejileri

Öz

Son yıllarda literatür, endüstriyel ve yenilikçi yaklaşımların bölgesel kalkınma ve ekonomik büyümedeki öneminin altını çizmektedir. Uluslararası dev şirketlerin Ar-Ge girişimlerinin yatırımları, gelişmekte olan ülkelerin ulusal ve yerel üretim kabiliyetini ve yerel rekabet güçlerini engelleyebilmektedir. Bu çalışma, çok disiplinli bir yaklaşımla inovasyon ve Ar-Ge paradigmalarına yönelik yenilikçi bir zihniyet kullanmaktadır. Çokuluslu şirketler, Ar-Ge projelerine daha fazla yatırım yaparak mevcut kapasitelerinden daha fazla değer kazanabilecekleri ve gelişmekte olan ekonomilerde yenilerini sağlayabilecekleri için, gelişmekte olan ülkelerin mevcut inovasyonun tersine mühendislik konusunda Ar-Ge girişimlerine yatırım yapabileceğini ve destekleyebileceğini savunmaktadır. Gelişmekte olan ekonomilerdeki şirketler, teorik olarak, yatırım yapan çok uluslu şirketlerden öğrenerek onlara yetişebilir ve şirket hisseleri üzerinden risk sermayesi fonları yoluyla kapasitelerini geliştirebilir. Bununla birlikte, bunu yapmak için, Çinli küresel büyük firmaların yaptığı gibi, yenilikçi yeteneklerini geliştirmeleri ve bir süreçten ürün odağına ve taklitten yeniliğe geçmeleri gerekmektedir.

Anahtar Kelimeler: Ar-Ge, İnovasyon, Yenilikçi Ekonomiler, Açık İnovasyon, Ürün Geliştirme

Introduction

The global capitalist system is currently facing a significant crisis that necessitates finding solutions to alleviate the recurring large-scale crises that arise every 9-10 years. It is crucial to address the repercussions experienced by regions or countries that have lost their profitability. When these areas are neglected, capital mobility tends to shift towards regions or countries with a higher rent/land-return rate, perpetuating a cyclic pattern. Furthermore, it is important to acknowledge the covert interventions, such as military coups, terrorist events, wars like the Ukrainian invasion, riots, and occasional pandemics like the Coronavirus, which are orchestrated to hinder the progress of developing countries or maintain their neutrality. Consequently, regions or countries that have lost their profitability continue to be overlooked, while capital mobility gravitates towards areas with higher rent/land-return rates in this cycle. However, countries with a resilient economic structure, open to the global market, are less vulnerable to speculative activities of international finance capital and capital movements driven by hit-and-run tactics and proxy wars. Such countries, driven by high added value, advanced technology, and export-based growth models, are better positioned to withstand economic fluctuations due to the high market demand for their products. Moreover, countries that establish robust production systems through innovation and research and development (R&D) enjoy greater stability than developing nations, regardless of their oil reserves.

The study aims to explore the extent to which innovative R&D initiatives contribute to national and local development amidst the challenges posed by global capitalism. It seeks to identify the impact of innovation on economic competitiveness, particularly in developing countries struggling with the "middle-income trap."

The study has the following assumptions:

1. Effective leadership in an economy, as highlighted by Akdemir et al. (2022), encompasses innovation as a crucial element.
2. Successful innovation ecosystems mirror the natural innovation processes observed in Divine creation, emphasizing the importance of continuous innovation and the development of new products.
3. Sustainable strategies and moral obligations necessitate resource efficiency, avoidance of unnecessary consumption, and adherence to essential needs.

The study has the following hypothesis:

Hypothesis 1: Technological paradigms follow a lifecycle encompassing birth, development, maturity, and stagnation phases, where diminishing returns to scale play a significant role.

Hypothesis 2: Technological advancements and the resulting changes in output lead to both quantitative and qualitative transformations in the socio-economic and political structures of nations.

The success of innovation ecosystems is based on their ability to imitate natural innovation within Divine creation in the nature. Continuous innovation and new products are also identified with capitalist production and consumption processes. While constant innovation is necessary, not wasting resources, not buying unnecessary products, and staying on the necessity scale are vital for sustainability strategies and religious&moral obligations.

1. Literature

There is much research in the literature on this area. Charles Alexander drew attention to the transition from a heavy industry economy to a new technology-based economy (Alexander, 1983). Shepherd (1997) wrote about the New Economy. In addition, in a public opinion survey conducted in March 2000, 57% of the consumers of the United States of America (USA) stated their belief that the American economy has transitioned to a new economy that is very different from the industrial economy (Kallio & Mallat, 2004). The underlying reason for this belief is the developments in information and communication technologies (ICT) and the globalization of companies. Together, these two reasons have created a new transformation and a new kind of economy. Opinion polls do not provide sufficient scientific evidence for the existence of such a new formation, but basic statistics on the transition to the New Economy are also available. Jalava and Pohjola (2002) found that, on average, two-thirds of the improvement in labor productivity for the USA is due to ICT. ICT industries accounted for 3-4% of employment, 6-9% of value-added, 10-25% of exports, and 25-40% of research and development expenditure in 1997 for countries such as the European Union (EU), Japan the USA (Koski *et al.,* 2002).

Ketteni et al. (2011) demonstrated the non-linear relationship between ICT and productivity for several OECD countries and a non-linear relationship between human capital and productivity. They write that the reason for this is that governments are at different stages in the transition process. Sánchez et al. (2009) confirmed the impact of ICT on per capita income using data from 102 countries. Shao and Shu (2004) measured productivity growth using the Malmquist total factor productivity (TFP) Index and find that each country's ICT industry exhibits a unique behavior. Jorgenson et al. (2011) identified 40% of the total productivity increase of TFP originating from the ICT-production sector. Daveri and Mascotto (2006) are other studies supporting this idea.

Thus, the transition to the New Economy originating from the ICT revolution is supported by basic statistics. There are other names for New Economy such as Digital Economy, Network Economy or Knowledge Economy. However, terms such as Internet Economic or E-Economy are insufficient to explain the whole transformation process and only describe a part of this economy (Tapscott, 1997).

Within this study's scope, the New Economic structure can be briefly defined as follows: It is the adaptation of globalization and ICT to the production and trade processes of the old economy. The reason for using this definition is the assumption that productivity, inflation-unemployment dilemma, cyclical fluctuations, and changes in enterprises are the basis for the New Economy according to Deardorff's Glossary of International Economics (2013). Since it is an ongoing process, its mechanisms are not fully resolved, and its main characteristics are not understood. It is not easy to give the correct definition for the New Economic relationships today (Kiracı, 2016). The techno-economic paradigm, which determines innovation in developed and developing countries, is radically transformed. Before this change, innovation was shaped around mass production, economies of scale, and corporate R&D predominantly. According to the studies in the literature, it has been revealed that R&D expenditures have a positive effect on exports, and exports have a positive impact on growth (Külünk, 2018). Since the last twenty years of the 21st century, this situation has been primarily replaced by the export-based economies of scale, the benefits of being connected, the flexible production systems, and R&D centralization. Flexibility, connectivity, and business collaboration are all based on IoT, facilitating research diversity and interdisciplinary approaches. Due to rapidly changing market conditions, national science-technology policies, and national innovation systems. Some developing countries like Turkey try to replace their production infrastructure and whatever has strategic importance in production supremacy with national and local ones due to foreign trade wars. All government plans, programs, and strategies are designed to mobilize this opportunity.

Innovation is an economic and social issue as it concerns the whole society. While economists need to increase or support the growth rate, it is also an essential issue for those who want to change the quality of goods, the direction of economic progress, or improve the quality of life. Economics is closely related to applying business and other social sciences to industry and firms. Innovation is limited to making several inventions and improvements in the use of the product, the production method, and process and new developments in management, information networks, organizational structure, and financing methods (Hacıoğlu, 2021).

In practice, R&D expenditures are generally used to evaluate the impact of innovation on economic growth. For example, in OECD countries, R&D expenditures within the gross national domestic product have increased over time. Therefore, it is observed that R&D activities substantially positively affect the growth process. However, in some studies, it is observed that the R&D investments made by the public inhibit the increase in output due to the exclusion effect in cases where the private sector replaces R&D investments (Tansel & Güngör, 2003; Özçelik & Taymaz, 2008; Günay, 2018). Economic development depends on the quantity and quality of the factors used in production. Therefore, in addition to the amount of labor, capital, and natural resources, factors that increase productivity, such as technological advances, innovative procedures, institutional maturity, and human capital accumulation, should also be considered as the key links between R&D and development. The link between R&D and development, highlighting key discussions and empirical evidence supporting this relationship in the literature:

1. Importance of R&D for Economic Development: Research suggests that R&D activities contribute significantly to economic growth and development (Smith, 2018). By investing in R&D, countries can stimulate technological progress, leading to improved productivity, increased competitiveness, and enhanced living standards (Grossman & Helpman, 2015). R&D activities are essential for fostering innovation and knowledge creation, which are central drivers of long-term economic growth (Aghion & Howitt, 2017).
2. Technology Transfer and Knowledge Spillovers: R&D investments facilitate the diffusion of technology and knowledge across sectors and countries, thereby promoting development (Arora, Fosfuri, & Gambardella, 2019). The presence of strong linkages between R&D-intensive industries and other sectors enhances the transfer of ideas, expertise, and best practices (Belderbos, Gilsing, Lokshin, & Carree, 2015). Knowledge spillovers resulting from R&D activities can generate positive externalities and amplify development effects in both developed and developing countries (Mohnen & Hoareau, 2019).
3. R&D and Human Capital Development: Investments in R&D contribute to the accumulation of human capital, fostering development (Aghion & Howitt, 2017). R&D-intensive sectors tend to attract highly skilled workers and promote skill upgrading through knowledge-intensive activities (Akcigit, Grigsby, & Nicholas, 2017). The development of a skilled workforce, in turn, enhances productivity, innovation, and competitiveness, creating a positive

feedback loop between R&D and development (Barlevy & Tsiddon, 2019).

4. R&D and Sustainable Development: R&D can play a critical role in addressing global challenges and promoting sustainable development (Acemoglu & Restrepo, 2021). Investments in clean technologies, renewable energy, and environmentally friendly innovations can contribute to mitigating climate change, improving resource efficiency, and promoting a sustainable future (Bosetti, Cattaneo, Fiorese, Verdolini, & Vergalli, 2015). R&D-driven advancements can enable the decoupling of economic growth from environmental degradation, leading to more sustainable development pathways (Weitzman, 2018).

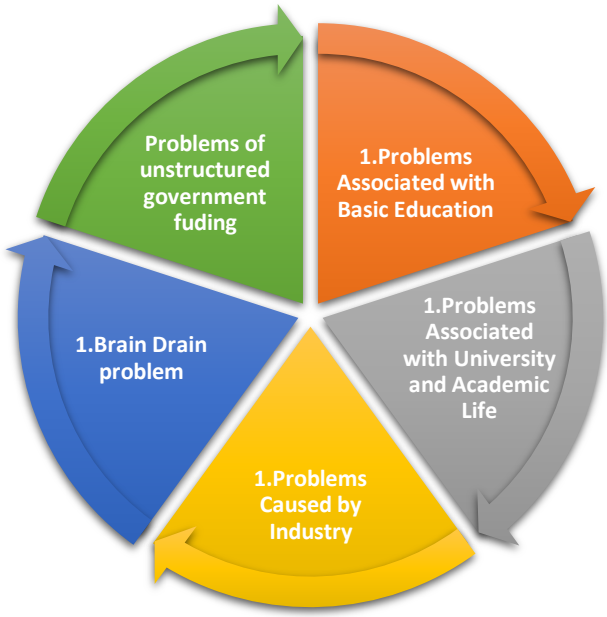
The link between R&D and development is well-established, with empirical evidence highlighting the positive impact of R&D on economic growth, technology transfer, human capital development, and sustainable development. Encouraging R&D investments and fostering an environment conducive to innovation are crucial for countries aiming to promote long-term economic development and address societal challenges.

2. Problems and Barriers in Innovative R&D

The application of innovations is acknowledged as a driver for economic and social development. However, the processes of technology development and transfer are affected by numerous barriers, which are understood as any limitations that hamper the effective functioning of a system of the generation, execution, and transfer of innovative technologies (Maruzkiewicz, 2018). The essence of R&D is the transformation of scientific knowledge into a unique service or product with economic value by using technology. For this, the scientific knowledge produced must be qualified. To make qualified scientific knowledge, talented scientists, suitable materials, orientation to the solution of a realistic problem, ensuring correct and sufficient cooperation between the necessary disciplines, conducting the whole process within the framework of ethical rules, and a suitable place and material are required. Together, these conditions constitute the indispensable environment for healthy R&D, which we call a "scientific climate." We can also think of the scientific climate as the atmosphere surrounding the institutions, organizations, and countries that will carry out R&D. The more suitable the climate, the more valid and sufficient R&D outputs can be. The inadequate scientific climate in a country is the main reason for insufficient R&D. Turkey's R&D inadequacy, which was started under the previous title, is also directly related to this situation. Scientific climate inadequacy covers all R&D activities, not just the health field. The problems and obstacles of the health field are not very different from other R&D activities in the context of scientific climate deficiency. In this

article, our subject is the problems and obstacles for R&D in health, but the determinations and explanations we will make below will be valid for other R&D activities and health.

Figure 1. Problem sources of innovation and R&D



2.1. Problems Associated with Basic Education

The results of studies measuring and comparing the quality of education in countries confirm the above criticisms. In a wide-ranging assessment based on reading comprehension and mathematical and scientific knowledge, Turkey appears to be average or below average in student scores, investment in education, and education quality (Roser *et al,* 2019). In evaluating the Program for International Student Assessment (PISA) based on mathematics, science, reading comprehension, and analysis for students around 15, Turkey is among the low-ranking countries with low scores (PISA, 2019). A report of the World Economic Forum also evaluated the quality of countries' mathematics and science education. In this evaluation, Turkey was ranked 104th among 137 countries. Countries such as Colombia, Pakistan, Vietnam, the Philippines, Saudi Arabia, Iran, Qatar, and Lebanon (Reddit, (2018).

The capacity of primary education to train qualified personnel for R&D is limited in Turkey. The system is generally far from an approach that inquires analytically, identifies problems correctly, asks logical questions for solutions, and teaches how to produce answers from primary school to university. In addition, many children or young people who have R&D aptitude and the

potential to be good scientists are lost in the system. University is seen as an institution that provides social labels and job guarantees to people rather than contributing to individual development and providing a correct perspective on specific areas. The approach of the last 30-40 years in the selections made for better education schools and universities is to find the right option within the question type that offers five different options within a certain period. The lessons taken by the student both at school and in special education and private teaching institutions for reinforcement purposes showed a completely result-based rote approach. Instead of teaching the subjects covered in a cause-effect relationship, only memorizing the results was deemed sufficient. While explaining the information presented by science to the student, the reasons, methods, scientific methodology, and questioning approaches related to the discussion of existing knowledge are neglected. The primary purpose of such a system is to acquire private schools or universities somehow. The decline in teacher quality, the fact that qualified teachers are more involved in paid education, and the transformation of education into trade and students into customers has limited equal and competent education access to most of the population. Foreign language education can be seen as another problem.

2.2. Problems Associated with University and Academic Life

Engineering schools are among major establishments where vital research and technological development activities occur. However, academia has its way of doing things and accomplishing research goals. It can be postulated that academic R&D teams require a unique portfolio of management practices, which has not been broadly discussed in the literature (Berber & Kurul, 2009). Countries with solid R&D activities all over the world have strong universities. Because universities provide education, they train good and research-oriented academicians and form an essential step towards transforming their scientific knowledge into technology through research laboratories, application, research centers, technoparks, incubation centers, technology transfer offices, and R&D incentives programs.

The world domination of Europe and America depends on the importance they attach to science, the fact that they have created a scientific culture, and scientific freedom and autonomy. Encouraging research has enhanced scientific creativity. For new ideas, it is necessary to think differently or differently. Most innovations and new ideas throughout history have come from excluded and blocked. Since it is known as a general fact that in history many important inventions were initially opposed and not accepted, satisfactory measures need to be taken to prevent research scientists' inhibition and encourage their work. Unfortunately, another critical obstacle in front of R&D in Turkey is that "pure research universities" have not yet

emerged or the inadequacy of research expected to support R&D in universities. Although some universities' efforts to be thematic and try to give job definitions to others is correct in terms of R&D, the job definitions for research areas of most universities are not clear yet. It is because industry is not at the same level of maturity that produce innovative products based on R&D. Government incentives to set-up robust relationship and collaboration between universities and industry for productive R&D are not satisfactory and prolific. Therefore, cooperation and research activities for qualified R&D are insufficient. In countries with inadequate R&D, science and scientific research are often sacrificed for monetary gain. There are various reasons for this. We can list them as follows:

1-Universities focus on education rather than research. In countries with developed R&D, research and education activities in universities are either carried out separately or by different universities or researchers. Academicians working at universities in Turkey try to carry out research and education together. An outstanding researcher can spend most of his time preparing lectures or attending various classes. The primary motivation source of scientific research in universities is the academic stages. For this reason, research activities are directed towards publishing articles rather than discussing established theories, putting forward new approaches, making discoveries.

2-Especially in post-doctoral research, there is a need for publications to be appointed to associate professor or professor positions at universities.

3-The academic staff of universities is primarily planned according to education. The academician who has reached certain academic stages by creating a certain number of publications can be a director, dean, rector, etc. Co-assignments are made to centers, laboratories, or units that need to deal with R&D, and exceptional staff and teams are not established for R&D units.

4-Here is the answer to why we cannot produce sufficient and qualified outputs even though we are no different from many countries with developed R&D in terms of space, tools, and equipment, and even better than some of them. Investments are made in buildings and tools rather than people. It needs a qualified R&D qualified workforce. Innovation is the creative force bringing new ideas (discoveries) to inventions that turn into technology. Innovation is the use and application of creativity. Creativity is thinking about new things, and the design shows that a technological product can be made. Innovation turns this product into a commercial value (Günay, 2018).

5- Industry-based R&D mainly supports the assembly and the creation of imitation products.

6- Postgraduate education is critical to train the qualified workforce for R&D activities. In comparison, the number of research scientists per 1000 people in South Korea and Germany can be considered close to us. Still, this figure is around one in Turkey. The opening of many new master's and doctorate programs, especially in foundation universities, will increase this number. Still, the serious problem here is that master's and doctoral education is gradually getting more accessible and diluted with commercial approaches. It does not seem possible to create human resources for essential activities such as R&D with unqualified personnel with a doctorate. Developing a severe roadmap or policy to restructure universities and their R&D activities is necessary to overcome these problems.

2.3. Problems Caused by Industry

Research findings indicate that public R&D support significantly and positively affects private R&D investment. There seems to be even an "acceleration effect" on firm-financed R&D expenditures. Given the scarcity of studies on R&D support in technologically weaker economies, we hope that the less-developed countries can exploit these findings in constructing socially beneficial technology policies (Özçelik & Taymaz, 2008). One of the most common clichés in R&D processes is "university and industry cooperation." In Turkey, remarkable projects have started to emerge in other fields of R&D such as automotive, chemistry, and electronics; however, we cannot talk about good cooperation in health sciences.

Universities see pharmaceutical and biotechnology R&D as a long-term, expensive, and complicated process. Another problem is venture investors' lack of promising discoveries or preliminary products. In Turkey, science is a field that does not even cross the minds of risk investors. Those who have extra money or want to invest in risk, instead of investing in a diagnostic kit or a patented drug molecule ready for preclinical research, invest in foreign currency, gold, interest, etc. They prefer immovables such as movable or real estate. It is necessary to solve the issues related to primary education and universities. In addition, establishing a genuinely domestic pharmaceutical industry and adding it to a research university with a well-defined job description to produce R&D projects in medicine and technology can provide the necessary support for removing restrictions.

2.4. Brain Drain problem

Turkey's first "brain drain" wave began in the 1960s, with doctors and engineers among the first group of emigrants. In recent years, attention has shifted to young university graduates who are seriously contemplating starting their careers abroad due to the current economic crisis which is not limited to local or national context but global. Postgraduate studies overseas provide the

first step for many in fulfilling this goal (Erduran *et al,* 2019). To contribute to the qualified workforce in science, Turkey has sent many of its staff to developed countries, mainly covering the post-doctoral period, with scholarships supported by the state at various levels. What is expected from the scholarship programs is that those who are sent improve themselves, return to Turkey and produce important R&D projects. However, it was not expected. In this case, unfortunately, Turkey has become a country that creates human resources for developed countries by giving money to the top.

One important discussion surrounding the brain drain problem in Turkey is the impact on the economy. Emigration of highly skilled professionals can lead to a scarcity of specialized expertise and talent within the country, hindering economic growth and innovation (Özden, Parsons, Schiff, & Walmsley, 2011). This can have negative consequences for key sectors such as healthcare, education, research, and technology.

Another crucial aspect of the brain drain problem is its impact on human capital development. When skilled individuals leave their home country, the loss of their knowledge and skills can impede the development of local industries and hinder the transfer of knowledge to other workers (Yumrutepe, 2013). This can create a cycle of limited human capital accumulation and hinder the country's overall progress.

Additionally, the brain drain problem in Turkey has been discussed in the context of social and political implications. The departure of highly skilled individuals may lead to a "brain waste" phenomenon, where their skills and qualifications are underutilized or not recognized in their host countries (Tansel, 2013). This can cause frustration and dissatisfaction among emigrants, potentially affecting their sense of belonging and social integration.

To address the brain drain problem, various strategies have been proposed. These include creating a conducive environment for professionals to thrive, improving job opportunities, and investing in education and research to retain skilled individuals (Akkoyunlu-Wigley & Güngör, 2013). Additionally, policies that encourage diaspora engagement and knowledge transfer between emigrants and their home country have been suggested as a way to mitigate the negative effects of brain drain.

Developed countries have attractive scholarship programs that will attract qualified and trained staff. These programs offer many promising opportunities to people who want to do scientific research and serious projects. On the other hand, working in an environment with a sufficient scientific climate is also essential for a talented and creative scientist to show himself, reveal crucial data, and make discoveries. Talented minds who cannot find a good research environment in Turkey continue to be admitted to suitable countries where they can express themselves.

The only way to prevent brain drain is to create a scientific climate. This is based on solving the problems listed so far and removing some obstacles. Providing "reverse brain drain" by delivering more salaries and opportunities does not seem to contribute to the solution either. There are two fundamental reasons for this: First, no developed country loses its trained workforce to another underdeveloped country. Migration is always for the better. There is no migration from good to bad. An active scientist with essential projects that he is currently conducting and well-integrated into the system does not return by leaving them.

Secondly, Whether the mediocre or idealist thinks and turns out to be the best, their contribution to qualified R&D will be limited due to their inability to find the order they are used to and other problems arising from the system. Their grants to the universities they are involved in will not go beyond small or medium-sized projects and scientific publications. Moreover, the opportunities provided to good scientists abroad are much better than those offered by Turkey.

2.5. Problems of Unstructured Government Funding

Assessments by Ilyash *et al.* (2021:35) shows that the reform changes should relate to the redistribution of financial flows in the direction of stimulating domestic production of high-tech products. In fact, there is a chaotic incentive structure and financial flows that are "wasted" in the hands of the multi-headed bureaucracy, which is disconnected from each other, lacks strategic integrity, and has scattered goals and objectives. An incentive structure that promotes everything and ultimately nothing is harmful. That everyone chases and is never satisfied; although there are those who are satisfied, an incentive structure, which remains an exception, is an obstacle to innovation (Erten, 2008). The directing of scarce public resources financed with budget revenues due to incentives to inefficient areas causes a waste of resources on the one hand, and negatively affects income distribution on the other hand. Because, through incentives, public resources are manifested in the form of redistribution of income to certain sectors, regions, and individuals. Since the payments made for the incentives are met from the general budget, the budget gives a deficit equal to the incentives given, and these deficits are financed either by new taxes or by borrowing. For this reason, considering that every incentive given has an economic cost, the economic and social gains to be obtained due to the incentive should be implemented in a way that at least compensates for the budget expenditures (Ersungur & Takım, 2008).

3. The reality, research, and development

Understanding and analyzing reality usually differ from the scientific and religious points of view. Data from science teachers suggest that they consider

the importance of testing in science. They refer to an 'objective' reality beyond the individual experience. On the other hand, religious education teachers refer to claims of truth that cannot necessarily be tested or need not refer to a reality beyond the individual's experience of this reality (Erduran *et al,* 2019). When it is called R&D, technological research, laboratories, and big projects come to mind for more innovative products. However, in the historical process, there was no R&D. Isn't it research of truth since the prophets and first-age philosophers?

According to materialist philosophy, everything comes from matter and continues as matter. Idealism and materialism investigate the nature of reality and come to different conclusions. The fundamental question is: What is reality, and why does it occur? In postmodernism, universality, totality, objectivity, and truth enforcing thesis were rejected. Postmodernist thinkers argue that objective reality has a more complex structure than we perceive. They put the human factor and its differing perceptions in front of everything while considering humans under the conditions of materialist philosophy. In the postmodernist conception, the reality is not something that exists outside our consciousness as in materialist understanding, and we shape reality. Everything like symbiotic factories is so intertwined that nothing is for its own sake in its material assets, services, and relationships. All needs are given in perfect order and balance without confusion.

The increase in the number of R&D investments and the number of companies opening is promising but still open to improvement, so many problems must be solved. To survive and grow under the conditions of today's heavy competition, companies need to constantly change, differentiate, and renew their products, services, methods of work, structuring, and social responsibility. Realizing this fact, the companies increase their R&D investments every year and pay attention to their activities in this field. In the last ten years, the brand of R&D investments in Turkey attests to the importance given to this issue. R&D and innovation have become indispensable elements of the competition of brands today. Since countries supported with active R&D incentives are at the highest levels in the World Competition Ranking, technoparks and R&D laboratories, opened after another, reveal institutions' importance to this subject.

3.1. East-West race in R&D

By showing the differences in knowledge mechanics, J.S. Mill shows that the historical distinction between 'West and East' countries is seated on the uneven diffusion of knowledge among people (Manioudis, 2021). The development of R&D and innovation activities worldwide, especially in China and the Asian countries, is remarkable. According to 2017 data, the graphic shows R&D spending sizes according to countries. The Chinese economy

ranks second after the USA economy, estimated to exceed USD 18 trillion by 2020. China's total R&D spending was $ 354 billion as of 2019, with more than 4 million researchers. Still, the USA ranks first in terms of the country based on the investments made in R&D. China is followed by China, the developing power of Asia. China, Japan, Germany, and Turkey in the list, followed by South Korea ranks 20th.

Figure 2. R&D Spending Per Country

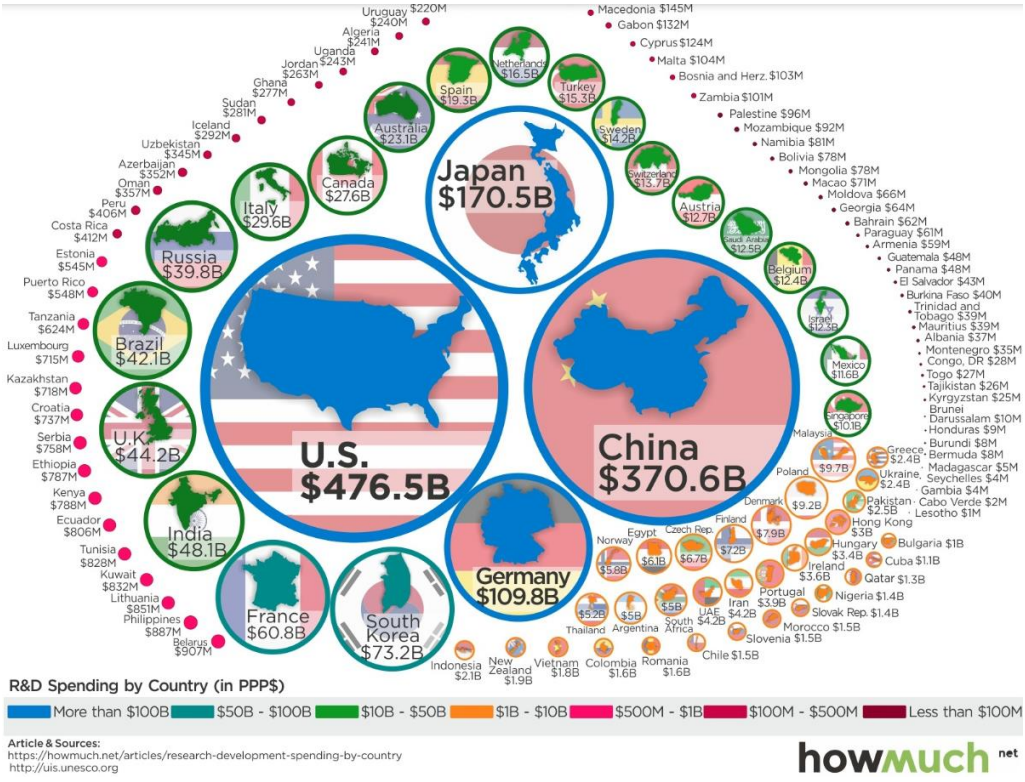
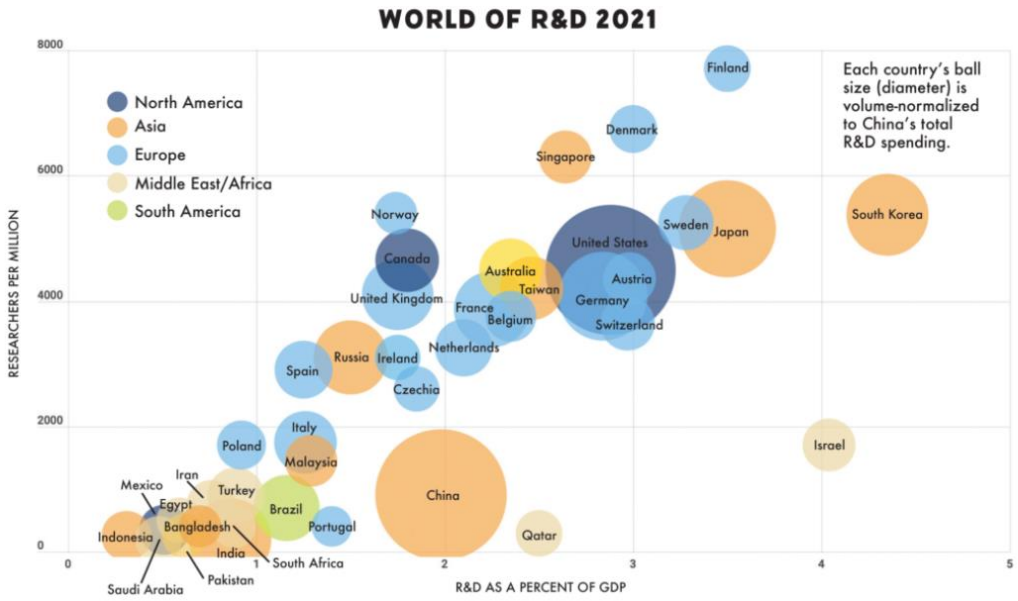


Figure 3. Map of R&D Expenditures Per Country



Source: (Heney, 2021)

3.2. R&D in Turkey

GEM (2017, p. 13) classifies economies under three groups according to their economic development level, namely factor-driven, efficiency driven, and innovation driven economies. Accordingly, Turkey is classified as an efficiency driven country, which means it has enhanced its competitiveness with more-efficient production processes and increased product quality, but it is yet to effectively develop knowledge-intensive sectors. (Cansız & Tekneci, 2018: 160).

In the last fourteen years, Turkey's economy has demonstrated a strong performance in terms of macroeconomic stability. Turkey recorded significant improvements in the provision of R&D expenditure and is still unable to take part in top positions in the world in terms of competitiveness. Indeed, the World Economic Forum (WEF) Global Competitiveness Index shows that the World Bank Doing Business Index and United Nations major global indices such as the Human Development Index in Turkey are far from the desired position. Turkey, 43 in the Global Competitiveness Index (among 144 countries), the Ease of Doing Business 71 (among 175 countries), and # 90 on the Human Development Index (out of 187 countries) are available (Çağla, 2019).

Turkey's R&D expenditure increased by 17% in 2019 to 30 billion 615 million TL. As a result, the share of R&D expenditures in the Gross Domestic Product (GDP) increased to 1.06% in 2019. The Government of the Republic of Turkey's

3% annual R&D expenditure has set a target until 2023. Despite this increase, the ratio of R&D expenditures in GDP (1.06%) has not yet reached the desired point. When we look at the first 15 countries with the highest GDP ratio, we see that the average R&D expenditures are 3%. Another essential element of R&D is innovation, which creates value in the market by transforming the idea or invention into a new product or service. It is possible to add new products or ideas to the existing idea or product in simple terms (Uzbay, 2007). Turkey is dominated by a wavy appearance in the distribution of patent data; the share of residents abroad in the past has increased the percentage of high While residents in recent years. Meanwhile, Turkey is still lagging behind other countries in many areas despite the progress made in these areas over the last decade that followed. In particular, the number of patents shows a weak picture compared to other comparative countries.

3.3. R&D in health

Healthcare-specific R&D may be for administrative or medical purposes. Administrative R&D activities include research projects and studies created to identify and solve problems to increase the efficiency and quality of general health services and the services provided to patients in health institutions such as hospitals. Medical R&D activities, on the other hand, are research aimed directly at the diagnosis, treatment, and prevention of diseases. The results of these activities are expected to be now reflected in the clinic. It is seen that areas that have an indirect relationship with health and health in the world constitute approximately a quarter of general R&D activities, and health ranks first among all industrial R&D areas. Here, medicine and biotechnology have a significant contribution with a share of 16.5% (Uzbay, 2017). In Turkey, health has been declared a priority area as a state policy. R&D priorities in health are listed under the titles of drugs and vaccines, medical diagnostic kits, biomaterials, and biomedical equipment. Thanks to three-dimensional printers, medical equipment and medicines can be printed out. Soon, this technology will also produce various organs and tissues. Although R&D studies on health are increasing in Turkey, they are still insufficient compared with developed countries (Gümüş, 2017).

3.4. Türkiye's R&D in the world?

In information societies considered the most advanced social stage, land and capital have been replaced by human capital and innovative technological know-how, defined as qualified human capital. Therefore, while the quantity of production factors comes into prominence in the economic development of industrial societies, the quality of the production factors in the information societies has strategic importance, which is being greatly affected by innovation capability. As a result, developing countries have begun to step back to the competition, requiring them to implement more active policies.

University technology transfer has been receiving significant government funding since 2012. The Turkish government and society now expect results of this substantial investment in terms of better teaching and research performance and new jobs, new products and services, enhanced regional development, and contribution to economic growth (Ranga *et al,* 2016). Turkey applied science and technology policies based on monetary support to development projects. This process, which started with the establishment of technoparks in the 2000s, continued with establishing Regional Development Agencies in 2006 and Technology Transfer Offices (TTO) after 2011, with accelerators, entrepreneurship centers, and financial support programs speeding the initiatives. As a result, the number of techno-parks, development agencies, TTOs, hatchers, and accelerators and the number of firms and entrepreneurs benefiting from these interfaces increased exponentially. This is only the scale, whereas the main problem is how we did with this scale, i.e., the quality and capability of the innovation ecosystem. For the size of the R&D activities in Turkey, we look at the value that indicates the scale, in other words. Turkey's total R&D expenditure of around 5 billion euros in 2017, 8 billion euros in 2018, and 10 billion in 2019. In the list of the 2500 companies that make the most R&D investments, there are only 2 Turkish companies in the first 1000; there are only 6 Turkish companies in the list.

Figure 4. Technology Transfer Ecosystem in Turkey

Source: http://ttaturkey.org/29/turkish-technology-transfer-ecosystem

Government-backed organizations such as Havelsan, Aselsan, Roketsan, TUBITAK, and TAI are examples of institutions and agencies forcing and pulling the industries to produce national and local innovative products. In addition, science, technology, industry, and innovation policy are experiencing a cycle in every technological paradigm. For example, Turkey is currently designing innovation policies that apply microprocessor technology to virtually any field. However, the competitiveness and quality are still far behind the developing markets. Therefore, we will see the increasing importance of science and industrial policies at the new technological paradigm threshold.

Various ways or reports can be used when comparing Turkey's R&D with the world. Practical R&D outputs can only be obtained from qualified scientific knowledge transformed into technology. For this reason, to determine the R&D potential of an institution or a country, it must first can produce scientific knowledge and transform it into technology with economic added value. The capacity to produce practical scientific knowledge and transform it into technology is a country's most effective source of wealth and global prestige power. A study to measure this was published by Tulp (2017) in which, 25 countries with scores ranging from 100 to 1 were included. The USA took first place with 100 points, Germany took second place with 20 points, and Finland took 25th place with 1 point. While countries such as India and Taiwan were also included, Turkey could not. Other countries include the UK, China, South Korea, Canada, Italy, Spain, Israel, Sweden, Singapore, and Brazil. We can look at the list to measure countries' capacity to transform scientific knowledge into technology with economic added value. Most of the countries here are also actors driving the global economy in the world. When the same study was updated in 2015, no significant change occurred, and Turkey still could not find a place on the list (Tulp, 2017)

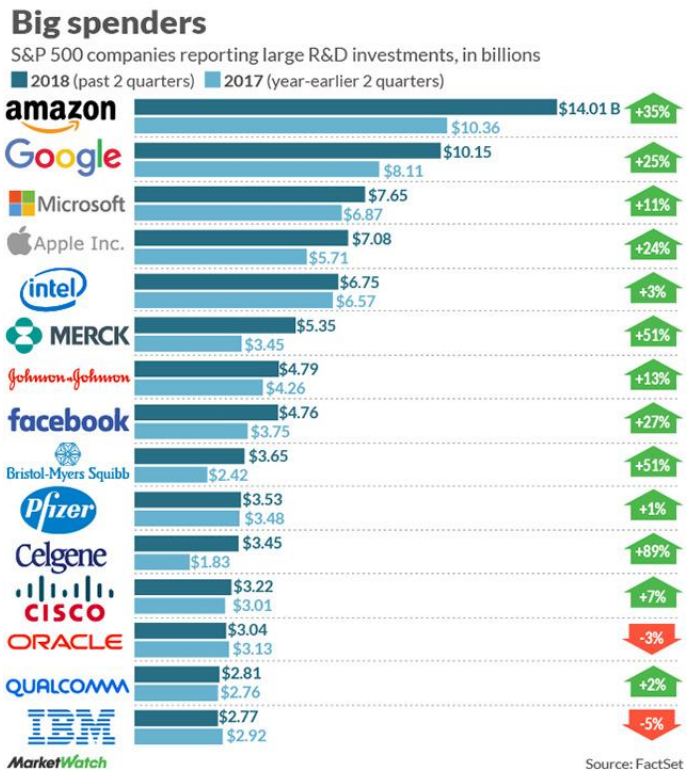
Turkey, which has more than two hundred state and foundation universities, does not seem to have a satisfactory performance not only in health R&D but also in general R&D activities and outputs. For example, looking at Turkey's situation in pharmaceutical R&D can give a more concrete idea. As mentioned above, pharmaceuticals and biotechnology have a valuable contribution to health R&D. The value of the world pharmaceutical market and the economic added value to the countries engaged in pharmaceutical R&D are increasing. Approximately 500 billion dollars at the beginning of the millennium, the world pharmaceutical market approached 1 trillion dollars in 2012. The expected figure for 2020 is around 1.5 trillion dollars. According to the Pharmaceutical Working Group report in the Development Plan, the share of Turkey's pharmaceutical R&D expenditures in Gross Domestic Product (GDP) is at a negligible level of 0.01%. GDP is one of the essential indicators of economic size. It is the monetary value of all final goods and services produced within a country's borders in a specific period. This report also points out that Turkey's number of registered pharmaceutical and biotechnology product patents is unsatisfactory (TCKB, 2014). The number of patents obtained by countries is the most critical indicator of reflecting technology to the economy and using scientific knowledge in economic development. In an evaluation made by comparing the share of R&D expenditures in GNP with the number of scientists who can do R&D, Turkey is quite behind countries such as Malaysia, Pakistan, Iran, and Argentina (Karagüllü, 2013). The significant economic problem we are experiencing nowadays is the inability to produce qualified products based on R&D.

4. Brands that brand R&D

Companies should see a brand as a "patent" through which customers emotionally connect and choose their products and services over competitors. Just as patents are designed to provide exclusivity in a market, the brand offers that, tacitly, if properly executed. Branding can establish an autonomous relationship between customers and the producers, thereby helping companies to be protected from patent infringement. In this study, the author shows evidence of the lack of any viable branding strategy on innovation by the few Turkish firms that have filed patents. This explains the lagging of the Turkish companies in internationalizing their brands (Aydoğan-Duda, 2012).

The top 10 companies that spend the most on R&D across the globe are Volkswagen, Samsung, Amazon, Alphabet, Intel Co., Microsoft, Roche, Novartis, Johnson & Johnson, and Toyota. However, when we look at the top 10 companies that make the most investments in innovation worldwide, we see a different picture. The top 10 companies led by technology giants are Apple, Alphabet, 3M, Tesla Motors, Amazon, Samsung, Facebook, Microsoft, General Electric, IBM.

Figure 5. Biggest Spenders on R&D



According to Turkstat, Turkey's R&D spending in 2015 was about 7.6 billion dollars. This figure is far behind even Volkswagen, which ranked first in the company's R&D budget of 13.6 billion euros. However, the country's R&D report, although the worst two entities of the coaching group Tofas and Ford Research in the automotive world-Gee that invests most in two thousand taking place among the 500 companies, announces Turkey's name globally league.

5. The future of R&D prospect

The prospects for Turkey are discussed concerning the present level of the country's technology infrastructure. It is emphasized that if Turkey achieves a better trade balance and a prominent share of world exports in the future, merely increasing its business sector's weak R&D expenditures will not be sufficient. Moreover, in the case of both R&D expenditures and researchers, quality and quantity are required, with the number and quality of the latter being crucial both for innovating and absorbing foreign technology (Ege & Ege, 2017). TÜBİTAK should work in the research sector for the industry. R&D and Innovation studies should be conducted from multidisciplinary and interdisciplinary sources, and public R&D incentives should be collected and focused on target technologies. Private-sector experts should be actively involved in the commissions where R&D projects are to be supported. Therefore, projects should be monitored to increase efficiency. In the United States, there is not much R&D incentive from the government to companies. Instead, companies find investors for R&D ideas. In this way, the investor provides capital to the company and becomes a partner. The period of making money from money is over. It would be a more profitable investment to invest a promising idea into a project instead of keeping the money in the bank. As individuals, we need to support projects and startup companies or angel investors. We should capitalize on projects and provide all kinds of moral support and coaching during the transformation of the business idea or project into a product. The role of incubating centers is of crucial importance, and they are being developed very rabidly in numbers as is seen in the table below, but the maturity and quality of system need time.

Albaraka Garaj	http://albarakagaraj.com
Anaç Pre-Incubation Center	http://bigganac.anadolu.edu.tr
Atom	http://www.atom.org.tr
BIC101 XO	http://bic101.com
BioİzmiR	http://www.bioizmir.com/
CAP (Bilkent)	http://cap.cyberpark.com.tr
Embryonix	http://www.yenifikiryenihayat.com
eTohum	http://www.etohum.com

Founder Institute Istanbul	http://www.fi.co
Game Garage	http://www.gamegarage.org/
Garanti Partners	http://www.garantipartners.com
Girisim Fabrikası	http://www.girisimfabrikasi.com
Hackquarters	http://www.hackquarters.co
incuba.city (Sehir TTO)	http://incuba.city/
Incubation İstanbul - İAÜ	http://incubation.istanbul/
InnoCampus	http://www.innocampus.org
Inovent	http://www.inovent.com.tr
ITU Gate	http://www.itugate.com
ITU Çekirdek	http://www.itucekirdek.com
Kadir Has iNEO	http://www.khasineotto.com
KWORKS	https://kworks.ku.edu.tr/
Ege, EU Incubation	https://www.nuvege.org/
Sera Incubation	http://www.seraincubation.com
StartersHub XO	https://www.startershubxo.org/
StartersHub XO	https://www.startershubxo.org
StartupBootcamp Istanbul	http://www.startupbootcamp.org
SuCool	http://www.sucool.sabanciuniv.edu
T-Jump	http://t-jump.com
Tekno Girişim Okulu	http://www.teknogirisimokulu.com/
Teknoloji Türkiye	http://www.teknolojiturkiye.com.tr
TIM TEB	http://www.teblegirisim.com
Türk Telekom Pilot	http://www.turktelekompilot.com.tr
Viveka	http://www.viveka.com.tr
Way Turkey	http://wayturkey.com/Index.aspx
Workup	http://workup.ist
YFYI	http://www.yfyi.odtuteknokent.com.tr

6. Conclusions

Efficient, cost-effective manufacturing of new products requires an R&D organization that understands and interacts effectively with the production department. How does a company create an environment where its R&D organization comprises market-savvy, production-friendly experts in diverse technologies? (Heney, 2021). Many companies in Turkey have Research and Development (R&D) departments, and many even have R&D Centers or Centers. According to the Ministry of Industry and Technology data dated January 5, 2021, there are 1229 R&D Centers, 360 Design Centers, and 87 Technology Development Zones in Turkey. According to the latest updated

data published by TURKSTAT, the share of R&D expenditures in Turkey's gross domestic product (GDP) increased to 1.06% in 2019, and private companies made 64.2% of R&D expenditure in Turkey.

For this reason, today's intellectual capital of companies determines business values. This is the difference between book value and market value. R&D must be sustainable. The business must allocate a reasonable proportion of its income to R&D activities, just as it allocates to marketing activities. Companies where innovations are not followed, and developments are not made cannot be long-lasting. Once a strong will has been demonstrated, one should never step back from R&D. Awareness of intellectual property rights should be created in companies. The design, utility model, and patent protections must be prepared to protect the project outputs. Trademark registrations should not be neglected either. Firms should increase the number of patents and use patent databases very well. Personnel who obtain patents and make innovations and improvements should be rewarded. If possible, staff with doctoral degrees and professional certifications should be employed in R&D departments. Increasing the number of innovative personnel, including those with Ph.D. degrees, should be encouraged. It should not be forgotten that the most important values of the companies are the patents they have obtained and the brands they have developed. Awareness about patents should be created in the business. Also, R&D should not be introverted. It is essential to follow technological developments with national and international experts in different disciplines. Problems should be solved with teams consisting of members with diverse expertise. Only in this way the "problem identification" phase, which is the first step of R&D and innovation, can be carried out correctly and effectively. It is essential that the technology preparation level is low but that the subjects considered a competency to be acquired transferred to universities and that effective planning is done. In this way, a structure that deals with companies' university problems and brings innovative solutions can be created. Thus, it may be possible to train qualified human resources suitable for the needs of the industry.

Where the concepts of open innovation and co-creation are spoken more and more every day, the principles of joining forces must be adopted. Today, the shortening of product life cycles, especially in high-tech products, and the increasing demands of customers have necessitated the sharing of resources and competencies among companies that will require continuous innovation. In realizing some projects, the business's resources alone may not be enough. Partnerships make the tasks easier both financially and in terms of the workforce. To give an example, when a few companies allocate resources for a project that is likely to be realized in 20 years, the resources allocated do not put the companies in trouble, and the burden is shared. Today, just for this

reason, automotive companies act together to develop electric vehicles. The formation of this culture is of great importance. Otherwise, carrying out the project with a single business will cause difficulties and inefficient use. In addition, international cooperation should be given priority, and different cultures should be benefited from it. The principle of "win-win" should always be considered in collaboration.

Turkey can improve its local and national R&D capacity with innovative technology by implementing several strategies, such as:

1. Encouraging private-sector investment in R&D: The government can offer tax incentives, subsidies, and grants to companies that invest in R&D. This will encourage companies to invest more in R&D and thereby increase their competitiveness in the global market (Gokmen & Ozer, 2019).
2. Strengthening the science and technology infrastructure: The government can allocate more funds for the development of science and technology infrastructure, such as universities, research institutions, and technology parks. This will create an environment conducive to R&D and innovation (Gokmen & Ozer, 2019).
3. Fostering collaboration between academia and industry: The government can support collaborations between universities and companies in R&D activities. This will increase the transfer of knowledge and technology from academia to industry and vice versa (Kamil & Haci, 2019).
4. Improving the quality of education and training: The government can invest in education and training programs to improve the quality of education and to produce a highly skilled workforce. This will increase the number of highly qualified professionals who can contribute to R&D activities (Kamil & Haci, 2019).
5. Collaboration between the Public and Private Sectors: Turkey can foster closer cooperation between the public and private sectors to drive R&D initiatives. The government can provide support for private companies to collaborate with universities and research institutes to develop innovative technology.
6. Encouraging Entrepreneurship: Turkey can create an environment that supports entrepreneurship and innovation by providing funding and support for startups. This will encourage the development of innovative technology and increase competitiveness in the local and national R&D sector.

7. Encouraging International Cooperation: Turkey can encourage international cooperation with other countries to share knowledge and expertise in R&D. This will help to accelerate the development of innovative technology and increase competitiveness.

In conclusion, improving the local and national R&D competitiveness of Turkey requires a multi-faceted approach that involves investment in R&D, education, collaboration between the public and private sectors, entrepreneurship, and international cooperation.

References

Acemoglu, D., & Restrepo, P. (2021). The race between man and machine: Implications of technology for growth, factor shares, and employment. The Quarterly Journal of Economics, 136(1), 79-127.

Aghion, P., & Howitt, P. (2017). The economics of growth. MIT Press.

Akcigit, U., Grigsby, J., & Nicholas, T. (2017). The rise of American ingenuity: Innovation and inventors of the golden age. NBER Working Paper No. 23047.

Akdemir, A., Tankişi, S., Aktaş, Ö., Yıldız, B. & Öztürk, H. (2022). Yöneticilerin, liderlik görevlerine ilişkin algılarının çeşitli sektörler bağlamında araştırılması. Disiplinlerarası Yenilik Araştırmaları Dergisi, 2 (1), 78-89. Retrieved from https://dergipark.org.tr/tr/pub/dyad/issue/66035/1056075

Akkoyunlu-Wigley, A., & Güngör, N. D. (2013). Does brain drain lead to institutional gain? An empirical analysis of the effect of high-skilled emigration on institutions. Journal of Development Economics, 102, 116-127.

Alexander, C. (1983) The New Economy. http://www.time.com/time/magazine/article/0,9171,926013-1,00.html

Arora, A., Fosfuri, A., & Gambardella, A. (2019). Markets for technology: The economics of innovation and corporate strategy. MIT Press.

Aydogan-Duda Neslihan (2012) Branding Innovation: The Case Study of Turkey Disruptive Technologies, Innovation and Global Redesign: Emerging Implications, Pages: 11, DOI: 10.4018/978-1-4666-0134-5.ch012

Barlevy, G., & Tsiddon, D. (2019). Economic growth, technological progress, and social capital: The inseparable links. The Review of Economic Studies, 86(6), 2435-2470.

Belderbos, R. A., Gilsing, V. A., Lokshin, B., & Carree, M. A. (2015). Heterogeneity in R&D cooperation strategies. Strategic Management Journal, 36(6), 745-763.

Berber R. and Kurul N. (2009) The motivating factors for productivity in R&D: Preliminary results of a survey in some engineering schools in Turkey, PICMET '09 - 2009 Portland International Conference on Management

of Engineering & Technology, pp. 1508-1515, doi:10.1109/PICMET.2009.5261982.

Bosetti, V., Cattaneo, M., Fiorese, G., Verdolini, E., & Vergalli, S. (2015). The future prospect of PV and CSP solar technologies: An expert elicitation survey. Renewable and Sustainable Energy Reviews, 42, 1309-1324.

Cansız, M. & Tekneci, P. D. (2018). Innovative and Technology-Based Women Entrepreneurs in Turkey: Capital and Performance . Journal of Economy Culture and Society, (57), 151-183. Retrieved from https://dergipark.org.tr/tr/pub/jecs/issue/37969/372449

Çağla C. (2019) AR-GE nedir? Ne Anlama Gelir? Bölümleri nelerdir? https://www.tech-worm.com/AR-GE-nedir-ne-anlama-gelir-bolumleri-nelerdir/

Daveri, F. and A. Mascotto (2006) The IT Revolution across the United States. Review of Income and Wealth, 52 (4), 569–602. http://dx.doi.org/10.1111/j.1475-4991.2006.00205.x

Deardorff's Glossary of International Economics (2013). http://www-personal.umich.edu/~alandear/glossary/n.html#NewEconomy

Ege, A., & Ege, A. (2017). The Turkish economy and the challenge of technology: A trade perspective. *New Perspectives on Turkey, 57*, 31-60. doi:10.1017/npt.2017.28

Erdogan, E. (2018). Encouraging entrepreneurship and innovation in Turkey: A policy perspective. Journal of Entrepreneurship and Innovation, 4(1), 1-12.

Erduran, S., Guilfoyle, L., Park, W. et al. (2019) Argumentation and interdisciplinarity: reflections from the Oxford Argumentation in Religion and Science Project. Discip Interdscip Sci Educ Res 1, 8https://doi.org/10.1186/s43031-019-0006-9

Ersungur, Ş. M. & Takım, A. (2018). Türkiye'de Teşvik Sisteminin Yapısı, Sorunları Ve Etkinliği Üzerine Bir Politika Önerisi: Tek Bir Uygulamacı Kuruluş Sorunları Çözer mi? . Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi, 32 (3), 725-744.

Erten, T., (2008) "Teşvik sistemi yenilenecekse…", Dünya Gazetesi, 23.04.2008.

GEM (2017). Global Entrepreneurship Monitor 2016/2017 global report. Retrieved April 3, 2017 from http://gemconsortium.org/report/49812

Gokmen, O., & Ozer, B. (2019). A comparative analysis of the R&D systems in Turkey and the EU: the case of biotechnology. The Journal of International Social Research, 12(56), 831-841.

Grossman, G. M., & Helpman, E. (2015). Innovation and growth in the global economy. MIT Press.

Gümüş B. (2017) Sağlıkta AR-GE ve İnovasyon. http://www.fokusakademi.com.tr/wp-content/uploads/2017/02/Sa%C4%9Fl%C4%B1k-ArGe_201702-web.pdf

Günay D. (2018) İnovasyon, teknoloji ve bilim. 2. AR-GE İnovasyon Zirvesi ve Sergisi Sonuç Raporu – AR-GE'den Projeye Projeden Üretime. Mavi Ofset, İstanbul, s. 60-74.

Hacıoğlu, V. (2021). Innovative Entrepreneurship and Development of Service Industry: A Macroeconomic Perspective . Disiplinlerarası Yenilik Araştırmaları Dergisi, 1 (1), 69-75.

Harryison Sigvald J., (2003) How Canon and Sony Drive Product Innovation Through Networking and Application-Focused R&D, Journal of Product Innovation Management, October 02 https://doi.org/10.1111/1540-5885.1440288

Heney, P. (2021) Global R&D Funding Forecast released, RDWORLD, February 22, https://www.rdworldonline.com/2021-global-rd-funding-forecast-released/

Ilyash, O., Lupak, R., Dzhadan, I. & Kolishenko, R. (2021). Assessing Structural Components of Investment and Innovation Provision of Economic Security in the Basic Types of Economic Activity. Journal of Economy Culture and Society, (63) , 17-37 . DOI: 10.26650/JECS2020-0038

Jalava, J. and M. Pohjola, (2002) Economic Growth in the New Economy: Evidence from Advanced Economies. Information Economics and Policy, 14, 189–210.

Jorgenson, D. W., Ho, M. S., and Samuels J. D. (2011) Information Technology and US Productivity Growth: Evidence from a Prototype Industry Production Account. Journal of Productivity Analysis, 36 (2), 159–175.

Kallio, J. and N. Mallat (2004) Trust in the New Economy – The Case of Finnish Banks. Ministry of Transport and Communications, Helsinki, http://www.lvm.fi/fileserver/1704.pdf

Kamil, A., & Haci, H. (2019). Innovative technology and its impact on R&D capacity in Turkey. European Journal of Education Studies, 5(4), 68-75.

Karagüllü E. (2013) Profesyonel Akıl. Forbes, Aralık, s. 68-72.

Ketteni, E., T. Mamuneas and T. Stengos (2011). Macroeconomic Dynamics, 15 (05), 595–61. http://dx.doi.org/10.1017/S1365100510000210

Kiracı, A. (2016) Yeni Ekonomide Yenilikçi Ürünler, Mahkumlar İkilemi ve Firmalar için Artan Bir Maliyet Bileşeni. İktisadi Yenilik Dergisi, 1 (1), 27-38. https://dergipark.org.tr/tr/pub/iy/issue/22651/241942

Koski, H., P. Rouvinen and P. Ylä-Anttila (2002) ICT Clusters in Europe: The Great Central Banana and the Small Nordic Potato. Information Economics and Policy, 14, 145–165.

Külünk, İ. (2018). Türkiye'de Arge Harcamaları, İhracat ve Büyüme Arasındaki İlişki: 1996-2016. Uluslararası Ekonomik Araştırmalar Dergisi, 4 (2), 73-82. https://dergipark.org.tr/tr/pub/ead/issue/48247/610768

Manioudis, M. (2021) An Early Anticipation of Smart Growth? John Stuart Mill, Knowledge and the 'East-West' Distinction. J Knowl Econ https://doi.org/10.1007/s13132-021-00809-7

Mazurkiewicz, A. (2018) Barriers of technological innovation development and implementation encountered by R&D organisations, Journal of Machine Construction and Maintenance - Problemy Eksploatacji, no. 1 127—138.

Mohnen, P., & Hoareau, C. (2019). Knowledge flows, R&D collaboration, and public policy. Annual Review of Resource Economics, 11, 497-519.

Özçelik Emre, Taymaz Erol, (2008) R&D support programs in developing countries: The Turkish experience, Research Policy, Volume 37, Issue 2, Pages 258-275, ISSN 0048-7333, https://doi.org/10.1016/j.respol.2007.11.001.

Özden, Ç., Parsons, C. R., Schiff, M., & Walmsley, T. L. (2011). Where on earth is everybody? The evolution of global bilateral migration 1960-2000. The World Bank Economic Review, 25(1), 12-56.

PISA, (2019) Worldwide ranking – average score of math, science and reading. http://factsmaps.com/pisa-worldwide-ranking-average-score-of-math-science-reading/

Ranga M., Temel S., Ar I. M., Yesilay R. B., Sukan F. V. (2016) Building Technology Transfer Capacity in Turkish Universities: a critical

analysis, European Journal of Education, Volume 51, Issue1, https://doi.org/10.1111/ejed.12164

Reddit, (2018) Maths and science education quality, World Economic Forum, Spectator Index. https://www.reddit.com/r/Turkey/comments/9y6rsd/maths_and_science_education_quality_2018_turkey/

Roser M, Nagdi M, Ortiz-Ospina E. (2019) Quality of Education. Our World in Data. https://ourworldindata.org/quality-of-education

Sánchez, R.L.M., Vega J. and Álvarez E. (2009) Information Technologies and Economic Growth: Do the Physical Measures Tell Us Something? http://dx.doi.org/10.2139/ssrn.1719067

Shao, B. and Shu W.S. (2004) Productivity Breakdown of the Information and Computing Technology Industries Across Countries. Journal of the Operational Research Society, 55, 23–33.

Shepherd, S.B. (1997) The New Economy: What it Really Means. http://www.businessweek.com/1997/46/b3553084.htm

Smith, K. (2018). Economic development and R&D: Introduction. The Journal of Technology Transfer, 43(2), 255-258.

Tansel, A. (2013). Brain drain from Turkey: An investigation of students' return intentions. IZA Journal of Migration, 2(1), 18.

Tansel, A. and Güngör Demet, N. (2003) Brain drain from Turkey: survey evidence of student non-return", Career Development International, Vol. 8 No. 2, pp. 52-69. https://doi.org/10.1108/13620430310465453

Tapscott, D. (1997) The Digital Economy: Promise and Peril In The Age of Networked Intelligence, McGraw-Hill.

TCKB (2014) TC Kalkınma Bakanlığı, 10. Kalkınma Planı – İlaç Çalışma Grubu Raporu, 2014-2018.

Tekin-Koru, A. (2017). A comparative study of the R&D investment in Turkey and the EU. Journal of Economics and International Finance, 9(11), 1-11.

Tosun, C. (2017). The role of education in the development of innovation and entrepreneurship in Turkey. Education and Development, 3(1), 33-43.

Tulp, Jan Willem (2017) The World's Best Countries in Science. Scientific American, 307(4): 36-37,

Uzbay İT. (2007) Türkiye'nin Çağdaş Uygarlığı Yakalama Hedefinden Bilimin Yeri. Silahlı Kuvvetler Dergisi, Sayı 391 (Ocak): 62-75.

Uzbay T. (2017) Türkiye'de İlaç AR-GE'sinin Geçmişi Bugünü ve Yarını. Health 4.0 Sağlıkta Yenilikler Kongresi, 24 Kasım, İstanbul.

Weitzman, M. L. (2018). Recombinant growth. The Quarterly Journal of Economics, 133(4), 1849-1891.

Yildiz, H., & Kose, M. (2019). The role of the public sector in promoting entrepreneurship and innovation in Turkey. Journal of Entrepreneurship and Business Development, 2(2), 1-12.

Yilmaz, E., & Demir, M. (2015). The impact of international cooperation on the R&D competitiveness of Turkish firms. International Journal of Economics and Management Sciences, 4(5), 35-45.

Yumrutepe, R. (2013). Brain drain and its determinants: A major issue for small and medium-sized enterprises (SMEs) in developing countries. Procedia-Social and Behavioral Sciences, 99, 824-831.