

# Journal of Business and Economic Options



Investing in Research and Development for Technological Innovation: A Strategy for Turkey's Economic Growth

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## Abstract

The gap between developed and underdeveloped countries continues to widen, perpetuating inequalities in various aspects of socio-economic development. Developed nations often wield significant influence over underdeveloped countries, which can lead to dependency relationships. One of the primary ways in which developed countries exert influence is through economic means. They may control key industries, resources, or markets in underdeveloped countries, exploiting them for their own benefit. This economic exploitation can deepen the dependency of underdeveloped nations on developed ones, hindering their ability to achieve self-sufficiency and sustainable growth. Furthermore, developed countries often have political and military power that they can leverage to maintain control or influence over underdeveloped nations. This influence can manifest through policies, agreements, or interventions that serve the interests of the developed countries, sometimes at the expense of the underdeveloped ones. Moreover, the unequal distribution of resources, technology, and opportunities between developed and underdeveloped countries exacerbates the disparities. Underdeveloped countries may struggle to access or afford essential resources and technologies, further perpetuating their dependence on developed nations. Addressing these inequalities requires concerted efforts at both national and international levels. Underdeveloped countries need to strengthen their economies, build infrastructure, invest in education and healthcare, and foster innovation to reduce dependency and achieve sustainable development. Additionally, there is a need for fair trade practices, international cooperation, and support from developed countries to ensure a more equitable global landscape. Investing in research and development (R&D) is indeed crucial for Turkey's efforts to enhance its technological innovation capabilities and drive economic growth. By analyzing R&D expenditures across public institutions, businesses, and universities in Turkey, policymakers can identify areas where investment is lacking and prioritize doubling down on those efforts. Increasing R&D spending can lead to several benefits for Turkey. Firstly, it fosters innovation and the development of new technologies, which can drive productivity gains across various sectors of the economy. This, in turn, can enhance competitiveness both domestically and internationally, allowing Turkish firms to produce higher value-added products and services. Moreover, investing in R&D can lead to the creation of high-skilled jobs and attract talent, particularly in the fields of science, technology, engineering, and mathematics (STEM). This can help retain skilled professionals within the country and prevent brain drain, where talented individuals seek opportunities abroad due to limited prospects at home. Furthermore, R&D investment can contribute to addressing societal challenges and promoting sustainable development. By focusing on areas such as renewable energy, healthcare, agriculture, and environmental protection, Turkey can develop innovative solutions to pressing issues, improving the quality of life for its citizens and ensuring long-term prosperity.

**Keywords:** Research and Development, Technological Innovation, Economic Growth, Turkey

**JEL Codes:** O32, O38, O57

## 1. INTRODUCTION

Investing in research and development (R&D) activities plays a pivotal role in driving economic growth and fostering technological innovation. The portion of GDP allocated to R&D expenses serves as a key indicator of a country's commitment to innovation and its potential for advancement. Theoretical frameworks developed by economists such as Romer and Lucas in the late 1980s have underscored the importance of incorporating R&D activities into models of economic growth. These studies have highlighted how technological advancements resulting from R&D efforts can fuel productivity gains, stimulate investment, and propel long-term economic development. In today's increasingly globalized and technology-driven landscape, the imperative to prioritize R&D activities has become even more pronounced. Companies that invest in R&D not only enhance their competitiveness but also expand their market share by introducing innovative products and services. This, in turn, can lead to increased profitability and sustained growth over time. Moreover, technological innovation spurred by R&D activities can have broader macroeconomic implications. It can drive structural transformation within economies, leading to the emergence of new industries and the revitalization of existing ones. By fostering a culture of innovation and entrepreneurship, countries can position themselves at the forefront of technological progress and reap the benefits of a dynamic and vibrant economy. The level of investment in research and

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development (R&D) activities serves as a crucial determinant of a country's ability to remain competitive in today's knowledge-driven global economy. Nations that fail to prioritize R&D risk falling behind in technology-based production and may struggle to maintain their competitive edge. Economic growth, which lies at the heart of macroeconomic concerns, directly impacts both living standards and overall welfare. R&D expenditures play a significant role in driving economic expansion by fostering innovation, facilitating the accumulation of capital, and enhancing human capital development. These investments contribute to the long-term competitiveness and prosperity of nations by fueling technological advancements and enabling sustainable productivity gains. Indeed, R&D expenses serve as vital indicators of a country's commitment to fostering innovation and driving economic development. By allocating resources towards R&D initiatives, countries can unlock new avenues for growth, spur job creation, and enhance their capacity to address complex societal challenges. In the long run, R&D emerges as a key driver of both welfare and productivity, laying the foundation for sustained economic progress and improved living standards. As such, policymakers and stakeholders must recognize the pivotal role of R&D investment in shaping the future trajectory of their economies and prioritize strategies that promote innovation and technological advancement. By doing so, countries can position themselves as leaders in the global marketplace and ensure the well-being of their citizens in an increasingly competitive and dynamic world. Research and development (R&D) investments serve as the cornerstone of technological advancement and economic growth for companies and nations alike. These investments are instrumental in elevating companies to higher technological standards, thereby fostering income growth and facilitating business expansion (Korkmaz, 2010; Miroleave et al., 2009). Through strategic allocation of resources towards R&D activities, companies not only enhance their competitive edge but also drive innovation across industries. By delving into R&D, companies explore new frontiers of technology, develop cutting-edge products and services, and pioneer breakthrough solutions to address complex challenges.

Moreover, R&D investments contribute significantly to broader economic development and progress. They play a pivotal role in driving productivity gains, fostering job creation, and stimulating overall economic growth (Sylwester, 2001). As companies invest in R&D initiatives, they not only bolster their own capabilities but also contribute to the development of human capital, technological infrastructure, and knowledge economy within their respective regions. Importantly, R&D investments are not made in isolation but are guided by a strategic approach that considers both internal factors inherent to the companies' organizational structures and external factors shaping the industry landscape. Companies strategically allocate funds to R&D based on market dynamics, competitive pressures, technological trends, and regulatory requirements. The productivity of a country's factors is not solely dependent on the investments made in research and development (R&D) but also on the allocation of funds towards R&D activities. The efficiency and effectiveness of R&D expenditures play a crucial role in driving innovation and economic growth (Bor et al., 2010; Jones and William, 2000). Increasing investments in R&D without proper utilization of resources can lead to inefficiencies and wastage, undermining the potential impact of R&D efforts on productivity and economic development.

Therefore, it is imperative for countries to not only increase their R&D investments but also ensure that these funds are utilized effectively and efficiently. Strategic allocation of R&D funds towards high-impact projects, fostering collaboration between academia and industry, and promoting innovation ecosystems can enhance the productivity of R&D investments and maximize their contribution to economic growth. Furthermore, fostering a culture of innovation and entrepreneurship, investing in education and skills development, and creating conducive regulatory frameworks are essential to harnessing the full potential of R&D investments. By prioritizing the efficient use of R&D funds and fostering an innovation-friendly environment, countries can accelerate their pace of technological advancement, drive productivity gains, and achieve sustainable economic growth.

## **2. THE CONCEPT OF SURVEY AND IMPROVEMENT**

According to the manual of the Organisation for Economic Co-operation and Development (OECD) Frascati, surveys and experimental developments constitute the generation of knowledge that arises from human culture and societal knowledge, representing creative endeavors aimed at systematically applying new discoveries (OECD, 2015). These activities encompass a broad spectrum of endeavors, ranging from scientific research to technological innovations and encompassing various fields such as natural sciences, engineering, social sciences, and humanities. Surveys involve systematic data collection, analysis, and interpretation to uncover new insights, patterns, and trends in a particular domain. They often serve as the foundation for further research and development efforts, guiding decision-making processes and informing policy formulation. Experimental developments, on the other hand, entail the systematic application of scientific and technological knowledge to create new products, processes, or services. These activities involve iterative testing, refinement, and optimization to ensure that the resulting innovations meet desired objectives and requirements.

Both surveys and experimental developments play a crucial role in driving innovation, fostering economic growth, and addressing societal challenges. By continuously expanding the frontiers of knowledge and translating discoveries into practical applications, these activities contribute to the advancement of human welfare and the betterment of society as a whole. According to the manual of the Organisation for Economic Co-operation and Development (OECD) Frascati, research and development (R&D) encompasses three fundamental elements. Firstly, it involves experimental or theoretical studies aimed at expanding knowledge in a particular field. These studies may not necessarily have an immediate application or practical use; instead, their primary purpose is to deepen our understanding of fundamental principles and

uncover new insights (Bilbao-Osorio & Rodríguez-Pose, 2004). These exploratory endeavors delve into the underlying mechanisms and principles governing observable phenomena, shedding light on previously unexplored areas of inquiry. They contribute to the accumulation of knowledge and the advancement of human understanding, laying the groundwork for future innovation and technological advancement. By elucidating the fundamental principles underlying natural phenomena or societal processes, these theoretical and experimental studies pave the way for the development of practical applications and innovative solutions to real-world challenges. They provide the intellectual foundation upon which subsequent research and development efforts can build, driving progress and fostering innovation across various domains. Practical research serves as a conduit for generating novel insights and information that directly contribute to tangible outcomes and practical applications. Unlike theoretical research, which focuses on expanding knowledge without immediate practical implications, practical research is inherently goal-oriented, with a specific aim or objective in mind. At its core, practical research endeavors to develop new materials, products, or equipment through a combination of systematic inquiry and empirical experimentation. By leveraging research findings and practical experiments, researchers seek to innovate and create novel solutions to real-world challenges. This may involve the design and fabrication of new materials with enhanced properties or the development of innovative technologies and processes that improve efficiency and productivity. Moreover, practical research extends beyond the realm of product development to encompass the refinement and enhancement of existing processes, systems, and methodologies. Researchers strive to identify areas for improvement and innovation, with the overarching goal of driving substantive advancements in various domains. In essence, practical research bridges the gap between theoretical knowledge and practical applications, translating abstract concepts into tangible outcomes that benefit society at large (Coe & Helpman, 1995). Through its focus on problem-solving and innovation, practical research plays a crucial role in driving progress and fostering technological advancement in diverse fields.

### **3. THE DEVELOPMENT OF R&D ACTIVITIES**

When examining the historical development of R&D activities, it becomes evident that the foundation of modern institutional R&D can be traced back to Germany around 1870. As noted by Freeman and Soete, pioneering companies such as Hoechst, Bayer, and BASF played pivotal roles in shaping this evolution (Freeman & Soete, 1997). These companies, driven by a spirit of innovation and scientific inquiry, laid the groundwork for the systematic pursuit of research and development endeavors. However, it was the tumultuous events of World War II that accelerated the trajectory of R&D activities. The exigencies of war spurred unprecedented levels of scientific and technological innovation, leading to rapid advancements in various fields. The wartime imperative propelled R&D efforts to new heights, fostering collaboration between governments, academia, and industry to tackle pressing challenges and develop cutting-edge technologies. Over time, what had begun as sporadic, amateurish R&D endeavors in the 19th century evolved into a sophisticated and professionalized enterprise. R&D activities expanded exponentially in scope, encompassing a wide range of scientific disciplines and specialized domains. The growing emphasis on scientific rigor and professional specialization transformed R&D into a cornerstone of modern industrial and technological progress. In essence, the historical trajectory of R&D development underscores its pivotal role in driving innovation and progress, with each milestone marking a significant leap forward in humanity's quest for knowledge and advancement.

### **4. AIM AND TECHNIQUE OF RESEARCH AND EVALUATION OF EVIDENCE**

The R&D activities of both public and private sectors, as well as the corresponding expenditures, have been subject to thorough examination. In Turkey, efforts have been made to assess the allocation of R&D expenditures across various entities, including public institutions, businesses, and universities. The aim is to identify areas where R&D investments are insufficient and pinpoint areas where doubling expenditures may be warranted. By undertaking such analyses, policymakers and stakeholders can develop targeted strategies to bolster R&D efforts and foster innovation. This proactive approach to R&D investment analysis facilitates the formulation of effective resolution strategies. By understanding the current landscape of R&D spending and identifying potential areas for enhancement, decision-makers can channel resources towards initiatives that promise the greatest returns in terms of technological advancement, economic growth, and societal development. The statistics pertaining to R&D activities in Turkey are compiled by the Turkish Statistical Institute (TUIK) through a combination of annual surveys and administrative registration processes. This comprehensive data collection effort encompasses R&D endeavors undertaken across the public sector, private enterprises, and academic institutions such as universities. For the public sector, data on R&D activities are collected through postal surveys, wherein relevant government agencies and entities are requested to provide information regarding their research and development initiatives. Similarly, administrative registration information is utilized to compile data on R&D efforts within public institutions. In the case of private enterprises, including commercial establishments, R&D data is gathered through face-to-face interviews conducted with area managers by TUIK personnel. These interviews aim to elicit details about the nature, scope, and magnitude of R&D activities undertaken by businesses operating within Turkey.

Furthermore, R&D data pertaining to universities is obtained through a combination of annual surveys and administrative registration processes. These mechanisms ensure the comprehensive capture of R&D endeavors within the academic sector, allowing for a holistic assessment of research and innovation efforts across the country. By employing a multi-faceted

approach to data collection, TUIK endeavors to provide accurate and reliable statistics on R&D activities in Turkey, facilitating informed decision-making and policy formulation in support of scientific and technological advancement. The compilation and publication of fundamental variable components, as well as guidance for the composition and interpretation of R&D data, are carried out in accordance with the guidelines outlined in the Frascati Manual. Upon examination of the initial, it becomes evident that the higher education sector accounts for the highest proportion, representing 45.5% of total R&D expenditure across sectors and expense groups. Following closely behind is the commercial sector, comprising 43.3% of the total expenditure. Conversely, the public sector exhibits the lowest proportion, accounting for only 11.3% of the total R&D expenditure. This distribution highlights the significant role played by the higher education and commercial sectors in driving research and development activities within Turkey. The substantial investment in R&D by these sectors underscores their commitment to innovation and technological advancement, contributing to overall economic growth and competitiveness. Furthermore, while the public sector's contribution to R&D expenditure may be comparatively lower, it is important to recognize the vital role of government-funded research initiatives in fostering scientific progress and addressing societal challenges. Despite its relatively smaller share, the public sector remains an integral part of Turkey's research and innovation ecosystem, complementing the efforts of other sectors and contributing to the country's overall R&D landscape.

An important aspect to consider is the significant disparity between current and investment expenditures, particularly within the higher education sector. The rationale behind the higher R&D expenditures in the higher education sector compared to the commercial and public sectors can be attributed to several factors. One contributing factor is the establishment and proliferation of technoparks, which have seen increased collaboration with universities in recent years. These technoparks serve as hubs for research, innovation, and technology transfer, fostering an environment conducive to R&D activities. Additionally, the operationalization of R&D units within technoparks has further fueled investment in research and development initiatives. It is worth noting that a substantial portion of Gross Domestic R&D expenditures across sectors, approximately 84.4%, comprises investment expenditures. This underscores the emphasis placed on long-term research projects, infrastructure development, and capacity-building efforts aimed at driving innovation and technological advancement in Turkey. The prioritization of investment expenditures reflects a strategic approach towards nurturing a conducive ecosystem for research and innovation. By allocating resources towards infrastructure development, talent acquisition, and collaborative partnerships, stakeholders aim to enhance Turkey's competitiveness on the global stage and position the country as a hub for cutting-edge research and development activities. Moreover, the higher education sector's larger share of R&D investment expenditures underscores its pivotal role as a driver of knowledge creation and dissemination. Through strategic investments in research infrastructure, human capital development, and collaborative research initiatives, universities play a crucial role in advancing scientific discovery and technological innovation, thereby contributing to the overall socio-economic development of the nation. According to data from the Turkish Statistical Institute (TUIK) in 2011, higher education institutions emerged as the leading contributors to research and development (R&D) expenditures across different scientific disciplines. These expenditures were categorized into various fields of study, including hard science, engineering science, health science, agriculture science, and social science.

Upon closer examination of the data, it becomes apparent that health science accounted for the largest share of R&D expenses within higher education institutions, constituting approximately 33.16% of total expenditures. This significant allocation towards health science research reflects the growing emphasis on medical and healthcare-related studies within university-affiliated research facilities. Furthermore, social science research received considerable attention, comprising approximately 22.85% of total R&D expenditures. This highlights the importance of interdisciplinary research aimed at addressing socio-economic challenges and informing policy decisions. Engineering science and hard science also received substantial funding, accounting for 17.32% and 9.5% of total R&D expenses, respectively. These investments underscore the commitment towards advancing technological innovation and fundamental scientific knowledge across various disciplines. Interestingly, agriculture science received a comparatively smaller share of R&D expenditures, amounting to 4.74%. This may reflect shifting priorities within higher education institutions, with greater emphasis placed on other scientific domains perceived to have a more immediate societal impact. A notable observation from the data is the predominance of investment expenditures within higher education institutions. Despite the significant allocation of resources towards R&D activities, universities appear to have prioritized long-term investments in research infrastructure, facilities, and equipment. This strategic approach reflects a commitment to enhancing research capabilities and fostering a conducive environment for scientific inquiry and innovation. In this segment of the study, research and development (R&D) expenditures related to economic activities and expense groups are analyzed based on R&D research activities conducted in 2011. These expenses are categorized under various headings, including knowledge and communication, professional scientific and technical activities, manufacturing, and other sectors.

The substantial investment in manufacturing underscores the importance of fostering innovation and technological advancement within Turkey's industrial sector. By prioritizing R&D initiatives in manufacturing, Turkey aims to enhance its competitiveness, drive productivity gains, and transition towards technology-based production methods. Additionally, approximately 23.6% of R&D expenditures within the commercial sector are directed towards knowledge and communication activities. This investment reflects efforts to leverage information and communication technologies (ICT) to drive innovation, digital transformation, and knowledge-based economic growth. Furthermore, a significant portion of R&D

expenses, approximately 15.26%, is allocated towards professional, scientific, and technical activities. This includes investments in research and consultancy services, specialized scientific studies, and technical expertise aimed at addressing industry-specific challenges and driving technological innovation. The remaining percentage of R&D expenses, approximately 7.81%, is attributed to various other economic activities, including water, electricity, gas production and distribution, construction, wholesale and retail trade, accommodation and food services, finance, insurance, administrative services, and support services. These diverse investments reflect the broad spectrum of economic sectors contributing to R&D activities and innovation-driven growth in Turkey.

It is noteworthy that a significant proportion, approximately 85%, of R&D expenses within the commercial sector consists of investment expenditures. This strategic emphasis on long-term investments underscores the commitment towards building research infrastructure, acquiring advanced technologies, and nurturing a conducive environment for innovation and technological development. Gross Domestic Expenditures on Research and Development (R&D), as reported by the Turkey Statistical Institute (TUIK) for the year 2011, are distributed across first-level statistical region units according to the EU harmonization process in Turkey, as mandated by Law No. 2002-4720. The allocation of R&D expenditures across these regions provides insights into the geographical distribution of research activities and investments within Turkey, it is evident that the distribution of R&D expenses varies across different regions. West Anatolian regions account for the highest proportion of R&D expenditures, with approximately 28.21% of total expenses allocated to this area. This highlights the significance of West Anatolian regions in terms of research and innovation activities within Turkey. Following West Anatolian regions, Istanbul emerges as another major hub for R&D investments, receiving approximately 19.2% of total expenditures. As Turkey's largest city and economic center, Istanbul plays a pivotal role in driving research and innovation initiatives, attracting significant investments and talent in various fields.

East Marmara and Aegean regions also command substantial shares of R&D expenditures, accounting for approximately 20.84% and 9.47% of total expenses, respectively. These regions benefit from strategic geographical locations, vibrant economic ecosystems, and established research institutions, contributing significantly to Turkey's innovation landscape. Other regions, such as West Marmara, Central Anatolian, Southeast Anatolian, West Black Sea, Central East Anatolian, East Black Sea, and Northeast Anatolian, also receive allocations for R&D activities. While their shares may be comparatively smaller, each region contributes uniquely to Turkey's research and innovation ecosystem, leveraging local resources, expertise, and infrastructure. Furthermore, the distribution of R&D employers across these regions provides insights into the regional employment dynamics within the R&D sector. West Anatolian regions employ the highest proportion of R&D professionals, accounting for approximately 23.68% of total R&D employment. Istanbul follows closely, with approximately 21.69% of R&D professionals employed in the city, further highlighting its significance as a talent hub. East Marmara, Aegean, and other regions also contribute significantly to R&D employment, reflecting the diverse talent pool and expertise available across different parts of Turkey. Overall, the distribution of R&D expenditures and employment underscores the importance of regional collaboration and investment in fostering research and innovation-driven growth across Turkey.

The increasing importance of research and development (R&D) activities has led to a growing demand for skilled R&D personnel, including scientists, engineers, and experts. As a result, there is a pressing need for effective government policies to address this demand and strategically direct human resources towards fulfilling future R&D requirements.

The outcomes provides insights into the allocation of R&D expenses within the public sector, categorized according to socio-economic objectives. These objectives encompass various fields such as earth and environmental sciences, space exploration, energy, industrial manufacturing and technology, healthcare, agriculture, defense, and other socio-economic priorities. It becomes evident that a significant portion of public sector R&D expenses is directed towards agriculture, accounting for approximately 20.02% of total expenditures. This allocation reflects the government's commitment to enhancing agricultural productivity, improving farming techniques, and addressing challenges related to food security and sustainability. Defense emerges as another major area of focus, with approximately 19.76% of R&D expenses allocated to this sector. This underscores the importance of research and innovation in strengthening national security, developing advanced defense technologies, and maintaining a competitive edge in defense capabilities. Industrial manufacturing and technology also command a substantial share of R&D expenditures, accounting for approximately 17.6% of total expenses. This allocation reflects efforts to drive innovation, promote technological advancements, and enhance competitiveness in industrial sectors, thereby stimulating economic growth and job creation. Energy, environment, health, and space exploration also receive allocations for R&D activities, albeit to a lesser extent. These investments signify the government's commitment to addressing critical issues such as renewable energy development, environmental conservation, healthcare innovation, and space exploration endeavors. Furthermore, a portion of R&D expenses is allocated to other socio-economic objectives, reflecting diverse priorities and initiatives within the public sector. Overall, the distribution of R&D expenditures across various socio-economic aims underscores the government's multifaceted approach to research and innovation, aimed at driving progress, addressing societal challenges, and fostering sustainable development.

## **5. DISCUSSION AND CONCLUSION**

The significance of research and development (R&D) expenditures has been steadily growing since the emergence of traditional growth theory. In growth economics, technology is regarded as an indispensable factor for the development of

countries. Despite the acknowledgment of technology's importance dating back to classical economic thought, it did not play a prominent role in economic growth theories until the studies conducted by R. Solow. Adam Smith, in his seminal works, laid the groundwork for understanding the role of technology in economic development. However, it wasn't until Robert Solow's groundbreaking research in the mid-20th century that technology's pivotal role in driving economic growth began to be fully appreciated. Solow's neoclassical growth model, which introduced the concept of technological progress as an exogenous factor, revolutionized the field of economics and highlighted the crucial contribution of technological innovation to long-term economic growth. Since then, the importance of R&D expenditures has become increasingly recognized as a key driver of technological advancement and innovation. Governments, businesses, and academic institutions worldwide have been investing significant resources in research and development activities to foster innovation, enhance productivity, and spur economic growth. Robert Solow's growth theory, while groundbreaking, has faced criticism for its treatment of technology as an exogenous factor. However, the emergence of the endogenous growth theory, pioneered by Paul Romer in 1986, challenged this perspective by emphasizing the role of internal factors such as human capital accumulation, R&D activities, and technological development in driving economic growth.

By prioritizing these investments, governments can stimulate economic growth, promote technological progress, and position their economies for long-term success in an increasingly competitive world. The significant allocation of R&D expenses in the higher education sector to health-related activities is likely attributed to the presence of research hospitals within universities. This concentration reflects the emphasis on medical research and healthcare advancements within academic institutions. However, one of the challenges faced by the agriculture sector is the relatively low level of investment in R&D activities, particularly in areas related to agriculture and hard sciences. This shortfall could hinder the sector's ability to innovate and address emerging challenges effectively. While the manufacturing industry plays a crucial role in the economy, many of the products manufactured fall into the category of medium-technology goods. To transition towards high-technology products and enhance global competitiveness, it is essential to increase R&D investment in the manufacturing sector. By allocating more resources to research and development within the commercial sector, particularly in manufacturing, companies can drive innovation, develop advanced technologies, and improve their competitive position in the global marketplace. This strategic investment in R&D can lead to the creation of high-value products and services, ultimately contributing to economic growth and prosperity.

The significant regional disparities in R&D expenses, particularly evident in territorial units classified at level-1 for statistics, underscore the importance of addressing these discrepancies. In regions such as East Anatolian, Southeast Anatolian, and the Black Sea, there is a need to increase R&D investment to mitigate these differences effectively. In terms of socio-economic objectives, while expenditures on defense, industrial production, and the exploration and utilization of natural resources are essential, there should also be a focus on areas such as healthcare and space exploration. Furthermore, increasing R&D investment, particularly in sectors with significant renewable energy potential, is crucial for sustainable development and reducing regional disparities. To achieve these objectives, it is imperative to augment the pool of expert personnel engaged in R&D activities. This entails investing in education and training programs to develop a skilled workforce capable of driving innovation and technological advancement. Additionally, given that universities contribute significantly to R&D expenditures in Turkey, fostering collaboration between academia, industry, and government can further enhance research capabilities and promote economic growth across all regions. By addressing regional disparities in R&D investment and promoting a culture of innovation and collaboration, Turkey can position itself as a leading hub for research and development in the region. Indeed, the ratio of R&D activities conducted by private enterprises in Turkey is relatively high compared to other countries. However, there is still room for improvement in various aspects of R&D management and innovation. To enhance R&D effectiveness and innovation output, it is essential to invest in specialized training programs for R&D leaders and professionals. These programs should focus on R&D-based technology management, informatics management, and other relevant areas. By equipping R&D leaders with the necessary skills and knowledge, organizations can streamline their research processes, avoid redundant efforts, and effectively leverage existing knowledge and resources. Furthermore, there is a need to foster a culture of continuous improvement and problem-solving within R&D teams. Encouraging thorough analysis of problems, exploring innovative solutions, and paying attention to detail can lead to the identification of unique opportunities and the development of products with a competitive edge. Ultimately, by investing in R&D leadership training and promoting a culture of innovation and excellence, Turkey can strengthen its position in the global market and drive sustainable economic growth through research and development.

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