INTEGRATING PATHWAYS: EXPLORING THE EVOLUTION AND CONVERGENCE OF SCIENCE AND TECHNOLOGY POLICIES IN THE EUROPEAN UNION AND TURKIYE (2000-2020)

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ABSTRACT

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This thesis provides a comprehensive analysis of Science and Technology (S&T) policies within the European Union (EU) and Türkiye over the period from 2000 to 2020. This study primarily focuses on investigating the influence of these policies on innovation and regional competitiveness. Through a methodological approach that involves examining primary and secondary sources including policy documents prepared by the national government and international organizations, the European Commission's Report on Türkiye's Progress Reports regarding the accession process, and scholarly articles, this research evaluates how these policies have adapted to global technological changes and how they addressed challenges in international cooperation. Emphasizing the alignment of Türkiye with various EU framework programs, the thesis discusses the contributions of S&T policies to economic competitiveness and innovation within both Türkiye and the EU. Furthermore, it explores the dynamic relationship between S&T policies and the broader socio-economic context, without neglecting the theoretical frameworks that shape these policies' implementations and implications. It highlights the impact of policy convergence on research and development ecosystems. Finally, this study

aspires to provide valuable insights for policymakers, researchers, and industry professionals, by informing them on the future of S&T policy-making processes and by fostering progress toward an integrated European Research Area (ERA).

Keywords: European Research Area (ERA), Framework Programmes (FPs), Science and Technology Policy, Policy Implementation, Research and Development (R&D), Innovation-Driven Development

ÖZ

ENTEGRASYON YOLLARI: AVRUPA BİRLİĞİ VE TÜRKİYE'DE BİLİM VE TEKNOLOJİ POLİTİKALARININ GELİŞİMİ VE YAKINSAMASI (2000-2020)

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Bu tez, 2000'den 2020'ye kadar olan dönemde Avrupa Birliği (AB) ve Türkiye'deki Bilim ve Teknoloji (B&T) politikalarının kapsamlı bir analizini sunmaktadır. Öncelikli odak noktası bunların inovasyon ve bölgesel rekabet edebilirlik politikalarına etkilerini araştırmaktır. Politika belgeleri, Avrupa İlerleme Raporları ve bilimsel makaleler dahil olmak üzere birincil ve ikincil kaynakların incelenmesini içeren metodolojik bir yaklaşım aracılığıyla bu araştırma, bu politikaların küresel teknolojik değişikliklere nasıl uyum sağladığını ve uluslararası iş birliğindeki zorlukları nasıl ele aldığı değerlendirilerek Türkiye'nin AB çerçeve programlarıyla uyumlaştırılmasını ele alarak her iki bölgedeki bilim ve teknoloji politikalarının ekonomik rekabete ve inovasyona katkılarını tartışılmaktadır. Ayrıca, bilim ve teknoloji politikaları ile sosyo-ekonomik bağlam arasındaki ilişkiyi incelerken, bu politikaların uygulanışını ve sonuçlarını şekillendiren teorik çerçeveleri göz ardı etmemektedir. AB ve Türkiye'deki bilim ve teknoloji stratejilerinin evrimini ve politika yakınsamasının araştırma ve geliştirme ekosistemleri üzerindeki etkisini vurgulamaktadır. Sonuç olarak bu çalışma, politika yapıcılara, araştırmacılara ve ilgili sektör yöneticilerine kapsamlı ve karşılaştırmalı bilgi sağlamayı, gelecekteki bilim ve teknoloji politika oluşturma süreçlerine ve Avrupa Araştırma Alanına

(ERA) ilişkin bilgi sağlayarak bu yönde atılacak adımlara akademik kaynak oluşturmayı amaçlamaktadır.

Anahtar Kelimeler: Avrupa Araştırma Alanı, Çerçeve Programları, Bilim ve Teknoloji Politikası, Politika Uygulaması, Araştırma ve Geliştirme, İnovasyona Dayalı Gelişim

To my family

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LIST OF ABBREVIATIONS

BTYK	The Supreme Council of Science and Technology
COST	European Cooperation in Science and Technology
CREST	The Scientific and Technical Research Committee
DG Research	The Directorate-General for Research and Innovation
EC	European Community
ECSC	European Coal and Steel Community
EIB	European Investment Bank
EIC	European Innovation Council
EIF	European Investment Fund
ERA	European Research Area
ERC	European Research Council
ERRIN	European Regions Research and Innovation Network
ESPRIT	The European Strategic Programme on Research in Information Technology
EU	European Union
EURAB	European Research Area Board
EURATOM	European Atomic Energy Community
FPs	Framework Programmes
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on Research and Development
ICT	Information and Communication Technologies
IPR	Intellectual Property Rights
ISTAG	The Information Society Technologies Advisory Group
IT	Information Technology
JRC	The Joint Research Center
KOSGEB	The Small and Medium Enterprises Development Organization

KVKK	Personal Data Protection Law
METU-MEMS	Middle East Technical University Micro-electro-mechanical Systems Research and Application Centre
MoIT	Ministry of Industry and Technology
NIS	National Innovation System
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
S&T	Science and Technology
SCST/BTYK	The Supreme Council of Science and Technology
SEA	Single European Act
TDZs	Technology Development Zones
TEKMER	The Technology Development Center
TTGV	The Turkish Technology Development Foundation
TTOs	Technology Transfer Offices
UNAM	Bilkent University National Nanotechnology Research Centre

CHAPTER 1

INTRODUCTION

In the era characterized by rapid technological advancements and increasing global interconnectedness, science, and technology(S&T) policies have emerged as a pivotal force in shaping the economic and social landscapes of nations and regions, serving as a crucial driver in national and regional development and profoundly influencing many factors ranging from economic competitiveness to societal well-being (Erdoğan&Canbay, 2016). The European Union (EU) and Türkiye have been at the forefront of developing and implementing these policies, each pursuing unique yet converging paths (Güzel, 2015). The study investigates the convergence in policy-making between Türkiye and the EU during 2000-2020, shedding light on its implications for research and development ecosystems and the broader goal of fostering progress toward an integrated European Research Area (ERA). The analysis is further enriched by utilizing the EU's Progress Reports on Türkiye, providing valuable insights into the dynamic interplay between the EU's expectations and Türkiye's policy adaptations.

Upon reviewing the existing literature, it is evident that there is a notable gap of comprehensive studies that scrutinize Türkiye's contemporary position in the field of science and technology within the context of its EU integration process. Chapter 25, which is on science and research, stands out as one of the most critical chapters for Türkiye in its EU accession process, especially concerning science and technology policies. Under this chapter, there exists a series of policies and reforms that need to be harmonized with the EU. Unlike the delays experienced in other chapters, some progress has been made in science and technology policies under Chapter 25. This thesis will discuss the extent to which Türkiye has converged with or diverged from EU science and technology policies during its accession process. Additionally, the

development and delays in Türkiye's science and technology policies during its EU integration process are of critical importance for the future of its relations with the EU.

The closure of Chapter 25, Science and Research, marks a significant milestone in Türkiye's accession process to the European Union, reflecting the country's adherence to EU standards in the fields of science, technology, and innovation, as well as the progress made in the integration process. This closure can be regarded as an indication of Türkiye's efforts to align its science and research policies with EU norms and standards. Türkiye's advancement in science and technology holds the potential to generate positive impacts in various areas such as economic development, competitiveness, innovation, and employment, while also fostering closer cooperation opportunities between the EU and Türkiye. Therefore, the closure of Chapter 25 serves as a pivotal moment underscoring Türkiye's progress in its EU accession process and the alignment of its S&T policies with EU standards.

Science and technology, transcending their traditional roles as sectors of innovation and discovery, have become indispensable pillars in driving economic growth, furthering social progress, and enhancing international diplomacy (Krugmann, 2009). The policies governing these domains extend beyond the mere advancement of scientific and technological boundaries; they are pivotal in steering the developmental trajectory of nations and regions. Integral to boosting economic competitiveness and ensuring societal well-being, these policies influence a myriad of aspects from societal welfare to addressing global challenges like climate change, health crises, and digital transformation, underscoring their paramount importance in shaping our contemporary world (Krugman et al., 2009). The EU, with its supranational governance structure and its emphasis on collaborative innovation and standardization, provides a model for coordinating regional policies. On the other hand, Türkiye, straddling the East and the West, offers a fascinating case study of a nation seeking to align its national policies with broader, international standards, particularly those of the EU. It also underscores how these strategies are implemented within their unique economic, political, and social frameworks. Additionally, by incorporating insights from the EU's Reports on Türkiye’s Progress,

this study provides a nuanced understanding of how Türkiye's policies evolve in response to external benchmarks and expectations, particularly during the period from 2000 to 2020. This analysis not only reflects the bilateral influences and adaptations, but also sheds light on the broader implications for regional and global S&T policy landscapes. This thesis aims to provide a broad review of S&T policies in the EU and accordingly, in Türkiye and to the extent possible build a bridge to the gap in the literature by comparing the S&T policies of the EU and Türkiye. The research intends to explore the challenges encountered and the achievements made. Additionally, the analysis considers the potential impact of these policies on future economic and technological collaboration between the EU and Türkiye.

The thesis aims to provide a ground for several issues as it will focus on understanding the scope of and how these policies include different topics arising from different economic theories on technology, the landscape of S&T policies within the EU and Türkiye, and the integration efforts of Türkiye towards EU standards. The thesis scrutinizes the policy frameworks, historical developments, strategic transformations, and effects of policies on research and development, as well as economic growth within both regions. From an academic perspective, it contributes significantly to the field of policy analysis, offering a deeper understanding of policy formulation in different geopolitical settings. Practically, the thesis is aimed to serve as a resource for policymakers and stakeholders in Türkiye, providing insights that can lead to the creation of more effective and informed S&T policies. This study can also be used for other countries seeking to align their policies with global standards, emphasizing its significance not only for the regions under scrutiny but also for the global community at large.

The uprising of the digital era has irreversibly transformed the global economic landscape, placing technology at the forefront of development and policymaking (Newman, 2020). Therefore, this thesis starts by delving into the connection between technology policy and economic theory, providing an analysis of varying economic schools of thought classical, neoclassical, and evolutionary, and their perspectives on technology. In connection with this discourse, the thesis continues with understanding National Innovation Systems (NIS) and their pivotal role in shaping

technological advancement and policy across nations. In an increasingly interconnected world, the study of the European Union and Türkiye's S&T policies offers an important perspective on the diverse approaches and challenges in S&T policy formulation and implementation, which makes up the following section of the study.

This research aims to help to understand theoretical economic models in the practical realm of technology policies. Through an analysis of how technology has developed and significantly affected economic frameworks, both locally and globally, it endeavors to provide a nuanced perspective on how theoretical economic principles are translated into technological innovation policies and so economic development. This study aims to fill the existing gap in the literature regarding S&T policies between Türkiye and the EU and shed light on Türkiye's progress in its EU integration process. Thus, it seeks to contribute to policymakers and researchers in enhancing Türkiye's competitiveness in the field of S&T and improving societal welfare.

This thesis also adopts a qualitative research methodology, integrating a thorough analysis of both primary and secondary sources to ensure a comprehensive understanding of the subject topic. The data collection process encompasses an extensive review of policy documents at the global and local level, official reports on national and international organizations, and academic literature, providing a rich and varied perspective. By using this method, the study delves deeply into the complex workings of policy creation, considering various viewpoints and insights.
The thesis is organized into several chapters, each focusing on a different aspect of the S&T policies in the EU and Türkiye. Following this introductory chapter which sets the stage for a detailed examination of the EU's and Türkiye's science and technology policies, Chapter 2 explores the different approaches to technology policy from economic perspectives where Chapter 3 delves into the EU's science and technology policy landscape, while Chapter 4 focuses on Türkiye's policies in this realm. Chapter 5 discusses the alignment of Türkiye with EU standards in science and research, leading to the concluding remarks in Chapter 6.

CHAPTER 2

DIFFERENT APPROACHES TO TECHNOLOGY POLICY

This chapter will examine classical, neoclassical, and evolutionary economics to understand the different approaches to technology policies to make clear and explain the complex links between science, technology, and economic theory. Understanding this relationship is essential as it guides the design of effective policy strategies for fostering innovation and economic growth (Mowery, 1983). A key part of this chapter is the examination of the National Innovation Systems, which are crucial for understanding how technology develops and spreads within countries. This section highlights the importance of a country's economic, socio-cultural, and institutional frameworks in shaping the technology and innovation approaches.

The exploration of classical, neoclassical, and evolutionary economics in the context of technology policy sets a foundational framework as it reveals the multifaceted nature of technology policy, underscored by the diverse economic theories that influence its development and implementation. The relevance of this thesis stems from its critical examination of how these distinct economic theories are manifested in the practical policymaking processes of the EU and Türkiye (Smith & Thomas, 2018). Through this lens, the convergence and divergence in technology policies, reflecting not only the theoretical debates within economic schools of thought, but also the unique socio-economic and institutional contexts of each region, will be elaborated (European Commission, 2021).

Ultimately, this chapter focuses on filling the gap between theoretical economic models and practical policy application, providing a comprehensive insight into the evolution and convergence of S&T policies that will shape the future of the European Union and Türkiye.

2.1. Intersecting Paths: Science, Technology, and Economic Theory

The transition from an industrial society to an information society, where information and knowledge are key, is a big change economic sphere. Altın&Kaya (2009) pointed out that a crucial part of this shift is focusing more on science and technology. For a country to maintain its independence and success, it is really important to not only keep up with new scientific and technological advancements, but also to be able to quickly adapt to these changes. The best way to do this is to boost the country's industries and promote the growth of technology within the country. This means supporting local businesses and encouraging them to innovate and use the latest technology (Altın&Kaya, 2009).

Technological advancements are really important for a country's economy. As Ertek (2005) explains: "When a country has better technology, it can produce more goods and services without needing more resources". This means with the same amount of input, such as materials and labor, a country can have a higher amount of output as the economy grows. As it is known, this growth is measured by the real Gross Domestic Product (GDP), which is the total value of goods/services produced within a country, adjusted for changes in prices over a specific time period. However, for the people in the country to actually live better lives, it is not enough for the economy to just grow. The real GDP needs to grow faster than the population does. This is because if there are more people, but the same amount of goods and services, there will not be enough to go around. That is, to make sure the real GDP grows faster than the population, a country needs to be more productive. To increase productivity, a country needs two main things: better physical resources like machines and buildings and better technology. In this regard, research and development (R&D) helps create new technologies, which can make a country's economy stronger with sustainable productivity. In summary, for a country to keep growing economically and improving the lives of its people, it is really important to focus on developing its own technology and constantly innovate.

Developing technology within a country involves more than just creating new gadgets or software. It also means changing and improving the technology that

already exists. Experts in both old and new economic theories agree that changing technology is key for a country to keep making more money per person and for the economy to grow (Lee et al., 1988). Özgüler (2003) points out that the United States is a great example of this as the U.S. has become wealthy largely because of its strong focus on creating new knowledge and its serious commitment to research and development (R&D), which includes efforts by both individuals and companies. In simple terms, having good technology policies and constantly developing new technology is important for a country's economy to grow and for its people to become more prosperous (Özgüler, 2003).

In this context, the intersection of science, technology, and economic theory becomes a critical field of exploration. By analyzing how scientific advancements fuel technological innovation, and in turn, how these innovations shape economic landscapes, insights could be gained into the cyclical relationship between these domains (Arthur, 2010). Economic theory provides a framework for understanding the allocation of resources, the scale of production, and the distribution of goods and services within a market. When infused with the dynamics of technological advancements, these theories evolve to address the changing nature of economies in the digital age. For instance, the concept of creative destruction, introduced by Joseph Schumpeter (1976), highlights how technological innovation can render existing products, processes, and even entire industries obsolete, paving the way for new economic growth and development. Moreover, it is crucial to recognize the significant impact of government policies on shaping the path of technological innovation. Through instruments such as subsidies, tax incentives, and direct funding of research and development, governments can significantly influence the direction and pace of technological progress (Mazzucato, 2015). This interplay between policy and technology not only determines the competitive advantage of nations, but also addresses societal challenges such as health care and inequality.

In conclusion, the intersection of science, technology, and economic theory constitutes a pivotal arena of study. This symbiotic relationship underscores the importance of proactive technology policies and government interventions in fostering sustainable economic development and addressing societal challenges, ultimately shaping the trajectory of nations in the digital age.

2.2. Technology Perspectives in Classical Economics

Before Adam Smith, economists did not focus much on technology, but Adam Smith was one of the first to look at technology in a scientific term. During his time, there were lots of new inventions and big technological changes (Pavitt, 1998). These new technologies led to more productivity and profits in various industries, making things more efficient and increasing the amount of goods produced. Adam Smith (1776) showed that a big reason for this increase in productivity was the division of labor, which means breaking down work into smaller, specialized tasks. This made the production process much more efficient. In his view, technology was a natural part of the production process as well. He noted that advanced machinery and new inventions had a big positive impact on making labor more productive.

David Ricardo on the other hand, believed that the main thing that makes an economy grow is investment. According to him, when people or companies invest money, it helps the economy get bigger and stronger. This is especially true in situations where there is full employment and when the market is very competitive (perfect competition). In Ricardo's view (1817), investments are really important because they not only make the economy grow, but also start a lot of other economic activities. This pushes the whole economy to develop more. He thought that in a world where nearly everyone has a job and where businesses compete fiercely, technological innovations would naturally happen. This competition drives companies to innovate to stay ahead. However, Ricardo (1817) did not go into great detail about how technology directly impacts economic growth. While he recognized that investments and competition are crucial for the economy to expand, he did not explore in depth how technological progress is linked to this growth. He saw that technology was part of the process but did not analyze exactly how it fits into the bigger picture of economic growth.

Karl Marx had a different focus compared to other economists when it came to technology. He was not primarily interested in how technological innovations directly cause economic growth. Instead, Marx (1885) was more concerned with the concept of surplus value, which comes from labor. He claimed that employers

considered labor as the main source of wealth and was interested in understanding how labor could be exploited more to increase this surplus value. For Marx (1885), introducing new technology served two main purposes. First, it helped increase the rate at which workers could be exploited. This means that with new technology, employers could get more value from their workers' labor. Second, Marx considered new technology as a natural part of a company's internal development in a competitive environment. In his view, the drive to compete leads to the development of new technologies. Marx believed that new technology played an active role in making the exploitation of workers more intense. This happens within a competitive setting and also drives the internal growth of a business or industry. Hence, in Marx's perspective, new technology both increased the exploitation of labor and was a consequence of the need to stay competitive in the market.

Alfred Marshall highlighted the growing importance of labor in production as economies develop. In simple terms, Marshall (1890) observed that as economies grow and evolve, the work people do become increasingly important in making and selling goods and services. Marshall also believed that technology, which keeps improving as development continues, does more than just help us control our environment. He thought that technological advances could significantly make change our lives in many positive ways, making things more convenient and comfortable for society. However, while Marshall recognized the big impact of technology and its potential on society at the micro level, he did not provide a detailed theory to investigate the deep connection between technological developments and overall economic growth.

Classical economists, who studied how economies grow, had a specific view about the increase in a country's real GDP, according to Yıldırım, Bakırtaş, and Yılmaz (2006), these economists thought that when the real GDP per worker rises above a basic living level, it triggers rapid population growth, which then brings it back down to that basic level again. As Yıldırım (2006) mentions, the classical economists believed that even if there is some growth due to better technology and higher real wages, this increase is only temporary. Eventually, things will go back to the minimum level of wages. This happens because as more people enter the workforce,

the average productivity of labor goes down, leading to a decrease in wages. Hence, in their view, any growth in real GDP per worker is only short term and will eventually stabilize at a basic subsistence level (Yıldırım&Bakırtaş&Yılmaz, 2006). The views of Adam Smith had reflections on many jurisdictions at different time intervals and had many followers also among scholars in Türkiye. Ildırar for example in 2016, focused on a strong link between technological advancements and increased labor productivity. Smith's theories highlight the crucial role of technology in improving how efficiently people work and contributing to economic growth (Ildırar, 2016).

Gürak on the other hand noted that Marshall did not fully explain how technological changes relate to broader economic patterns. Hence, there is room for more research and studies in this area. Future researchers have the opportunity to delve into the complex ways in which technology and economic growth are connected, adding to our understanding of both economics studies and technology studies (Gürak, 2004).

2.3. Technology Perspectives in Neoclassical Economic Theory

Neoclassical economics, a popular approach in the field of economics provides a specific way of looking at technology and its role in the process of producing goods and services. In the 1950s, Robert Solow developed a theory called the neoclassical growth theory.

In the Solow growth model, the increase in both the amount of capital and the overall production of goods and services happens at a rate that matches the growth of the population and the improvement in technology (Solow, 1957). Similarly, Freeman and Soete (2012) explain that if either the population stops growing or technological advancements stop happening, economic growth will slow down. This slowdown is due to what's called the "diminishing returns of capital". Basically, just adding more capital does not keep increasing production at the same rate forever. The Solow model tells us that better technology makes companies more efficient and helps them make more money. When companies use new technology well, they tend to invest more and therefore earn more (Freeman& Soete, 2004). The model points out that

economic growth mostly comes from these technological advancements. However, an interesting aspect of this model is that it does not really explain how or why technology has this role in economic growth. According to Freeman and Soete (2004), until we better understand what drives technological progress, this aspect of economic growth in the Solow model is considered to be external or coming from outside the main factors of the economy.

The neoclassical model provides insights into how countries' economies might evolve relative to each other. Specifically, it suggests a concept called "convergence" (Solow, 1956). This means that if two countries are experiencing the same population growth and are utilizing identical business practices and production methods, over time, they should achieve similar economic standings or incomes. According to this concept, the reason some countries are economically behind is that they have less capital to invest and develop. However, there is a silver lining: if these poorer nations can adopt the savings habits of their wealthier counterparts and also integrate the same advanced technologies into their systems, they stand a good chance of catching up and matching the economic levels of those more developed countries in the long run (Fischer, 1998).

The transition from traditional neoclassical economics to the perspectives offered by evolutionary economics marks a pivotal shift in understanding economic growth and technological change. Traditional models, with their treatment of technology as an exogenous, uniformly affecting factor, fail to capture the complexities and dynamics of technological innovation and diffusion. In stark contrast, evolutionary economics embeds technology deeply within the economic fabric, viewing it as an endogenous outcome shaped by a myriad of factors including firm strategies, institutional support, and investment in human capital. This approach acknowledges the diversity in technological capabilities across nations and firms, highlighting the crucial role of tailored policies in fostering innovation ecosystems. By differentiating between types of capital and recognizing the unique pathways of development each economy undertakes, evolutionary economics advocates for a nuanced, context-sensitive approach to economic policy. This perspective not only challenges the one-size-fits-all approach of neoclassical models, but also underscores the importance of

innovation-focused policies, capability building, and customized development strategies in achieving sustainable economic growth in the face of technological change (Nelson&Winter, 1985).

According to this view, technological advancements are seen as changes in the factors that determine how goods and services are produced. (Kökocak in 2001). In other words, these advancements are like updates or new data that are important for both individual companies and the entire economy. In neoclassical economics, there is a particular perspective on technology that includes several interesting points. First, the origin of technology is something of a mystery in this model; it does not really explain where technology comes from. Second, this approach suggests that there are no inherent costs associated with obtaining or using technology. This means that, in theory, businesses can access and implement new technology without worrying about the expense. Third, in the neoclassical view, there is no need for time to be spent in acquiring and implementing technology; it is as if businesses can use new technologies instantly. Also, this model suggests that businesses do not compete based on their use or adoption of technology, which is quite different from many real-world scenarios where technology is not a factor in production that finishes at the end. Finally, an essential aspect of this perspective is the idea that technology does not get used up. No matter how much it is used, it is always available and does not diminish, which is a stark contrast to physical resources that can deplete over time.

Narin in 1999, which stated that that companies have many different methods to produce their goods and services. In this view, as explained by Ansal in 2004, technological advancement is seen as the ability to have the same product using less input, like materials or labor. This improvement is often thought to come from outside the economy, meaning it is not something that businesses or the economy itself directly control. A key point in this neoclassical perspective is that it does not really look at how technology has changed over time and how this change is connected to economic growth. In other words, it does not focus much on the history of technology and how that history is intertwined with the way economies develop and grow.

In Kökocak'sresearch (2001), several assumptions about technology in the realm of neoclassical economics are presented. The first assumption is that technology is seen as a static factor in the production process in the short run, with changes in technology expected only in the medium to long run, implying that businesses do not expect to rapidly change or update their technology initially. The second point brings up the uncertainty around whether technology should be considered an external factor to an economy or business. Thirdly, Kökocak suggests that technology is something that can be easily shared from one company to another, is understandable by everyone, and can be duplicated, meaning that any business can adopt new technology, understand it, and reproduce it without much difficulty. Lastly, the research implies that very recent technological innovations can be acquired by any firm without any cost, making the latest advancements freely available to all businesses. This perspective essentially views technology as a universally accessible and easily transferable resource in the business world (Kökocak, 2001).

According to Yıldırım, Bakırtaş, and Yılmaz in 2006, neoclassical theory explains how economies grow. The increase in a country's real GDP per worker is mainly because of how technology changes and affects savings and investments. This results in more capital like money, buildings, and machinery for each worker. The theory also states that economic growth will only stop if technological advancements stop. It suggests that these advancements happen on their own and are not directly caused by the main factors of the economy. In other words, technological changes are seen as something that just happens from outside the economy.

Parasız in 2000 elaborates that technological changes can really drive economic growth. However, the growth of the economy does not influence the development or direction of technology. Technology evolves mostly by chance. If conditions are right, technological progress can happen quickly, but without these conditions, it might slow down. The direction of technological change is something that we can not really control or predict. Hence, in Parasız's view, technology is like an independent force that can boost the economy but is not directly influenced by economic activities (Parasız, 2000). Solow (1957) introduces the idea that technological progress is a key factor for stimulating economic growth, separate from increases in labor and capital. The model proposes that technological

innovation is the key factor in long-term increases in income and output, after accounting for the diminishing returns of capital and labor.

To sum up, the premises of neoclassical economic theory have significantly shaped economic policies and research by focusing on how investments in technology can enhance productivity and growth.

2.4. Technology Perspectives in Evolutionary Economic Theory

Evolutionary economics is a theory that suggests economic processes change over time and are influenced by both individual actions and society. This idea was first introduced by Thorstein Veblen (1899), an American economist and sociologist. Unlike traditional economics, which relies heavily on the rational choice theory, evolutionary economics emphasizes that psychological factors play a significant role in driving economic behaviors. It sees the economy as dynamic and constantly evolving, rather than always striving for a stable equilibrium. One key idea in evolutionary economics is that failure is not necessarily a bad thing. In fact, many evolutionary economists believe that failure is just as important as success because it can pave the way for economic progress and prosperity (Hodgson, 1998).

In the realm of evolutionary economics, a key emphasis is placed on the learning and comprehension capabilities of economic agents. The term 'bounded-rational' is introduced to literacy through evolutionary economics (Simon, 1955). “Bounded-rational” is about how people make decisions in economics, especially when things are always changing. It says that people cannot always make perfect decisions because they have limits on how much they know and how smart they are. In modern economies, people have to figure out how to deal with new situations, and this can be challenging. Innovation, which means coming up with new ideas, is a smart thing to do, but it is not always easy because people have limits in what they know and can do. Hence, it underscores that while innovation is a rational pursuit, it is subject to the constraints of bounded rationality that characterize economic actors. This complexity not only complicates technology transfer, but also increases research costs (Nelson&Winter, 1985). As a result, financing technological innovations

becomes inherently challenging, emphasizing the unpredictable nature of technological growth and its various influencing factors (Nelson&Winter, 1985).

In evolutionary economics, scholars agree that decision-making often transcends pure logic, embracing real-world insights and ongoing learning over mere theoretical constructs. This field advocates for a behavioral approach that emphasizes experience and adaptive learning (Nelson, 1987). Businesses balance their historical insights with industry trends to inform decisions, constrained by both internal and external factors. These limitations sometimes hinder the full exploitation of new opportunities as businesses cope with changing market and technology landscapes (Soyak, 1996). Nevertheless, businesses are in a constant cycle of learning and evolution. Instead of merely aiming for maximal profit or efficiency, the primary objective is to strengthen innovation capacities and refine technological performance, ensuring they maintain adaptability and significance in the face of market changes (Metcalfe, 1995).

Dosi's (2002) work contributes significantly to understanding how companies learn, adapt, and grow, emphasizing the role of technology as both a driver and an outcome of evolutionary economic processes. His research highlights the importance of both local and cumulative learning processes in fostering innovation. For example, a company trying to build something new, like a gadget or service does not start from scratch, but they often try to understand the technology used in similar products or methods that already exist. This is what experts call "local" learning because companies are using local, or nearby, examples as a starting point. Then there's the "cumulative" aspect, in which every new idea or product, is built upon the layers that came before it. Hence, a company's current projects often benefit from the accumulated knowledge and experience of its past projects (Dosi et al., 2002).

Another important concept to evaluate evolutionary theory is "path dependence.". It is the idea that small decisions or events from a company's early days can have tremendous effects in the future. In business terms, an early advantage, like a unique feature in a product, or even random events, like an unexpected meeting with an investor, can shape a company's entire future. In other words, companies' actions,

decisions, and growth are influenced by what's around them, their past experiences, and even luck. This approach in evolutionary economics helps us understand that businesses are complex, always growing and adapting based on a mix of history, present challenges, and random events.

Austrian economist Joseph Schumpeter had a big influence on evolutionary economics. He had this idea called "creative destruction" which explained how capitalism works (Schumpeter, 1976). According to Schumpeter (1976), entrepreneurs, which are people who start new businesses and come up with new ideas destroying the old ones, and pushing the economy to grow. Hence, Schumpeter believed that capitalism keeps progressing because of these entrepreneurs and their ideas. And the economy goes through ups and downs as these businesses compete to make things better for everyone (Schumpeter, 1976).

In economics, historical factors come from the unique mix of technology, rules, and politics in each country. Every country starts with its own conditions, which can give them advantages or disadvantages when it comes to developing their economy. Evolutionary economists pay attention to big innovations like Schumpeter talked about, which can completely change things, but they also focus on smaller, gradual improvements in technology that build on these big changes (Dosi, 2002). They believe that today's technology builds on what we had in the past, and the technology of the future will come from what we are doing now. Hence, evolutionary economists think that historical factors, both big and small, shape how economies grow and develop over time.

On the other hand, in evolutionary economics, achieving economic growth is more complicated than it may seem depending on several interconnected elements evolving together. These elements include technological advancements, how companies are organized and their strategies, and the overall structure of entire industries (Hodgson, 1996). This simultaneous evolution of these three components is referred to in the following studies as well, and it is called 'coevolution' (Nelson, 1987). However, this coevolution does not happen on its own and, requires the support of institutions that not only encourage economic growth, but also enable

everything to work together smoothly. Firstly, universities play a significant role in this network by conducting depth research and providing a strong foundation of knowledge. Government agencies are also important because they are explicitly designed to push the boundaries of technology. Then, there are companies themselves, actively involved in creating new technological ideas and applying them in their day-to-day operations (Soyak, 1995). Hence, achieving economic growth in evolutionary economics involves the coevolution of technology, company strategies, and industry structures, all supported by institutions like universities, government agencies, and firms working together to advance technology and drive economic progress.

In the realm of evolutionary economics, there is a particular focus on companies that do not just experiment with new technologies, but actively invest in developing them. According to Taymaz (2001), these companies take these innovations and incorporate them into their products and services. Unlike the more isolated entities that could be seen in traditional neoclassical economic theories, these forward-thinking companies are always engaged in dialogue and collaboration with research institutions and government agencies. In other words, in evolutionary economics, companies that actively invest in new technologies work together with research institutions and government agencies to advance and share their knowledge. This collaborative environment is not solely driven by market forces either. There are mechanisms outside of the traditional marketplace that significantly influence this interactive exchange of knowledge and progress. When trying to understand the complexities of technological advancement, evolutionary economists take a holistic, systemic approach, considering all these interconnected factors (Taymaz, 2001).

2.5. The Dynamics of National Innovation Systems

The concept of the National Innovation System (NIS) marks a seminal development in the field of economics, bridging the gap between technological innovation and economic theory. Initially put forward by pioneers such as Christopher Freeman and Bengt-Åke Lundvall in the late 1980s, NIS has since emerged as a cornerstone for understanding how countries foster and sustain technological advancement and

economic growth. Rooted in the principles of evolutionary economics, NIS emphasizes the critical role of systemic interactions among various actors, including government institutions, private sector entities, and academic and research institutions, in nurturing an environment conducive to innovation (Freeman, 1987). This chapter evaluates the foundational aspects of NIS, tracing its historical origins, theoretical underpinnings, and the dynamic interaction between government and businesses that characterizes the NIS framework. Through exploring the contributions of key scholars to the development of the concept, it aims to provide a comprehensive overview of NIS and its significance in shaping contemporary economic landscapes.

The NIS is imperative to delve into the complex ecosystem that characterizes NIS within a country. The Organization for Economic Co-operation and Development (OECD) in its 1998 publication describes a comprehensive categorization of the institutions that form the backbone of NIS. Leading the way in innovation are the organizations, both public and private, that are actively involved in researching and developing new ideas and technologies. Their efforts are bolstered by a network of dedicated research entities, encompassing both formal research institutions and the wider scientific community, alongside entities oriented towards supporting innovation. Financial institutions play a significant role by providing the necessary capital for innovative projects, thus fueling the engine of technological advancement. Moreover, a specialized bloc of institutions is tasked with the formulation, implementation, and assessment of policies concerning innovation and technology. This framework is essential for the governance of the innovation system, ensuring that the NIS operates within a conducive regulatory environment that fosters growth and facilitates the diffusion of technology (Freeman,1987). Together, these components constitute a dynamic ecosystem that is pivotal in shaping the trajectory of innovation and the dissemination of technological advancements across the economy.

Evolutionary economics urges an investigation beyond the structural boundaries of the National Innovation System, encouraging a closer look at the diverse influences that shape its functionality and ultimate success. This approach avoids focusing

narrowly on single entities and instead takes a broader view of all the factors involved. It scrutinizes not just the organizations, but also the broader economic policies and regulations crafted by governments and international entities. The pivotal role of education is acknowledged, underlining how the nature and quality of educational systems are instrumental in cultivating a culture of innovation and progress (Lundvall, 1998). In addition, communication networks are recognized for their critical importance in facilitating the exchange and proliferation of ideas, thus enhancing the efficacy of institutions. The market dynamics surrounding the sale and competitiveness of products are analyzed to understand their impact on innovation. Moreover, evolutionary economics takes the pulse of both job and financial markets, acknowledging that these sectors' conditions can significantly influence the support or constraints on institutional growth (Nelson, 1987). By weaving these elements into a cohesive narrative, evolutionary economics offers a nuanced and comprehensive panorama of the environment within which institutions navigate, highlighting the myriad of external factors that contribute to their evolution and effectiveness in fostering innovation.

In the digital age, people are overwhelmed with a vast amount of information and have numerous means of communication available. This makes frameworks like the National Innovation System (NIS) extremely important to help manage and use this abundance of information wisely. A notable trend is the increasing linkage between scientific research and the creation of innovative products (Melcalfe, 1995). For instance, within the U.S., the origination of novel inventions frequently derives from the foundations of academic research. This phenomenon was clarified by Metcalfe's pioneering investigation in 1995. This evolution exemplifies the crucial role that systems like NIS play in ensuring that research and product development are synchronized, thereby optimizing the outcomes of innovation efforts.

In the rapidly evolving landscape of scientific and technological advancements, there is a marked shift in the nature and application of knowledge (Arthur, 2010). This shifting landscape stresses the significance of 'generic technologies', the technologies with broad applicability across numerous sectors, marking a transition from specialized, sector-specific innovations to those with universal applicability.

Simultaneously, the inherently complex nature of contemporary innovation demands an interdisciplinary methodology. Knowledge, previously compartmentalized within distinct disciplines, is now amalgamated across a wide array of fields (Gibbons et all, 1994). This trend is particularly evident in the realm of product development, where contemporary products are increasingly the confluence of expertise from varied technological specializations. Eventually, such an integrative approach underscores the essence of collaboration and cross-disciplinary fusion in driving the next frontier of innovation.

In contemporary business ecosystems, firms confront the inherent challenge of maximizing their innovations using solely their internal resources. This limitation is highlighted by the distinct nature of information, which often lacks the properties of excludability and rivalry, making it challenging for firms to retain exclusive rights to their innovations (Arrow, 1972). Moreover, the intrinsic value of tacit knowledge, deeply rooted in personal experiences and often difficult to articulate, adds another layer of difficulty. These characteristics underscore the limitations of conventional market mechanisms in efficiently employing and monetizing innovation. Consequently, there is an escalating focus on alternative, non-market strategies. Therefore, partnerships, collaborations, and open innovation platforms are increasingly recognized as more suitable approaches to navigating these intricacies, facilitating a more inclusive and expansive innovation process (Chesbrough, 2003).

In the rapidly changing modern era, characterized by continuous technological advancements, the idea of a "learning economy" is becoming more relevant. This theoretical construct, as proposed by Lundvall (1998), posits that the attainment of success hinges not merely on one's knowledge base, but also on the agility and efficacy with which one can adapt and assimilate new information. In essence, the central goal of NIS is to effectively manage the continuous cycle of acquiring new knowledge and abandoning outdated concepts and ideas. However, adapting and changing these large-scale innovation systems is not a swift task. As Lundvall (1998) points out, making foundational changes to regional or national innovation practices can take decades, not just years. This underscores the intrinsic challenges in

revitalizing and modernizing these systems, notwithstanding the persistent necessity for adaptability.

In the domain of evolutionary economics, S&T policies emerge as critical instruments (Lundvall & Borrás, 2005). These policies are strategically crafted to cultivate NIS, ranging from individuals and businesses to broader institutions (Edquist, 1998). This interconnectedness is essential for sparking innovation and propelling national development forward. Moreover, S&T policies endeavor not just to establish, but also to expedite the evolution of these innovation ecosystems, thereby enabling nations to navigate and prosper in the ever-shifting global economic landscape swiftly. However, the implementation of S&T policies is not without its challenges. Issues such as the potential for resource misallocation, difficulties in gauging policy impact, and the risk of engendering government support dependency emerge. Despite these hurdles, there are examples of success where strategic S&T policy deployment has significantly bolstered NIS. For instance, countries like South Korea and Finland have demonstrated remarkable economic transformations, underpinned by targeted S&T initiatives that fostered robust innovation ecosystems (Freeman, 1987). These policies have included comprehensive R&D tax incentives, direct innovation project financing, and the establishment of conducive environments like technology parks. These measures have not only accelerated the maturation of their national innovation systems but have also showcased the critical balance between policy-driven support and the cultivation of a self-sustaining innovation culture.

This nuanced approach underscores the complexity of fostering innovation through S&T policies within the framework of evolutionary economics. It highlights the necessity for policies that are both forward-looking and adaptable, capable of overcoming the inherent challenges in building resilient and dynamic NIS.

2.6. Policy Tools for Science and Technology

In the changing world of new inventions, it is very important to use the right strategies to help science and technology grow and this means creating a good

environment for research, making new innovations, and improving technology. Governments and policymakers have many ways to help S&T grow (Mazzucato, 2015). They provide monetary support like incentives, grants, and tax cuts, and render legislation that protects new ideas and helps share technology. These endeavors are key to progress in S&T with the help of policymakers. These kinds of policy developments also help the competitiveness in the world market globally (Rogers, 2003). This part of the thesis mentions the different ways policymakers can help S&T. It explains how these methods work, how they are used, and the effects they have on a country's ability to make new things. This is important for making the economy stronger and improving the quality of life for people (Hall&Rosenberg, 2010). This section wraps up the chapter by introducing "policy tools," which are essential instruments used by decision-makers to guide the progress and direction of S&T within a country.

In the field of S&T, certain key policies stand out for their importance. The foundation of any technologically progressive nation rests on a solid commitment to basic research and education. This commitment forms the basis for increased activities in research and development (R&D), which enhance a country's intensity in R&D and its ability to make significant breakthroughs (Burke et al., 2022). At the same time, it is important to ensure that the benefits of these technological advancements are shared widely, allowing all stakeholders in the system to gain from them. However, the economic success of these innovations is also critical. Therefore, without clear market demand, industries might hesitate to invest in new technologies. Further strengthening a nation's position in technology, the development of high-tech companies is vital, as the OECD (2023) reports have pointed out, making the country not only a hub of innovation, but also a leader in certain technological fields. Finally, given the ever-changing nature of science and technology, it is essential to regularly review and update policies. This approach, grounded in the principles of evolutionary economics, guarantees that policies remain flexible and evolve in response to adapting to evolving conditions.

In the evolving landscape of S&T policy, a variety of instrumental tools play pivotal roles in facilitating policy implementation. Central to this framework are legislative

and institutional regulations, such as intellectual property rights and competition laws, which create a protective and structured environment conducive to innovation. Additionally, strategic procurement policies, especially prevalent in sectors like defense, underscore how targeted purchasing can propel technological advancements. The contribution of public research institutions and universities is also indispensable, often pioneering in areas of basic research that the private sector may deem risky. To mitigate this risk and encourage the involvement of the private sector in R&D, mechanisms such as tax incentives and grants are vital, incentivizing companies to pursue research initiatives. Furthermore, the establishment of techno-parks and incubators provides an essential ecosystem for startups and high-tech companies to thrive, fostering innovation and collaboration. Orchestrating these efforts through coordinated R&D activities is crucial to ensure that research endeavors are aligned with national technological priorities, optimizing resource utilization and strategic direction (Flanagan et al., 2011).

In the context of Türkiye's evolving S&T policy landscape, the advent of Industry 4.0 presents both significant challenges and unique opportunities. Erdil and Ertekin Bolelli (2017) critically examine the impact of the advanced technologies that arose with Industry 4.0 on the Turkish National Innovation System, highlighting the pressing need for strategic policy tools to navigate the complexities of the Fourth Industrial Revolution. Their analysis underscores the importance of enhancing Türkiye’s innovation capacity and infrastructure to harness the potential of digital transformation. This involves not only adapting existing policy tools, but also introducing novel mechanisms that can effectively respond to the demands of Industry 4.0, such as supporting digital skills development, fostering public-private partnerships in tech innovation, and incentivizing research in cutting-edge technologies. The insights from their study suggest that a proactive and dynamic approach to policy formulation and implementation is essential for Türkiye to capitalize on Industry 4.0, positioning the nation at the forefront of technological progress and economic competitiveness (Erdil&Bollelli, 2017).

When implementing policies in the realm of science and technology, it is crucial to focus on two main areas for effective decision-making. Firstly, understanding the

stage of technological development that the policy aims to support is essential, as different stages of technology development require distinct strategies. Identifying the correct stage is key to designing effective policies (Rogers, 2003). Secondly, it is important to clearly define the technological challenges that the policy intends to address, ensuring that the policy efforts are focused and impactful (Mowery, 1983). This research will closely examine the S&T Policies of Türkiye to see how well they align with these important areas Additionally, it will look at significant policy tools mentioned in other parts of this thesis, such as The European Strategic Programme on Research in Information Technology, European Cooperation in Science and Technology, European Research Coordination Agency, and the Framework Programs. These tools play a major role in shaping the EU's approach to science and technology (COST, 2020). The study will also evaluate the influence of the Development Plan's focus on venture capital in promoting high-tech startups.

Following the framework suggested by Borrás and Edquist (2013), this analysis will explore a variety of tools used in S&T policy. These tools include fiscal and monetary incentives, regulatory measures, and informal mechanisms. They represent a broad range of interventions, from direct economic incentives to softer, more informal approaches. This comprehensive look at the tools available to policymakers highlights the multifaceted strategies needed to support specific socio-economic goals within the science and technology sectors.

In conclusion, it is pivotal that the policy tools steer the trajectory of innovation and technological advancement. In the next chapters, how policy instruments, from fiscal incentives to the establishment of techno-parks, highlight a unified dedication to fostering innovation environments that can keep pace with the swift advancements in technology in the EU and Türkiye will be evaluated. By emphasizing the strategic employment of policy tools to meet specific socio-economic objectives, this chapter deepened the understanding of the complex S&T policy landscape. Subsequent chapters will delve further into the themes introduced here, exploring how the EU and Türkiye continue to navigate these integrated pathways in the face of new technological challenges and the global innovation landscape.

2.7. Concluding Remarks

In this chapter, the intersection of economics, technology, and innovation was delved into. In this way, it provided a trip through the history of economic theories and their views on how innovation happens, as well as the policymaking process in technology policy. It was not just to explain how technology has evolved over time, but also to dig deep into how different economic theories and technological paths come together. In this thesis, the primary objective is to comprehend Türkiye's science and technology policy within the framework of the EU integration process between 2000 and 2020. The thesis endeavors to explore the extent to which Türkiye has aligned or deviated from the EU concerning S&T policy throughout the integration journey, in other words, the current status of policy convergence in S&T policy is examined. Therefore, it is important to examine how economic theories, innovation models, and policies interact in order to address this question. Within this context, I contend that the S&T policies of both the EU and Türkiye can be assessed through the lens of the National Innovation System (NIS), which helps us understand how innovation functions within countries.

To summarize, classical economics highlights technological progress as a key driver of productivity and profit. Moving forward, neoclassical economics adds depth by exploring how economic growth, population dynamics, and technological innovation interact. However, it is within the framework of evolutionary economics that the deepest insights are provided. Here, innovation is seen as a cumulative process influenced by adaptive learning and historical factors. Building on these theoretical foundations, the focus shifts to the practical realm where policy intersects with technological progress. This is where the concept of the National Innovation System (NIS) becomes crucial. It sheds light on the systemic dynamics driving innovation ecosystems within both the EU and Türkiye. Through this framework, the aim is to analyze how policies in science, technology, and innovation converge between the EU and Türkiye, covering both the similarities and differences that shape their innovation landscapes.

By closely examining the S&T policies of both the EU and Türkiye, evaluating the similarities and differences in their policy approaches is crucial for gaining a better

understanding of their impact on the future of innovation. In the next chapter, the focus will be on conducting these analyses and comparisons. This transition to practical application will allow us to move from the theoretical framework discussed in the previous chapter to its real-world implementation.

CHAPTER 3

EUROPEAN UNION SCIENCE AND TECHNOLOGY POLICY LANDSCAPE

The science and technology policies of the European Union (EU) which help drive innovation, and competitiveness, and tackle the challenges of rapid technological changes (Köseoğlu&Erdem, 2016) are crucial not only for the EU economy but also for its global standing. This chapter aims to provide an overview of these policies, examining their historical evolution, current status, and future directions.

In the realm of digital innovation and regulation, the EU exercises significant global influence through what is known as the "Brussels Effect" (Bradford, 2012). This phenomenon refers to the EU's ability to set standards that are adopted worldwide. As evaluated by Aşçıoğlu Öz in 2023, this influence extends to countries outside the EU, such as Türkiye, which, despite not being a member, aligns its policies with EU standards. The EU's regulatory initiatives like Horizon Europe and the Digital Single Market Strategy aim to foster innovation while upholding fundamental rights and democratic values. This alignment facilitates cooperation and harmonization, enhancing integration into the global science and technology landscape. Compared to China and the US, the EU, which operates as a technology importer, asserts its claim to global influence in managing the digital economy. Amidst the competition between the US's technoliberalism and China's digital authoritarianism, the EU's strong commitment to law and democracy positions it as a leader in shaping digital governance and legal standards (Aşçıoğlu Öz, 2023). Thus, the EU plays a pivotal role in shaping the global digital economy and ensuring the protection of basic rights and freedoms.

The chapter proceeds by examining the historical background of the EU science and technology policies, starting from the post-World War II era and highlighting key

developments such as the establishment of EURATOM and the ECSC. It then critically evaluates the EU's unified approach to innovation, particularly under the Lisbon Strategy, and assesses its success in connecting research to marketable innovations. Furthermore, the chapter explores how Türkiye's science and technology policy could be influenced by the EU's policies, considering Türkiye's unique geopolitical and economic position. This relationship is crucial for Türkiye's alignment with EU standards, which has significant implications for its research and development, innovation capacity, and global competitiveness. The synergies and challenges of harmonizing Turkish policies with EU standards are discussed, alongside the implications for Türkiye's EU membership aspirations and its role in the global technology landscape. Overall, this part of the thesis provides a structured examination of the EU's science and technology strategy, laying the groundwork for understanding Türkiye's alignment with these policies. By focusing on the EU's approach to science and technology and its broader impact, the chapter serves as a valuable resource for countries like Türkiye seeking to enhance their technological and economic standing on the global stage.

3.1. Establishment and Evolution of EU Research Policies

Following World War II, the EU prioritized scientific research as a cornerstone of its strategic plan to rebuild economies and stand up to the economic prowess of the United States. A notable early effort was the founding of the European Coal and Steel Community (ECSC) through the 1951 Treaty of Paris. This initiative underscored the importance of coal and steel, key wartime industries, in the region's recovery and integration processes. By removing trade barriers and encouraging a free market for these crucial sectors, the ECSC laid the groundwork for economic renewal and set a precedent for cooperation that would later underpin the EU's approach to research and innovation. This period marks the commencement of a concerted effort to combine research strengths, embodying a theme that has persisted in the development of the EU's research policies (Urwin, 2014).

The Treaty of Rome, signed in 1957, encompasses key articles aimed at fostering European integration and cooperation. Articles 1, 2, and 4 lay the groundwork for the

establishment of the European Economic Community (EEC) and the European Atomic Energy Community (EURATOM), with the overarching goal of promoting economic cooperation and integration among European countries. Article 1 sets forth the objectives of creating a common market and promoting economic growth and employment, while Article 2 outlines the principles of a customs union and the elimination of trade barriers among member states. Additionally, Article 4 emphasizes the importance of strengthening the international role of Europe, particularly in contributing to peace and prosperity. These articles reflect the foundational aspirations of the Treaty of Rome, which sought to build a united Europe based on economic cooperation, shared values, and global engagement.

The introduction of EURATOM in 1958 was a turning point in European scientific cooperation, building on the groundwork of the Treaty of Paris. Despite individual nations having their research agendas and strong foundations in science and industry, they faced several challenges, including disparities in research capabilities, redundant research efforts, and the inefficiencies of working in isolation. These issues underscored the necessity for a unified research framework. EURATOM emerged as a response, aiming to enhance collective capabilities, especially in atomic energy (Borrás, 2001). It pioneered intergovernmental research collaboration, facilitated the exchange of research and technical knowledge, and established the Joint Nuclear Research Centre, symbolizing the cooperative spirit that would define Europe's future research initiatives.

However, it was not until the 1970s that the EU explicitly recognized the significant role of Research and Development (R&D) within its broader industrial strategy, driven by the rapid industrial growth of Japan, which had successfully integrated S&T policy to enhance its technological capabilities and competitiveness. Similarly, the technological and economic power of the United States underscored the need for a collective European response. In this regard, the EU sought to consolidate its scientific and technological resources, aiming to create a more interconnected and technologically advanced community capable of competing globally (Pavitt, 1998)

The 1970s marked a significant shift towards scientific collaboration within the EU, exemplified by the establishment of the European Cooperation in Science and

Technology (COST) in 1971. As Guzetti (1995) mentions, COST served as a platform for coordinating nationally-funded research across Europe. This era also witnessed efforts to develop a unified R&D policy, highlighted by the 1972 Paris Summit agreement on integrating S&T initiatives (Guzetti, 1995). The European Council's 1974 resolution further emphasized the importance of an EU-wide R&D policy (Banchoff, 2002). Moreover, according to Caracostas and Muldur (2001), the establishment of the Directorate General for Research, Science and Education and the advisory group, the Scientific and Technical Research Committee (CREST), marked steps towards improving policy coordination. However, these efforts faced challenges due to the economic downturns experienced in the mid-1970s, notably the oil crisis, which hindered the progress toward comprehensive EU policy harmonization.

3.1.1. Advancements and Challenges in EU Research Policies

In the mid-1980s, the EU marked a significant milestone in its journey toward a unified research and innovation landscape (Mazzucato, 2018). This period heralded the inception of the EU's flagship initiatives, the Framework Programs, which kicked off in 1984 and extended into 1994. These initial Framework Programs were a departure from the past, creating a supportive environment for collaborative research that received substantial EU funding. Unlike previous efforts that were somewhat scattered and uncoordinated, these programs embraced a wide spectrum of scientific and technological fields, encouraging diverse research activities. This strategy was pivotal in fully activating the EU's S&T agenda and in moving towards a more cohesive and vibrant European research ecosystem.

The enactment of the Single European Act (SEA) in 1986 was a transformative event that furthered the integration of the EU's research and innovation efforts. With the amendments on the SEA, Article 130f of the Treaty establishing the EEC, the Single European Act (SEA) laid the foundation for a comprehensive research and innovation policy within the EU. This act introduced a specific section on "Research and Development", aiming to boost the scientific capabilities and international competitiveness of the European industry. It emphasized collaborative projects,

knowledge exchange, and mobility among researchers, setting the stage for a dynamic and interconnected European research area. This phase of EU policy development focused on creating a cooperative research environment capable of driving innovation and competing on a global scale.

The provisions outlined in Articles 130g-130q of the Single European Act aim to strengthen the scientific and technological basis of European industry while promoting competitiveness at the international level. Central to this objective is the encouragement of collaboration among enterprises, research centers, and universities, with an emphasis on leveraging the internal market's potential. As detailed in Article 130h of the SEA, the importance of coordinating national-level policies and programs, complementing activities carried out at the Member States' level is underscored. It establishes a framework for multiannual programs, detailing scientific and technical objectives, priorities, and financial participation (Article 130i). Furthermore, it allows for supplementary programs involving certain Member States, with provisions for Community participation. The Act also facilitates cooperation with third countries and international organizations in research, technological development, and demonstration, with detailed arrangements subject to international agreements (Article 130k). These provisions reflect the Single European Act's commitment to advancing research and technological development within the European Community, contributing to its overall integration and competitiveness.

Following the SEA, the EU sought to establish a cohesive policy framework and organizational structure to guide its collective research initiatives. However, this period revealed a critical imbalance, according to Georghiou (2001): the EU's focus on scientific research inadvertently overshadowed the vital area of technological innovation, particularly in the fast-evolving information technology (IT) sector. This oversight was glaringly apparent as the United States, S.Korea and Japan, alongside other East Asian nations like South Korea and China, capitalized on the IT revolution, dominating software development and electronics manufacturing, respectively (Georghiou, 2001). This science-centric approach exposed a significant flaw in the EU's strategy, underscoring its struggle to synchronize policy across

member states. For Archibugi and Coco (2001), the situation underscored a clear message: without embracing an innovation-driven agenda that leverages current technological trends, the EU risked falling behind in the global race, where IT prowess was becoming a key determinant of economic leadership. This period emphasized the importance of policy adaptability and alignment with technological advancements, lessons that continue to be vital for the EU's research and development strategies today.

3.1.2. Addressing Europe's Innovation Dilemma

Europe's shortcomings are not confined to the information technology sector; this extends across a broad array of high-tech industries. As Maassen and Olsen defined (2007), this discrepancy is encapsulated in what's termed the "European Paradox". While Europe stands at the forefront of scientific research and scholarly publications, it falls behind in translating this intellectual capital into innovations that spur economic growth (Dosi et.al., 2002). This contradiction becomes clear upon analyzing essential innovation indicators: the EU shows a notable rate of 32.5 scientific publications per million inhabitants, slightly surpassing the USA's 30.9 and Japan's 8.8. However, the scenario changes when considering the patents number filed per million inhabitants, revealing a contrasting trend (OECD, 2023). With just 43 patents per million, the EU significantly trails the USA and Japan, which boast 58 and an impressive 92 patents per million, respectively (the US, European and Japanese Patent Offices, 2021). These figures from the OECD highlight a pressing issue: Europe's challenge in connecting academic research with its practical, commercial utilization through patents and innovation.

The early 1990s marked a pivotal moment for the EU in recognizing and addressing its innovation deficit and the segmented nature of its Research and Development (RD) initiatives. In 1993, in his critique, Research Commissioner Antonio Ruberti advocated for the establishment of a coherent European Research Policy and emphasized transcending the fragmented landscape of national projects and joint efforts, proposing a unified approach to match the technological and innovative achievements of the United States, S.Korea and Japan. Highlighting Europe's lag in

R&D investment compared to its competitors, Ruberti underscored the necessity for Europe to not only increase its R&D spending, but also to improve the conversion of research outcomes into marketable innovations to stimulate economic growth (Ruberti, 1995).

The Maastricht Treaty of 1993 played an important role in reshaping the EU's research policies and objectives to align with the Union's wider policies at a supranational level (Caracostas and Müldür, 2001). The Maastricht Treaty, encompassing Articles 130f to 130p, establishes a framework for research and technological development within the European Community. It emphasizes collaboration among enterprises, research centers, and universities (Article 130f) and coordination between the Community and Member States (Article 130h). The treaty introduces a multiannual framework program (Article 130i) and provisions for supplementary programs (Article 130k), cooperation with third countries (Article 130m), and the establishment of joint undertakings (Article 130n). Additionally, it mandates reporting on research activities (Article 130p). It tasked the European Commission with the harmonization of research policy across the continent. This shift towards more collaborative and integrated efforts was partly a strategic maneuver to catch up with the technological advancements and innovation prowess of the United States, S.Korea and Japan. The term 'innovation' was thus introduced into the EU's research policy vocabulary as a key focus area (European Commission, 2020). This period underscored the EU's commitment to overcoming its innovation challenges, aiming to bridge the gap between scientific excellence and its application in driving economic development and competitiveness on the global stage.

The so-called "European Paradox" encapsulates the challenge faced by the European Union in effectively translating its prowess in scientific research into tangible innovations that drive economic growth. Despite Europe's leading position in scientific research output, as evidenced by its high number of scholarly publications per capita in the next chapters, it lags behind in converting this intellectual capital into marketable products and technologies. This paradox becomes evident when comparing Europe's publication rates to its patent filings per capita, revealing a significant gap between academic research and practical application. This disconnect

inhibits Europe's ability to compete globally in innovation and hampers its economic potential. Strategies like those proposed in the Green Paper on Innovation and subsequent action plans aim to address this disparity by fostering a more conducive environment for innovation, bridging the gap between research and commercialization, and stimulating technological advancement across various sectors. However, addressing the European Paradox requires sustained efforts to overcome structural barriers and promote a culture of innovation that values the translation of scientific discoveries into tangible successes in the marketplace.

3.1.3. The European Commission's Strategic Shift Towards Innovation

In 1995, a significant stride was made in the EU's approach to innovation with the release of the Green Paper on Innovation by the European Commission. This document marked a pivotal shift in perspective towards the integration of science, technology, and business within the EU. It highlighted a critical issue known as the "European Paradox", which is Europe's proficiency in scientific research was not translating into market success with new products. The Green Paper proposed strategies to bridge this gap, aiming to convert scientific discoveries into profitable products and services, thereby enhancing the EU's economic landscape (European Commission, 1995). Following this, in 1996, the EU launched the ‘First Action Plan for Innovation in Europe’, a blueprint designed to stimulate technological advancement. This plan was based on several key objectives: i. Fostering a culture that embraces innovation. ii. Providing support structures for innovative ideas. iii. Facilitating a direct connection between research and innovation. The action plan outlined in the Green Paper on Innovation delineated specific steps for prompt execution (European Commission, 1996). These included regulatory reforms to foster innovation and the establishment of a comprehensive support network across Europe, aiming to sustain innovation over the long term. The primary goal was to ensure that current innovations could evolve into tomorrow's successful products and technologies.

According to Caracostas and Müldür (2001), building on the principles outlined in the Green Paper, the Action Plan proposed a holistic and collaborative approach

through the formation of a European Innovation System. This system aimed to harmonize with the innovation strategies of individual EU Member States, focusing on the intricate web of interactions necessary for innovation. Also, Georghiou in 2001, extended the concept of Innovation Systems to a European level, promoting cooperation beyond national confines and encouraging a unified effort among the National Innovation Systems of the EU Member States. This initiative sought to monitor the EU's innovation trajectory through key indicators like expenditure on R&D and the number of active researchers, offering a measurable framework for assessing the EU's innovation capacity.

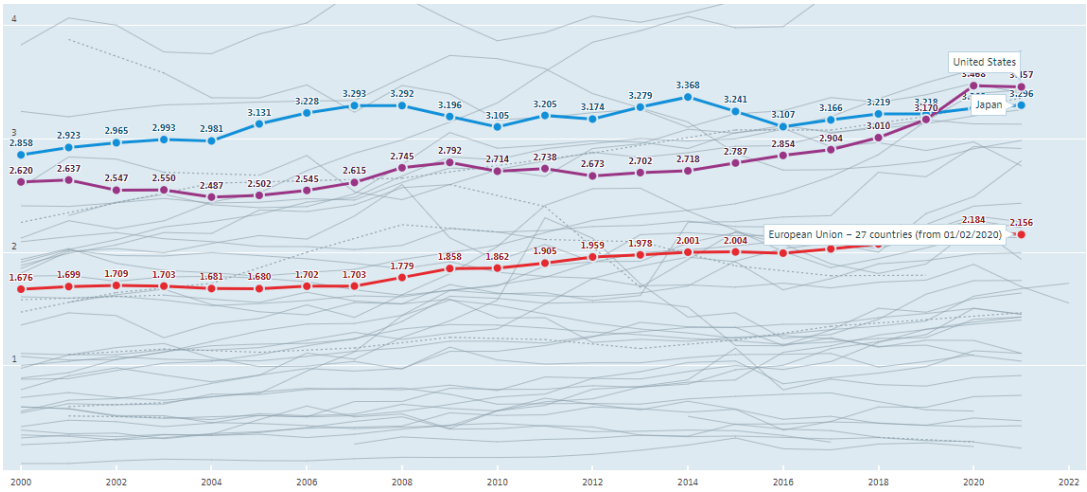

Figure 1. Gross domestic expenditure on R&D (indicator) (OECD, 2023)

Aghion and Howitt (1998) propose that the most suitable empirical indicator for assessing innovation focus is R&D intensity. This measure is critical for analysis as it evaluates the concentration on innovation by comparing R&D expenditures to the GDP. Data provided by the OECD (2023) covering 1991 to 2022 reveals the investment trends in R&D of the EU, the United States, and Japan. Despite all three entities showing a rise in R&D expenditure over time, the EU consistently allocated a smaller portion of its GDP towards expenditure on R&D compared to the US and Japan. With the US nearing a 3% investment rate and Japan surpassing it in the early 2000s, the EU's expenditure remained below 2% as of 2022. This gap indicates the potential for the EU to bolster its global innovation stance by enhancing R&D investment, aligning with the broader research focus on systemic approaches to support EU innovation.

This chapter underscores the EU's strategic efforts to address its innovation deficit through systemic policy initiatives and increased R&D investment, aiming to transform its strong scientific base into tangible economic and technological achievements.

3.2. The Pivotal Shift in the European Union's Strategy for Science and Technology Policy (2000-2010)

3.2.1. Harnessing Unity for Innovation and Steering Towards a Innovation-Driven Based Economy: The European Research Area (ERA) and The Lisbon Strategy

In the early 21st century, the EU undertook a significant strategic shift in its approach to science and technology, marking a departure from the previously fragmented, nation-specific efforts towards a more unified and coordinated agenda. The Amsterdam Treaty, effective from May 1, 1999, plays a important role in the EU's research programs. It provides the necessary legal regulations required for the development and implementation of these R&D policies. The EU Commission, guided by advice from groups like the Information Society Technologies Advisory Group (ISTAG), decides the direction of these programs (EUR-Lex, 1997). Treaty significantly influenced the EU's approach to R&D. Aimed at improving the efficiency of the EU, democratic processes, and the quality of life for European citizens, the treaty also prioritized the promotion of R&D activities according to the report by European Commission. It sought to strengthen the EU's research and technological development policies, fostering scientific and technological cooperation among member states and supporting the advancement of the European Research Area (ERA). Following the treaty's implementation, increased financial support for R&D projects through Framework Programmes was noted, which boosted the EU's research infrastructure, researcher mobility, and innovative technology development. In other words, the Amsterdam Treaty not only reinforced the EU's stance as a significant participant in science and technology, but also contributed to the economic growth and innovation capacity of its member countries, underlining the critical role of coordinated and integrated R&D efforts in enhancing competitiveness and innovation within the EU.

The introduction of the European Research Area (ERA) marked a significant shift from the previous landscape of fragmented, largely uncoordinated, and country-specific research efforts. According to Delaghe&Muldur and Soete (2011), the ERA aimed to harmonize Europe's research landscape by integrating individual national policies into a unified European strategy, enhancing researcher mobility across borders, and streamlining the patent process. Its overarching ambition was to elevate the research sector's efficiency to the level of the EU's single market, fostering a robust research community capable of innovation and knowledge dissemination throughout the continent.

Simultaneously, Europe faced difficulties in becoming more united because of slow economic growth and increasing feelings of insecurity among its people. According to Tuncer (2008), the effort to bring countries closer was aimed at improving not only politics and culture, but also at solving economic problems. As the economies of EU countries started to struggle, marked by fewer job opportunities and an aging population that slowed down economic progress, there was a clear need for a new plan to improve these economies (Tuncer, 2008). In 2000, EU leaders met in Lisbon, to launch the Lisbon Strategy, a plan designed to equip the EU for the future by prioritizing technology policies for the next decade (European Council, 2000). They set ambitious goals for fostering sustainable economic growth, generating high-quality employment opportunities, and promoting social cohesion with a strong emphasis on R&D investment and embracing the digital era. Their aim was to transform the EU into a hub of innovation and knowledge, driving economic and societal progress.

During this time, European countries struggled to adapt to rapid technological changes. Although Europe had strong manufacturing and traditional industries, transitioning to high-tech fields was challenging. The Lisbon Strategy aimed to address these challenges by promoting innovation, increasing R&D investments, and moving towards a dynamic and competitive economy. This strategy intended to modernize Europe's economic landscape by integrating its industrial strength with technological innovation (Çelebi&Kahriman, 2011). By 2010, the objectives included not only creating more and better jobs, but also enhancing societal unity and

agreement, securing sustainable economic growth, and establishing the EU as the leading innovation-driven economy globally.

The European Council's goals were not only about changing the economy, but also about improving education and social security. They wanted Europe to be the leading innovation-driven based economy by 2010, staying ahead in technology and competing strongly worldwide (European Council, 2000). This plan was about making sure Europe could keep up with new trends and be a leader in tech and economy, supported by better education for its people and a strong social security system. This would help Europe grow sustainably and stay competitive globally (Öztürk, 2008). In simple terms, Europe aimed to boost its economy, educate its people well, and make sure everyone felt secure, helping it stay at the top in global competition.

The purpose of the Lisbon Strategy was to assess the EU's progress by comparing its policies and achievements with those of major economies like the United States, S.Korea and Japan. The goal was to assess whether the EU could rival or exceed these nations in economic achievements. For Öztürk (2008), this strategy focused on catching up to the U.S. in information technology and other high-tech areas, while also keeping an eye on emerging tech giants like China and India, aiming to stay ahead in the global technological race.

The Lisbon Strategy identified strengths and areas for improvement in the EU. According to Yılmaz (2008), a key issue is the EU's slow shift to a Innovation-Driven economy, leading to a lack of new startups and small to medium-sized companies (SMEs), and consequently, not enough job creation. To address this, the strategy proposes several actions: boosting business investment in research and innovation, upgrading technology for small businesses, expanding access to modern technology and the internet throughout the EU, making the internet more affordable, focusing on providing youth with the education and skills needed for the current economy, and increasing employment opportunities (Yılmaz, 2008). These measures aim to enhance the EU's economic performance and tackle its challenges.

Treidler (2011) evaluated that the Lisbon Strategy includes extra goals to strengthen its approach further. These include boosting financial options like venture capital, vital for a thriving knowledge economy, and improving the management of patents and intellectual property rights to safeguard innovations. Additionally, the strategy aims to enhance the financial system with a wider range of financial tools, increase cohesion within the EU's internal market, create a more conducive environment for European research, and invest more in workforce development (Treidler, 2011). These additional measures seek to improve the effectiveness of the strategy and bolster the EU's economic strength.

Çapanoğlu (2010) built Lisbon Strategy on three main pillars. First, it aims to push forward R&D to create a society based on knowledge, speed up structural changes to improve competitiveness and innovation, and complete the development of the internal market. Second, the strategy seeks to refresh the European social model by increasing investments in people's skills and addressing social exclusion. Lastly, it plans to use a mix of economic policies designed to support steady economic growth and keep this positive trend going.

The Lisbon Strategy, started in 2000, aimed for long-term job creation, improved social cohesion, and stable economic growth. However, by the 2005 review, it had not met its goals due to ongoing employment issues and limited success. As Öztürk mentions (2008), factors like the global economic downturn, political troubles since the early 2000s, member countries' weak commitment, and the strategy's own planning and coordination flaws made these goals challenging to achieve. The lower development status of new EU members further complicated reaching these targets.

3.2.2. Challenges and Revisions: Adapting to an Evolving Global Context

Despite these strategic efforts, Europe faced obstacles in its journey towards unity and innovation. These challenges included economic recessions, political upheavals, and the complexities of integrating new EU members. The Lisbon Strategy, aimed at establishing the EU as a leading global economy driven by competitiveness and innovation, encountered difficulties in meeting its initial objectives in 2005. The

European Commission (2008) decided it was time for a significant update. Recognizing the strategy's overly ambitious scope and diffuse focus, they narrowed it down to two main objectives: stimulating economic expansion and increasing employment opportunities throughout the EU. To make the revised strategy more effective and better organized, they introduced Integrated Guidelines and National Reform Programs (NRP). These tools were designed to simplify the strategy's goals, providing a clearer direction on the policies needed to achieve economic growth and reduce unemployment.

This revision was largely inspired by insights from two critical reports: the Kok and the Sapir Reports. In November 2004, a crucial evaluation led by ex-Dutch Prime Minister Wim Kok scrutinized the EU's Lisbon strategy, which aimed to make the EU a leading knowledge-based economy by 2010, focusing on economic growth, job creation, and social cohesion (Broughton, 2004). Moreover, the report criticized the slow progress, blaming inadequate urgency and coordination among EU and Member States. It was created to give the Lisbon Strategy a new lease on life. It stressed how important it was for Europe to become more digital, make its market more efficient, especially in banking and services, improve the business and investment climate, make job markets better, and keep the environment in mind. The report was straightforward about the EU and its countries not doing a great job with the Lisbon Strategy before. It pointed out big problems with how things were run and that the strategy tried to do too much at once, suggesting instead to really focus on creating more jobs and growing the economy (Yılmaz, 2008). In essence, the 2005 revision of the Lisbon Strategy, guided by these insightful reports, marked a pivotal shift towards a more focused and pragmatic approach. By concentrating on economic growth and job creation while leveraging detailed analysis and strategic recommendations from the Sapir and Kok Reports, the EU aimed to address its previous mistakes and set a course for more robust and inclusive economic development.

The Sapir Report (André Sapir), echoing the need for substantial institutional reforms within Europe, argued that to realize a truly knowledge-based economy, the EU needed to prioritize research and development, technology adoption, and

investment in human capital. It pointed out a stark warning: without making these reforms, the EU's aspirations for expansion and deeper integration were at risk, mainly because of the bloc' underwhelming growth performance (Pisani-Ferry&Sapir, 2006). The report meticulously evaluated the EU's economic standing, identified existing challenges, and offered detailed recommendations for addressing both social and economic issues, highlighting the EU's shortcomings in establishing a knowledge-based economy as a particularly pressing concern.

The European Commission acknowledged the Lisbon Strategy's underwhelming performance in fostering growth, productivity, and employment, which led to a strategic pivot towards action over targets, except for maintaining the 3% GDP investment in research and development by 2010 (European Commission, 2005). This shift was encapsulated in the "Working together for growth and jobs" communication, proposing a simplified coordination process centered around National Action Plans (NAPs) and emphasizing immediate actions in Member States over medium and long-term goals (European Commission, 2005). Critically evaluated by the report from the high-level group for its lack of political determination and failure to complete the internal market, the strategy's refresh aimed at making the EU more attractive for investment, stimulating knowledge and innovation, creating quality jobs, and improving governance through better coordination and clearer responsibilities (European Commission, 2004). This approach was further endorsed by subsequent Presidency Conclusions and the initiation of the second phase of the updated Lisbon strategy for growth and employment spanning from 2008 to 2010, underscoring the importance of investing in knowledge and innovation, unleashing SME potential, modernizing labor markets, and fostering an energy-efficient economy (European Council, 2008).

In the span of a decade, the EU has demonstrated commendable adaptability and resilience in its approach to S&T policy, navigating through economic, social, and technological challenges with a forward-looking vision. The transition from a fragmented to a unified research landscape through the European Research Area (ERA) and the recalibration of economic strategies via the Lisbon Strategy mark significant milestones in the EU's quest for knowledge-driven growth and social

cohesion. While the journey was punctuated by hurdles and required revisions, the overarching ambition to mold the EU into a leading knowledge-based economy remained steadfast. This period of strategic evolution not only reflects the EU's capacity to introspect and adapt, but also underscores the critical role of cohesive policy-making and the willingness to reform in achieving long-term objectives. As the EU continues to refine its strategies in response to an ever-changing global landscape, the lessons learned from 2000 to 2010 serve as a valuable blueprint for navigating the complexities of modern governance and economic development.

3.3. Evolving European Union Strategy: From Lisbon Agenda to Horizon Europe and Beyond (2010-2020)

3.3.1. Europe 2020: A Strategy for Smart, Sustainable, and Inclusive Growth

The EU has undergone significant economic and technological strategy shifts from the early 2000s, transitioning from the Lisbon Strategy to the Europe 2020 Strategy. The Lisbon Strategy, implemented by the EU to stimulate economic growth, employment, and research and development; unfortunately, did not meet its comprehensive objectives, significantly influenced by factors such as the EU's enlargement and the advent of the global financial crisis. During this time, there was a significant change in the global economic order, as China's economy exceeded that of Japan, making it the third largest in the world economy, closely behind the USA and the EU (Çapanoğlu, 2010). This change, occurring in the early 2000s, marked a pivotal transformation in the global economic landscape, signaling a redistribution of economic power and influence on a global scale.

In response to the shortcomings of the Lisbon Strategy, the European Commission unveiled the "Europe 2020 Strategy" on March 30, 2010, as a successor to its predecessor. As it was introduced by the European Commission (2010), titled "Europe 2020: A Strategy for Smart, Sustainable, and Inclusive Growth" this new plan aimed to address the inadequacies of the Lisbon Strategy by pivoting towards more significant, innovative changes. The Europe 2020 Strategy laid out a framework for the EU to adapt post-Lisbon, emphasizing the necessity to tackle

emerging challenges and problems through a triad of ambitious objectives (European Commission, 2010). When it is elaborated, these include fostering growth driven by innovation and knowledge, supporting social inclusion within welcoming communities, and advancing towards a competitive, cohesive, and environmentally sustainable economy. By delineating these strategies and their impacts, it is evident that the EU has been in a continuous process of adapting and restructuring its economic policies in response to both internal and external pressures.

The Europe 2020 Strategy, developed by the EU, aimed to strengthen Europe after the global financial crisis, which significantly emphasized the EU's economic vulnerabilities, like unemployment rates. For Yılmaz (2010), this strategy was a reaction to both global challenges, like globalization and climate change, and internal issues like an aging population. It represented a critical shift towards addressing these complex challenges with forward-looking policies focused on sustainability, innovation, R&D and inclusivity. According to Yılmaz (2010), this strategic initiative underscores the EU's dedication to creating a resilient, competitive, and sustainable economy capable of facing future adversities.

The strategy emphasizes the necessity for EU countries to enhance collaboration and improve coordination, particularly in crafting policies aligned with the EU's overarching goals, characterized by the principles of being smart, sustainable, and inclusive. In other words, the strategy's emphasis on the crucial role of a unified, efficient market in stimulating job creation and economic expansion, advocating for the alignment of national policies with the overarching EU goals to realize this vision.

3.3.2. Horizon Europe: Fostering Scientific Excellence and Innovation

Since 1984, the European Union (EU) has significantly emphasized fostering R&D through its successive Framework Programmes (FPs). These programs have expanded in scope and ambition, becoming central to the EU's strategy for enhancing scientific and technological capabilities across its member states. Initially, the focus was predominantly on technological research, as seen in FP6 and FP7. However,

there was a strategic shift with Horizon 2020, which broadened the scope to include innovation and economic growth, marking a pivotal moment in the EU's research agenda (European Commission, 2021). The primary objective of these FPs was to establish a cohesive European Research Area (ERA), streamlining the research policies and funding of EU countries to prevent resource wastage through duplication of efforts (Kok, 2004). Horizon 2020 exemplified this by organizing its framework around three pillars: Excellent Science, Industrial Leadership, and Societal Challenges, thereby aligning with broader EU policies like Europe 2020 to foster competitiveness and innovation (European Commission, 2005).

The introduction of Horizon 2020 represented a significant leap forward, with increased funding and an emphasis on addressing contemporary societal challenges. A noteworthy feature was the inclusion of the European Research Council and a push towards open access for research findings, reflecting a commitment to innovation and knowledge dissemination (König, 2017). This shift towards simplified procedures and increased funding from earlier frameworks was a notable improvement. As it is seen in the European Commission's (2002) explanation, building on Horizon Europe, with its substantial €95.5 billion budget, aims to further support scientific excellence, innovation, and societal challenges.

At the center of Horizon Europe's innovation strategy is the European Innovation Council (EIC) (Hollanders, 2009). The EIC serves as a cornerstone for transforming groundbreaking ideas into innovative products, services, or processes that have the potential to establish new markets or revolutionize current ones (European Commission, 2023). By providing funding, mentorship, and networking opportunities, the EIC plays a critical role in closing the divide between research and market, thus ensuring that scientific advancements translate into tangible benefits for society and the economy. The EIC not only focuses on technological innovation, but also encourages social innovation, and sustainable development, and contributes to the EU's key objectives such as the digital transformation and the European Green Deal (European Council, 2002). This multifaceted approach to innovation underscores the EU's vision of a resilient and competitive economy powered by knowledge and innovation.

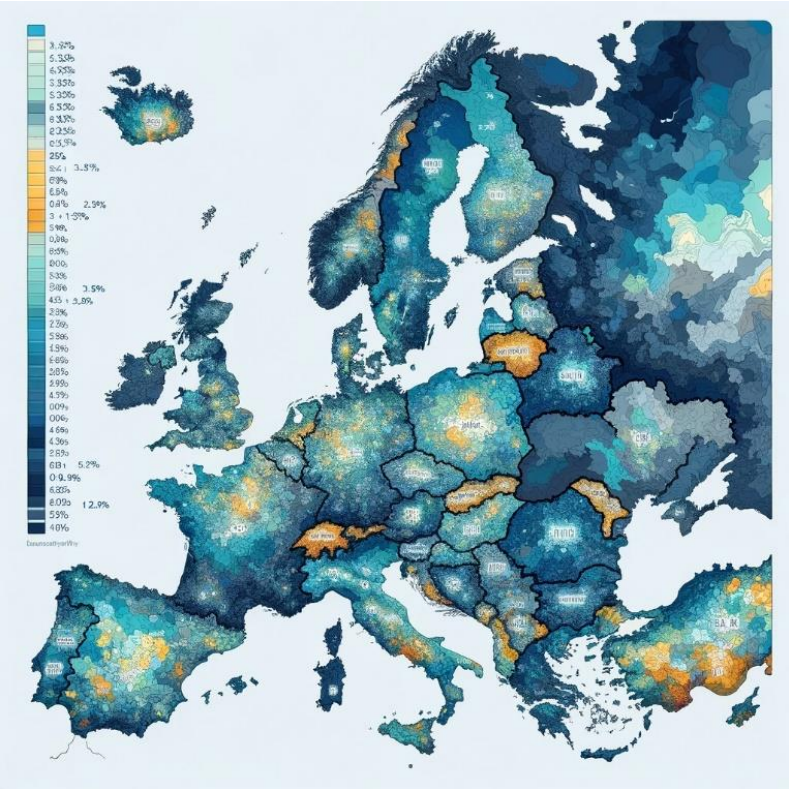

Figure 2. R&D intensity, 2020 (Eurostat, 2023) (%, based on gross domestic expenditure on R&D (GERD) relative to gross domestic product (GDP), by NUTS 2 regions)

Data from Eurostat (2023) illustrates the disparities in Europe's expenditure in research and development (R&D) for the year 2020 through a colored map, revealing significant variations across different regions. Dark blue areas, including central Germany, some parts of Austria, Sweden, and Denmark, led the pack by spending on R&D more than 3.35% of the GDP, showing a strong commitment to innovation. Medium blue regions spent above the EU average of 2.30%, indicating good investment levels. However, light blue and green areas, mostly in Southern and Eastern Europe, invested between 0.85% and 2.20%, falling below the EU average. The yellow zones, mainly in Eastern Europe and some Southern countries like Greece and Portugal, invested less than 0.50%, which is quite low. Gray areas on the map did not have available data. This map reveals the uneven distribution of R&D spending across Europe, highlighting areas that are at the forefront of technological advancements and others that are not investing as much. As it discussed, these differences impact each region's potential for economic growth and innovation. In this regard, programs like Horizon Europe aim to address these disparities by

funding research and innovation projects across the continent, especially in regions that spend less on R&D. By doing so, Horizon Europe seeks to ensure that all parts of Europe can contribute to and benefit from scientific advancements and technological innovations.

The European Commission and related agencies are responsible for putting these big research programs into action (Schmidt, 2012). They take the big goals and turn them into specific research projects. What is interesting is that these programs are not just for EU countries. They also include countries outside the EU, like Israel and Switzerland. This is shown in projects like IMPETUS and OpenAIRE (Manghi et al., 2010). These projects are good examples of how the EU uses its research funding in a focused way. These projects illustrate how the EU focuses its research funding to promote innovation and open science, which aims to make scientific research widely accessible to enhance knowledge sharing and collaboration.

Table 1. Evolving European Union Strategy (European Commission, 2024)

Strategy	**Objectives**	**Key Differences**
Lisbon Strategy	To promote economic growth, employment, and R&D	Focus on economic growth, employment, and R&D
Europe 2020	To aim for smart, sustainable, and inclusive growth	Emphasis on sustainability and inclusivity
Horizon 2020	To foster scientific excellence, innovation, and address societal challenges	Focus on research, innovation, and societal challenges
Horizon Europe	To foster scientific excellence, innovation, and address societal challenges	Larger budget, expanded objectives

In summary, the EU's strategic evolution from the Lisbon Strategy to Horizon Europe embodies a significant shift towards prioritizing innovation, sustainability, and inclusivity, aligning closely with the principles of National Innovation Systems (NIS). This journey reflects a transition from focusing solely on economic growth to a holistic approach that integrates societal challenges and technological advancements. By fostering collaboration among member states, encouraging scientific excellence, and supporting sustainable development, the EU's strategies

exemplify a commitment to building a resilient and innovative Union. This alignment with NIS principles not only underscores the significance of systemic innovation in achieving economic competitiveness and societal well-being, but also positions the EU as a pivotal force in shaping global innovation landscapes and responding effectively to both global and domestic imperatives for progress and sustainability.

3.4. Synergizing European Innovation: The Role of the European Union in Fostering Science and Technology Policy

The EU has established an effective framework to promote science and technology, centered around the European Commission. This system involves strategic collaboration with entities like the Directorate-General for Enterprise and Industry, orchestrating policies to bolster innovation within the European Research Area (ERA). The ERA serves as a central point for research and business collaboration throughout the EU, fostering collaboration through initiatives like the Framework Programmes (European Commission, 2020). Advisory bodies, financial institutions, and policy measures further support this ecosystem, enhancing innovation capabilities and workforce skills. This chapter explores the EU's integrative approach to science and technology, underscoring the synergy between policy, finance, and collaboration in advancing European innovation.

The EU has a complex system for handling S&T policies. At the center of this system is the European Commission, which holds an important position in making policies. It gets support from specialized groups like the Directorate-General for Research and Innovation (DG Research) and DG Enterprise and Industry. These groups work together to plan and fund activities that encourage innovation within the European Research Area (ERA). The ERA has an important role in this system. It is like a big network that connects researchers and businesses across different EU countries, encouraging them to work together. Framework Programmes are a major part of this because they provide specific support for R&D projects. Other important parts of the EU's approach include expert advice from groups like the European Research Area Board (EURAB), and financial support from organizations like the

European Investment Bank (EIB) and the European Investment Fund (EIF). Moreover, the EU emphasizes the protection of Intellectual Property Rights, the promotion of educational excellence, and the assurance of competitive equity, alongside workforce training initiatives. These efforts ensure that the EU workforce remains skilled and adaptable, essential for sustaining innovation momentum (Ghion et al., 2015). Overall, this system is designed to make a seamless and dynamic environment for innovation across the EU. Altogether, the EU's approach seeks to foster a dynamic and cohesive innovation ecosystem, leveraging regional resources and expertise for maximal impact.

Veugelers (2015) emphasizes the necessity of multidimensional collaboration in Europe to foster innovation, highlighting the role of political leaders, educational institutions, research groups, the financial sector, and businesses in this collective effort. This collaboration, rooted in a systemic approach, leverages the EU's commitment to unity and best practice sharing among member states, thereby facilitating a seamless knowledge exchange network. This network is crucial for enhancing innovation efficiency across Europe. Viewing the EU's strategy through the lens of National Innovation Systems theory illuminates the interconnectedness of societal segments, which are economy, industry, and education, revealing a comprehensive framework that underpins the region's science and technology policies (Veugelers, 2015).

The European Research Area (ERA) operates differently from traditional innovation systems, as it involves both the European Commission and individual EU member states in its management (Hodson et al., 2022). The European Commission, particularly through the Directorate-General for Research and Innovation (DG Research) and the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, plays an important role in policy formulation. DG Research, led by the Commissioner for Science and Research, is tasked with aligning EU research initiatives with national efforts and bolstering EU policies in sectors such as the environment, information technology, energy, and regional development. Furthermore, DG Research oversees critical mechanisms highlighting its integral function in the ERA and underscoring its significance in the EU's S&T strategies (European Commission, 2023).

Table 2. Organizational Structure of EU Science, Technology, and Innovation (European Commission, 2024)

Component	Description	Key Entities/Programs
Policy Making	European Commission as the central policymaker, directing science, technology, and innovation policies.	European Commission, Directorate-General for Research and Innovation, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
Advisory Mechanisms	Provide expert guidance to the European Commission in policy formulation.	EURAB, CREST, JRC
Financial Support	Funding and incentives for R&D activities and innovation.	EIB, EIF, Framework Programs (e.g., FP6), National Financial Agencies
Strategic Frameworks	Guiding strategies for shaping the European Research Area and innovation policies.	Lisbon Strategy, Barcelona Target, ERA
Research and Innovation Infrastructure	Integrating diverse national policies and stakeholders within the ERA.	European Commission, National Governments, ERA
Supportive Policies	Policies that underpin innovation, like Intellectual Property Rights.	Intellectual Property Rights (IPR) Competition Law EU-wide and National Policies
Collaboration and Networking	Promoting EU-wide collaboration and knowledge exchange.	ERA-NETs, National Contact Points (NCPs), IRCs, ERRIN
Policy Analysis and Development	Crafting and executing innovation policies, analyzing impacts.	Directorate-General for Research and Innovation, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
Multi-Level Collaboration	Emphasis on cooperation across different sectors and levels.	Political leaders, educational bodies, research entities, financial sectors, industry stakeholders

As it is categorized in Table 1, the Directorate-General for Internal Market, Industry, Entrepreneurship, and SMEs is at the heart of the EU's efforts to foster innovation, guided by overarching strategies like the Lisbon strategy and the Barcelona target. Its core responsibilities include developing innovation policies, evaluating their effectiveness, and promoting technology transfer, with a particular focus on assisting small and medium-sized enterprises (SMEs). While it shares a connection with the Directorate-General for Research and Innovation, its focus is more on practical application in the marketplace. This body is instrumental in nurturing an innovative

culture within the EU, working closely with entities like Innovation Relay Centers (IRCs) and the European Regions Research and Innovation Network (ERRIN) to bolster industrial innovation. It also plays a vital role in collecting and analyzing data on EU-wide innovation, which informs future policy directions (European Commission, 2023). In parallel, the EU benefits from the expertise of advisory groups such as the Scientific and Technical Research Committee (CREST), the European Research Advisory Board (EURAB) and the Joint Research Center (JRC) to shape its research and innovation policies. These groups, consisting of experts from diverse fields, provide strategic advice, oversee national research policies, and offer scientific and technical support to the EU policymaking process (European Commission, 2020). This collaborative approach ensures that EU policies on science and technology are well-informed and effectively implemented.

The EU employs a multifaceted approach to fund research and development (R&D), utilizing various funding sources. The European Investment Bank (EIB) is a pivotal institution, that provides funding for research and development initiatives in both the public and private sectors. Similarly, the European Investment Fund (EIF) operates similarly to a venture capital fund, targeting entrepreneurs. These entities maintain independent financial oversight. Beyond the EIB and EIF, the EU supports R&D through Framework Programs and collaborative projects like the European Cooperation in Science and Technology (COST). Moreover, individual EU member states contribute to this ecosystem with their initiatives and financial incentives, such as Finland's Tekes and France's Anvar, which offer national funding options. Countries within the EU also implement incentives like tax breaks to spur research and innovation. However, as Borrás (2012) notes, the nuanced reality of the EU's support for innovation, points out the variability in how different member states experience this support despite the EU's extensive funding programs and incentives. The effectiveness of R&D efforts, as noted by Borrás, is not solely determined by the level of investment, but also by factors such as research quality, technology transfer efficiency, and national entrepreneurial cultures. This shows that while the EU seeks to foster innovation, the impact of its support varies widely across countries, suggesting that successful innovation relies on more than just financial backing.

The EU's innovation landscape has been significantly shaped by the Lisbon Strategy and the Barcelona target, emphasizing the advancement of the European Research Area (ERA). Central to this effort were the 6th and 7th Framework Programs, designed to solidify the ERA's foundations and supported by national research initiatives, patent regulations, and innovation policies. The inception of Horizon Europe represents a continuation of this commitment, aiming to further foster scientific and technological progress across member states. The ERA itself, a network connecting policymakers and stakeholders, aligns with the National Innovation Systems concept, aiming to catalyze innovation throughout the EU. However, the effectiveness of these mechanisms in spurring innovation warrants a closer examination, as indicated by Borrás (2011) and echoed by Charles Edquist (1998), who acknowledged the EU's institutional advancements while cautioning against premature evaluations of its development. This evolving nature of the EU's approach, alongside mixed results from mid-term evaluations, underscores the importance of ongoing analysis and adaptation of S&T policies within the EU context.

In conclusion, this multifaceted approach not only fosters dynamic innovation but also positions the EU as a global model for scientific advancement by integrating policy formulation, financial support, and collaborative initiatives effectively.

3.5. Implementing Policies: The Role of Framework Programs in the European Union

By harmonizing the research and innovation policies of its member countries, the European Union (EU) aims to boost science and technology. This ensures that all countries have similar capabilities, preventing duplicate efforts and maximizing the collective expertise for greater results. Highlighting the need for harmonization, as noted by Diederen (1999), the EU implements this through collaborative research projects and programs across member states, financially backed by the EU itself. This effort aims to unify and enhance the research and innovation landscape among its members. This chapter will delve into critical policy tools such as The European Strategic Programme on Research in Information Technology, European

Cooperation in Science and Technology, the European Research Coordination Agency, and the Framework Programs, examining their significant role in defining the EU's science and technology strategy.

Since its inception in 1971, the European Cooperation in Science and Technology (COST) has served as a foundational intergovernmental framework within the EU, fostering the coordination of fundamental research projects across Europe with a focus beyond market-driven interests (Georghiou, 2001). Including Türkiye from its outset, a flexible, 'bottom-up' approach that empowers researchers to launch projects on a broad range of topics, as highlighted by the European Science Foundation in 2020. These initiatives, characterized by their international collaboration and societal relevance, are designed to tackle public and societal challenges, ensuring research under COST is not only cooperative, but also deeply aligned with societal needs.

The EU provides several databases to help people find information about research and innovation projects it funds. This includes CORDIS for detailed project information and others focused on health, energy efficiency, transport, and climate action. For example, the EU supports public-private partnerships, where EU countries work together on research to solve common problems more effectively (CORDIS, 2020). The Intelligent Energy Europe (IEE) program, started in 2003, works on making energy use in Europe more sustainable by funding projects that improve energy efficiency and increase renewable energy use (Berrutto, 2007). Additionally, the European Innovation Council (EIC) data hub showcases companies and projects, especially those aiming to make Europe's energy use greener and more efficient, funded under the Horizon 2020 program.

The EU offers a range of financial support programs for research and innovation, each targeting different areas with its own budget and timeframe. Horizon Europe, for instance, is a major program with €95.5 billion to spend from 2021 to 2027, aiming to tackle climate change, support sustainable development, and boost the EU's capacity for global competitiveness (European Commission, 2023). The EU4Health program, the biggest EU health initiative since 2003, has a budget of €5.3 billion. Additionally, the EU provides funds through the Cohesion Fund to help less

economically developed countries within the EU, the LIFE programme focusing on environmental and climate projects with new opportunities in 2023, and the Technical Support Instrument that aids EU countries in implementing reforms. There is also the Research Fund for Coal and Steel, dedicating around €55 million each year to research in these specific industries.

Table 3.Organizations and Number of Project Involved in EUREKA Projects, 2023 (EUREKA, 2023)

Organisation Type	Organizations	Share (%)	Number of Project	Share (%)
SME	7.970,00	32,68%	10.286,00	22,31%
R&D SME	6.302,00	25,84%	19.332,00	41,94%
Large Company	3.725,00	15,27%	4.901,00	10,63%
University	3.419,00	14,02%	6.201,00	13,45%
Research Institute	2.408,00	9,87%	4.205,00	9,12%
Other	305,00	1,25%	623,00	1,35%
Innovative SME	221,00	0,91%	436,00	0,95%
Founding Company	21,00	0,09%	40,00	0,09%
RTO	8,00	0,03%	6,00	0,01%
Startup	8,00	0,03%	66,00	0,14%
Government	2,00	0,01%	1,00	0,00%
	24.389,00		46.097,00	

As mentioned in a 2023 report from EUREKA, it is an intergovernmental network launched in 1985 as part of the European Research Coordination Agency, and is focused on driving industrial R&D, making sure it is focused on creating products and services that do well in the market. Türkiye was one of the founding members. This network specifically supports projects in high-tech areas aiming to make European industries more competitive globally and to produce high-quality offerings. As of 2023, EUREKA has grown significantly, running 6,119 active projects with 23,700 people from 62 countries, and a total budget of 11.696 billion Euros. It is also supportive of small and medium-sized businesses (SMEs), fostering cross-border

cooperation and partnerships between companies and research groups. According to the table, SMEs participate in about 32.68% of these projects, with a notable involvement of universities and research institutes as well. According to Caracostas and Muldur (2006), the diversity in project participation highlights EUREKA's success in encouraging a broad range of collaborative research efforts. The evolution in project types and growth in numbers show how EUREKA is keeping pace with changes in European R&D (Caracostas and Müldür, 2006).

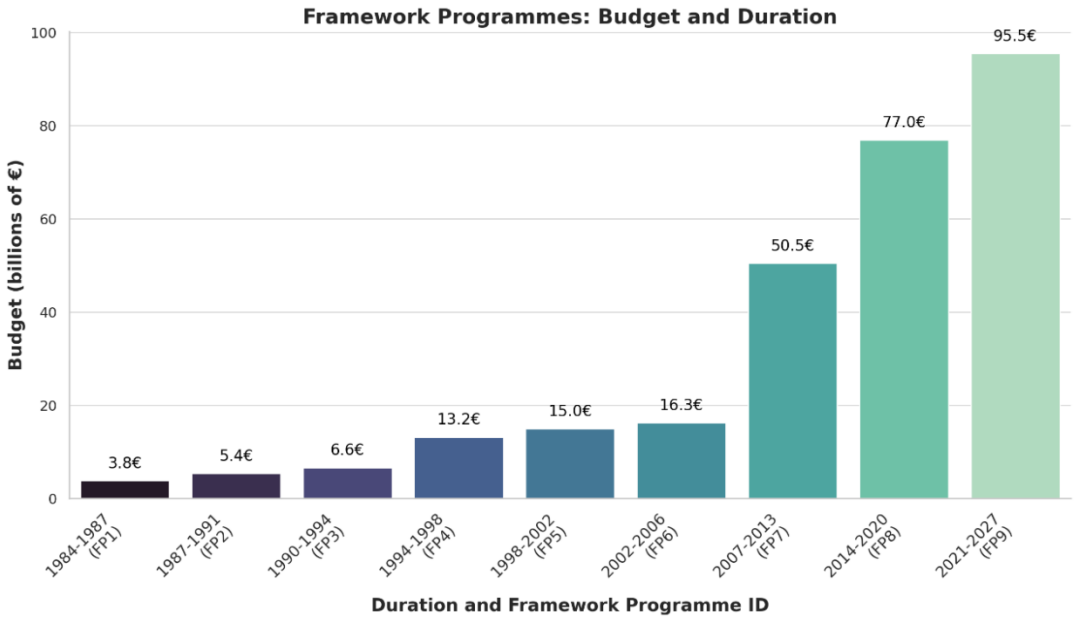

Figure 3. Framework Programmes: Budget and Duration, (European Commission, 2023)

Since 1984, the EU has used Framework Programs (FPs) to boost research and development (R&D) among its member countries, helping them to be more competitive and innovative (Luukkonen, 1998). These FPs have provided significant funding for collaborative research and technology projects. The budget has increased from 3.27 billion Euros in the initial program (FP1) to an impressive 17.5 billion Euros by the Sixth Framework Program (FP6), showing the EU's growing commitment to research. Each FP has built upon the accomplishments of earlier programs and has been tailored to meet the EU's changing strategic objectives. For example, FP1 aimed to bring together various research initiatives for greater impact, while FP2 focused more on industry-relevant research tied to the Single Market.

Successive FPs have increasingly emphasized strategic areas like high-tech fields to enhance the global competitiveness of European industries.

The Fourth Framework Program (FP4), from 1994 to 1998, marked a significant effort by the EU to bridge the gap in R&D advancements of Japan, S. Korea and the United States (Luukkonen, 1998). With a budget nearly double that of the previous program, at 13.12 billion Euros, FP4 focused on better coordinating EU-wide research and facilitating cross-border collaboration among researchers. It introduced the “Innovation Programme” to provide an environment that encourages innovation and technological adoption in businesses, alongside incorporating the ESPRIT program for Information and Communication Technologies (ICT) sector advancements. The evolution of FPs is highlighted by the Horizon Europe spanning 2021-2027, with a budget of 95.5 billion Euros. This substantial investment underscores the EU's intensified focus on R&D as an essential catalyst for future growth and global competitiveness.

Table 4. EU Framework Programmes Summary, (European Commission, 2023)

Program	**Duration**	**Objectives**	**Key Features**
FP5	1998-2002	Stimulate innovation and integrate SMEs	"Thematic" and "horizontal programs", focus on socio-economic goals
FP6	2002-2006	Create and complete the ERA	Integration of European research, structured in thematic areas
FP7	2007-2013	Expand research and innovation support	Built upon previous programs, expanded scope and scale
Horizon 2020	2014-2020	Address global challenges, support science	Focused on global challenges, competitiveness, and science
Horizon Europe	2021-2027	Tackle societal challenges, promote competitiveness	Ambitious budget, ERC grants, European Partnerships, focus on open science

Since the "Green Paper on Innovation" emphasized the significance of innovation for the EU's economic growth, the EU's Framework Programmes have undergone significant changes over time. Starting with the 5th Framework Programme (FP5,

1998-2002), the focus shifted to promoting innovation and supporting SMEs (European Commission, 2003). This program broke away from traditional scientific disciplines, organizing research into thematic and horizontal programs with priorities like renewable energy and improving quality of life. The subsequent 6th Framework Programme (FP6, 2002-2006) aimed to integrate and coordinate research across Europe, focusing on creating the European Research Area (ERA). It emphasized areas like nanotechnology and sustainable development, grouped into seven thematic areas. Following FP6, the 7th Framework Programme (FP7) and Horizon 2020 continued to expand the scope and scale of research support. The current program, Horizon Europe (2021-2027), stands as the most comprehensive program to date, boasting a significant budget concentrating on global challenges and boosting European industrial competitiveness. It retains effective strategies from previous programs while introducing novel efforts like European Partnerships and Missions to address major societal challenges. This includes a focus on open science and enhancing readiness for emergencies like health crises. Each new program marks a significant step in enhancing the EU's research and innovation environment.

In summary, the EU's Framework Programmes have continually adapted and expanded over the years, always with a strong emphasis on fostering innovation, integrating SMEs, and aligning research activities with socio-economic goals and broader EU policies. Horizon Europe, as the latest iteration, reflects these ongoing priorities while introducing new mechanisms and approaches to adapt to the changing needs and challenges of the 21st century.

3.6. Identifying Challenges and Opportunities in European Union Science and Technology Policies

The EU, responsible for formulating science and technology guidelines for its members, is confronted with several significant challenges. According to Wallace & Young (2020), the expansion of the EU complicates the harmonization of science and technology policies due to increasing member diversity. Furthermore, R&D expenditure is insufficient in comparison to the requisite levels. A notable disparity exists in the capacity for R&D investment across member states, with some nations

outpacing others. This discrepancy, along with decentralized and uncoordinated R&D activities, poses a challenge (Vadell, 2017). Additionally, an aging population threatens the EU's labor market and innovation potential. Moreover, a diminishing interest in science and technology among the youth poses a risk to future innovation and advancements (Rasa, 2022). The EU needs to devise new methods to bring its science and technology plans together. This means solving problems and using the different strengths of its countries.

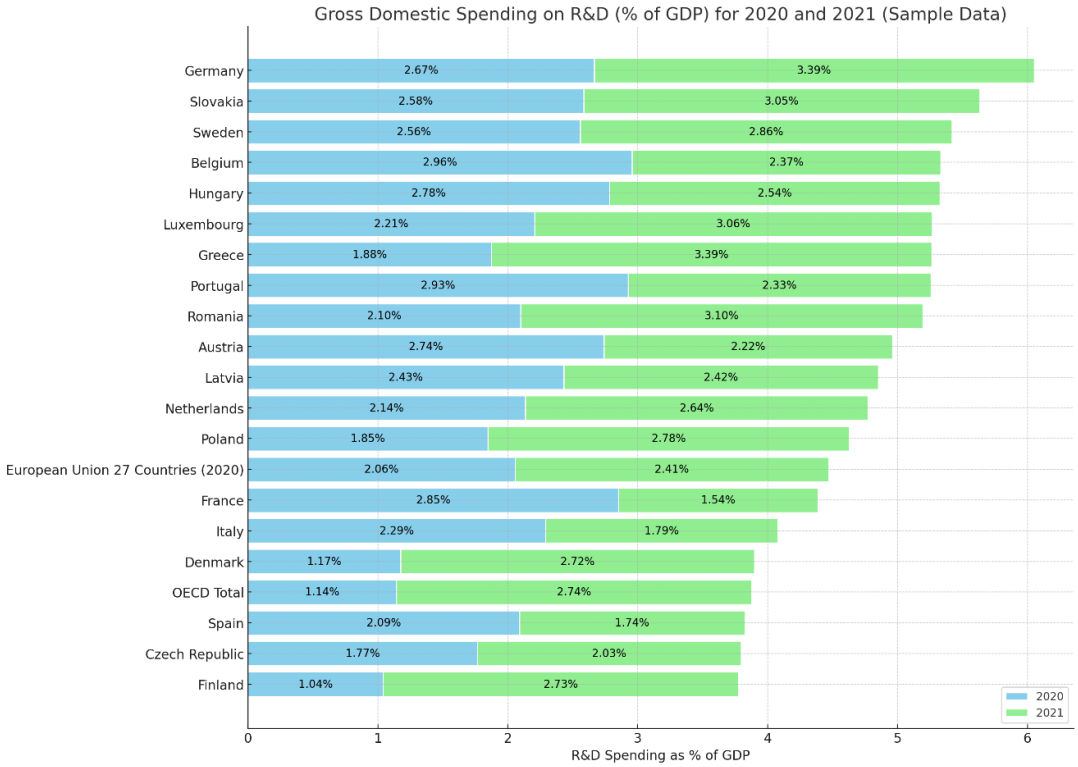

Figure 4. Gross Domestic Spending on R&D 2020-2021, (OECD, 2023)

According to the European Commission report in 2022, the EU is developing new strategies for a unified science and technology plan, addressing challenges while leveraging the diverse strengths of its member states. Efforts to enhance the R&D sector have focused on balancing capabilities across both new and established members. As is seen in Figure 4, some of the newer EU countries are still trying to catch up because they do not have as many resources or as much experience in R&D. For example, Romania's spending on R&D went up a little bit, from 0.45% of its total economy (GDP) in 2020 to 0.47% in 2021. Latvia also increased its R&D

spending from 0.77% to 0.91% during the same time (OECD, 2023). These are small changes, but they show that these countries are starting to focus more on R&D, even though they are still behind the EU average. On the other side, older EU members like Belgium, Sweden, and Austria are already spending a lot on R&D. In 2021, Belgium spent 3.39% of its GDP on R&D, Sweden spent 3.40%, and Austria 3.26%. These numbers are high and show that these countries are really strong in making new technologies and doing scientific research. This disparity underscores the EU's ongoing effort to elevate R&D uniformly across its 27-member states, a push reflected in the slight rise in overall R&D spending to 2.41% of combined GDP in 2021, as per the European Commission's 2022 report.

The "European Paradox" highlights the EU's struggle to translate scientific research into marketable products, despite its proficiency in generating knowledge. While the EU lags behind global innovation leaders like the USA and Japan, certain countries within the EU, such as Finland and Sweden, excel in specific innovation metrics. However, challenges such as brain drain and an aging population threaten the EU's ability to maintain a skilled workforce essential for research and innovation.

Another issue is that there is not enough venture capital funding in the EU. According to a study by Demirhan in 2019, venture capital funding is crucial for supporting start-ups and small businesses that show potential for significant growth. However, the EU faces a notable shortfall in this type of investment. Without enough of this funding, it is hard for new technologies and innovations to grow and succeed. The EU's policies for encouraging innovation need to be better organized by Treidler (2011). This means that the member states in the EU and the EU need to work together more closely to fix these problems. In 2021, the EU increased its research funding. However, there is still a big gap in how much money each country funds on research. Even though there is a small improvement in total funding, it is not enough. The EU needs to spend more on research and work better together to be successful worldwide, as Eurostat highlighted in 2023. A significant challenge is achieving consensus among member states, each with distinct priorities, leading to inconsistent policies that hinder the EU's competitive edge in technological advancements. For enhancement, a reevaluation of current strategies towards a more integrated and

globally aligned research and innovation framework is essential, as highlighted by Dosi et al. in 2002.

Despite the challenges facing its S&T policies, the EU continues to push forward in enhancing its R&D sector. This ongoing effort is built on the solid foundation of previous initiatives, such as the Lisbon Strategy and the European Research Area (ERA). The Lisbon Strategy set out with the goal of transforming the EU into a leading knowledge-based economy (European Commission, 2018). Concurrently, the ERA was established to promote collaborative research efforts across Europe. These foundational strategies have since given way to more advanced plans, among which the Horizon Europe program for 2021-2027 stands out. Horizon Europe is the EU's most ambitious R&D initiative yet, aiming to confront significant societal challenges, drive technological advancement, and strengthen the EU's capabilities in S&T. For countries that want to join the EU, like Türkiye, these changes are both a challenge and an opportunity (Artan&Keşap, 2021). It is important for Türkiye to keep up with the EU's changes, especially those related to Horizon Europe. Türkiye needs to carefully look at and possibly change its own science and technology policies to match what the EU is doing now and plans to do in the future. Aligning its strategies with the EU's is crucial for Türkiye (Artan&Keşap, 2021). This way, Türkiye can be a part of the EU's research and innovation community, work together with EU countries, and contribute to scientific progress that benefits everyone. In the next chapter, it will be delved into Türkiye's alignment with these policies and how this is reflected in the EU progress reports.

3.7. Concluding Remarks

In this chapter, a comprehensive exploration of European Union (EU) science and technology policies was undertaken, uncovering key themes, milestones, challenges, and opportunities. Throughout the journey, the profound global influence wielded by the EU was encountered, exemplified by the "Brussels Effect" and its role in shaping global standards and digital governance. This underscores the EU's leadership in driving innovation and setting the international agenda. As the scope of this chapter is reflected upon, it should be noted that the primary objective is to understand

Türkiye's science and technology policy within the context of EU integration. By scrutinizing the EU's science and technology policies, the groundwork for analysis is laid, and insights that inform our examination of Türkiye's policy landscape are drawn.

Summarizing the chapter, the historical evolution of EU S&T policies has been traced, from post-World War II reconstruction efforts to strategic initiatives like the Lisbon Strategy. Pivotal moments such as Horizon 2020 and Horizon Europe underscore the EU's commitment to scientific excellence and societal challenges. Additionally, adaptable framework programs and collaborative initiatives highlight the EU's capacity to foster innovation and align research activities with socio-economic goals. Despite notable progress, challenges persist, including member diversity and insufficient R&D expenditure. However, these challenges also present opportunities for collaboration and scientific progress, particularly for aspiring EU members like Türkiye. By aligning with EU policies, Türkiye can leverage these opportunities to drive innovation and foster international partnerships.

The next chapter will focus on Türkiye's science and technology policy landscape, and the insights gained from our exploration of EU policies will be further developed. Thorough analyses of the policies of the EU and Türkiye will be conducted to shed light on the impact of these policies on innovation. This research effort is characterized by critical analysis and inquiry, aimed at uncovering the subtleties of policy convergence, and divergence, and their implications for Türkiye's journey towards integration.

CHAPTER 4

SCIENCE AND TECHNOLOGY POLICY LANDSCAPE IN TURKIYE

This chapter aims to review the development of Türkiye's science and technology policies, starting from as early as the 1960s and whether or not and how these policies have become aligned with the EU's science and technology strategies.

There have been significant legislative and institutional shifts in Türkiye where there has been a transformation to a broader emphasis on innovation, embracing digital transformation and actively engaging in global scientific collaboration. Beyond just outlining Türkiye's key achievements in science and technology, this chapter also considers the challenges and opportunities that have emerged along the way. The changes in Türkiye's science and technology policies have been shaped by both national and international factors. Understanding both the commonalities and divergences between Türkiye and the EU, by addressing the key aspects of Türkiye's alignment with the EU, this chapter aims to contribute to the comprehension of the intricacies in the relationship between these two actors.

The S&T policies of the EU which help drive innovation, and competitiveness, and tackle the challenges of rapid technological changes (Köseoğlu&Erdem, 2016) are crucial not only for the EU economy but also for its global standing. This chapter aims to provide

4.1. Initial Steps in Science and Technology Policy in Türkiye

Türkiye has been progressively developing its S&T policy since the 1960s, shifting its focus towards innovation, digitalization, and global collaboration (Tümer, 2003). By 2023, the expenditures in research and development, notably in digital technology, renewable energy sources like solar and wind, and artificial intelligence

had been intensified. This emphasis aligns with global technology trends and reflects an evolving national innovation system (NIS) that fosters cooperation between the government and the private sector, enhances education on technology, and increases participation in international scientific platforms (Freeman, 1995). These strategic efforts are part of Türkiye's ambition to emerge as a leader in science and technology, aiming to bolster the economy and improve societal well-being through technological advancements. This progression will be delved into through the lens of the NIS, and Türkiye's dynamic approach to integrating into the global scientific community and its potential economic and societal impacts.

Since 1963, Türkiye has undergone significant evolution marked by five key phases leading up to 2023, each characterized by pivotal policy advancement and strategic shifts toward enhancing national welfare through science and technology (Oralhan, 2023). According to Oralhan, the journey commenced with the foundation of TÜBİTAK, symbolizing the inception of organized scientific endeavors. This was followed by a period of policy institutionalization, the adoption of the "Turkish Science Policy: 1983," and the establishment of the Supreme Council of Science and Technology (BTYK/ SCST). Subsequent phases focused on strategic initiatives like innovative R&D funding mechanisms and the Vision 2023 project, aiming to elevate Türkiye's status within EU scientific research and create a robust National Innovation System. The latest phase emphasizes digital transformation, renewable energy, and artificial intelligence, reflecting global trends and prioritizing R&D investment, international collaboration, technology education, and public-private partnerships (Ezanoğlu&Çetin, 2021). This period not only underscores Türkiye's ambition to become a significant participant in the global science and technology arena but also highlights its efforts to foster a closer alignment with the European Union regarding S&T policies.

Between 1963 and 1983, Türkiye embarked on developing its national S&T policy, highlighted by joining the OECD's Pilot Teams Project in the 1960s (TÜBA, 2006) and the inception of the 1st Five-Year Development Plan, by which The Scientific and Technical Research Council of Türkiye (TÜBİTAK) was established. TÜBİTAK’s main function was to organize, coordinate, and promote research in

various fields, keeping up with the global trend of strengthening research through dedicated institutions and laboratories, initially supporting university research through grants and expanding its role to include shaping Türkiye's S&Tpolicies, marking it as a pivotal public institution in research and development (TÜBİTAK, 2023). After 1999, TÜBİTAK also started funding research in social sciences and humanities, expanding its influence beyond just natural sciences (Türkcan, 1998). The OECD project, involving developing countries like Greece, Spain, and Portugal, aimed to o examine the contribution of science and technology research to economic growth and to delineate the challenges and strategies for S&T policy. The project also investigated the challenges and necessary steps to create a S&T policy in each of the participating countries (Göker, 2002). For Türkiye, this was an important early effort to create a strategy and policy for science and technology. However, as Göker mentions, the ideas and plans developed during this project were not eventually put into practice.

Pursuant to Türkiye's Five-Year Development Plan 1963-1967 TÜBİTAK conducted the first national R&D survey in 1964. The goal of this survey was to assess Türkiye's capabilities in science and technology. Several key aspects, such as the number of people working in research, the scope of fundamental research conducted in universities, and the level of R&D activities in the industrial sector have been studied in the survey (Özdaş, 2000). As to the findings of the survey Türkiye had about 4,000 researchers, mostly working in universities, and only 0.37 percent of its resources on R&D had been spent. industrial research and technology development in Türkiye, with most research efforts focused on agriculture rather than technology (Özdaş, 2000). This lack of industrial R&D was linked to the limited advancement of Türkiye's industrial sector and the lack of demand for research and development in this field. Türkcan (1998) pointed out that Türkiye's growing industry preferred to import technology rather than develop it domestically because it was easier and more cost-effective. Additionally, Türkiye faced challenges in creating a demand for industrial R&D due to limited resources, such as skilled workers, scientific knowledge, and funding. During the 2nd (1968- 1972) and 3rd (1973- 1977) Five-Year Development Plans, the importance of technological progress and the need to bring in new technology were recognized (DPT, 1973). In this regard, Türkiye

focused on improving research in both basic and practical areas, while also working to boost the number of researchers in the country. However, these plans did not specify exact steps or methods to achieve these goals (Türkcan, 1998).

4th Five Year Development Plan, (1979 to 1983) (DPT, 1990) was the first to specifically refer to the term "Technology Policy". It aimed to combine technology policy with wider national goals in areas like industry, job creation, and investments. The plan also aimed to improve the technological abilities of important industrial sectors (Eşiyok, 2008). Following the guidelines of this plan, Türkiye set up its initial comprehensive S&T policy in the 1980s. This was an important step in linking technological progress with the country's overall goals for economic and industrial growth.

Table 5. Key Developments

Year Range	**Key Developments**
1960s	*Participation in OECD's Pilot Teams Project *Establishment of TÜBİTAK and initiation of activities in line with the first five-year development plan
1970s	*Emphasis on technological advancement in Türkiye's five-year development plans
1980s	*Formation of Türkiye's first comprehensive Science and Technology policy
1990s	*Commencement of support for research in social sciences and humanities by TÜBİTAK
2000s	*Revision and updating of Science and Technology policy in accordance with Türkiye's objectives
2010s	*Adoption of innovative R&D funding mechanisms and initiation of the Vision 2023 project
2020-2023	*Acceleration of investments in areas such as digital transformation, renewable energy, and artificial intelligence, along with increased international collaborations

4.1.1. Strategic Planning and Policy Formulation

The strategic document "Turkish Science Policy: 1983 – 2003" developed by TÜBİTAK with help from the State Planning Organization (DPT) and contributions

from over 350 experts, is a key element of Türkiye's science and technology strategy (Bayraktutan&Bıdırdı, 2015). This document focuses on two main objectives: enhancing Türkiye's research and development (R&D) infrastructure by ensuring enough skilled professionals and funding and identifying key areas for scientific focus such as computer science, electronic engineering and telecommunications. These areas were chosen not only for their direct importance but also because they play an significant role in improving the skills and knowledge of Türkiye's R&D workforce (Yücel, 2006). Over time, Türkiye has updated its strategic focus to include new technology sectors like renewable energy, showing a flexible approach to adapting to global innovation trends and national development needs (Özdaş, 2000).

During the late 20th century, significant shifts in Türkiye's science and technology policies were evident, particularly highlighted by the 5th and 6th Five-Year Development Plans. The 5th Plan (1985-1989) was a pivotal moment, featuring a dedicated section on "Science, Research, Technology" which underscored the critical role of R&D in economic growth (DPT, 1990). The last decade of the 20th century saw a lot of activity in shaping Türkiye's science and technology policy, especially in establishing institutions and laws. The 6th Five Year Development Plan was particularly significant as it introduced new methods and goals (1990-1994). These goals included increasing R&D in both the private and public sectors, using technology transfer to improve product quality and international competitiveness, and setting up a patent organization to protect intellectual property rights (Official Gazette No. 21970). Important organizations like the Small and Medium Enterprises Development Organization (KOSGEB) and the Turkish Technology Development Foundation (TTGV) were established, showing a strong commitment to developing a national innovation system (Official Gazette No. 20498). Furthermore, the establishment of the Academy of Sciences in Türkiye in 1993 (TÜBA) aimed to increase public interest in science, encourage research, and spread scientific knowledge, as mentioned in Official Gazette No. 21686. The 6th Five Year Development Plan had big goals, like doubling the researchers' number and reaching an R&D intensity of 1 percent. However, achieving these goals proved difficult due to the challenging economic conditions in Türkiye during the 1990s. The country

faced problems like high inflation, budget deficits, and a reliance on short-term financial strategies, which made it difficult to invest in high-tech industries and R&D activities for the long term (TÜİK, 2023). This gap between the planned objectives and the actual results showed the complexity of implementing S&T policies, especially when the economy is not stable (Tekin&Polat, 2023).

During a pivotal period marked by policy shifts and the formation of key organizations, Türkiye aimed to redefine its science and technology landscape. Recognizing the gaps in its initial policy framework, TÜBİTAK introduced 'Türkiye's Science and Technology Policy: 1993- 2003', a document that proposed new policy strategies and established more specific objectives (TÜBİTAK, 1993). However, the difficulty in achieving these goals and implementing plans in critical research domains underscored the need for a more adaptable policy model, capable of navigating economic fluctuations and fostering sustained progress in science and technology (Işık, 2001). Despite ambitious visions for its science and technology sectors, Türkiye encountered significant obstacles, primarily due to its unstable economy throughout the 1990s, characterized by budget deficits, high inflation, and a tendency towards short-term financial strategies. These economic challenges blocked long-term investments in high-tech industries and R&D, constraining the government's ability to financially support technological advancement and industrial research projects (Bayraktutan&Bıdırdı, 2015). As a result, there was a notable discrepancy between policy intentions and actual outcomes. By the conclusion of the 6th development plan, Türkiye fell short of its R&D intensity and researcher targets, illustrating the difficulties of translating policies into practice amid economic adversity (Yücel, 2006). This era in Türkiye's history highlights the critical interdependence of economic health and the efficacy of S&T policies, demonstrating the complexities nations face in aligning ambitious policy objectives with the reality of economic and institutional limitations (Işık, 2001).

4.1.2. Modernization and Global Alignment

The Supreme Council of Science and Technology (SCST/BTYK) is crucial in making Türkiye more competitive in technology both regionally and globally. The

council works to align R&D strategies with Türkiye's goals to foster economic prosperity enhance societal welfare and ensure national security. By working together with government agencies, institutions, civil society, and industry representatives, the SCST/BTYK oversees the execution of these strategies, keeps track of policies, and supports efforts to reduce Türkiye's dependency on imports and enhance its technological production capabilities (Uyar, 2020). It also actively seeks input from the private sector to understand research needs, identify key technology areas, and assess the potential economic impacts for future development (TÜBİTAK, 2023). BTYPK even asks for feedback from the private sector through online surveys to help make strategic decisions. At the same time, the Supreme Council for Science and Technology (SCST/BTYK) emphasized the integration with European S&T policies, marking a significant step by advocating for full participation in the EU's 6th Framework Program (FP6) during a 2002 BTYK meeting. This move was built on a history of collaboration with European research initiatives, starting with joining COST in 1971 and EUREKA in 1985. The involvement in FP6, with a 17.5 billion Euros budget, was seen as an opportunity for Türkiye to enhance its role within the European Research Area (ERA), fostering international collaboration, and improving innovation capabilities. Despite the commitment, illustrated by a 250 million Euros contribution and coordination efforts by TÜBİTAK, Türkiye's engagement in FP6 fell short of expectations, participating in only 55 of the 5,467 projects, a mere 1.01 percent, with an application success rate of 15.3 percent (CORDIS, 2023).

In the late 1990s, Türkiye notably shifted its approach to science and technology, increasing expenditure on R&D and altering its policies and collaboration methods (Göker, 2002). This period marked a departure from the earlier focus on establishing modern R&D facilities to a strategy that emphasized innovation, as outlined in the 7th Five-Year Development Plan. A significant initiative 'Science and Technology Policy of Türkiye: 1993 – 2003' aimed to set new science and technology targets and identify priority investment areas (Tümer, 2003). Then, Türkiye concentrated its investments/spending on specific science and industry sectors, aiming to direct industry efforts and research toward critical fields. This included enhancing transportation infrastructure and fostering innovation in the electronics sector,

underscoring the importance of specialized industrial R&D. The success of such strategic investments required a supportive legal framework to translate R&D outcomes into tangible economic or social benefits. A notable instance was the advancement in renewable energy technologies, which gained momentum with the enactment of the 'Legislation for the Promotion of Renewable Energy Sources in Electricity Production' in 2005 (Official Gazette No. 25819, 2005). This underscores the necessity of cohesive policies, investments, and legal frameworks to catalyze innovation and growth in key sectors (Mazzucato & Perez, 2015).

The 7th Development Plan highlighted the importance of venture capital in supporting high tech startups, identifying the lack of funding as a significant challenge for innovative startups (DPT, 1996). Venture capital (VC) and business angels were pointed out as key to driving technological progress and innovation, especially needing substantial government support. In response, Türkiye initiated its first national venture capital effort, the Garanti Girişim Venture Capital Investment Co., established by Garanti Bankası in 1996 (Official Gazette No. 21629, 1993). This venture set an example, leading to the creation of other major venture capital firms like Akbank-Risk and TekfenLab by 2000, marking significant progress in supporting new high-tech companies and enhancing innovation across the country. Also, as it is understood, these ventures provided crucial financial support and resources, enabling startups to grow and introduce innovative technologies to the marketplace.

In summary, over the past few decades, Türkiye has made considerable strides in developing its S&T policy framework. From the foundational efforts in establishing TÜBİTAK and participating in OECD's Pilot Teams Project to the strategic policy formulation and implementation of comprehensive development plans, Türkiye's approach has evolved significantly. The efforts to align its S&T policies with global trends and national development goals underscore a commitment to innovation and progress. Despite challenges, including economic fluctuations and the gap between policy objectives and outcomes, Türkiye's experience offers valuable insights into the complexities of fostering a robust science and technology ecosystem. As Türkiye continues to adapt and refine its policies, it remains poised to enhance its technological capabilities and competitive edge on the global stage.

4.2. Strategic Transformation in Türkiye's Science and Technology Policy: Developing the National Innovation System in the 21st Century (2000-2020)

At the beginning of the 21st century, Türkiye embarked on a significant transformation of its science and technology policies, marking a new phase that prioritized technological innovation and development as cornerstones of national strategy (Temiz Dinç, 2020). This era was characterized by a series of strategic plans and initiatives aimed at enhancing the country's R&D capabilities, fostering innovation, and positioning Türkiye as a competitive player in the global science and technology arena (Çubukcu, 2024).

One of the steps in this journey was the National Science and Technology Policies: 2003-2023 Strategy Document, which was initiated at the BTYK's 7th meeting, under the Vision 2023 project, sought to establish a "welfare society" proficient in S&T, capable of generating and utilizing new technologies for social and economic benefit (TÜBİTAK, 2018). This long-term strategy focused on identifying Türkiye's current standing and future directions in science and technology, estimating the demands for strategic technologies, and formulating policies for their development or acquisition. During this period, a significant milestone was reached with the introduction of the Science and Technology Implementation Plan covering 2005 to 2010, unveiled during the 10th meeting of the Supreme Council for Science and Technology (BTYK) in 2004 (TÜBİTAK, 2018). This plan outlined Türkiye's primary objectives, principles, and goals in science and technology, introducing the concept of the Turkish Research Area (TARAL) as a means to coordinate the efforts of public institutions, private sector entities, NGOs, and universities within a unified strategic framework (Erdil&Çetin, 2014). TARAL was envisioned as a platform for synergy, coordinating various activities in science, technology, and R&D. This was aimed at aligning various activities in science, technology, and R&D to maximize impact and efficiency.

The National Science, Technology, and Innovation Strategy (UBTYS) for 2011-2016 was designed to sustain the momentum gained through earlier initiatives, particularly the BTP-UP 2005-2010 (Bayraktutan & Bıdırdı, 2015). As TÜBİTAK (2011) prepared document, this strategy emphasized the importance of multistakeholder and

multidisciplinary collaboration in R&D and innovation, strengthening sector-specific and regional research and development activities, promoting increased involvement of small and medium-sized enterprises (SMEs) in innovation initiatives, and augmenting the role of research infrastructure in generating knowledge. It also supported specific strategies in fields where Türkiye already had established R&D and innovation capabilities, like automotive and machinery manufacturing, and need-based strategies in sectors requiring rapid development, such as defense and energy, as stated by TÜBİTAK.

In the development plans, Türkiye updated the key sectors targeted for Research and Development (R&D), which are called 'areas of high-tech advancement'. The plan identified a variety of new priority areas for R&D in Türkiye, covering a wide range of sectors (Temiz Dinç, 2020). The areas that received increased focus and support include Information and Communication Technology (ICT), new material sciences, aerospace and space technologies, and oceanography (Presidency of The Republic of Türkiye Presidency of Strategy and Budget, 2023). It also strongly focused on large-scale science projects, clean energy technologies, biotechnology, and genetic engineering. These changes show Türkiye's strategic goal to make its scientific work align with the latest global trends and challenges (Rizzi, 2014).

The 8th Five Year Development Plan (2001-2005) marked a significant step toward visions. In this regard as Olcay (2018) mentions, the plan focused on establishing a National Innovation System (NIS), improving R&D in SMEs, and setting ambitious targets for technological startups, Technoparks, and Technological Development Zones. In this way, partnerships between academia and corporations, focusing R&D activities on specific sectors, and setting new, challenging goals for science and technology realized (Olcay&Bulu, 2018). Despite the efforts, Türkiye's science and technology output did not meet the preceding plan's targets, spending only 0.64 % of its GDP on R&D and employing 1.25 researchers per 1,000 workers, which was less than the desired 1.5% of GDP for R&D spending and 1.5 researchers per 1,000 people. The next plan kept the same goal for R&D expenditure, while changing the target for researchers to 2 per 1,000 people in the workforce (TÜİK, 2023). In simple terms, the plans that followed continued to improve how Türkiye handles its S&T

policies, slowly but surely increasing its competitive advantage both at home and around the world.

Table 6. Targets of the Science and Technology Policy of Türkiye, (Presidency of The Republic of Türkiye Presidency of Strategy and Budget, 2023)

Development Plan (Law No. 3067)	**9th Five Year Development Plan (2007-2013)**	**10th Five Year Development Plan (2014-2018)**	**11th Five Year Development Plan (2019-2023)**
Goals and Targets	to structure R&D efforts aimed at the market to foster innovation that enhances competitiveness and efficiency.	to boost competitive strength on a worldwide level.	to establish a productive ecosystem for research and innovation.
	to boost the proportion of R&D spending in the Gross National Product and to amplify the contribution of the private sector in these investments.	to enhance technology and innovation initiatives for profit, with an emphasis on the private sector.	to elevate research and innovation efforts to a standard that underpins the creation of high value added products and services.
	the primary goal is to enhance the private sector's capacity for generating innovation.	to capitalize on research outcomes by developing an ecosystem focused on innovation and featuring products rich in technology and protected by trademarks.	to improve the capacity for generating and utilizing knowledge.
	lack of focus on the commercialization process	emphasis on commercialization	focus on producing high value-added products.
	lack of focus on establishing an ecosystem	focus on both engaging the private sector and developing an ecosystem.	aligned with contemporary trends like fostering collaboration, endorsing interdisciplinary efforts, preparing for future technologies, and embracing Industry 4.0 principles.

Over three development plans, Türkiye has gradually refined its strategy in R&D to enhance its competitiveness in both domestic and global markets (Bozkurt, 2015). The 9th Development Plan (2007-2013) laid the initial groundwork, focusing on market-oriented R&D activities. This plan aimed to boost innovation, improve productivity, and enhance market competitiveness, with a particular emphasis on increasing private sector involvement in R&D funding (Avcı, 2010). Following this, the 10th Five-Year Development Plan (2014-2018) raised the ambitions further, stressing the need to improve global competitiveness. It encouraged more technology and innovation activities, especially involving the private sector, and aimed to create an environment where research could be transformed into commercially viable products and services. This plan marked a shift towards building an innovation ecosystem, known for technology-intensive products. The 11th Development Plan (2019-2023) sought to integrate these advancements into a cohesive and influential research and innovation network. Its goal was to enhance research and innovation in sectors that produce high-value products and services, thereby improving the creation and application of knowledge (Çelikkaya et. al., 2019). This recent phase underscored the importance of keeping up with modern trends, including working across different sectors and interdisciplinary efforts, while also preparing for new technologies, particularly those related to Industry 4.0. It could be inferred from these plans show the evolution of Türkiye's S&T policy, moving from basic R&D improvements to developing an advanced, innovation-driven economy.

Türkiye's choice to use the OECD's Oslo, Frascati, and Canberra Manuals in its R&D statistics is a major step in aligning its science and technology evaluations with international standards as mentioned by Beşballı (2018). By adopting these well-known guidelines, Türkiye is making sure its methods for assessing R&D are in line with those used by leading countries like EU Member States, the USA, South Korea and Japan. This move to international standards improves the reliability of Türkiye's scientific data and helps the country become more integrated with the global scientific community (Beşballı, 2018). It shows Türkiye's commitment to following the best practices in S&T that are recognized globally.

The main goals of Vision 2023 were to assess where Türkiye stands in science and technology, figure out the key technologies needed to achieve its goals, look at long-

term global trends in science and technology, and suggest ways to develop or acquire these Technologies (Taymaz&Özçelik, 2004). The Vision 2023 Project was remarkable for how many different groups it involved. NGOs, public entities, universities, chambers, and the Higher Education Council (YÖK) all worked together on this project. TÜBİTAK, Türkiye's main organization for scientific and technological research, managed this collaboration. The project covered different areas like the Technology Foresight Initiative and the National Technology Capability Survey (TÜBİTAK, 2023). The Technology Foresight Initiative is a key part of Türkiye's Vision 2023 strategy. It is about planning ahead and figuring out which technology areas will be important in the next 20 years. The project continues to focus on 'Information Technologies', which has always been important, but it also includes emerging fields like biotechnology, gene technologies, and nanotechnology. This planning shows Türkiye's proactive approach to shaping its scientific and technological future, considering both its own needs and global developments.

Through these strategic and development plans, Türkiye has continually refined its approach to S&T policy. From foundational improvements in R&D to developing an advanced, innovation-driven economy, these efforts demonstrate Türkiye's evolving strategy to enhance its domestic and global competitiveness in the R&D sector.

4.3. Six Decades of Science and Technology Policy in Türkiye: A Journey from Research Orientation to Innovation and Global Collaboration

Over the last sixty years, Türkiye has been dedicated to including science and technology in its development plans, showing how much the country values progress and innovation. The concept of Türkiye's National Innovation System (NIS) plays an important role in orchestrating the country's pursuits in science and technology. As Taymaz (2001) noted, longstanding policies and frameworks continue to shape Türkiye's achievements in these fields. The development of S&T policies in Türkiye is a blend of historical experiences and future aspirations, highlighting the influence of its past on the trajectory of national innovation strategies. This combination emphasizes the dynamic interaction between historical influences and future objectives in shaping Türkiye's NIS, illustrating how enduring policies and

objectives continue to shape its scientific and technological prowess (Taymaz, 2001). Simply, Türkiye's policy development shows a mix of its historical background and modern goals.

A key part of this effort was the 6th Five Year Development Plan. This plan was important because it started using two important measures: the researchers' number in comparison to the population and the percentage of GDP spent on R&D (DPT, 1990). These measures helped show how committed Türkiye was to R&D and helped match its goals with global standards. In this regard, increasing the number of individuals engaged in research and dedicating a higher proportion of the country's GDP to R&D are significant steps for Türkiye's advancement in S&T.

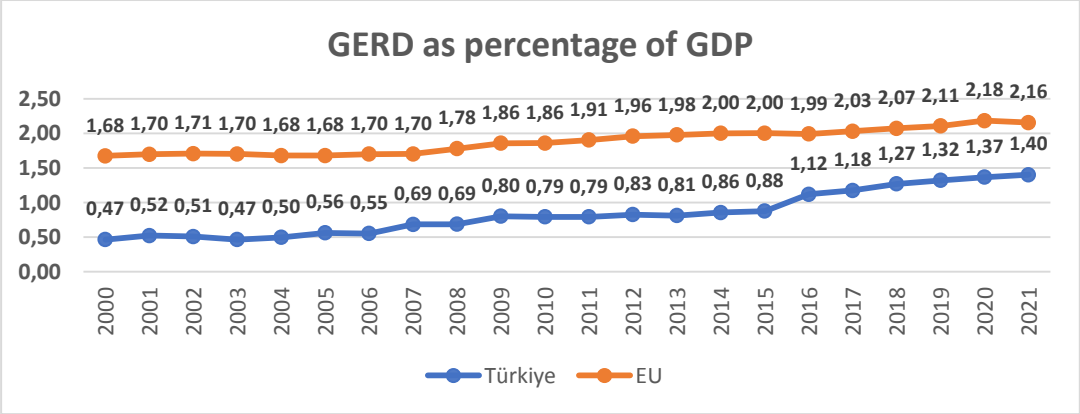

Figure 5. R&D Intensity of Türkiye and European Union (2000-2021), (OECD,2023)

The graph presents a comparative view of R&D spending as a share of the country's GDP between Türkiye and the EU from 2000 to 2021(OECD,2023). Türkiye started the millennium with limited R&D investment, focusing on boosting its researcher numbers and R&D expenditure. Over the years, there was a clear trend of increasing investment with significant policy efforts such as the founding of new universities and the adoption of a National HR Strategy and Action Plan, along with increased national R&D support and TÜBİTAK's budget (Erdil&Çetin&Pamukçu, 2013). From 2005 onwards, Türkiye made concerted efforts to align more closely with the European Research Area, illustrating a desire to integrate with European standards and practices in scientific research. This period saw a significant policy shift with

new universities established in 2016 and increased R&D budgets, signaling a growing recognition of the significance of R&D for national development. The EU had consistently higher R&D expenditure throughout these years, showcasing a robust strategy for maintaining its global competitiveness through innovation (Torun, 2020). The EU's investment remained stable and above 2% after 2014, reflecting its long-term commitment to science and technology. Türkiye's R&D investments saw a remarkable increase, reaching 1.3% of GDP by 2020, demonstrating a substantial progression from the earlier years of the millennium.

Türkiye's strategy to build an innovation-driven economy, evidenced by this increase, aligns with the global shift towards high-tech industries. The big jump in recent years can be linked to government efforts to encourage R&D with tax benefits, grants, and investments in technology parks and universities (Kükrer&Mercan, 2023).

When examining the growth rates from 2000 to 2020, it is observed that Türkiye's expenditures on research and development increased at a rate of 0.93, while the EU's rate was observed to be 0.48. This clearly demonstrates that Türkiye has achieved a rapid increase in its R&D expenditures. However, despite Türkiye's efforts and progress, there is a gap in comparison to the EU's level and its requirements (Çubukcu, 2024). In its 11th Development Plan, Türkiye set a big goal to increase its spending on R&D. The plan aimed for R&D spending to be 1.8% of the country's total spending by 2023, up from 0.81% in 2013. Initially, Türkiye even hoped to reach 2.00% by 2023. However, the actual results did not fully meet these high expectations (Çubukcu, 2024). In 2018, R&D spending was only 1.27%, which was below the 1.8% target. Among the OECD countries, Türkiye had the biggest difference between its R&D spending goal and what it actually achieved (OECD, 2023). This suggests that while Türkiye has been strengthening its policies and investments in R&D, it is still in the process of catching up with the more established R&D frameworks of the EU.

According to Tuna and Bektaş (2015), Increase in R&D as a percentage of its GDP can have many positive effects. Economically, it could lead to better productivity,

more variety in industries, and exports that are worth more. Socially, it could improve people's lives through better healthcare, education, and efforts to protect the environment. Politically, it shows that the government is adapting to a modern economy that values new ideas and innovation. In short, this rise in R&D spending not only shows Türkiye's growing focus on research and development, but also represents the country's ambition to become a leading economy based on knowledge (Tuna&Bektaş, 2015). This period of change, marked by strategic investments in R&D, could set the stage for Türkiye's long-term economic stability and social development. For this reason, meeting EU standards, in terms of R&D intensity, will benefit Türkiye in many ways.

Table 7. Türkiye's Research and Development (R&D) Personnel Headcount, (TÜİK, 2023)

Year- R&D Personnel Headcount in Türkiye (2001-2020)			
2001	75.960,00	**2011**	162.289,00
2002	79.958,00	**2012**	184.301,00
2003	83.281,00	**2013**	196.362,00
2004	86.600,00	**2014**	213.666,00
2005	97.355,00	**2015**	224.284,00
2006	105.093,00	**2016**	242.217,00
2007	119.738,00	**2017**	266.479,00
2008	125.142,00	**2018**	289.791,00
2009	135.043,00	**2019**	305.811,00
2010	147.417,00	**2020**	321.936,00

The number of individuals working in R&D in Türkiye has seen a significant increase from 2001 to 2020. As is seen in the table (TÜİK, 2023), there were about 75,960 people in R&D in 2001, and this number had grown to 321,936 by 2020. This big jump shows that the Turkish government has been focusing a lot on R&D, seeing it as a significant part of economic growth and a way to stand out in the global market (Temel, 2023). What is especially noticeable is that how much faster this growth became after 2005, with an even bigger increase after 2010. This growth is part of a larger shift in Türkiye's policies, aiming to encourage innovation, technological progress, and the creation of new knowledge. These efforts are turning Türkiye into an important place for scientific research and development.

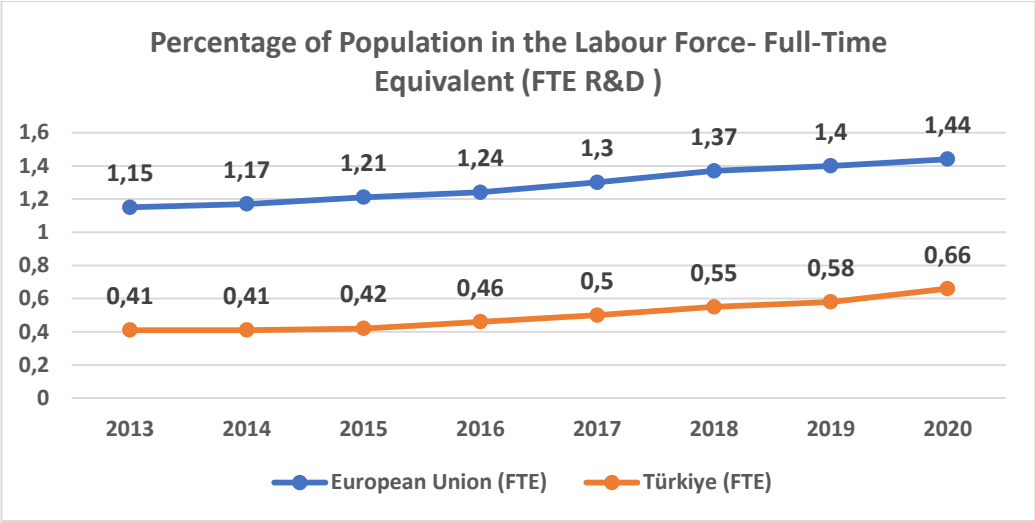

Figure 6. Trends in Full-Time Equivalent (FTE) R&D Labour Force Participation: European Union vs. Türkiye (2013-2020), (OECD, 2023)

The graph comparing the EU and Türkiye from 2013 to 2020 shows how many people are working full-time in jobs related to science and technology (OECD, 2023). This comparison helps to see how science and technology policies, especially those aiming to align with the EU, affect the number of people employed in these fields. Over these ten years, the EU consistently had a higher percentage of its population working full-time in these areas compared to Türkiye. This suggests that the EU has been better at incorporating scientific and technological advancements into jobs (European Commission, 2018). The EU saw steady growth in this area, going from 1.15% to 1.44% of its population in these full-time jobs. On the other hand, Türkiye's progress was less steady. This might show that while Türkiye's adoption of EU-aligned science and technology policies was slower, it is starting to catch up. The difference between the EU and Türkiye highlights the importance of policy decisions and suggests that Türkiye has room to grow in this area by continuing to adopt EU standards in its S&T policies.

The number of people employed in R&D went from 172,000 in 2018 to 300,000 in 2023. Also, the number of highly qualified people (with PhDs or higher) working in R&D per one million people grew from 352 in 2017 to 863 in 2023 (Presidency of The Republic of Türkiye Presidency of Strategy and Budget, 2023). This shows that there are more experts in Türkiye's R&D sector. These numbers from the 11th

Development Plan for 2023 show that Türkiye is committed to improving its R&D capabilities, even though it faced challenges in reaching its very ambitious goals (TÜBİTAK, 2023).

Table 8. Components of Innovation Process and Institutional Roles of Türkiye

Innovation Ecosystem Components	**Institutions Involved**	**Role**	**Activities**
Research Development	Science, Technology, and Innovation Policies Board (BTYPK)	Oversight & Strategy Formulation	Formulating long-term S&T policies
	Ministry of Industry and Technology (MoIT)	Policy Implementation	Implementing and managing science and industry policies
	TUBITAK, MAM, and institutes	Research & Development	Conducting research and technological development
Knowledge Development	Universities	Education & Research	Providing education and conducting innovative research
Knowledge Diffusion	Technology Development Zone (Technoparks)	Commercialization & Support	Facilitating the transition from ideas to market-ready products
Increasing R&D	Technology Development Center (TEKMER)	Support & Funding	Offering financial and infrastructural support for R&D
	The Ministry of National Education (MoNE)	Educational Policy	Setting educational standards and policies for innovation
Market Formation	Private companies	Product Development & Sales	Developing and selling innovative products in the market

The table reflects the organizational structure of Türkiye's innovation system. The system is a well-coordinated, multi-layered network of governmental bodies, research institutions, and private sector entities, each with defined roles that contribute to the overarching goal of fostering a dynamic and sustainable innovation ecosystem (Mercan&Goktas, 2011). This structure is anchored by the Science,

Technology, and Innovation Policies Board (BTYPK), which holds the strategic responsibility for the oversight and formulation of S&T policies. These policies are shaped by long-term objectives and are pivotal in directing the national agenda for innovation. Working closely with the BTYPK, the Ministry of Industry and Technology (MoIT) is tasked with the practical implementation of these policies. MoIT ensures that the strategic plans are operationalized within the scientific and industrial communities, thereby acting as the connective tissue between policy formulation and on-the-ground execution. Research and development, the bedrock of innovation, are driven by institutions such as TÜBİTAK, MAM, and their affiliate institutes. These organizations form the backbone of the scientific research community in Türkiye, working on a diverse array of projects that span from fundamental research to applied science. Universities in Türkiye play a dual role within this organizational matrix, serving as both educational institutions and research centers (Erdil&Akçomak, 2021). They play a significant role in developing human capital, providing students with the essential competencies and information needed to excel in an economy driven by innovation. The research conducted within these universities often leads to breakthroughs that have the potential for commercial application.

The bridge between theoretical research and market application is constituted by Technology Development Zones (Technoparks) and the Technology Development Center (TEKMER). These institutions support innovators and entrepreneurs in commercializing their ideas, providing the necessary resources, including funding, mentorship, and infrastructural facilities, to translate scientific research into market-ready products (Akçomak, 2003). The Ministry of National Education (MoNE) shapes the foundational aspects of the innovation system by developing educational policies that promote critical thinking, creativity, and a scientific mindset from an early stage. By aligning the educational curriculum with the needs of an innovation-based economy, MoNE ensures a steady stream of skilled individuals who can contribute to and sustain the innovation pipeline. At the market formation end of the spectrum, private companies are the last part of the process. They bear the responsibility for advancing, manufacturing, and marketing innovative products and services. These companies not only respond to market demands but also create new

markets through their innovative offerings, thus completing the cycle from idea generation to market realization. This structured, interdependent organizational framework allows for a seamless flow of ideas, resources, and knowledge, ensuring that each stage of the process of innovation is supported and that the transition between stages is smooth and efficient (Atmaca, 2006). It is through this collaborative and systematic approach that Türkiye seeks to advance its position as a leader in science and technology on the global stage.

Figure 7. TÜBİTAK Venture Capital Funding Program (TÜBİTAK, 2018)

In the dynamic landscape of Türkiye's economy, the venture capital ecosystem has emerged as a cornerstone for technological advancement and economic revitalization. Central to this ecosystem is the TÜBİTAK Tech-InvesTR Venture Capital Support Program, which exemplifies a successful synergy between government initiatives and private sector dynamism (TÜBİTAK, 2018). This program, through its diverse array of funds including the Tech-InvesTR Funds, has catalyzed the transformation of academic research into viable commercial ventures. Particularly noteworthy is the role of technology development zones and technology transfer offices in nurturing early-stage, technology-focused startups (Demirhan, et al., 2019). The program's inclusion of international entities, exemplified by the European Investment Fund's contribution of 30 million Euros, highlights its global dimension and appeal in the international venture capital community. Such strategic alliances underscore Türkiye's commitment to fostering an environment conducive to innovation and economic growth, by leveraging venture capital as a tool for sustaining and expanding its technological frontiers (Altunbasak, 2016). This approach not only bolsters Türkiye's position in the global market but also sets a precedent for how emerging economies can integrate venture capital into their growth strategies.

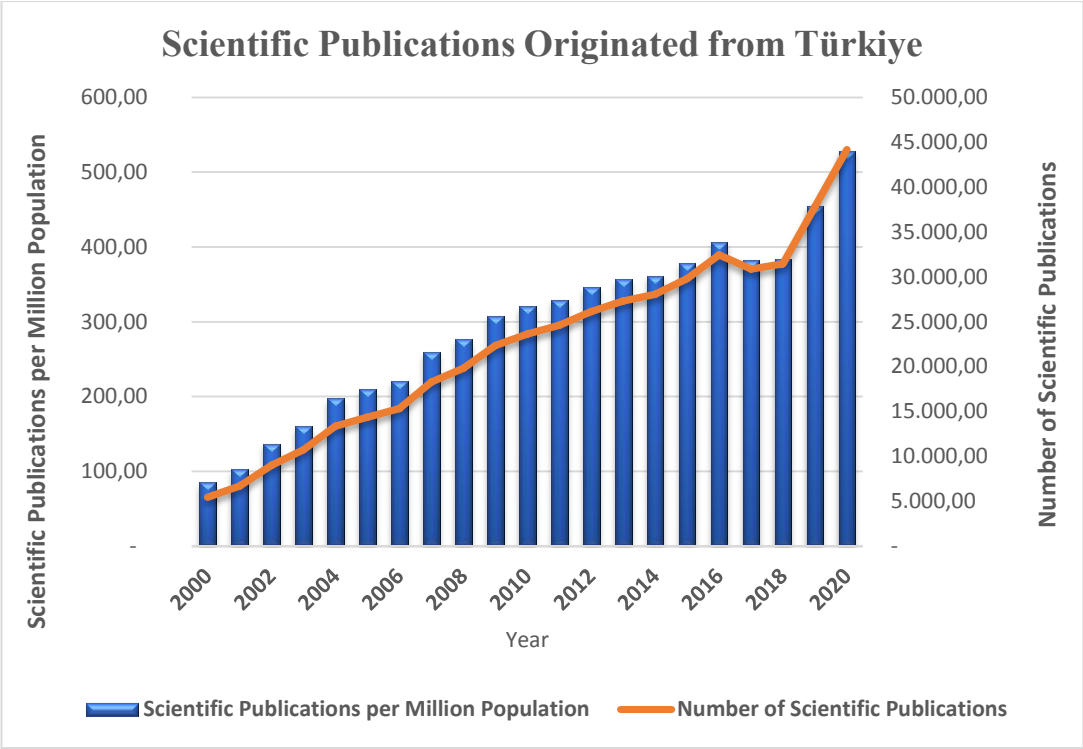

Figure 8. Scientific Publications Originated from Türkiye, (TÜBİTAK, 2023)

The graph delineates a clear trajectory of escalating scientific productivity in Türkiye from 2000 to 2020, evidenced by two metrics: the overall number of scientific publications' number and publications per million population (TÜBİTAK, 2023). Commencing in 1990, there is a discernible ascent in scientific outputs, with a marked intensification beginning in 2004 and continuing until 2016, after which the increase moderates yet persists, then, it shows a sharply increasing trend. Increased spending in R&D under S&T policies is among the main reasons for this increasing trend (Altın&Kaya, 2009). This trend likely reflects the impact of Türkiye's policies, aimed at bolstering research capacity, fostering academic excellence, and facilitating international scholarly engagement. However, when comparing Türkiye's performance with the EU, Türkiye lags behind in both the number of scientific papers and publications per person (OECD, 2023). EU countries generally have higher scientific publication outputs, often associated with more advanced S&T policies (Eurostat, 2023). To improve Türkiye's performance in this area compared to the EU, more investment and strengthening of science policies may be necessary. This insight is important for the evaluation of the effectiveness of S&T policies in advancing research within the country.

Türkiye's path toward innovation and technological advancement has been marked by strategic policy interventions, institutional collaborations, and a dedicated focus on developing human capital. Despite facing challenges in meeting ambitious R&D spending targets, Türkiye's efforts have resulted in a notable rise in R&D spending and scientific productivity. The venture capital ecosystem, exemplified by programs like the TÜBİTAK Tech-InvesTR Venture Capital Support Program, has emerged as an important force behind technological advancement and economic growth. In conclusion, Türkiye's policy landscape presents a dynamic and evolving framework, with a strategic focus on innovation, international collaboration, and alignment with global trends. However, realizing these ambitions will require continued attention to policy implementation, economic stability, and fostering an effective national innovation system.

4.3.1. Legislative Frameworks and Policy Tools Shaping the Science, Technology

The landscape of S&T policy has been shaped by a diverse array of policy tools, as categorized by Borrás and Edquist (2013). These tools are classified into three main categories: i) fiscal and monetary tools, ii) regulatory measures, and iii) informal mechanisms. Economic tools, often deemed as 'hard tools', play a crucial role by providing monetary incentives or disincentives to support specific socio-economic activities (Erdil&Akçomak, 2021). These include various forms of financial aid and economic encouragements or restrictions. On the other hand, regulatory instruments employ legal means to govern social and market interactions. These mandatory regulations, such as laws and directives, are instrumental in shaping the operational frameworks within society and economy, particularly in the realm of Intellectual Property Rights (IPRs) and competition policies (Davidson&Liedekerke, 2021). A notable shift towards a policy mix approach has been observed, emphasizing the combination of these varied instruments to address specific innovation-related challenges (Erdil&Akçomak, 2021). This approach acknowledges the interaction and complementarity of different policy tools. An example of this policy mix in action is the National Technology Act, which incorporates a blend of hard, soft, and regulatory tools.

When it comes to policy tools in the context of S&T policies in Türkiye, over recent years, Türkiye's constitutional and S&T regulatory landscape has undergone significant transformations. This complexity and dynamic nature often create confusion for stakeholders (Erdil&Akçomak, 2021). The legal landscape in Türkiye is comprised of several legal tools; related S&T Laws, Digital Regulations, Personal Data Protection Law (KVKK), Cybercrime, Presidential Decrees and Decisions, Statutory Rules, Orders and Other Legal Observations. Law No. 4691, Law No.5746, Law No. 6676, Law No. 7263, Law No. 6550, Law No. 6769, will be evaluated.

Law No. 4691 on Technology Development Zones" dated 2001 represents a significant advancement in bolstering R&D in Enterprises and fostering university-industry collaborations this legislation strategically introduced innovation hubs and specialized technology zones, primarily initiated by universities and the Small and Medium Enterprises Development Organization (KOSGEB), to serve as nurturing grounds for startups and as dedicated office spaces for a diverse range of corporate entities (Official Gazette No. 24454, 2001). As indicated in the first Article of Law No. 4691, the primary aim of these innovation hubs is to create a collaborative environment conducive to knowledge transfer, thereby spurring technology production and innovation. A significant aspect of the law is the provision of incentives such as tax exemptions to enhance the appeal of these zones to companies and entrepreneurs (Kükrer&Mercan, 2023). This policy initiative underscores the critical role of government legislation in stimulating technological advancements and innovation within the private sector, particularly among SMEs, and highlights the importance of synergizing academia and industry for an innovative ecosystem.

Law No. 5746, titled "Support of Research, Development, and Design Activities" holds an important position in advancing Türkiye's research, development, and design landscape (Official Gazette No. 26814, 2008). As indicated in the first article of law no. 5746, enacted with the aim of strengthening Türkiye's R&D ecosystem, as part of the R&D reform package, offers various incentives and support mechanisms to businesses actively involved in research and development endeavors. Key provisions include allowing companies to treat R&D project expenditures as deductible expenses and offering substantial income tax withholding benefits.

Additionally, the law exempts purchases related to these activities from customs duties and fees, while employees in these sectors are relieved from paying stamp duty. Also, as it is indicated in the Law, it extends insurance premiums to employers and commits to providing personnel support to companies. Additionally, it ensures a gross wage for two years for recent graduates in fundamental sciences who are employed within R&D centers established in compliance with the Law. Notably, the legislation incorporates design activities into the framework of R&D support, acknowledging the establishment of Design Centers and providing them with substantial assistance.

An essential aspect of Law No. 4691 involves the issuance of certificates for R&D centers. enabling non-governmental businesses to access infrastructure support in Technology Development Zones where it aims to create an innovation-driven economic environment, cultivate a skilled workforce, and boost Türkiye's global competitiveness. By this regulation, foreign-owned or financed companies to invest in Türkiye are also encouraged and organized in their research and development units within the country to foster technology development.

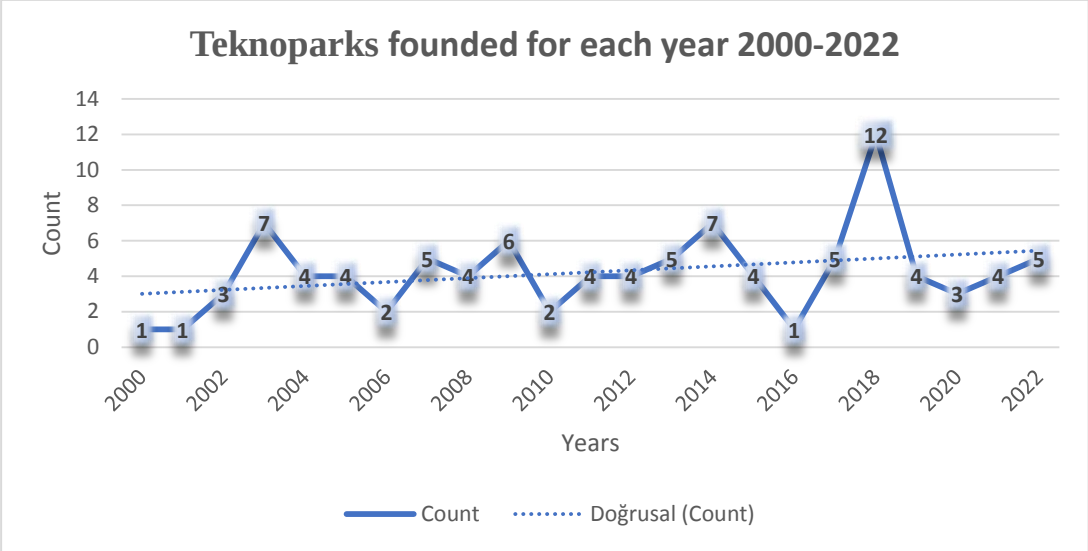

Figure 9. Technology Parks in Türkiye (2000-2022), (Ministry of Industry and Technology, 2023)

Technology Development Zones (TDZs) in Türkiye are specialized regions established to foster innovation and technological progress. Technology Parks and

Technocities in Türkiye significantly contribute to the advancement of S&T policy (Unsal, 2019). Since their introduction by law in 2001, these zones have expanded to a total of 97 in number (Ministry of Industry and Technology, 2023). These parks not only contribute significantly to Türkiye's Gross Domestic Product (GDP) and technological entrepreneurship but also host a diverse range of companies from various sectors, fostering R&D activities. The focus of these technoparks is primarily on sectors such as computer and communication technologies, software, machinery and equipment manufacturing.

Technoparks also support young and innovative startups. For instance, ODTÜ Teknokent hosts globally successful ventures like Udemy. Other technoparks like Yıldız Teknopark, İTÜ ARI Teknokent, Boğaziçi Teknopark, Bilkent Cyberpark, Gazi Teknopark, Ankara University Teknokent, and many others, provide a nurturing environment for numerous startups achieving both national and international success in R&D (TÜBİTAK, 2023). As it is indicated in law no 4691, these zones offer various incentives like tax exemptions for software and R&D revenue and government-supported insurance premiums for R&D employees. Consequently, the country's investment in R&D enhances its importance, contributing to increased science and technology outputs (Zuhal, 2017). The TDZs facilitate close collaboration between technology companies and academic institutions, providing an integrated environment for research and development. Additionally, these zones are equipped with advanced infrastructure and services tailored for high-tech enterprises, along with streamlined legal and administrative processes to encourage and support innovation-focused activities. It is indicated that these incentives are integral to Türkiye's strategy to enhance its technological capabilities and stimulate economic growth through R&D and innovation.

Law no. 6676, integral to the Information Society Strategy, named as Law on R&D Support and Amendments, marks a significant legislative step in bolstering research and development activities. This law, embedded in a broader strategy to enhance the IT sector, focuses on refining the efficiency of incentives and support mechanisms (Dokuzoğlu&Kayahan, 2020). It emerged from a detailed impact analysis conducted by the Ministry of Industry and Technology (MoIT), identifying areas necessitating

improvement as mentioned by Dokuzoğlu and Kayahan (2020). Consequently, Law No. 6676 was enacted, aiming to amplify the effectiveness of the existing supports (Official Gazette No. 29636, 2016). However, despite these advancements, there remains an evident need for more comprehensive coordination, monitoring, and control over these incentives.

Law no. 7263, amending Law number 4691, has catalyzed the establishment of many TDZs across Türkiye, driving technological progress (Official Gazette No. 31384, 2021). This amendment extends the subsidies and exemptions provided under Laws 4691 and 5746 until the end of 2028. One of the most notable changes introduced by this amendment is that, starting from 2022, firms and R&D and Design Centers generating revenue exceeding 1 million Turkish Lira must allocate 2 percent of the revenue that they earn to support a venture capital fund (Law No. 7263, 2021). This fund is specifically designed to support local entrepreneurs and invest in startups, particularly those based in incubators. This amendment reflects a strategic shift towards fostering a more robust startup ecosystem and enhancing the role of private sector investment in fueling innovation within Türkiye's Technology Development Zones (Erdil&Akçomak, 2021).

Similarly, the EU emphasizes the importance of R&D activities through various legislative frameworks and initiatives. One of the examples is the European Digital Innovation Hubs (DIHs). DIHs are entities that provide a range of services to foster digital innovation and support SMEs in integrating digital technologies. They offer expertise, access to funding, and networking opportunities to accelerate digital transformation and enhance competitiveness. By promoting collaboration between academia, government and industry, Digital Innovation Hubs contribute to the advancement of digital innovation across the EU (EurLex, 2023). Therefore, both Türkiye and the EU recognize the significance of legislation and policies aimed at enhancing R&D efforts to promote economic development and enhance competitiveness on a global scale.

Law no. 6550, concerning the Support of Research Infrastructures, represents a pivotal legal framework in the realm of research development in Türkiye. As is

mentioned in the law (6550) article, this law 6550 plays an important role in shaping the country's research infrastructure (Official Gazette No. 29056, 2014). It focuses on enhancing the effectiveness and sustainability of research infrastructures within higher education institutions (Erdil&Akçomak, 2021). For this purpose, the Board of Research Infrastructure, which has legal authority, recognized the exceptional status of four distinguished research facilities for a period of five years. This decision recognized the Dokuz Eylül University İzmir International Biomedicine and Genome Institute (İBG), Sabancı University Nanotechnology Research and Application Centre (SUNUM), Bilkent University National Nanotechnology Research Centre (UNAM) (Official Gazette No. 28033), and the Middle East Technical University Microelectromechanical Systems Research and Application Centre (METU-MEMS) for their excellence (Official Gazette No. 26992). The law continues to undergo an evaluation process for other research infrastructures, indicating an ongoing commitment to bolstering the research capabilities and infrastructural sophistication within Türkiye. The European Union similarly emphasizes the importance of research infrastructure through initiatives such as the Horizon Europe program. These frameworks aim to strengthen collaboration, facilitate access to cutting-edge facilities, and drive progress in various fields of science and technology (Erdil&Akçomak, 2021). In conclusion, having legislation supporting research infrastructures is essential for both Türkiye and the European Union, as it fosters innovation, technological advancement, and scientific development.

As indicated in Article 1 of Law no. 6769, the Law aims to protect intellectual property rights such as trademarks, traditional product names, patents, geographical indications, utility models, and thereby fostering technological advancement and contributing to economic and social progress (Official Gazette No. 29944, 2016). Preserving intellectual property rights contributes to the encouragement of innovation and the promotion of technological advancement (Chen&Puttitanun, 2005). Additionally, these laws enhance economic growth and competitiveness while also contributing to social development. On the EU side, EU intellectual property policies are designed to ensure the operation of the EU's internal market, promote innovation, and support economic growth. These policies establish a standard for the protection and enforcing intellectual property rights across EU member states. and

foster cooperation across the EU. Thus, EU intellectual property policies, along with the EU's S&T policies, have a positive impact on research, innovation, and economic development. Hence, having legislation on intellectual property rights is important for both Türkiye and the European Union, as it supports innovation, technological advancement, and economic development in both regions.

Türkiye's S&T policy landscape is not only framed with the above summarised laws but also modeled upon the policies of the EU and the National Innovation System (NIS). Türkiye's alignment with EU technology policies ensures compatibility with regional standards and facilitates collaboration on research, development, and innovation initiatives. Moreover, the National Innovation System (NIS) framework provides a strategic approach to foster innovation and technological advancement within Türkiye, emphasizing the coordination of public and private sector efforts, investment in research infrastructure, and the promotion of entrepreneurship. By incorporating elements from both EU technology policies and the NIS framework, Türkiye aims to enhance its innovation ecosystem, strengthen competitiveness, and achieve sustainable economic growth.

4.4. Concluding Remarks

The scope of this chapter is intricately tied to the research aim, which is to understand Türkiye's science and technology policy within the context of its integration journey with the European Union (EU). By delving into Türkiye's policy landscape, the groundwork for the analysis of EU policies is laid, aiming to uncover the nuances of policy convergence, divergence, and their implications for Türkiye's integration trajectory.

In summary, Türkiye's evolution from early initiatives in the 1960s to strategic transformations in the 21st century, emphasizing innovation and technology-driven growth, has been observed. Initiatives such as Vision 2023 and the National Science, Technology, and Innovation Strategy highlight Türkiye's ambition to position itself as an innovation leader. Central to Türkiye's progress has been its investment in R&D, as seen in initiatives like the Technology Foresight Initiative and the

establishment of technology development zones. Türkiye's innovation ecosystem, supported by various institutions and legislative frameworks, provides fertile ground for fostering creativity, entrepreneurship, and knowledge exchange. While Türkiye has made significant strides in R&D spending and scientific publications, there is still room for growth, particularly in aligning with EU standards and enhancing collaboration. Looking forward, sustained focus on policy implementation, investment in research infrastructure, and fostering a supportive environment for innovation will be crucial for Türkiye to achieve its goals of becoming an innovation powerhouse globally. Türkiye's journey in science and technology policy underscores its commitment to innovation, adaptability, and global collaboration. Throughout the years, Türkiye has faced various challenges, emphasizing the crucial role of S&T in driving progress and national development.

In this chapter, the foundation is laid by providing insights into Türkiye's policy landscape. In the next chapter, Türkiye's evolving S&T policies over the past two decades will be delved into in the context of its journey towards EU integration by analyzing the European Progress Report. This will help in understanding to what extent Türkiye is being converged or diverged from EU science and technology policies and contribute to understanding policy convergence.

CHAPTER 5

EVOLVING SCIENCE AND TECHNOLOGY POLICIES OF TURKIYE: A TWO DECADE JOURNEY TOWARDS EU INTEGRATION (2000-2023)

A primary area of consideration is Türkiye's participation in EU research and science programs and the convergence of its policy with the EU expectations. These programs are designed to foster scientific excellence, enhance competitiveness, and foster innovation. "Chapter 25" of the EU accession negotiations on "Science and Research", focuses on how well Türkiye aligns with EU policies and programs in these areas (European Commission, 2023). It looks into Türkiye's involvement in various EU research and innovation programs aimed at promoting scientific excellence, boosting competitiveness, and advancing new technologies. Chapter 25 also assesses Türkiye's R&D infrastructure and investments, including those in universities, research institutes, and the private sector (Işık, 2001). Additionally, it scrutinizes Türkiye's ability to establish and maintain scientific and technological partnerships with the EU, covering joint research ventures, knowledge exchange, and scientist mobility (Akdoğan, 2014). Furthermore, compliance with EU standards and regulations regarding ethics, research quality, and access to funding is examined. Türkiye's financial contributions to EU research programs and its benefits from them are also key aspects of this chapter. In this regard, collaborative efforts in science and research bring significant advantages for both the EU and Türkiye, playing a crucial role in achieving shared goals.

Türkiye has strategically accelerated its development process while considering key EU strategies. Notably, its R&D spending has increased, with R&D expenditure relative to GDP reaching 1.09% in 2020 (TÜİK, 2023). Human capital is recognized as an important catalyst of progress in science and technology, leading Türkiye to double its number of researchers in the past decade (European Commission, 2021).

The 11th Development Plan (2019-2023) prioritizes high-value R&D and innovation activities, focusing on sectors such as chemistry, pharmaceuticals, electronics, and advanced Technologies (Presidency of The Republic of Türkiye Presidency of Strategy and Budget, 2019). Türkiye has actively participated in EU Framework Programmes for Research and Development since 2002, with significant involvement in Horizon 2020 and Horizon Europe. It ranks fourth among associated countries in Horizon 2020 participation (European Commission, 2023). Furthermore, Türkiye is recognized as an "emerging innovative country" according to the 2021 Innovation Scoreboard. In addition to its participation in EU programmes, Türkiye aims to enhance its role within the European Research Area (ERA) (Çetin&Ezanoğlu, 2021). It engages as an observer in all COST (Cooperation in Science and Technology) and ERA activities, contributing to ERA governance initiatives.

Chapter 25 holds significant importance in Türkiye's journey toward European Union (EU) accession, particularly in the realm of science and technology policies. Unlike some other chapters where progress may have been slow, advancements in science and technology policies have been notable under Chapter 25. This chapter underscores Türkiye's efforts to align its policies with EU standards, showcasing its dedication to harmonizing its science and research frameworks with those of the EU. The closure of Chapter 25 in 2006, focusing on Science and Research, marks a pivotal milestone in Türkiye's EU accession process, illustrating its commitment to EU norms in science, technology, and innovation. This closure signifies Türkiye's strides in integrating its science and research policies with EU standards, which can have positive implications for various sectors such as economic growth, innovation, and employment. Notably advancing in this chapter, Türkiye's commitment to harmonizing its science and research policies with the EU's not only fosters innovation but also drives economic prosperity, societal advancement, and international cooperation, shedding light on the challenges, accomplishments, and future collaborations between the two entities.

As Türkiye strides towards further integration with EU policies and frameworks, it not only showcases a remarkable commitment to enhancing its scientific and

research landscape but also demonstrates a strategic alignment with key EU strategies as it is analyzed and will be analyzed. As it is delved deeper into the following section, it will analyze the details of Türkiye's journey, emphasizing its strong commitment to meeting EU standards and working together on science and research projects.

5.1. Progress and Challenges in Türkiye's Science and Research Policy: The Road to EU Accession (2000-2012)

From 2000 to 2005, Türkiye made significant progress in the field of S&T, as part of its EU accession process (Nas&Özer, 2017). The 2000 EU Progress Report by the European Commission (2005) noted Türkiye's active participation in European research initiatives, including the Eureka program and the European Cooperation in Science and Technology (COST). The foundation of the National Accreditation Council and the National Council for Information Technologies marked legislative advancements. However, challenges included limited private sector R&D spending, with R&D expenditure being merely 0.49% of GDP in 1997 (TÜİK, 2023). The report highlighted the need for increased spending on R&D, especially for SMEs, to strengthen Türkiye's position in the European scientific community (European Commission, 2002). 2002 saw a pivotal moment with Türkiye's full participation in the 6th European Community (EC) Framework Programme, facilitated by TÜBITAK. However, the report identified the necessity for increased private-sector participation in R&D activities. In 2003 and 2004, Türkiye's involvement with the 6th EC Framework Programme marked a significant milestone as reported by the European Commission in 2003. To exemplify, The Turkish Research and Business Office in Brussels (TuR&Bo) was established in Brussels to track developments in the European Research Area. It offers policy advice to its founding partners, focusing on strategic analysis for Türkiye's involvement in EU programs. On the other hand, challenges remained in the form of low investment in R&D and a limited researchers' number. Also, emphasizing the importance of the private sector's role, particularly that of SMEs, was deemed essential (European Commission, 2004). Moreover, the 2005 report underscored advancements in coordination, and a rise in the quantity of National Contact Points. In this regard, financially, TÜBITAK's

budget significantly increased. Also, Türkiye expanded bilateral science and technology cooperation agreements, improving international publication output. The report concluded that while Türkiye had made strides in strengthening its science and research capacities, there was still a need for increasing project proposals, addressing legal challenges, and further supporting R&D activities (European Commission, 2005).

Table 9. Türkiye Science and Research Progress 2000-2005, (European Commission, 2023)

Year	Major Developments and Achievements	EU Program Participation	R&D Investment and Personnel	Challenges and Goals
2000	Some progress since the last report. Participation in European research activities increased. Establishment of National Accreditation Council and an IT National Council.	Not a full partner in the 5th RD Framework Programme, continued project-based participation.	Restricted spending in R&D from the private sector. Strategy to boost the researchers' number and escalate R&D expenditure.	Need to rise total R&D spending and improve private sector investment.
2001	New developments; decision to evaluate final participation in the 2002-2006 R&D Framework Programme. Continued project-based participation in the 5th FP	Continued project-based participation in the 5th FP	Low activity and spending level in the R&D sector. Need to increase total domestic expenditure on technological development.	Important deficiencies in the R&D sector; need to increase total domestic expenditure on technological development.
2002	Endorsement of complete involvement in the 6th EU Research and Development FP. TÜBİTAK persists in its endeavors to enhance consciousness and offer guidance and training for engagement in the program.	Complete involvement in the 6th EU Research and Development Framework Programme.	Low R&D expenditures relative to GDP, low researchers' number.	Low R&D expenditures and researchers number compared to EU average. Constrained involvement of the private sector and SMEs in research initiatives.

Table 9. (continued)

2003	Participation in the 6th FP. New law for TÜBİTAK to regulate procurement of goods and services for R&D. Increase in R&D expenditures but still low compared to EU average.	Continued participation in the 6th FP.	Increase in R&D expenditures but still low in comparison to EU average. No increase in the researchers' number.	Low R&D spending and researchers' number. Need to increase research activities and role of private sector and SMEs.
2004	Minor progress since the last report. Continuation in the Sixth Framework Programme. Changes in TÜBİTAK law to give appointment powers to the Prime Minister.	Continued participation in the 6th FP.	Low R&D expenditures relative to GDP. The role of universities and public research institutions remains significant.	Low R&D expenditures and researcher numbers. Need for further development in research and technological advancement.
2005	Some progress continued participation in the 6th FP. Strengthening of the National Coordination Office for FP6.	Continued participation in the 6th Framework Programme.	Increase in R&D expenditures. Efforts to integrate more into the European Research Area.	Low R&D expenditures relative to GDP. Need to strengthen research activities and increase the involvement of private sector and SMEs.

In the years between 2006 and 2012, Türkiye continued its efforts in the Science and Research sector, with ongoing improvements and developments, aligning with the requirements of the EU accession process (Karagöl&Karahan, 2014). According to a European Commission report in 2006, Türkiye's participation in the 6th Framework Programme for Research and Development (FP6) resulted in a nearly fivefold rise in research budgets compared to 2002. However, despite these strides, challenges persisted. Türkiye encountered a 17% success rate in FP6 projects, falling below the EU average, and faced limited engagement from the private sector and SMEs in research endeavors. Furthermore, the integration of research into education remained inadequate. In 2007, Türkiye took significant steps by adopting a national innovation

strategy and establishing 17 new universities alongside the existing 15. The success rate in FP6 projects improved to approximately 18.7%. However, Türkiye had fewer researchers per million people compared to the EU average, and private sector involvement in research remained limited. Türkiye was preparing for participation in the 7th Framework Programme for Research and Development (FP7, 2007-2013), focusing on enhancing international collaboration, promoting researcher mobility, and fostering science-society initiatives (European Commission, 2007). In 2008, Türkiye enacted a new law aimed at fostering research and technological development. Additionally, Türkiye adopted a National Human Resources Strategy and Action Plan to bolster the researchers' number. Participation in FP7 increased, with Türkiye actively seeking collaboration in the Seventh Euratom Research Framework Programme, emphasizing researcher mobility and international cooperation. According to the European Commission report in 2009, Türkiye revised regulations governing R&D support programs and boosted national R&D funding by €100 million. Türkiye's active participation in international research initiatives like COST and EUREKA, as well as its success in securing Marie Curie scholarships, underscored its dedication to advancing research endeavors. In 2011, the EU Progress Report acknowledged Türkiye's adoption of the national S&T strategy for 2011-2016. TÜBİTAK's budget increased to €340 million, though R&D expenditure relative to GDP stayed beneath the set national goal. Türkiye's participation in FP7 was active, with a slight improvement needed in the success rate of project funding. Also, efforts to enhance administrative capacity and effective operation of the national contact point network were noted. In 2012, Türkiye maintained a high success rate in FP7 projects, particularly excelling in thematic areas such as ICT, Knowledge-Based Bio-Economy, Transportation, and Security. Effective collaboration with the Joint Research Centre (JRC) persisted (EU Progress Report, 2012).

Between 2006 and 2012, Türkiye advanced in science and research through EU program participation and new universities. Limited private sector engagement was a challenge, but Türkiye's global research involvement shows dedication to progress. Overcoming these hurdles and sustaining international partnerships are crucial for future progress.

Table 10. Türkiye Science and Research Progress 2006-2012, (European Commission, 2023)

Year	Major Developments and Achievements	EU Program Participation	R&D Investment and Personnel	Challenges and Goals
2006	Significant progress. Continued participation in FP6 with an improved success rate. Significant increase in R&D budgets.	Continued participation in FP6 with an improved success rate.	Significant increase in R&D budgets. New universities established.	Improvement in research capacities. Need for further integration into the European Research Area.
2007	Good progress. Adoption of a NIS and action plan. Active cooperation with Joint Research Centre.	Partnership in the 6th Framework Programme (FP6) with an advanced success rate of 18.7%.	Increase in R&D expenditures. Adoption of National HR Strategy and Action Plan.	Necessity to boost the quantity of researchers and reinforce the involvement of the private sector and SMEs in R&D.
2008	Good progress. Update of R&D support programs. Appointment of a State Minister to coordinate stakeholders in R&D policy.	Progress in participation in the 7th Framework Programme (FP7).	Rise in national R&D support and TÜBİTAK budget.	Need to enhance the effectiveness of existing support programs and rise the role of private sector in R&D.
2009	Good progress. Rise in national R&D support and budget for TÜBİTAK. Continued involvement in the FP7.	Increased involvement in the FP7.	Increased national R&D support. New support program for Turkish researchers returning from abroad.	Need to increase research capacities and scientific excellence to maintain and improve success rates in EU programs.
2010	Good progress. New support programs for returning Turkish researchers. Decision to prepare a national science and technology action plan for 2011-2016.	Progress in participation in the Seventh Framework Programme (FP7).	Increased R&D budget for TÜBİTAK. Increase in private sector R&D centers.	Need to strengthen research capacity and scientific excellence to improve success rates in EU programs.

Table 10. (continued)

2011	Good progress. Adoption of the National S&T Strategy. Rise in R&D budget. Active cooperation with the Joint Research Centre.	Good progress in involvement in the Seventh Framework Programme (FP7).	Increase in R&D budget. Improvement in R&D personnel numbers and distribution.	Need to enhance research capacity and scientific excellence. Challenges in increasing participation in EU research programs.
2012	Good progress. Strengthening of national research and innovation capacity. Participation in FP7. Establishment of new universities.	Participation in FP7, but challenges in research capacity and excellence.	Slight decrease in R&D spending relative to GDP. Increase in private sector contribution and full-time researchers' number.	Need to increase research quality and competitiveness. Challenges in fully utilizing research potential.

Throughout this period, Türkiye demonstrated a commitment to enhancing its science and research sector, focusing on rising the number of researchers, improving participation in EU programs, and bolstering the involvement of the private industry and SMEs in research. Despite challenges, the overall progress remained promising, contributing positively to Türkiye's integration into the European research landscape.

5.2. Progress and Challenges in Türkiye's Science and Research Policy: The Road to EU Accession (2013-2023)

According to the EU Progress Report by the European Commission in 2013, Türkiye achieved significant progress in research and innovation, aligning closely with the goals set by the ERA Committee. Active participation in the 7th EU Framework Program served as a catalyst, fostering collaborative research endeavors with European partners while also involving SMEs in Türkiye's research sector. Despite these advancements, Türkiye's project success rate of 15.20% falls below the EU average of 20%, indicating a need for improvement. Furthermore, Türkiye's insufficient engagement in the European Research Council's Ideas Specific Program reveals gaps in achieving scientific excellence. However, strengthened collaboration

with the Joint Research Centre and participation in Joint Programming Initiatives demonstrate Türkiye's ambition to integrate fully into the ERA. The report generally mentions that Türkiye's strategic plan for 2013-2017 and initiatives to bolster technological capacity underscored its dedication to advancement, positioning the country for future growth within the European scientific community. As reported by the European Commission in 2014, Türkiye demonstrated notable progress in its pursuit of S&T excellence, particularly in alignment with the EU's frameworks. Participation in the EU Seventh Framework Program (FP7) saw an improved success rate of 16.2%, although still below the EU average. A crucial step forward occurred with Türkiye's accession to Horizon 2020, the EU's leading R&D program, enabled by an agreement allowing retrospective participation. Despite these advancements, Türkiye's research investment, at about 0.9% of GDP, remained below the EU average, highlighting an area for development. According to the 2014 Innovation Union Scoreboard, Türkiye was classified as moderately innovative, signaling a need for substantial improvement in innovation indicators. In response to these challenges, with the 10th Development Plan, Türkiye aimed to boost R&D investment and increase researchers, underlining its commitment to sustained economic growth through science, technology, and innovation, showing its aspiration for improvement in this field. In 2015, Türkiye's efforts to strengthen its position in the Science and Research sector, especially in the context of EU accession, faced significant challenges. Although Türkiye demonstrated commitment to integration by appointing a representative to the ERAC and participating in ERA advisory bodies, policy actions needed realignment with ERA principles. Notably, Türkiye's research investment stood at around 0.95% of GDP, underscoring the need for increased investment to match EU counterparts (European Commission, 2015). In the EU Progress Report (2015), despite efforts to stimulate innovation and academic-industry collaboration, the 2015 Union Innovation Scoreboard categorized Türkiye as a 'modestly innovative' country, highlighting its lag in innovation indicators in comparison to the EU average.

According to the EU Progress Report by the European Commission in 2016, Türkiye's efforts in science and technology, as it aimed to become more involved in the European Research Area (ERA), showed progress alongside ongoing challenges.

Türkiye made significant progress in its integration into the European Research Area (ERA) by developing a National ERA Roadmap and a National Research Infrastructure Roadmap. Its active participation in the EU Horizon 2020 Research and Innovation Program, supported by a robust network of contact points, facilitated involvement in all program committees. However, challenges remained in increasing participation in 'Societal Challenges' initiatives and achieving success in the 'Scientific Excellence' pillar of Horizon 2020. Nationally, efforts to enhance research and innovation capacities progressed, but promoting technology transfer and aligning policy actions with ERA principles required further refinement. Despite increased research investment to 1.01% of GDP, Türkiye fell short of the EU average, indicating a need for augmented financial commitment. Measures to stimulate academia-industry collaboration aimed at fostering innovation, yet Türkiye's classification as 'modestly innovative' in the 2016 Innovation Scoreboard highlighted the imperative to intensify efforts to elevate its innovation ecosystem to meet EU standards. As the European Commission reported in 2018, despite positive steps in open access and e-infrastructure, there were ongoing challenges, particularly in getting more Turkish researchers involved in Horizon 2020. The state of emergency measures further hindered collaboration between European and Turkish researchers, resulting in Türkiye's ongoing underperformance in the European Innovation Scoreboard. The fact that research and development spending remained at 1% of GDP highlighted the need for increased investment to catch up with the European average. Nevertheless, as mentioned by the EU Progress Report (2018), Türkiye actively participated in mutual learning under the Horizon 2020 Policy Support Program. The increase in technology development zones from 64 in 2016 to 69 in 2017 showed progress in fostering collaboration between industry and academia.

Between 2013 and 2023, Türkiye worked on aligning its science policies with the EU, participating in EU programs. Despite challenges like fluctuating investment and limited private sector involvement, Türkiye took strategic steps to boost national research. Ongoing efforts are needed to align domestic research sectors with EU standards and enhance innovation, showing Türkiye's commitment to excelling in European research.

Table 11. Türkiye Science and Research Progress 2013-2028, (European Commission, 2023)

Year	Major Developments and Achievements	EU Program Participation	R&D Investment and Personnel	Challenges and Goals
2013	Continued enhancement of R&D capabilities in alignment with the European Research and Innovation initiative.	Active participation and collaboration in the EU's 7th FP for Research (FP7); success rate 15.2%	92,801 full-time R&D personnel, R&D investments at 0.86% of GDP.	Improvement needed in success rate and participation in the ERA. A goal to establish science centers in major cities by 2016 and in all provinces by 2023.
2014	Increase in participation level in FP7. Adoption of the 10th Development Plan focusing on scientific, technological, and innovative development.	Signed agreement for participation in Horizon 2020, FP7 participation; success rate 16.2%	R&D investments remain below the EU average, with continued low innovation performance.	Increase in national R&D investment and improvement in participation in scientific excellence programs and collaborative projects.
2015	Progress in national research and innovation capacity, focus on integration with ERA	Participation in Horizon 2020; good level of involvement but more effort needed in societal challenges and SME integration.	R&D investments approximately 0.95% of GDP.	Enhancing the contribution of universities in research and innovation through the augmentation of national funding.
2016	Improved integration with the European Research Area (ERA).	Active involvement in Horizon 2020; however, improvement needed in 'Societal Challenges' and 'Scientific Excellence'.	R&D investments reached 1.01% of GDP.	Policy action needed for better alignment with ERA principles.

Table 11. (continued)

2018	Progress in e-infrastructure.	Participation in Horizon 2020, but no significant increase in Turkish researchers' involvement.	R&D investments stagnant at 1% of GDP.	Improve participation and success rates in EU Framework Programs; address the limited general research capacity due to state of emergency.

In 2019, Türkiye's progress was noticeable, particularly in its engagement with the EU's programs as reported by the European Commission (2019). Efforts to improve scientific infrastructure, such as focusing on e-infrastructure and open data, showcased Türkiye's commitment to aligning with EU standards. Despite progress, challenges remained, including low R&D expenditure, which fell below 1% of GDP, and a low density of researchers compared to the EU average. To address these issues, strategic measures like the New Economic Program and the establishment of the Science and Technology Policies Board were introduced. The 2018 European Innovation Scoreboard classified Türkiye as a 'modest innovator', emphasizing the need for further collaboration between academia and industry. The increase in technology development zones to 81 in 2018 reflects Türkiye's multifaceted approach to enhancing research capacity and addressing gaps in innovation. In 2020, Türkiye's journey in research and innovation, as detailed in the EU's Progress Report, showcased a mix of progress and ongoing challenges. Notable improvements were observed in energy research and participation in prestigious EU programs like the European Research Council and the Marie Sklodowska-Curie Programs, indicating Türkiye's focused efforts in scientific excellence. A significant milestone was the formulation of an action plan to enhance national research capacity, reflecting Türkiye's response to previous recommendations for alignment with the European Research Area (ERA). Financially, Türkiye's research and development (R&D) spending modestly increased from 0.96% to 1.03% of its GDP between 2017 and 2018, but still fell short of the EU28 average of 2%. On the other hand, the number of full-time equivalent R&D personnel increased. Türkiye's participation in Horizon 2020 showed improvement but remained low, with a success rate of around 10.2%,

below the Horizon 2020 average of 12% (European Commission, 2020). The 2019 European Innovation Scoreboard labeled Türkiye as a 'modest innovator', underscoring the challenges it faces. Limited foreign investment and low employment in advanced technology sectors add to the complexity of Türkiye's efforts to align with EU research and innovation standards.

Table 12. Türkiye Science and Research Progress 2019-2023, (European Commission, 2023)

Year	Major Developments and Achievements	EU Program Participation	R&D Investment and Personnel	Challenges and Goals
2019	Advancements in electronic infrastructure, the promotion of open data.	Stagnant participation in Horizon 2020.	Slight increase in R&D investments, but still below 1% of GDP.	Enhancement of national strategies and infrastructure in science and technology sectors.
2020	Progress in energy, European Research Council, and Marie Sklodowska-Curie Programs.	Horizon 2020 participation improved, but still at a low level.	R&D investments increased to 1.03% of GDP.	Update National Science and Technology Strategy; increase involvement in EU Research and Innovation Framework Programs.
2021	Significant impact of the national action plan for innovation capacity on the success of Horizon 2020.	Initiation of informal partnership negotiations for Horizon Europe.	R&D investments at 1.06% of GDP.	Update National Science, Technology, and Innovation Strategy; enhance performance in EU Framework Programs.

In 2021, Türkiye's advancements in research and innovation, as detailed in the EU's Progress Report (2021), illustrated a forward-moving landscape. Türkiye's effective action plan boosted its national research capacity, aligning with the ERA and enhancing performance in Horizon 2020. This was a significant step, especially

considering Türkiye's initiation of discussions for participation in Horizon Europe. Financially, Türkiye's R&D spending increased from 1.03% to 1.06% of GDP in 2018-2019 modestly, with a 6.2% rise in full-time equivalent R&D personnel. Despite these positive strides, it remained below the EU28 average of 2.19%, highlighting a gap in research funding (European Commission Progress Report, 2021). In the realm of innovation, Türkiye's status improved from a "modest innovator" to an "emerging innovator". Additionally, Türkiye's efforts in Smart Specialization, with five regions engaging in the EU's Smart Specialization Platform, and its proactive reaction to COVID-19 through the establishment of the COVID-19 Türkiye Platform for vaccine and drug development, underscored its commitment to aligning with European standards in S&T understanding. At the end of the EU Progress Report by the European Commission in 2021, it was implied that these examples collectively reflect Türkiye's ongoing journey towards enhancing its research and innovation landscape, marked by significant progress in strategic planning and implementation, yet tempered by the need to bridge gaps in funding.

In 2022, Türkiye's progress in the realm of S&T, as detailed in the EU's Progress Report (2022), highlighted several significant developments and ongoing challenges. A key achievement was Türkiye's formal entry into the Horizon Europe Program for 2021-2027, marking a concrete step in its commitment to research and innovation collaboration with the EU. Despite increased R&D spending, Türkiye still fell short of its investment targets, highlighting a persistent gap; on the other hand, there were positive trends that included growth in R&D personnel. The report also noted that Türkiye's efforts in Horizon 2020 had not fully met expectations, indicating a need for more assessment and adaptation of strategies for Horizon Europe, where initial indications showed a more promising trend. In the innovation sector, Türkiye retained its status as an 'emerging innovator,' with the report suggesting a greater focus on the digital transition to revitalize this area (European Commission, 2022). These developments reflect Türkiye's comprehensive approach to enhancing its research and innovation landscape.

In 2023, Türkiye's progress in research and science, as outlined in the EU's Progress Report (2023), showed significant advancements alongside ongoing challenges.

Notably, Türkiye's active involvement in the Horizon Europe Program demonstrated its commitment to enhancing research collaboration with the EU. Efforts to increase awareness and capacity regarding the program led to substantial progress. Despite updating its R&D expenditure calculation method, Türkiye's spending, from 1.37% to 1.4% of GDP, remained below targets and the EU average, Türkiye's target of 1.8% and the EU average of 2.26%. The growth in R&D personnel indicated an expanding research workforce. Türkiye's classification as an "Emerging Innovator", with a performance level of 47.6% of the EU average, which means Türkiye's innovation performance is approximately half of the EU's average innovation performance, underscored the need for enhanced innovation efforts. As reported by European Commission (2023), the successful collaboration in EU Missions, particularly in climate-neutral initiatives with cities like Istanbul and Izmir, demonstrated Türkiye's engagement in critical environmental challenges. Together, these advancements illustrate Türkiye's ongoing efforts to strengthen its scientific capabilities and innovation ecosystem. They balance significant achievements with the need for continual progress in aligning with EU standards.

Table 13. Türkiye Science and Research Progress 2021-2023, (European Commission, 2023)

Year	Major Developments and Achievements	EU Program Participation	R&D Investment and Personnel	Challenges and Goals
2021	Significant impact of the national action plan for innovation capacity on the success of Horizon 2020.	Initiation of informal partnership negotiations for Horizon Europe.	R&D investments at 1.06% of GDP.	Update National Science, Technology, and Innovation Strategy; enhance performance in EU Framework Programs.
2022	Signing of the participation agreement for the Horizon Europe Program.	Intensified efforts to increase awareness and participation in Horizon Europe.	R&D investments at 1.09% of GDP.	Increase innovation activities, especially in environmental technologies; improve performance in EU Missions and Innovation.

Table 13. (continued)

2023	Notable advancement in involvement with Horizon Europe and efforts to enhance awareness and capabilities.	Active and increasing collaboration with the EU in S&T.	R&D investments at 1.4% of GDP.	Harmonize the national R&D sector with the newly established European Research Area; accelerate innovation activities to address ongoing decline in European Innovation Scoreboard rankings.

In conclusion, Türkiye's efforts to meet EU standards in science and research have seen significant progress, challenges, and ongoing development over the past two decades. From the early 2000s to 2023, Türkiye has shown a strong commitment to improving its science and research sector. This commitment is visible through its active involvement in various EU S&T programs, gradual rise in R&D investments, and steps taken to upgrade its research infrastructure. Notably, Türkiye's participation in initiatives like the 6th and 7th Framework Programmes, and also Horizon Europe, highlights its alignment with EU policies and goals in science and research. Alongside efforts to meet EU standards, Türkiye also follows the principles of the National Innovation System (NIS) theory to guide its progress. This theory emphasizes how different parts of a country's innovation ecosystem, such as government policies, research institutions, universities, industries, and others, work together. Türkiye aims to strengthen its innovation capabilities and global competitiveness by promoting collaboration and coherence among these elements. This strategic approach reflects Türkiye's commitment to continuous improvement and adaptability in the ever-changing landscape of science and research in Europe. Despite progress, Türkiye still faces challenges such as fluctuating research and development spending, limited involvement of the private sector in R&D, and the need to rise both the researchers' number and the research outcomes quality. Türkiye's ongoing efforts to integrate into the European Research Area, improve collaborations between universities and industries, and promote gender equality in research are commendable steps towards overcoming these challenges.

As Türkiye continues to progress, it is essential for the country to continue harmonizing its domestic R&D sector with the European Research Area, improve its innovation practices, and tackle the imbalances within its innovation ecosystem. The steady rise in R&D investments, coupled with strategic policy measures and a comprehensive action plan to enhance national research and innovation capabilities, demonstrate Türkiye's capacity to bridge the disparity with EU standards. The journey of Türkiye in the realm of science and research, while complex and demanding, is a testament to its resilience and dedication to achieving excellence and a robust position within the European research landscape.

5.3. Concluding Remarks

This chapter provides a comprehensive overview of Türkiye's science and technology policies in the context of its journey toward EU integration, with a focus on Türkiye's efforts, challenges, and achievements. Emphasis is placed on Türkiye's commitment to aligning its policies with EU standards, particularly in research and innovation. Through an examination of Türkiye's participation in EU research programs, its R&D investments, and efforts to harmonize policies with EU expectations, key aspects of Türkiye's integration process are illuminated.

One notable aspect is the strategic acceleration of Türkiye's development process in line with key EU strategies. The significant increase in R&D spending and the prioritization of high-value R&D and innovation activities demonstrate Türkiye's proactive approach to fostering scientific excellence and technological advancement. Additionally, Türkiye's active engagement in EU Framework Programmes for Research and Development, coupled with its recognition as an "emerging innovative country," underscores its commitment to enhancing its role within the European Research Area. The closure of Chapter 25 on "Science and Research" in Türkiye's EU accession negotiations serves as a pivotal milestone, signaling Türkiye's dedication to harmonizing its science and research policies with EU standards. This alignment is viewed not only as fostering innovation but also as contributing to economic prosperity, societal advancement, and international cooperation.

In conclusion, this chapter serves as a vital reference point for research, providing valuable insights into Türkiye's science and technology policies and their alignment with EU standards. Through an examination of Türkiye's integration journey in this domain, a deeper understanding of the challenges, accomplishments, and future collaborations between Türkiye and the EU is gained, paving the way for informed analysis and strategic decision-making.

CHAPTER 6

CONCLUSION

This thesis aimed to explore the dynamic interaction between science and technology policies in the European Union and Türkiye from 2000 to 2020. It has illuminated the complex and ever-changing landscape of technological and scientific advancements, underlining the pivotal role of strategic policymaking in this field.

Over the past two decades, Türkiye has embarked on an ambitious journey to align its science and technology policies with the dynamic and evolving European Union standards. This long pursuit, which is encapsulated comprehensively in this thesis, highlights both progress and challenges in Türkiye's policy evolution.

Türkiye's commitment to enhancing its human capital base is palpable, evident in the incremental rise of researchers, R&D personnel, and scientific publications. Despite these gains, Türkiye faces the pressing challenge of translating educational enhancements into a substantial increase in knowledge-intensive employment, which remains significantly lower than the EU average.

The thesis identified several dynamics that have been shaping science and technology policymaking in recent years.

1. Firstly, the move towards mission-oriented policies, as seen in the EU's Horizon Europe program, marks a significant shift in science and technology policymaking for Türkiye. These policies, characterized by their focus on achieving specific, ambitious goals such as creating carbon-free cities, represent a strategic approach to technology diffusion and innovation.
2. Secondly, it is seen that the evolving role of government in science and technology is significant. Moving beyond traditional regulatory functions,

3. governments are increasingly taking on a more proactive role in creating and fostering new technologies and markets. This shift is evident in initiatives like the EU's Horizon Europe and Türkiye's active involvement in sectors such as defense and energy.
4. Also, it is seen that the growing importance of public procurement in driving innovation, especially in the early stages of research and development. This approach helps signal market readiness and creates demand for new, radical technologies, thereby encouraging firms to innovate.
5. This research has underscored the critical importance of adaptive and forward-looking science and technology policies in shaping a resilient and innovative society.
6. Furthermore, Türkiye's approach to venture capital and business angel investment could be reevaluated. In this regard, for Türkiye, with a view towards fostering high-growth innovative start-ups, there is a notable need for policy intervention to develop growth-stage investment funds and to enhance the absorptive potential of the private sector for research and development and innovation, especially among small and medium-sized enterprises.
7. It also provides insights for policymakers into the lessons drawn from the European Union and Türkiye's experiences, emphasizing the need for tailored, strategic approaches to foster innovation and address the complex challenges of the modern world.

Türkiye, in its response to these global shifts, has demonstrated a commitment to advancing its science and technology policy landscape. However, as it is evaluated in this thesis, challenges persist, including the need to develop sustainable human capital, enhance university-industry collaborations, enhance the survival rates of innovative start-ups, and improve policy coordination. Addressing these issues is critical for Türkiye to capitalize on its R&D potential and effectively navigate the rapidly evolving global technological environment. This thesis underscores the importance of adaptive and forward-looking science and technology policies in fostering a resilient and innovative society, capable of responding to the multifaceted challenges of our time.

The European Union's framework has been instrumental in guiding Türkiye's policy orientation, emphasizing the need for regional innovation systems that cater to localized strengths and address regional disparities. Türkiye's central decision-making structure, however, has often hindered the practical application of such regionally nuanced policies, underscoring the necessity for greater autonomy and coordination among regional policy-making bodies.

As is implied from the thesis, fostering effective university-industry collaboration remains a key challenge. Türkiye has made considerable progress in establishing channels like Technology Transfer Offices (TTOs) and Technological Development Zones (TDZs). However, is it seen that the desired synergy between academia and industry is yet to be achieved, largely due to cultural barriers and a formal institutional framework that does not sufficiently encourage team-oriented and collaborative innovation endeavors.

The analysis within "Integrating Pathways" indicates that while Türkiye has established a multitude of support mechanisms for innovation, there is an urgent need for a more nuanced and targeted approach. Specifically, there is a call for policies that not only initiate relations but actively cultivate collaborations, particularly in priority areas. Such measures could include the strategic deployment of TEYDEB programs by TÜBİTAK, which, unlike previous efforts, would directly support collaborative links rather than isolated nodes within the innovation ecosystem (Erdil&Akçomak, 2021).

In the face of these challenges, "Integrating Pathways" underscores the importance of open innovation ecosystems, where collaboration is fostered across all segments of society. The dissertation advocates for a holistic approach that incorporates a multi-helix model of stakeholders, including the public sector, industry, academia, and civil society. This approach aims to not only foster innovation but to do so in a manner that is sustainable, inclusive, and attuned to the socio-economic fabric of Türkiye.

As Türkiye looks forward, the nation could craft a narrative of S&T policy-making that is not only responsive to the needs of its domestic landscape but also resonant

with the broader objectives and values of the European Union. Such a narrative will involve embracing policy-making that is evidence-based, coordinated, and capable of fostering an environment where innovation can thrive through collaborative efforts that cover both the public and private sectors, as well as the academic community. Only through such integrated and concerted efforts can Türkiye hope to realize the full potential of its science and technology capabilities, ensuring strong economic development and societal welfare in the upcoming years.

6.1. Policy Recommendations

In this study, the convergence and divergence trends between Türkiye and the European Union (EU) in the realms of science, technology, and policy from 2000 to 2020 are examined, with Türkiye's progress reports, which are significant documents in the EU integration process, being considered. Specifically, the advancements under the "Science and Research" chapter, the 25th chapter, are delved into, and the policies pursued by the EU in the field of science and research are evaluated. Following this comprehensive analysis, it has become evident that specific policy recommendations are deemed imperative for Türkiye. In this context, the policy recommendations presented in this chapter are believed to contribute to Türkiye's advancement in science, technology, and policy domains, bringing it closer to EU standards and thereby paving the way for a stronger and more sustainable development trajectory. These recommendations are designed to have a positive impact on both Türkiye's domestic policymakers and its relations with the EU.

Drawing upon the insights derived from the research findings and in recognition of the shared challenges and opportunities within the EU's broader S&T landscape, these recommendations are offered as a strategic roadmap for Türkiye to enhance its S&T ecosystem. By addressing critical areas such as mission-oriented policies, the evolving role of government, leveraging public procurement, enhancing collaboration, reevaluating investment approaches, adopting a holistic innovation strategy, and aligning with EU objectives, Türkiye can not only strengthen its domestic innovation capabilities but also foster greater integration into the European Research Area. These policy recommendations serve to foster collaboration and

coherence between Türkiye and the EU, facilitating a shared vision of innovation-driven growth and societal progress. They provide actionable steps for Türkiye's policymakers, researchers, and industry stakeholders to navigate the evolving S&T landscape within the broader context of European cooperation and integration.

Building upon the key dynamics identified and the challenges and responses outlined, along with the recommendations provided, here are the expanded policy recommendations for Türkiye's future S&T policy framework:

1. Mission-Oriented Policies: Türkiye should proactively adopt mission-oriented policies akin to the EU's Horizon Europe program. These policies should set ambitious goals aligned with national priorities, such as transitioning to sustainable energy sources, enhancing healthcare access and quality, or mitigating the effects of climate change. By focusing S&T efforts on achieving specific societal objectives, Türkiye can drive innovation and address pressing challenges effectively.
2. Evolving Government Role: Recognizing the evolving role of government in S&T, Türkiye should further expand its proactive involvement beyond regulatory functions. This includes fostering innovation ecosystems through strategic investments, supporting technology development in key sectors such as defense, energy, and healthcare, and incentivizing private sector participation in R&D activities. By acting as a catalyst for innovation, Türkiye can stimulate economic growth and enhance its competitiveness on the global stage.
3. Public Procurement's Role: Türkiye should leverage public procurement as a strategic tool for driving innovation across various sectors of the economy. By incorporating innovation criteria into public procurement processes and actively seeking out cutting-edge technologies and solutions, Türkiye can create a conducive environment for technology adoption and market development. Additionally, targeted procurement initiatives can stimulate demand for innovative products and services, thereby encouraging firms to invest in R&D and innovation.
4. Enhanced Collaboration: Türkiye should prioritize efforts to strengthen collaboration between universities, research institutions, and industry

stakeholders. This involves implementing policies and programs that facilitate knowledge exchange, technology transfer, and joint research initiatives. Initiatives such as establishing innovation hubs, funding collaborative projects, and promoting industry-academia partnerships can foster a culture of innovation and entrepreneurship, driving economic development and societal welfare.

5. Reevaluation of Investment Approach: Türkiye should reassess its approach to venture capital and business angel investment to better support the growth and scalability of innovative startups. This includes establishing growth-stage investment funds, providing tax incentives for angel investors, and streamlining regulatory processes for startup funding. By enhancing access to capital and reducing barriers to investment, Türkiye can nurture a vibrant startup ecosystem and unlock the potential of high-growth innovative ventures.
6. Holistic Approach: Türkiye should adopt a holistic approach to innovation policy that encompasses all segments of society, including the public sector, industry, academia, and civil society. This multi-helix model of innovation governance should prioritize collaboration, inclusivity, and sustainability, ensuring that the benefits of innovation are shared equitably across society. By fostering an open innovation ecosystem that encourages participation from diverse stakeholders, Türkiye can drive collective action towards common goals and address complex societal challenges effectively.
7. Alignment with EU Objectives: Türkiye should align its science and technology policymaking with the objectives and values of the European Union, while also addressing its unique national priorities and challenges. This involves adopting evidence-based, coordinated policies that promote collaborative innovation across sectors and regions. By embracing a shared vision of innovation and cooperation, Türkiye can enhance its integration into the European Research Area and strengthen its position as a key player in the global S&T landscape.

By implementing these comprehensive policy recommendations, Türkiye can build a resilient and dynamic science and technology ecosystem that drives sustainable

economic development, fosters social inclusion, and enhances the country's competitiveness in the global knowledge economy. These recommendations not only address Türkiye's domestic needs but also strengthen its integration into the European Research Area, positioning it as a significant contributor to the global science and technology landscape. Through collective action and strategic policymaking, Türkiye can embark on a trajectory of innovation-driven growth, ensuring a prosperous and competitive future in the knowledge economy.

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APPENDICES

A. TURKISH SUMMARY / TÜRKÇE ÖZET

2000 ile 2020 arası dönem, Avrupa Birliği (AB) ve Türkiye'nin bilim, teknoloji ve inovasyon politikalarında önemli dönüşümlere tanık olduğu bir zaman dilimini temsil eder. Bu dönemde AB, bilimsel araştırma ve teknolojik ilerlemenin öncüsü olarak konumunu güçlendirirken, Türkiye ise modernleşme ve entegrasyon sürecine adım atarak Avrupa standartlarına uyum sağlama çabasındadır. Bu çalışma, AB ve Türkiye'nin bilim ve teknoloji politikalarını detaylı bir şekilde inceleyerek, ortak noktaları, farklılıkları, zorlukları ve başarıları ortaya koymaktadır. AB ve Türkiye'nin bilim ve teknoloji politikalarının evrimini ele alan bu çalışma, aynı zamanda politika yakınsamasının araştırma ve geliştirme ekosistemleri üzerindeki etkisine odaklanmaktadır. Bu bağlamda, bölgesel iş birliği, sosyo-ekonomik kalkınma ve küresel rekabetçilik gibi konular da incelenmektedir. Geleceğe yönelik bilinçli kararlar alınabilmesi ve stratejik planlamalar yapılabilmesi için Türkiye'nin bilim ve teknoloji politikalarının geçmişi ile geleceği arasında bir köprü kurulmaktadır. Bu çalışma, hızla değişen teknoloji karşısında Türkiye'nin AB entegrasyon sürecindeki yerini anlamak adına önemli bir adımdır. Hem AB'nin hem de Türkiye'nin bilim ve teknoloji politikalarının gelişimini anlamak, böylece bu politikaların gelecekteki yönünü belirlemek için kritik bir öneme sahiptir. Bu çalışma, sadece geçmişin bir değerlendirmesi değil, aynı zamanda gelecek için bir rehberlik ve yol haritası sunmaktadır.

Bu çalışma, hızlı teknolojik ilerlemelerin ve artan küresel bağlantıların damgasını vurduğu bir dönemde, bilim ve teknoloji politikalarının ulusların ve bölgelerin ekonomik ve sosyal manzarasını şekillendiren önemli bir güç olduğunu vurgulamaktadır. Türkiye ve AB, bu politikaların geliştirilmesi ve uygulanmasında öncü roller üstlenmiş, her biri benzersiz ancak birbirini kesişen yollar izlemiştir. Bu

çalışma, 2000-2020 yılları arasında Türkiye ve AB arasındaki politika yapımındaki yakınsamayı inceleyerek, bu durumun araştırma ve geliştirme ekosistemlerine etkilerini ve daha geniş bir entegre Avrupa Araştırma Alanı (ERA) hedefine doğru ilerleme konusundaki önemini açıklığa kavuşturmayı amaçlamaktadır. Türkiye'nin AB bilim ve teknoloji politikalarıyla ne ölçüde uyum sağladığı veya farklılaştığı tartışılmaktadır. AB'nin Türkiye'ye yönelik İlerleme Raporları üzerinden yapılan analiz, AB'nin beklentileri ile Türkiye'nin politika uyumları arasındaki dinamik etkileşim hakkında değerli içgörüler sunmaktadır. Bu çalışma, Türkiye'nin bilim ve teknoloji politikalarının AB normlarına ne ölçüde uyum sağladığını ve bu uyumun gerçekleştirilmesindeki zorlukları ele almaktadır.

Mevcut literatür incelendiğinde, Türkiye'nin AB entegrasyon süreci bağlamında bilim ve teknoloji alanındaki çağdaş konumunu detaylı bir şekilde inceleyen kapsamlı çalışmalarda belirgin bir boşluk olduğu görülmektedir. Türkiye için özellikle bilim ve teknoloji politikaları açısından kritik olan Fasıl 25, AB katılım sürecindeki en önemli adımlardan biri olarak öne çıkmaktadır. Bu bölüm altında, AB ile uyumlu hale getirilmesi gereken bir dizi politika ve reform bulunmaktadır. Diğer fasıllarda yaşanan gecikmelere rağmen Fasıl 25 altında bilim ve teknoloji politikalarında bazı ilerlemeler kaydedildiği gözlemlenmektedir. Türkiye'nin bilim ve teknoloji politikalarındaki gelişmelerin ve gecikmelerin AB entegrasyon sürecindeki önemi, Türkiye'nin AB ile ilişkilerinin geleceği açısından önem arz etmektedir. Bilim ve Araştırma başlıklı Fasıl 25'in kapatılması Türkiye'nin Avrupa Birliği'ne katılım sürecinde önemli bir kilometre taşını işaret etmektedir. Bu durum, Türkiye'nin bilim, teknoloji ve yenilik alanlarında AB standartlarına uyumunu ve entegrasyon sürecinde kaydedilen ilerlemeyi yansıtmaktadır. Bu kapanış, Türkiye'nin bilim ve araştırma politikalarını AB normları ve standartlarıyla uyumlu hale getirme çabalarını göstermektedir. Türkiye'nin bilim ve teknolojideki ilerlemesi, ekonomik kalkınma, rekabet gücü, inovasyon ve istihdam gibi çeşitli alanlarda olumlu etkiler yaratabilirken, AB ile Türkiye arasında daha yakın işbirliği fırsatlarını da oluşturmaktadır. Bu nedenle, 25. Fasılın kapanışı, Türkiye'nin AB katılım sürecindeki ilerlemesini ve bilim ve teknoloji politikalarını AB standartlarıyla uyumlu hale getirmesini vurgulayan dönüm noktası niteliğindedir. Bilim ve teknoloji, geleneksel rollerinin ötesinde, ekonomik büyümeyi yönlendirmede, sosyal

ilerlemeyi ilerletmede ve uluslararası diplomasiyi güçlendirmede vazgeçilmez direkler haline gelmiştir. Bu alanları yöneten politikalar, sadece bilimsel ve teknolojik sınırların ilerletilmesiyle sınırlı kalmamaktadır; aynı zamanda ulusların ve bölgelerin gelişme trajektoryasını yönlendirmede kilit rol oynamaktadır. Ekonomik rekabet gücünü artırmak ve toplumsal refahı sağlamak için kilit öneme sahip olan bu politikalar, toplumsal refahından iklim değişikliği, sağlık krizleri ve dijital dönüşüm gibi küresel zorluklarla başa çıkmaya kadar birçok yönü etkilemektedir, bu da bilim ve teknoloji politikalarının çağdaş dünyamızın şekillenmesindeki rolünü göstermektedir.

Bu çalışma, 2000 ile 2020 yılları arasındaki dönemde AB ve Türkiye'nin bilim, teknoloji ve inovasyon politikalarındaki değişimleri incelemekte ve karşılaştırmaktadır. İlk olarak, AB ve Türkiye'nin bilim ve teknoloji politikalarının evrimi ve bu politikaların gelişim stratejileri ele alınmaktadır. Ardından, AB ve Türkiye'nin politika yaklaşımlarındaki benzerlikler ve farklılıklar değerlendirilmekte, inovasyonun geleceği üzerindeki etkileri anlaşılmaya çalışılmaktadır. Üçüncü olarak, AB'nin bilim ve teknoloji politikalarının detaylı bir keşfi yapılırken, Türkiye'nin AB normlarına uyum sürecinin analizi gerçekleştirilmekte ve bu sürecin Türkiye'nin bilim ve teknoloji alanındaki performansı üzerindeki etkileri incelenmektedir. Son olarak, Türkiye'nin AB entegrasyon süreci bağlamında bilim ve teknoloji politikalarının analizi yapılmakta ve Türkiye'nin ulusal AR-GE ve inovasyon ekosisteminin güçlendirilmesi ve rekabet gücünün artırılması hedeflenmektedir. Bu özet, AB ve Türkiye'nin bilim ve teknoloji politikalarındaki değişimleri ve bu değişimlerin ülkelerin entegrasyon süreçlerine etkilerini kapsamlı bir şekilde ele almaktadır.

Çalışmanın ilk bölümünde, çeşitli ekonomi teorilerine ve teknoloji politikası oluşturma sürecine odaklanılmaktadır. Bu şekilde, ekonomi teorilerinin tarihini ve inovasyonun nasıl gerçekleştiğine dair görüşleri, ayrıca teknoloji politikası oluşturma süreci incelemektedir. Bu bölüm, teknolojinin sadece zaman içinde nasıl evrildiğini açıklamakla kalmamakla, aynı zamanda farklı ekonomi teorilerinin ve teknoloji yollarının nasıl bir araya geldiğini de incelemektedir. Bu çalışmanın temel amacı, Türkiye'nin 2000 ve 2020 arasındaki AB entegrasyon süreci içinde bilim ve teknoloji

politikasını anlamaktır. Bu çalışma, Türkiye'nin AB ile bilim ve teknoloji politikası konusunda ne ölçüde uyum sağladığını veya sapkınlık gösterdiğini araştırmayı amaçlamaktadır. Bu nedenle, ekonomi teorilerinin, inovasyon modellerinin ve politikalarının nasıl etkileşime girdiğini anlamak önem arz etmektedir. Bu bağlamda, hem AB hem de Türkiye'nin bilim ve teknoloji politikalarının Ulusal İnovasyon Sistemi (NIS) bakış açısıyla değerlendirilebileceğini düşülmektedir, bu sayede ülkelerin kendi içinde inovasyon sistemlerinin nasıl işlediğini anlamaya yardımcı olmaktadır. Bu bölümü özetlemek gerekirse, klasik ekonomi, teknolojik ilerlemeyi verimlilik ve karın anahtarı olarak vurgulamaktadır. Diğer yandan, neoklasik ekonomi, ekonomik büyüme, nüfus dinamikleri ve teknolojik inovasyonun nasıl etkileştiğini sunmaktadır. Ancak, en derin anlayışların sağlandığı yer evrimsel ekonomi çerçevesindedir. Burada, inovasyon, öğrenme ve tarihsel faktörler tarafından etkilenen birikimli bir süreç olarak görülmektedir. Bu çalışma, teorik temeller üzerine inşa edilerek ve odağını pratik alanda tutarak Tükiye'nin ve AB'nin bilim teknolojilerini incelemektedir. Bu noktada Ulusal İnovasyon Sistemi (NIS) kavramının önemi ortaya çıkmaktadır. Bu çerçeve aracılığıyla, AB ve Türkiye arasındaki bilim, teknoloji ve inovasyon politikalarının nasıl birbirine yaklaştığını analiz edilmektedir ve inovasyonu şekillendiren benzerlikleri ve farklılıkları ele almaktadır.

Bu çalışma kapsamında, AB ve Türkiye'nin bilim ve teknoloji politikalarını yakından inceleyerek, politika yaklaşımlarındaki benzerlikleri ve farklılıkları değerlendirmek, inovasyonun geleceği üzerindeki etkilerini anlamak önem arz etmektedir. Bu bağlamda, bir sonraki bölümde, bu analizleri ve karşılaştırmaları yapmaya odaklanılmaktadır. Bu sayede, bu bölümde tartışılan teorik çerçeveden gerçek dünya uygulamasına geçiş sağlanmaktadır. Çalışmanın ikinci bölümünde AB bilim ve teknoloji politikalarının kapsamlı bir keşfi yapılmaktadır ve ana temalar, kilometre taşları, zorluklar ve fırsatlar ortaya çıkarılmaktadır. Bu yolculuk boyunca AB'nin sahip olduğu derin küresel etki ortaya konulmaktadır. "Brüksel Etkisi" ile bu durum açıklanmaktadır ve küresel standartları ve dijital yönetişimi şekillendirme rolü ortaya konmaktadır. Bu kapsamda AB'nin inovasyonu teşvik etme ve uluslararası gündemi belirleme liderliğini vurgulanmaktadır. Bu bölümün kapsamı değerlendirildiğinde temel amaç Türkiye'nin AB entegrasyon bağlamında bilim ve teknoloji politikasını

anlamaktır. AB'nin bilim ve teknoloji politikaları incelenerek, analiz için temel atılmaktadır ve Türkiye'nin bilim ve teknoloji politika görüler elde edilmektedir. Çalışmanın ikinci bölümünü özetleyecek olursak AB bilim ve teknoloji politikalarının tarihsel evrimi, II. Dünya Savaşı sonrası yeniden yapılanma çabalarından Lisbon Stratejisi gibi stratejik girişimler izlenmektedir. Horizon 2020 ve Horizon Europe gibi dönüm noktaları, AB'nin bilimsel mükemmeliyete ve toplumsal zorluklara olan bağlılığını vurgulamaktadır. Ayrıca, uyumlu çerçeve programları ve işbirlikçi girişimler, AB'nin inovasyonu teşvik etme ve araştırma faaliyetlerini sosyo-ekonomik hedeflerle uyumlu hale getirme kapasitesini vurgulamaktadır. Kayda değer ilerlemelere rağmen, üye çeşitliliği ve yetersiz AR-GE harcamaları gibi zorluklar devam etmektedir. Ancak, bu zorluklar aynı zamanda özellikle Türkiye gibi AB üyeliklerine aday olan ülkeler için işbirliği ve bilimsel ilerleme fırsatları sunmaktadır. Türkiye'nin AB politikalarıyla uyumlu olması, bu fırsatlardan yararlanarak inovasyonu teşvik etmek ve uluslararası ortaklıklar kurmak için bu fırsatları kullanabilir. Bir sonraki bölüm, Türkiye'nin bilim ve teknoloji politika manzarasına odaklanarak ve AB politikalarının keşfinden elde edilen içgörüler daha da geliştirilecektir. AB ve Türkiye'nin politikalarının ayrışma ve birleşme etkilerini aydınlatmak için politikalarının ayrıntılı analizleri yapılacaktır. Bu çalışma daha önce de belirtildiği üzere, entegrasyon yolculuğu üzerine kritik bir analiz ve sorgulamayı içermektedir ve politika yakınlaşması, ayrışma ve bunların Türkiye'nin entegrasyonuna yönelik etkilerini açığa çıkarmayı amaçlamaktadır.

Bu çalışmanın üçüncü bölümünde Türkiye'nin bilim ve teknoloji politikalarının gelişimi incelenmektedir, AB'nin stratejileriyle uyumunun değerlendirilmesi ve ana başarılar, zorluklar ve fırsatlar göz önüne alınmaktadır. Bu bölüm, Türkiye'nin politikalarını şekillendiren ulusal ve uluslararası faktörleri anlamak, Türkiye ile AB arasındaki ilişkiyi anlamaya katkıda bulunmaktadır. Türkiye'nin bilim ve teknoloji politikaları, uzun bir evrimsel süreç boyunca önemli değişiklikler geçirmiştir. Bu değişim, ülkenin inovasyon ve teknoloji gelişimine olan bağlılığını yansıtmaktadır. Türkiye, bilim ve teknoloji politikalarını şekillendiren ulusal ve uluslararası faktörleri anlamak için önemli adımlar atmaktadır. Türkiye'nin bilim ve teknoloji politikalarındaki ilk adımlar, 1960'larda atılmıştır. Bu dönemde, ülke, bilim ve teknolojiye verdiği önemi artırmış ve TÜBİTAK gibi kurumların kuruluşuyla

bilimsel araştırmaları desteklemektedir. "Türk Bilim Politikası: 1983"ün kabul edilmesi, Türkiye'nin bilim ve teknoloji alanındaki stratejik hedeflerini belirlemede önemli bir kilometre taşı oluşturmaktadır. Ayrıca, Türkiye'nin AB bilimsel araştırmalarındaki statüsünü yükseltmeyi amaçlayan Vision 2023 projesi gibi girişimler, ülkenin uluslararası alanda bilim ve teknoloji alanında etkin bir rol oynamasını amaçlamaktadır. Türkiye bilim ve teknoloji politikalarını güçlendirmek için stratejik bir dönüşüm başlatılmıştır. Bu dönüşüm, Ulusal Bilim ve Teknoloji Politikaları: 2003-2023 Strateji Belgesi ve Bilim ve Teknoloji Uygulama Planı gibi girişimlerle desteklenmektedir. Bu belgeler, Türkiye'nin bilim ve teknoloji alanındaki hedeflerini belirlemekte ve ilerlemeyi izlemekte önemli bir rol oynamıştır. Ayrıca, dijital teknoloji, yenilenebilir enerji ve yapay zeka gibi alanlara yönelik araştırma ve geliştirme harcamalarına yapılan vurgu, Türkiye'nin bilim ve teknolojide bir lider haline gelme hedefini yansıtmaktadır. Türkiye'nin bilim ve teknoloji politika manzarası, inovasyon, uluslararası iş birliği ve küresel trendlerle uyumlu bir çerçeve sunmaktadır. Politika uygulamasına ekonomik istikrar ve etkili bir ulusal inovasyon sisteminin teşvik edilmesi, Türkiye'nin bilim ve teknoloji alanındaki hedeflerini gerçekleştirmesi için büyük öneme sahiptir. Türkiye'nin yasal çerçevesi, bilim ve teknoloji üzerine kanunlar, Dijital Yönetmelikler ve Cumhurbaşkanlığı Kararnameleri gibi çeşitli yasal araçları içerir ve inovasyonla ilgili zorlukları adreslemek için farklı araçların bir karışımını birleştiren bir politika karışımı yaklaşımını benimsemektedir. Bu politika dönüşümü, Türkiye'nin AB entegrasyon sürecindeki ilerlemesine katkıda bulunurken, Türkiye'nin AB politikalarıyla uyumlu olması, inovasyonu teşvik etmek ve uluslararası ortaklıklar kurmak için önemli fırsatlar sunmaktadır. Türkiye'nin bilim ve teknoloji politikalarının kapsamlı bir şekilde değerlendirilmesi, ülkenin bilim ve teknoloji alanındaki potansiyelini tam olarak ortaya koymak için önemlidir. Bu değerlendirme, Türkiye'nin gelecekteki bilim ve teknoloji politikalarını daha etkili bir şekilde şekillendirmesine yardımcı olabilir. Bu bölümün kapsamı, Türkiye'nin entegrasyon yolculuğu bağlamında bilim ve teknoloji politikasını anlamakla ilgilidir. Türkiye'nin politika manzarasına dair sağladığı incelemeler AB politikalarıyla yapılan analiz için temel oluştururken, politika yakınsamasının, ayrışmasının ve bunların Türkiye'nin entegrasyon trajektuarına etkilerinin anlaşılmasına katkıda bulunmaktadır.

Bu çalışmanın dördüncü bölümünde Türkiye'nin bilim ve teknoloji politikaları, AB entegrasyon süreci bağlamında ele alındığında, çeşitli yönleriyle incelenmiş ve bu politikaların evrimi, uygulanması ve sonuçları detaylı bir şekilde değerlendirilmektedir. Bu bölümde, Türkiye'nin AB normlarına uyum sağlama süreci ve bu sürecin Türkiye'nin bilim ve teknoloji alanındaki performansı üzerindeki etkileri ayrıntılı bir şekilde ele alınmaktadır.

Bu çalışmanın dördüncü bölümü Türkiye'nin AB entegrasyon sürecindeki bilim ve teknoloji politikalarının analizini, Türkiye'nin AB'ye uyum sürecini ve bu çabaların sonuçlarını ortaya koymaktadır. Özellikle, Türkiye'nin AB araştırma ve inovasyon programlarına katılımı, AR-GE yatırımlarındaki artış ve AB'nin bilim ve teknoloji politikalarındaki güncellemelerle uyum sağlama çabaları bu analizin odak noktaları arasındadır. Bu bağlamda, Türkiye'nin AB ile entegrasyon çabaları, bilim ve teknoloji politikalarının AB normlarına uyum sağlamasıyla sınırlı kalmayıp, aynı zamanda Türkiye'nin bilim ve teknoloji alanındaki ulusal kapasitesini ve rekabet gücünü artırma hedefini de içermektedir. Türkiye'nin bilim ve teknoloji politikalarının AB standartlarıyla uyumlu hale getirilmesi, Türkiye'nin ulusal AR-GE ve inovasyon ekosisteminin güçlendirilmesi ve küresel rekabet gücünün artırılması açısından kritik öneme sahiptir. Bu süreç, Türkiye'nin bilim ve teknoloji politikalarının AB normlarına uyum sağlamasını teşvik eden politika araçlarının ve mekanizmalarının incelenmesini gerektirmektedir. Ayrıca, Türkiye'nin AB ile entegrasyon sürecindeki ilerlemesini ölçmek için belirli göstergeler ve kriterlerin kullanılması önemlidir. Bu göstergeler arasında, Türkiye'nin AB araştırma ve inovasyon programlarına katılım oranı, ulusal AR-GE harcamalarının AB ortalamasına göre oranı ve Türkiye'nin AB normlarına uyum sağlamak için benimsediği politika ve stratejilerin etkinliği bulunmaktadır. Bu çalışma kapsamında varılan sonuçlardan biri olarak Türkiye'nin bilim ve teknoloji politikalarının AB ile uyumlu hale getirilmesi süreci, Türkiye'nin bilim ve teknoloji alanındaki ulusal kapasitesini güçlendirmek, inovasyon ve rekabet gücünü artırmak ve uluslararası işbirliğini teşvik etmek için önemli bir fırsat sunmaktadır. Bu sürecin başarılı bir şekilde yönetilmesi, Türkiye'nin AB ile entegrasyon sürecindeki ilerlemesini ve bilim ve teknoloji alanındaki ulusal hedeflerini başarıyla gerçekleştirmesini sağlayacaktır. Bu bağlamda, Türkiye'nin bilim ve teknoloji politikalarının AB

normlarına uyum sağlama sürecinin başarıyla tamamlanması, Türkiye'nin ulusal kalkınma ve rekabet gücünü artırma yolunda önemli bir adım olacaktır. Türkiye'nin AB'ye uyum süreci, AR-GE yatırımlarındaki artış ve AB'nin bilim ve teknoloji politikalarındaki güncellemelerle uyum sağlama çabaları bu analizin odak noktalarıdır. Türkiye'nin bu süreçte AB normlarına uyum sağlaması, ulusal AR-GE ve inovasyon ekosisteminin güçlenmesi ve küresel rekabet gücünün artırılması için hayati bir adımdır. Başarılı bir şekilde yönetilmesi durumunda, Türkiye'nin AB ile entegrasyon sürecinde ilerlemesi ve ulusal hedeflerini gerçekleştirmesi sağlanacaktır. Türkiye'nin bilim ve teknoloji politikalarının AB ile uyumlu hale getirilmesi süreci, ulusal AR-GE ve inovasyon ekosisteminin güçlenmesi, küresel rekabet gücünün artırılması ve uluslararası işbirliğinin teşvik edilmesi açısından önemli bir fırsat sunmaktadır. Bu sürecin başarılı bir şekilde yönetilmesi, Türkiye'nin AB ile entegrasyon sürecinde ilerlemesini ve ulusal hedeflerini başarıyla gerçekleştirmesini sağlayacaktır.

Sonuç bölümünde, bu çalışma belirtildiği üzere 2000'den 2020'ye kadar Avrupa Birliği ve Türkiye arasındaki bilim ve teknoloji politikaları arasındaki dinamik etkileşimi keşfetmeyi amaçlamaktadır. Teknolojik ve bilimsel ilerlemelerin karmaşık ve sürekli değişen peyzajını aydınlatarak, bu alandaki stratejik politika yapmanın kilit rolünü vurgulamaktadır. Geçen yirmi yıl boyunca, Türkiye, bilim ve teknoloji politikalarını dinamik ve evrensel Avrupa Birliği standartlarıyla uyumlu hale getirme hedefiyle iddialı bir yolculuğa çıkmış bulunmaktadır. Bu uzun yolculuk, bu çalışmada kapsamlı bir şekilde ele alınan, Türkiye'nin politika evrimindeki hem ilerlemeleri hem de zorlukları vurgulamaktadır. Türkiye'nin insan sermayesi tabanını geliştirme konusundaki taahhüdü ortadadır, araştırmacıların, AR-GE personelinin ve bilimsel yayınların artan sayılarıyla kendini göstermektedir. Bununla birlikte, bu kazanımlara rağmen, eğitimdeki iyileştirmelerin bilgi yoğun işlerde belirgin bir artışa dönüşmesi gereken, hala AB ortalamasının önemli ölçüde altında kalan bir durumda olduğu acil bir sorunla karşı karşıya kalmaktadır. Bu çalışma, son yıllarda bilim ve teknoloji politikası oluşturmada şekillenen çeşitli dinamikleri tanımlamaktadır.

Bilim ve teknoloji politikalarının evrimi, günümüzde AB'nin Ufuk Avrupa programında belirginleşen görev odaklı politikalara doğru bir kayma ile belirgin hale

gelmektedir. İlk olarak, AB'nin Ufuk Avrupa (Horizon Europe) programında görüldüğü gibi, görev odaklı politikalara doğru bir hareket, Türkiye için bilim ve teknoloji politika yapımında önemli bir değişimi işaret etmektedir. Bu politikalar, karbon içermeyen şehirler oluşturmak gibi belirli, iddialı hedeflere ulaşmaya odaklanmalarıyla karakterize edilmektedir ve teknoloji yayılımı ve inovasyon için stratejik bir yaklaşımı temsil etmektedir. İkinci olarak, hükümetin bilim ve teknolojideki değişen rolünün önemi görülmektedir. Geleneksel düzenleyici işlevlerin ötesine geçen hükümetler, giderek daha fazla yeni teknolojiler ve pazarlar oluşturma ve teşvik etme rolü üstlenmektedirler. Bu değişim, AB'nin Ufuk Avrupa (Horizon Europe) gibi girişimlerinde ve Türkiye'nin savunma ve enerji gibi sektörlerdeki aktif katılımında açıkça görülmektedir. Ayrıca, özellikle araştırma ve geliştirme çalışmalarının erken aşamalarında kamu alımlarının artan önemi görülmektedir. Bu yaklaşım, pazar hazırlığını işaret etmeye ve yeni, radikal teknolojilere talep yaratmaya yardımcı olmaktadır, böylece firmaları inovasyon yapmaya teşvik etmektedir. Bu araştırma, esnek ve ileriye dönük bilim ve teknoloji politikalarının, dayanıklı ve yenilikçi bir toplumun şekillendirilmesinde kritik önemini vurgulamaktadır. Ayrıca, Türkiye'nin risk sermayesi ve iş meleği yatırımlarına yaklaşımının yeniden değerlendirilmesi gerektiği görülmektedir. Bu bağlamda, Türkiye için, yüksek büyüme potansiyeline sahip yenilikçi start-up'ları teşvik etme amacıyla, büyüme aşaması yatırım fonlarını geliştirmek ve özellikle küçük ve orta ölçekli işletmeler arasında AR-GE ve inovasyon için kamu-özel sektörün işbirliğini artırmak için önemli bir ihtiyaç bulunmaktadır. Ayrıca, politika yapıcılar için AB ve Türkiye deneyimlerinden çıkarılan dersler, inovasyonu teşvik etmek ve modern dünyanın karmaşık zorluklarıyla başa çıkmak için özelleştirilmiş, stratejik yaklaşımlara olan ihtiyacı vurgulamaktadır.

Türkiye, bu küresel değişikliklere yanıt olarak, bilim ve teknoloji politika yolculuğunu geliştirme konusundaki taahhüdünü göstermiştir. Ancak, bu çalışmada değerlendirildiği gibi, hala sürmekte olan zorluklar, sürdürülebilir insan sermayesi geliştirmek, üniversite-sanayi işbirliklerini güçlendirmek, yenilikçi start-up'ların hayatta kalma oranlarını artırmak ve politika koordinasyonunu iyileştirmek için bir ihtiyaç duyulmaktadır. Bu sorunların ele alınması, Türkiye'nin AR-GE potansiyelini değerlendirmesi ve hızla değişen küresel teknolojik ortamda etkili bir şekilde yol

alması için kritiktir. Bu tez, dayanıklı ve yenilikçi bir toplumun şekillenmesinde esnek ve ileriye dönük bilim ve teknoloji politikalarının önemini vurgulamaktadır. Avrupa Birliği çerçevesi, Türkiye'nin politika yönelimini yönlendirmede önemli olmuştur ve yerel güçlü yönleri hedefleyen ve bölgesel farklılıkları ele alan bölgesel yenilik sistemlerine ihtiyaç duyulduğunu vurgulamaktadır. Ancak, Türkiye'nin merkezi karar alma yapısı, bölgesel nüanslı politikaların pratik uygulanmasını sık sık engellemiş, bölgesel politika yapım organları arasında daha büyük bir özerklik ve koordinasyonun gerekliliğini vurgulamaktadır.

Bu çalışmadan çıkarılabilecek sonuçlardan biri de etkili üniversite-sanayi işbirliğinin teşviki hala temel bir zorluk olmasıdır. Türkiye, Teknoloji Transfer Ofisleri (TTO'lar) ve Teknolojik Gelişim Bölgeleri gibi kanalları kurmada önemli ilerlemeler kaydetmektedir. Ancak, üniversite ile endüstri arasında istenilen sinerji henüz sağlanamamaktadır, bunun büyük ölçüde, kültürel engeller ve takım odaklı ve işbirlikçi inovasyon girişimlerini yeterince teşvik etmeyen resmi bir kurumsal yapı nedeniyle olduğu görülmektedir. "Entegrasyon Yolları" içindeki analiz, Türkiye'nin yenilik için birçok destek mekanizması kurduğunu, ancak daha ince bir hedefe ve hedef alan işbirliklerine daha çok ihtiyaç duyduğunu vurgulamaktadır. Özellikle, TEYDEB programlarının stratejik olarak kullanılmasını içeren politikalar, önceki çabaların aksine, yenilik ekosistemi içinde izole edilmiş düğümleri değil, doğrudan işbirliği bağlantılarını destekleyecektir (Erdil ve Akçomak, 2021). Bu zorluklarla yüzleşirken, "Entegrasyon Yolları", işbirliğinin toplumun tüm kesimlerinde teşvik edildiği açık bir inovasyon ekosisteminin önemini vurgulamaktadır. Bu çalışma, kamu sektörü, endüstri, akademi ve sivil toplum gibi çoklu aktörlerin bir heliks modelini içeren bütünsel bir yaklaşımı savunmaktadır. Bu yaklaşım, sadece inovasyonu teşvik etmekle kalmaz, aynı zamanda sürdürülebilir, kapsayıcı ve Türkiye'nin sosyo-ekonomik dokusuna uygun bir şekilde ayarlanmış bir şekilde yapmaktadır.

Türkiye ileriye baktığında, ulusal manzaranın ihtiyaçlarına duyarlı olmanın yanı sıra Avrupa Birliği'nin daha geniş hedefleri ve değerleriyle uyumlu olan bir bilim ve teknoloji politika yapımı hikayesi oluşturabilir. Böyle bir anlatı, kanıta dayalı, koordine edilmiş politika yapımını ve hem kamu hem de özel sektörü kapsayan,

işbirliğiyle inovasyonun gelişimini teşvik edebilecek bir ortamı sağlamayı içerir. Ancak bu entegre ve ortak çabalara katkıda bulunulmadığı sürece Türkiye'nin bilim ve teknoloji yeteneklerinin tam potansiyelini gerçekleştirmesi ve güçlü ekonomik kalkınma ve toplumsal refah sağlaması mümkün olmayacaktır.

Bilim ve teknoloji politikalarının Türkiye'nin geleceğini şekillendirmedeki kritik rolü göz önüne alındığında, sonuçlar çarpıcıdır. Türkiye, 2000 ile 2020 arasında AB'nin bilim ve teknoloji politikalarına uyum sağlama çabalarında önemli ilerlemeler kaydetmiştir. Ancak, bu süreçte hala belirgin zorluklarla karşılaşılmaktadır, özellikle eğitimdeki iyileştirmelerin iş gücü kalitesi ve bilgi tabanlı ekonomiye dönüşüm açısından önemi göz önüne alındığında. Türkiye'nin bu dönüşüm sürecinde, AB'nin öncülük ettiği politika alanlarına daha fazla entegre olması ve kamu-özel sektör işbirliğini güçlendirmesi gerekmektedir. Ayrıca, risk sermayesi ve iş meleği yatırımlarının artırılmasıyla, yenilikçi girişimleri destekleyerek ve AR-GE faaliyetlerini teşvik ederek Türkiye'nin rekabet gücünü artırması gerekmektedir. Türkiye'nin bu politika alanındaki değişen rolü ve AB ile yakınlaşması, gelecekteki ekonomik kalkınma ve uluslararası rekabet gücü açısından kritik öneme sahiptir. Bu bağlamda, esnek, ileriye dönük ve stratejik bilim ve teknoloji politikalarının uygulanması, Türkiye'nin sürdürülebilir büyümesini sağlayacak önemli bir itici güç olabilir.

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