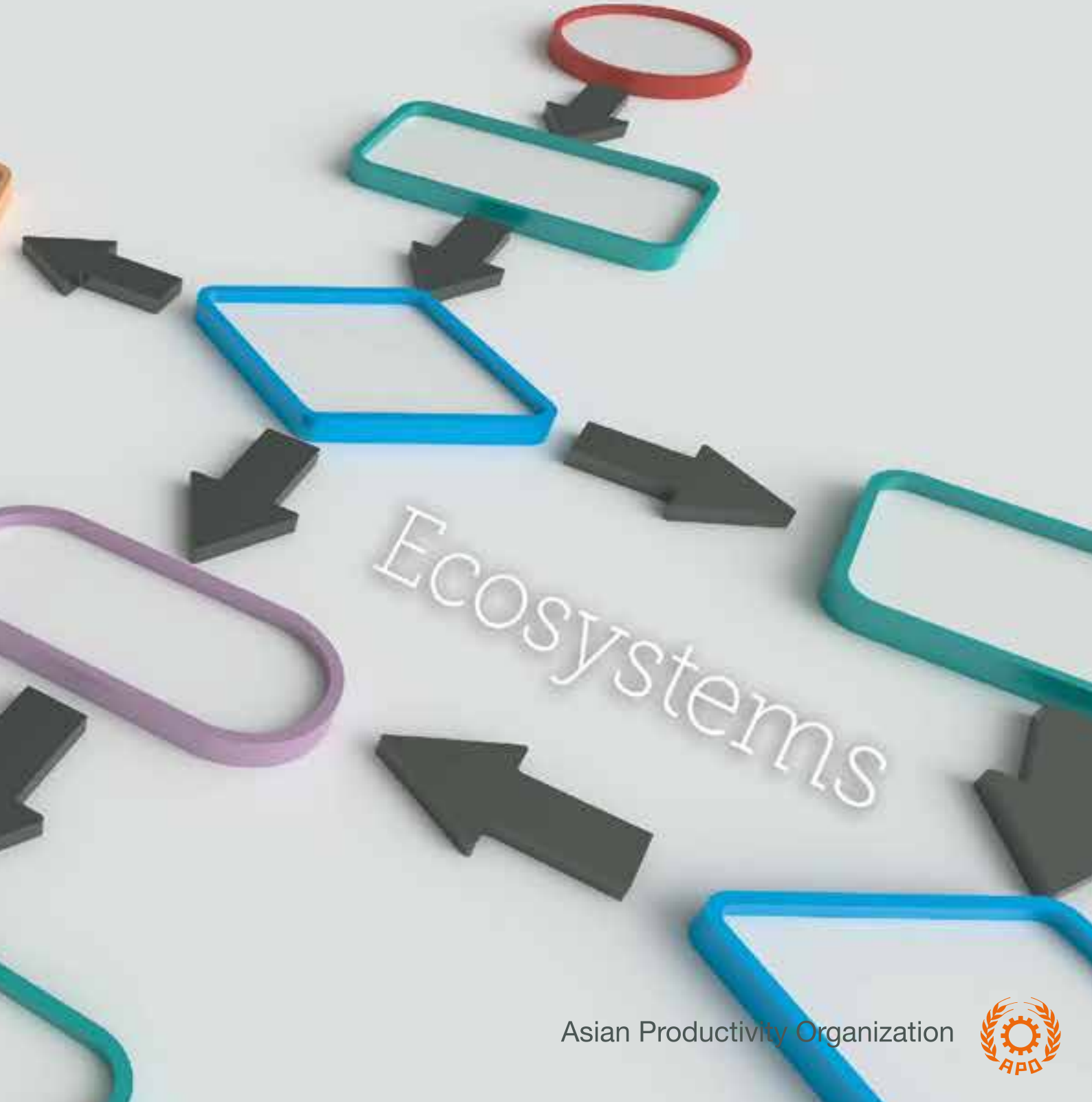
Institutional Innovation Ecosystems to Drive Productivity in APO Member Economies



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INSTITUTIONAL INNOVATION ECOSYSTEMS TO DRIVE PRODUCTIVITY IN APO MEMBER ECONOMIES

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INSTITUTIONAL INNOVATION ECOSYSTEMS TO DRIVE PRODUCTIVITY IN APO MEMBER ECONOMIES

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FOREWORD

In an era marked by rapid technological advances and global competition, the establishment of robust institutional ecosystems to drive productivity has emerged as a critical factor for sustained economic growth and development. Typical institutional ecosystems include a variety of stakeholders, policies, and institutions that promote innovation, the adoption of technology, and efficient resource allocation. By encouraging collaboration and knowledge sharing, those ecosystems address complex challenges, achieve higher productivity, and improve living standards.

This comprehensive report on Institutional Innovation Ecosystems to Drive Productivity in APO Member Economies examines how nine members are creating policies and plans to increase productivity and innovation. It explores the strategies, initiatives, and outcomes of national innovation systems and the factors contributing to their success. Variations among institutional ecosystems are compared, focusing on gross domestic expenditure on R&D as a percentage of GDP. Initiatives undertaken by the APO to improve innovation ecosystems within its member countries are analyzed to facilitate knowledge transfers and exchanges of best practices.

There is no one-size-fits-all set of policy interventions to encourage innovation and increase productivity. This report emphasizes efforts to promote partnerships and collaborations among the private sector, academia, and government to foster innovation and promote knowledge transfers. Joint research initiatives, exchange programs, and regional innovation networks all play important roles in bridging innovation gaps.

The APO acknowledges the dedication of the multinational expert team led by Professor Sunil Kumar of South Asian University, New Delhi, India, and other researchers who contributed to this report. We hope that this publication will serve as a valuable resource for policymakers and assist in efforts to build supportive institutional ecosystems for achieving higher productivity levels.

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Asian Productivity Organization
Tokyo

CHAPTER 1

INSTITUTIONAL INNOVATION ECOSYSTEMS TO DRIVE PRODUCTIVITY IN APO MEMBER ECONOMIES: AN OVERVIEW

Appreciating the role of productivity in the economic development process, Krugman (1994) rightly remarked that "productivity isn't everything, but in the long run it is almost everything" [1]. In fact, productivity growth is considered as the primary driver of economic development and a critical factor in increasing output, creating jobs, improving the standard of living, and fostering wealth in a nation. It also promotes innovation and improves efficient resource allocation, which can lead to a more sustainable and prosperous economy. Technological advancement, innovation, and the efficient deployment of resources can all contribute to a higher productivity growth. A measure of productivity growth indicates the ability of an economy to generate more output with the same amount of input or produce the same amount of output with fewer inputs.

Researchers typically use either single-factor productivity ratios or total factor productivity (TFP) indexes for the purpose of deriving empirical estimates of productivity. A single-factor productivity ratio compares the output to a single input factor, such as labor or capital. It is calculated by dividing the total output by the quantity of the input factor used to produce that output. However, these ratios are limited in their scope since they only analyze one input factor and do not account for the effect of other factors on productivity. TFP index (also known as the multifactor productivity index) is a measure that takes into account multiple input factors, such as labor, capital, energy, materials, and any other factor that contribute to output. It quantifies the efficiency of all inputs used to produce a given level of output and is calculated by dividing the total output by a weighted combination of all inputs used. Since a TFP measure takes into account the impact of multiple input factors on productivity, it offers a more holistic perspective of productivity than a single-factor productivity ratio. In applied studies on cross-country comparisons of economic growth, a comparison of TFP levels has become a standard tool. However, calculating the TFP index is a complex task since it requires detailed data on all inputs and outputs used in the production process.

In his seminal work, Solow (1957) developed a growth accounting framework that allows to decompose the sources of economic growth into components: the "perspiration" component, which is proxied by factor accumulation (i.e., input growth), and the "inspiration" component, which is proxied by TFP growth [2]. In the growth literature, the inspiration component is widely acknowledged as a critical driver of economic growth. There is a broad consensus among economists and policymakers that sustained output growth can only be achieved through the preponderance of the "inspiration component", which is marked by positive trends in TFP growth. In addition, the output growth generated solely by increasing inputs is not sustainable over the long run, as diminishing returns to scale apply with any additional dose of inputs after a certain level of output.

The estimates of productivity measures released by the Asian Productivity Organization (APO) in its flagship publication "APO Productivity Databook 2022" [3] reveal that productivity in APO member economies regressed during the subperiod 2010–20 compared to the preceding decade (Table 1.1). The observed regress in productivity is the result of a precipitous decrease in the underlined productivity measures during the first half of the decade. The subsequent recovery process that seems to be initiated in the second half was abruptly halted as a result of the COVID-19 pandemic. The pandemic produced a sharp (-) 5.5% drop in TFP growth rate in APO member economies between 2019 and 2020. Both labor and capital productivities followed the similar trajectory. The deterioration in productivity that has been seen is largely dependent on how robust the institutional ecosystem for improving productivity is in the member economies.

TABLE 1.1

PRODUCTIVITY ESTIMATES FOR APO MEMBER ECONOMIES IN SELECTED SUBPERIODS AND YEARS

Productivity measure	1970–80	1980–90	1990–2000	2000–10	2010–20	2015–20	2017–18	2018–19	2019–20
Per worker labor productivity growth	2.0	3.0	2.0	2.6	2.2	1.5	2.7	1.2	-3.7
Per hour labor productivity growth	2.1	2.9	2.1	2.7	2.4	1.7	3.0	1.2	-3.3
Capital productivity growth	-6.0	-5.1	-4.2	-3.5	-4.1	-4.2	-4.4	-4.3	-3.8
TFP growth	0.1	1.0	0.3	1.0	0.2	-0.4	1.1	-0.7	-5.5

Source: APO Productivity Databook 2022 [3].

An institutional ecosystem to drive productivity refers to a set of institutions, policies, and regulations that support and promote productivity growth through technological progress, innovation, and the efficient allocation of resources. This system is comprised of various stakeholders, such as governments, academic institutions, research organizations, and businesses, which work in collaboration to create an enabling environment for productivity growth. The institutional ecosystem provides a framework that incentivizes investment, innovation, and skill development as well as promotes competition and trade. A robust ecosystem enables businesses to improve their processes, technologies, and products, which in turn leads to higher economic growth, better resource-use efficiency, more job opportunities, and elevated living standards. Overall, a productivity-driving institutional ecosystem is essential for sustainable economic growth and development.

The productivity ecosystems in APO member economies are diverse and multifaceted. The differences in these ecosystems can be largely attributed to variations in their level of economic development, government policies, educational and skills development infrastructure, business culture, and technological infrastructure. The member economies pursue different policies, programs, and initiatives that are meant to increase productivity at the individual, firm, and national levels. However, it is noteworthy that there exists a shared commitment among APO member economies to improve productivity as a major engine of economic growth and development.

One of the essential and most dominant components of the institutional ecosystem that drives productivity is the national innovation system (NIS), which focuses on promoting innovation and productivity at the national and subnational levels. The NIS facilitates the development, dissemination, and application of new knowledge and technologies, which can lead to the creation of new products, services, and processes. In addition to promoting innovation, the NIS encourages the adoption of new technologies by providing a supportive infrastructure and regulatory framework. A well-developed NIS can help a country in achieving higher productivity levels, sustainable economic growth and competitiveness as well as addressing social and environmental challenges through the development and diffusion of new technologies and solutions. The importance of NIS lies in its ability to enhance

productivity by promoting innovation and technological progress. NIS can be defined as the network of institutions, policies, and agents in a country that interact to create, acquire, diffuse, and use of new knowledge and technologies. NIS includes a wide range of players, such as universities, research institutions, private-sector firms, government agencies, and other organizations that are involved in innovation activities. These players collaborate and compete with each other to create new knowledge and technologies, which may later be employed to drive productivity and economic growth. Overall, by providing an environment that encourages innovation and facilitates the adoption of new technologies, the NIS can help firms to complete in global markets with higher productivity and ultimately contribute to economic growth.

The APO recognizes the importance of innovation in boosting productivity and competitiveness, and as a result, has undertaken several initiatives to support the development of NIS in its member economies. The organization conducts and sponsors capacity building programs, such as training programs, workshops, seminars, and conferences, to better equip policymakers and practitioners in NIS-related activities. In addition, the organization encourages knowledge sharing, innovation management, technology transfer, and the exchange of best practices among its member economies. This is done to promote collaboration and strengthening the NIS. Overall, the APO assists member economies to develop their robust innovation ecosystems by promoting partnerships between academia, industry, and government, and by cultivating a culture of innovation and entrepreneurship.

APO member economies have each developed their distinct NIS that have contributed to their economic growth and competitiveness. These systems involve close collaboration among government, industry, and academia with a strong emphasis on R&D education and training, and the promotion of entrepreneurship and innovation. However, there exists striking variations in the resources and outcomes devoted to the knowledge production process. For example, the statistics available within the website of UNESCO Institute for Statistics and the Report on Global Innovation Index[1] (2022) show that gross domestic expenditure on R&D (GERD) as a percentage of GDP, a crucial indicator of a country's commitment to innovation, differ significantly across member economies. This indicator ranges from less than 0.1% to over 4%. At the high end of the spectrum, countries like Japan and the Republic of Korea (ROK) have GERD as a percentage of GDP of over 3%. These countries are known for their strong innovation ecosystems with well-funded research institutions and supportive government policies. Japan, for example, has a well-established R&D infrastructure and is a world leader in technology innovation. The ROK has also made significant investments in R&D, particularly in the fields of semiconductors and telecommunications, which have helped to drive its economic growth. On the other hand, there are countries like Cambodia, Sri Lanka, Mongolia, the Philippines, and Pakistan, which have GERD as a percentage of GDP of less than 0.2%. These countries face significant challenges in developing their innovation ecosystems due to limited financial resources and a lack of skilled personnel. India, Hong Kong, Islamic Republic of Iran, Vietnam, and Indonesia have GERD as a percentage of GDP in the range between 0.2% and 1%. However, there is growing recognition among these countries of the importance of investing in R&D to drive economic growth and they are taking steps to increase their R&D spending. Turkiye, Malaysia, and Thailand have an R&D expenditure as a percentage of GDP of around 1%, which has helped them develop a strong research infrastructure. PR China and Singapore have GERD as a percentage of GDP of around 2%, and this has allowed them to become technological frontrunners. The variations in this indicator can be attributed to several factors. The level of economic development plays a significant role in this regard. Economies with higher GDPs tend to invest more in R&D as they have more resources to allocate to R&D. This is evident in Japan and the ROK, which have high GDPs and significant investments in R&D. Other factors that contribute to these variations include government policies, the nature of the economy and industry, and cultural and societal factors.

[1] The Global Innovation Index is a yearly ranking of countries based on their innovation capacity and accomplishments, compiled by the World Intellectual Property Organization (WIPO).

Against this backdrop, this report provides an in-depth analysis of institutional ecosystems that have been developed in nine APO member economies to support innovation and productivity. The report consists of eleven chapters, including this overview.

SYNOPSIS OF EACH CHAPTER

Cambodia

This chapter provides a detailed analysis of key aspects of R&D and innovation developments in Cambodia. Prior to the COVID-19 pandemic, Cambodia had robust economic performance and was making steady progress toward its long-term goals of being an upper-middle-income country by 2030 and a high-income economy by 2050. The Royal Government of Cambodia adopted the National Policy on Science and Technology Innovation (STI) with the objective to strengthen the STI foundation and improve the STI ecosystem to support an innovation environment that would lead to sustainable and inclusive development. The Ministry of Industry, Science, Technology & Innovation (MISTI) and the National Council of Science, Technology & Innovation (NCSTI) were founded in 2020 to lead, coordinate, and develop STI policy and implement STI programs throughout the country. Higher education institutions and research institutes are working to build a strong ecosystem for promoting innovation and developing collaborations with businesses. However, a major barrier to creating a robust environment for innovation and productivity is the lack of funding for R&D activities. The policymakers are aware that a robust patent regime is required to derive economic benefits from R&D and innovation activities. Cambodia joined the "Madrid Protocol" and is a member of both the WIPO convention and the Paris Convention for the protection of intellectual property (IP). The innovation activity in Cambodia has been rising rapidly, as reflected on the Global Innovation Index (GII) that shows a consistent rise over the last three years. According to the most recent World Bank Business Survey, more than 30% of firms reported a process, product, or service innovation, and 27% reported spending on R&D activities. The number of start-ups has also increased rapidly in recent years. Cambodia has achieved significant progress in its innovation infrastructure system with a growing venture capital market, efforts in protecting intellectual property rights, and increased spending on R&D. However, there are still weaknesses in the system, such as a lack of coordination between government offices, businesses, and academia as well as difficulties with IP law enforcement.

Fiji

This chapter investigates the role of institutional ecosystems in boosting productivity growth and GDP in Fiji. It begins by noting that the productivity performance of Fiji is dismal in comparison to other APO member economies, and the country lost opportunities to improve its performance on innovation-related indicators, such as patents granted, trademarks issued, and high-tech exports as a percentage of total exports. In Fiji, the institutional ecosystem for productivity entails a collaborative effort to promote economic growth and development by various government agencies, industry organizations, and educational institutions. The National Training and Productivity Centre (NTPC), the National Productivity Council (NPC), and the Ministry of Employment, Productivity, and Industrial Relations (MEPIR) are the three key institutions spearheading the productivity movement. In addition to the well-known challenges that the country is facing, such as a lack of R&D funding, a shortage of skilled researchers, and a limited capacity for innovation, the real challenges in building a robust NIS are a lack of understanding of innovation and its important links to economic growth. The national expert suggests that the roles of NTPC and MEPIR need to be reviewed with an emphasis on deriving productivity growth and innovation-led economic growth. The new Fijian government needs to give paramount importance to innovation and productivity and should develop a range of policies and initiatives to support productivity and R&D activities. It has been emphasized that the responsibilities of the existing MEPIR and NTPC must be rationalized.

The national expert's main policy recommendation is to reboot the Fijian NIS. Some key recommendations in this regard include the establishment of a National Coordinating Agency and National Innovation and Productivity Council, the formulation of relevant regulations to support NIS operationalization, the identification of implementing agencies, the setting of R&D priorities, and the realignment of national priorities in the Fijian education system. A Fiji National Innovation and Productivity Act, backed by applicable laws, is also advocated for building a climate conducive to innovation and boosting coordination among key players, particularly academics and industry. The national expert has stressed that a high-level commitment led by the Prime Minister's Office is required to reconstruct and relaunch the Fijian National Productivity Movement. The lessons learned from other APO member economies and developed OECD economies can help policymakers build a strong institutional ecosystem in Fiji to achieve improved productivity.

India

This chapter provides a detailed overview of institutional ecosystem for productivity improvement in India. It begins with the discussion on the profile of Indian economy and briefly discusses the impact of COVID-19 pandemic on some key performance parameters of economy. India has made great strides in recent years in developing its NIS. The government has implemented several policies and programs to create a supportive ecosystem for innovation and entrepreneurship. The NIS of India includes a variety of stakeholders, such as government agencies, universities, research institutions, private companies, and NGOs. The Indian government has taken many proactive steps to strengthen the linkages between the different actors in the NIS, such as by promoting collaboration between universities and industry and by supporting networking among researchers and entrepreneurs. In addition to these initiatives, India has a strong network of research institutions and universities that conduct cutting-edge research in science, technology and engineering. Moreover, India has a fast expanding start-up ecosystem. In several industries, like IT and biotechnology, the country is now a global leader in innovation. In recent years, India's NIS has shifted from the traditional top-down approach to the bottom-up approach. It is prioritizing the involvement of grassroots institutions and integrating the small and medium enterprises (SMEs) into the overall system in order to encourage market-oriented innovations.

Overall, the existing institutional ecosystem in India primarily focuses on inculcating innovation and entrepreneurship among youth through the educational system. With its research programs, the government has played a catalytic role in promoting industry-academia ties. Efforts have also been made for strengthening the regime governing IP rights. The Indian government has sponsored initiatives, such as Startup India, Digital India, and the Atal Innovation mission to promote innovation and entrepreneurship. The transformation of India's NIS has contributed to the building of an institutional ecosystem that can foster innovation and derive productivity. This is clear from the overall TFP growth and is reflected in India's improved performance in the GII. The examination of GII subindicators, however, reveals a mixed picture. India, for instance, has progressed significantly in terms of knowledge inputs and knowledge creation indicators, but it lags behind in terms of commercialization and the creation of tangible assets. The ecosystem in India must overcome several obstacles to reach its full potential. Improving the quality of research, promoting greater collaboration between diverse actors in the ecosystem, and addressing the shortage of skilled personnel in the country are among the most prominent challenges.

The national experts believe that India needs to do a lot more to make innovation the main driver of economic growth. This is possible if the NIS keeps getting better through the interventions in three dimensions: (i) the "policy and incentives" dimension, which is related to the enabling aspect; (ii) "institutions and infrastructure", which is the facilitating aspect; and (iii) "stakeholder engagement", which is related to the sustaining aspect of NIS. The national experts suggest 12 action areas across these three dimensions to alleviate current concerns and make India's innovation system better.

Indonesia

The chapter on Indonesia looks at its institutional ecosystem for deriving productivity. The national expert found that the performance of national economy was weak with respect to productivity. The decline in TFP was most pronounced in 1977, 1982, and 1998 and was attributed to the global economic crisis, excessive foreign debt, and weak banking and financial institutions during those years. Further, from 2000 to 2014, the trend of TFP growth was somewhat unstable. The Global Financial Crisis of 2007 also had an adverse impact on the TFP growth trajectory. The existing institutional ecosystem includes a wider variety of participants, including a significant number of small and large enterprises. The Indonesian NIS is highlighted by the interactions between institutions undertaking R&D, user industry, and intermediate institutions. Universities and government research institutes are the actors in the first layer of the ecosystem. The interaction between these actors requires the support of intermediary institutions in order to incubate and promote research output. The innovation process in Indonesia is supported by Law 11/2019 and Industrial Law 3/2014, which promote the development of innovation through scientific education, R&D studies, technology transfer, diffusion, and commercialization. The central government takes the responsibility of protecting IP, promoting the application of inventions and innovations for national development, and ensuring the utilization of research results. The number of patents and scientific publications in Indonesia as well as spending on R&D have expanded significantly. Moreover, the number of S&T workers engaged in research and innovation has grown. Unfortunately, the participation of the private sector remains below 20% and the commercialization of innovative products is unsatisfactory. Human Capital and Business Sophistication are the weakest pillars of the GII for the 75th-ranked Indonesia. Indonesia's place on the Global Talent Competitiveness Index is weakened as a result of its inability to attract global talent and international-standard personnel.

A number of policy initiatives are necessary to boost productivity and develop a robust NIS in Indonesia. The Indonesian government must enhance science and technology (S&T) adoption in order to increase industrial productivity and close the innovation divide between the production sector and research activities. The government must also optimize its policies regarding the utilization of patents and develop unambiguous policies for the development of S&T-related human resources. Current innovation policies have failed to facilitate effective interactions between research institutions and industry, resulting in frequent misalignment between what research institutions produce and what industry needs. The Indonesian government must consolidate the existing programs and S&T resources under a single agency, the National Research and Innovation Agency. As an incentive for the private sector to invest in research and innovation, the government must provide significant tax reductions to this sector.

Mongolia

This chapter describes the existing institutional ecosystem for innovation and productivity gains in Mongolia, a small landlocked country in Central Asia. From 1970 to 1980, Mongolia's labor productivity improved at a rate of 4.1% each year, which was higher than the APO21 average of 2.1%. The following two decades (1980–2000) saw a fall, followed by a rising trend beginning in the 2010s. Furthermore, as a result of the COVID-19 pandemic, the indexes of labor productivity, capital productivity, and TFP declined significantly (4.1%–7.4%) in 2019–20. The institutional ecosystem for innovation consists of several legal acts and programs associated with the formulation of state policy. The legal environment of innovation includes: (i) legislation, (ii) state policy documents, and (iii) the rules and regulations of authorized institutions. Under the 2012 Law on Innovation, the government provides funding support for innovation activities in the country. The administrative system of innovation activities consists of the government, ministries, agencies, the National Council of Science and Technology, and local administrative organizations. Industrial technology parks, technology transfer centers, technology incubators, and business incubators are key actors in the existing innovation ecosystem.

Recently, the Mongolian government approved five leading technology areas, including IT, new material technology, biotechnology/industrial technology, renewable energy technology, and cultural

innovation and creative industry. The intertemporal analysis of innovation development levels between 2007 and 2017 reveals Mongolia improved its performance in a variety of areas, particularly innovation capacity, the level of NIS activity, the effectiveness of NIS operations, the innovation environment of NIS, the performance of NIS, and science and technology security rating. It has been found that the Innovation Output Index has had a positive effect on labor productivity. The national expert contends that it is critical for both law enforcers and legislators to make the legal system more sophisticated, systematic, and result-oriented because the legislation has failed to define the responsibilities of various stakeholders or regulate their interactions in the innovation process. Even though several policies and programs have been launched and numerous legal measures have been passed, the subject of identifying the root causes of low innovative activities is not given the necessary attention. The country's scientific, technological, and industrial capacities are not being utilized to their full potential and the process of modernizing them to match current requirements is still in its infancy. It has been proposed to alter tax and financial policy and to imitate the best practices adopted by other countries that have created the conditions for the support and development of science, technology, and innovation activities, all with the goal of strengthening the ecosystem for deriving productivity gains.

Pakistan

In this chapter, the institutional ecosystem for innovation and improving productivity was given detailed focus. The main components of the ecosystem are identified as the government, industry, academic institutions, and R&D organizations. In the existing institutional ecosystem, the government has a role to play as a provider of an innovation-friendly policy environment that allows the other three components to function. The ecosystem functions through the creation of knowledge by academic institutions and R&D organizations and the application of that knowledge by businesses and industries. In the existing ecosystem, the Higher Education Commission (HEC) of Pakistan plays a significant role in promoting R&D and innovation activities and developing a knowledge-based industry in the country through the establishment of numerous national centers and partnerships.

As part of the Pakistani government's emphasis on digitization and the growth of a knowledge economy, the National Incubation Centre and Ignite National Technology Fund support start-ups and promote entrepreneurship. The chapter also emphasizes that the country has significantly advanced in a few areas, such as increasing spending on schooling, research, venture capital funding, and the export of creative and cultural services. It has constantly improved in the innovation rankings, climbing into the top 90 at 87th place out of the 132 economies covered in the GII report 2022. However, there is still a potential for improvement, particularly in the areas of entrepreneurship policy, educational spending, and environmental performance. The lack of an innovation mindset in universities, sparse university-industry collaboration, the dominance of family-owned businesses, and a lack of enthusiasm for innovation are listed as the key challenges confronted by the existing NIS. The national expert emphasized on creating a favorable environment for the NIS to operate efficiently and effectively by designing optimal policies and regulations that support innovation and research activities. It has been suggested that the NIS must switch from "scholar-driven" to "demand-driven" research in order to better serve end-user industries. The national expert contends that more attention should be paid to increasing funds for R&D activities, encouraging collaboration and coordination among various stakeholders, and increasing IP protection.

Philippines

The chapter takes a detailed look at the state of STI in the Philippines and compares it to that of Indonesia, Malaysia, Singapore, Thailand, and other ASEAN countries. The Department of Science and Technology (DOST) oversees the institutional ecosystem for innovation in the Philippines. The DOST is the country's premier science and technology agency, tasked with providing central direction, leadership, and coordination of all scientific and technological activities as well as formulating policies, programs, and projects to support national development. The Philippine Innovation Act of 2018, also known as

Republic Act No. 11293, seeks to establish an innovation ecosystem in the country that will foster the development of STI as a means to create a more competitive and dynamic economy. The Act aims to promote innovation in the country by establishing a national innovation strategy, creating innovation centers, providing incentives for innovation activities, and strengthening the intellectual property rights (IPR) system. The Innovative Startup Act, also known as Republic Act No. 11337, plays a vital role in the institutional ecosystem by promoting entrepreneurship, innovation, and collaboration among start-ups, investors, and other stakeholders. The Philippine Council for Industry, Energy, and Emerging Technologies Research and Development (PCIEERD) is an essential component of the institutional ecosystem. The primary objective of the council is to organize, coordinate, and oversee R&D efforts in the sectors of industry, energy, and emerging technologies. PCIEERD provides funding assistance to a variety of research institutions, universities, and businesses conducting R&D in its focus areas. Through its many initiatives and funding support, the council aims to contribute to the sustainable development and economic progress of the Philippines.

Although the proportion of total R&D expenditures to GDP has doubled in recent years, it remains relatively low compared to other Southeast Asian nations. In addition, the number of researchers per million population in the Philippines is relatively low compared to other countries in the Southeast Asian region. The Philippines has consistently improved its performance in several indicators of the GII. However, compared to its peers in the South Asian regions, the Philippines still faces challenges in other areas, including the quality of institutions and market sophistication. These areas are critical for creating an enabling environment for innovation and attracting investment in R&D. Although the legal framework for protecting IPR conforms to international norms, the majority of IP outputs generated in the country between 2015 and 2019 were not registered. This may be due to an onerous registration procedure that deterred IP developers/inventors from proceeding with registration, or a failure to meet registration standards. Such situations hinder the commercialization and usage of IP outputs. The national expert believes that increasing the GERD to at least 1%, similar to leading ASEAN nations, and augmenting the number of R&D human resources will elevate the country's competitiveness and enhance its productivity.

Turkiye

Turkiye provides an exhaustive examination of its institutional ecosystem for improving productivity. The chapter begins with the note that Turkiye's economy has had a moderate but volatile performance on the productivity front during the past decade. The existing institutional ecosystem for innovation and productivity places a strong emphasis on boosting university-industry collaboration, strengthening R&D capacities, and closing regional development gaps. Various public institutions have evolved support measures to provide an environment conducive for raising the innovative capacities of the economy.

The Ministry of Industry and Technology, Scientific and Technical Research Council of Turkiye (TUBITAK), the Presidency of Strategy and Budget, Council of Higher Education (YOK), and Small and Medium Enterprises Development (KOSGEB) are a few of the institutions that help the nation's ability for innovation to grow. R&D and design centers get tax exemptions on individual and corporate income, incentives for income tax withholding, and employer contributions to social security premiums. Technology Development Zones (TGBs) are areas where private sector organizations can work closer to universities and reduce their R&D costs as well as receive TUBITAK's various tax exemptions. Research infrastructures managed by academic staff are also important actors in the ecosystem for conducting research on basic sciences and also commercializing knowledge by capabilities, such as establishing companies, partnering with established companies, cooperating in the national and international arena or participating in existing collaborations, benefiting from various exemptions, discounts, and exceptions, in terms of human resources and assets.

The Priority Areas Research Technology Development and Innovation Projects Support Program, the Entrepreneurship Support Program, the Support Program for Capacity Building in the Fields of

Innovation and Entrepreneurship, and the Technology Transfer Offices Support Program are some other programs that aim to encourage innovation, technology development, and entrepreneurship.

The goal of the Industrial Innovation Network Mechanism (SAYEM) Program is to foster collaboration between businesses, academic institutions, and government agencies in order to develop high-value products. Due to the institutional ecosystem, R&D expenditures have continually increased over the years with private sector R&D expenditures increasing significantly. The private sector has played an important role in increasing the number of R&D workers and researchers. Also, the number of patent applications and granted patents has increased, demonstrating a greater understanding of the significance of preserving intellectual and industrial property rights. Yet, the proportion of high and medium-high technology exports to overall manufacturing exports has not increased significantly, indicating a potential issue with the commercialization potential of new inventions.

With the exception of a modest drop in 2018–20, Turkiye's position on the GII has improved dramatically. In addition to the issue of a low GERD as a percentage of GDP, there is also room for improvement regarding the collaboration between academia and industry in Turkiye. Collaboration among private corporations also remains limited due the misperceptions about settling IPR and lack of corporate cooperation culture. This generally limits the commercialization of existing knowledge and conducting further research on basic sciences which would potentially improve the competitiveness of industry. Addressing the highlighted issues will require a concerted effort from both the government and private sector. Policies that support innovation and productivity growth, such as streamlined regulations, improved allocation to R&D funding, and encouraging more collaboration between academia and industry and within industry, can help create a more supportive institutional ecosystem in Turkiye.

Vietnam

The final APO member chapter delves into the state of STI in Vietnam. Over the past three decades, Vietnam has experienced remarkable economic growth, driven in large part by its agriculture, forestry, and fishery sectors. Vietnamese planners have acknowledged the importance of productivity in achieving competitiveness. Despite labor productivity tripled between 2000 and 2018, it still trails behind other ASEAN countries. Notably, TFP in Vietnam has exhibited positive growth during this time period. In 2015, the Ministry of Science and Technology took a significant step by consolidating the government's innovation activities for the period 2016–20. The primary emphasis of the implemented policies was on restructuring innovation organizations, management mechanisms, and activities. In 2017, the government issued a plan intended at improving labor quality and fostering competitiveness. Within the business sector, leading domestic enterprises have established R&D institutes and several start-up accelerator programs have been launched to stimulate technology upgrading and innovation. In May 2017, the prime minister issued a directive on Industry 4.0 capacity development and ratified a decision on the digitization of the Vietnamese Knowledge System to support these efforts. However, the actual implementation of these policies continues to face significant obstacles and challenges.

Vietnam has issued a number of policies to encourage and support innovation-related initiatives in response to a growing recognition of the vital role innovation plays in its economic development. Notably, Vietnam has achieved positive results in innovation, securing the 42nd rank out of 131 countries in the WIPO GII 2020 ranking. SOEs in Vietnam have displayed significant activity in the realm of innovation. When it comes to the relationship between innovation and revenue, FDI enterprises have contributed the most (65.6%), followed by private enterprises (59.1%), and SOEs (3.4%). Notably, large enterprises accounted for 86% of the total revenue generated from innovation-based products. The government of Vietnam provides support for innovation through credit channels, technological innovation support policies, and technology consulting services. However, it is concerning that only one out of four innovative enterprises receive government support, primarily due to businesses lacking information about available policies and support subjects. The shortage of qualified human resources stands as a major hindrance to the innovation potential of enterprises. It has been recommended that

efforts should be made to develop policies that aid enterprises in enhancing their innovation capacity, including strengthening collaborations with universities and research institutes. Furthermore, the national expert emphasizes the need to pay more attention to promoting innovation activities in SMEs.

Since 2015, Vietnam has demonstrated improved quantitative trends in R&D input, academic papers, and patents. However, the impact on innovation and productivity improvement remains modest. The science and technology market plays a crucial role in Vietnam's socialist-oriented market economy and it has been strengthened from the central to the local levels. This market has been instrumental in boosting labor productivity, product quality, and the overall competitiveness of the economy. The state has been instrumental in fostering the growth of the science and technology market. It has accomplished this through, among other activities, facilitating the supply of technology, eliminating information barriers, reducing transaction costs, establishing market infrastructure, and supporting the development of certification organizations for appraisal, valuation, and technology transfer consulting. The source of Vietnam's technology provision is scientific research and technology development at research institutes, universities, technology incubators, and businesses in all cities. However, it is notable that only 16% of businesses consider Vietnamese research institutes and universities as a source of science and technology goods.

The national expert observes that Vietnam still lacks enterprise-level policies aimed at enhancing productivity. Vietnam, like many developing nations, devotes considerable time and resources to deliberating new laws and planning policies. The implementation of these laws and policies, however, is typically sluggish and burdensome. Government agencies should be given a larger budget allocation in order to increase their capacity, recruit more qualified personnel, enhance performance-based reward mechanisms, and restructure work processes. Despite Vietnam's substantial FDI, the transmission of knowledge and technology to SOEs and local small and medium-sized businesses remains limited. Vietnam should prioritize the development of policies that promote technology transfer and increase spillover effects. These policies should be intertwined with investment promotion strategies that encourage investment and increase productivity as well as innovation policies that incentivize local SMEs to acquire vital skills and knowledge.

Policy Interventions for Revamping Institutional Ecosystems

The final chapter offers a comprehensive overview of the commonalities and challenges confronted by selected APO member economies in improving the institutional ecosystem that fosters innovation and drives productivity. This chapter also proposes some policy interventions that could help these countries in dealing with issues like low R&D funding, poor infrastructure, a primitive innovation culture, lax IP protection, and insufficient human capital development.

CHAPTER 2

CAMBODIA

INTRODUCTION

Cambodia demonstrated robust economic performance over the past two decades, averaging approximately 7.7% per year, before facing a decline forced by the COVID-19 pandemic. However, according to the National Institute of Statistics of Cambodia, GDP growth was estimated at 5.1% in 2022 compared the previous year, showing signs of recovery. The remarkable growth during the past two decades and the rapid recovery from COVID-19 can be attributed to the strong commitment of the government of Cambodia in developing and implementing a variety of public policies and strategies aimed at ensuring national macroeconomic stability and an open economy.

Cambodia is deeply committed to transition into an upper-middle-income economy by 2030 and a high-income economy by 2050. To realize this vision, science, technology and innovation (STI) have been recognized as the backbone of economic growth. In addition, the Cambodian government has drafted significant policies to promote research and development (R&D), innovation, and entrepreneurship. More recently, the National Policy on STI was adopted in 2019 with the main objectives that include strengthening the foundation of STI and improving the STI ecosystem in order to support an innovation environment for sustainable and inclusive development.

In 2020, the Ministry of Industry, Science, Technology & Innovation (MISTI) and the National Council of Science, Technology & Innovation (NCSTI) were established to lead, coordinate, and develop STI policy and initiatives in the country. Subsequently, a core document supporting the national policy on STI, Cambodia's STI Roadmap 2030, was endorsed by the NCSTI in July 2021. This roadmap focused on five main pillars: governance, education, research, collaboration, and ecosystem. Its aim was to improve the legislative framework for STI and create the necessary components for a dynamic STI system, including Cambodia's National Research Agenda, a national research fund, and offices to establish and maintain university-industry linkages.

Examining the relationship between productivity growth and innovation is one of the most important topics in economics. In general, productivity is defined as the efficiency in production obtained from a ratio of output to input. Productivity has been considered as one of the most important indicators of economic growth [1–2]. According to Crossan and Apaydin [3], innovation can be broadly defined as "production or adoption, assimilation, and exploitation of value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and the establishment of new management systems".

The relationship between productivity growth and innovation has been widely discussed over the last three decades. An effective role of innovation in driving productivity growth as well as enhancing economic performance has been consistently demonstrated in a great number of the literature [4–8]. The positive role of innovation has also been observed in European countries [5]. Innovation becomes more beneficial to countries that experience slower productivity growth, where they can leverage on technology/innovation adoption and knowledge flows more effectively. In terms of process innovation, all types of innovation have a positive effect in productivity growth. Introducing new production

process can lead companies to achieve higher production yields and reduce production costs. Further, a positive and significant effect of innovation on productivity has been observed through R&D cooperation with companies or research institutions and the incorporation of innovations. Numerous studies conducted at the micro level [9–11] support the conclusion that accelerating the adoption of innovation through cooperation with companies or research institutions or incorporating innovations has a clear and positive effect on productivity growth. However, the impact of innovation (dependent on type of innovation) on productivity performance through increased R&D spending is not consistently clear. In this regard, countries tend to experience higher increases in productivity when they manage to expand the number of companies engaged in extramural R&D or participating in training programs. In short, the relationship between innovation and productivity growth is closely intertwined, as also suggested by Zhao and Jin [12].

Innovation has been recognized as instrumental to the success of economies across all scales. The success of innovation in a country hinges on the presence of conducive national innovation system (NIS) that attracts STI investment and improves STI capacity within firms. Based on the World Bank's research findings, it is recommended that developing countries and least developed countries should establish comprehensive programs to strengthen their NIS, improve capabilities in evidence-based policy making, and enhance the ability to implement research and innovation policies [13].

This chapter contains six sections: (i) Introduction - providing an overview of the context of STI in Cambodia and explore the connection between the productivity growth and innovation with a focus on the contribution of NIS to boosting productivity growth; (ii) National Socioeconomic Context; iii) National Innovation Performance; (iv) Empirical Analysis of Productivity, which focuses on trends in national productivity, sources of labor productivity growth and total output growth, and a comparison of national productivity with neighboring countries; (v) Structures and Weaknesses of NIS in the national economy, examining the interconnections between productivity growth and the policy interventions required to achieve productivity gains, and (vi) Conclusions and Recommendations that highlight the key inferences drawn from the empirical analysis, outlining the important policy implications, and providing recommendations to strengthen NIS to generate greater productivity gains.

National Socioeconomic Profile

Key Indicators

The summarization of Cambodia's socioeconomic indicators is as follows:

- Area: 181,035 sq km
- Capital: Phnom Penh
- Population: 15,552,211 million people (2019) [14]
- Population based on mother tongue: Khmer (95.8%), Chinese (0.7%), Vietnamese (0.5%), Lao (0.1%), minority language (2.9%)
- Population based on age group: 0–14 years (29.4%), 15–59 years (61.7%), 60+ years (8.9%)
- Life expectancy at birth: 75.5 years
- Spoken language: The official language is Khmer
- Ethnic groups: Khmer (90%), Vietnamese, Cham, and Lao

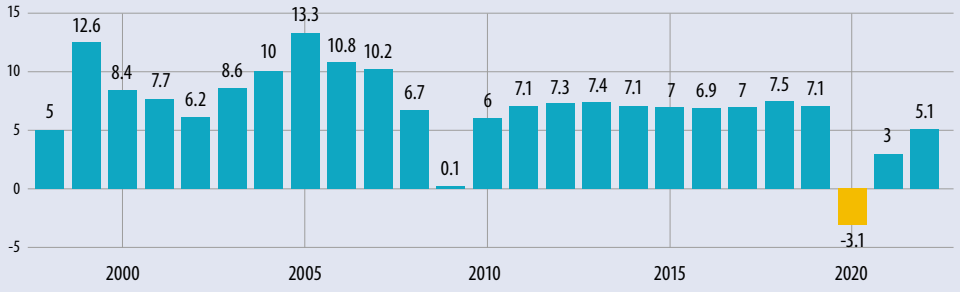
- Religions: Buddhism (97%), Muslim (2%), other religions (0.8%)
- GDP: USD26.96 billion (2021)
- GDP per capita: USD1,625.2 (2021)
- Economic growth: 7.5% (2018/19), -3.10% (2020, a decline of 10.5% from 2019), 3.03% (2021, an increase of 6.12% from 2020), 5.1% (2022)
- Cambodia government budget: -2.6% of GDP (2020)
- Important industry sectors: Agriculture, manufacturing (garment, nongarment, and footwear), construction, and tourism
- Employment sectors: Government, SOEs, local private enterprises, foreign enterprises, nonprofit organizations, household sector, international organizations/embassies, and others
- Unemployment (% of total labor force): 0.6% (2021)
- Share of the workforce in informal/vulnerable employment: 70% (2018)

Evolution of GDP Growth

Prior to the COVID-19 pandemic crisis, Cambodia achieved a remarkable average GDP growth rate of 7.7% annually from 1998 to 2019 [15]. The country reached the lower middle-income level in 2015. With Cambodia's substantial economic growth over the past two decades, it stood as the sixth fastest growing economy globally. The success can be attributed to the prevailing peace, security, and political stability under the current government as well as economic openness, macroeconomic stability, significant inflows of public and private capital, and active collaboration with neighboring countries. Amid the COVID-19 pandemic, Cambodia experienced a -3.10% growth rate in 2020, indicating a decline of 10.5% from 2019, followed by a 3.03% growth rate in 2021, showing a 6.12% increase from 2020. The Cambodian economy was estimated to have grown by 5.1% in 2022, reflecting a robust recovery from the pandemic's impact. Figure 2.1 shows Cambodia's GDP growth from 2000 to 2022.

FIGURE 2.1

CAMBODIA'S GDP GROWTH IN 2000–22 [16]



Sectoral Structure of Economy

Figure 2.2 illustrates the transformation of the main sectors contributing to Cambodia's economy from 2011 to 2021. The country's economy has undergone structural shifts since 2011. The share of GDP originating from the agriculture sector has declined while the industry sector has grown. Further, a correlation exists between the employment status of labor force by economic sector and the share of GDP growth (Figure 2.3). The percentage of total employment has transitioned from the agriculture sector to industry and service sectors. The share of total employment decreased from 45.3% in 2014 to 37.0% in 2017, and slid further to 35.5% in 2019. In contrast, the shares of industry and service sectors increased, progressing from 24.3% and 30.5% in 2014 to 26.3% and 36.8% in 2017, and reaching 26.1% and 38.4% in 2019, respectively [17].

FIGURE 2.2

CONTRIBUTION TO GDP BY ECONOMIC SECTOR % IN 2011–21 [18]

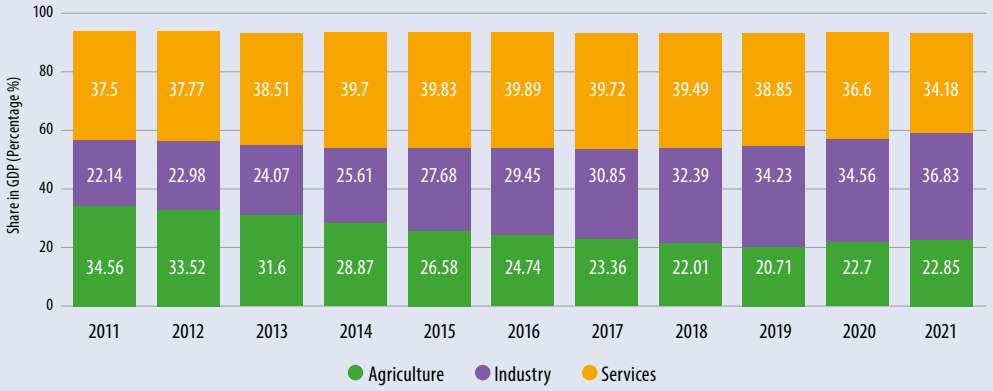
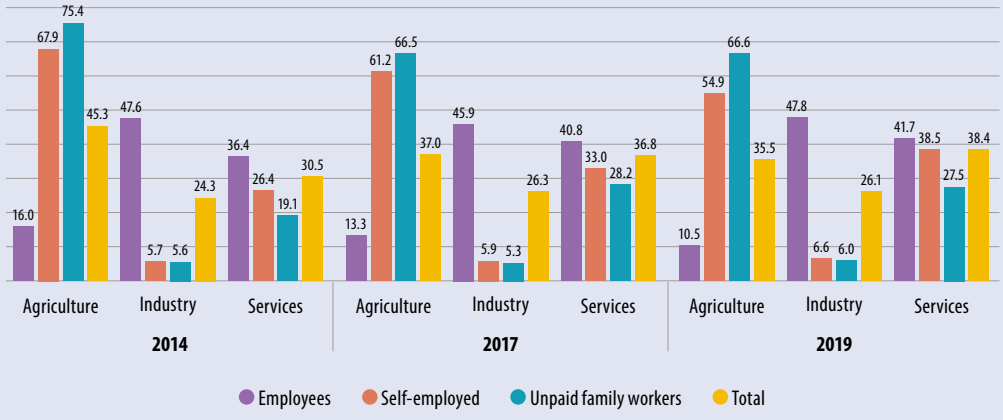


FIGURE 2.3

EMPLOYMENT STATUS OF LABOR FORCE BY ECONOMIC SECTOR (%) [17]



INNOVATION PERFORMANCE

R&D Expenditure

According to UNDP, Cambodia allocated 0.12% of its gross domestic expenditure on R&D (GERD) in 2015 while the average R&D expenditure of ASEAN countries stood at 0.7% [19]. During the same year, the majority of R&D spending was made by private nonprofit sectors and the government, accounting for 37.08% and 31.19%, respectively, followed by higher education (18.22%) and business enterprises (13.51%). More recent figures from Cambodia's Ministry of Economy and Finance showed that government R&D expenditure was 0.19% in 2021. However, the criteria for R&D spending remains under discussion with the line-ministries, specifically MISTI.

Figure 2.4 shows the source of funds for R&D in 2015. The majority of R&D funding originated from abroad (34.93%), followed by the government (23.5%), private nonprofit entities (22.06%), business enterprise (19.44%), and higher education (0.06%). This suggests that universities were not significantly engaged in R&D and the key players in sponsoring R&D were foreign entities, likely through loans from international institutions, such as ADB and the World Bank.

FIGURE 2.4

R&D SOURCES OF FUND

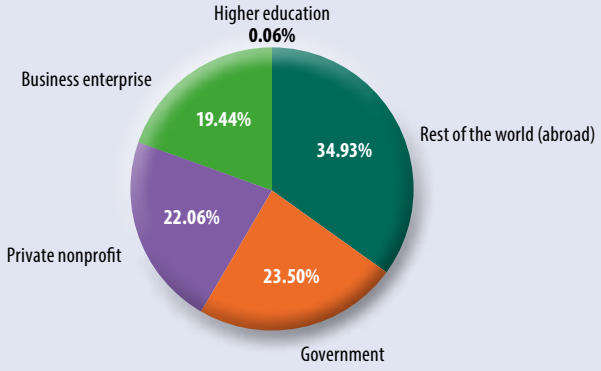
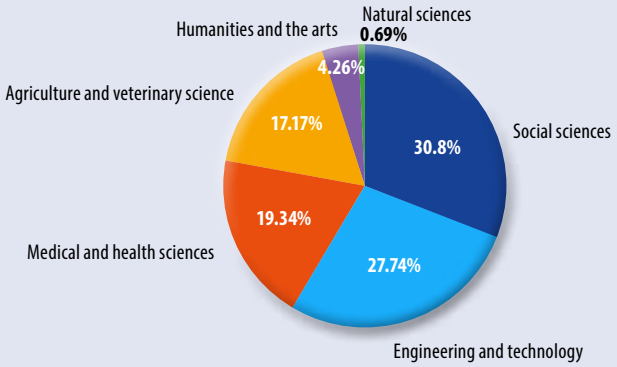


Figure 2.5 highlights the distribution of R&D spending across disciplines with the largest portion of funding was directed toward social sciences (30.80%) and engineering and technology (27.74%). Additionally, 19.34% of funding were allocated to medical sciences while 17.17% went to agriculture sciences. Humanities and the arts received only 4.26% of the funding with only 0.69% were directed toward natural sciences.

It is evident that Cambodia's R&D expenditures remain constrained. A lack of funds for R&D stands as a significant barrier for higher education institutions, research institutes, and businesses in the country [20]. Addressing this challenge, the Cambodian government should focus in developing a robust research system capable of producing high quality scientific outputs that can be commercialized as well as translated into practical solutions for societal challenges. This involves developing capacity at individual, organizational, and policy levels. To this end, MISTI, as the leading ministry responsible for STI policy and regulation, is in the process of drafting a subdecree on R&D management to address the nation's pressing R&D needs. In addition, allocating dedicated funds to support knowledge creation activities will further enhance the country's innovation landscape.

FIGURE 2.5

R&D SPENDING

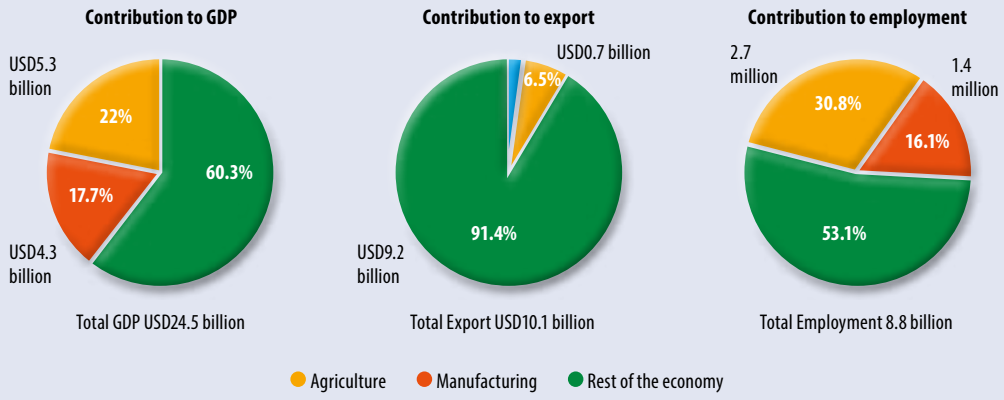


High-tech Export

According to World Bank, high-technology exports are defined as "products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery" [21]. In recent years, Cambodia's economic structure has undergone significant changes. One of the main contributors to Cambodia's GDP is the manufacturing sector (excluding construction), representing 17.7% of the country's GDP and generating 1.4 million jobs, which accounts for 16.1% of total employment. In addition, this sector covers a significant portion of Cambodia's total exports, amounting to 91.4% or USD9.2 billion (Figure 2.6).

FIGURE 2.6

CAMBODIA'S MANUFACTURING CONTRIBUTION TO THE ECONOMY [19]



According to UNDP's 2020 data, Cambodia's export structure is composed of textiles and clothing (67.5%), footwear (8.2%), machinery and equipment (4.8%), vegetables (3.6%), transportation (3.5%), hides and skins (3.3%), plastic and rubber (2.9%), and others (6.2%). The lower value-added production, such as textiles, clothing, and footwear represent 75.7% of the total exports (Figure 2.7).

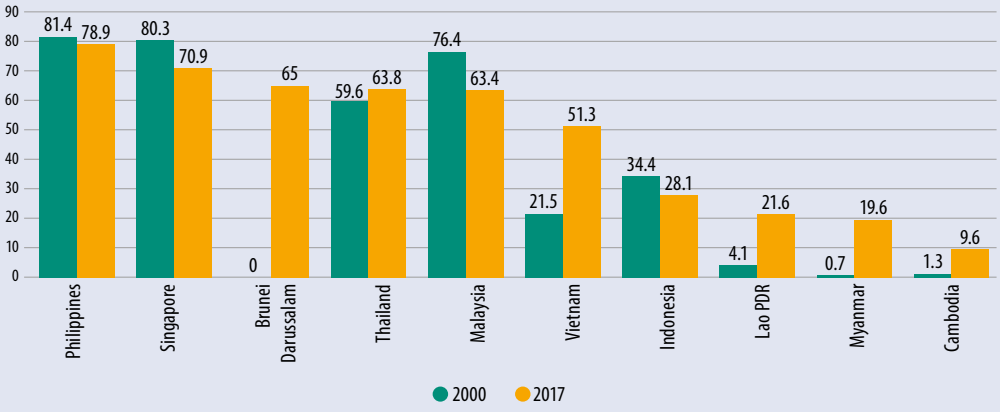
Figure 2.8 illustrates the medium- and high-technology exports of ASEAN countries in 2000 and 2017. From 2000 to 2017, Cambodia experienced an increase in medium- and high-tech exports, rising from 1.3% to 9.6% of manufactured exports. Despite this growth, Cambodia's figure remains the lowest among ASEAN countries. According to Sandu and Ciocanel [22], an increase in total R&D volume correlates with higher levels of high-tech exports.

FIGURE 2.7

CAMBODIA'S EXPORT IN 2016 (% MANUFACTURED EXPORTS) [19]

FIGURE 2.8

ASEAN COUNTRIES' MEDIUM- AND HIGH-TECH EXPORTS IN 2000 AND 2017 (% MANUFACTURED EXPORTS) [19]



Patent

A patent is defined as "an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem" [23]. Following Cambodia's accession to the World Trade Organization (WTO) in 2004, the country had to put more effort to fulfill its obligations in the implementation of intellectual property (IP) related laws and regulation.

Cambodia holds membership in the Paris Convention members of IP, the World Intellectual Property Organization (WIPO) convention, and the agreement of trade-related aspects of IP rights. These memberships offer advantages for protecting their IP through registration. In 2015, Cambodia has made significant progress in IP protection by joining the "Madrid Protocol". This step led to improvements in IP registration through the international patent application framework of the Patent Cooperation Treaty (PCT).

According to the WIPO data, the period from 2012 to 2020 witnessed a rise in nonresidents' patent applications, increasing from 53 to 248. Patent grants, on the other hand, rose from 0 to 96 (Figure 2.9 and Figure 2.10) while there is no record of resident patent grants within the same period.

The result of a survey conducted by UNESCO and MISTI reveals a relatively low level of intellectual property rights (IPR) protection in Cambodia. The survey's outcomes indicate that only six patents were filed by the organizational respondents over the three-year span from 2018 to 2020 [20].

FIGURE 2.9

NUMBER OF PATENT APPLICATIONS BETWEEN 2012–21 [23]

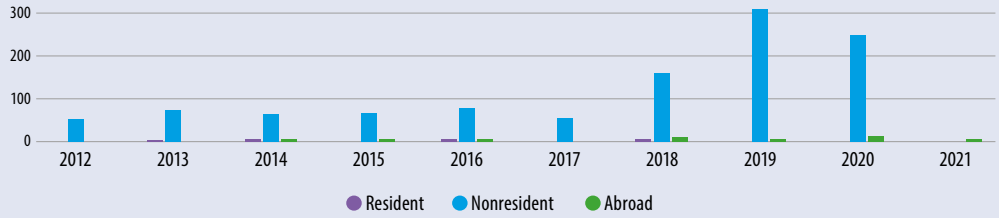
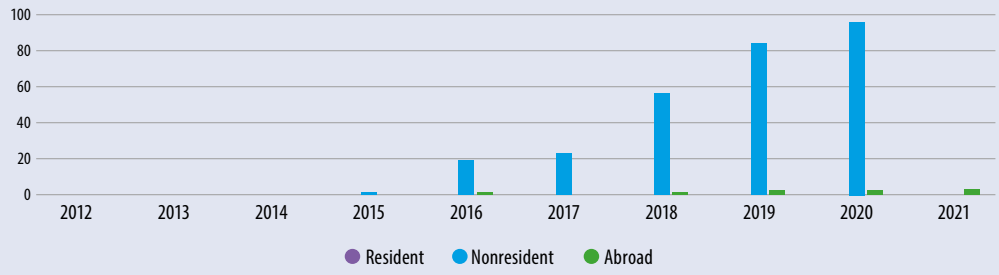


FIGURE 2.10

NUMBER OF PATENT GRANTS BETWEEN 2012–21 [23]



To advance STI-based careers and employability, introducing mobility schemes to support the placement of STEM teachers and university students within national and international enterprises is recommended. This initiative could be supported by policy instruments developed by the Cambodia Science Fund.

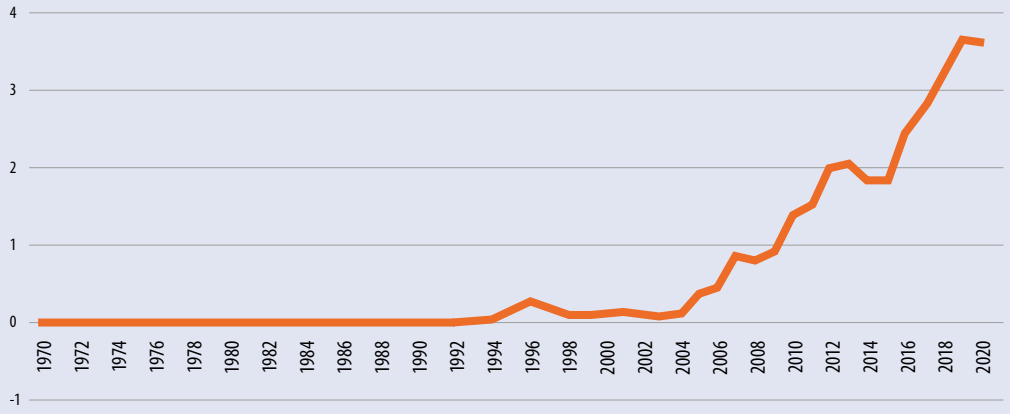
Foreign Direct Investment (FDI)

Cambodia's economic growth has been driven by FDI, preferential trade treatment, and official development assistance (ODA) inflows. The combination of rapid economic growth, an open economic

environment, and open borders to investment and international trade has positioned Cambodia as the second highest FDI recipient in the region of Southeast Asia and Oceania, after Singapore in 2019. Figure 2.11 shows the trajectory of FDI in Cambodia. In 2019, Cambodia experienced its highest FDI of USD3.7 billion, primarily driven by substantial investment from PR China, intra-ASEAN countries, and Japan. The investments were predominantly channeled into the manufacturing and services sector.

FIGURE 2.11

TRAJECTORY OF FDI NET FLOW IN CAMBODIA BETWEEN 1970–2020 (IN CURRENT USD'BILLION) [21]



Generally, FDI flows into Cambodia are often directed to infrastructure development, encompassing commercial and residential real estate projects. More recently, Cambodia had started to attract investments in manufacturing and agro-processing, which could potentially facilitate the transfer of knowledge and technology as well as R&D and innovation skills.

Innovation Activity

The Global Innovation Index (GII) serves as a ranking of global economies based on their innovation capabilities. The GII encompasses a comprehensive assessment of a country's innovation dimensions, considering a range of inputs and outputs across 80 indicators. Table 2.1 presents Cambodia's rankings from 2020 to 2022. Among 132 countries, Cambodia ranks at the 110th, 109th, and 97th positions in the GII for 2020, 2021, and 2022, respectively. In 2022, Cambodia showcases stronger innovation inputs compared to outputs. Within the group of 17 countries in Southeast Asia, East Asia, and Oceania, Cambodia ranks at the 15th spot while it ranks 17th among 36 lower-middle-income countries.

TABLE 2.1

CAMBODIA'S RANKING IN 2020–22

GIIYR	GII	Innovation Inputs	Innovation Outputs
2020	110	117	101
2021	109	106	104
2022	97	92	102

Figure 2.12 shows the GII scores across pillars in comparison to lower-middle-income economies, Southeast Asia, East Asia, and Oceania as well as the top 10. Cambodia demonstrates performance above the average of the lower-middle-income group in institution and market sophisticated pillars while falling below the average when compared to regional countries. Cambodia excels in market sophistication, yet reveals a weaker performance in business sophistication.

FIGURE 2.12

SEVEN GII SCORES BY PILLAR IN CAMBODIA [23]

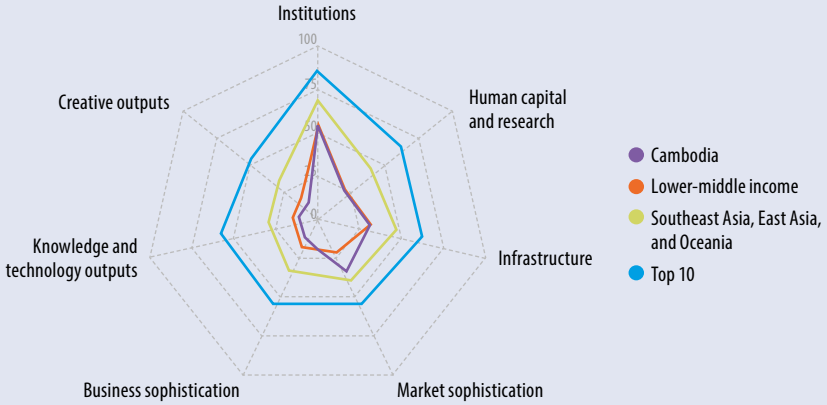
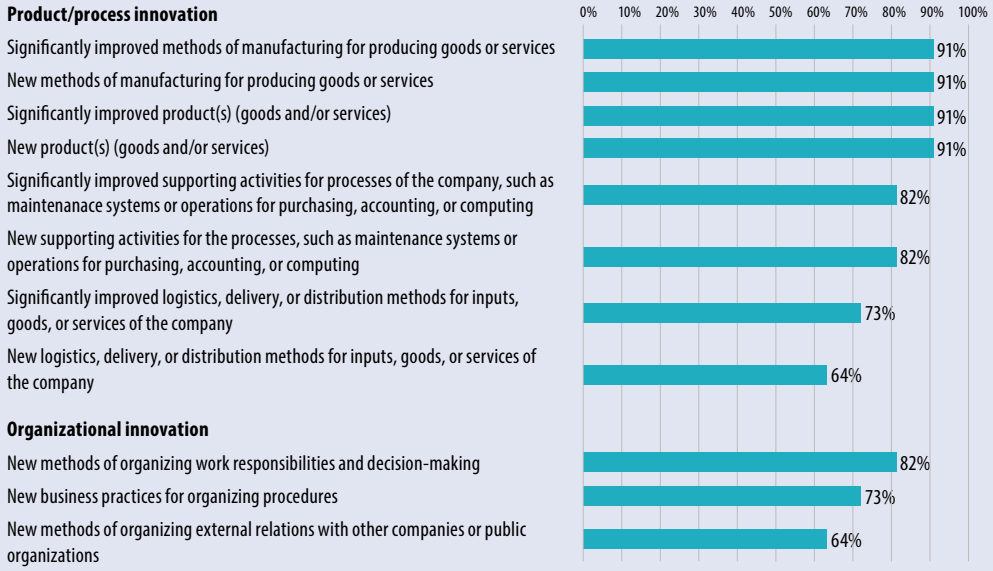


FIGURE 2.13

PRODUCT, PROCESS, AND ORGANIZATIONAL INNOVATIONS INTRODUCED BY COMPANIES [20]

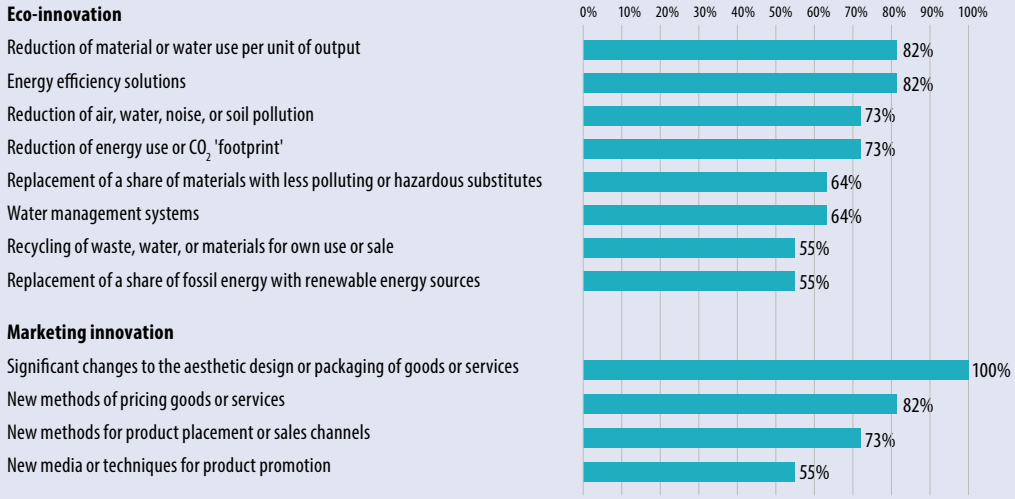


A recent study conducted by UNESCO and MISTI [20], through a demand-side survey spanning from 2018 to 2020, reveals that 65% of companies claimed to have introduced innovations. Among these, a majority of the companies focused on new product development, significant product improvements,

new methods of manufacturing, and significantly improved methods of manufacturing for new products (goods and services). Companies also reported developing new methods for organizational responsibilities and decision-making (Figure 2.13). In addition, eco-innovations gained traction, particularly for enhancing material/water use efficiency per output unit as well as offering energy efficient solutions. Marketing innovation was introduced in the form of significant changes in the aesthetic design or packaging of new products, along with new methods of pricing (Figure 2.14).

FIGURE 2.14

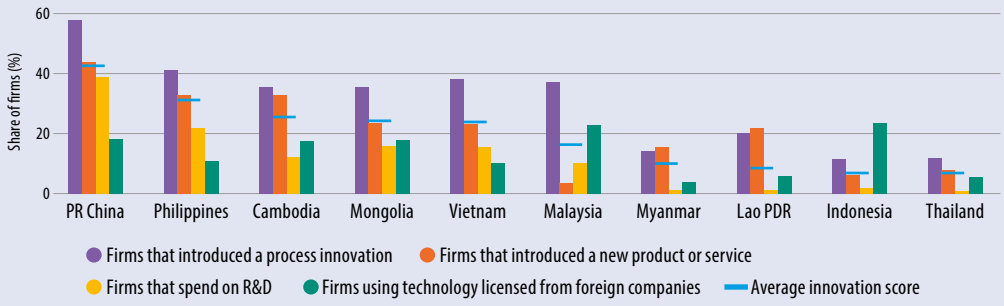
ECO-INNOVATIONS AND MARKETING INNOVATIONS INTRODUCED BY COMPANIES [20]



World Bank Enterprise Survey results announced in 2021 indicated that more than 30% of Cambodian firms reported of being engaged in process, product, or service innovation, and 20% have licensed foreign technology. Overall, Cambodian firms perform better in innovation activities compared to their counterparts in Lao PDR, Myanmar, Indonesia, and Thailand, where innovation activity was less pronounced (Figure 2.15). The World Bank study also revealed that only a small share of firms in Cambodia were involved in more sophisticated innovation activities, such as R&D.

FIGURE 2.15

FIRM-LEVEL INNOVATION ACTIVITY IN CAMBODIA AND SELECTED EAST ASIAN COUNTRIES [24]



EMPIRICAL ANALYSIS OF PRODUCTIVITY

Productivity is generally defined as a ratio of output to inputs. In the context of the economy, productivity measures the efficiency of producing goods by comparing the volume of economic output to the volume of inputs used in their production, such as labor and capital [25]. Typically, productivity is measured through capital, labor, and total factor productivity (TFP). Labor productivity is measured based on hours of labor input and employment count while capital productivity assesses the efficiency of capital utilization for producing specific output. TFP, or also multifactor productivity, measures the ratio of aggregate output to aggregate inputs. TFP is calculated by dividing an index of real output by an index of combined inputs of labor and capital. Several factors can affect TFP, including cultural, technological and innovation elements. For policymakers and economists, productivity growth is seen as the core factor to long-term economic growth and tangible enhancements in individual living standards set by policymakers and economists.

Trends in Productivity

Based on APO Database [26], the decade-wise average of productivity indices of Cambodia is presented in Table 2.2. The 1981–90 period sees Cambodia's TFP (0.67), labor productivity based hours worked (0.49), and number of employment (0.45) as well as capital productivity (0.73) witnessed the lowest average levels. The highest average level of TFP and capital productivity were observed between 2001–10 at 1.02 and 1.12, respectively. Moreover, the highest average labor productivity, measured both by hours worked and number of employment, reached an equivalent level of 1.13 during this period.

TABLE 2.2

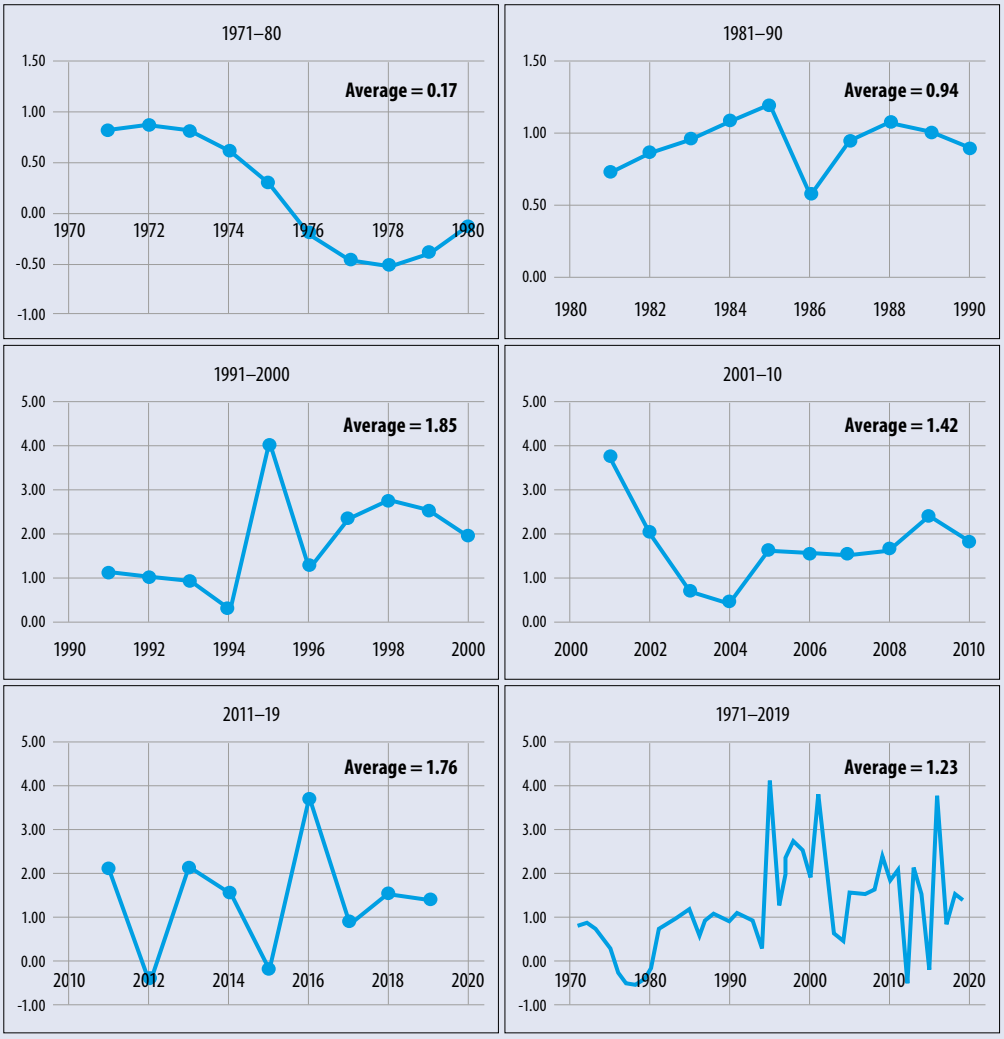
AVERAGE PRODUCTIVITY INDICES BY DECADE IN CAMBODIA

Decade	TFP	Labor Productivity (based on hours worked)	Labor Productivity (based on number of employment)	Capital Productivity
1971–80	0.86	0.64	0.58	0.90
1981–90	0.67	0.49	0.45	0.73
1991–2000	0.85	0.60	0.56	1.01
2001–10	1.02	0.89	0.88	1.12
2011–19	0.95	1.13	1.13	0.91

Figure 2.16 illustrates Cambodia's labor productivity growth (per hours worked). In growth terms from 1971 to 2019, there has been a gradual increase with an average annual growth rate of 1.23%. This growth exhibited an increase from 0.17% in the 1970s to 0.94% in the 1980s, followed by a rise to 1.85% in the 1990s. However, there was decline to 1.76% in the 2000s and 1.42% in 2010s.

FIGURE 2.16

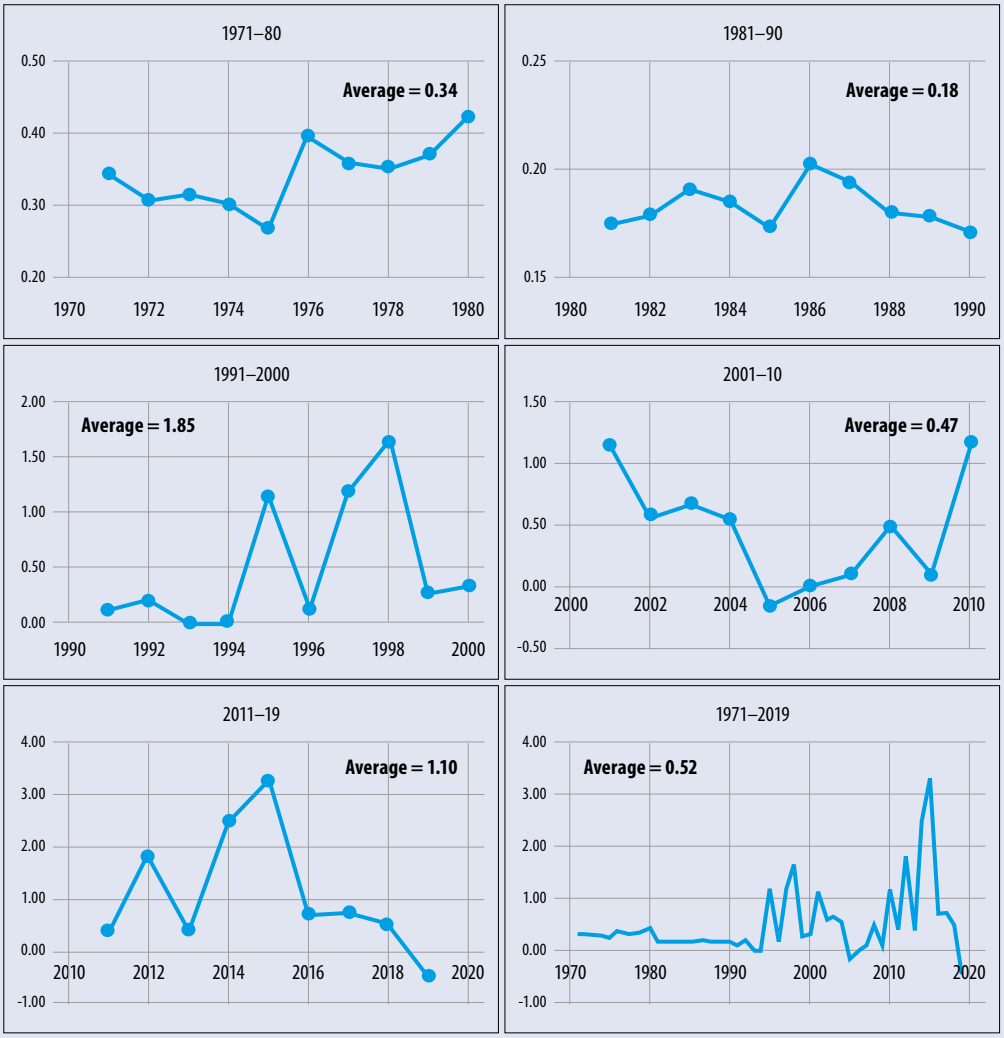
LABOR PRODUCTIVITY GROWTH (PER HOURS WORKED) IN CAMBODIA



When productivity growth is measured in terms of labor quality (Figure 2.17), the average productivity growth exhibited fluctuations across decades. Cambodia's labor productivity growth, as measured in terms of quality, achieved its highest average during the 2010s at 1.10. Over the period between 1971 and 2019, Cambodia's average of labor quality-based growth rate was 0.52%, which matched with the period from 1990 to 2010.

FIGURE 2.17

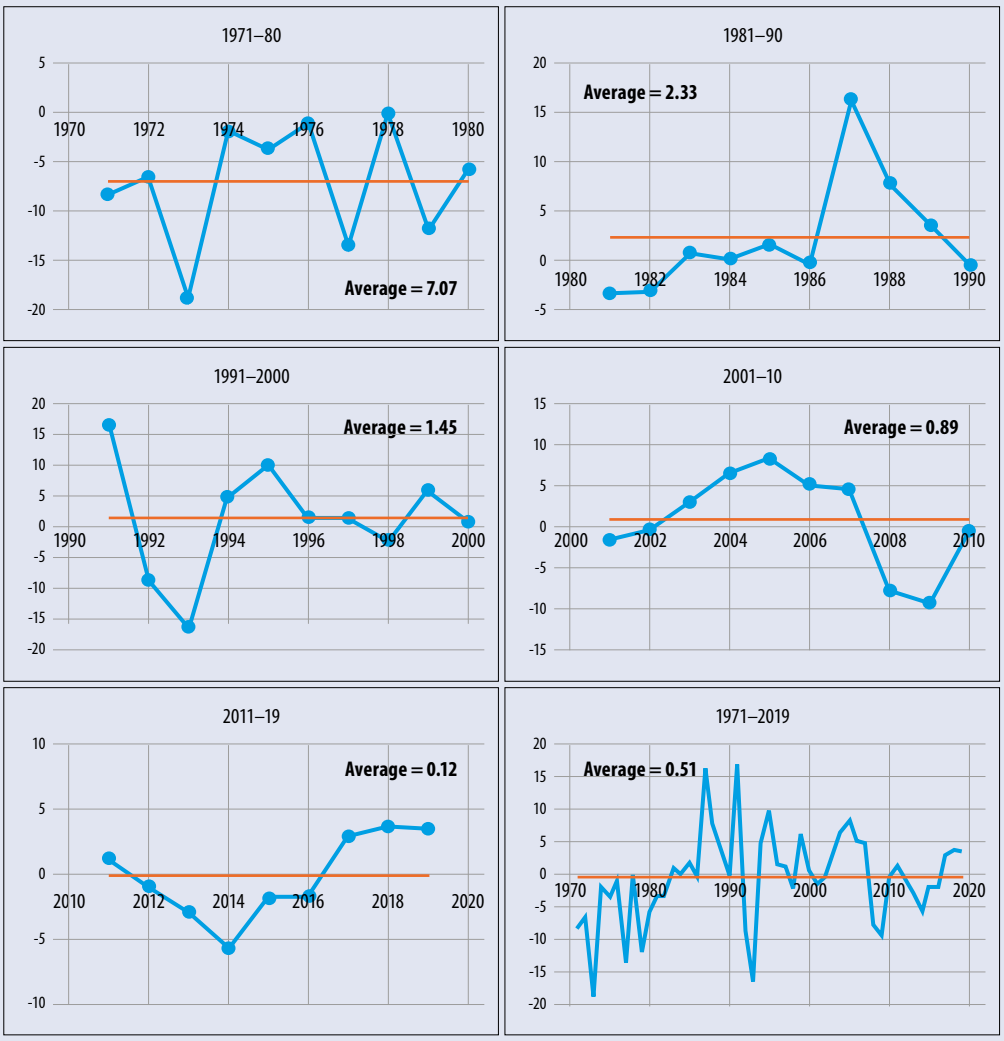
LABOR PRODUCTIVITY GROWTH (LABOR QUALITY) IN CAMBODIA



Cambodia's TFP decade average levels between 1970 and 2019 are presented in Figure 2.18. In particular, Cambodia's TFP experienced a dramatic increase from -7.07% in the 1970s to 2.33% in the 1980s. However, the TFP decade average witnessed a decline from the 1980s to the 2010s, recording 1.45%, 0.89%, -0.12%, in the 1990s, 2000s, and 2010s, respectively. The average TFP from the period 1970 to 2019 was -0.51%. This negative average was influenced by very low TFP levels of -18.76%, -13.30%, and -11.79% in the 1970s, specifically in 1973, 1977 and 1979, respectively.

FIGURE 2.18

TFP GROWTH IN CAMBODIA



Decomposition of Labor Productivity Growth and Total Output Growth

Labor Productivity

Productivity measures the efficient utilization of production inputs, such as labor and capital, in generating output within an economy. The theory of neoclassical growth outlines three fundamental factors that contribute to economic growth, which are labor quality improvements, capital deepening (IT and non-IT capital deepening), and TFP. Capital deepening measures the relationship between an increase in capital and labor. This can be achieved by elevating the capital stock or decreasing the number of labor employment. In addition, technological development and process improvements result in higher output per unit of labor. The output growth per labor hour can be attained by improving labor quality, physical capital levels, technological, and processes.

FIGURE 2.19

SOURCES OF LABOR PRODUCTIVITY GROWTH IN CAMBODIA

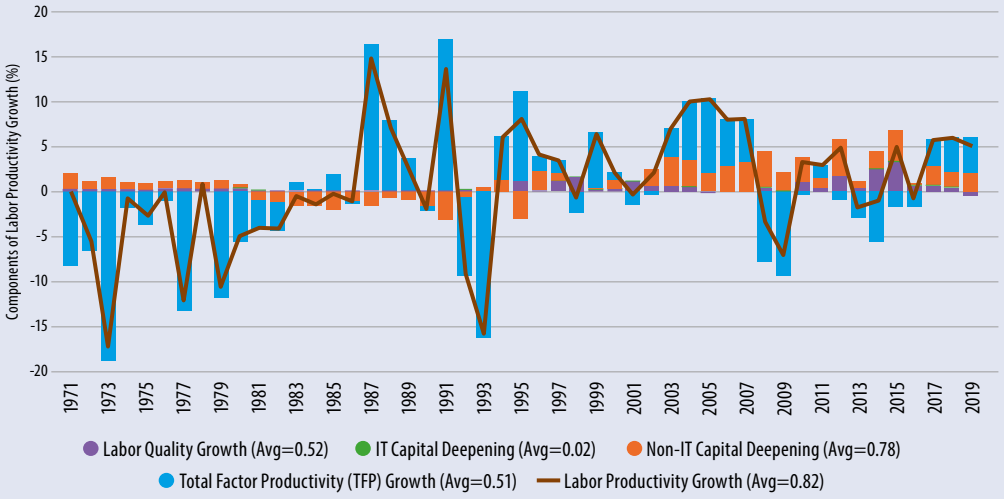


Figure 2.19 shows Cambodia's sources of labor productivity growth from 1971 to 2019. The country's labor productivity growth was driven by increasing TFP, followed by the non-IT capital deepening. In addition to this, the IT capital deepening and labor quality growth had only a minor impact on labor productivity growth. Cambodia's decade-wise average of labor productivity witnessed an upward trajectory every decade until 2010, after which it declined to 2.94% between 2011 and 2019 (Table 2.3). From the 1990s, Cambodia's labor productivity was slowed down by TFP deceleration in 1992–93, 2008–09, and 2013–14 during the recessionary years and periods of macroeconomic stress.

TABLE 2.3

DECADE-WISE AVERAGE OF LABOR PRODUCTIVITY SOURCES (DECOMPOSITION)

Decade	Labor Productivity	Labor Quality	Capital Deepening	IT Capital Deepening	Non-IT Capital Deepening	TFP
1971–80	-5.80	0.34	0.92	0.01	0.91	-7.07
1981–90	1.22	0.18	-1.29	0.00	-1.30	2.33
1991-2000	1.90	0.51	-0.06	0.03	-0.09	1.45
2001–10	3.87	0.47	2.52	0.03	2.49	0.89
2011–19	2.94	1.10	1.96	0.05	1.91	-0.12

Total Output Growth

Total output growth constitutes capital inputs, labor inputs, and TFP. From 1971 to 2019, Cambodia's total output growth increased in an average of 3.48%. Analyzing the average contributions, capital inputs emerged as the main contributor to growth (2.25%), followed by labor inputs (1.74%) and TFP (-0.51%) (Figure 2.20). Cambodia's decade-wise average total output growth displayed an upward trend until 2010 at 7.56%, followed by a decline to 5.57% between 2011 and 2019 (Table 2.4). In the 1970s, 2000s, and 2010s, capital input was the main contributor to the total output growth, representing 1.21%, 4.44%, and 3.16% for the total outputs of -5.53%, 7.56%, and 5.57%, respectively. In the 1980s, TFP was the main contributor to the total output growth, representing 2.33% for the total output growth of

3.68%. In the 1990s, labor input and capital input shared a similar level of contribution at 2.36% and 2.31%, respectively, to the total output growth of 6.12%.

FIGURE 2.20

SOURCES OF TOTAL OUTPUT GROWTH IN CAMBODIA

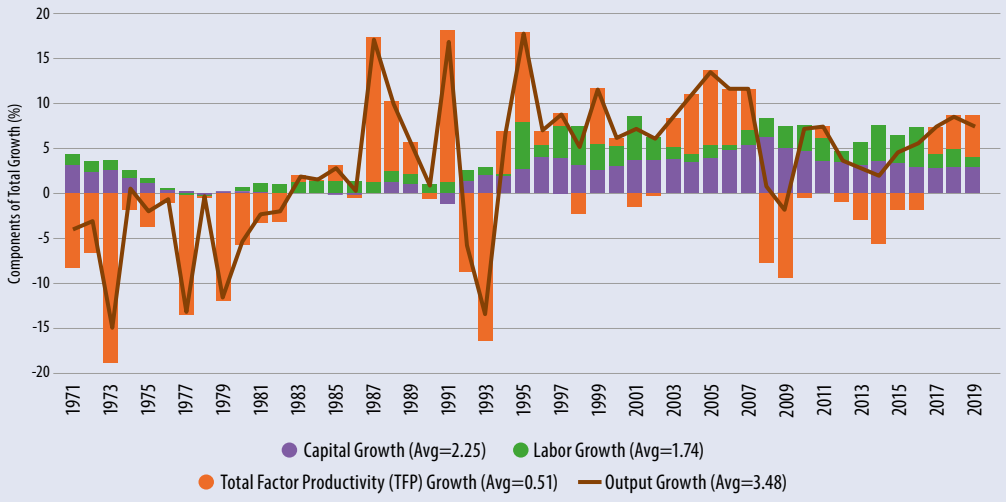


TABLE 2.4

DECADE-WISE AVERAGE OF TOTAL OUTPUT GROWTH SOURCES IN CAMBODIA

Decade	Output Growth	Contribution of Capital Input	Contribution of Labor Input	TFP Growth
1971–80	-5.34	1.21	0.52	-7.07
1981–90	3.68	0.23	1.12	2.33
1991–2000	6.12	2.31	2.36	1.45
2001–10	7.56	4.44	2.24	0.89
2011–19	5.57	3.16	2.52	-0.12

Comparative Productivity Indices with Regional Countries

Figures 2.21–2.24 [26] reveal insights of Cambodia's decade-wise average of productivity indices (TFP, labor productivity based on hours worked and based on number of employment, and capital productivity) compared to regional countries, such as Lao PDR, Myanmar, Thailand, and Vietnam. In the 1970s to 1990s, Cambodia's TFP index showed its lowest performance when compared to other countries. However, Cambodia's TFP level (1.02) surpassed Lao PDR (0.98) and Thailand (0.97) in the 2000s, and a more significant TFP level (0.95) compared to Lao PDR (0.88) and Myanmar (0.83) in 2010s (Figure 2.21). In terms of labor productivity level in both per hours worked and per worker, all countries witnessed an upward trend from the 1980s to 2010s (Figures 2.22 and 2.23). In the last decade-wide of the 2010s, Cambodia's labor productivity levels stood at 1.13 for both per worker and per hours worked, trailing behind Vietnam (1.31 and 1.25), Thailand (1.25 and 1.19), and Myanmar (1.19 and 1.14).

In terms of capital productivity level, Cambodia's decade-wise average fluctuated every decade, yet the country outperformed other nations (Figure 2.24). In the 1970s and 1980s, Cambodia capital productivity

level charted 0.90 and 0.73, respectively. These were the lowest levels compared to other countries, surpassed by Myanmar's high levels of productivity at 2.99 and 2.27 for the 1970s and 1980s, respectively. In the 1990s, Cambodia performed better, recording capital productivity level of 1.01, which is higher than Lao PDR's 0.89. The 2000s yielded better results too with Cambodia's capital productivity level recorded at 1.12, ahead of Lao PDR (1.01) and Thailand (0.96). In the 2010s, Cambodia's capital productivity level (0.91) also surpassed Lao PDR (0.81) and Myanmar (0.70), but lagged behind Vietnam (1.01) and Thailand (0.95).

FIGURE 2.21

CAMBODIA'S DECADE-WISE PRODUCTIVITY INDICES AVERAGE COMPARED TO REGIONAL COUNTRIES ON TFP

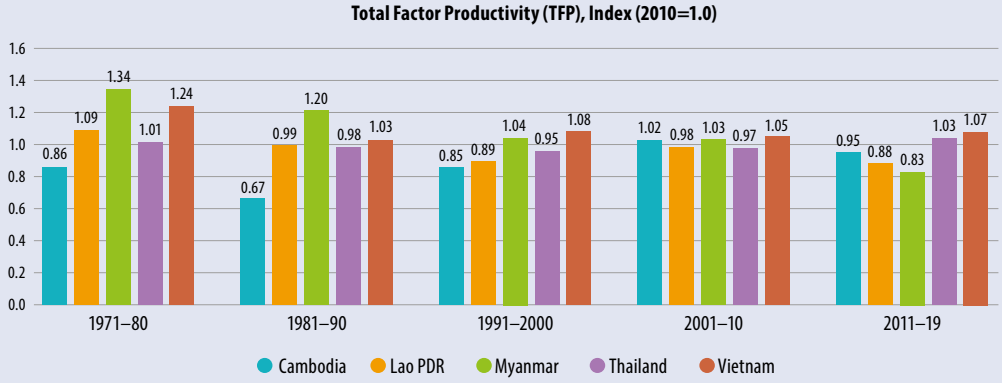


FIGURE 2.22

CAMBODIA'S DECADE-WISE PRODUCTIVITY INDICES AVERAGE COMPARED TO REGIONAL COUNTRIES ON LABOR PRODUCTIVITY (BASED ON HOURS WORKED)

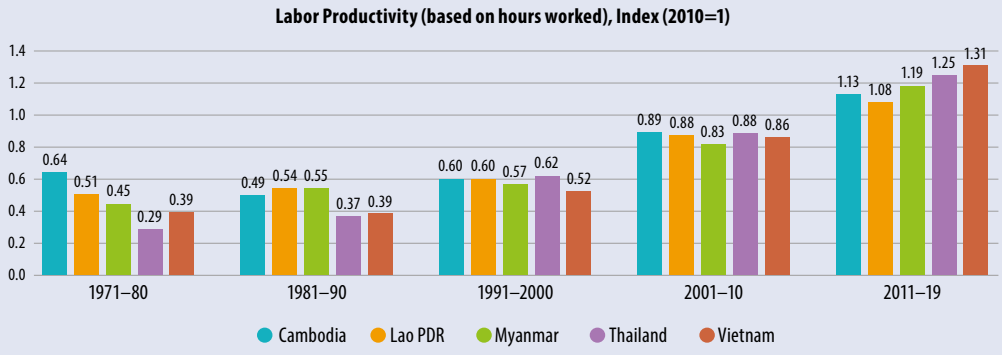


FIGURE 2.23

CAMBODIA'S DECADE-WISE PRODUCTIVITY INDICES AVERAGE COMPARED TO REGIONAL COUNTRIES ON LABOR PRODUCTIVITY (BASED ON NUMBER OF EMPLOYMENT)

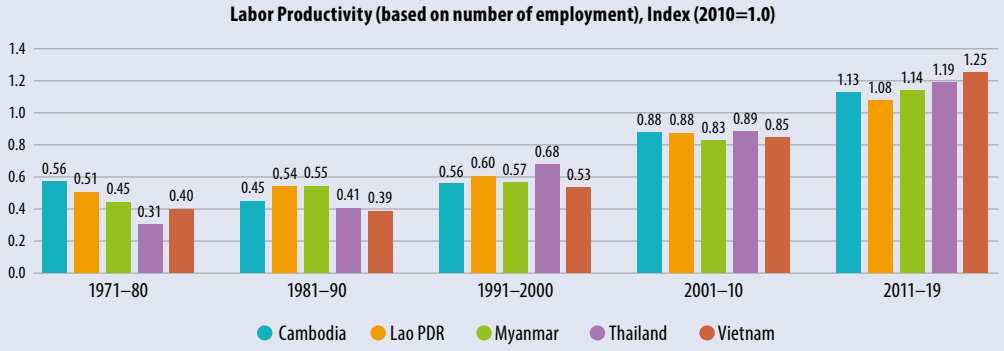
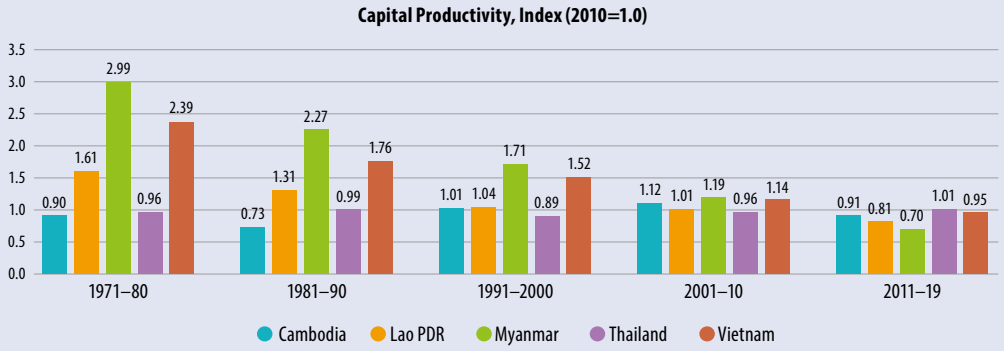


FIGURE 2.24

CAMBODIA'S DECADE-WISE PRODUCTIVITY INDICES AVERAGE COMPARED TO REGIONAL COUNTRIES ON CAPITAL PRODUCTIVITY

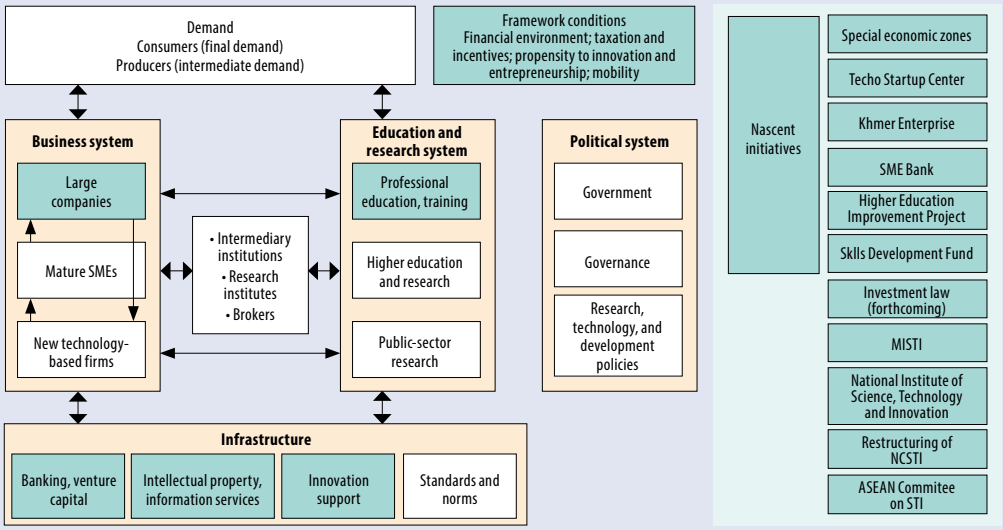


NATIONAL INNOVATION SYSTEM (NIS)

Cambodia's NIS has progressed significantly in the last eight years. Figure 2.25 shows the strengths of Cambodia's NIS, underpinned by initiatives carried out by the government of Cambodia to build a solid foundation for innovative and inclusive development of the nation by 2030. The government has demonstrated a strong commitment to steering the development of the country toward STI. NIS, comprised of four mains components - political system, infrastructure, business system, and education and research system for STI - requires to be strengthened to create an inclusive ecosystem.

FIGURE 2.25

STRENGTHS OF CAMBODIA'S NIS [27]



Governance of STI Development

In March 2020, the government established the new Ministry of Industry, Science, Technology & Innovation (MISTI) and the National Council on Science, Technology & Innovation (NCSTI) to spearhead STI efforts in the country. MISTI and NCSTI play pivotal roles as the lead coordinators of STI policy, setting the direction, overseeing policy implementation, and evaluation. Alongside MISTI, the General Department of Science, Technology & Innovation was also created. On a regional level, this department has been assigned the responsibility of heading the ASEAN Committee on Science, Technology and Innovation (COSTI) for Cambodia. COSTI plays an essential role in implementing the ASEAN Plan of Action on Science, Technology and Innovation (APASTI) for 2016–2025 while currently engaged in drafting the APASTI 2026–2035.

The National Policy on STI 2020–2030 was launched in 2019, forming the core of STI policy in Cambodia. This policy is drafted with five specific objectives:

i) Developing and strengthening sufficient human resource in STI with a focus on quantity, quality, and composition with professional ethics while striving for gender equality.

ii) Empowering exceptional human resource in STI to carry out leading tasks and establish a robust support system for a thriving R&D ecosystem, enabling these resources to maximize their full potential.

iii) Ensuring an efficient and effective national R&D direction that emphasizes technology adaptation for national context and improving absorptive capacity of international technology.

iv) Developing and strengthening dynamic innovation ecosystem with capacity to synthesize technologies and engineering to achieve national achievements through incremental innovation, thereby fostering prioritized national industries and businesses for both domestic and export markets with the aim of more productive development.

v) Instilling in society an STI culture in an inclusive manner with the aim to ensure public confidence and trust on products and services that use national technologies. This approach ensures that those who made efforts and investments in STI development have satisfaction of their achievements, alongside the outcomes of STI governance reform.

This STI Policy identifies five priority technology areas:

- Agricultural yield increase, produce diversification, and agro-processing
- Modern production and engineering
- Health and biomedical
- Materials science and engineering
- Services and digital economy with a focus on emerging technologies, such as artificial intelligence, space, and spatial technology

Considering the National Policy on STI 2020–2030, Cambodia's STI Roadmap 2030 was developed and implemented in 2021. MISTI has recently finalized a Monitoring & Evaluation (M&E) Framework for Cambodia's STI Roadmap 2030 to ensure effective roadmap implementation. Further, Cambodia's National Research Agenda (NRA) was drafted and approved by NCSTI in December 2022. The NRA sets the direction for research to be carried out for the next five to 10 years, delineating core research themes and the policy mix to support research activities. This overarching agenda serves as a guiding beacon to drive significant advances in scientific research, especially in the face of upcoming challenges. It is aimed at relevant institutions, including relevant line ministries, research, and academic institutions, and seeks to encourage research among the private sector, particularly in priority research areas.

In terms of STI governance, creating robust STI ecosystem for the industrial innovation improvement is an ongoing process and remains crucial in Cambodia's context. In addition, the government is drafting the law on technology transfer. The proposed law outlines the competent institutions for managing technology transfer, creates mechanisms to achieve the development goals of socioeconomic and environmentally inclusive and sustainable development through technology transfer, promotes and encourages R&D and innovation in technology, determines mechanisms for resolving disputes, and investigates and addresses technology transfer-related offenses, all geared toward effectively managing, promoting, and facilitating technology transfer within and beyond Cambodia. The law also promotes technology transfer across ministries, institutions, competent authorities, private sectors, universities, research institutions, researchers, and civil society while ensuring investments in science technology and innovation sectors.

Innovation Infrastructure

Cambodia's emerging innovation infrastructure system includes banking and venture capital, IP, information services, innovation support, and standards and norms. In Cambodia, the landscape of investment is built with the availability of venture capital funds in the market and an increasing number of local angel investors and private equity stakeholder. The government has launched important initiatives in order to enhance access to finance on the national level, such as small and medium enterprises (SMEs), SME Bank, Capacity Building and R&D Fund, and Entrepreneurship Development Fund ASEAN Plan of Action on Science, Technology, and Innovation. Cambodia is also currently in the process of preparing a subdecree on STI Parks, aiming to foster inclusive growth of the national economic level.

In Cambodia, three ministries are responsible for IP matters. The Ministry of Commerce, the Ministry of Culture and Fine Arts, and MISTI oversee trademarks, patents and industrial designs, and copyrights, respectively. Collaborating with the IP Office of Singapore, MISTI facilitates the registration of patent owners and applicants. To enhance patent registration, Cambodia has streamlined patent application processes by establishing fast-track procedures with Japanese IP authorities. Furthermore, patent protection will be carried out under the Patent Cooperation Treaty framework [27]. These initiatives have significantly improved Cambodia's patent registration process. In the current context, the country is actively enhancing its court system functionality, a move that would benefit IPR holders by facilitating more effective enforcement of these rights.

Business System

From 2019 to 2022, the number of start-ups in Cambodia has approximately doubled. This rapid growth is necessary to fulfill the expanding demands of digital economy and its fundamental requirements, including e-commerce, logistics, and fintech. For example, during COVID-19 pandemic, both consumers and suppliers have shown an increased inclination toward technology adoption [27]. Over the last five years, the number of technology start-ups in Cambodia has surged significantly. Currently, there are more than 300 active technology start-ups, at various stage of development, operating across the country.

Two important opportunities emerge for the innovation development within Cambodia's business system. First, the diversification and expansion of the country's manufacturing sector by transitioning from labor-intensive operations to a workforce skilled in advance technologies, and higher value-added processes. Second, the availability of deep technology worldwide that opens a doorway of opportunity for those equipped with the requisite drive and skills to partake in the potential wave of innovation in the business landscape.

Education and Research System

Cambodia's NIS is currently in a transition phase within its education and research domain. Driven by the government's commitment, Cambodia has made significant progress in key education. The country's education system is being developed, ranging from foundational education to postgraduate levels, which are aligned to achieving the government's vision for 2030 in transitioning into a higher-middle-income country. Remarkable progress has been made from 2015 to 2018, recording the completion rate at primary levels from 80% to 86.1%, secondary levels from 39% to 47.6%, and the proportion of grade 1 students who passed through all early childhood education (ECE) programs have improved from 62.0% to 72% [27].

Entrepreneurship and innovation have been strategically integrated into higher education institutions. In recent years, a number of initiatives have been set into motion. Several renowned higher education and research institutions, such as the Royal University of Phnom Penh (RUPP), the Institute of Technology of Cambodia (ITC), the National University of Management, and the Royal Academy of Digital Technology (CADT) have established university-based incubation centers, start-up hubs, and industry-university linkage offices.

The national research landscape has improved over the last 20 years. Research activities are mainly focused on scientific publications, carried out by universities and public research institutions [21]. It was recorded that there were very few Cambodian research publications prior to 2000. The trend has shifted, seeing an approximately 500 publications recorded per year in 2018 with the majority of which (80%) were scientific articles. To further advance and boost R&D and innovation, criteria of Centers of Excellence and professorship are currently in development.

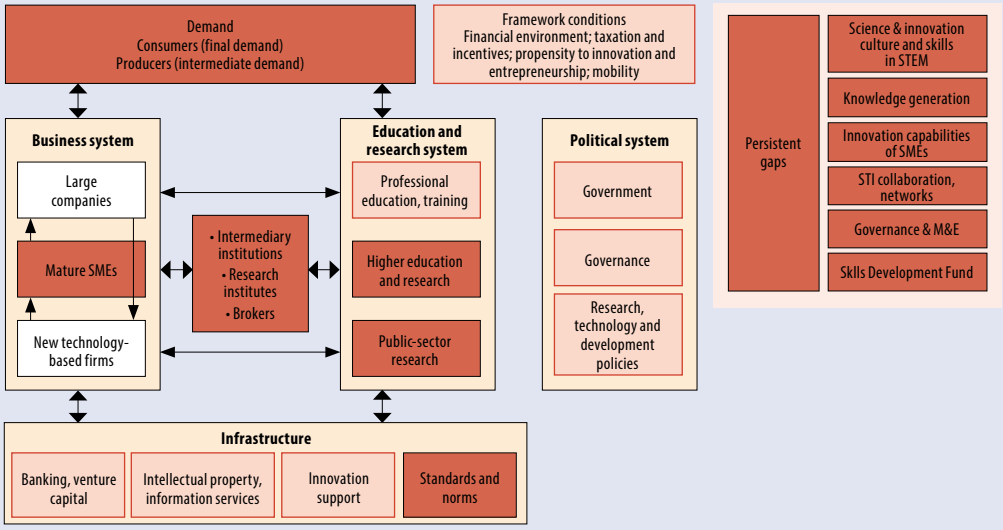
A number of policies and strategies has been implemented to improve the educational and research framework in Cambodia. These include the Cambodian Higher Education Roadmap 2030 and Beyond, Education Strategic Plan 2019–2023, Policy on Higher Education Vision 2030, Policy on Science, Technology, Engineering and Mathematics Education, Cambodia's Education 2030 Roadmap, Policy and Strategy on Information and Communication Technology in Education (2018), and the National Technical Vocational Education and Training Policy 2017–2025. Beyond these comprehensive measures, Cambodia, under the leadership of MISTI, is drafting a subdecree on R&D management. This initiative aims to strengthen the development of knowledge and innovation to promote an inclusive and sustainable socioeconomic growth trajectory.

Weaknesses of the National Innovation System

Figure 2.26 shows the weaknesses of Cambodia's NIS. According to MISTI and ESCAP [27], challenges confronting innovation governance encompass the absence of a culture of coordination among government agencies (breaking silos of works), informal nature of SMEs (not registered SMEs), and the uneven distribution of benefits following a recent industrial shift. Relatively weaker components in Cambodia's NIS include limited representation of large enterprises, persisting modernization hurdles for SMEs, lack of intermediary institution, research institutes, and brokers as well as an incomplete and inaccessible norms and certification system for start-ups and SMEs. Further, the enforcement of IP laws face challenges due to shortage of funds for patent authority.

FIGURE 2.26

WEAKNESSES IN CAMBODIA'S NIS [27]



Note: Darker shade indicates weaker components.

Within Cambodia's NIS, discernible gaps emerge in terms of fostering scientific and entrepreneurial excellence, along with a lack of professional skills and a culture of research excellence. In addition, science, digitalization, and entrepreneurship cultures are weak while the higher education system falls short in producing graduates equipped with the required skills. The Technical and Vocational Education and Training (TVET) sector faces pressing challenges to increase technological capacities within SMEs as well as facing issues of attractiveness and research quality.

In tandem with the aforementioned shortcomings, suboptimal incubation facilities and restricted access to early-stage finance for companies contribute to the prevailing weaknesses. A further strengthening of nascent infrastructure and framework conditions underscores the necessity for Cambodia's NIS to evolve in line with the needs of current context.

CONCLUSIONS AND RECOMMENDATIONS

In order to achieve the ambitious vision to become a higher middle-income economy by 2030 and a high-income economy by 2050, the government of Cambodia has taken several significant steps. Specifically, STI has been recognized as the backbone of economic growth and increasing productivity is the direct effect of fueling economic growth. The literature review emphasized a positive relation between innovation and productivity growth. According to the result of empirical analysis of national productivity within the existing NIS framework, the following policy recommendations are put forward to generate greater productivity gains to strengthen Cambodia's NIS:

- **Enhance R&D capacity and quality** - Building human capital in STI within the science, technology, engineering, and mathematics (STEM) education and healthcare. Allocate sufficient fund for R&D endeavors and improve standardization and norms

- **Develop evidence-based policy** - Construct a comprehensive STI human resource database and create a digital profile that encompasses education, employment, and healthcare

- **Strengthen collaboration and networking** - Cultivate a robust triple helix model encompassing government, private sector, and research institution. Establish technology transfer centers to facilitate transfer of technology in both vertical (R&D, research institutions, patents) and horizontal (private sector to private sector) levels. Roll out incubation and acceleration programs for STI start-ups. Encourage the growth of technology clusters and enhance university-industry linkage offices and technology transfer centers

- **Promote innovation environment** - Enable an environment for all levels of innovation that include governmental and grassroots innovations to attract investments in high-tech industries and SMEs

- **Empower STI governance** - Set up a robust M&E framework to oversee the implementation of policies and establish government budget to encourage STI investments

CHAPTER 3

FIJI

INTRODUCTION

Fiji, a small developing island country with a GDP per capita PPP of USD12,060, is one of the most developed among Pacific Island Countries (PICs) and is categorized as an upper middle-income country [1], as shown in Table 3.1. It is centrally located in the South Pacific region and given its well-developed economic, infrastructure, transport, and education systems compared to other PICs, the country is ideally positioned as a vital trade hub for regional and small island countries. However, Fiji continues to grapple with country-specific problems, including economic vulnerability, narrow income base, trade imbalances, increasing public debt, political instability, geographical remoteness, climate change issues, and vulnerability to natural disaster. These factors continue to restrict growth and sustainable development in Fiji [2].

TABLE 3.1

PICS' INDICATORS

Country	Land Area (sq km)	Population Estimate 2022	Growth GDP 2020 (% Constant Prices)	Growth GDP 2021 (% Constant Prices)	GDP Per Capita (PPP 2021 USD)
Papua New Guinea	462,840	10,142,619	-3.5	1.5	4,340
Fiji	18,272	929,766	-15.2	-4.0	12,059.8
Solomon Islands	28,370	724,273	-4.3	-0.2	2,656.1
Vanuatu	12,190	326,740	-5.4	0.5	3,105.1
Samoa	2,935		-2.6	-8.1	6,420.4
Federated States of Micronesia	701	114,164	-1.8	-3.2	3,544.2
Tonga	650	106,858	0.7	-0.7	6,693.8*
Kiribati	811	131,232	-0.5	1.5	2,171.9*
Marshall Islands	181	41,569	-1.6	1.7	4,181.5
Palau	444	18,055	-9.7	-17.1	16,318.7*
Nauru	21	12,668	0.7	1.6	15,102.7
Tuvalu	26	11,312	1.0	2.5	5,082.4

Source: World Economic Data [3].
Note: * represent figures for 2020.

Selected Socioeconomic Indicators

GDP Growth

Prior to the emergence of COVID-19, Fiji's economic growth, measured by GDP in constant USD, was already slowing down since 2018. The average annual GDP growth over the span of 10 years between 2012–21 was at 0.82% [4]. The total value of goods and services in 2012 amounted to USD3.97 billion and

increased marginally to USD4.59 billion in 2021. This slow growth reflects a sluggish economy and a relatively poor living standard (Table 3.2). The deceleration in growth in 2020 and 2021 can be attributed to supply chain restrictions in the international markets and the complete halt of Fiji's tourism industry due to the impact of COVID-19. The overall economic slowdown was consistent with the global economic recession and was further compounded by on-going domestic challenges, such as depressed consumer demand, natural disasters, mounting debt, and increasing food prices [4].

TABLE 3.2

SELECTED SOCIOECONOMIC INDICATORS

Economic Indicators	2016	2017	2018	2019	2020	2021
GDP (USD in billion)	4.93	5.35	5.58	5.50	4.57	4.59
GDP per capita (USD)	5,651	6,101	6,317	6,176	5,103	5,086
GDP growth (%)	0.7	5.35	3.81	-0.45	-15.15	-4.08
Annual average inflation rate (%)	3.9	3.35	4.08	1.77	-2.60	0.16
Trade (% of GDP)	78.0	97	103	107	70	75
Current account balance (% of GDP)	-3.6	-6.6	-8.4	-12.5	-12.6	-13
Personal remittances (% of GDP)	5.8	5.21	5.27	5.37	7.77	n/a
Foreign direct investment (% of GDP)	6.0	7.2	8.4	5.9	5.2	n/a
Social Indicators	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Annual population growth (%)	0.43	0.58	0.68	0.73	0.73	0.72
Age dependency ratio	53.57	53.71	53.76	53.65	53.44	53.69
Child mortality rate per 1,000 live births (under five years)	25	25	26	27	27	n/a
Life expectancy	67.14	67.21	67.27	67.40	67.53	67.65
Population density (people per sq km)	50.27	50.30	50.30	50.27	50.38	50.89
Poverty rate	42.30	37.30	35.80	49.40	n/a	n/a
Labor force participation rate for ages 15–24 (%)	39.53	38.92	38.55	38.48	37.80	38.14

Source: World Bank Data [3]; Fiji Bureau of Statistics (FBoS) [5]; Reserve Bank of Fiji (RBF) [6].
Note: Poverty rates are for 2002, 2008, 2013, and 2019; n/a - not available.

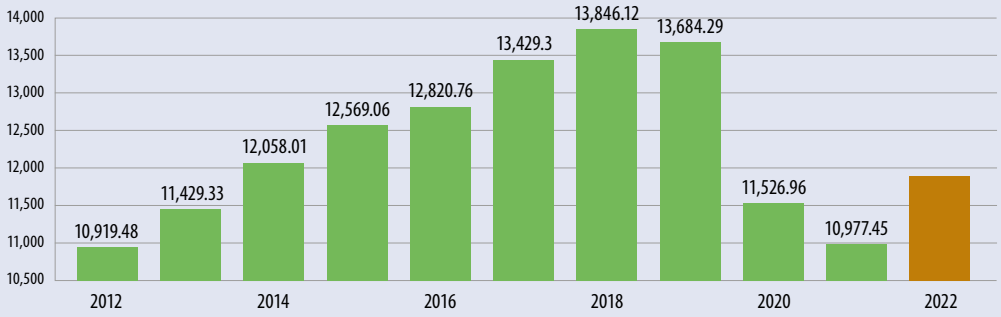
GDP Per Capita PPP

GDP per capita PPP uses an exchange-rate calculation to compare purchasing power across countries based on a basket of goods. It assumes that prices of a basket of similar goods across countries should be equivalent. The PPP theory posits that the international price for one product should be consistent in different markets. For example, the price of shoes should be identical as that in Fiji, Sri Lanka, Vietnam, and Cambodia, after accounting for exchange rate. In 2012, Fiji's PPP value was at USD10,919.48 (Figure 3.1), and after accounting for changes over the subsequent 10-year period, the value stood at USD10,977.45 in 2021, translating to an average of USD12,326 per annum since 2012.

Figure 3.2 compares Fiji 1990–2021 data with selected APO members, such as Sri Lanka, Indonesia, Vietnam, India, Bangladesh, and Cambodia. Fiji ranked 97th out of a global list of 173 countries. Sri Lanka was ranked 89 with the highest PPP, followed by Indonesia and Fiji.

FIGURE 3.1

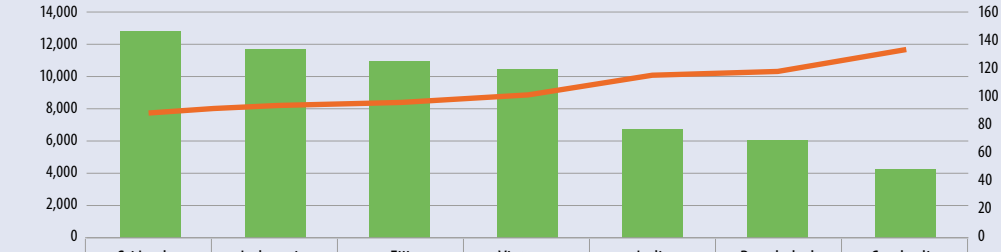
FIJI GDP PER CAPITA PPP



Source: Trading Economics.com [7].

FIGURE 3.2

COMPARATIVE GDP PER CAPITA



	Sri Lanka	Indonesia	Fiji	Vietnam	India	Bangladesh	Cambodia
GDP PPP	12,859.34	11,746.22	10,977.45	10,516.22	6,675.35	6,019.52	4,262.72
Ranking	89	95	97	102	116	119	134

Source: Trading Economics.com [7].

Sectoral Contribution

Fiji's economic structure has remained relatively unchanged for several decades. The service sector continues to be the main contributor to total output, followed by the industry and agriculture sectors. The average annual contribution of the service sector for the 10-year period between 2012–21 was about 68%, followed by industry with 20% and agriculture with 12% per annum (Table 3.3). The service sector encompasses five main subsectors, including wholesale, retail, and motor vehicle repairs; financial and insurance activities; and public administration.

TABLE 3.3

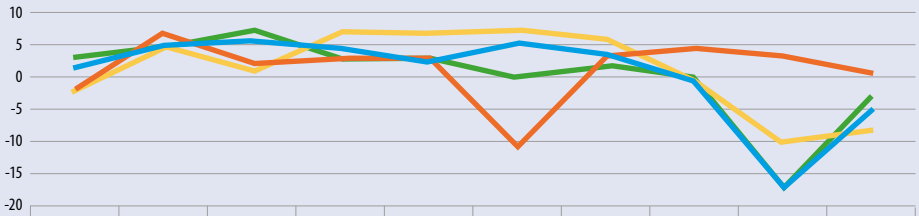
AGRICULTURE, INDUSTRY, AND SERVICES AS PERCENTAGE OF GDP

Structure of Output	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Agriculture	11.5	12.1	10.3	10.0	13.1	13.0	13.6	14.6	12.1	13.0
Industry	19.8	19.6	19.1	19.3	19.9	19.4	19.3	19.3	22.0	21.0
Services	68.7	68.3	70.6	70.6	67.0	67.5	67.1	66.1	63.1	66.5

Source: Fiji Bureau of Statistics [5].
Note: Authors calculation for 2020 and 2021.

FIGURE 3.3

REAL OUTPUT GROWTH BY SECTORS IN 2012–22 (%)



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Output	1.4	4.73	5.6	4.5	2.45	5.35	3.81	-0.45	-17.2	-5.1
Agriculture	-1.9	6.7	1.9	2.9	2.9	-10.9	3.3	4.5	3.3	0.5
Industry	-2.2	4.4	1.2	6.9	6.9	7.2	5.5	-0.9	-10.3	-8.3
Services	3	4.5	7.4	3	3	0.1	1.7	0	-17.1	-2.9

Source: Fiji Bureau of Statistics [5], RBF [6].

On real sectoral growth, as shown in Figure 3.3, the agriculture sector displayed positive performance. However, the Category 5 Cyclone Winston caused a devastating impact on output growth and trade in 2017. Despite this setback, the average annual growth rate of agricultural output was 1.3% per annum, surpassing the national output growth average of 0.5% per annum. Industry output grew at an average of 1% per annum between 2012–21 while the services sector recorded a marginal growth of 0.3% on average for the same 10-year period.

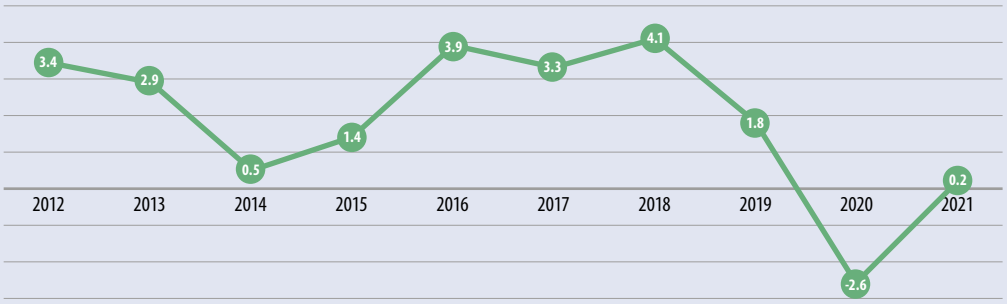
Inflation

The term "inflation", which has a direct impact on the consumer's purchasing power, refers to the increase in prices of goods and services within a specific period, usually a year. Figure 3.4 shows Fiji's annual inflation rate between 2012–21. High inflation rate was noted for the years 2016, 2017, and 2018, where inflation rate was at 3.9%, 3.3%, and 4.1%, respectively [8]. Changes in tax rates for this period, local supply chain disruptions due to cyclones, and unexpected increase in price with the country's trading partners contributed to a general increase in local prices.

Fiji's average annual change in price for the 10-year period was around 2% per annum, closely aligned with the 2.5% recorded for the East Asia Pacific region and lower- and middle-income countries in 2021. The impact of COVID-19 was significant, especially in 2020 and 2021. However, consumer prices of goods and services are expected to be high on monthly basis as economies recover and rebuild toward pre-pandemic conditions.

FIGURE 3.4

INFLATION AS ANNUAL PERCENTAGE CHANGE IN THE CONSUMER PRICE INDEX



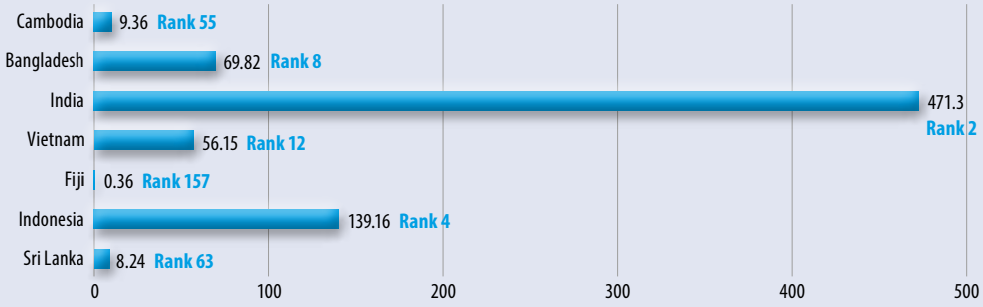
Source: The Globaleconomy.com [9].

Labor Force and Unemployment Rate

Labor is widely recognized as an important factor of production, alongside land, capital, and entrepreneurial capability. The early industrial revolutions in India and PR China were propelled by their readily available human resources to drive mass production and process automation across various industries. In 2021, PR China and India continue to lead the global ranking among 180 countries. Other APO member economies, such as Vietnam, Indonesia, and Bangladesh are also ranked at the top 10 countries in abundant labor force, as seen in Figure 3.5.

FIGURE 3.5

COMPARATIVE LABOR FORCE IN FIJI AND SELECTED APO ECONOMIES (IN MILLIONS), 2021

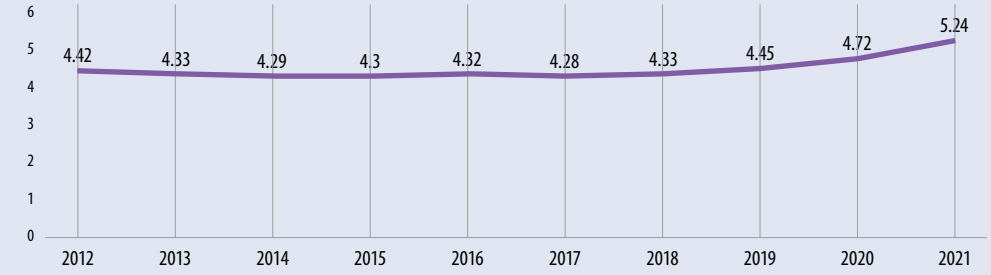


Source: The Globaleconomy.com [9].

In terms of unemployment rate, shown as percentage of the labor force, Fiji registered 5.24% in 2021 - the highest recorded for the period 2012–21 (Figure 3.6). The average unemployment rate for Fiji over the 10-year period was 4.49%. The world average in 2021, based on 180 countries, was 8.46%.

FIGURE 3.6

UNEMPLOYMENT RATE AS PERCENTAGE OF LABOR FORCE



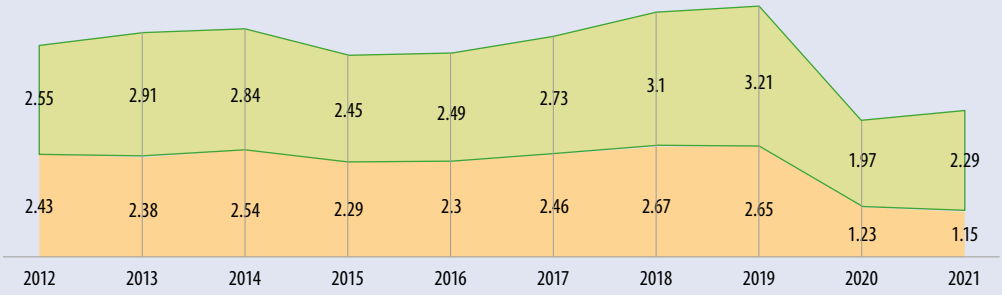
Source: The Globaleconomy.com [9].

Comparative Trend on Exports and Imports

Trade between Fiji and its major trading partners had remained constant for the last 10 years between 2012–21, as presented in Figure 3.7. Import growth was positive yet marginal, averaging 0.5% per annum. For the same period, Fijian export experienced a decline of -5.5% per annum. The total value of exports hovered around USD2.2 billion per annum while imports were valued at USD2.65 billion per annum.

FIGURE 3.7

EXPORTS AND IMPORTS VALUE IN USD (BILLION)

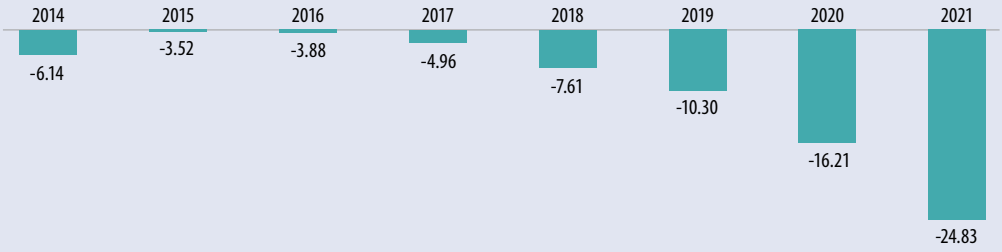


Source: Macrotrends.net [10].

Figure 3.8 illustrates Fiji's trade balance for the period 2014–21, calculated as the difference between exports and imports of goods and services, relative to GDP. A positive figure denotes a trade surplus whereas a negative figure signifies a trade deficit. The average annual trade balance for Fiji during the said period was -9.68%, reaching a minimum of -24.83% in 2021 and a maximum of -3.52% in 2015.

FIGURE 3.8

TRADE BALANCE AS PERCENTAGE OF GDP

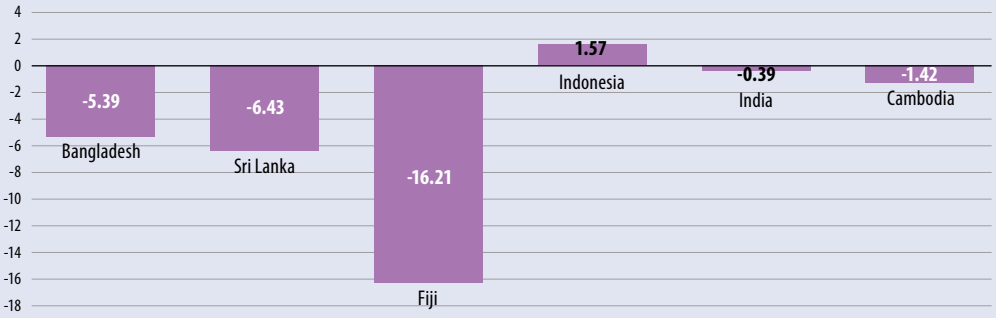


Source: Macrotrends.net [10].

Using the latest global ranking for trade balance (as a percentage of GDP), Fiji falls with the bottom half with a global rank of 132 out of 164 countries. Due to limitations in land size, critical mass, and resource availability, Fiji faces challenges in positively influencing its current trade balance. In comparison with selected APO member economies, Fiji's position is less favorable compared to Sri Lanka, Bangladesh, Indonesia, India, and Cambodia. Notably, Indonesia is the only country with a positive trade balance ratio in 2020.

FIGURE 3.9

COMPARATIVE TRADE BALANCE AS PERCENTAGE OF GDP BETWEEN FIJI AND SELECTED APO MEMBERS



Source: The Globaleconomy.com [9].

Overall, Fiji stands to gain from growing international trade. Consumers are able to access a wide range of imported goods and services. Also, local exporting companies do have the opportunity to venture into new markets thus increasing their competitiveness, elevating product quality, refining company efficiency, and fostering their ability to adapt new technologies. Other benefits include increasing local employment opportunities as well as encouraging new economic activities, ideas, and innovation.

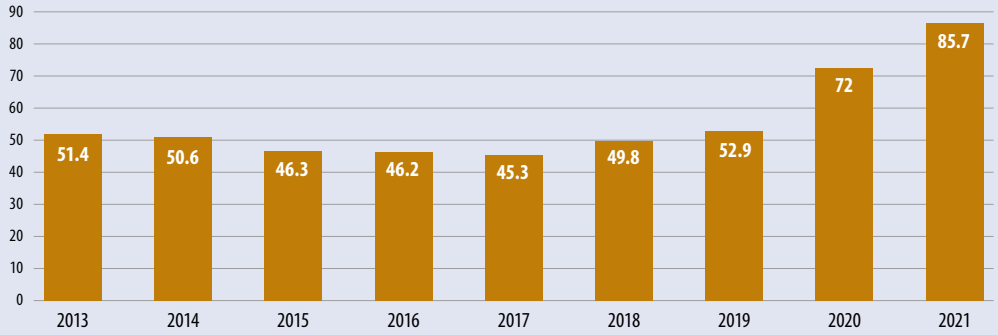
Public Debt as a Percentage of GDP

Public debt as a percentage of GDP is used by investors to determine Fiji's ability to fulfill its future financial obligations. The Fijian data for the period 2013–21 shows an increasing debt ratio trend,

illustrated in Figure 3.10. In general, debt restricts household demand and puts pressure on overall government expenditure, among other implications. Unless the new Fijian government replaces the current expenditure-led growth strategy, it is highly likely that the debt ratio will reach 100% within the next five years.

FIGURE 3.10

COMPARATIVE PUBLIC DEBT AS PERCENTAGE OF GDP



Source: : The Globaleconomy.com [9]; Ministry of Education (MoE) Fiji [11].

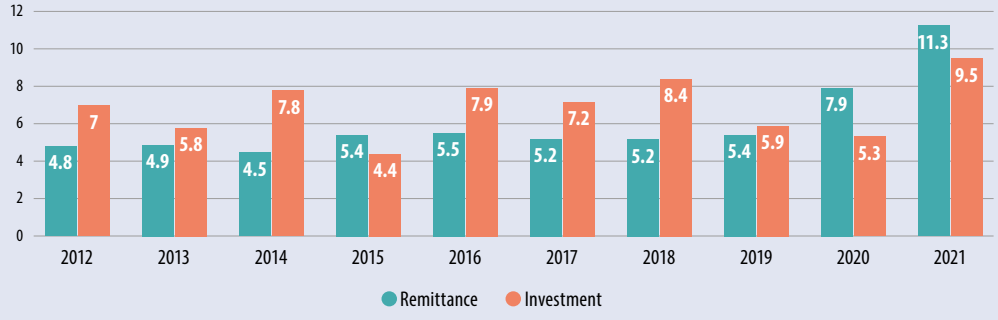
In the most recent global ranking of debt as a percentage of GDP showed Fiji as one of the heavy borrowers among the 137 listed countries. In comparison with the selected APO member economies, Fiji and Sri Lanka ranked 33rd and 20th position, respectively. Conversely, Indonesia was ranked at the 109th spot while Bangladesh ranked the 121st position.

Remittance and Investment Trend

Across both pre- and post-COVID-19 periods, remittances as a percentage of GDP was on an increasing trend, as highlighted in Figure 3.11. The average for the last 10 years ending 2021 was 6% per annum. The actual remittance value in 2021 reached USD45 million (equivalent to FJD842 million) and there were indications of potentially crossing the Fijian billion-dollar mark.

FIGURE 3.11

REMITTANCE AS PERCENTAGE OF GDP



Source: : The Globaleconomy.com [9]; RBF [6], MoE Fiji [10].

Investment's contribution to output has averaged around 7% per annum over the last 10 years. In comparison to selected APO member economies, the investment percentage of GDP in 2021 reached 9.5%, placing Fiji among the highest, alongside Cambodia at 13%. This stands substantially higher than the 2.1% contribution recorded for East Asia and the Pacific region as well as for upper-middle-income countries. Looking at Fiji's elevated debt levels, the country needs foreign direct investment to stabilize its government finances.

Ongoing Challenges

Fiji continues to face complex and interrelated issues, such as:

- Government expenditure failing to yield economic returns
- Escalating debt level as a percentage of GDP
- A fraught political landscape where money has seeped through to influence decision-making
- Imperatives of green productivity and climate change
- Natural disasters, such as cyclones, droughts, flooding, and rising sea levels
- Increasing unemployment and poverty issues
- Young population putting pressure on job creation
- Education system not producing graduates who are job-ready
- Unequal income distribution

An expenditure-led growth model was used by the former Bainimarama-led government to keep the economy growing. However, when expenditure kept rising above revenue, external and domestic debt had to be raised to stabilize the budget. The combined impact of the COVID-19 pandemic and natural disasters precipitated the ongoing structural challenges, leading to a weak economic performance, as discussed earlier.

PRODUCTIVITY ANALYSIS

This section presents the Fijian productivity movement, measurement indicators and trends, challenges, and strategies to boost productivity growth.

Origin of the Fijian Productivity Movement

Productivity is defined as the efficiency with which resources, such as labor and capital are used in an economy to produce a given level of output. It is measured as a ratio between the output volume and the volume of inputs. It is an important pillar of a modern and efficient economic system and has a powerful influence over the economic and social well-being of members of society.

Productivity movement is a national effort of key stakeholders in the public and private sectors to achieve economic and social progress. Fiji's productivity movement began in 1995, following an agreement with government, trade unions, and employer organizations. It is specifically aimed at

improving the quality of life of Fiji's citizens under the National Productivity Charter [8]. Table 3.4 details the productivity movement in Fiji.

TABLE 3.4

PRODUCTIVITY MOVEMENT IN FIJI

Government Initiative	Objectives	Responsible Organization
National Productivity Charter (NPC) 1995 [8]	"…raise the standard of living of the people and create full employment by producing more goods and services, more efficiently, and at a level of quality sufficient to meet the expectations of customers"	National Training & Productivity Centre (NTPC)
NPC 2005 [8]	"…raise national competitiveness, eradicate poverty and raise standard of living of our people, create economic opportunities by producing more goods and services more efficiently and effectively, advance the promotion of sustainable development, make Fiji the premier place to live and work."	NTPC and Ministry of Employment, Productivity & Industrial Relations (MEPIR)
National Productivity Report (NPR) 2018 [12]	Report on the productivity movement in Fiji and what comparative trend available on productivity indicators	NTPC and MEPIR
National Productivity Master Plan 2021–2036 (NPMP) [8]	Setting specific productivity targets and strategic thrusts to boost productivity growth and economic progress	NTPC and MEPIR

The Productivity Charter 2005 ushered in an amended version of the 1995 Charter to replace its predecessor as the framework for Fiji's productivity movement. This revision sought to clarify the stakeholders' roles, promote awareness campaigns, create excellence awards, enhance the wage systems, and foster education and training. The NTPC, in collaboration with the MEPIR, was tasked with the responsibilities of implementing the initiatives of the Charter. The coordination and program implementation had remained focused on business excellence and quality circles with limited integration between productivity, competitiveness, enterprise development, and economic growth.

Comparative Trends in Labor Productivity

Labor productivity per hours worked:

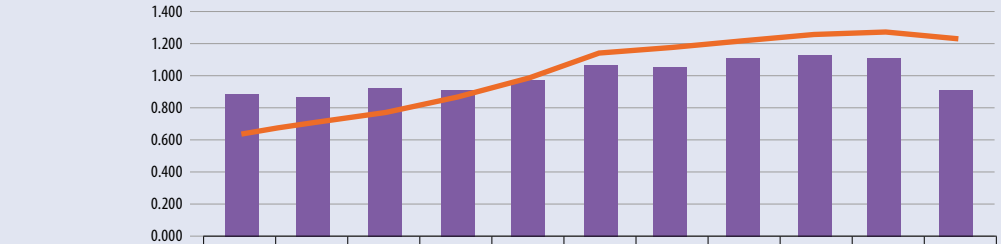
Labor productivity is measured by output per hour and output per worker. Output per hour is calculated by dividing the total output (GDP) by the total number of hours worked.

Labor Productivity = Total Output / Total Man-hours

Figure 3.12 shows that labor productivity per hours worked have been increasing since 1990 but it slowed down between 2018–20, owing to supply side constraints resulted from the COVID-19 pandemic. The average labor productivity per hours worked for the period 2000–20 was 1.02. In comparison with APO21 member economies, the average labor productivity for the same period was 1.017. From the highlighted trend, the APO21 member economies were doing well, particularly between 2015–19.

FIGURE 3.12

LABOR PRODUCTIVITY PER HOURS WORKED



	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Fiji Labor per Hrs Worked	0.915	0.894	0.951	0.933	1.000	1.093	1.084	1.141	1.162	1.141	0.934
APO21 Labor Hrs Worked	0.623	0.704	0.767	0.871	1.000	1.165	1.206	1.257	1.296	1.312	1.269

Source: APO data 2022 [13].

Labor productivity per number of employees:

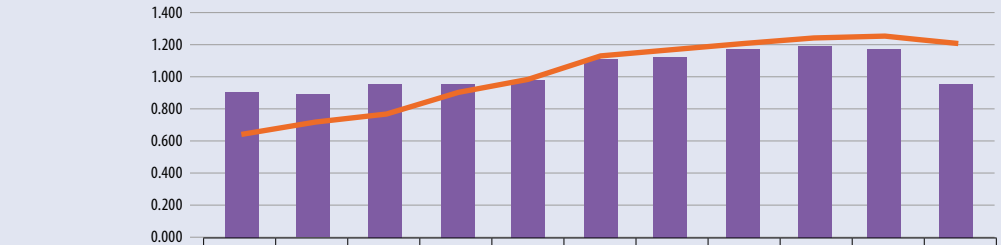
Labor productivity is measured by output per worker. Output per worker is calculated by dividing the total output (GDP) per period by the total number of employees.

Labor productivity = Output per period / Number of employments

Figure 3.13 shows that labor productivity per number of employees has increased since 1990, but it slowed down during the COVID-19 period. The average labor productivity per total number of employees for the period 2000–20 was 1.05. In comparison with APO21 member economies, the average labor productivity for the same period was 1.017. From the trend shown here, the APO21 member economies showed increasing trajectories, particularly between 2010–19.

FIGURE 3.13

LABOR PRODUCTIVITY PER NUMBER OF EMPLOYEES



	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
Fiji Labor per Employee	0.919	0.907	0.975	0.976	1.000	1.134	1.146	1.195	1.218	1.196	0.979
APO21 Labor per Employee	0.628	0.707	0.769	0.903	1.000	1.158	1.197	1.243	1.277	1.292	1.245

Source: APO data 2022 [13].

There was no significant difference between labor productivity per hours worked and labor productivity per employment across both Fiji and APO21 level. Labor productivity is influenced by many factors, such as the level of technology, the quality of workforce, and the efficiency of management. However, one of the most important factors is the level of motivation among employees. A company or country with highly motivated employees will exhibit higher labor productivity than those with less motivated employees.

Decomposing Output Growth

Total output growth is a composite of capital input, labor input, and TFP, as outlined in Table 3.5. The average growth between 2010–20 was 3.3% per annum, which is lower than the APO21 member economies' average growth.

TABLE 3.5

DECOMPOSING OUTPUT GROWTH

Variable	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Output growth (1) + (2) + (3)	2.91	2.67	1.4	4.63	5.46	4.41	2.42	5.22	3.74	-0.45	3.847
Contribution of capital input (1)	-1.04	-0.58	-0.48	0.17	2.05	1.05	-0.16	1.88	1.75	1.6	0.986
... of which, IT capital	-0.16	-0.12	0.02	0.12	0.29	0.38	0.19	0.2	0.23	0.19	n/a
... of which, non-IT capital	-0.88	-0.46	-0.5	0.05	1.76	0.67	-0.35	1.68	1.52	1.42	n/a
Contribution of labor input (2)	0.25	0.04	0.68	0.28	0.55	2.95	1.98	0.23	0.84	0.58	1.909
... of which, hours worked	0.23	0.07	0.67	0.4	0.52	2.46	1.37	0.06	0.83	0.56	0.93
... of which, labor quality	0.02	-0.04	0.01	-0.13	0.02	0.48	0.61	0.16	0	0.02	0.979
Total factor productivity (TFP) (3)	3.7	3.21	1.2	4.18	2.86	0.41	0.6	3.11	1.15	-2.63	0.952

Source: APO Data [13].
Note: n/a – not available.

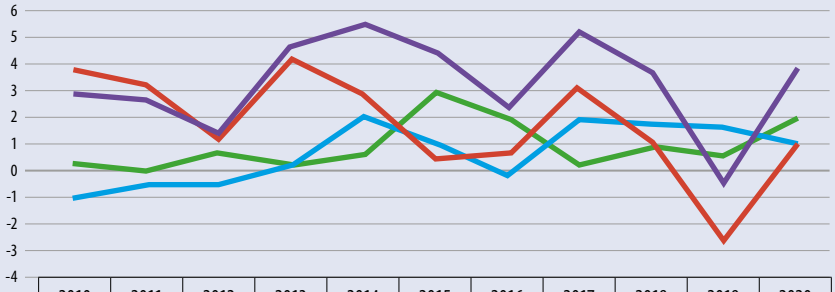
Figure 3.14 presents the distribution of capital, labor, and TFP in output growth. Capital productivity is an indicator of Fiji's economic well-being and competitive edge over other APO member economies. Capital inputs, made up of IT capital and non-IT capital, have shown gradual recovery, bouncing back after negative contributions in 2010–12 and 2016. The hiatus in foreign direct investment is due to political instability and unattractive investment climate.

Labor input share to output growth is slowly growing with an average increase of 0.94% between 2010 and 2020. There are also indications of improved labor quality and efficiency that are substantiated by concurrent output growth. Overall, the data indicates slow growth in labor inputs attributed to fluctuations in physical capital, new technology, and human capital.

Raising output growth and local productivity necessitate high level commitments and input from all stakeholders in an integrated manner. Specific policies to encourage FDI, local investment, diffusion of technological inputs, R&D, enterprise development, and education are important requisites in this integrated endeavor.

FIGURE 3.14

DECOMPOSING OUTPUT GROWTH



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Labor Input	0.25	0.04	0.68	0.28	0.55	2.95	1.98	0.23	0.84	0.58	1.909
Capital Input	-1.04	-0.58	-0.48	0.17	2.05	1.05	-0.16	1.88	1.75	1.6	0.986
TFP	3.700	3.210	1.200	4.180	2.860	0.410	0.600	3.110	1.150	-2.630	0.952
Output Growth	2.910	2.670	1.400	4.630	5.460	4.410	2.420	5.220	3.740	-0.450	3.847

Source: APO data 2022 [13].

THREE NIS FRAMEWORKS

Institutional Framework

According to Freeman [14], "NIS is the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies." and Lundvall [15] adds that "these interactions are located within or rooted inside the borders of a nation state."

At the outset, there is an existing Fijian NIS, though undocumented in the grey literature but largely driven by private manufacturing firms that are motivated by the production of consumer goods and profits. Further, there are other key players operating independently within the three economic sectors - agriculture, industries, and services - but leaned heavily toward individual needs, such as appropriate land use, climate change, employers' claims, access to finance, skills development, insurance, use of technology, value adding, and markets, among others. However, what is sorely missing is connecting the private and public sectors as a network of national institutions with common interests to share knowledge, build relationships, develop a viable platform, and drive productivity.

FIGURE 3.15

PRODUCTIVITY ECOSYSTEM

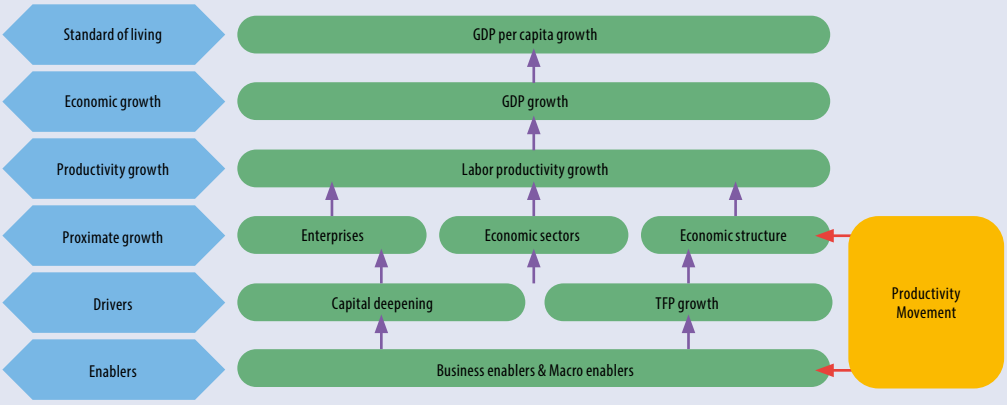
Source: MEPIR [8].

Figure 3.15 presents three integral components to the productivity ecosystem, consisting key institutions, engagement partners, and target groups. The key institutions, namely NTPC, NPC, and MEPIR, are driving the country's productivity. Going forward, there is a need to reorganize and rationalize the roles and responsibilities of these institutions, especially in light of the new Fijian government in place and a number of policy changes implemented on the ground.

In addition, Fiji's NPMP 2021–2036 propounds that the first task in institutionalizing the productivity movement is to expand "the perception and management of productivity from efficiency to include effectiveness in the use of resources and capital deepening growth" [8]. This implies a transition in focus, from business excellence and quality circles, as championed by NTPC, to include broader economic sectors, structural economic dynamics, and enablers. However, instead of grounding on the 2005 Productivity Charter, a new National Innovation and Productivity Act (supported by relevant regulations) should serve as the new basis of rebuilding a new Fijian Productivity Movement.

FIGURE 3.16

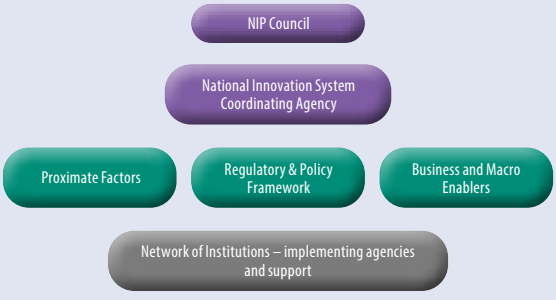
FRAMEWORK ON PRODUCTIVITY GROWTH STRATEGY



Source: MEPIR [8].

FIGURE 3.17

INSTITUTIONAL FRAMEWORK AND APEX BODY



In Figure 3.16, the interconnection between the productivity movement, output growth, and living standards unfolds, along with the sources of productivity growth. The workings of both models will be dependent on the two driving institutions. However, performance reports on the Fiji NPR 2018 and the Fiji NPMP underscore the need to strengthen the two institutions to be able to design, coordinate, and integrate the activities of all implementing agencies and local partners.

Figure 3.17 shows a hybrid NIS model takes shape and emphasizes a network of key institutions, facilitating partners, and target groups. At the apex, an overarching body coordinates strategic planning, policy making, program implementation, monitoring, and innovation activities reporting. In this model, the Office of the Prime Minister is to provide secretariat services to a newly formed National Innovation and Productivity Council, chaired by the prime minister, who will also be the productivity champion.

National Innovation and Productivity (NIP) Council – Apex Body

A high-level entity, referred to as the NIP Council, is to be formed under the auspices of the Office of the Prime Minister that will encourage the development of innovation in economic sectors, local enterprises, small and medium enterprises (SMEs), and large manufacturing industries. Council members, to be nominated by the prime minister, will comprise from key implementing institutions, academics, researchers, private businesses, and other local enablers. The composition, objectives, funding, policies, and responsibilities of the NIP Council are to be determined by the NIP Secretariat within the Office of the Prime Minister.

NIS as the Coordinating Agency

The NIS Coordinating Agency could be established either as a new department or a special unit within the Prime Minister Office, or potentially by reorganizing the current setup within NTPC. The NIS's main purpose is to drive the productivity development and promotion work in Fiji, including policy planning, program implementation, and reporting. The goals and strategic thrusts espoused in the Fiji NPMP 2021–2036 should be relaunched under the platform of the new NIS coordinating agency. This will be the same platform to rally the support, interests, and commitments of existing stakeholders toward the 15-year roadmap.

Following the Cabinet's approval to reform the Fijian Productivity Movement, the Office of the Prime Minister will require to set up a secretariat. This unit will serve to coordinate the development work, including program implementation on the ground in consultations with NTPC and MEPIR. This initiative is to ensure that a high-level involvement and commitment is maintained during the rebuilding stages. The role of the coordinating agency, however, can be transferred to MEPIR after a minimum of two years as to sustain itself from the ministry's budgetary allocations.

Enablers - Implementing Ministries and Agencies

A proposed National Productivity Regulation, serving as a complement to the new National Productivity Act, will list all the government implementing ministries and agencies together with their reporting lines, roles, and responsibilities. Funding of activities or programs with implementing ministries are to come from their annual budgetary allocations.

Enablers - Academic Institutions, R&D, Science, and Technical Organizations

A National Research Council Act (Act No. 20) was approved in 2017 that outlined the objectives, composition, and functions of the Council. However, to date, no tangible progress has been registered. The concept of innovation and productivity, including entrepreneurship, could be included in the Act for the purpose of knowledge creation, dissemination, and data collection. Local universities and

innovation-focused training institutions would play a critical role in the education and training pertaining to innovation and productivity.

Business and Macro Enablers

Within the three major economic sectors of agriculture, manufacturing, and services, there are existing bodies (committees, councils, and boards) that are at the forefront of industry development and promotion. Apart from legislated institutions and corporate organizations (for example, Business Assistance Fiji that targets SMEs), there are other existing bodies organized within industries to undertake specific functions. Table 3.6 highlights some of these organizations.

TABLE 3.6

EXAMPLES OF ORGANIZED MACRO ENABLERS

Economic Sector	Organized Macro Enablers	Target
Agriculture	Fiji Dairy Cooperative	Dairy industry
	Fiji Beekeepers Association	Honey industry
	Fiji Sugar Cane Growers Association	Cane industry
	Fiji Pig Association	Pork industry
	Fiji Ginger Farmers Association	Ginger farming
	Fiji Crop and Livestock Council	Crops and livestock
	Agricultural and Marketing Authority	All agro-based products
Manufacturing	Fiji Retailers Association	Retail industry
	Fiji Textile, Clothing and Footwear Council	Textile Industry
	Fiji Manufacturers' Association	Manufacturing industry
Services	Fiji Hotel and Tourism Association	Tourism industry
	International Air Transport Association	Professional
	Fiji Bankers and Finance Sectors Union	Professional
	Fiji Teachers Association	Professional
	Fiji Trade Union Congress	Professional
	Fiji Institute of Accountants	Professional

Programs to Boost Innovative and Entrepreneurial Culture

A 2017 Fijian micro, small, and medium enterprises (MSME) diagnostic report affirmed there was no shortage of business start-ups and management programs in Fiji [16]. However, SME owners-managers experience are varied due to inability to access funds and stringent requirements set by the service providers, such as financial institutions. Over 150 MSME programs were active for the purpose of providing grant funding, new venture business training, research, capacity building, infrastructure, and product development. Private programs were also available through financial institutions (including microfinance institutions), private companies, civil societies, social networks, and friends.

In the analysis of current programs, several suggestions were proposed to boost business start-ups and significantly improve the survival rate of small businesses. It is believed that when innovative and productive MSMEs survive and grow, it will generate a positive ripple effect on the economy.

i) **Reconstruct MSMEs on entrepreneurial foundations** - There was too much emphasis on national objectives, such as employment and income. These are the goals "but the emphasis should be placed on the entrepreneurial person and the nature of business."

ii) **Deepening and broadening the current SME policy** - Fiji had no replacement MSME policy following the suspension of the governments' Affirmative Action Programs (AAP). Leadership within the sector was going to come from the National Centre for Small and Micro Enterprise Development (NCSMED), which had the SME development mandate. A comprehensive review of the existing SME policy is needed to incorporate global shifts and the impacts of COVID-19.

iii) **Funding for innovative business start-ups** - Availability of grant funding, partly through political influence, is now driving the structure of support, target groups, nature of support, and funding objectives. In other words, SME owners' needs do not drive the programs; rather the availability of government funding.

iv) **Programs with real impact** - These are the current SME programs with real impact of local businesses: (a) Market Development Facility (MDF) technical and financial support; (b) NCSMED small business training and grant funding; (c) small business grant under the Northern Development Program; (d) South Pacific Business Development (SPBD) microfinance schemes; (e) Integrated Human Resource Development Programme (IHRDP) technical and financial support; (f) Small Business Credit scheme with the Fiji Development Bank (FDB); (g) National Export Facility; and (h) the RBF Credit Guarantee Scheme. Whiles some of these schemes have been in existence for over 10 years, their coordination and targeting require improvement to ensure that the holistic and highly productive growth firms are given preference (indigenous Fijians were given preference in past programs at FDB and the AAP).

v) **Programs overlapping** - Instances of program overlaps, such as the self-help program with the Ministry of Rural and Maritime Development and the Ministry of Agriculture's agri-business programs. Also, the Sustainable Livelihood Programme (SLP) implemented by the Fiji National University (FNU) could overlap with other business and skills training delivered by the Nadave Centre for Appropriate Technology and Development (CATD), NCSMED, IHRDP, the Ministry of Youth and Sports, and the Ministry of Agriculture [16].

vi) **SME business start-ups targets** - A benchmark on the characteristics of new start-ups to include qualifications, innovative ideas, infusion of technology to improve efficiency, use of local resources, and alignment with national research and sectoral priorities.

vii) **Rethinking the appropriateness of traditional business platform** - Reflecting on the appropriateness of traditional business platforms, such as cooperatives, particularly in local rural communities, where the "living experience" had mixed results. Cooperative businesses were built on social capital and cultural values, such as communal living, charity, care, unity, and respect.

viii) **Streamlining registration and licensing processes** - Applying current business rules and norms, suited for large businesses, to small businesses has been the practice. However, small businesses differ significantly from their larger peers. Understanding of the business with appropriate registration and licensing guidelines, including associated fees, should be applied. During the initial three years of operation, new businesses and start-ups should be allowed to commence activities to facilitate the accumulation of capital and networks.

ix) **Corporatize Business Assistance Fiji (BAF)** - BAF has assumed the role and responsibilities of NCSMED due to a political decision which primarily served political interest. The new Fijian government should raise the profile of SME development and assistance through the establishment of a legislated body, similar to NCSMED. However, the recruitment of experienced and qualified staff is necessary for effective planning, policy design, program implementation, monitoring, and reporting. A similar framework is proposed for a National Innovation and Productivity Organization. It would be prudent to include Entrepreneurship and Small Businesses in the new act, policy, and organizational structure.

x) **Entrepreneurial research, education, and training** - Fiji needs to develop a cadre of entrepreneurial thinkers, planners, and experts in the field. Current local knowledge in the field comes from mainstream accounting, finance, economics, and management. The embedding of entrepreneurial topics and skills training should begin at all educational levels, from primary to tertiary.

High Productivity Growth Strategy

Expert views on the ground suggest the need for a new Fiji National Innovation and Productivity Act to replace the outdated Productivity Charter 2005. This Act would establish the legal frame for a national productivity council and a coordinating agency. Despite the productivity experience of NTPC and MEPIR, the Office of the Prime Minister should assume the role of Secretariat to the NIP Council and act as a coordinating agency during the rebuilding phase.

FIGURE 3.18

MASTER PLAN NATIONAL TARGET AND GOALS

Source: MEPIR [8].

The Secretariat will then organize a national forum to relaunch Fiji's productivity movement and announce the prime minister as the productivity champion. At this forum, stakeholders are to review the master plan and strategic directions before the Secretariat tables the resolutions to the National Productivity Council for approval and implementation.

The overarching productivity target outlined in the Fiji NPMP 2021–2036 targets an average annual growth of 3.2%. This target hinges on the following assumptions:

- Productivity of the agriculture sector must grow by 2.53% a year
- Productivity of the industry and services sectors should increase by 3.23% each a year
- Quadrupling nominal per capita income or doubling real per capita income by 2036
- A sustained real GDP growth of 4%–5% a year, which will have to come from a combination of labor growth and productivity growth
- Fiji's labor force is to grow by an average of 0.83% a year till 2036

To achieve the National Productivity target of 3.2%, five broad goals are developed:

(i) Productive and agile enterprises make efficient and effective use of resources that can sustain the generation of high added value.

(ii) High value-added sectors produce products and services that are in the high end of the product spectrum.

(iii) A broad economic base with high value-added industries is characterized by a modern and highly productive services sector, a diversified and productive industry sector, and a comparatively smaller yet productive agriculture sector.

(iv) Robust business enablers propel enterprise and sector growth.

(v) Advanced macro enablers underpin sustained productivity growth of enterprises, sectors, and the overall economy.

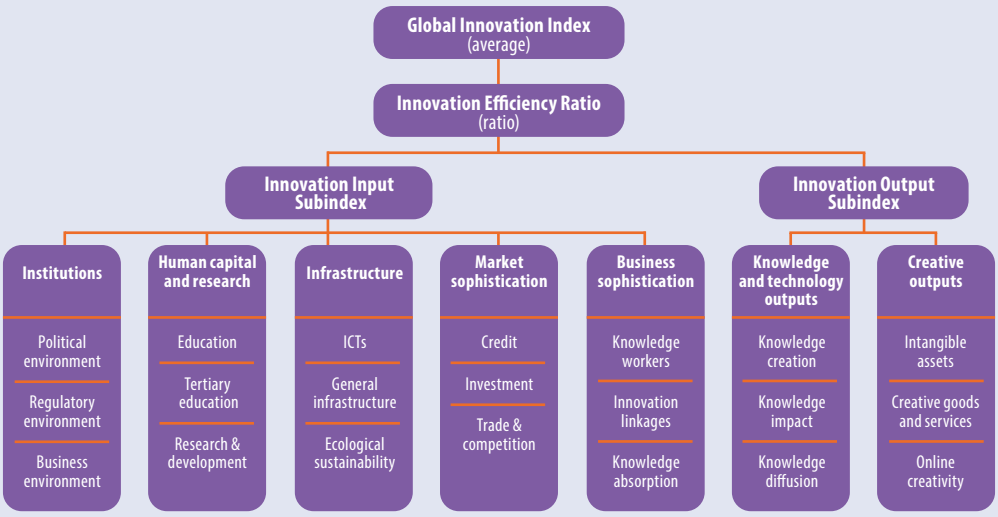
These strategic goals will ensure that labor and capital resources are channeled to areas with the potential for the highest productivity growth.

DYNAMIC ANALYSIS OF INNOVATION PERFORMANCE

This segment presents a dynamic analysis of Fiji's innovation performance based on key indicators, such as knowledge production process, knowledge commercialization, patent applications, and R&D expenditure as a percentage of GDP, among others. Prior to this, the data on Global Innovation Index (GII) and Top Innovation Economies (TIE) are discussed as a prelude to what communities are doing to improve their lives.

FIGURE 3.19

FRAMEWORK FOR GLOBAL INNOVATION



Source: WIPO [17].

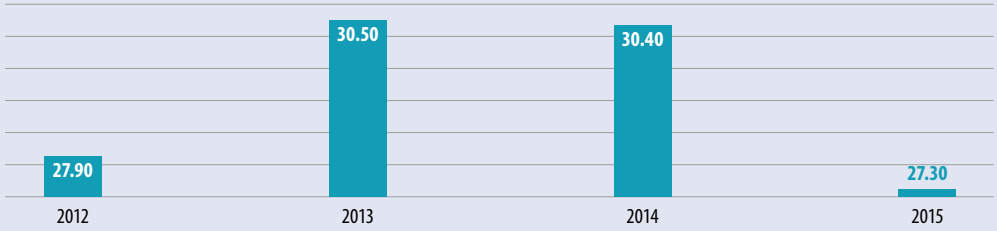
GII

GII framework is aimed at finding the right metrics and approaches that will encapsulate "innovativeness" within an economy. As seen in Figure 3.19, the GII framework captures five Innovation Input Subindeces and two Innovation Output Subindeces.

Fiji's score and rank in 2015 is presented in Figure 3.20, highlighting the country's overall innovation index at 27.3, falling from 30.46 in 2013. In contrast, most high-income countries have high GII score and ranking as well. Fiji's Innovation Efficiency Ratio designed to assess the effectiveness of innovation systems and policies showed a score of 0.3 and a rank of 140, implying a weak combination of innovation inputs and innovation outputs within the nation. Fiji's score on Innovation Input Subindex was 42.61 and ranked 64 on global ranking while the score of Innovation Output Subindex was 12.01 with a ranking of 137 - again showing lackluster performance on innovation outputs.

FIGURE 3.20

FIJI GII 2015

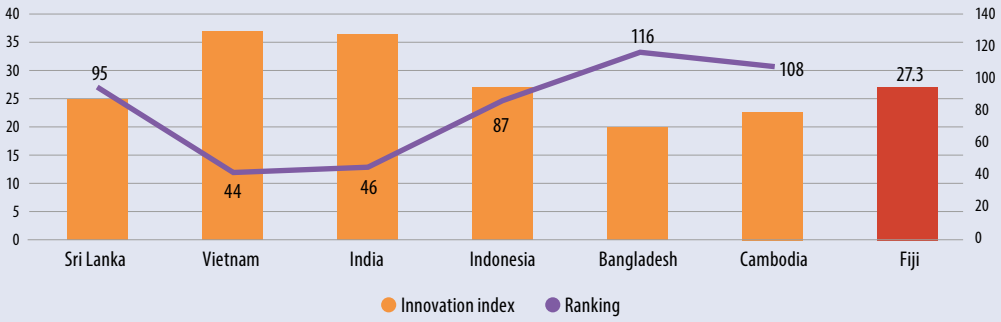


Source: : The GlobalEconomy.com [9].

Figure 3.21 shows a comparative analysis of seven selected APO member economies on innovation index and rankings. While Fiji's innovation index was for 2015, other member economies, like Sri Lanka, Vietnam, India, Indonesia, Bangladesh, and Cambodia, showed index and ranking for 2021. The highest ranked country in terms of innovation index was Vietnam with 44 points while Bangladesh was at the lowest with 116 points.

FIGURE 3.21

INNOVATION INDEX AND RANKING IN 2021



Source: : The GlobalEconomy.com [9].

Table 3.7 presents the score and rank of activities under Innovation Input Subindex and Innovation Out Subindex. Fiji showed strength in institutions, human capital, and research and business sophistication under the Innovation Input Subindex, but was weak in market sophistication and infrastructure. Fiji's score and rank for Innovation Outputs Subindex was poor. It was not surprising that Fiji had dropped out of the GII survey after 2015, missing out on having an international benchmark, the ability to update its innovative capacity and output, and the need to learn policy lessons from the WIPO databases.

TABLE 3.7

FIJI'S SCORE AND RANK IN GII IN 2015

Key Indicators	Innovation Activities	Index	Rank
GII		27.3	115
Innovation efficiency ratio		0.3	140
Innovation input subindex		42.6	64
• *Institutions*	*Political, regulatory and business environments*	54.4	88
• *Human capital & research*	*Education, tertiary education and R&D*	30.6	61
• *Infrastructure*	*ICT, general infrastructure and ecological sustainability*	32.9	90
• *Market sophistication*	*Credit, investment, trade and competition*	38.7	119
• *Business sophistication*	*Knowledge workers, innovation linkages, knowledge absorption*	56.5	8
Innovation output subindex		12.0	137
• *Knowledge and technology outputs*	*Knowledge creation, knowledge impact, knowledge diffusion*	13.4	128
• *Creative outputs*	*Intangible assets, creative goods and services, online creativity*	10.6	137

Source: WIPO [17].

Top Innovation Economies (TIE)

Figures 3.22 and 3.23 present top innovation economies categorized by region and income group. The purpose is to provide global markers and motivation for countries like Fiji who has the potential to emerge as a global innovative economy.

FIGURE 3.22

TOP THREE INNOVATION ECONOMIES BY REGION

Latin America and the Caribbean
1. Chile
2. Brazil★
3. Mexico↓

Sub-Saharan Africa
1. South Africa
2. Botswana★
3. Kenya↓

Northern Africa and Western Africa
1. Israel
2. United Arab Emirates
3. Turkiye

South East Asia, East Asia, and Ocenia
1. Republic of Korea
2. Singapore
3. PR China

Northern America
1. United States of America (USA)
2. Canada

Europe
1. Switzerland
2. Sweden
3. United Kingdom

Central and Southern Asia
1. India
2. I.R. Iran
3. Uzbekistan★

Source: : GII 14th Edition.

FIGURE 3.23

TOP THREE INNOVATION ECONOMIES BY INCOME GROUP

High-income	Upper middle-income	Lower middle-income	Low-income
1. Switzerland	1. PR China	1. India	1. Rwanda
2. USA	2. Bulgaria	2. Vietnam	2. Madagascar
3. Sweden	3. Malaysia	3. I.R. Iran	3. Ethiopia

Source: : WIPO [18].

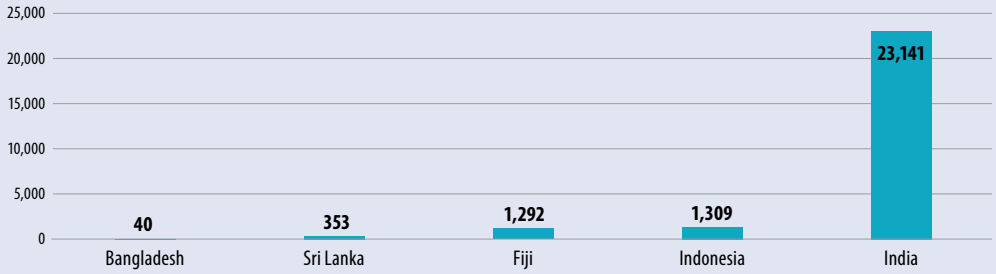
It is interesting to see a small country like Singapore, despite its modest land size, to emerge as the pinnacle for economies in Southeast Asia and Oceania. However, it will be a huge challenge for a smaller country like Fiji to emulate Singapore and identify the right mix of innovative factors.

Patent Applications Granted

Patent applications are filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention - a product or process that provides a new way of doing something or offers a new technical solution to a problem. Patents provide protection for owners' invention for a limited period, generally 20 years. In 2017, Fiji's patent register recorded 1,292 patents. No other details have been available for better trend analysis.

FIGURE 3.24

PATENT APPLICATIONS IN FIJI AND SELECTED APO MEMBER ECONOMIES IN 2020



Source: : The GlobalEconomy.com [9].
Note: : Fiji's figure is from 2017.

A Fijian Patents Bill 2020 was referred to the Standing Committee on Justice, Law, and Human Rights, by the Parliament with a view to modernize the Patents Act 1879. In addition, the Bill's purpose was to provide an efficient and effective patent system that promotes innovation and economic growth while providing an appropriate balance between the interests of inventors, patent owners, and the community.

Trademark Applications

Trademark applications are filed to register a trademark with a national or regional Intellectual Property (IP) office. Between 1980 and 1986, direct nonresident trademark applications increased from 326 to 680, exhibiting an average growth of 34.89%.

Trademark registration by class count, either within Fiji or through the UK Intellectual Property Office, protects trademarks for specific goods or services. National registered trademarks in Fiji and the UK have a validity of 14 years from the application date with the option for indefinite renewal of further 14 years periods.

Table 3.8 shows trademark registrations abroad had decreased from over 600 in 2013 to less than 100 since 2018. In 2021, registration by class count stood only 16.

R&D Expenditure as a Share of GDP

Expenditures for R&D are for both current and capital expenditures (public and private) on creative works, undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, along with the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development.

TABLE 3.8

NUMBER OF CLASSES SPECIFIED IN TRADEMARK REGISTRATIONS

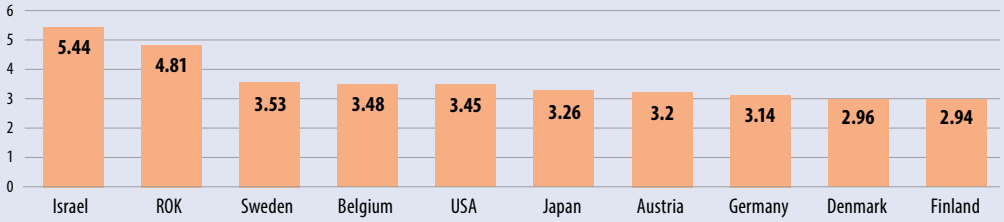
Year	Resident	Nonresident	Abroad
2012	n/a	n/a	256
2013			632
2014			65
2015			182
2016			81
2017			183
2018			42
2019			45
2020			75
2021			16

Source: The Globaleconomy.com [9].

Figure 3.25 features the top 10 countries with high R&D as percentage of GDP. Israel achieved the highest with 5.44% of GDP, followed by the Republic of Korea (ROK) and Sweden at 4.81% and 3.53%, respectively. All results included both capital and current expenditures in the four main sectors: business enterprise, government, higher education, and private nonprofit. R&D covers basic research, applied research, and experimental development.

FIGURE 3.25

TOP 10 COUNTRIES WITH HIGH R&D AS PERCENTAGE OF GDP IN 2020



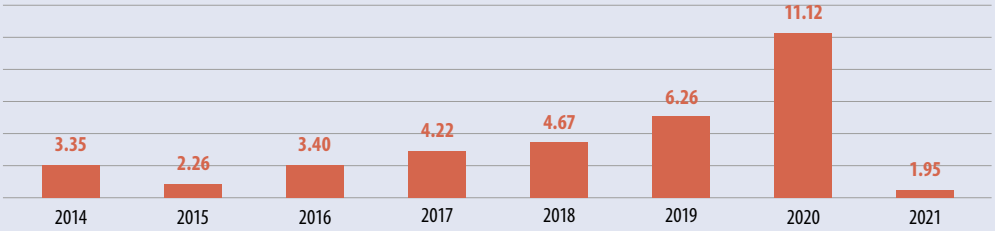
Source: : The Globaleconomy.com [9].

High-tech Exports

High-tech exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Data is presented in current USD. In 2021, Fiji's high-tech export was USD1.95 million (Figure 3.26). Though Fiji's high-tech exports fluctuated substantially in recent years, it tended to increase through the 2012–21 period, ending at USD1.95 million in 2021 with the highest recorded at USD11.12 million in 2020. Fiji was ranked at 88 in the global ranking of high-tech exports.

FIGURE 3.26

HIGH-TECH EXPORTS



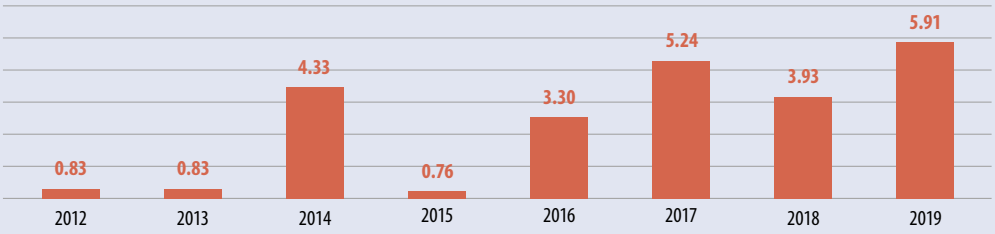
Source: : The Globaleconomy.com [9].

IT Exports, Percentage of Total Goods Exports

Information and communication technology (ICT) goods exports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods (miscellaneous). Figure 3.27 presents Fiji's data from 2012 to 2019. The lowest value for Fiji during this period was 0.76% in 2015 while the highest was at 5.91% in 2019. For perspective, the world average in 2019, based on 135 countries, was 4.27%.

FIGURE 3.27

HIGH-TECH EXPORTS AS PERCENTAGE OF TOTAL EXPORTS



Source: : The Globaleconomy.com [9].

High-tech Exports, Percentage of Manufactured Exports

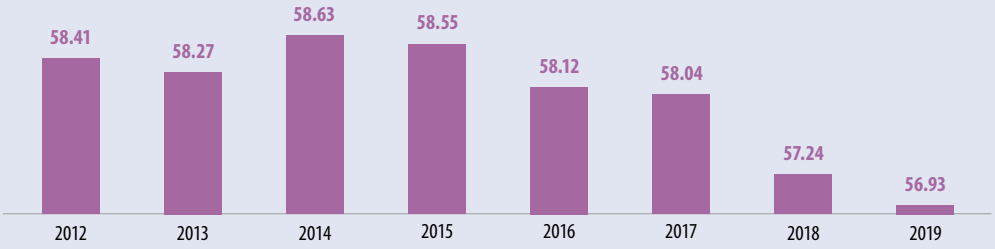
High-tech exports are products with considerable R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. In 2021, high-technology exports as a

share of manufactured exports for Fiji was 1.9 %. Though Fiji's high-tech exports as a proportion of manufactured exports fluctuated substantially in recent years, it tended to increase through 2011–21 period, ending at 1.9 % in 2021.

The overall index of globalization covers economic, social, and political dimensions, where the higher values denoted to greater globalization. For this indicator, Figure 3.28 provides data for Fiji from 2012 to 2019. The highest value for Fiji during this period was 58.63 points in 2014 while the lowest was at 56.93 points in 2019. For comparison, the world average in 2019, based on 191 countries, was 61.96 points (Figure 3.25).

FIGURE 3.28

GLOBALIZATION INDEX



Source: : The Globaleconomy.com [8].

Overall, Fiji misses the opportunity to benchmark and evaluate itself using the GII provided by WIPO. It last appeared in the GII Tracker in 2015, unveiling weak innovation inputs and outputs. Other insights from 2015 also showed low investments in science and innovation, R&D, and venture capitals to grow the economy.

At present, Fiji is struggling, following the aftermath of the global pandemic which saw the collapse of key economic sectors, such as tourism, agriculture, and manufacturing. Debt burden continues to rise, and Fiji faces a prolonged journey toward recovery and the transition to technology-driven, R&D-focused innovative business enterprises.

POLICY RECOMMENDATIONS AND CONCLUSION

Fiji has a NIS; however, the system is weak, as evidenced in the WIPO Global Innovation Tracker. This is owing to lack of institutional engagement and integration among key players, weak NIS structure and environmental conditions, insubstantial strategic leadership, and management prowess, among others.

This section presents major policy recommendations aimed to reboot the Fijian NIS. Specifically, issues regarding the establishment of a National Coordinating Agency, the creation of relevant regulations to support NIS operationalization, the identification of implementing agencies, delineation of R&D priorities, knowledge creation and management, monitoring and evaluation mechanisms, and the realignment of national priorities in Fijian education are the key recommendation areas.

Underlying this report is the notion of innovation to drive productivity. A salient lesson from other APO member economies and developed OECD economies underscores that sustainable economic and social development can be achieved through a well-coordinated, integrated, and workable NIS.

i) **Reforming the Fijian productivity movement** - In the early months of 2023, Fiji ushered in a new government, marking the end of the 16-year rule of the Bainimarama-led government. It is uncommon in Fiji for any new government to continue polices of previous governments, thus the need to appraise the new government through a Cabinet paper discussing key concepts, such as innovation, productivity, technological improvements, R&D, education, and the need to reboot or restructure existing frameworks. Revitalization of the Fijian productivity movement will be a challenging one, particularly the first two years of the new government as the focus will be on reestablishing socioeconomic structures, and consolidation of government expenditures, including an audit of previous government spending.

ii) **Raise the profile of the productivity movement** - A nationwide productivity dialogue should be organized for the purpose of engaging and educating all relevant stakeholders, including the mapping of immediate course of actions. Key messages from the Fijian NPR 2018 and the Fijian NPMP 2021–2036 are to be highlighted and disseminated to media partners, academic, and research institutions as part of raising the productivity profile. A national forum organized by the Office of the Prime Minister should consider reformation strategies, which encompass crucial elements, such as the apex body, regulatory frameworks, and a national productivity champion, among others.

iii) **Fitting productivity into the political manifesto** - It is important that appropriate terms are used to connect the productivity agenda with the new government's political manifesto. NTPC and MEPIR will need to approach this through political networks in order to attract the interest of the new government.

iv) **Legal and regulatory framework** - Productivity Charter of 2005 is already outdated. A Fiji National Innovation and Productivity Act accompanied by relevant regulations must be developed, specifying the objectives, scope, administration, reporting systems, coordinating agencies, and others. This initiative could form one of the policy recommendations outlined in a Cabinet paper, following a stakeholders' meeting involving key institutions, business and professional bodies, education and training institutions, and engagement partners, such as media, trade unions, NGOs, and development partners.

v) **Establishment of "National Innovation and Productivity Council" as an apex body** - The council is to be established and chaired by the prime minister. The Office of the Prime Minister could also provide the secretariat services before transferring this role to either NTPC or MEPIR.

vi) **Productivity champion** - The formation of a NIP Council (apex body) should precede the appointment of the prime minister in the first two years. Subsequently, the reins can be handed over to the Minister of Employment, Productivity, and Industrial Relations.

vii) **Rationalization of responsibilities and reporting structures of MEPIR and NTPC** - While both organizations have been involved with the productivity movement for an extended duration, it is prudent that the Office of the Prime Minister leads the revival and restructuring within the first two years. The proposed national forum should also discuss MEPIR and NTPC roles and responsibilities, considering the new changes in government and with NTPC merging with FNU.

viii) **Shifting the productivity focus** - Productivity scope should shift from quality circles and excellence in business enterprise to national-level productivity, covering all the economic sectors, economic structure, and entrepreneurial development. This shift should be accompanied by education and training initiatives, aimed at building capacities in strategic areas, such as research, planning, monitoring and evaluation, and communication.

ix) **Reform of the Fijian MSME sector** - Political influence had previously tarnished the trajectory of MSME development and business program implementation, including funding targets. A comprehensive revamp in the form of two important pillars are suggested: the entrepreneurial person and the business enterprise. Instead of high level economic and social objectives, these pillars will focus on MSME development, including employment, national income, and poverty alleviation. To support this transformation, it is imperative to enhance institutional capacity and equip staff with targeted training, emphasizing areas, such as MSME needs assessment, profiling target groups, sector and business ecosystems analysis, and the diffusion of technology.

x) **Research in innovation and entrepreneurial issues** - This initiative entails the integration of education and training contents in the TVET curricula through short-term courses and traditional semester-based modules. Further, the establishment of a Business Innovative Lab as a pilot within a selected local university, designed to harness new innovative ideas from internal and external sources, is recommended.

xi) **Creation of a multisectoral working group** - Collaboration among the core ministries and service providers is crucial for efficient policy and system planning, business development, industry networking, knowledge creation, and the development of a national database on innovative and high-growth enterprises. In order to leverage synergies with existing stakeholders, a national innovation and productivity forum could be organized by a local university or the Office of the Prime Minister, in conjunction with the relaunch of the National Innovation and Productivity Act and Regulations.

In the final analysis, a high-level commitment led by the Office of the Prime Minister is a prerequisite to the rebuilding and relaunch of the Fijian National Productivity Movement. The Fijian NPMP2021–2036 suggested the adoption of the following strategies:

i) An integrated framework that anchors the high-productivity growth strategy.

ii) Adoption of a holistic approach to productivity management, covering all the proximate factors and enablers affecting productivity.

iii) Execution of the holistic approach through a high-profile productivity movement.

iv) Strengthening of the productivity ecosystem of key institutions and engagement partners to drive the productivity movement.

In conclusion, the pivotal message is to reboot and relaunch the Fijian Productivity Movement. The Office of the Prime Minister is poised to provide secretariat services to a new NIP Council established under a new NIP Act as well as assuming the role of coordinating during the early stages of rebuilding.

CHAPTER 4

INDIA

INTRODUCTION

India, the world's largest democracy, is home to approximately 1.37 billion people according to 2021 estimates. Situated in South Asia, India's economy in 2021 was the sixth largest in terms of nominal GDP, reaching a substantial size of USD3,170 billion. In purchasing power parity (PPP) terms, India is also the third largest economy in the world, valued at USD9,420 billion (2017 constant price). This places India behind the United States of America (USA) and PR China, and just ahead of Japan, as per the Asian Productivity Organization's (APO) estimates [1]. Yet, when assessed on per capita terms, the assessment is more restrained. India ranks 151st among world countries in per capita GDP with the average Indian producing USD6,695 worth of output in 2021 [2].

Snapshot of the Indian Economy

The Indian economy has a vibrant primary sector (agriculture and allied activities) that produced USD1,509 billion worth of output in 2019[1]. India's secondary sector (manufacturing and allied output), which comprises industrial output, such as manufacturing, mining, quarrying, construction, and utilities, produced USD2,099 billion worth of output. The tertiary sector (services sector), which comprises the largest share of the monetary value of output recorded a substantial production worth USD6,389 billion. In the same year, the primary sector contributed 15%, the secondary sector approximately 21%, and the tertiary sector (services) contributed around 64% to the GDP. In terms of growth rates since 1970, India's agricultural and allied output has grown by a modest 2.8% CAGR (compound annual growth rate), in comparison to the secondary sector's 5.5% growth, and 6.6% CAGR in the tertiary sector, according to APO [1] data.

An estimated 520 million workers were engaged in production activity with the primary sector employing 42% of the workforce, 26% by the secondary sector, and the remaining 32% employed in the services sector. A combination of sectoral employment and output value data reveals the efficiency levels, highlighting that agriculture has the lowest efficiency, followed by the secondary sector, and the tertiary sector in terms of output produced per worker employed.

India's strength is often portrayed as its demographic dividend, which can be explained in terms of the transition in the working-age population of 15–64 years. Data from the APO database [1] demonstrates that between 1970 and 2019, the proportion of the working-age population grew by 11.22% while the proportion of the older-age population increased by 3.07%. This shift came at the expense of a decline of the proportion of children by 14.3%.

1 Output measured in terms of PPP adjusted Constant USD (2017 prices). The latest data from APO productivity database is for 2019 which was released in 2021.

Despite favorable shifts in demography, the levels of labor force participation among working-age adults remain considerably lower in India compared to other major economies, like PR China. According to estimates from Centre for Monitoring Indian Economy (CMIE) [3], labor force participation rates among working-age adults stood at 40.1% in 2021–22. Simultaneously, India's unemployment rate fell in recent times. By January 2022, India's unemployment rate was only 6.6%, a decline from 7.9% in December 2021. However, some analysis of the underlying cause reveal that the marginal decline in unemployment is due to the withdrawal of job seekers from the labor force [3].

India's trade in goods and services with the world has been growing multifold since it liberalized its economy in 1992. India's goods exports have been focused in petroleum products, drug formulations, precious and semiprecious metals, pearls, gold ornaments, aluminum, iron and steel products, and marine products. According to India's Economic Survey 2021–22 [4], merchandise exports reached a peak of USD313.4 billion in 2019–21. However, 40% of India's total export value reaches only 10 countries, namely the USA, United Arab Emirates (UAE), PR China, Hong Kong, Singapore, Bangladesh, the Netherlands, the United Kingdom (UK), Belgium, and Germany. Notably, India's exports to Japan, the world's fourth-largest economy, amounted to only USD6 billion. Meanwhile, India's imports grew to USD613 billion in 2021–22 after a brief downturn in 2020–21 due to the impact of the COVID-19 pandemic. Leading imports include crude petroleum, pearls, gold, coal, edible oils, organic chemicals, and electronics. PR China is the primary source of goods with around 16% share, followed by the UAE and the USA. Overall, India's trade deficit has been widening since 2016–17, almost doubling to USD190 billion in 2021–22.

In terms of capital flows, India has been the third-highest receiver of foreign capital within Asia, following PR China and Indonesia in recent years. Foreign direct investments (FDI) were consistently rising from the start of the 21st century until 2015–16, despite adverse global conditions in 2008–09 (global financial crisis) and 2013–14 (taper tantrum). Following a slowdown in FDI flows from 2016 onwards, there was a resurgence during the COVID-19-induced lockdowns. Short-term capital flows into India's securities market have been very volatile, turning net negative during periods of global macroeconomic slowdown or stress. Nevertheless, India's stock of foreign exchange reserves have grown substantially by 10 times, expanding from USD54 billion to approximately USD607 billion. Despite India's sustained current account deficit throughout a major portion of the last two decades, from 2001 until 2021, the country managed to maintain a capital account surplus that exceeded the current account deficit [4].

Impact of COVID-19 on the Indian Economy

The Indian economy had entered a phase of cyclical slowdown prior to the onset of the COVID-19 pandemic. The annual average real growth rate of India was 5.7% in the years between 2017 and 2020, marking the lowest three-year average from 2003 onwards [5]. From the onset of the pandemic in March 2020[2], India faced three waves of the COVID-19 pandemic with a combined caseload of 8.5 million infections [5]. In response, the Indian government implemented stringent measures in dealing with COVID-19 (ranking 36th globally in terms of stringency index[3]). Due to this nationwide containment strategy, India's GDP declined substantially by 23.8% in the first quarter of 2020–21.

The contact-intensive services sector is a major contributor to India's GDP at 32%. Compounded by the fact that 75% of workers are self-employed and only 43% of Indians have internet access, the GDP of the country contracted by a total of 6.6% in the total fiscal year ending 2021. During the second wave of COVID-19, GDP further declined by 8.3% in the first quarter of 2021–22. The Indian labor market was

2 WHO declared COVID-19 as a global pandemic on 11 March 2020. Shortly, thereafter, the Indian government imposed the lockdown on 24 March 2020.

3 Oxford Coronavirus Government Response Tracker (OxCGRT [6]).

deeply affected during the first wave of the pandemic with labor participation falling to 36% and unemployment rate surging to 43% in April 2020. Casual laborers were the worst hit, in comparison to self-employed and regular workers, which led to reverse migration from urban to rural areas [5]. Concurrently, there was a rise in demand for MGNREGA[4](Mahatma Gandhi National Rural Employment Guarantee Scheme) work opportunities in rural areas, with 45,000 households seeking work in the first quarter of 2020. Owing to uncertainty about the future, fixed investment spending in India fell by 10.4% in the 2020–21 financial year. Following the disruptions caused by COVID-19, the value of export trade fell to USD291.8 billion.

India's fiscal and monetary response to COVID-19 was both wide-ranging and agile. Instead of announcing support measures all at once, the Indian government consistently gathered feedback to progressively expand the financial support package across the three waves of the pandemic [4]. During 2020–21, the government and the central bank (Reserve Bank of India or RBI) announced a total stimulus amounting to 15% of GDP and benchmark interest rates for central bank lending dropping below 4%. The government's strategy was to first ensure food security through free and subsidized food grains for around 809 million beneficiaries via the public distribution system. An employment guarantee was provided by extra funding toward MGNREGA. Subsequently, the stimulus extended emergency credit and liquidity to micro, small, and medium enterprises (MSMEs) by allocating funds toward the purchase of subordinate debt, equity purchase via funds, providing emergency credit line guarantee, and interest subvention for small-business loans. In June 2021, the government announced INR6.29 trillion of support during the second wave, followed by additional spending rounds in July and December 2021, focused on healthcare and food security, respectively.

More importantly, the government of India embarked on structural reforms aimed at enhancing the investment climate and improving the country's export performance, all while promoting employment under the broad ambit of *Atma Nirbhar Bharat* scheme[5]. District export promotion committees were set up in 739 districts to help diversify the exports portfolio. From 2021–22, the government set a budget of USD26 billion for the production-linked incentive (PLI) scheme across 14 key sectors, including auto components, pharmaceuticals, electronics, and telecom, and more. The PLI initiative incentivizes firms based on incremental sales and investment with the goal of boosting domestic production by a minimum of USD500 billion in five years. Additionally, the government further injected approximately USD538 billion capital into the Export Credit Guarantee Corporation (ECGC) to underwrite risks arising from lending to exporters, as per India's economic survey [4]. To improve logistics efficiency and multimodal connectivity, the Prime Minister Gati Shakti National Master Plan intends to bring 16 ministries together for integrated planning and implementation of nationwide infrastructure projects.

The agile support by the government and RBI resulted in a V-shaped recovery for India during the first and second waves of COVID-19. By the second half of FY 2021–22, all components of aggregate demand in India had returned to prepandemic levels. However, this growth momentum was derailed due to the Russia-Ukraine conflict in February 2022. In summary, the pandemic's short-term impact on the Indian economy was uneven, disproportionately affecting services and manufacturing sectors as opposed to the agricultural sector. Nevertheless, the government's response through capital expenditure spending and structural reforms lays the foundation for productivity enhancements and promising prospects for the Indian economy.

4 Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGA) aims to provide legally guaranteed 'right to work', by providing 100 days of employment on demand, through rural rejuvenation and new infrastructure building.

5 *Atma Nirbhar Bharat Yojana*, a broad-based approach toward self-reliance through domestic production, import substitution, and employment generation.

PRODUCTIVITY ANALYSIS

Economists and policymakers are generally interested in three broad measures of productivity: capital productivity, labor productivity, and total factor productivity (TFP). Given that capital and labor are necessary inputs in macroeconomic output, measuring capital and labor productivity is important. Further, labor productivity is often measured in two distinct terms: one, in terms of hours of labor input, and the other, in terms of the number of people employed. TFP is a multifactor productivity measure that is commonly considered critical for the success of modern economies. As a residual productivity measure, TFP generally captures the intangible aspects of an economy, such as cultural, technological, and innovation efficiency. This section highlights the intertemporal trends in productivity measures, drawn from the Asian Productivity Organization's (APO) database [1].

Trends in Capital, Labor, and TFP

Analysis of India's productivity data shows that decade-wise simple average capital productivity level has remained steady, consistently hovering slightly above 1 between 1970 and 2010. However, between 2011 and 2019, the productivity level declined to 0.9.

India's labor productivity levels, measured in both per worker and per hours worked basis, have been on an upward trend from 1971 to 2019. A close analysis of the decade-wise average labor productivity in per worker terms shows a consistent rising of productivity levels (Table 4.1). In the 1970s, labor productivity was at 0.26, rose to 0.33 in the 1980s, and further elevated to 0.47 in the 1990s. Notably, at the turn of the century, labor productivity levels doubled to 0.75 in the 2000s. The year 2010 marked an inflection point, leading to an average labor productivity level of 1.31 in the most recent decade between 2011 to 2019.

Labor productivity levels, in per hours worked basis, also display remarkably similar trends over time, with average productivity doubling (over the previous decade) in the 2000s. The highest average productivity (1.31) for labor was attained in the latest period between 2011–19.

TABLE 4.1

DECADE-WISE AVERAGE OF PRODUCTIVITY LEVELS IN INDIA

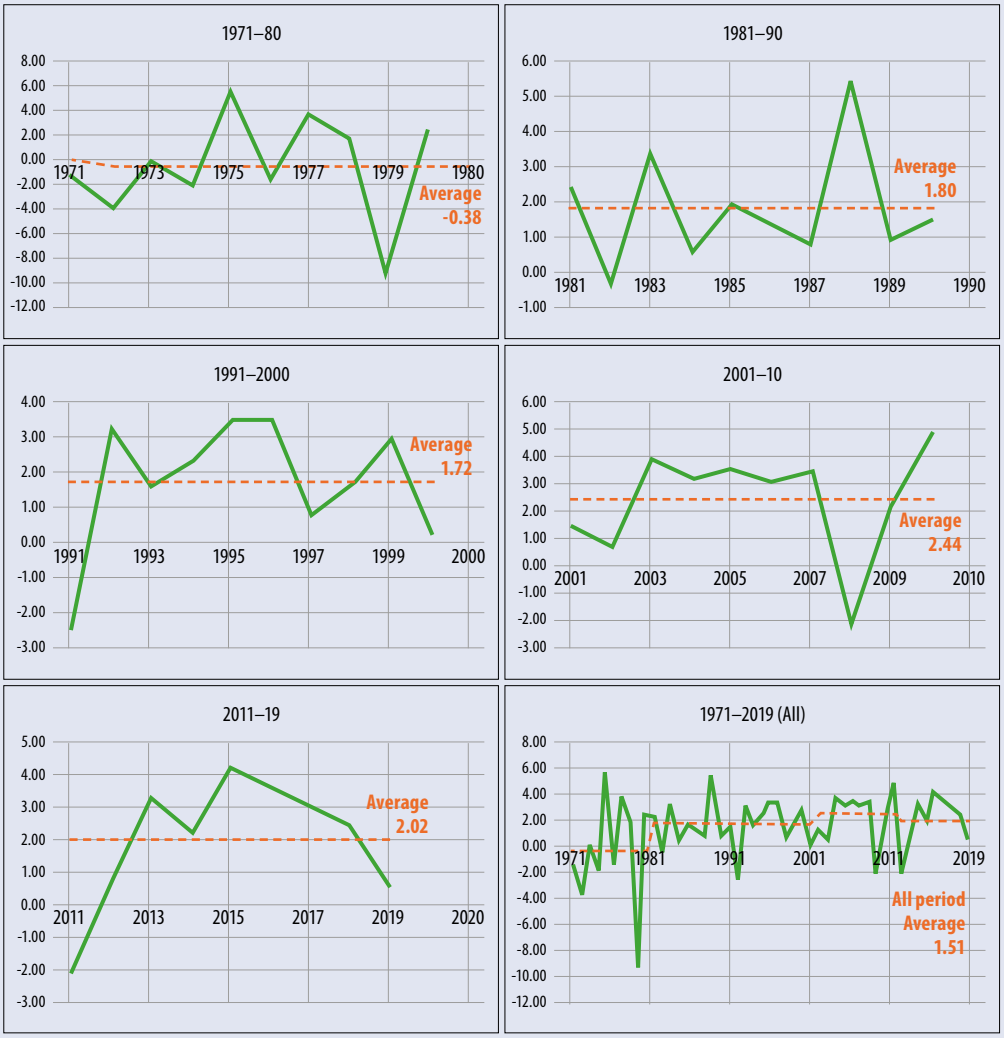
Decade	Total Factor Productivity (TFP)	Labor Productivity (based on hours worked)	Labor Productivity (based on number of employment)	Capital Productivity
1970–80	0.56	0.27	0.26	1.09
1980–90	0.61	0.33	0.33	1.04
1990–2000	0.72	0.47	0.47	1.02
2000–10	0.89	0.75	0.75	1.03
2010–19	1.09	1.31	1.31	0.9

Source: APO [1].

India's TFP level fluctuated in the 1970s (Figure 4.1). However, in subsequent decades, the average TFP levels consistently rose from 0.60 in the 1980s to 0.72 in the 1990s. Between 2001 and 2010, the average TFP reached 0.89, stabilizing at 1.09 in most recent decade. In terms of growth, the average TFP growth in each decade experienced an upward trend, beginning at an average rate of -0.38 in the 1970s and accelerating to an average growth rates of 1.84%, 1.72%, and 2.44% in the 1980s, 1990s, and 2000s, respectively. This growth momentum slowed down slightly to 2.02% between 2011–19. Overall, India's labor productivity has risen multifold since the turn of the century while TFP exhibited gradual growth and capital productivity displayed a decline over time.

FIGURE 4.1

TFP GROWTH IN INDIA



Source: APO [1].

Decomposition of Labor Productivity Growth and Output Growth

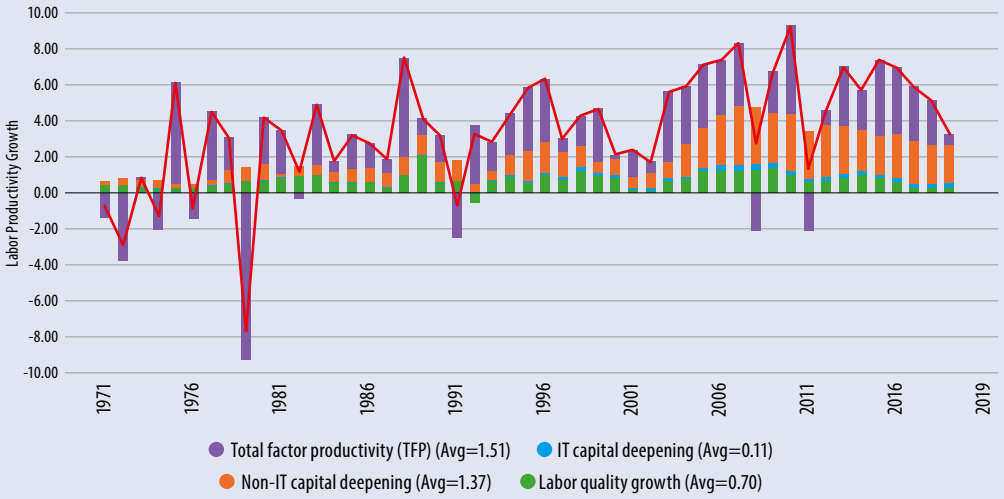
Analyzing Labor Productivity Decomposition

Labor productivity is measured in terms of the volume of output (or value-added) per volume of labor time (inputs). Neoclassical growth accounting attributes labor productivity growth to three broad factors, namely, labor quality improvements, capital deepening changes (IT and non-IT capital), and TFP changes. Capital deepening measures can increase in the capital stock per unit of labor. Labor productivity can be enhanced from improved processes or technological developments, leading to efficiency in the utilization of capital. In addition, labor quality can be improved by better education, skill training, better health conditions, and having an energetic or experienced workforce - factors that further contribute to labor productivity.

In India, since the 1970s, average labor productivity growth was driven by rising TFP, followed by the deepening of non-IT capital. The deepening of IT capital and labor quality growth had only a marginal effect on labor productivity growth. Despite variations within each decade, the average rate of labor productivity growth has risen progressively every decade until 2010, when there has been a marginal decline to 5.28% between 2010 to 2019 (Figure 4.2). TFP growth rate was the dominant reason for labor productivity growth from 1970 to 2010. From 2010 onwards, capital deepening, particularly non-IT capital, drove up labor productivity, despite a slowdown in the TFP growth rate.

FIGURE 4.2

SOURCE OF GROWTH IN INDIA'S LABOR PRODUCTIVITY IN 1970–2019



Source: APO [1].

During recessionary years and periods of macroeconomic stress (2008–09 and 2013–14), labor productivity growth was slowed down by a decelerating TFP growth from 2.44% in the first decade of the 2000s to 2.02% in the subsequent decade (Table 4.2). In the corresponding period, capital per labor hour deepened in India, accelerating from 2.4% to 2.67%. This could be attributed to substantial public investment in infrastructure within this period. As a proportion of GDP, gross fixed capital formation went up from 22% in 2000–01 to a robust 31.7% by 2019–20, as per CMIE Economic Outlook database [7].

TABLE 4.2

LABOR PRODUCTIVITY SOURCES (DECOMPOSITION)

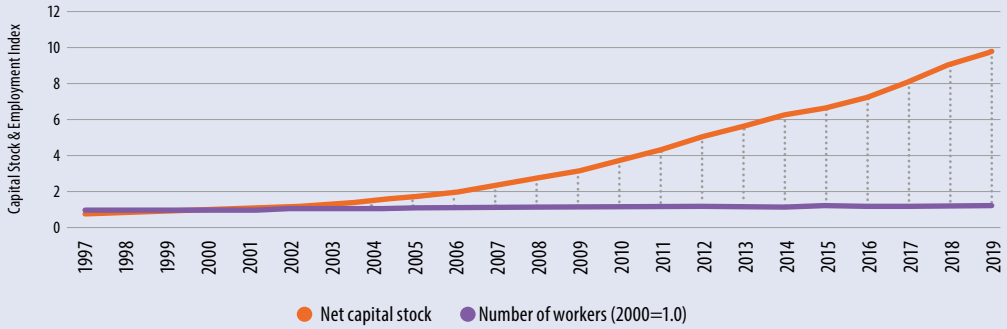
Decade	Labor Productivity	Labor Quality	Capital Deepening	IT Capital Deepening	Non-IT Capital Deepening	TFP
1970–80	0.52	0.42	0.48	0.02	0.46	-0.38
1980–90	3.43	0.83	0.79	0.04	0.75	1.8
1990–2000	3.63	0.71	1.2	0.1	1.1	1.72
2000–10	5.74	0.9	2.4	0.21	2.19	2.44
2010–19	5.28	0.6	2.67	0.21	2.46	2.02

Source: APO [1].

The net capital stock witnessed exponential growth rate between 1997 to 2021–22. During this period, net capital stock multiplied tenfold from 2000 to 2019, whereas number of workers only grew by a mere 12%. It can be inferred that more capital was being made available to labor across sectors and industries, effectively deepening capital per labor hour, which led to improved labor productivity (Figure 4.3). Similar trends were observed by researchers using the RBI's KLEMS[6] database [8].

FIGURE 4.3

CAPITAL DEEPENING TRENDS IN INDIA



Source: CMIE Economic Outlook [2].

Total Growth Decomposition

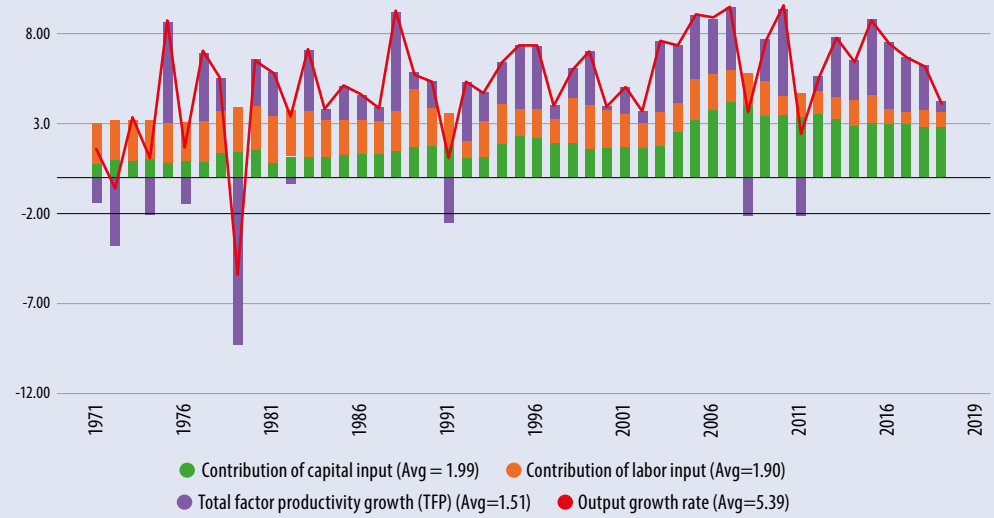
Total real output growth increased at a simple average rate of 5.99% between 1970 and 2019. Much of this growth stemmed from factor accumulation, where capital inputs grew at close to 2% and labor inputs at 1.90%. TFP growth was the lowest contributor at 1.51%. Only at the turn of the new millennium that TFP growth surpassed labor input growth, becoming India's second-highest contributor to its real GDP (Figure 4.4).

Throughout the period from 1970, each successive decade saw a notable variation in the contribution of capital, labor, and TFP toward real output growth. In the 1970s and 1980s, labor inputs contributed around 2.29% toward total output growth. In the 1990s, the contribution of labor stood only at 1.88%, whereas TFP and capital inputs contributed an equal share of 1.72%. In subsequent decades, the contribution of labor stagnated and then declined to a mere 1.17% between 2010–19.

6 KLEMS- Capital, Labor, Energy, Material, and Service inputs is a framework used in economics to measure the growth of an economy by looking at the contributions of various factors of production.

FIGURE 4.4

DECOMPOSITION OF TOTAL GROWTH RATE OF OUTPUT IN 1970–2019



Source: APO [1].

Capital inputs contributed a progressive share at 3.02%, which accounts for almost half of the growth in the latest decade. TFP contribution peaked in the early 2000s until the 2008 financial crisis slowed India's growth from 2008 to 2013. India's TFP declined in 2008 and 2011, registering a negative growth of 2.12% each year. TFP growth has slowed down since 2016, resulting in a decline in its contribution to the overall growth rate to just 2.02% in the last decade (Table 4.3).

TABLE 4.3

SOURCES OF TOTAL OUTPUT GROWTH (GROWTH RATE DECOMPOSITION - DECADE-WISE AVERAGE)

Decade	Output Growth	Contribution of Capital Input	Contribution of Labor Input	TFP Growth
1970–80	2.96	1.05	2.28	-0.38
1980–90	5.4	1.3	2.3	1.8
1990–2000	5.32	1.72	1.88	1.72
2000–10	7.17	2.94	1.78	2.44
2010–19	6.2	3.02	1.17	2.02

Source: APO [1].

In summary, the growth in labor productivity resulted from capital deepening, culminating in a net capital stock reaching around USD3.6 trillion by 2021 [9]. In recent years, the major contributor to total output growth has been capital growth, followed by TFP growth at the expense of labor input share.

The standard growth models in prevalent economic literature characterize capital and labor accumulation-driven growth as predominately catch-up growth while TFP-driven growth is identified as frontier growth. Frontier growth is the most critical aspect of growth for knowledge economies and economies transitioning to a developed state [10]. For India, which seeks to transform from a low-middle economy to a high-middle economy must therefore focus on high TFP growth.

TFP generally captures a nation's technological progress catalyzed by innovation and R&D within a competitive yet enabling business environment with an adequate regulatory and legal framework. Therefore, a high TFP growth needs an enabling economic environment that prioritizes technological progress in terms of R&D, innovations, and economic applications of such innovations [11–12]. In essence, a country's economic progress and sustained growth need an all-encompassing system that prioritizes, facilitates, and enhances technological advancement through R&D, innovations, and creation of entrepreneurial ecosystems for economic progress.

NATIONAL INNOVATION SYSTEM (NIS)

The OECD emphasizes that long-run economic growth depends on creating and fostering an environment that encourages innovation and the application of new technologies. Innovation is now considered as the most important driver of productivity and competitiveness, leading to the economic growth of a nation. Increasing the innovation quotient through an appropriate innovation system is one of the key elements of successful modern economies. The importance of a system that encompasses a nation's innovation policy, key institutions, and other stakeholders to further innovation and economic growth is widely acknowledged by scholars and policymakers [13–14]. This interwoven network of institutions and organizations within a country involved in the creation, diffusion, and commercialization of new technologies and ideas is generally referred to as the National Innovation System (NIS).

While the concept of NIS has gained popularity recently, the idea is not new. Danish scientist Lundvall first introduced the concept as an approach to address bottlenecks resulting from systemic failures arising during the interaction between diverse players involved in the complex process of innovation [15]. Later, economists, such as Nelson [14] and Freeman [16] popularized the concept of NIS as a macro-level systemic tool that promotes innovation and technological development within a country, which can lead to economic growth and improved standards of living. Thereafter, NIS was broadly defined as the "network of institutions in public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies" [16]. Other researchers, such as Patel and Pavitt [17], define NIS as "the national institutions, their incentive structures, and their competencies that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country." Though the definition of NIS may vary marginally, there is unanimity revolving the following characteristics of NIS:

- A national-level system of networked institutions and facilitators
- Encompasses the policy framework, competency parameters, resources, and incentive system that manage the complex interactions and dynamics between networked institutions
- Facilitates the creation, diffusion, and commercialization of innovation, including new technologies and processes, to drive productivity, competitiveness, and economic growth

Naturally, different countries possess distinct institutions, systems, and policies that make their respective NIS. Therefore, the architecture and functioning of NIS can vary across nations. In the following section, the researcher illustrates the overall architecture and contextual framework of India's NIS.

India's NIS and its Genesis

The country's NIS can be conceptualized based on four fundamental dimensions, encompassing:

1. **Institutions** - Institutions in NIS include (i) government policy-making institutions, such as different ministries, (ii) universities and research institutes; (iii) bridging institutions, such as research councils

that act as intermediaries between government and research institutes; (iv) private enterprises and their funding arms; and (v) other public and private organizations, including technology transfer organizations, incubators, IP facilitative organizations, skill development, and training organizations, etc.

2. **Policy framework** - Primarily government policies on different eras that determine the establishment and function of institutions, the scope and activities of institutions, priority areas, incentivization structures, and funding frameworks.

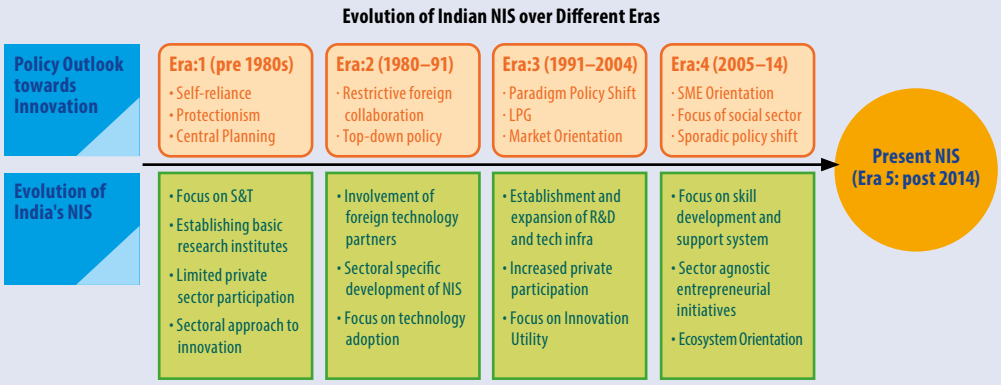
3. **Engagement** - Within the context of NIS, engagement refers to the fluidity of interactions and dynamics among institutions. It gauges how efficiently and effectively the institutions engage, complement, and collaborate in interactions that generate value. This dimension also explains the degree to which the policy framework enhances interactions that lead to substantial research outcomes and innovations.

4. **Ensuring innovation utility** - The facilitative process that ensures intellectual property (IP) and research outcomes transforms into utility-oriented products and services. It is also the process of facilitating wide diffusion of technology leading to successful commercialization.

Viewing India's NIS from these four fundamental dimensions, it is apparent that India's NIS has gone through a long and complex evolutionary process, starting from 1947. India's NIS evolved in tandem with changing economic policies, reimagining institutions and their engagement, and changing outlook toward innovation outcomes. Reflecting on these changes, the genesis and evolution of India's NIS is mapped out across three major and two intermediate eras (Figure 4.5).

FIGURE 4.5

EVOLUTION OF NIS IN INDIA



Source: Author's rendition.

Era 1: Era of Central Planning and Protectionism (pre-1980s)

Soon after India became independent from the disabling British occupation, the then-prime minister opined that India could not be economically or politically independent unless it strengthened its scientific and technological capacity. The policymakers of that time feared the domination of foreign firms if free and unrestricted entry were allowed [18]. India's objective was to create local technological capabilities to cater to local demands and reduce foreign dependency rather than creating global competitiveness. Broadly speaking, India's self-reliant policy was defensive and inward-looking. This

fundamental political outlook was the primary factor in shaping India's NIS in this era. Consequently, the country's NIS was primarily focused on self-sufficiency and import substitution. The government focused on developing India's scientific and technological potential but under a restrictive environment [19]. The Scientific Policy Resolution of 1958 captured this vision, which was instrumental in shaping the nation's innovation system for years to come.

Following the vision of self-reliance and protection, the government took the leading role in promoting innovation and technological development with a strong emphasis on state-led R&D activities, but with very limited scope for private players and other nongovernment institutions. A review of India's five-year plans shows that India's innovation infrastructure was built up in phases during this era through government-backed central planning. During the first Five Year Plan (1951–56), the government built national laboratories and research institutions, primarily under the Council for Scientific and Industrial Research (CSIR). The Second Plan (1956–61) promoted more broad-based scientific research and saw the creation of institutes, such as the Indian Institutes of Technology (IITs) and expansion of the Indian Institute of Science (IISc) to support basic research and technological development. The Department of Atomic Energy and the Department of Space were also set up to support the development of nuclear and space technologies.

Going forward, the fifth plan took a sectoral approach [20] and focused on technology transfer. In the 1970s, the government introduced the Technology Development and Transfer for Rural Areas (TDTRA) program, which aimed to promote the use of appropriate technologies in rural areas. The program focused on transferring technologies developed by research institutions to local entrepreneurs and small and medium enterprises (SMEs). This era also took initial steps for changes in IP policy in the form of the Indian Patent Act 1970. This Act was instrumental in facilitating process patents in the pharmaceutical sector, ultimately leading to process innovations.

Broadly, this era focused on creating initial R&D infrastructure through central planning and established industrial policy that strictly regulated the innovation system. The policy frameworks clearly defined the roles of both private and public sectors, regulated private investment through industrial licensing, and controlled technology imports to encourage domestic R&D [21]. There were two main implications of such a system. On one hand, India reached a higher level of technological potential and created scientific knowledge based on strong basic research in a protected environment. On the other, the overall innovation system witnessed suboptimal development as Indian companies and the private sector did not make any substantial innovations, did not leverage the international market, and were busy trying to catch up in R&D and with limited diffusion. Despite the government's efforts, India's NIS before the 1980s was limited by several factors, including a lack of private-sector participation and a lack of emphasis on the commercialization of research. This led to a slow pace of technological development and a limited impact on economic growth and development.

Era 2: Intermediate Era of Baby Step Reforms (1981–pre-1991)

In this era, the government gradually acknowledged the limitations of inward-looking and protectionist policies that hindered technology adoption and innovations. By the early 1980s, the government realized that the country needed a strong NIS to reach the high level of competitiveness required for improving the economic situation. It introduced the second Science and Technology Policy in 1983, after about 30 years of the first one. This era coincided with the 6th and 7th five-year plans, which emphasized self-reliance while allowing exploration of technology collaboration and sourcing from abroad. In selected areas and despite opposition from entrenched stakeholders, the government started relaxing rules, especially in the domain of technology adoption and IT. For example, the government gave up its attempt to force firms to buy technology from public R&D institutes. Taking lessons from India's missed opportunity during the semiconductor revolution in the 1970s, it took policy measures to promote and expand the IT industry. The 1985 Electronic Policy was a major shift in policy outlook as it facilitated large-scale participation of private players in the IT and computer industry [18].

This fostered innovation and technology adaptation in the IT sector and was one of the major reasons for India's success in the IT sector.

Nevertheless, despite success stories in specific sectors, policy reforms in other sectors to facilitate a strong innovation system were few and far between. This lack of enabling policy measures in other sectors negatively impacted further development of the NIS, restricted its scope, and confined innovations to a few chosen sectors. Nonetheless, in this era, the government began to implement sporadic economic reforms and liberalization policies, which led to a marginal increase in private sector participation in R&D and innovation. Though very limited in scope, the initiatives of this era contributed to the development of a more vibrant innovation ecosystem in India.

Era 3: Era of Economic Liberalization and Policy Shift (1991–2004)

The year 1991 was a watershed moment in the economic history of post-Independent India. This year, India finally shifted from an inward-looking policy to an outward-looking policy and embraced a market-based economic policy. This policy shift augured a new era characterized by Liberalization, Privatization, and Globalization (LPG). It led to major changes in policies regarding foreign investment, industrial licensing, restrictive trade practices act, foreign technology agreements, public-private engagement, and involvement of SMEs. In this era, the economic outlook clearly shifted from being restrictive to facilitative, from focusing on import regulating activity to export promotion activity, and from domestic orientation to internationalization.

Along with increased business activities across sectors, this era witnessed increased engagement of domestic and foreign private institutions and companies in R&D and innovation-oriented activities. Public-private partnership (PPP) models for creating R&D infrastructure and research activities were encouraged. Many sector-specific industry-institute joint research projects, such as the Drugs and Pharmaceuticals Research Program (DPRP) and New Millennium Indian Technology Leadership Initiative (NMITLI) were launched. Many multinational corporations (MNCs) opened R&D centers in India and collaborated with government science & technology (S&T) institutions. New S&T institutions and facilitative institutions, such as the Technology Development Board (TDB), came into being after the TDB act was passed in the parliament in 1995. Gradually, the outlook of private R&D players and government R&D institutions became complementary, cooperative, and result-oriented.

With enhanced scope of engagement, involvement of multiple stakeholders across sectors, and significant socioeconomic potential for innovation, India's NIS witnessed both quantitative and qualitative change. This change included establishment of new institutions, involvement of new players facilitated by new policies, and change in engagement modalities among various stakeholders in the overall architecture of India's NIS. With these changes, India saw increased import of foreign technology, collaborative production systems, and foreign investment in innovative activities [21]. For example, these changes helped foreign companies increase their efficiency and reduce costs by outsourcing operational activities to leverage the cost arbitrage India offered. Positive outcomes of the initial change resulted in creating a positive spiral of engagement between more institutional players, skilled manpower, and other stakeholders. This led to improvement and expansion of what is now called "the knowledge economy" and brought economic prosperity to many. This era witnessed an emerging India with significant GDP growth, FDI inflow, global R&D partnership and technology transfer, better export performance, the emergence of Indian ICT sector, employment growth, and other socioeconomic developments.

The structural and qualitative transformation in the economy and the new reality of an emerging India pushed the country's NIS to change. The basic transformation in the outlook of India's NIS was reflected in the Science and Technology Policy (STP)-2003, which acknowledged India's emergence as a fast-growing large economy based on contributions from the knowledge-intensive sectors. STP-2003 highlighted the need to ensure synergy between industry and research organizations, created platforms

for the commercialization of knowledge, and encouraged the industry for more R&D activities. As a result, the characteristic of India's NIS changed from being only basic research oriented to a more market-driven orientation. This era marked a fundamental and irreversible shift in all the four basic dimensions of India's NIS: institutions, policy framework, engagement modalities, and innovation utility. Simultaneous changes in the four dimensions were the precursor to creating a vibrant ecosystem of institutions and organizations dedicated to driving innovation and providing techno-commercial support for managing the innovation process and associated risks.

Era 4: Intermediate Era of Passive Engagement (2005–14)

The STP-2003 intended to bring renewed vigor to India's NIS as to create and nurture a vibrant innovation ecosystem across India. This outlook was subsequently supported by the 11th five-year plan (2007–12), which highlighted the urgency to create an institutional mechanism linking public and private players to enhance innovations in the SME sector [20]. The SME sector became the government's focus area as it contributed around 45% of all manufacturing output, 40% of related exports, and employed a large number of skilled and semiskilled workforce. Accordingly, the government policy focused on enterprise development by supporting SMEs through: (i) incubation and risk funding; (ii) providing skill development and management support, (iii) facilitating SME cluster development; and (iv) encouraging informal and open-source innovations.

To ensure SMEs benefit from the overall NIS and integrate their goal and processes, the government launched new institutions and programs. Small Business Innovation Research Initiative (SIBRI) was launched in 2005 to support indigenous early-stage technologies in the biotechnology sector. Technopreneur Promotion Program (TPP) was launched to promote utility-oriented S&T innovations in rural areas. Modified Special Incentive Package Schemes (MISIPS) and the Self-Reliant Initiatives through Joint Action (SRIJAN) program was launched to support SMEs with financial aid. Further, various technology management programs, such as International Technology Transfer Program (ITTP) and Technology and Quality Upgradation Support (TQIS) program were launched to support SMEs with technology transfer, collaboration, and innovation diffusion.

However, the impact of various programs and initiatives for SMEs was muted as many programs and initiatives lacked proper implementation and interstakeholder coordination. Most programs had very limited ongoing-institutional support and were marred by a top-down governance approach. The engagement with other branches of NIS was suboptimal and lacked appropriate incentive structure. Notably, toward the second half of this era, the government was perceived to be blighted by policy paralysis and decreased cohesion. Despite the government's good intentions, it lacked influence over other stakeholders and their engagement in NIS became passive. Overall, this era saw the renewed interest of NIS in fostering innovations for social sectors and SMEs, and endeavored to create grassroots microsystems to encourage microentrepreneurs and social innovations. Despite the limited success in enhancing NIS's structure and effectiveness, the initiatives of this era created a strong foundation for the next era that saw a further transformation of India's NIS to focus on entrepreneurial initiatives and creating a facilitative ecosystem.

STRUCTURE AND FRAMEWORK OF INDIA'S CURRENT NIS

Undoubtedly, India's current NIS, its overall architecture, and the nature of stakeholder engagement have evolved through the above-mentioned four eras. Toward the end of the fourth era, it was apparent that a government-centered innovation system had a limited advantage in the new economy. The new government soon realized that a bottom-up collaborative approach to innovation and entrepreneurship might be better than top-heavy innovation management. A strong focus on facilitative policy, cooperative institutional engagement, and the creation of entrepreneurial ecosystems emerged to be a

better solution for fostering innovation, economic growth, and prosperity. Accordingly, India's NIS, post-2014, focused more on creating innovation intermediaries and enabling facilitative market-oriented processes that seek to democratize innovation through grassroots problem-solving and entrepreneurial ventures. To realize this, the new policy outlook in the current era primarily emphasized four dimensions:

1. Providing institutional access to all types and sizes of businesses.

2. Ensuring process simplicity to ensure ease of doing business and stakeholder engagements.

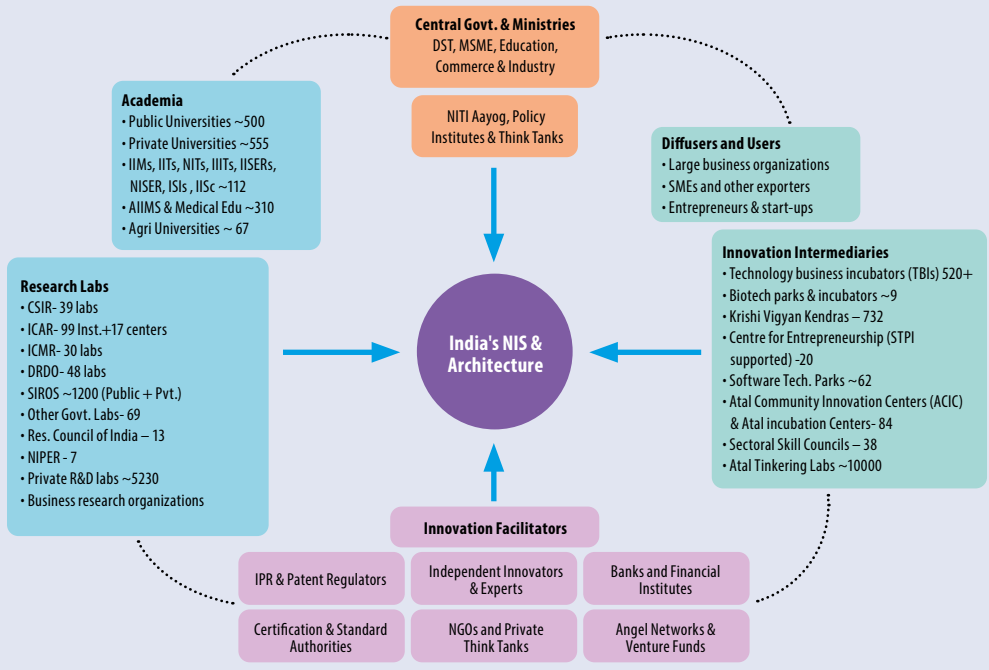
3. Inculcating a systemic approach toward innovation and its diffusion.

4. Entrepreneurship development by supporting entrepreneurs at each stage of the entrepreneurial process, i.e., from concept to market.

In tandem with the new policy outlook, India's NIS went through a further transformation. Figure 4.6 shows the macroarchitecture of India's current NIS.

FIGURE 4.6

NIS ARCHITECTURE IN INDIA



Source: Author's rendition.

A vibrant innovation ecosystem is fundamentally upheld by four essential pillars, complemented by five facilitative pillars. The fundamental pillars are: (i) R&D institutions; (ii) infrastructure; (iii) appropriate skill sets and manpower (Scientists, Innovators, Entrepreneurs); and (iv) a vibrant market. The facilitative pillars which complement the fundamental pillars are: (i) higher education and training; (ii) technological readiness; (iii) financial market sophistication; (iv) business sophistication; and (v) favorable macroeconomic conditions. The renewed architecture of India's NIS in the post-2014 era encompasses most of the pillars, though at varying degrees. While the transformation of NIS in the present era has its root in the accomplishments of the previous eras, a few visible changes are worth noting.

Structural Transformation with Addition of Grassroots Institutes and Intermediaries

Even prior to 2014, India's NIS was supported by a wide range of institutions and organizations. The NIS' institutional architecture was mainly dominated by Department of Science and Technology (DST), governmental facilitators, policy institutes, R&D institutes, and academia. However, around 2014, with the focus shifting to nurturing entrepreneurial ecosystems, market-oriented innovation, and a bottom-up approach to economic growth, there arose a need for the integration of additional grassroots organizations and involvement of a wide spectrum of value-centric intermediaries. The renewed effort to create a vibrant entrepreneurial ecosystem saw the addition of many local, geographically dispersed, entrepreneurial-oriented microorganizations being integrated into the NIS architecture. Some of the noted additions were SME-based Technology Business Incubators (TBIs), Atal Incubation Centers, Atal Tinkering Labs, Centers of Entrepreneurships based within educational institutions, and independent private incubators. The addition of these organizations to the NIS enhanced access to the innovation system and inculcated innovation orientation to a wide spectrum of the population. These organizations made the NIS more inclusive and were instrumental in creating a vibrant grassroots level entrepreneurial initiative.

In addition to new grassroots institutes, the post-2014 era also saw a strengthening higher education infrastructure to ensure wide geographic reach. There were significant additions of "institutes of national importance", such as IITs, Indian Institutes of Management (IIMs), All India Institutes of Medical Sciences (AIIMs), and central universities. The focus toward innovation in these institutes also went through significant change. With entrepreneurship taking center stage, the outlook of these institutes shifted from basic and applied research orientation to market and utility orientation. The majority of institutes of national importance developed the necessary infrastructure, policies, processes, and support systems for in-house entrepreneurial activities, establishing a firm connection with the entrepreneurial ecosystem. This era also saw greater participation of private sector companies and incubators promoting entrepreneurship and innovation. Many of these organizations were involved in cutting-edge R&D in various fields, including IT, biotechnology, defense research, healthcare, sanitation, and renewable energy.

Collectively, this era witnessed a significant number of innovation intermediaries, SMEs, and entrepreneurs being integrated into the NIS. This led to the creation of a strong ecosystem of institutions and organizations dedicated to driving innovation and fostering a culture of entrepreneurship in the country.

Proactive Policies Targeting Specific Focus Areas

In addition to increased organizational involvement in India's NIS, this era also saw significant policy initiatives by the government. Between 2014 and 2022, a total of 39 major policies with the potential to impact the NIS were introduced. Highlighted in Table 4.4, most of the policies were aimed at improving core infrastructure, providing incentives and support to businesses of all sizes, and fostering innovation and entrepreneurship. All these policy initiatives have a direct bearing on the functioning of India's NIS.

TABLE 4.4

POLICIES TO PROMOTE INNOVATION-LED ECONOMIC GROWTH IN INDIA 2014 ONWARDS

SN	Year	Name of the Scheme/Policy	Description
1	2014	DBT and DST Open Access Policy	Policy on open access to DBT- and DST-funded research
2	2014	Sub-Mission on Agricultural Mechanization (SMAM) scheme	Under the scheme, funding is provided for farm mechanization, like establishment of custom hiring centers, farm machinery bank, high-tech hubs in different states
3	2014	NewGen Innovation and Entrepreneurship Development Centre Scheme	For educational institutions to develop institutional mechanism to create entrepreneurial culture in S&T and to foster techno-entrepreneurship for generation of wealth and employment by S&T persons
4	2014	National Urban Transport Policy, 2014	Its objective is to plan for the people rather than vehicles by providing sustainable mobility and accessibility to all citizens to jobs, education, social services, and recreation at affordable cost and within reasonable time
5	2015	National Policy on Skill Development and Entrepreneurship 2015	Create an ecosystem of empowerment by skilling on a large scale with high standards and to promote a culture of innovation-based entrepreneurship, which can generate wealth and employment as to ensure sustainable livelihoods for all citizens in the country
6	2015	Technology Vision 2035	It brings out parallel comprehensive Technology Roadmaps on 12 select sectors. This vision document with technology roadmap of each sector that would provide details outlining future technology trends, R&D directives, pointers for research, anticipated challenges, and policy imperatives pertaining to each sector
7	2015	A Scheme for Promoting Innovation, Rural Industry & Entrepreneurship (ASPIRE)	The main objectives are to: (i) create new jobs and reduce unemployment; (ii) promote entrepreneurship culture in India; (iii) boost grassroots economic development at district level; (iv) facilitate innovative business solution for unmet social needs; and (v) promote innovation to further strengthen the competitiveness of the MSME sector
8	2015	Smart Cities Mission	To promote sustainable and inclusive cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment, and application of 'smart' solutions. Some core infrastructure elements are adequate water supply, assured electricity supply, sanitation, including solid waste management, efficient urban mobility and public transport, robust IT connectivity and digitalization, e-Governance
9	2015	Heritage City Development and Augmentation Yojana (HRIDAY) Scheme	To bring together urban planning, economic growth, and heritage conservation in an inclusive manner and with the objective of preserving the heritage character of the city
10	2015	Atal Mission for Rejuvenation and Urban Transformation (AMRUT) scheme	Basic civic amenities, like water supply, sewerage, urban transport, and parks, as to improve the quality of life for all, especially the poor and the disadvantaged. The focus of the mission is on infrastructure creation that has a direct link to provision of better services to the citizens.
11	2015	National Offshore Wind Energy Policy 2015	Exploring and promoting the deployment of offshore wind farms in India's Exclusive Economic Zone and encouraging investment in energy infrastructure
12	2016	States' & Union Territory's' Start-up Policies	This helps in providing the essential funding, mentorship, and market access support required by start-ups to grow as important contributors to the state's economy in terms of revenue and job creation
13	2016	National Intellectual Property Rights (IPR) Policy	Innovation to IP for the benefit of all; ensure IP promotes advancement in science and technology, arts and culture, traditional knowledge, and biodiversity resources; making knowledge the main driver of development, and knowledge owned is transformed into knowledge shared

SN	Year	Name of the Scheme/Policy	Description
14	2016	Electronics Development Fund (EDF) policy. **Note:** EDF was first mentioned in the NPE 2012 but was formally launched on 15 February 2016	To foster innovation and product development by investing in IP/R&D/product start-ups in the areas of technology (IoT, Fabless Semiconductors, software as a service (SAAS), and IT), healthcare (digital health, medical devices, nanotech in pharmaceutical/biotech) and consumer tech, focused on tackling India problems with a potential to scale globally
15	2016	Zero Defect Zero Effect (ZED) Certification scheme	To create awareness among MSMEs about ZED practices. Motivate and incentivize them for ZED certification and to become MSME champions
16	2016	National Civil Aviation Policy 2016	Mission is to provide safe, secure, affordable, and sustainable air travel for passengers and air transportation of cargo with access to various parts of India and the world
17	2017	National Health Policy 2017	It seeks to reach everyone in a comprehensive integrated way to move toward wellness. It aims at achieving universal health coverage and delivering quality health care services to all at affordable cost
18	2017	Draft National Energy Policy 2017	Its key objectives are: (i) energy access at affordable prices; (ii) improved security and independence; and (iii) greater sustainability and economic growth
19	2017	Indian Footwear and Leather Development Programme (IFLDP)	To encourage development of infrastructure for the leather and footwear sector, address environment concerns specific to the leather and footwear sector, facilitate additional investments, employment generation, and increase in production
20	2017	Pradhan Mantri Kisan SAMPADA Yojana (PMKSY) SAMPADA - Scheme for Agromarine processing and Development of Agroprocessing Clusters	Creating modern infrastructure with efficient supply chain management from farm gate to retail outlet. Focus on doubling of farmers income, creating employment opportunities, especially in the rural areas, reducing wastage of agricultural produce, increasing the processing level, and enhancing the export of the processed foods
21	2018	National Policy on Biofuels 2018	Aims to utilize, develop, and promote domestic feedstock for production of biofuels, thereby increasingly substitute fossil fuels while contributing to national energy security, climate change mitigation, apart from creating new employment opportunities in a sustainable way
22	2018	National Digital Communications Policy 2018	The vision is to fulfil the ICT needs of citizens and enterprises through the establishment of a ubiquitous, resilient, secure, accessible, and affordable digital communications infrastructure and services; and in the process, support India's transition to a digitally empowered economy and society
23	2019	National Innovation and Start-up Policy 2019 for Students and Faculty	Aim is to enable the institutes to actively engage students, faculties, and staff in innovation and entrepreneurship-related activities
24	2019	Scientific Social Responsibility Policy (SSR) SERB	Main objective is to harness the voluntary potential that is latent in the country's scientific community to strengthen science and society linkages as to make S&T ecosystem vibrant
25	2019	Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS)	Aims to provide financial incentive of 25% on capital expenditure for the identified list of electronic goods, i.e., electronic components, semiconductor/display fabrication units, Assembly, Testing, Marking, and Packaging (ATMP) units, specialized subassemblies, and capital goods to manufacture them
26	2019	National Policy on Electronics 2019	Envisages to position India as a global hub for Electronics System Design and Manufacturing (ESDM) with thrust driving capabilities for developing core components, including chipsets, and creating an enabling environment for the industry to compete globally
27	2019	Production Linked Incentive (PLI) Scheme for Large Scale Electronics Manufacturing	Offers PLI to boost domestic manufacturing and attract large investments in mobile phone manufacturing and electronic components, including ATMP units

SN	Year	Name of the Scheme/Policy	Description
28	2019	Entrepreneurial and Managerial Development of SMEs through Incubators	To promote emerging technological- and knowledge-based innovative ventures. Supporting untapped creativity of individual innovators and also to assist individual innovators to become technology-based entrepreneurs. Promoting networking with other constituents of the innovation chain for commercialization of innovation
29	2020	Science, Technology, and Innovation Policy (STIP), Dec 2020	To bring changes to mission mode projects by building a nurtured ecosystem that promotes research and innovation on the part of both individuals and organizations
30	2020	National Education Policy 2020	Promotes an education system rooted in Indian ethos that contributes directly to transforming India, sustainably into an equitable and vibrant knowledge society, by providing high-quality education to all, and making India a global knowledge superpower
31	2020	Modified Electronics Manufacturing Clusters (EMC 2.0) Scheme	To offset the disabilities faced by industries for quality infrastructure and to develop a robust electronics manufacturing ecosystem in the country. It provides financial assistance for setting up of both EMC projects and Common Facility Centers (CFCs) across the country
32	2020	PM Formalisation of Micro food processing Enterprises (PMFME) Scheme. **Note**: Later converged with Deendayal Antayodaya Yojana	To augment the existing individual microenterprises in the unorganized segment of the food processing industry and formalize 200,000 microfood processing enterprises with special focus on supporting groups, such as Farmer Producer Organizations (FPOs) and Self-Help Groups (SHGs), engaged in agrifood processing sector
33	2021	PLI Scheme for IT Hardware	Offers a PLI to boost domestic manufacturing and attract large investments in the value chain, primarily electronics manufacturing sector
34	2021	SAMRIDH scheme	To support existing and upcoming accelerators to select and accelerate potential product based start-ups to scale. The program will focus on providing customer connect, investor connect, and internationalization connect services
35	2021	Production Linked Incentive Scheme for White Goods (PLIWG)	Financial incentive to boost domestic manufacturing and attract large investments in the white goods manufacturing value chain
36	2021	Production Linked Incentive Scheme for Food Processing Industry (PLISFPI)	To support food manufacturing entities for expansion of processing capacity and branding abroad for creating strong Indian brands and support creation of global food manufacturing champions
37	2022	Innovation Policy for Indian Railway	It lays down a broad framework for engagement of Ministry of Railways with innovators for development of technology, products, and need-based solutions for Indian railways
38	2022	National Policy for Micro, Small and Medium Enterprises (MSME) in India (Draft)	To stimulate efficiency and productivity of MSME sector to generate income, employment, and become part of domestic and global value chains taking into account structural transformation, competitive edge, demographic dividend, and regional balance
39	2022	National Logistics Policy 2022	To develop a technologically enabled, integrated, cost-efficient, and sustainable logistics ecosystem in the country for accelerated and inclusive growth

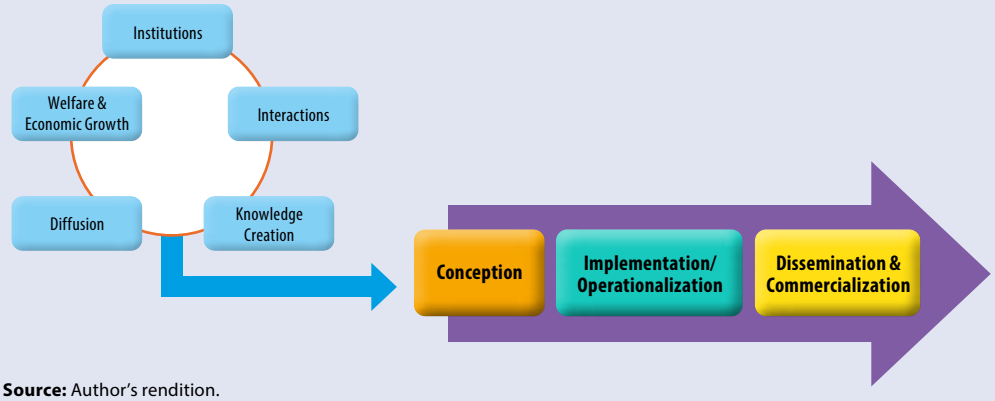
Source: Author's compilation.

Focus on Full Entrepreneurial Cycle, Interaction, and Impact

Scholars and policymakers are unanimous that NIS must focus on managing entrepreneurial activities in addition to basic research and educational activities to propel innovation that brings economic growth and prosperity [13]. Managing entrepreneurial activities in the context of NIS mean contributing to each of the major parts of the entrepreneurial cycle (Figure 4.7). To effectively achieve this, NIS must facilitate entrepreneurs in all the major three stages of their journey, i.e., conceptualization of their idea, converting the idea to an economically viable product or service, and facilitating market access for successful commercialization.

FIGURE 4.7

INNOVATION AND ENTREPRENEURSHIP CYCLE



Source: Author's rendition.

With the inclusion of grassroots level entrepreneurship-oriented stakeholders in NIS architecture and proactive policies for market-oriented innovation, the current NIS is better prepared to bridge the gap between basic research and commercialization. Having presence across domains in the full entrepreneurial cycle, India's NIS has been proactive in strengthening the nature of the interaction between stakeholders with better:

- Interactions among primary knowledge creators (public and private R&D institutes, educational organizations, foreign collaborators)
- Interaction between primary knowledge creators and knowledge diffusers and users (businesses and entrepreneurs)
- Interaction between entrepreneurs, start-ups, and innovation intermediaries (TBIs, incubators, skill partners)
- Interaction between innovation facilitators (financial institutions, IP agencies, angel networks, venture capitals, other business experts), and entrepreneurs

The transformation of NIS in the last 10 years to the present stage has seen evolution in both tangible and intangible aspects. Tangible evolutions, such as the addition of organizations and institutes, presence in all phases of the innovation cycle, and creation of facilitative innovation infrastructure have changed the overall architecture of India's NIS. Intangible evolution, such as policy initiatives, enhancing the scope and quality of interactions among stakeholders, and creating competency for managing the entrepreneurial cycle, has the potential to create a vibrant innovation-oriented entrepreneurial ecosystem.

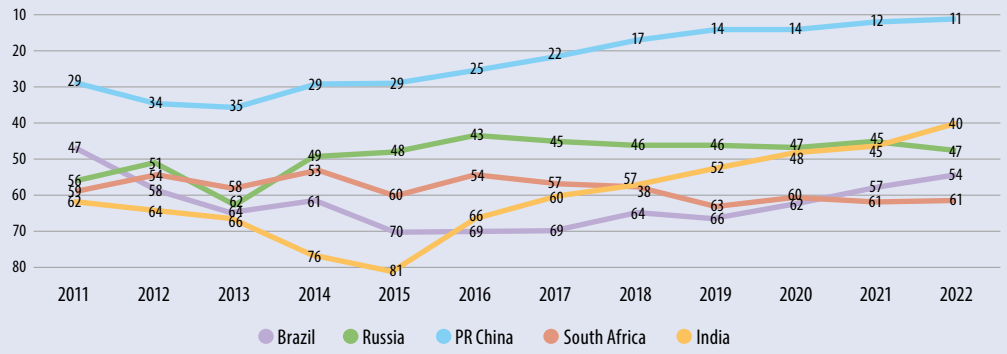
Analysis of Innovation Performance

The global innovation index (GII[7]), a well-known index, measures the innovation capabilities of countries and ranks the performance of economies based on 81 indicators. Overall measurement and evaluation are done across two broad categories, namely innovation inputs (input for knowledge production) and innovation outputs (knowledge outputs). Seven subcategories exist, five related to inputs and two pertaining to innovation outputs. Output pillars include knowledge & technology and creative. This study utilizes GII data owing to its breadth and longitudinal coverage for over a decade in the recent past.

Over the past decade, India's performance in GII parameters has been encouraging. The country has improved its overall GII rank from 62 in 2011 to 40 in 2022. It has consistently improved its rank and overall scores from 2011 to 2022. India's progress in the overall GII rank in comparison to important middle economies, such as BRICS countries (Brazil, Russia, India, PR China and South Africa), shows that India's relative performance post-2014 has shown significant improvements (Figure 4.8). India was ranked the lowest among BRICS countries in 2015 but improved its position to become number two in 2022. Though India has a long way ahead to rival PR China, India's GII ranking has been the highest in the last decade among BRICS countries. Part of this improvement can be attributed to changing metrics within the GII and partly due to vastly improving scores within many subcategories.

FIGURE 4.8

GII PERFORMANCE OF BRICS NATIONS IN 2011–22



Source: Author's rendition based on GII data.

Innovation Input Indicators (Input for Knowledge Production)

Within the GII framework, inputs to innovation are measured on five pillars. They are institutions, human capital and research, infrastructure, market sophistication, and business sophistication. Each of the pillars has various subpillars. Table 4.5 presents a snapshot of India's best and worst performing innovation input indices across five pillars and various subpillars.

7 GII began in 2007 at INSEAD and by 2011, World Intellectual Property Organization (WIPO) started copublishing the report.

TABLE 4.5

BEST AND WORST PERFORMING INNOVATION INPUTS FOR INDIA: CHANGES BETWEEN 2011–22

Subpillars	Pillars	Simple % Change in Decadal Scores (2011–22)
Best Performing Innovation Input Indices		
ICTs	Infrastructure	339.26
Tertiary education	Human capital and research	250.53
Trade, diversification, and market scale	Market sophistication	86.33
Infrastructure (composite)	Infrastructure	46.93
Political environment	Institutions	41.94
Worst Performing Innovation Input Indices		
Ecological sustainability	Infrastructure	-9.73
Innovation linkages	Business sophistication	-17.53
Investment	Market sophistication	-21.93
General infrastructure	Infrastructure	-29.81
Credit	Market sophistication	-30.89

Source: GII.

India vastly improved its perception of institutional quality from 2011 onwards. From a low ranking of 94 in 2011, India stands at 54 worldwide among surveyed countries in terms of institutional quality. Predominantly, this improvement was led by good ranking gains in political, and business environment perception. However, the regulatory environment and its perception (the ability of the government to formulate policies and regulations that permit and promote private sector development, contract enforcement, and redundancy pay) has seen only marginal improvement from 71 to 67.

Remarkably, India's rank in human capital and research inputs improved drastically by 61 points. Most of this gain was driven by a 250% rise in scores for tertiary education, whose rank saw an improvement of 59 points. Enrollment in tertiary education and the share of STEM (Science, Technology, Engineering, and Management) among tertiary graduates were rising consistently. However, R&D ranks and scores growth was only marginal due to low gross expenditure on R&D. For instance, India's spending on R&D in 2017 was only 0.7% of GDP, compared to Japan at 3.2%, the USA at 2.8% and PR China at 2.1% [22]. Moreover, India's manpower in R&D jobs stands at 340,000 (as of 2018) of whom two-thirds are employed in higher education and government-run scientific agencies while the remainder in private and public enterprises. Most of the full-time R&D personnel concentrated on engineering technology. The overall manpower employed in R&D as well as the skewness in favor of government R&D employment, is contrary from the patterns observed in developed knowledge economies.

As depicted in Table 4.6, the bulk of gross spending on R&D is shouldered by India's central government, followed by the private sector. The central government spending centers on R&D in defense and space exploration while the private sector spending are primarily in areas of health and industrial production.

TABLE 4.6

R&D EXPENDITURE IN INDIA BY CATEGORY OF SPENDER

Agency	Central Government			State Government			Private Sector			Public Sector		
Years	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18
R&D spending values[8]	42,433.33	45,513.21	51,666.83	6,447.94	6,866.95	7,264.82	35,683.97	38,769.63	41,483.03	4,453.85	4,706.22	5,253.21
% of total R&D (within year)	0.48	0.47	0.49	0.07	0.07	0.07	0.40	0.40	0.39	0.05	0.05	0.05

Source: S&T Report 2020, DST, Government of India.

Infrastructure Inputs

India's performance on the infrastructure inputs has not been encouraging between 2011 and 2022. In terms of general infrastructure scores, i.e., electricity production per capita, logistics performance, and fixed capital formation, India has consistently recorded declining scores with a 29% drop. A similar trend is observed concerning in ecological sustainability, which comprises ISO environmental certification, environmental performance, and energy intensity of GDP. The ecology scores fell by 9% in the last 11 years. However, India's scores trebled for ICT infrastructure, which accounts for ICT access and use by the public and the use of ICT for government service provision. This growth in ICT infrastructure contributed to the composite infrastructure score, but it did not prevent India's overall infrastructure rank to decline by 15 points in the last decade.

Market Sophistication

The pillar of market sophistication relates to credit availability, investment, and measures of trade, diversification, and scale of domestic markets. In terms of credit being made available to start-ups and scale-ups, India's score showed growth until 2021. However, a change in methodology in 2022 led to a score reduction by 40% from the 2021 level[9]. As a result, India's rank in credit availability also reduced significantly by 12 positions, but its decadal position remained relatively stable. The investment scores based on the value of market capitalization of listed stocks, venture capital investment value, and the number of deals fell by 21% over the decade.

However, in terms of trade tariffs, India has been scoring better owing to rationalized tariff rates. Domestic industry diversification scores stood at an all-time high of 97.7 in 2022. India being the third largest economy in purchasing power parity (PPP) terms, scored a full 100 points on the scale of the domestic market measure. Resultantly, the trade, diversification and market scale score registered a rise of 86%, lifting India's overall market sophistication rank. The decadal rank of market sophistication jumped 26 points within the GII subcategory rank, despite falling credit availability and investment valuation scores.

8 Values in Table 4.6 are in crores of Indian rupees (INR) (1 crore = 10 million).

9 Metric for credit availability changed from the World Bank's Ease of Doing Business based on ease of getting credit, measured on expert's perception of credit availability via the global entrepreneurship monitor (GEM) project.

Business Sophistication

Business sophistication scores showed no marked improvement in the decade since 2011. The business sophistication pillar comprises scores from knowledge workers, innovation linkages, and knowledge absorption metrics. In terms of inputs to create knowledge workers, the score is compiled based on employment in knowledge-intensive sectors, gross expenditure in R&D, and female employment with advanced degrees. Herein the scores grew a paltry 1.9% in a decade. Innovation linkages that measure university-industry linkage, industrial cluster development, and foreign financing of R&D expenditure showed a declining score of 17%.

The knowledge absorption score is based on payments made to foreign intellectual property, ICT, and high-tech imports. This score grew by 18% in the most recent decade. Despite varying scores in its subcomponent, the overall score on business sophistication was stagnant. However, India's rank improved by 30 positions, indicating better relative performance among countries compared to what the raw scores would suggest.

Innovation Output Indicators (Knowledge Commercialization Indicators)

Innovation output comprises two broad pillars: knowledge and technology outputs, and creative outputs. Table 4.7 presents a snapshot of the best and worst performing innovation output indices across the two pillars and six subpillars.

TABLE 4.7

BEST AND WORST PERFORMING INNOVATION OUTPUTS FOR INDIA: CHANGES BETWEEN 2011–22

Subpillars	Pillars	Simple % Change in Decadal Scores (2011–22)
Best Performing Knowledge Output		
Knowledge creation	Knowledge and technology outputs	95.19
Knowledge impact	Knowledge and technology outputs	25.62
Knowledge diffusion	Knowledge and technology outputs	27.07
Worst Performing Knowledge Output		
Online creativity	Creative outputs	-60.95
Creative goods and services	Creative outputs	-41.89
Intangible assets	Creative outputs	-25.49

Source: GII.

The knowledge and technology outputs pillar has subpillars of knowledge creation, knowledge impact, and knowledge diffusion. India's knowledge creation score, which is measured in terms of patents filed (directly or through patent cooperation treaties, within domestic and foreign countries), scientific papers published, utility models, and citable documents H-index has almost doubled between 2011 and 2022. Knowledge impact measures labor productivity in terms of GDP per worker employed in the economy, along with software spending, new limited liability business registrations, ISO quality certifications, and the share of high-tech manufacturing as a share of total manufacturing output. India's composite score for knowledge impact grew by 25% in the last decade. Similarly, India has performed well in terms of knowledge diffusion, which accounts for high-tech exports, ICT service exports, and a generally rising product complexity and diversity in the export basket. India's knowledge diffusion scores grew by 27% in the last decade.

Commensurate with growth in all three aspects, primarily driven by advances in the knowledge creation subcategory, India's knowledge and technology output score improved by a significant 38%. This resulted in India's knowledge and technology output getting a rank of 34 in 2022, a gain of 26 positions as compared to 2011.

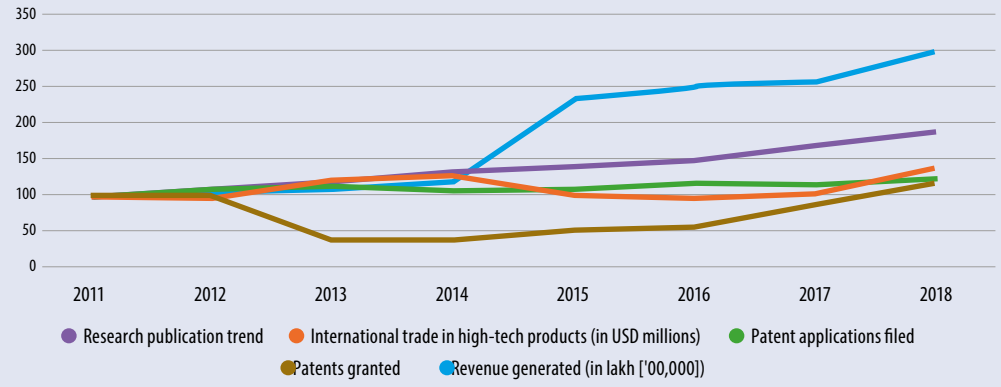
However, India did not perform well in other major pillar of innovation output, namely, creative outputs. Creative outputs, which measure intangible assets (such as trademarks, industrial designs, and the country's share of the world's top 5000 brands), creative goods and services (such as films, cultural, and entertainment services), and online creativity saw a significant drop in individual scores as well as in the aggregate score. As a result, the overall rank in the knowledge output pillar slipped by 14 positions to 52 between 2011 and 2022.

To summarize, when the overall dynamics of innovation performance are considered, India's performance in innovation outputs has outperformed the innovation inputs category. On the input front, India's political environment, widening ICT infrastructure, and achievement in tertiary education have been noteworthy. However, India's business and regulatory environment, and weak linkages between universities and industry to foster innovation have been major concerns. Indicators related to both these aspects have seen a decline in GII scores and ranks. It also indicates that India needs to improve capital availability for R&D and focus more on cluster-based economic development to attain better innovation performance.

Compared to India's innovation inputs, its performance in outputs has been stronger, primarily attributed to knowledge and technology outputs. Even though India's knowledge and technology output derive its strength from the knowledge creation aspect, there are still many areas of concern. Mapping the decadal movement of some select indicators of innovation output, compiled from India's official R&D data, highlights the areas of improvement in Figure 4.9.

FIGURE 4.9

SELECT KNOWLEDGE OUTPUTS TIME TREND (INDEX 2011=100)



Source: Author's rendition based on GII data.

As one may observe, from 2011 onwards, there has been steady growth in research publications, but patent applications and consequent grants fell in the interim, only to rebound by 2018 to match 2011 levels. This shows an undesirable gap between academic research and application-oriented outcomes, which reflects on India's GII performance. A closer look at India's innovation output performance shows that despite India's good performance in research publications, they have not translated into commercialization and diffusion in terms of patents, designs, and other intellectual property rights

(IPRs). This shows there is a lot of room to grow even in the knowledge creation aspect, which makes India's innovation output performance noteworthy. Encouragingly, there are positive indicators, as shown by the almost threefold increase in revenue generated from patents. This indicates that India's innovation ecosystem has the potential for the profitable commercialization of application-oriented research and its resulting outputs.

INTERVENTIONS FOR A ROBUST NIS AND ENHANCING PRODUCTIVITY

The 2022 GII report shows an excellent positive correlation between innovation and economic development. The relationship indicates that countries with high innovation quotient in terms of GII score are able to command economic prosperity when measured in GDP per capita (PPP) terms. Economically developed countries with high GDP are highly productive. Innovation, as a key driver of productivity, leads to the development of new and improved products, processes, and services, which increases efficiency, reduces costs, and enhances the competitiveness of firms and industries. Therefore, economic prosperity has its roots in higher productivity, which in turn depends on a nation's progress in innovations and their applications. NIS plays a critical role in fostering innovation and ensuring such innovations result in higher productivity leading to economic prosperity.

Though India has performed better in innovation among low middle-income economies, given its potential and the vast scale of its population, India has a long way to go. The primary reason for India's overall productivity growth in the recent decade has been capital deepening, followed by growth in TFP. Though India's progress in innovation has resulted in a positive trend in TFP growth, there is a pressing need for India to elevate innovation as the primary engine of economic growth, as charted by many other developed economies. India's success in fostering widespread innovations and linking them to economic growth needs working on many levers, as evident from its mixed performance in GII indicators. That means India needs an even stronger and more robust NIS to graduate from a low middle-income economy to an upper middle-income economy.

Areas of Improvement for India's NIS

There are three pivotal dimensions to the success of a NIS in nurturing developmental innovations: (i) robustness of institutions and availability of supporting infrastructure; (ii) supportive policy environment and incentive structure; and (iii) participative stakeholders and value-added engagements. Though India's NIS has progressed in these three dimensions across different eras, a deeper analysis of its impact and India's innovation performance shows some areas of concern. These concerns are across the three dimensions, as depicted in Figure 4.10.

Institutional Infrastructure

A resilient NIS begins with a robust primary education infrastructure. India still lacks this infrastructure across the country despite the presence of private players in large- and medium-sized cities. Even where primary and secondary education infrastructure is available, the student-teacher ratio is less than ideal. This situation has adversely affected India's human capital and reflects in India's GII performance.

While India has established institutes of national importance, such as IITs and AIIMs across the country, basic research institutes are still geographically concentrated, resulting in unequal geographical dispersion affecting grassroots entrepreneurship. More importantly, India does poorly in the per capita number of researchers. In essence, India's performance in creating and sustaining primary and secondary education infrastructure and the availability of appropriate human capital for higher-level R&D is a major concern. Some other associated problems along this dimension are:

i) Skewed availability of technology infrastructure, especially in rural and remote areas, despite mobile penetration.

ii) Suboptimal institutional presence coupled with a lack of focus in strategic and emergent areas of innovations, such as energy, environment, sustainability, and digital media & influence management.

iii) Lack of institutional presence and support for interdisciplinary and futuristic R&D coupled with rare interinstitutional infrastructure and manpower sharing.

iv) Inadequate private infrastructure for research and innovation, which are largely available only for targeted R&D within private business organizations.

v) Negligible availability of institutional credit and investment beyond governmental grants.

Policy and Incentives

While the last 10 years have seen a plethora of new policy initiatives, the implementation mechanism and funding of policy initiatives are still major areas of concern. A cursory look at the list of policies in the last decade shows multiple policies for similar goals. Diverse policy ownerships across departments/ministries remain a peculiar character of the government's policy initiatives. Unless resolved, these issues may give rise to policy cannibalization or overlaps, policy fragmentation, and uncoordinated implementation leading to suboptimal performance of India's NIS. These policy complexities may further exacerbate process inefficiencies, such as lengthy and complex bureaucratic processes in identifying, approving, and funding innovation activities. India also needs a strong IP framework that protects innovations and encourages commercialization of new technologies. Some of the other concern areas relevant to this dimension are:

i) Limited funding for R&D in new institutes and lack of government funding for nonpriority yet futuristic areas. A prevalence of highly commercial-oriented venture capitalists (VCs) and angel funds results in low private funding for basic research.

ii) Insufficient institutional incentives and facilities to attract and retain highly skilled talent, especially in public institutions.

iii) Inadequate entrepreneurial ecosystem at the grassroots level, despite support for entrepreneurship in the last few years. India continues to lack a strong support policy for entrepreneurs in various areas, such as IP process management, facilitating market access, ensuring institutional support for R&D, regulatory & legal support systems, and safety-net provision.

Stakeholder Engagement and Interaction

This is the most important dimension that affects a country's innovation culture and innovation output. If institutional infrastructure is the hardware of a NIS, then interaction among stakeholders is the software of a NIS. Traditionally, various stakeholders in India's innovation system have worked in their silos, leading to lost opportunities. Fortunately, these silos are gradually breaking down, particularly in the past decade, post-economic liberalization, with the integration of grassroots innovators and innovation intermediaries into NIS. Nevertheless, the situation is far from ideal. NIS in a large country cannot perform efficiently without being inclusive to varied stakeholders, starting from curious school children to private venture capitalists. Performing better in GII indices, such as market sophistication and business sophistication, largely depends on stakeholders' quality, complementarity, and synergy. India's NIS grapples with ensuring these three aspects. Apart from these, the other important concerns are:

i) Lack of coordination and collaboration between different stakeholders within the innovation system, especially the interaction between the four primary stakeholders of NIS, consisting of knowledge creators, knowledge diffusors, innovation intermediaries, and innovation facilitators.

ii) Challenges in promoting diversity and inclusion within the innovation system, particularly in removing language and pedigree biases.

iii) Limited access to knowledge, technology, and IP for local and grassroots innovators. This is further exacerbated by weak linkages between academia, industry, and the public sector, particularly at the regional level. Lack of common coordination platform leading to weak or no stakeholder coordination.

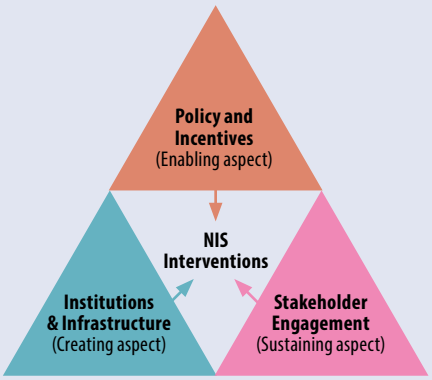
iv) Inadequate support for the integration of SMEs within NIS.

v) Limited access to global markets and international networks for new and emerging innovators and entrepreneurs.

Distinctly, these concerns are interrelated and require system-wide solutions. Relying solely on policy interventions or creating more institutional infrastructure will be a suboptimal solution. Therefore, any suggestion to improve India's NIS needs consideration of all three dimensions - appropriate policy, institutional and human infrastructure, and value-added interactions - across stakeholders (Figure 4.10).

FIGURE 4.10

THREE DIMENSIONS OF NIS INTERVENTION



Source: Author's rendition.

Proposed are 12 action areas across these dimensions to alleviate the prevailing concerns and make India's innovation system even better:

1. Invest in quality primary and secondary education with a focus on nonurban areas. Inculcating innovation awareness at a young age.

2. Strengthen the tertiary education system with a three-pronged approach: (i) incentivizing STEM for higher education; (ii) connecting education institutes with network of public R&D institutes and businesses; and (iii) focusing on skill development programs for other tertiary education modes.

3. Simplify the research funding process and encouraging private funding for research with appropriate incentive systems, such as access to infrastructure and IP sharing.

4. Reorient universities for fundamental and applied research. Most Indian universities lack a strong research orientation, which affects their global standing and R&D output. Select universities should be reoriented toward research, reducing the long-term cost of R&D while expanding geographical access to research-based education and entrepreneurial innovations.

5. Implement stringent evaluation criteria for leadership selection in public R&D and higher education institutes of national importance. A nonresearch oriented leadership may adversely impact the culture and system of education institutes.

6. Rationalize and consolidate various policies impacting NIS. This will reduce policy fragmentation and cannibalization, and facilitate better implementation.

7. Identify priority areas for innovation and focus on the strategic development of technology in high-impact and future-critical areas, such as energy, environment, and artificial intelligence (AI). Implementing regulations and policies that support resource allocation and resource efficiency in priority areas of research.

8. Provide targeted support for industries and sectors with promising potential for productivity growth. Implement policies that support the adoption of new technologies and processes to enhance productivity.

9. Link market access to long-term R&D investment for large foreign players. Prioritize local innovations for nonlocal players and linking them to market access.

10. Encourage the development of the entrepreneurial ecosystem at the local level by facilitating both formal and informal channels of engagement among the four stakeholder groups of NIS.

11. Create local platforms for stakeholder engagements to help, nurture, and mentor entrepreneurs. Focus on providing information, intelligence, interaction, and inclusiveness to use the platform effectively in enhancing entrepreneurial innovation.

12. Intervene consciously to enhance innovation input parameters in states or regions that are facing regional imbalance. This will gradually help alleviate income inequality among regions.

India needs to work on all three dimensions mentioned above to create a well-educated and skilled workforce, robust R&D infrastructure, a facilitative investment mechanism, and a supportive business environment that encourages entrepreneurship and innovation. To be able to support a culture of innovation, there must be active collaboration between the government, academia, and the private sector. As a large and rapidly growing economy, India has the potential to become a leader in global innovation. But whether India is positioned to take a leadership role in global innovation hinges on its performance across these dimensions, which largely depends on how India's NIS evolves further.

CONCLUSION

For India to take leadership role in global innovation, a robust, functional and adaptive NIS is imperative. India's NIS has evolved through a long period of divergent policy outlooks, resource constraints, social challenges, and even foreign restrictions. In spite of these challenges, India has made commendable strides, emerging as the sixth largest economy with the highest growth rate and securing the 40th position among innovative countries in 2022. However, the path ahead is formidable. India's trajectory demands an enhanced NIS to increase productivity even further and extend economic prosperity to its large population. Without further evolution and adaptation of the NIS, breaking into the upper-middle-income economy will not be possible.

APPENDIX

Note on APO methodology for Productivity and Output Estimates for India

The economic growth estimates are based on the growth accounting framework, in which, growth is decomposed into the contributions of capital and labor inputs and TFP. The approach is based on a Cobb-Douglas type production function, and consequently, based on balancing the input and output of production. The underpining principles adhere to the OECD Manual for Productivity estimates. A brief outline of the measures and methods employed is as follows:

1. **Growth accounting equation** - $\frac{\Delta Y}{Y} = \frac{\Delta T}{T} + \alpha \frac{\Delta K}{K} + (1-\alpha) \frac{\Delta L}{L}$ where Y is Output, K is capital stock, and L is labor input, α is share of capital remuneration to total value. T is total factor (multifactor productivity.

2. **Output estimates (Y)** - The measure for output is GDP at basic prices in constant PPP terms (gross value at market prices minus indirect taxes). India adopted the SNA-2008[10] standard in 2010 and has back-estimates for GDP from 2004 to 2019 based on this standard. Other year GDP series estimates are based on SNA-63 (1950 to 2007) and SNA-93 (1999 to 2014).

3. **Capital Input (K)** - This comprises Gross Fixed Capital Formation (includes 16 types of fixed assets broadly between buildings, machinery and IP), Fixed Asset Stocks, Inventory stock (limited to 8% of GDP from official national estimates), and disaster damages to capital stock (based on EM-DAT[11]), stock-output ratio, land stock (based on estimates by KEO[12] 2016), and capital services.

4. **Labor Input (L)** - Three distinct measures of labor input exist, labor in terms of the number of persons employed, number of filled jobs, and hours worked. Labor data in the APO productivity database is sourced from three broad labor force surveys, i.e., Census of India, the Employment and Unemployment Survey, and the National Sample Survey of India. Further, quality-adjusted labor input (QALI) is estimated by differentiating workers by types and weighed by respective marginal productivity in their jobs. The Asia QALI database has data on hours worked, labor qualities and QALI itself [23].

10 SNA- United Nations' System of National Accounts.

11 EM-DAT: Emergencies Database, Centre for Research on Epidemiology of Disasters, University Catholique Louvain.

12 Keio Economic Observatory (KEO) Estimates.

5. **Labor-Productivity** - The APO estimates two broad measures of labor productivity, each adhering to the principle of output over inputs as a measure of efficiency.

   - $Labour\ Productivity = \frac{Quantity\ index\ of\ gross\ output}{Quantity\ index\ of\ labor\ output}$, here which measure accounts for the quantity index of labor input will determine, if labor productivity measure is calculated in per worker terms or in hours worked terms

6. **Total factor productivity** - $TFP = \frac{Quantity\ index\ of\ gross\ output}{Quantity\ index\ of\ combined\ K,L\ output}$. TFP measures disembodied technical change when the K and L measures are detailed and are adjusted for quality changes and efficiency, as is the case with APO measures.

CHAPTER 5

INDONESIA

INTRODUCTION TO NATIONAL ECONOMY

Indonesia's economy was expected to have a promising growth in 2022 (Table 5.1). In fact, the Indonesian economy grew impressively by 5.44% year-on-year (YoY) increase in quarter 2 of 2022. Further, on a quarterly basis, the national economy expanded by 3.73% (quarter on quarter or QoQ) (Figure 5.1). Remarkably, the constant price GDP was much higher than pre-COVID-10 pandemic levels, reaching IDR2,924 trillion. This achievement underscores the positive ongoing trend and strengthening trajectory of Indonesia's economic recovery. Solid macroeconomic fundamentals were the key to driving the expansion of economic activity. The controlled inflation rate and the sustainability of the government's strategic programs were the main factors supporting consumption and investment activities in Indonesia, even though export performance contracted by 0.5% in real terms [1].

TABLE 5.1

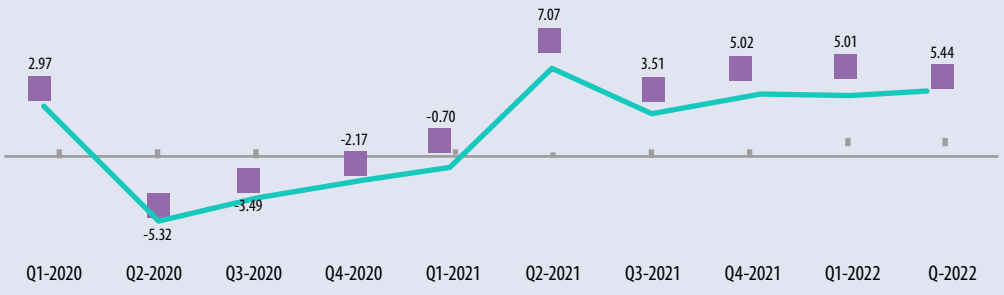
INDONESIA'S GROWTH PROJECTION BY INTERNATIONAL AGENCIES

	2022	2023
IMF (WEO OKT)	5.3	5.0
WORLD BANK (EAP OKT)	5.1	5.1
ADB (ADO UPDATE SEPT)	5.4	5.0
BLOOMBERG CONSENSUS (OKT)	5.2	5.0

Source: IMF (International Monetary Fund), World Bank, ADB, and Bloomberg (2022).

FIGURE 5.1

INDONESIA'S ECONOMIC GROWTH QUARTER IN 2020–22



Source: Bank Indonesia (2022).

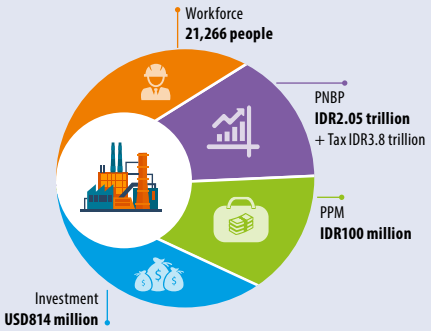
Indonesia has experienced trade balance surplus, attributed to high non-oil and gas surpluses, heightened non-oil and gas exports, and increased commodity exports, especially coal and crude palm oil (CPO). The positive performance of exports was influenced by the strengthening of both non-oil and gas and oil and gas exports, such as palm oil, coal, and natural gas commodities. The positive performance of imports is influenced by the growth of oil, gas, and industrial needs, including raw materials and capital goods.

High inflationary pressures have driven the tightening of monetary policies across many countries, resulting in elevated interest rates and potential hikes in fund costs, consequently affecting global liquidity. The Indonesian central bank, Bank Indonesia (BI), raised the BI 7-Day Reverse Repo Rate (BI7DRR) by 50 basis-point elevation to 5.25%, the Deposit Facility rate by 50 basis point to 4.50%, and the Lending Facility rate by 50 basis points to 6%. The decision to increase interest rates is a front-loaded, preemptive, and forward-looking step to reduce inflation expectations which are currently still high and ensure that core inflation will return to the target of 3.0 ± 1% [2].

Indonesia is profoundly serious about downstream policies. One of the downstream policies for the mineral and coal industry is to encourage the domestic industry, increase employment, and increase state revenues. Law number 3 of the year 2020, pertaining to minerals and coal, explains the obligation of mining entrepreneurs to process and refine metal mining commodities within the country.

FIGURE 5.2

IMPACT OF MINERAL AND COAL (NICKEL) DOWNSTREAM POLICIES



Source: Ministry of Energy and Mineral Resources[1] (2022).

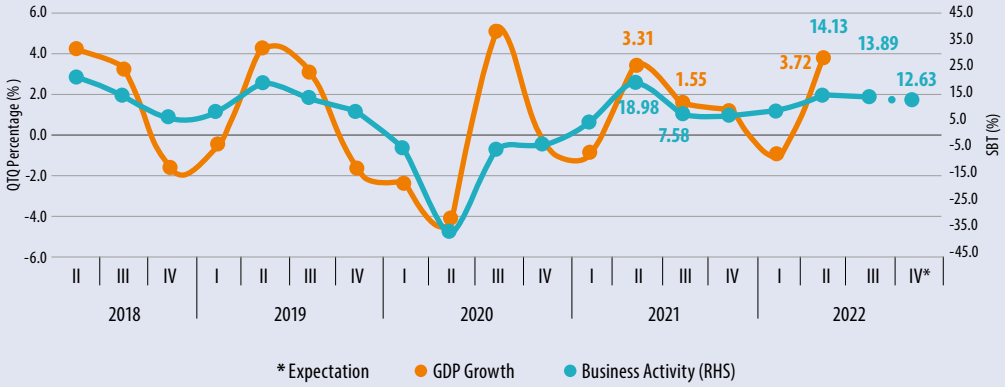
Figure 5.2 shows a consistent yearly expansion of the nickel smelter industry, leading to a concurrent rise in the workforce. This growth also correlates with a 13% rise in the proportion of foreign workers. The financial landscape that encompasses both tax and nontax components demonstrated a notable progression. In 2019, revenue from nickel royalties and associated products soared to IDR2.05 trillion, marking a fourfold increase compared to 2015 while tax revenues reached IDR3.8 trillion. Community development and empowerment programs witnessed significant outcomes in 2019, contributing IDR100 billion to the overall output. On the investment front, foreign capital investment into the nickel smelter base metal industry amounted to USD814 million in 2019.

[1] Ministry of Finance at the webinar "The Indonesia Summit 2023 Rebuild the Economy", Jakarta, 27 October 2022.

The policy of using domestic products plays a crucial role in the recovery of the real sector, aligning seamlessly with the mandate of Indonesian President Joko Widodo[2]. All stakeholders, especially the government, effectively contribute in fostering the development of domestic products. Ministries, agencies, and local governments are expected to lend their support to these endeavors. In 2023, the National Budget *(APBN or Anggaran Pendapatan dan Belanja Negara)* is expected to exceed IDR3,000 trillion. Within this framework, the government has identified IDR750 trillion which must be spent on domestic products. While this domestic spending has the potential to generate short-term economic growth, the medium-term source of Indonesia's new economic growth will be the economic transition toward a green economy, which will unlock new opportunities.

FIGURE 5.3

BUSINESS ACTIVITY SURVEY



Source: Bank Indonesia (2022).

Business Activity Survey

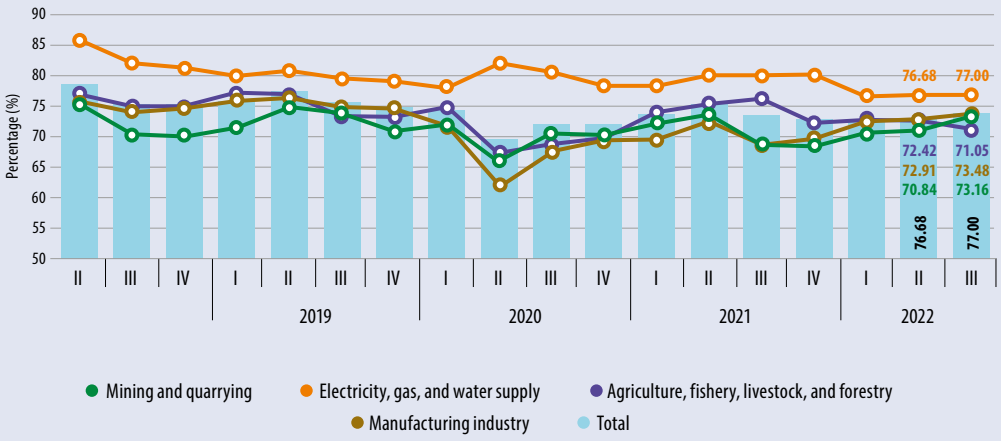
According to the latest survey by Bank Indonesia, business activity maintained its robust stance in the third quarter of 2022 with a weighted net balance of 13.89%. However, this figure is nevertheless slightly lower than 14.13%, recorded in the second quarter of the same year. This moderation is primarily attributed to factors within the agricultural, plantation, livestock, forestry, and fishing sector, specifically the food crop subsector, due to the onset of planting season. Further, trade, accommodation, food services activities, and transport and communication sector also contributed to this moderation [3].

The survey findings confirm that production capacity utilization in the third quarter of 2022 was at 73.67%, showing a slight increase from 73.22% in the preceding quarter. Respondents also reported escalated production capacity utilization in the mining and quarrying sector (73.16%), manufacturing industry (73.48%) as well as electricity, gas, and water supply (77%) in the second quarter of 2022. In contrast, production capacity utilization in the agricultural, plantation livestock, forestry, and fishing sectors experienced a decline to 71.05%, in the reporting period of prevailing business activities [3].

2 President Joko Widodo's speech at the opening of the Ministry of Trade meeting at Istana Presiden 2021.

FIGURE 5.4

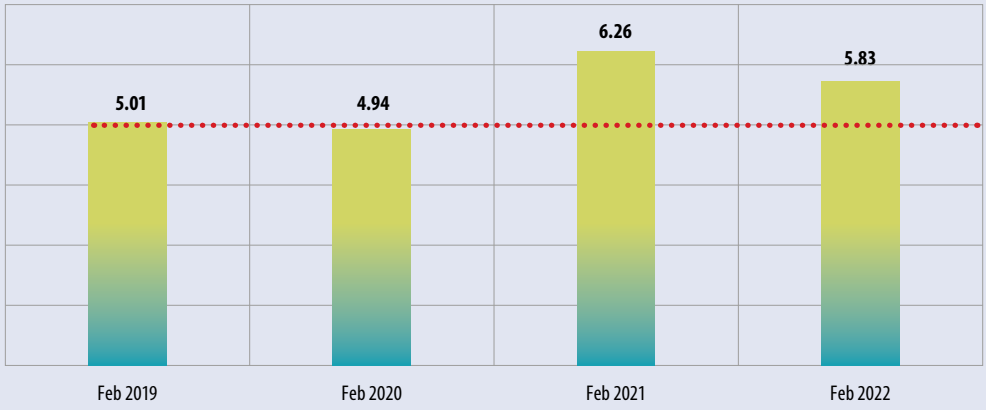
PRODUCTION CAPACITY



Source: Bank Indonesia (2022).

FIGURE 5.5

UNEMPLOYMENT RATE (%) IN 2019–22



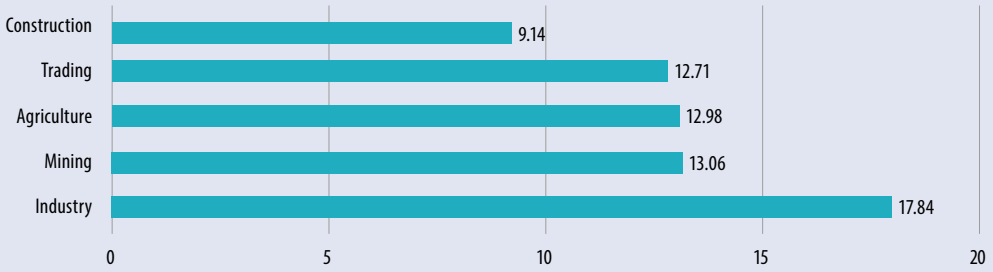
Source: Ministry of National Development Planning[3] (2022).

According to the provided data, it shows that the unemployment rate, despite a significant surge to 6.26% in 2021 due to the pandemic, experienced only a slight decrease to 5.83% by February 2022.

3 Ministry of Investment at the webinar "The Indonesia Summit 2023 Rebuild the Economy", Jakarta, 27 October 2022.

FIGURE 5.6

ECONOMIC GROWTH CONTRIBUTION BY SECTOR IN THE SECOND QUARTER 2022



Source: Central Bureau of Statistics (BPS) (2022).

Based on data from the Central Statistics Agency (BPS), the industrial sector's GDP at current prices reached IDR 877.8 trillion in the second quarter of 2022. Consequently, the industrial sector's contribution to the national GDP amounted to 17.84%, within the context of total national GDP of IDR 4.92 quadrillion for the same period. The industrial sector is also the largest source of economic growth in the second quarter of 2022, namely 0.82% of the annual growth of 5.44% (YoY). The contribution of the industrial sector to Gross Domestic Product (GDP) shows an increasing trend from year to year. Since 2010, the industrial sector has continued to make the largest contribution to national GDP, even when the peak of the pandemic occurred in 2020–21. In 2021, the industrial sector recorded a GDP of IDR 2,946.9 trillion, an increase from 2020 which reached IDR 2,760.43 trillion [4].

Indonesia's position in the world trade has improved. According to the Indonesian Ministry of Trade, Indonesia ranks 29th among exporting countries with a share of 0.96% of world exports in 2017. In 2021, Indonesia climbed one rung up to 28th ranking as an exporting country with a share of 1.04% to global exports. Similarly, in the imports sector, Indonesia was ranked 29th in 2017, accounting for the share of 0.88%. Meanwhile in 2021, Indonesia ranked 30th as an importing country with a share of 0.88%[4].

PRODUCTIVITY ANALYSIS

Output Growth, Contribution of Capital Input, Contribution of Labor Input, and TFP in Indonesia

Indonesia's output growth throughout the 1971–2019 period was primarily driven by the contribution of capital input. This is evident in the significant value of capital input's contribution to output growth, which is 4.18% (YoY). Conversely, the roles of labor input and total factor productivity (TFP) contributions in output growth were still low. Labor input contributed 2.19% while TFP registered a contribution of -0.72%. In fact, the Indonesian economic condition during that period was still heavily reliant on capital inputs, underscoring its pivotal role in economic expansion. The importance of capital in economic growth made the government focus more on efforts, such as attracting foreign direct investments, to bolster the economy.

4 Ministry of Trade at the webinar "The Indonesia Summit 2023 Rebuild the Economy", Jakarta, 27 October 2022.

TABLE 5.2

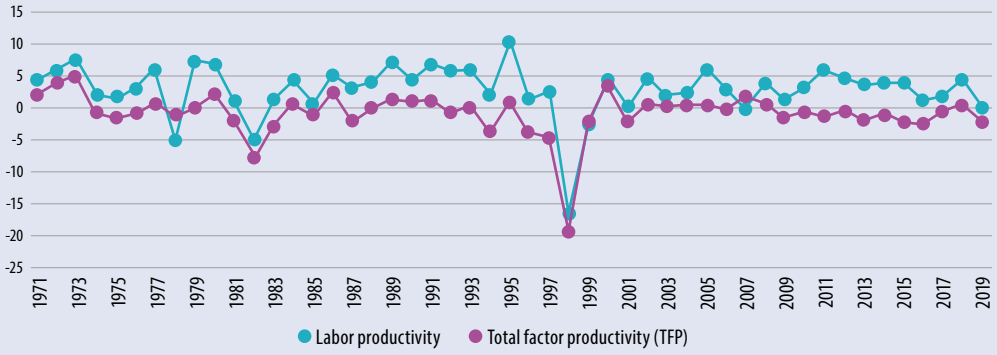
CONTRIBUTION OF CAPITAL INPUT, LABOR INPUT, TFP, AND OUTPUT GROWTH

	Annual Growth Rate (Percentage) (the average value of the five year period)			
Year Period	**Output Growth**	**Contribution of Capital Input**	**Contribution of Labor Input**	**Total Factor Productivity (TFP)**
1971–75	8.28	4.14	2.26	1.88
1976–80	7.78	5.50	1.97	0.30
1981–85	4.65	5.12	1.91	-2.38
1986–90	7.46	4.61	2.19	0.66
1991–95	7.51	4.80	3.00	-0.28
1996–2000	0.67	3.72	2.14	-5.19
2001–05	4.48	2.55	1.95	-0.02
2006–10	5.45	3.57	1.77	0.11
2011–15	5.29	4.17	2.45	-1.33
2016–19	4.77	3.55	2.25	-1.04
Mean	5.65	4.18	2.19	-0.72
Correlation		0.23281626	0.205172765	0.859254891

Source: Asian Productivity Organization (APO) (2022).

FIGURE 5.7

TRENDS OF LABOR PRODUCTIVITY AND TFP



Source: APO (2022).

Data on labor productivity and TFP reveals a declining trend from 1971 to 2019. There was a significant drop in 1977, which coincided with a national economic crisis triggered by a substantial foreign debt and was set to be paid in a very short period. This set the stage for economic instability in Indonesia, further exacerbated by overconfidence in the face of the crisis. Of particular concern was the prevalence of substantial short-term private foreign debt, comprising 85% of Indonesia's additional foreign debt. The banking sector's frailty, at the time was far below national standards and classified as very weak, amplified the economic turmoil that became a crisis - the issues of the private debts led to domestic problems.

The decline in TFP in 1982, reaching -7.55%, was caused by the foreign debt crisis in developing countries, including Indonesia. The surge in global oil prices during 1973–74 and 1979–80, coupled with high

interest rates from 1980 to 1982, along with falling export volumes and prices of commodity goods during the global recessions, compounded by problems in the management of the domestic economy, collectively contributed to this decline [5]. In 1982, the data showed a significant decrease in labor productivity and TFP at -5.03% and -7.55%, respectively.

The highest decline, however, occurred in 1998 due to the severe financial crisis that led to a sharp drop of TFP by -19.47% and labor productivity by -16.69%. This downturn decline was recorded as the steepest decline in Indonesia's economic history with a combined drop of -15.11% in TFP and -19.37% labor productivity from the previous year. The worst economic crisis in Indonesia occurred in 1997–98 which caused the TFP value to plummet by -19.47%. There was the weakness of the national financial system prior to the crisis. The deregulation of various sectors in the national economy during the 1980s while promoting the inflow of foreign capital reduced the government's ability to implement prudential regulations governing the financial industry [6].

The Trend of TFP Growth and Its Dynamics

The trend in TFP growth was relatively unstable during the 2000–14 period. This situation was triggered by several factors, including widespread corruption, unstable economic and political conditions in Indonesia post-political reforms, weak law enforcement, and poor investment climate. The impact of these factors was further magnified by the increase in international oil prices in 2000, subsequently leading to a decline in the national TFP growth. Additionally, the onset of the global financial crisis had affected the economic conditions across several countries, including Indonesia [7]. This condition contributed significantly to a decline in TFP, reducing from 2.06 in 2007 to 0.54 in 2008.

As the national political conditions became more stable, TFP showed a positive trend and reached 0.71 in 2018. While Indonesia's TFP was still low compared to neighboring countries, such as Malaysia and Thailand, this achievement represented a noteworthy improvement over the post-global financial crisis, in which, TFP was consistently below zero.

Impact of the National Innovation System (NIS)

The trajectory of both TFP growth and the contributions of labor and capital to national output growth are influenced by the dynamics of NIS. The subsequent section will discuss the framework of NIS in Indonesia, including the roles played by various stakeholders and the interactions between them. Additionally, the discussion will encompass the important policies that support the innovation process in Indonesia.

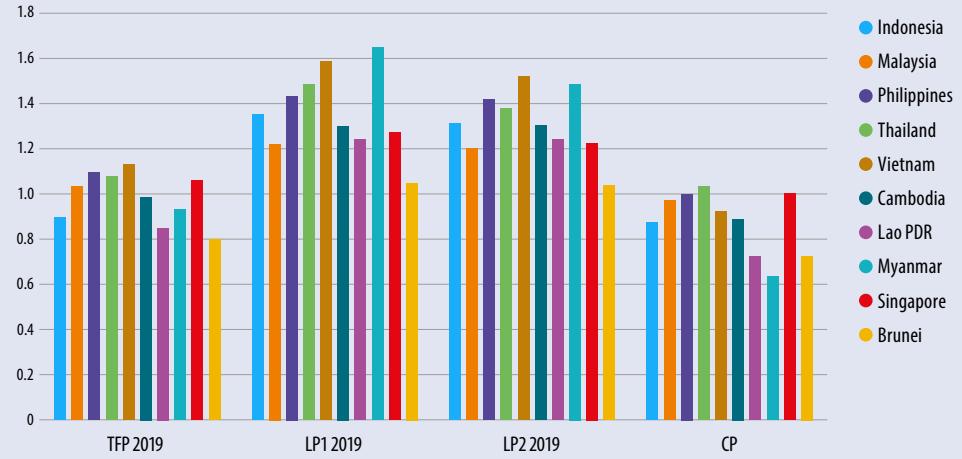
Output Growth, Contribution of Capital Input, Contribution of Labor Input, and TFP in Southeast Asia Countries

Comparative Productivity Analysis in Southeast Asia

Figure 5.8 presents a comprehensive overview of TFP, labor productivity, and capital productivity in selected Southeast Asia countries, including Indonesia, Malaysia, the Philippines, Thailand, Vietnam, Cambodia, Lao PDR, Myanmar, Singapore, and Brunei in 2019. In this context, Indonesia's TFP was ranked seventh in the region, slightly better than Lao PDR and Brunei. Vietnam emerged with the highest TFP in the specified period compared to other countries in the region.

FIGURE 5.8

TFP, LABOR PRODUCTIVITY, AND CAPITAL PRODUCTIVITY IN SOUTHEAST ASIA COUNTRIES IN 2019



Source: APO (2022).

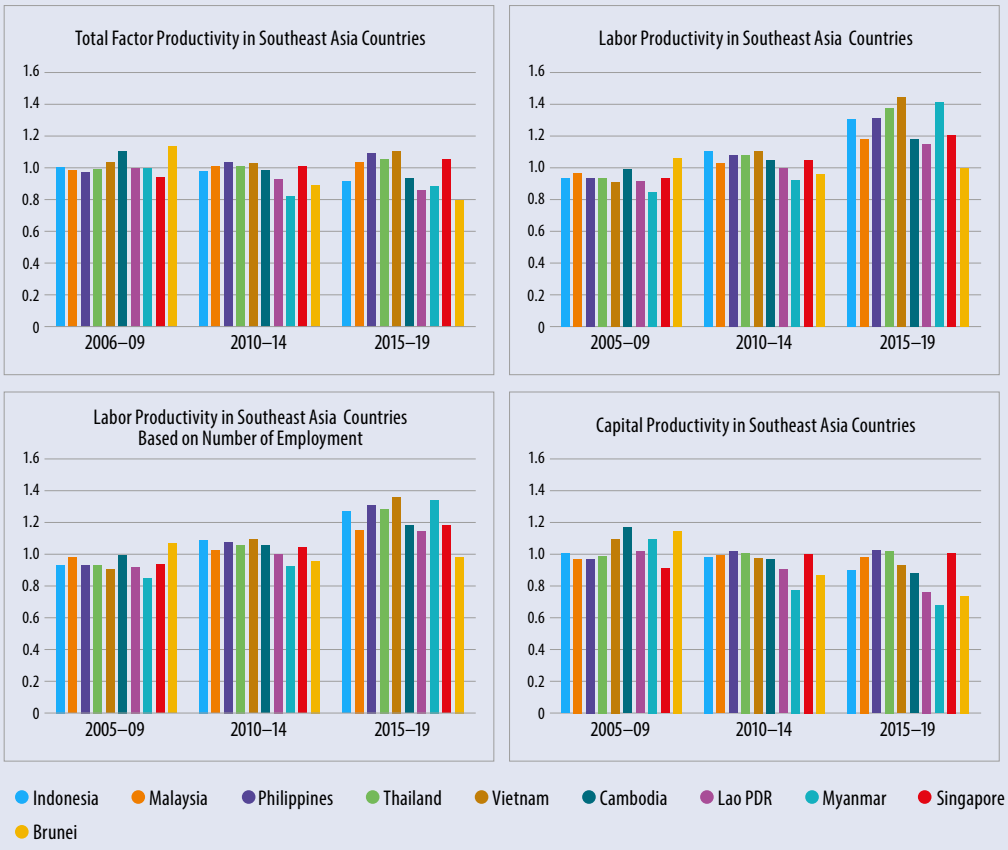
Labor productivity in Indonesia, based on hours spent on work in 2019 was ranked fifth in the region. Indonesia lagged behind Myanmar, Vietnam, Thailand, and the Philippines. A similar trend persisted in terms of labor productivity based by the number of employments in each country, where Indonesia again ranked fifth, surpassing Cambodia, Vietnam, Malaysia, Singapore, and Brunei. The relatively lower labor productivity percentage for Singapore can be attributed to its industries' emphasis on technology intensity over employment intensity. This can be seen from Singapore's capital productivity rate of 0.9984 annual growth. Technology-intensive industries can produce outputs more efficiently in terms of time and operational cost than labor-intensive sectors.

Enhancing Indonesia's Productivity Landscape

The Indonesian government needs to prioritize advancements in science and technology (S&T) to escalate its productivity growth rate. In 2019, Indonesia trailed Thailand, Vietnam, and the Philippines in terms of TFP, labor productivity, and capital productivity growth rate. Indonesia was only better than Lao PDR and Cambodia across these productivity measurements. This calls for a concerted effort by the government to boost productivity across all sectors by improving education quality, especially in vocational schools. Further, there is also the need to establish supportive ecosystem to attract foreign investors who can bring in advanced technologies to the nation. Additionally, the government also needs to provide equal access to essential services, such as electricity, internet, educational infrastructure, healthcare facilities, and good transport infrastructure, especially in rural areas.

FIGURE 5.9

TFP, LABOR PRODUCTIVITY, AND CAPITAL PRODUCTIVITY IN SOUTHEAST ASIA COUNTRIES IN VARIOUS PERIODS



Source: APO (2022).

Productivity Trends and Industry Characteristics

The distinct characteristics of industries in each country significantly influence productivity trends. Indonesia's industries, which are largely labor-intensive industries, experienced the descending trends of TFP and capital productivity while simultaneously recorded ascending trends for labor productivity based on hours spent for working and the number of employments. Figure 5.9 illustrates the average TFP growth in the 2005–09 period was 1.005. Its average annual growth decreased to 0.978 in 2010–14 and further decreased to 0.915 in 2015–19. Other countries in the Southeast Asia region that experienced decreasing trend of TFP growth during these periods were Cambodia, Lao PDR, and Brunei. Malaysia, the Philippines, Thailand, and Singapore showed increasing trends in the same periods. In contrast, Vietnam and Myanmar exhibited stable trends. The comparable results were also observed in capital productivity trends. Indonesia, Cambodia, Lao PDR, and Brunei exhibited decreasing trends from 2005 to 2009.

Labor Market Dynamics and Innovation

All selected countries in Southeast Asia, except Brunei, showed an upward trend in labor productivity. This result indicates that labor market competition in this region is going to increase. Brunei, on the

other hand, experienced decreasing trends for all productivity indicators; TFP, labor productivity, and capital productivity, during the periods of interest.

The performance indicators: TFP, labor productivity, and capital productivity are determined by a country's innovation capabilities. Therefore, it is necessary to understand the conceptual framework of the NIS in Indonesia.

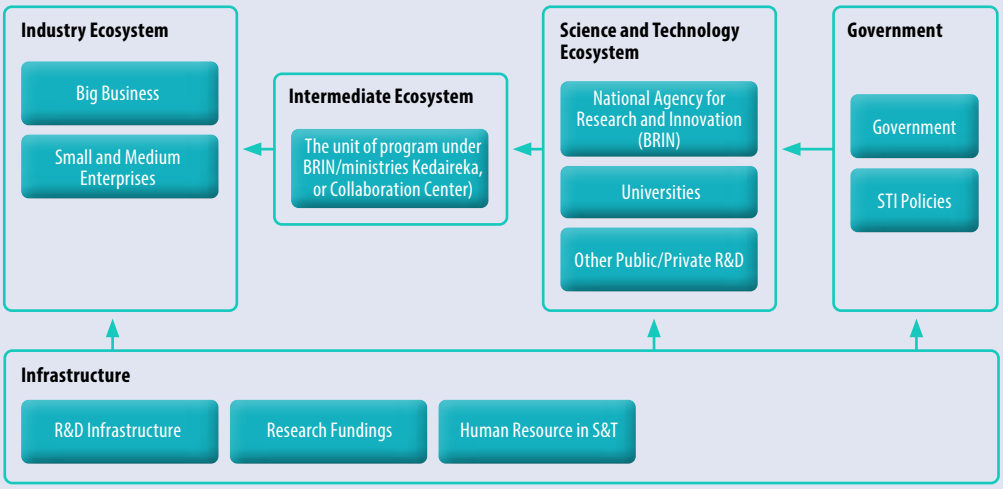
CONCEPTUAL FRAMEWORK OF NIS IN INDONESIA

Interaction with Different Agents of the Innovation Process

According to Pawennei, et al. (2020), the three most important NIS players are the R&D entities, user industries, and intermediary institutions. The three crucial actors' straightforward interaction are facilitated through intermediary institutions, before innovations are commercialized by industries. The role of intermediary institutions becomes essential in bridging the gap between R&D outcomes (Demand Pull) and industrial needs (Demand Push) [8–9].

FIGURE 5.10

INDONESIAN NIS ACTORS AND ITS INTERACTIONS



Source: Adapted from Byron & Prasanta (2015) [8] and Nabradi (2010) [9].

Diverge Agents in the S&T Ecosystem

Based on Figure 5.10, the first actors in the S&T ecosystem are the government research institutes (GRIs) and universities. Following the consolidation of all R&D institutes in Indonesia, the government has established a national research institute known as the National Research and Innovation Agency (BRIN). Based on Presidential Regulation 78/2021, BRIN has become an organization resulting from the integration of various entities, comprising: (i) the Indonesian Institute of Sciences (LIPI); (ii) the National Institute of Aeronautics and Space (LAPAN); (iii) the National Nuclear Energy Agency of Indonesia (BATAN); (iv) The Assessment and Application of Technology Research Organization (BPPT); and (v) other R&D institutions under the ministry. Operating since late 2021, BRIN oversees a diverse cadre of

approximately 10,000 researchers in diverse areas and specializations, scattered across Indonesian provinces.

In addition to researchers at BRIN, research responsibilities are also entrusted to university lecturers, who are guided in the principle of 'tri dharma' that encompasses three functions of teaching, research, and community service. Therefore, in the context of Law 14/2015 underscores that research is an integral aspect of lecturers' responsibilities. The current number of lecturers is 265,000 who spread across 3,400 universities in Indonesia [10].

The Robust Indonesian Industrial Ecosystem

The Indonesian industrial ecosystem, in the meanwhile, includes a broader range of actors. Between 2017 and 2020, Indonesia recorded 4.2 million small businesses and 33,000 big businesses [11]. Although this number does not cover all industries requiring innovation, it is one of the largest in Southeast Asia countries. Indonesia has the most number of micro, small, and medium enterprises (MSMEs) in this region. Even Thailand, which ranks second, accounts for only 10% of total enterprises present in Indonesia [12].

However, the extensive diversity of companies, which also includes a substantial number of researcher cohort, cannot be easily linked. This is where it becomes critical to have intermediary institutions. Most of these intermediary institutions are affiliated with universities and GRIs, which have the function of incubating and promoting research output. However, the approach will vary, depending on the kind of innovative business model being carried out. For example, the demand-pull approach will encourage intermediary actors to provide facilities for researchers to solve industrial problems while technology-push approach will compel the promotion of modern technologies in industries, facilitating investment and product development based on research findings [13].

Programs, Policies, and Regulations for Innovation Process and Activities

The successful collaboration among actors within the NIS hinges on two conditions, which are (i) the research infrastructure and its supporters along with policy instruments; and (ii) S&T programs that support innovation.

STI policies in Indonesia are not new, tracing their origins back to the mid-1980s when the government, led by BJ Habibie under the Ministry of Research and Technology, recognized the significance of innovation through technology transfer. BJ Habibie saw that Indonesia needed to undertake reengineering, attain mastery, and catch up with technology, which then will pave the way for making heavy investment in high-intensity technology [14].

Recently, one of the main policies steering innovation in Indonesia include Law 11/2019, which pertains to regulating the national system of S&T and industrial law 3/2014. The two laws jointly dictate how research and industry ecosystems support each other in promoting innovation for the country's development and contributing to the national economy. Several principles of innovation development in Law 11/2019 are shown in Table 5.3.

TABLE 5.3

LAW 11/2019 ON NATIONAL SYSTEM OF SCIENCE AND TECHNOLOGY

No.	Chapter	Content-related Innovation
1	**Chapter IV:** Implementation of Science and Technology	**Article 13:** The implementation S&T actors are consisting of individuals, groups, enterprises, private and public institutions, and universities. **Article 14:** The implementation of S&T through education, research, development, study, and implementation. **Article 28:** The implementation S&T through technology transfer, technology intermediation, S&T diffusion, and technology commercialization. **Article 29:** The transfer technology through license, corporation, S&T services, and others. **Article 30:** Technology intermediation is an attempt to bridge the process of Invention and Innovation between producers and potential users of Technology. **Article 31:** Technology Intermediation can be technology incubator, business match technology, partnership, and invention promotion.
2	**Chapter V:** Invention and Innovation	**Chapter 34:** Invention and Innovation can be through: basic research, applied research, developing science, technology transfer, reengineering, technology intermediation, science and technology diffusion, and technology commercialization. **Chapter 35:** The central government is obliged to facilitate the protection of Intellectual Property and its utilization because of national Inventions and Innovations. **Chapter 37:** The central government is obliged to guarantee the utilization of the results of Research, Development, Assessment, and Application in the form of Inventions and Innovations for national development.
3	**Chapter VI:** Science and Technology Institutions	**Chapter 42:** Science and Technology Institutions consists of: Research and development (R&D) institutions, research and application institutions, universities, business entities, and supporting institutions. **Chapter 46:** The business entity functions to develop capabilities in Engineering, Invention, Innovation, and Diffusion of Science and Technology to produce goods and/or services that have added value.
4	**Chapter VII:** Resource of S&T	**Chapter 49:** Science and Technology Resources consist of Science and Technology Human Resources, Science and Technology Funding, and Science and Technology Facilities and Infrastructure. **Chapter 50:** Science and Technology human resources are classified: researchers, engineers, lecturers, and other Science and Technology human resources. **Chapter 51:** Science and Technology human resources working status as: State Civil Apparatus, Army Indonesian National Armed Forces, or National Police Republic of Indonesia, employees who work for institutions determined by laws and regulations, private workers; or individuals.

Within the context of industry, the innovation system is predominantly encapsulated in Law 3/2014. This law assigns industries the role of conduits that channel innovation from R&D and universities. A range of principles of this law delineate the responsibilities industries hold in advancing the innovation agenda, as depicted in Table 5.4.

TABLE 5.4

LAW 3/2014 ON INDUSTRY

No.	Chapter	Content-related Innovation
1	**Chapter IV:** Developing and Utilization Technology of Industry	**Article 38:** Industrial technology procurement can be through R&D, research agreement and development, joint venture, and technology transfer by license and technology acquisition. **Article 39:** Industrial technology procurement on turnkey project must provide technology transfer to domestic side. **Article 40:** Government responsible to protect risk on technology utilization that is domestically developed.
2	**Chapter V:** Development and Utilization Creativity and Innovation	**Article 43:** Central government and local government must provide for community to be creative and innovative.
3	**Chapter VIII:** Development Industrial Infrastructure	**Article 49:** The Development Infrastructure consists of standardization of industry, infrastructure of industry, and national information system.

This updated industry law marks a departure from the original version made in the 1980s. In the previous law, industrial policy emphasized medium technology and raw goods industries[5], whereas the new edition finds more focus is placed on the pivotal role of innovation in shaping the industry.

Several policies in Indonesia limit the number of raw commodities available. The increase in added value for mineral products that started in 2014 requires domestic mineral processing, as stipulated in Law 4/2009. The prohibition on the type of commodity was expanded and also encompassed the utilization of imported raw materials. Recently, Indonesia has stopped using nickel from abroad[6]. In the automotive industry, Regulation of the Minister of Industry 36/2021 on low carbon emission four-wheeled motorized vehicles, set the minimum local component value of at least 70%.

Law 11/2019 has ushered several significant changes in the development and interaction of the NIS, especially in providing a new perspective on the preexisting Law 3/2014 policy framework. These two legislative policies form the bedrock in the NIS, governing both S&T domain and the industrial domain.

A series of programs are in place, aligning the roles of R&D and industry to invigorate innovation. First is witnessed in Kedaireka, a prominent initiative that allocates more than IDR1 trillion to higher education and vocational programs through the Kedaireka 2022 Matching Fund program. Designed to address societal and state strategic national innovation system, Kedaireka encourages innovation to solve these problems through academic community-led solutions. The program's objective includes achieving Penta helix collaboration in Tri Dharma of Higher Education, streamlining the Tri Dharma's results, and assisting the Industrial World Business (DUDI) through higher education, research agendas, and community service.

It should be noted that this funding (Kedaireka) acts as a bridge or matching fund for the needs of lecturers and researchers in fostering relationships with industrial partners. It also serves as an instrument to attract investments from industrial partners for research purposes. The research funding's scope extends beyond the completion of scientific article, aspiring for the program to result in the continuation and commercialization of products derived from research.

5 See the five-year national development plan III-IV (Repelita). In the 1980s, the industry leaned heavily toward labor-intensive practices. Infrastructure is built to support medium-sized industries and facilitate increased investments to become a global industry parts supplier.

6 This restriction is introduced by the Minister of Energy and Mineral Resources Regulation Number 11 of 2019 which amends the Minister of Energy and Mineral Resources Regulation Number 25 of 2018 regarding Mineral and Coal Mining Exploitation.

Kedaireka research topics include digital economy, health independence, green economy, economic recovery and tourism, and blue economy. Researchers can secure funding by submitting proposals through the stipulated channels with a funding scheme of 1:1 (50% for industry and 50% for universities) or 1:3 (30% for industry and 70% for universities).

ANALYSIS OF THE INNOVATION PERFORMANCE IN INDONESIA

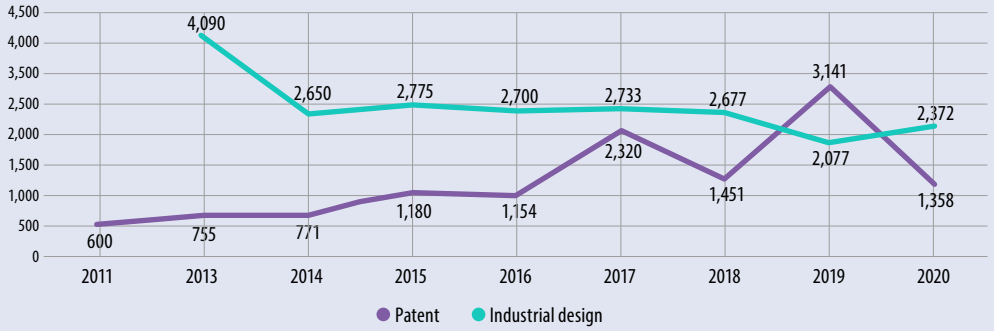
Intertemporal Innovation Indicators

Dynamics of Knowledge Production

This segment looks into the knowledge production process that encompass patent application, patent granted, scientific publication, R&D expenditure by government and private sector, and R&D human capital.

FIGURE 5.11

NUMBER OF PATENTS AND INDUSTRIAL DESIGNS



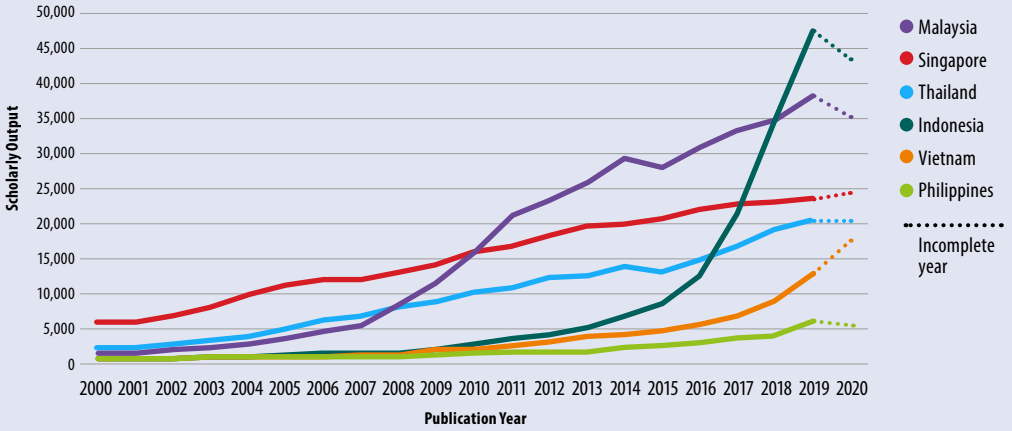
Source: Adapted from Byron & Prasanta (2015) [8] and Nabradi (2010) [9].

The number of patents in Indonesia, as shown in Figure 5.11, experienced a substantial surge between 2011 and 2017, increasing nearly fourfold from 600 to 2,320 applications. Although in the period 2017 to 2020, there was a fluctuating increase, the number of patent applications consistently remained above 1,000 applications.

The number of scientific publications also showed a similar upward trajectory. In over two decades, the volume surged over tenfold, escalating from 3,000 articles in 2000 to more than 20,000 articles in 2020. However, it should be noted that this progression also occurred in other Southeast Asia countries. Several countries in the region that experienced high acceleration and preceded Indonesia in the period 2000–20 were Malaysia and Thailand. The development of both patents and scientific publications cannot be separated from the increasing spending on R&D. The government increased almost five times R&D expenditure from 0.07 in 2000 to 0.28 in 2020.

FIGURE 5.12

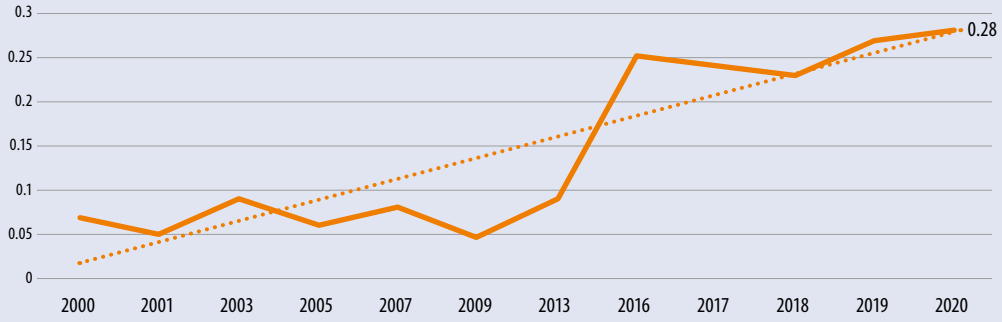
NUMBER OF SCIENTIFIC PUBLICATIONS AMONG SOUTHEAST ASIA COUNTRIES



Source: Elsevier (2020).
Note: Metrics for incomplete years can vary more over time than for the complete years.

FIGURE 5.13

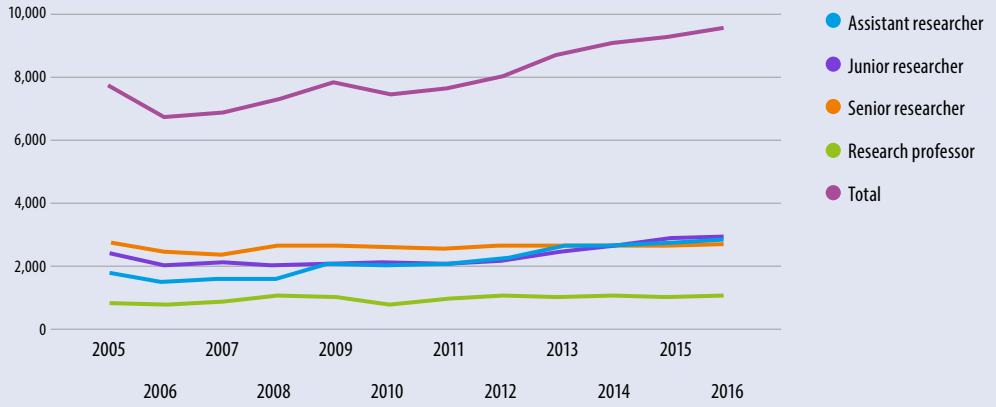
INDONESIAN R&D EXPENDITURE BY GOVERNMENT IN 2000–20



Aligning to these strides, the cohort of S&T human resources involved in research and innovation activities has also increased significantly. From 9,000 researchers in 2005, the count escalated to almost 15,000 by 2022.

FIGURE 5.14

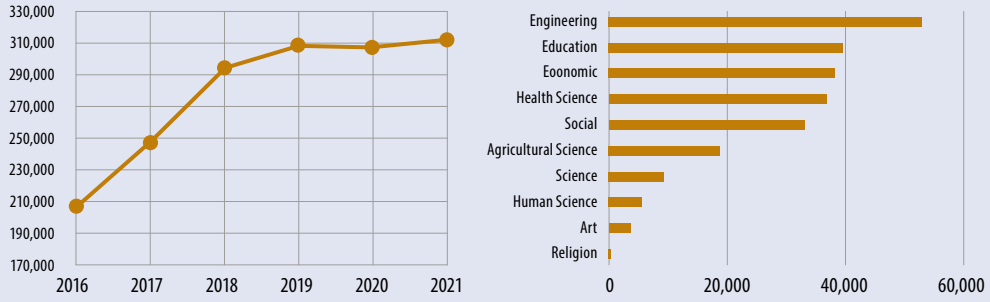
NUMBER OF RESEARCHERS IN 2005–16



Apart from researchers, lecturers in Indonesia are also involved both in the advancement of S&T and the research process. The total lecturers in Indonesia presents the largest number among Southeast Asia countries. The number has increased significantly over the last five years, ascending from 210,000 in 2016 to 310,000 in 2021.

FIGURE 5.15

NUMBER OF LECTURERS BASED ON FACULTY



Based on several simulations conducted by several researchers, it is predicted that S&T performance through S&T indicators in Indonesia will improve [15]. Aminullah [16] even estimates that the increase in gross domestic expenditure on R&D (GERD) optimally could have increased S&T performance up to fivefold. This, however, hinges on the prerequisite investment in technological development that affects consumption growth.

This means that knowledge production is emphasized not only on activities carried out by GRIs and universities, but also encompassing those from the private sector. Nonetheless, the contribution from the private sector is still below 20%. One of the toughest challenges is convincing investors to invest in the technology sector in Indonesia. To this end, the government's proactive step involves issuing the Omnibus Law 11/2020 which aims to create supportive investment climate to attract investors.

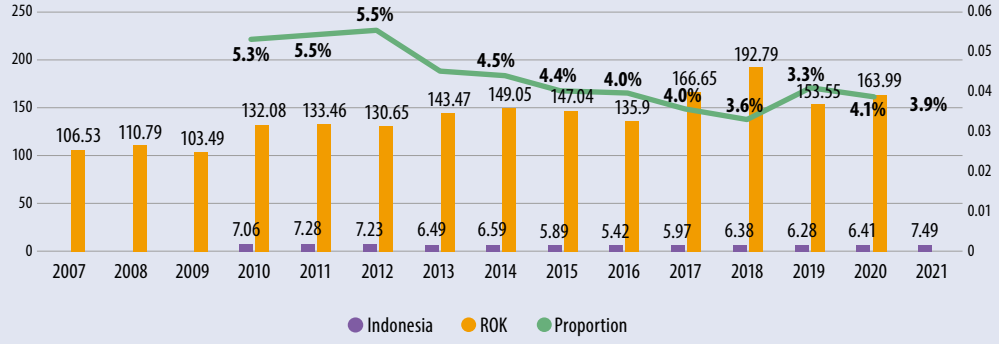
Knowledge Commercialization Process

This segment looks at high-tech export from world development indices, revenue from patents, trademark applications, and sales revenue based on figures from WPO and UNESCO Institute of Statistics.

Figure 5.16 shows that high-tech exports in Indonesia have increased modestly from 7.06 in 2010 to 7.49 in 2021. When compared to Republic of Korea (ROK), which has encountered a relative plateau, the juxtaposition underscores ROK's accelerated trajectory vis-à-vis these two countries. Encouragingly, the comparison bears witness to a narrowing gap between Indonesia and ROK. Commencing at a 5.3% differential in 2010, it fell to 3.9% by 2020.

FIGURE 5.16

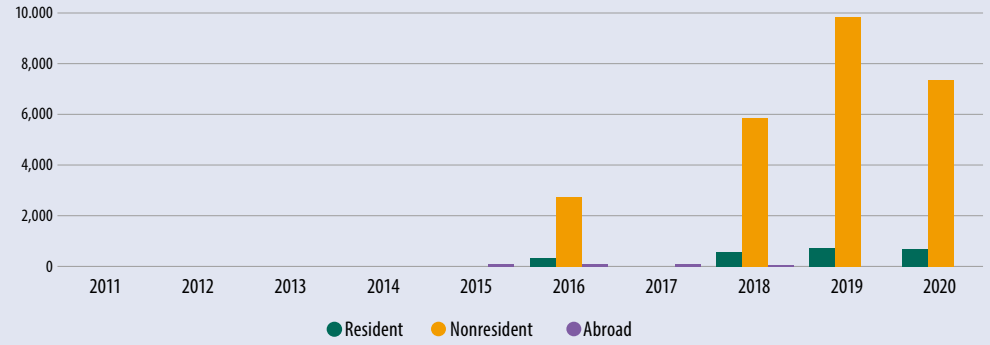
INDONESIAN HIGH TECHNOLOGY EXPORT (COMPARED TO ROK)



On the other hand, the number of patent grants produced by Indonesia indicates an upward inclination. Although the data series is limited, it shows that there is more than twofold increase between 2016 and 2019.

FIGURE 5.17

PATENT REVENUE

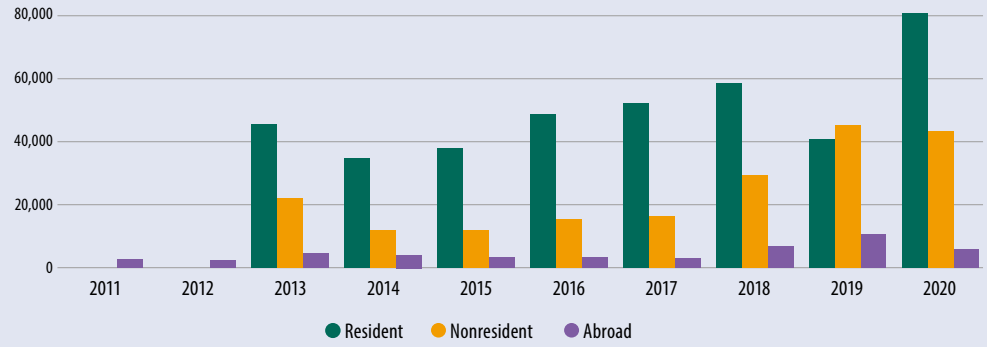


Source: WIPO statistics database; last updated: 11/2021.

Simultaneously, the number of trademark applications in Indonesia has increased sharply in 2020, especially from the resident category, which almost doubled from 40,000 applications in 2013 to 80,000 applications in 2020.

FIGURE 5.18

TRADEMARK APPLICATION CLASS COUNT



Source: WIPO statistics database; last updated: 11/2021.

Yet, the data shows that the commercialization of innovative products in Indonesia is not at a satisfactory level. Based on a WIPO report in 2022 [17], the global innovation index (GII) ranks Indonesia at 75, which is the highest achievement for Indonesia in recent years. Several pillars that are still considered low are Human Capital (90th) and Business Sophistication (92nd). This is in accordance with another index, the Global Talent Competitiveness Index (GTCI) [18], where Indonesia is ranked 90 out of 113 countries. The factors that weaken Indonesia's position in GTCI are the ability to attract global talent to work in the county and the ability of its workers in adhering to global standards.

ESSENTIAL POLICY INTERVENTIONS IN ENHANCING PRODUCTIVITY AND BUILDING A ROBUST NIS

As discussed in the earlier segments, the Indonesian government's policies have several limitations. These include a lack of links between industrial policies and S&T policies, suboptimal use of patents, and unclear policies on the development of S&T human resources in Indonesia. While the government has issued policies to support the NIS and accelerate industrial production, the effectiveness of these measures in establishing a thriving innovation ecosystem remains relatively modest. Indonesia's production growth has not relied heavily on domestic technology to spur industry growth. Based on the policy constraints outlined earlier, a series of strategic measures must be implemented to build an effective NIS in Indonesia.

i) Increase the adoption of S&T to boost industry productivity

The data presented in the preceding sections demonstrate that Indonesia still faces numerous challenges and obstacles that must be overcome to progress toward an advanced and competitive Indonesia based on S&T as the engine of development. Aligned with Indonesia's visionary goals for 2045, the government has made various efforts to bridge innovation in the production sector through research activities. However, some parties continue to question the role of S&T in underpinning the competitiveness of the manufacturing sector and its contribution to the economy and overall national development through research activities.

Meanwhile, to encourage economic growth and national development using S&T, Indonesia has formulated policies on Industrial Law 3/2014 and National System on Science and Technology Law 11/2019. The enactment of Law 11/2019 has resulted in several changes to the development and interaction of the NIS. Particularly noteworthy is the fresh perspective it has afforded to the previously published Law 3/2014 policy. From both the S&T and industry perspectives, these two policies have emerged as pivotal cornerstones within the framework of the NIS. But it is imperative to note that the progression of S&T policies tend to run in parallel tracks.

Research significantly contributes to innovation by providing quality resources that empower a country's industries to compete in the swiftly evolving global market. Without research, innovation tends to produce only simple or superficial novelties that have no impact on the country's industrial progress. In fact, in Indonesia, innovation activities without research in the production sector have existed for a long time [19].

Research is often regarded less attractive because of its nature, which requires large investment value with an elevated level of uncertainty regarding its market success. On the other hand, regardless of whether they were originated from research activities or otherwise, numerous innovative products that have undergone market trials remain the primary choice for industry players to enhance their businesses. This is not surprising given the industry's primary goal of maximizing profit while minimizing costs and business risks as much as possible.

The Indonesian government intends to use S&T as the foundation for various development policies to promote economic growth and improve industrial competitiveness. The substantial role of S&T and innovation in economic growth and competitiveness in Indonesia can also be seen from the size of TFP's contribution to GDP. Over the 2010–17 period, the average growth of TFP to GDP in Indonesia was at -1.5%. This means that the contribution of TFP has reduced the GDP value stemming from capital and labor factors of production, which reached 6.8%. As a result, the cumulative GDP value remains at 5.3% [20]. This demonstrates that proficiency in S&T contributes extraordinarily little to the national economy. The various components of TFP that are not related to the factors of production of capital and labor (but are related to their interaction) do not yet play a role, and it remains a separate disincentive for economic growth in Indonesia. The ability of a country to use S&T, proficiency in the latest technology, innovation capabilities, and so on is a determining component of the formation of TFP production factors, which have not been developed and utilized optimally to propel Indonesia's economy and competitiveness.

According to Triyono, et al. [21], existing innovation policies in Indonesia have failed to bridge effective interactions between research institutions and industry. This is exacerbated by Indonesia's research planning mechanism's proclivity to be technology-push rather than market-driven, resulting in a frequent mismatch between what research institutions produce and what industry truly requires. Meanwhile, innovation occurs when S&T providers (innovation suppliers) and science users (innovation users) come together [22]. This is inextricably linked to the fundamental economic concept of supply and demand.

The underperformance of research in Indonesia in supporting the competitiveness of the production sector is partly due to major governance issues. Government agencies as S&T regulators and facilitators, research institutions (including universities) as S&T providers, and industry as S&T users collectively contribute to the inefficiencies disrupting the innovation ecosystem.

In terms of institutional governance, the National Science and Technology Law requires the integration of planning, programs, budgets, and scientific and technological resources in the fields of research, development, study, and application in Indonesia into a single institution, namely the National Research and Innovation Agency (BRIN). As of September 2021, public R&D institutions have been merged into BRIN, facilitating focused control over directed R&D activities within the

national R&D program. Nonetheless, it is imperative to recognize that the process of structural integration requires a lengthy and comprehensive planning and execution to be successful. The main challenge is the integration of public R&D institutions from various diverse sectors and wide-ranging scope, which, if not carefully planned and designed, could jeopardize the continuity of R&D activities in Indonesia.

So far, the Indonesian government has encouraged industries and the private sector to invest in research and innovation activities by providing financial incentives in the form of significant tax reductions. However, unless a systematic effort is made to improve the knowledge and innovation ecosystem, the government's efforts to encourage research and innovation and to encourage the private sector to invest in research and innovation will be ineffective. Increasing funding for private research and innovation must be a part of strengthening the national S&T system through regulatory support and incentives, as stipulated in the National Science and Technology Law's implementing regulations.

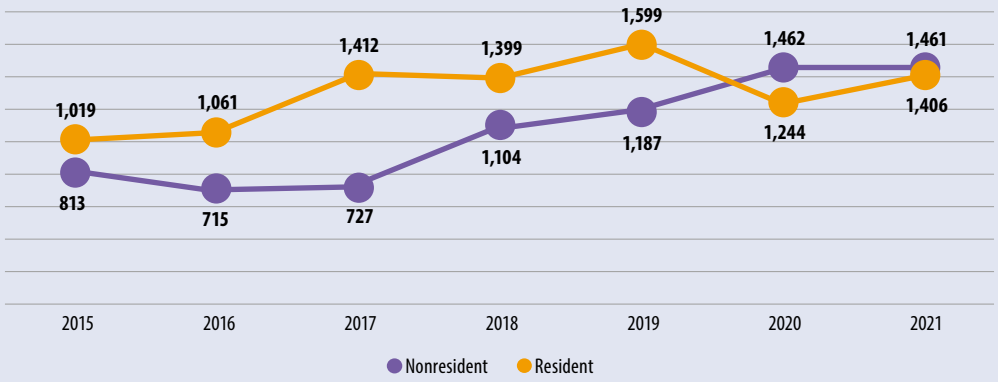
ii) Encouraging transfer technology from domestic patents in Indonesia

Patents are an indicator of an economy's NIS operational efficacy. The greater the number of patents produced in a country, the greater is the country's ability to innovate. This innovation capability symbolizes the synergy of elements within the innovation system, including universities, R&D institutions, and industries. From the standpoint of innovation policy, patents are intended to encourage innovation by providing benefits to inventors for their produced innovations. Simultaneously, patents are viewed as economic incentives that can provide economic value to innovators.

Intellectual property rights play a critical role in a country's economic growth. For example, in 2008, PR China achieved the highest economic growth rate among ASEAN+3 countries at 9.6%, a rate positively correlated with the high number of applications for Chinese patent protection through World Intellectual Property Organization (WIPO) (289,893 applications) and standard patents (225,586 applications) (Ministry of Law and Human Rights Republic Indonesia, 2021). In Indonesia, the number of patent applications increases significantly every year with domestic patent applicants outnumbering foreign counterparts since 2015 (Figure 5.19).

FIGURE 5.19

PATENTS REGISTERED IN INDONESIA IN 2015–21



Source: DJKI (2021).

Despite the rising number of patent applicants from within the country, STI continues to play a minor role in Indonesia's economic growth. This is demonstrated by Indonesia's average TFP growth, which continues to fall. By dividing the sequence into three timelines, namely the first period 1970–90, the second period 1990–2010, and the third period 2010–17 (the last year of data collection), the average TFP growth in Indonesia is at 0%, -1.1%, and -1.5%, respectively [23].

The discourse on patent and technology transfer has been a subject of workshops and seminars organized by Indonesia's National Law Development Agency (Badan Pembinaan Hukum Nasional), despite the lack of clear definition of technology transfer at the time [24]. Technological innovation is critical, but accessing, adopting, and transferring such technology has proven difficult in Indonesia. To address this, Indonesia enacted legislation and policies to encourage technology transfer, including revisions to intellectual property rights (IPR laws), the Technology Transfer Regulation, the National System of Research and Development Law, the Bilateral Free Trade Agreement (BFTA), and many others [25].

It is difficult to see how international patent law promotes innovation and technology transfer in Indonesia for several reasons. To begin with, the Indonesian Patent Law is not comprehensively designed to promote innovation and technology transfer. It does not fully utilize the TRIPs Agreement's flexibility to enhance technological capacity, particularly in critical areas that have a significant impact on innovation and technology transfer, such as licensing, compulsory licensing, full disclosure requirements, and broad research and education exceptions. As a result, that regulation must be revised to conform to the new Law on the National System of Research, Development, and Application of Science and Technology. This alignment will ensure that all legislations and regulations pertaining to technology transfer are harmoniously supportive and consistent with one another.

iii) Increasing the quantity and quality of outstanding S&T personnel

The key to improve the quality of the knowledge and innovation ecosystem is to have reliable and appropriate resources. It is critical to plan management and development for the quality of human resources, infrastructure, logistics, and supporting equipment. One area that requires attention is determining the most effective way to manage human resources in the fields of science, higher education, research, and innovation. These domains have a different rhythm, work culture, rules, and incentive mechanisms that set them apart from other fields.

As highlighted in the preceding segments, the number of researchers in Indonesia has grown dramatically. Currently, about 15,000 researchers work at government R&D institutions, primarily BRIN. But there are very few competent HR (Human Resource) professionals in S&T. Only about 25% of researchers possess doctoral degrees. In general, Indonesians continue to participate in higher education at a rate of around 50%. This demonstrates that, in addition to efforts to increase national innovation, fundamental education policies, particularly those aimed at providing higher education to all communities, are essential.

The following steps are imperative to improve the quality and quantity of S&T human resources in Indonesia, necessitating the implementation of several supportive policies [20, 26].

a) Increasing the number of S&T human resources

Since 2007, the government has attempted to increase the number of students enrolled in vocational schools via the 'Big Bang Policy', a strategic plan outlined in Education Ministry Regulation No. 44 in 2010. In 2017, the ratio of students in senior high school to those in vocational high school was 67:37 with projection ratio to be 40:60 by 2020. About 20% of

graduate students were in engineering compared to 60% of students graduating in social sciences, politics, cultural studies, law, and humanities in 2017. To foster awareness of production-related careers, distinct strategies aimed at both production and nonproduction jobs are crucial. This approach is consistent with the discovery that distinct incentive strategies based on job characteristics generate firm productivity and performance.

b) Increasing the number of human resources with doctoral degrees in all fields

- Adopt the practice of establishing national doctoral training centers and networks, akin to the Laureate scheme in Australia
- Create a research funding scheme to support senior researchers who have demonstrated their ability to serve as effective research trainers and mentors
- Establish an international partnership scheme for Ph.D. and mobility programs to increase the capacity of both supervisors and students

c) Creation of dependable human resources for research, innovation, and public policy through continuous capacity building (both formal education and training) as part of the career path development process

- Develop a critical mass of human resources in S&T, with a target of 30% of the population holding postgraduate degrees
- Create human resource development plans in every research and innovation institution, including the private sector, in the form of competitive degree and nondegree scholarships, akin to the Indonesian Education Fund Management Institution (LPDP)
- Improve talent management practices at R&D and educational institutions
- Advocate for the existence of educational and training facilities, including in-house training and nontraditional training
- Align the HR roadmaps across sectors with the Higher Education LPDP-K/L initiatives

CONCLUSION

Indonesia's economic growth projection in 2023 is expected to be stable at around 5%, at par with pandemic levels at 5% and 5.3% in 2019 and 2018, respectively. Even though the economic growth is stable, Bank Indonesia has implemented a tightening monetary policy in the first half of 2023 by increasing 7-Day Reverse Repo Rate, Deposit Facility Rate, and Lending Facility Rate by 50 basis points. This monetary policy approach, combined with efforts to stabilize the rupiah exchange rate, is implemented to mitigate uncertainties impacting global financial markets in 2023. In the industrial level, the Indonesian government has strived to increase the value-added output of mining sectors by mandating domestic processing and refining of metal mining commodities. This move aims to increase the export value of mining products. The main contributors for Indonesian exports include palm oil, coal, and natural gas commodities. In 2021, Indonesia ranked 28th globally in terms of exports with a share of 1.04% while in imports, it ranked 30th with a share of 0.88%.

Among economic sectors, manufacturing industries have dominated the contribution to national GDP. In the second quarter of 2022, manufacturing industries accounted for 17.84% of the national GDP,

showing a consistent increasing trend even during the COVID-19 pandemic of 2020–21. In 2021, the manufacturing industries contributed IDR 2,946.9 trillion to GDP, an increase from 2020 which reached IDR 2,760.43 trillion. Amid these trends, global economic growth witnessed a slowdown by mid-2022, partly attributed to supply disruptions due to the ongoing war between Russia and Ukraine. In 2023, the global economy is expected to slowdown, which will impact Indonesian economy. The WTO and IMF predict a slowdown in trade growth in 2022 to 2023.

The output growth during the period 1971–2019 was dominated by the contribution of capital input with an average contribution of 4.18. This surpasses the contributions of labor input at 2.19% and TFP with -0.72%. Labor productivity decreased significantly in 1977, 1982, and 1998. Meanwhile, TFP also experienced a significant decline in 1982 and 1998. The substantial drop in labor productivity in 1977 was triggered by a very large stock of foreign debt with largely short-term effects. The significant fall in TFP and labor productivity in 1982 was caused by several factors, including the foreign debt crisis in most developing countries (including Indonesia), rising world oil prices, high interest rates from 1980 to 1982, falling prices of goods, and decreasing export volume. The most significant drop occurred in 1998 with labor productivity and TFP falling by -19.47% and -16.69%, respectively. This decline was triggered by the weakness in the national financial system, particularly in banking and capital markets, where the deregulation of the banking industry was not accompanied by the government's ability to implement prudential regulations governing the financial industry.

Comparing Indonesia to its neighboring countries in Southeast Asia, it is evident that both the capital productivity and TFP need to be improved. This trend is observed when dividing time periods into three segments 2006–09, 2010–14, and 2015–19. As with Indonesia, similar patterns can be seen in Cambodia, Lao PDR, and Brunei. This result shows that the growth of industries and economic development in those countries have been driven by labor productivity rather than TFP or capital productivity. With the exception of Brunei, all selected countries in the Southeast Asia showed increasing trend of labor productivity during the period of interest, which indicates heightened competition in the labor market.

Productivity indicators show the capability of NIS in each country. Indonesia's NIS can be divided into five key elements: industrial ecosystem, intermediate ecosystem, S&T ecosystem, government, and infrastructure. The S&T ecosystem includes BRIN, universities, and public/private nongovernment R&D entities. BRIN is an organization resulting from the integration of various government research institution in Indonesia, comprising LIPI, LAPAN, BATAN, BPPT, and other R&D institutions, under the ministry. The Indonesian industrial ecosystem consists of 4.2 million small business and 33,000 big business, making it the largest in Southeast Asia. Initiatives like Kedaireka, a matching fund program connecting industries with applied technology resulting from university research, bridge the gap between the industrial and S&T ecosystems. Universities, together with BRIN, act as intermediary actors by promoting research outcomes to industries.

Policies and regulations are pivotal in supporting the S&T ecosystem and industries. Law 11/2019, a recent key S&T policy in Indonesia, has led to significant changes in the NIS' development and interaction. Prior to this law, innovation indicators such as patents, industrial designs, scientific publications, R&D government expenditure, the number of researchers and lecturers, and patents and trademarks showed different trends. While the number of patents from 2011 to 2019 showed an increasing trend, there were significant declines in 2018 and 2020.

Industrial design, on the other hand, exhibited a slight increase in 2020 after a decreasing trend. Another indicator is scientific publications, surging from 3,000 articles in 2000 to more than 20,000 articles in 2020. Compared to Southeast Asia countries, the number of scientific publications before 2016 were trailing Thailand, Singapore, and Malaysia. Since 2017, it showed positive trend although its number decreased slightly in 2020 due to the pandemic. This trend is in line with the increase of R&D expenditure by government from 2000 to 2020. The number of researchers, lecturers, patents, and trademark also show increasing trends, showing the optimistic picture of future Indonesian innovation capabilities.

However, there are some limitations of existing policy framework on innovation, including the need to enhance the number of patents and scientific publications. Another highlighted issue is addressing the scarcity of S&T human resources, especially those with doctoral degrees.

Effective policy interventions are still required to bolster the capability of innovation and S&T development, which can boost industrial productivity. Key industrial policies, encompassed in Industrial Law 3/2014 and National System on Science and Technology Law 11/2019, form the cornerstone of Indonesia's NIS. To further optimize this system, the Indonesian government should consider several factors that include increasing R&D expenditure, fostering a supportive ecosystem and mechanism to increase funding for R&D in private sectors, encouraging technology transfer from domestic patents, and elevating the quality and quantity of outstanding S&T personnel.

CHAPTER 6

MONGOLIA

SOCIOECONOMIC CONTEXT OF MONGOLIA

General Overview

Mongolia is a landlocked Central Asian country, sharing its border with both Russia and PR China. It has 21 *aimags* or provinces, the first-level administrative subdivisions, and six regions (Eastern, Gobi, Altai, Western, Khangai, and Central). Covering an expansive area of more than 1.5 million sq km, Mongolia is home to approximately 3.4 million people. It is an ethnically and linguistically homogeneous nation with a relatively young population (Table 6.1) [1–2]. Ulaanbaatar, the nation's capital and largest city, operates as an independent municipality and is populated by almost half of the total population.

TABLE 6.1

SOCIOECONOMIC SNAPSHOT OF MONGOLIA

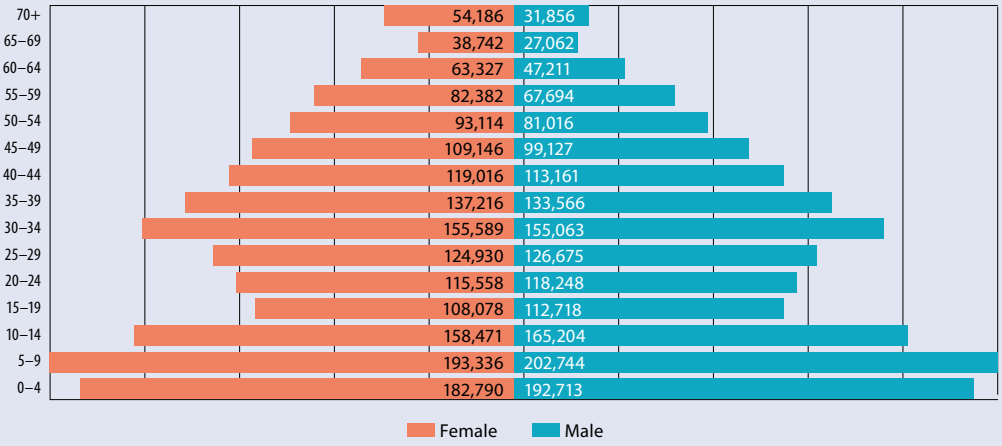
Population	3,409,939 people
Total Area	1,564,116 sq km
Religion	Buddhist (51.7%), Non-religious (40.6%), Muslim (3.2%), Shamanist (2.5%), Christian (1.3%), Others (0.7%)
Ethnicity	Khalkh (83.8%), Kazakh (3.8%), Durvud, Bayad, Buriad, and others
Language	Mongolian (official)
Literacy rate*	98.7%
Higher-Ed.**	26.5%
ICT use	Internet: 64.7% Mobile phone: 87.8%
Capital city	Ulaanbaatar
Population	*1,539,252 people*
Area	*4,704,400 sq km*

Source: The 2020 Population and Housing Census, and National statistics.
Note: The image is in the public domain. The political map of Asia by CIA, 2013. *15 years or older, ** Bachelor's or higher degree attainment rate.

The Mongolian road network consists of 111,916.7 km of refined or paved roads, of which 14,919 km are international and state grade roads. In recent years, international organizations assisted the Mongolian government with funding for developing and maintaining road systems. The investment has resulted in the extension of paved roadways of the length 7,445 km and improved accessibility to the remote settlements [3]. The 1,111 km long trans-Mongolian railway, one of the trans-Siberian railway branches, is considered to be the country's primary economic corridor. This railway owes its existence to a trilateral agreement among Russia, Mongolia, and PR China in 1956, making the 2,215 km journey from Jining, PR China to Ulan-Ude, Russia possible. Today, about 70% of Mongolia's import and export freight transportation goes through this route [4].

FIGURE 6.1

MONGOLIAN POPULATION COMPOSITION BY GENDER AND AGE GROUPS



Source: National statistics, 2021.

Mongolia underwent a number of political and socioeconomic shifts in the 20th century, beginning with the declaration of independence from PR China's Qing dynasty by the Bogd Khanate of Mongolia in 1911. Subsequently, Mongolia aligned itself with the Soviet Union, adopting socialism and establishing the Mongolian People's Republic in 1924. The late 1980s gave rise to democratic movements, culminating in a peaceful democratic revolution that transitioned into a market economy with the new Constitution of 1992 [5].

During the socialist regime, Mongolia succeeded in accelerating its industrialization. The foundation of the light industry and mining sector was laid by attracting financial aid, soft loans, and joint ventures within the COMECON[1] [5]. Significant strides were made in public education policy, which mandated compulsory secondary school attendance for every child. Even after the socialist regime ended, Mongolia maintains a high literacy rate of 98.7% among citizens aged 15 and above, according to the 2020 population and housing census [1].

Box 6.1. Key Economic indicators

- GDP USD15,098.0 million (2021)
- GDP per capita: USD4,179 (2021)
- GDP rank 132 (PPP, 2021)
- Economic growth: 7.7% (2019), -4.6% (2020), 1.6% (2021)
- Budget balance indicators in percent of GDP: -9.0% (2020), -3% (2021)
- Unemployment (percentage of the total labor force): 7.08% (2021)
- Share of the workforce in informal/vulnerable employment: 17.6% (2021)*
- IMD World Digital Competitiveness ranking: 62 (2021)

Notes: * www.ilo.org/ilostat

1 COMECON stands for The Council for Mutual Economic Assistance, an economic organization operated under the leadership of the Soviet Union from 1949 to 1991.

Mongolia's Economic Sectoral Structure

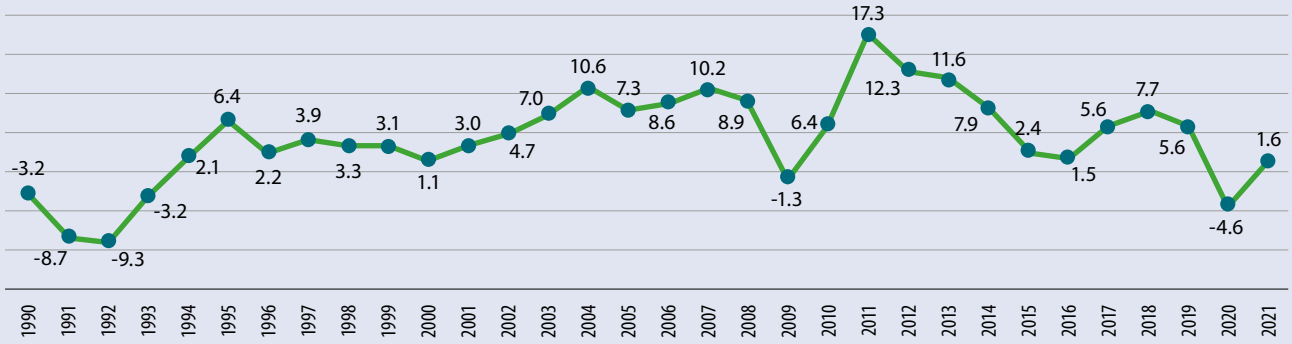
The collapse of the Soviet Union left Mongolia with fluctuating inflation, scarcity of commodity goods, and the difficulty of managing abruptly halted trading of large-scale industries [6]. The period witnessed extensive privatization of state-owned industries, resulting in the deterioration of well-developed light industry value-chain. However, it also provided citizens with opportunities to participate in economic activities. According to statistical data, in 1989, the private sector contributed a mere 3.3% to the GDP. By 2007, this figure reached 68%, and by 2017, it had reached an impressive 78.7% [5].

In the past three decades, the Mongolian economy demonstrated steady economic growth, averaging 4.3% from 1991 to 2021. In the first decade of transitioning into market economy, the average economic growth rate was 3.1%. In the second decade, the figure doubled to 6%, and in the third decade, it hit the healthy growth level of 7.8% on average. The peak of the GDP growth of 17.5% was recorded in 2011, making Mongolia one of the fastest-growing economies in the world. This achievement was largely attributed to the funding and development of the first phase of the USD6 billion Oyu-Tolgoi copper-gold project, coupled with increased revenue from mining exports [5].

In 2015 Mongolia achieved the status of an upper-middle-income-country, marked by an increase in GDP per capita. However, the very next year, the World Bank reclassified Mongolia as the lower-middle-income-country. This change was primarily owing to a sharp decline in the exchange rate and was not necessarily related to a decline in per capita income [7].

FIGURE 6.2

MONGOLIAN GDP ANNUAL GROWTH RATE IN PERCENTAGE BETWEEN 1990–2021



Source: Mongolian Statistical Yearbook, 2005–2021.

Mongolia's national economy has long relied on agriculture. However, as the information on Mongolia's mineral resources was disclosed to the world, the Mongolian mining industry attracted significant foreign and domestic investments. Today, the mining sector accounts for 95% of total production and 70% of total export. In 2021, Mongolia's GDP reached USD47,115 million with GDP per capita of USD4,179 (Table 6.2). The estimated GDP growth rate for 2022 is USD15,720 million, which positioned Mongolia nominally at the 132nd rank [2].

TABLE 6.2

GDP AND CONTRIBUTION TO GDP GROWTH BY SECTORS IN 2017–21

No	Indicators	2017	2018	2019	2020	2021
1	GDP, USD'million*	11,476.8	13,177.1	14,204.2	13,311.8	15,098.0
2	GDP per capita, at constant prices of 2015, USD	4,021	4,248	4,440	4,194	4,179
3	Annual changes of GDP, %	5.6	7.7	5.6	- 4.6	1.4
4	Contribution to GDP growth by sectors					
4.1	Agriculture, forestry, and fishing	0.0	0.9	0.7	0.8	-0.8
4.2	Industry:	0.5	2.5	0.1	-1.0	0.4
	- Mining and quarrying	-0.7	0.9	-0.3	-1.4	0.2
	- Manufacturing	1.1	1.4	0.3	0.3	0.0
	- Electricity, gas, steam, air condition supply	0.1	0.2	0.1	0.1	0.2
	- Water supply, sewerage, remediation act	0.0	0.0	0.0	0.0	0.0
4.3	Construction	-0.1	0.1	0.7	-0.1	-1.3
4.4	Service:	5.2	4.2	4.1	-4.3	3.1
	- Information & communication	-0.1	0.2	0.2	0.1	0.3
	- Professional scientific & technical activities	0.0	0.0	0.0	-0.1	0.0
	- Others services	5.3	4.0	3.9	-4.3	2.8

Source: National statistics, 2021.
Note: *Calculated GDP in national currency by annual average official exchange rates.

The European Bank for Reconstruction and Development (EBRD) is projecting the GDP growth of 2023 at the modest level of 3.5% due to the rising global demand for gold and the contrasting impact of PR China's demand for main commodities, such as coal, copper, and iron ore [8].

TABLE 6.3

STRUCTURAL CHANGES IN THE ECONOMY OF MONGOLIA, PERCENTAGE IN GDP

No	Sectors	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	Industry	23.4	22.1	25.4	29.9	30.2	37.7	35.7	36.3	36.1	36.0	34.6
2	Agriculture	24.9	20.7	20.1	20.9	21.7	19.5	20.6	18.8	15.2	11.6	11.2
3	Service	51.7	57.2	54.5	49.2	48.1	42.8	43.7	44.9	48.6	52.3	54.2
No	**Sectors**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022***
1	Industry	34.4	34.7	33.7	36.4	41.4	41.9	36.8	37.4	36.9	36.0	33.7
2	Agriculture	13.4	13.3	13.3	11.5	10.1	10.7	11.3	11.5	12.8	13.0	15.3
3	Service	52.3	52.0	53.1	52.1	48.5	47.4	52.2	51.3	51.6	51.2	51.0

Source: National Statistics Office of Mongolia, *- 2022, 1-YI.

Despite robust overall economic growth, some concerns threaten the country's sustainable economic development. These include Mongolia's overreliance on mining, rising inequality, political unrest, limited growth in the creation of decent jobs, inadequate and quality-over-quantity oriented livestock management, and degradation of grasslands.

PRODUCTIVITY ANALYSIS

Productivity Measurement and Research in Mongolia

Productivity growth plays a crucial role in improving a nation's competitiveness. It is intrinsically tied to the competitiveness of the national economy as it reflects the capability and capacity to efficiently allocate and utilize available resources to produce competitive outputs and outcomes. Therefore, nations have developed national productivity strategies, started global productivity movements, and embraced the concept of productivity-centered development trends in order to increase competitiveness and achieve sustainable development.

Under the communist regime, Mongolia gave a significant amount of consideration to increasing worker productivity. As a result, industrial labor productivity indicators had been calculated and formally included in national statistics since 1973 [7].

Mongolia's transition to a market economy in the 1990s resulted in a new perspective on productivity, the development of new means to enhance it, and the requirement to reform market economy-based policies and strategies to boost productivity. Subsequently, research on productivity has been actively pursued.

The establishment of the National Productivity Development Center in 1992 served as a significant catalyst in the modernization of productivity enhancement concepts, accelerating the productivity movement nationally. This entity, currently operating under the name of Mongolian Productivity Organization (MPO), along with the Asian Productivity Organization (APO), has actively supported the implementation of productivity improvement initiatives in the industrial and agricultural sectors [9].

Simultaneously, several researchers, such as Oyuntsetseg L. (1998) [9], Adiya Y. (1999) [10], Shurchuluu P. (1999) [11], Batgerel L. (2007) [12], Enhsaikhan S. (2010) [13], Bathishig I. (2013) [14], Sumjidmaa T. (2019) [7], and others have conducted extensive research in the field of productivity management. Their work has focused on productivity measurement, analysis, and productivity improvement across various economic sectors, including agriculture, industry, and manufacturing.

The "Supporting National Productivity" initiative and the "Promoting Labor Productivity Movement at the National Level" guidelines were, respectively, developed at the strategic level of state policy in 2007 and 2012 [15–16]. The Law on Statistics of Mongolia was enacted in 1997, and in accordance with this legislation, macroeconomic statistics started to include productivity indicators. The National Statistics Office (NSO) of Mongolia published the regulatory document "Productivity Measurement Methodologies" in 2005, which later was amended in 2017 [17]. This document delineates the calculation of labor productivity at the national level, by economic sector, by economic activity sector, and by GDP per worker, employing data sources that include working hours of labor productivity, capital productivity, and productivity of multiple factors.

Currently, the national productivity is calculated using the aforementioned methodology and is included in the statistical data compilation. The NSO provides productivity data for the inclusion in the annual publication, the APO Productivity Databook [18]. This report summarizes the findings of a productivity analysis conducted using data from the APO [19], the ILO [20], the NSO [21], and research carried out by Mongolian academics.

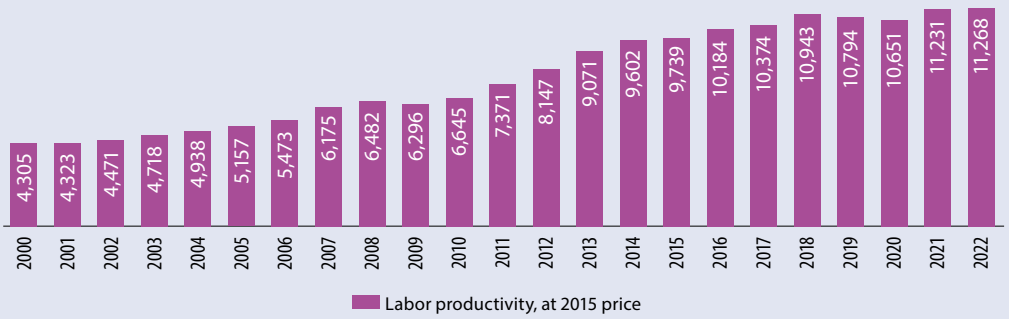
Trends in Labor and Total Factor Productivity (TFP)

Trends of Labor Productivity

According to research, Mongolian labor productivity has a tendency to increase, as illustrated in Figure 6.3. However, when compared on the international stage, it is relatively low. For instance, from 2000 to 2017, Mongolia's average labor productivity stood at USD6,800. In comparison, it is 12.5 times lower than that of high-income countries (USD85,500), 3.2 times lower than upper-middle-income countries (USD21,600), and 1.7 times lower than middle-income countries (USD12,000). In contrast, it is 1.6 times higher than lower-middle-income (USD4,200) and 5.7 times higher than low-income countries (USD1,200) [20].

FIGURE 6.3

MONGOLIA'S LABOR PRODUCTIVITY IN USD



Source: ILO data.

TABLE 6.4

LABOR PRODUCTIVITY BASED ON NUMBER OF EMPLOYEES INDICES OF ASIAN COUNTRIES: WORLD BANK INCOME LEVEL CATEGORIES

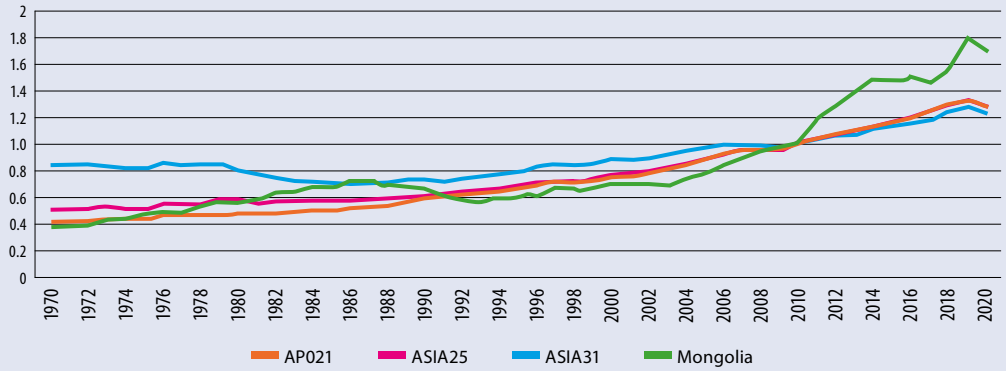
Indicators	Period									
	1970–75	1975–80	1980–85	1985–90	1990–95	1995–2000	2000–05	2005–10	2010–15	2015–20
High-income countries	0.28	0.34	0.41	0.51	0.63	0.72	0.82	0.94	1.03	1.11
Growth rate, %		*21.16*	*20.02*	*26.35*	*23.45*	*13.94*	*13.73*	*14.42*	*9.65*	*7.97*
Upper middle-income countries	0.39	0.45	0.48	0.52	0.63	0.74	0.83	0.96	1.05	1.21
Growth rate, %		*14.17*	*8.07*	*7.63*	*20.80*	*17.83*	*12.43*	*16.07*	*8.49*	*15.25*
Lower middle-income countries	0.47	0.49	0.50	0.53	0.58	0.66	0.75	0.91	1.08	1.30
Growth rate, %		*3.98*	*1.32*	*5.80*	*10.81*	*13.59*	*13.09*	*21.10*	*18.85*	*20.21*
Mongolia	0.39	0.50	0.61	0.68	0.59	0.64	0.69	0.88	1.27	1.58
Growth rate, %		*26.41*	*22.37*	*11.93*	*-13.40*	*8.40*	*8.69*	*27.50*	*43.68*	*24.81*

Source: APO Databook 2022.

Between 1970 and 1990, Mongolia's labor productivity (by the number of employees) averaged 0.58, surpassing that of high-income nations by 42.3%, upper-middle-income countries by 18.6%, and lower-middle-income countries by 9.5%. Early in the 1990s, however, its annual growth rate plummeted to -13.97%. From 1990 to 2010, labor productivity indexes fell short of higher, upper-middle, and lower-middle-income countries by 10.1%, 11.7%, and 3.9%, respectively. Nevertheless, it outperformed the average for each income level after 2010, experiencing exceptional growth (Table 6.4) [18].

FIGURE 6.4

GROWTH TREND OF LABOR PRODUCTIVITY BY NUMBER OF EMPLOYEES



Source: APO Databook 2022.

Figure 6.4 shows the upward trend in labor productivity per employee over the past 50 years, spanning from 1970 to 2020. Between 1970 to 1990, Mongolia's labor productivity growth rate per employee was higher than APO21 countries. However, from 1990 to 2010, it experienced a decline. Nevertheless, since 2010, it has displayed stronger growth compared to both APO21 and ASIA25 countries [18].

TABLE 6.5

LABOR PRODUCTIVITY BASED ON HOURS WORKED INDICES OF ASIAN COUNTRIES: WORLD BANK INCOME LEVEL CATEGORIES

Indicators	Period									
	1970–75	1975–80	1980–85	1985–90	1990–95	1995–2000	2000–05	2005–10	2010–15	2015–20
High-income countries	0.25	0.31	0.37	0.47	0.60	0.69	0.79	0.92	1.04	1.17
Growth rate, %		*23.02*	*20.36*	*26.89*	*26.42*	*15.27*	*14.37*	*17.62*	*12.84*	*12.20*
Upper middle-income countries	0.39	0.44	0.47	0.51	0.61	0.72	0.82	0.95	1.05	1.24
Growth rate, %		*13.26*	*8.38*	*7.88*	*19.76*	*17.96*	*12.85*	*15.91*	*11.45*	*17.64*
Lower middle-income countries	0.47	0.48	0.49	0.52	0.57	0.66	0.75	0.91	1.08	1.29
Growth rate, %		*3.30*	*0.61*	*5.66*	*11.24*	*14.37*	*13.66*	*21.96*	*18.44*	*19.81*
Mongolia	0.32	0.41	0.50	0.56	0.48	0.54	0.63	0.86	1.22	1.40
Growth rate, %		*26.46*	*22.51*	*12.03*	*-14.09*	*12.45*	*15.56*	*37.12*	*41.18*	*15.20*

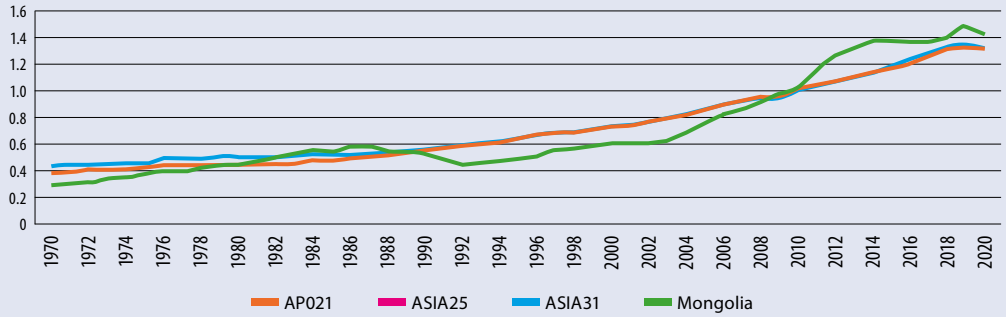
Source: APO Databook 2022.

Between 1970 and 1990, middle-income countries, including Mongolia, saw a more significant increase in labor productivity based on hours worked compared to high-income countries. Mongolia, then a socialist country, boasted labor productivity (hours worked) that was 28.2% greater than that of higher income countries, almost on par with upper-middle-income countries (0.45), and trailing slightly (-8.16%) that of lower-middle-income countries. However, from 1990 to 2010, Mongolia fell behind the high-income, upper-middle-income, and lower-middle-income countries by 15.9%, 18.8%, and 12.8%, respectively. Since 2010, the landscape has shifted. Labor productivity levels are now surpassing the income groups from high to lower-middle by 18.2%, 14.0%, and 10.5%, respectively (Table 6.5) [18].

Comparatively, when measured against high-income, middle-income, and lower-middle-income countries, the level of labor productivity (by hours worked) has decreased by 2.1 times, 1.9 times, and 1.1 times, respectively. It followed a relatively similar trend with APO21 and ASIA25 countries until 1990, after which it fell but began to rise again from 2010 (Figure 6.5) [18].

FIGURE 6.5

LABOR PRODUCTIVITY PER WORKED HOUR GROWTH TREND



Source: APO Databook 2022.

Trends of TFP

In terms of TFP growth, Mongolia fell behind upper-middle and lower-middle-economy countries by 23.5% and 21.7%, respectively, from 1970 to 1990. However, during this period, it remained at the same level as higher-income countries. Subsequently, from 1990 to 1995, the average annual growth rate plummeted to -14.3%, and between 1990 to 2010, Mongolia's TFP growth was lesser than other countries by 12.4% compared to high-income countries, and by 17.6% and 14.6% than upper-middle and lower-middle-income countries, respectively. The trend improved starting from 2010, where Mongolia surpassed other countries in TFP growth. It was greater by 5.9% than high-income countries, by 3.9% than upper-middle-income countries, and 8.4% than lower-middle-income countries (Table 6.6) [18].

According to the graph highlighting the TFP growth trend over the past five decades, spanning from 1970 to 2020, Mongolia saw modest development from 1970 to 1990, followed by a significant decline from 1990 to 1995. Thereafter, consistent rise resumed till 2018. Between 1970 and 2010, Mongolia's TFP rose at a slower rate than the average of the APO21 and ASIA25 countries [18]. However, it quickly surpassed them after 2011, primarily due to the dramatic increase in national output (GDP 17.3% in 2011). This was brought on by substantial investments in the mining sector, particularly the Oyu-Tolgoi project (Figure 6.6).

TABLE 6.6

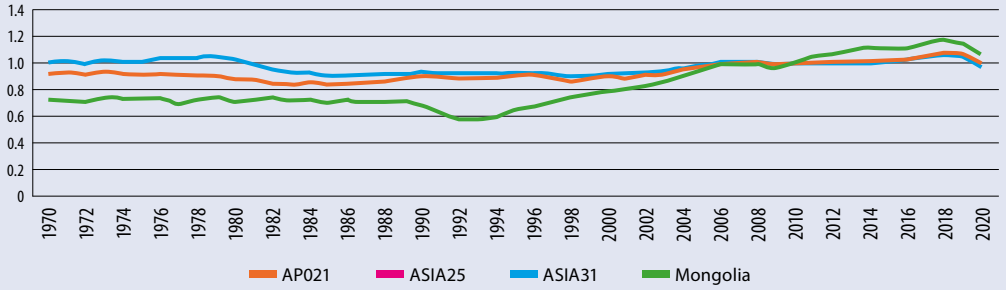
TFP INDICES OF ASIAN COUNTRIES: WORLD BANK INCOME LEVEL CATEGORIES

Indicators	Period									
	1970–75	1975–80	1980–85	1985–90	1990–95	1995–2000	2000–05	2005–10	2010–15	2015–20
High-income countries	0.65	0.70	0.72	0.79	0.86	0.87	0.89	0.97	1.02	1.05
Growth rate, %		*6.43*	*3.88*	*9.18*	*8.18*	*1.35*	*2.84*	*8.31*	*5.16*	*3.89*
Upper middle-income countries	0.97	0.97	0.92	0.92	0.95	0.93	0.94	0.98	1.03	1.08
Growth rate, %		*0.73*	*-5.53*	*-0.31*	*3.34*	*-1.45*	*1.11*	*4.18*	*4.69*	*4.95*
Lower middle-income countries	0.99	0.95	0.88	0.86	0.88	0.89	0.91	0.99	1.00	1.02
Growth rate, %		*-4.12*	*-7.70*	*-2.51*	*2.97*	*0.48*	*2.61*	*8.74*	*1.01*	*2.28*
Mongolia	0.72	0.73	0.72	0.71	0.61	0.71	0.83	0.98	1.06	1.13
Growth rate, %		*0.38*	*-1.07*	*-0.80*	*-14.28*	*15.96*	*17.53*	*17.55*	*8.16*	*6.71*

Source: APO Databook 2022.

FIGURE 6.6

TFP GROWTH TREND



Source: APO Databook 2022.

APO's Productivity Profile of Mongolia

The APO publishes an annual report monitoring and evaluating the productivity metrics of member economies, which build an extensive database. The following summarizes comparative analysis results of Mongolia's productivity indices.

In 2020, Mongolia's labor productivity was USD31,700 (GDP per worker), which was 77% lower that that of the USA level (USD137,500). The country's performance in labor productivity was 12.8% higher than APO21 and 9.3% higher than APO25. It surpassed the lowest level by 5.3 times (USD6,000, Myanmar), but remained -19.2% lower than East Asia and 4.7 times less than the top-performing country (USD150,300, Singapore) (Table 6.7) [18].

TABLE 6.7

CROSS-COUNTRY COMPARISONS OF LABOR PRODUCTIVITY IN 2022

No	Indicators	Mongolia	APO21	ASIA25	East Asia	Top	Lowest level
1	Per worker labor productivity, USD'000, 2020	31.7	28.1	29.0	37.8	150.3 (Singapore)	6.0 (Myanmar)
2	Mongolian comparison		+12.8%	+9.3%	-19.2%	- 4.7 times	+ 5.3 times

Source: APO Productivity Databook 2022.

Based on GDP at constant basic prices per worker and per hour, labor productivity increased annually at a rate of 4.1% from 1970 to 1980, which was higher than the APO21 average of 2.1%. The following two decades (1980 to 2000) saw a decline. However, the upward trend started from 2010s (Table 6.8).

The annual growth of labor productivity per worker reached the highest level (6.1%) in 2017–18 while the annual growth of labor productivity per hour reached its peak (5.8%) in 2018–19.

However, in 2019–20, due to the impact of COVID-19, productivity indicators decreased significantly (4.1%–7.4%). TFP and capital productivity generally showed negative, but they are expected to rebound between 2022 and 2025 (Table 6.8) [2, 18, 21].

TABLE 6.8

LABOR PRODUCTIVITY, CAPITAL PRODUCTIVITY, AND TFP TRENDS IN MONGOLIA

Rates, %	1970–80	1980–90	1990–2000	2000–10	2010–20	2015–20	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2021–25
1	2	3	4	5	6	7	8	9	10	11	12	13	14
LP_w* 1	4.1[1]	1.6	0.6	3.9	5.2	2.8	6.1	4.2	-5.9	-3.4	2.4	5.1	4.7
	2.0[2]	3.0	2.0	2.6	2.2	1.5	2.7	1.2	-3.7	4.5	3.2	2.9	3.2
LP_h**	4.1[1]	1.6	1.4	5.0	3.5	0.9	2.2	5.8	-4.1	1.1	1.8	4.6	4.2
	2.1[2]	2.9	2.1	2.7	2.4	1.7	3.0	1.2	-3.3	4.0	3.3	2.9	3.2
CP	-6.2[1]	-6.1	0.0	-4.0	-5.6	-3.4	-4.3	-6.5	-5.2	-1.8	-0.7	2.1	1.6
	-6.0[2]	-5.1	-4.2	-3.5	-4.1	-4.2	-4.4	-4.3	-3.8	2.0	0.1	-0.4	-0.1
TFP	-0.2[1]	-0.5	1.6	2.3	0.7	-0.8	2.2	-1.9	-7.4	-0.4	-0.5	2.3	1.9
	0.1[2]	1.0	0.3	1.0	0.2	-0.4	1.1	-0.7	-5.5	2.6	1.4	1.0	1.3

Source: APO Productivity Databook 2022, Mongolian Statistical Information Service, 2022.
Note: *By average annual growth rate in percentage, since 1970.
LPw* - Per Worker Labor Productivity, LPh** - Per Hour Labor Productivity;
[1]- data of Mongolia, [2] - data of APO21; (11–14) - data of projection.

Decomposition of Output Growth

Identifying the drivers of economic growth is necessary for the formulation of appropriate macroeconomic development policies, including policies increasing productivity and upgrading innovation.

Labor, capital, and TFP are the primary drivers of national output growth. The impact of these factors on Mongolia's GDP growth is calculated based on the data from the APO productivity report (Tables 6.9 and 6.10) [18].

The following indicators are considered:

- GDP growth, 1970–2020
- Sources of economic growth:
  - TFP growth
  - Labor composition (Labor quality, Worked hours)
  - Capital accumulation (Non-IT capital and IT capital)

The analysis results show that before the 1990s, output growth had been driven mostly by non-IT capital accumulation (contributing 46.2% to 76.3%) and had a substantial contribution from labor composition (ranging from 20.6% to 49.2%) while TFP growth demonstrated lower contributions (1.5% to 4.6%), or even negative influences down to -23.9% (1985–90) [18].

During the first five years (1990–95) of transitioning to a market economy, profound societal and economic changes led to a dramatic decline in economic performance. Output reduction was mainly due to the decrease in labor (-72.2%) and TFP (-27.8%) [18].

Starting from 1995, the country's economy gradually recovered and demonstrated annual growth of 3.6%. The increase in TFP (102.7%) contributed greatly to this growth (6.2% for APO21) while the non-IT capital accumulation had a negative influence at -2.7% (compared to 46.9% for APO21) [19].

Between 2000 and 2005, the contribution of TFP growth to the country's economic growth was much higher (58.7%) than among the APO member economies (28.6%). However, it showed a declining trend, reaching 14.1% (2005–10) and 21.7% (201–15). In 2015–20, TFP had a negative influence, recording -26.7% (-15.4% for APO21) [18].

On contribution of labor composition, it demonstrates nonstable contributions to economic growth. For example, the readings for different time periods are highlighted as following [18]:

- Before the 1990s, contribution rate ranged from 20.6% to 49.2%
- 1990–95, it was negative (-79.2%)
- 1995–2000 chartered zero
- 2000–05 recorded +23.8%
- 2005–10 showed +6.3%
- 2010–15 marked +22,6%
- 2015–20 reached 50.0% (34.7% for APO21)

The contribution of capital accumulation, especially non-IT capital, consistently demonstrated a high, stable, and positive influence, ranging from 81.5% to the country's output growth over the years, similar to APO member economies (30.9% to 76.9%) [18].

Capital accumulation related to IT capital had a lower contribution to economic growth compared to the APO member economies (contributing 2.1% to 9.4%). For Mongolia, its contribution has remained consistently lower, starting from the 2000s and maintaining levels between 0% to 10%, in comparison to other contributing factors [18].

TABLE 6.9

GDP GROWTH AND CONTRIBUTION OF LABOR, CAPITAL, AND TFP IN 1970–2020

Rates (%)	1970–75	1975–80	1980–85	1985–90	1990–95	1995–2000	2000–05	2005–10	2010–15	2015–20
Output growth	6.5[1]	5.4	6.6	3.8	-1.8	3.6	6.3	6.4	9.8	3.0
	4.9[2]	4.4	4.7	5.7	4.2	3.2	4.2	4.2	4.0	2.6
TFP	0.3[1]	-0.8	0.1	-0.9	-0.5	3.7	3.7	0.9	2.1	-0.8
	0.3[1]	0.0	0.6	1.4	0.4	0.2	1.2	0.8	0.7	-0.4
Labor quality	2.6[1]	0.7	0.4	0.3	-0.2	0.0	1.0	0.3	1.1	0.8
	0.3[2]	0.4	0.5	0.6	0.5	0.5	0.7	0.7	0.8	0.5
Worked hours	0.6[1]	0.9	0.9	1.5	-1.1	0.0	0.5	0.1	1.1	0.7
	1.3[2]	1.5	1.2	1.2	0.9	0.7	0.8	0.7	0.5	0.4
Non-IT capital	3.0[1]	4.4	5.2	2.9	0.0	-0.1	0.8	4.7	5.4	2.0
	2.9[2]	2.4	2.2	2.2	2.2	1.5	1.3	1.8	1.9	2.0
IT capital	0.0[1]	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.3
	0.1[2]	0.1	0.2	0.3	0.2	0.3	0.2	0.2	0.1	0.1

Source: APO Productivity Databook (2022).
Note: %, average annual growth rate, [1]- data of Mongolia, [2]- data of APO21.

TABLE 6.10

CALCULATION OF DECOMPOSITION OF OUTPUT GROWTH IN 1970–2020

Rates (%)	1970–75	1975–80	1980–85	1985–90	1990–95	1995–2000	2000–05	2005–10	2010–15	2015–20
Output growth	100.0[1]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	100.0[2]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TFP	4.6[1]	-11.0	1.5	-23.9	-27.8	102.7	58.7	14.1	21.7	-26.7
	6.1[1]	0.0	12.8	24.5	9.5	6.2	28.6	19.0	17.5	-15.4
Labor quality	40.0[1]	13.0	6.1	7.9	-11.1	0.0	15.9	4.7	11.3	26.7
	6.1[2]	9.1	10.6	10.5	11.9	15.7	16.7	16.7	20.0	19.3
Worked hours	9.2[1]	16.7	13.6	39.5	-61.1	0.0	7.9	1.6	11.3	23.3
	26.5[2]	34.1	25.5	21.1	21.4	21.9	19.0	16.7	12.5	15.4
Non-IT capital	46.2[1]	81.5	78.8	76.3	0.0	-2.7	12.7	73.4	55.7	66.7
	59.2[2]	54.5	46.8	58.6	52.4	46.9	30.9	42.8	47.5	76.9
IT capital	0.0[1]	0.0	0.0	0.0	0.0	0.0	4.8	6.2	0.0	10.0
	2.1[2]	2.3	4.3	5.3	4.8	9.4	4.8	4.8	2.5	3.8

Source: APO Productivity Databook (2022).
Note: Contribution in %; calculated based on the APO's Productivity Data; [1]- data of Mongolia, [2]- data of APO21.

Findings from Mongolia's Productivity Analysis

Since 2000, Mongolia's productivity level has shown an upward trend. The results of an international comparison show that it is still at a relatively low level.

The average annual growth of labor productivity (per worker labor productivity) from 1970 to 1980 was 4.1%. When compared to other APO member economies, it was significantly higher than the APO21, which stood at 2%. Nonetheless, during the first decade (1990–2000) of the country making the transition to a market economy, the average annual growth of labor productivity per worker and per hour was 0.6% and 1.4%, respectively. These figures were much lower than the APO average (APO21 +2.0% and +2.1%). However, from 2000 to 2020, productivity measures grew and surpassed the APO average (average annual growth of labor productivity per worker +5.2%/APO21 +2.2%, labor productivity per hour +3.5%/APO21 +2.4%, and TFP +0.7%/APO21 +0.2%).

All productivity indices for 2019–2020 have declined as a result of the COVID-19 pandemic. Some examples are:

- Labor productivity per worker: -5.9% (APO21 -3.7%)
- Labor productivity per hour: -4.1% (APO21 -3.3%)
- Capital productivity: -5.2% (APO21 -3.8%)
- TFP: -7.4% (APO21 -5.5%)

Per worker labor productivity is expected to increase by 4.7% (APO21 +3.2%), per hour labor productivity by 4.2% (APO21 +3.2%), capital productivity by 1.6% (APO21 -0.1%), and TFP by 1.9% (APO21 +1.3%) between 2021 and 2025, according to the APO estimates.

Although the increase of capital productivity and TFP is slower in Mongolia than the average level among APO21 countries, the average annual growth of labor productivity remains relatively higher.

INNOVATION DEVELOPMENT OF MONGOLIA

Innovation and National Innovation System (NIS) Studies

The term "national innovation system" (NIS), which refers to an institutional ecosystem for innovation, is frequently used in economic literature and policy papers. Many countries around the world consider the creation of the NIS as a top priority mission for their national science, technology, and innovation policies.

The concept of NIS was first defined in 1987 by C. Freeman as "a network of institutions in public and private sectors, whose activities and interactions initiate, import, modify and diffuse new technologies" [22]. Although there is no single definition of NIS, Mongolia generally adheres to the one adopted by the OECD in 1995, by S. Metcalfe (1998), which reads: "... that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills, and artifacts which define new technologies" [23].

Since the 1990s, the theory of market economy and practice had been used to study socioeconomic development issues in Mongolia. Here are the highlights of the existing works on innovation development being done:

- Davaasuren B. (1994) [24] on enhancing university academic research in conformity with market circumstances
- Otgontsetseg L. (1999) [25] and S. Tugs (2000) [26] studied about technology management development issues
- Enhbaigal B. (2003) [27] on development of the knowledge-based economy
- Molomjamts D. (2007) [28] studied issues about restructuring science, technology, and innovation investment financing
- Ganzorig B. (2008) [29] on enhancing state regulation and the utilization of foreign direct investment (FDI)
- Oyuntsetseg L. (2009) [30] investigated the issue of the formation and development of a NIS in Mongolia

Innovation and its application studies are still ongoing and have become quite a trending topic since the 2010s. The knowledge base on this subject continues to be expanded by young researchers, such as Zaya M. (2016) [31], Munkhuu N. (2016) [32], Erkhemtugs J. (2016) [33], Odmaa P. (2017) [34], Burmaa M. (2018) [35], Ariunjargal B. (2018) [36], and Jargal G. (2019) [37] further extending the knowledge base in this field.

The government commissioned various research projects in the areas of NIS, start-up business growth, and building ecosystems, resulting in publications and reports [38–46], such as:

- "Current Situation of the Mongolian S&T Sector" (2017), assessment report, Ministry of Education, Culture, Sports, Science (MECSS) of Mongolia (Working group for state policy for development of S&T)
- "Evaluation of the Legal Environment of Innovation in Mongolia" (2017) - assessment report, MECSS of Mongolia (Working group for state policy for innovation development), 2017–2018
- Study of Youth Employment Status and Start-up Business Development Environment - assessment report, Ministry of Labor and Social Security of Mongolia, Youth employment promotion project, 2017
- "Current Situation of Development of Mongolian Universities" (2018) - assessment report, MECSS of Mongolia (Working group for developing the national program on research-based university), 2017–2018
- "Current State of Innovation Development in the Ulaanbaatar City" (2018) - assessment report, Capital city governance office, MUST, Graduate School of Business, 2017-2018
- "A Feasibility Study of National Center for Technology Transfer", National Development Agency of Mongolia, MUST, Research office, 2020

- "A Feasibility Study on Mongolian Apparel and Sewing Industry National Sectoral Database and Industry Diversification" - Ministry of Food, Agriculture and Light industry of Mongolia, ADB, Agriculture and Rural Development Project, 2020

- "Development of a Pilot Model for a National System to Support Innovation Development" - research report, MECS, Foundation for Young Researchers NGO, Socrates Start-up Studio, 2022

- "Baseline Survey of the Mongolian Start-up Ecosystem" - research report, for JICA by Mongolian Marketing Consulting Group, 2022

The findings from the aforementioned research activities were taken into account when drafting this report.

A Conceptual Framework and Methodology for Assessing NIS

This segment elaborates on the steps and logic behind the dynamic analysis of the country's innovation performance. In this work, the results are summarized in the following order:

i) Policy and regulations analysis results

ii) Innovation and NIS performance in Mongolia

- Country's level of innovation development: International comparison
- Evaluation of NIS
- Development of innovation infrastructure and start-up ecosystem of Mongolia
- Summary of Mongolia's innovation and NIS development

iii) Regression analysis of productivity and innovation performance

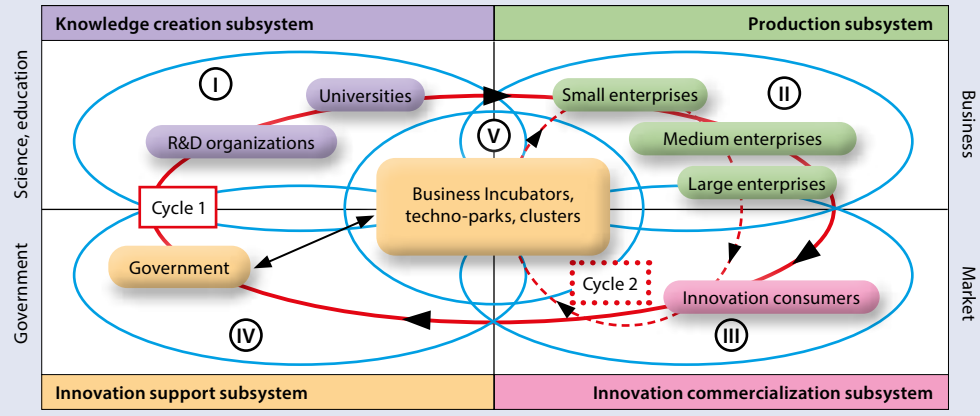
In the analysis of policy and regulations, content analysis methods were used. The evaluation of the country's innovation and NIS utilized an integrated assessment methodology and the conceptual framework proposed by Dr. Oyuntsetseg L. (2009). Comparative analysis was also employed to position Mongolia in the global innovation landscape.

The integrated assessment methodology aims to provide a comprehensive index for monitoring NIS performance, reflecting the level of national innovation development and the maturity of the NIS.

The conceptual framework for this methodology is shown in Figure 6.7, which was used as a roadmap for understanding and analyzing the NIS. The basic NIS model is often used to assist stakeholders in understanding their roles and objectives in order to be productive participants while allowing them to grasp the big picture of the NIS [30, 47].

FIGURE 6.7

BASIC MODEL OF NIS



Source: Oyuntsetseg L. (2019).
Note: i) Science education block, ii) Production block, iii) Innovation usage block, iv) Control regulation block, v) Innovation infrastructure block. Cycle-1: Fundamental science research cycle, Cycle-2: Commercialization cycle.

The NIS is composed of four subsystems categorized by their activity orientation and five blocks made up of organizations with common functions (Table 6.11). In other words, it is modeled to clearly illustrate the connection between the actors and the innovation activities, shown as Cycles I and 2 in Figure 6.7 [30].

TABLE 6.11

COMPONENTS, FUNCTIONS, AND ACTORS OF THE BASIC MODEL OF NIS

	System Components and Blocks	Main Functions	Main Actors
I	Knowledge creation subsystem (I-Science education block)	Knowledge creation and preparation of innovation human resources (researchers, engineers, technical specialists, designers, managers, and others) and expansion of the innovation awareness and innovation culture in society.	- Universities, higher education institutions (HEIs) - Academia, research institutions, labs, and others
II	Innovation production subsystem (II-Production block)	Application of innovative ideas and technological know-how to develop new products, services, and technologies that will meet societal and individual needs.	- SMEs, big companies - Manufacturers - Start-ups
III	Innovation market subsystem (III-Innovation commercialization block)	There are three types of markets: production factor market, end-user market, and public procurement market. The government may use its purchasing power to encourage businesses to innovate.	- Businesses - Government organizations - Consumers
IV	Innovation support subsystem (IV-Innovation regulation and V-Innovation infrastructure blocks)	The innovation regulation block serves a strategic and governing purpose by fostering cooperation among the NIS stakeholders and coordinating innovative initiatives under legal regulations. The innovation infrastructure block serves as the primary node, where the simultaneous interaction of four subsystems happens. When matured, it will be possible to utilize the skills, assets, and resources engaged in innovation activities in a strategic and effective way.	- Government, legislation bodies - Funding and investment entities - Innovation infrastructure entities, such as business incubators, start-up business accelerators, technology transfer offices, and S&T parks

Source: Oyuntsetseg L. (2009).

Evaluation and monitoring indicators of the NIS are elaborated in Table 6.12. Dr. Oyuntsetseg L. employed this methodology for her research works that were published in 2009 [30] and 2019 [47], using the data from NSO [21], Ministry of Education, Culture and Science [48] as well as data and reports from international organizations, such as World Bank [49], ADB [50], OECD [51], WEF [52], World Intellectual Property Organization (WIPO) [53], and the APO [19]. The results are shown in the next segment.

TABLE 6.12

NIS EVALUATION INDICATORS

No.	Indicators		Symbol
I.	**NIS capability (K_{nis})**		
1.1	Innovation capability (K_{ipo})	1.2.1. Human resource	K^1_{ipo}
		1.2.2. Material and technical resources	K^2_{ipo}
		1.2.3. Financial resources	K^3_{ipo}
		1.2.4. Information resources	K^4_{ipo}
		1.2.5. Organizational resources	K^5_{ipo}
		1.2.6. Sociocultural resources	K^6_{ipo}
II.	**NIS function (F_{nis})**		
2.1	Knowledge creation subsystem (K_{kg})	2.1.1. Scientific institutions (research institutes, laboratories, universities, etc.)	K^1_{kg}
		2.1.2. Science and technology base	K^2_{kg}
		2.1.3. Funding and resource allocation	K^3_{kg}
		2.1.4. The number of scientific publications	K^4_{kg}
2.2	Innovation production subsystem (K_{pi})	2.2.1. Industry technology competitiveness	K^1_{pi}
		2.2.2. Level of production technology	K^2_{pi}
		2.2.3. Material-technical base for production	K^3_{pi}
		2.2.4. Innovation activity of manufacturers	K^4_{pi}
		2.2.5. SME development and innovation activity	K^4_{pi}
2.3	Commercialization subsystem (K_{im})	2.3.1. Development of market mechanisms	K^1_{im}
		2.3.2. Innovation market development	K^2_{im}
		2.3.3. Innovation market size and capacity	K^3_{im}
		2.3.4. Competition	K^4_{im}
		2.3.5. Market regulation	K^5_{im}
2.4	Innovation support subsystem (K_{si})	2.4.1. Innovation infrastructure (business incubator, innovation center, technology transfer center, science and technology park, consulting services, etc.)	K^1_{si}
		2.4.2. Level of ICT infrastructure (internet access, IT literacy level, affordance of computers and other devices)	K^2_{si}
		2.4.3. Sophistication of the financial system (accessibility of low-cost financing, availability of other financial services, stock market development)	K^3_{si}
		2.4.4. Formation of the legal framework for innovation activities (effect of law and regulatory measures)	K^4_{si}
		2.4.5. Government intervention in innovation activities (innovation policies, programs, projects, and incentives)	K^5_{si}

No.	Indicators		Symbol
III.	**NIS effectiveness (R_{nis})**		
3.1	NIS effectiveness (R_{nis})	3.1.1. Number of patents, know-hows, published papers in scientific journals	R_{nkg}
		3.1.2. Number of innovative product production	R_{np}
		3.1.3. Number of technology transfers	R_{nt}
		3.1.4. New market development	R_{nm}
		3.1.5. Number of R&D works	R_{rd}
IV.	**Environment: Innovation environment/Innovativeness of NIS environment (F_{si})**		
4.1	Integration level within NIS (K_{int})	4.1.1. Internal integration level within the NIS: The presence of knowledge and technology transfer mechanism (cycle of research and commerce)	K^1_{int}
		4.1.2. Level of innovation integration within the country (NIS - national economy, NIS - society, NIS - government)	K^2_{int}
		4.1.3. International innovation cooperation level (contacts, cooperation level, number of joint projects, etc.)	K^3_{ins}
4.2	Innovation environment (K_{ins})	4.2.1. The innovation climate within the NIS	K^1_{ins}
		4.2.2. Innovation culture of the public	K^2_{ins}
	Integrated Index of NIS status (E_{nis})		
	Integrated index of NIS status	The evaluation will be conducted using the qualitative method by the following formula: $E_{nis} = f(F_{gov}, F_{sis}, R_{nis}, F_{si})$ $\text{Emis} = \prod_{i=1}^{n} \left[x_i^{-\left(\frac{w_i}{x_i}\right)} \right]$	

Source: Oyuntsetseg L. (2019).

While comprehensive, the evaluation process relies on qualimetric analysis, posing challenges in collecting consequential data from multiple sources.

DYNAMIC ANALYSIS OF INNOVATION PERFORMANCE

Policy Regulations for the Promotion of Innovation Development

A number of legal acts and programs connected to the formulation of state policy and its implementation has been adopted in the context of the current state of the legal environment in Mongolia's science, technology, and innovation (STI). The legal framework for innovation can be classified into the following areas [30, 47], which encompass:

- **Legislation** - Currently, there are more than 10 laws related to STI in Mongolia
- **State and government policy documents** - Over the past 30 years, Mongolia produced more than 100 policy documents, which are development concepts, policies, main directions, strategies, and national programs, including development policy and planning legal documents of the national economy and sectors
- **Regulatory documents by authorities** - This section includes documents, such as rules and regulations approved by the local government and executive authorities related to STI. Some researchers proposed that the government should be more diligent on delivering long-due regulations for innovation funding, taxation, and statistical data collection on R&D activities in the private sector, among others

Box 6.2. Key legislative documents for promoting innovation development in Mongolia

I. Legislation

1. Constitution of Mongolia, 1992
2. Environment Protection Act, 1995
3. Law on Legal Status of Mongolian Academy of Science, 1996
4. Technology Transfer Act, 1998
5. National Security Act, 2001
6. Higher Education Act, 2002
7. Civil Law, 2002
8. Corporate Income Tax Act, 2006
9. Law on Science and Technology, 2006
10. Law on Patenting, 2006
11. Intellectual Property Protection Act, 2006
12. Law of Mongolia on Property Appraisal, 2010
13. Law on Company, 2011
14. Law on Innovation, 2012
15. Law on Development Policy Planning, 2015

II. Government Policy Documents

i. Development concepts

1. National Development Concept of Mongolia, 1996
2. Regional Development Concept, 2001
3. Millennium Development Goals of Mongolia, 2005
4. Comprehensive national development policy based on Millennium Development Goals, 2008
5. Concept of development of ICT until 2010, 2009
6. National Security Concept, 2010
7. Concept of foreign policy, 2011
8. Concept of sustainable development-2030, 2016

ii. Development policies

1. Technology Policy, 1996 (Revised, 2021)
2. State Policy on SSC, 1998 (Revised, 2017)
3. Heavy Industry Development Policy in Mongolia, 2006 (Repealed, 2021)
4. State policy on high-tech industries, 2010 (Repealed, 2021)
5. Green Development Policy, 2014 (Repealed, 2021)
6. Government policy in the field of mineral resources, 2014 (Repealed, 2021)
7. State Industrial Policy, 2015 (Repealed, 2021)
8. State Policy on SSC, 2017 (Repealed, 2021)
9. State Innovation Policy, 2018 (Repealed, 2021)
10. Three Pillar Development Policy, 2018 (Repealed, 2021)
11. "Vision - 2050 long-term development policy of Mongolia" (Res. 52, 2020)

iii. Main direction and strategy

1. The main direction of establishing an industrial technology park in Mongolia, 2003
2. The main direction of the government of Mongolia, 2004–2007
3. Medium-term socioeconomic development strategy of Mongolia, 2006–2009
4. National Strategy for Promotion of Private Sector Development, 2011
5. Priority areas of innovation activities, 2020–2025

iv. Development program and master plan

1. Education Development Master Plan, 1993
2. National program to support the development of SMEs, 1996
3. 21st century sustainable development program, 1998
4. Biotechnology Development Program, 1998
5. Export Production Promotion Program, 1998
6. National Program for the Development of Mongolia's SSC until 2010, 2000
7. National Program to Support the Development of SMEs, 2005
8. Masterplan for the Development of Education in 2006–2015, Ministry of Education and Culture, 2006
9. Master plan for development of SHUT in 2007–2020, 2007
10. National program for the development of IIT in Mongolia (2008–2015), 2007
11. Industrialization 21:100 national program, 2018
12. National Program for the Development of Research-based Universities, 2018

III. Regulatory documents by authorities

1. Regulation on S&T projects, 1998
2. Comprehensive regulation on S&T and industrial association (corporation), 1998
3. Regulation on technology level assessment, 1998
4. Regulations for the implementation and financing S&T projects, 2005
5. Regulation for the S&T National Council, 2007
6. Procedures for S&T project implementation, 2014
7. Rules for establishing a start-up company under the research organizations, 2014
8. Procedure for awarding grants to the innovation activity participants, 2018
9. Regulation on national innovation award procedure, 2018

The following is a summary on the important legal acts and documents related to STI.

According to the Constitution of Mongolia (January 13, 1992), science, technology, and intellectual heritage are protected by the state. It is declared that the intellectual work created by a citizen is his property and the wealth of Mongolia (Chapter 7, Clauses 1, 2). In addition, chapter 16 declares the fundamental rights and freedoms of Mongolian citizens, and states that Mongolian citizens have the right to carry out cultural, artistic, scientific and technological activities, to create works, and to gain profit by doing so. Copyrights, inventions, and discoveries are protected by law (clause 8). The government is responsible for ensuring the enforcement of laws and regulations, providing administration for the economic, social, and cultural development of the country, determining the main areas of social and economic development, drafting legislation to the legislature, the State Great Khural ("Parliament"), developing a unified policy for science and technology (S&T), state budget, finance, and credit (Chapter 38, Clause 2-2.2). The Law on National Security (2001) states that the science and technical security is a component of the national security (3.4.5).

The Law on Innovation (2012) defines the purpose of the law as "to regulate relationships related to the principles, management, organization, financing, state support, ownership and use of intellectual property (IP) in economic circulation, and establishment of legal basis for innovation". The legislation consists of the Constitution of Mongolia, the Law on Science and Technology, the Law on Higher Education, the Law on Company, the Law on Patenting, the Law on the Legal Status of Industrial and Technological Parks, the Law on Property Appraisal, and other legislative acts. In addition, the administrative system of innovation activities consists of the government, ministries, agencies, the National Council of Science and Technology, and local administrative organizations.

Approved in 2016, the "Sustainable Development Concept of Mongolia - 2030" emphasized high productivity where cutting-edge technologies were to be introduced in every sector. It also supported and encouraged new types of goods, production, and services that incorporated innovation; supported production that was resource-efficient and had low greenhouse gas emissions and waste; and strictly adhered to the fundamentals of economy and efficiency in all economic and social sectors [54]. It further aimed to progress the industry through creativity, technology, and advanced practices, in addition to increasing productivity in three phases. However, it was annulled by decree No.52 in 2020, and the most of the principles were subsequently integrated into the country's "Vision 2050".

In the "Vision 2050 long-term development policy of Mongolia" of 2020, it is stated that "... the new economy differs from the traditional economic growth model based on capital accumulation by formulating knowledge, technology, entrepreneurship, and innovation as the main drivers of economic growth" and determined the goal to develop internationally competitive national science, technology, and innovation system (2.4). The stages of implementation and expected results under this objective are [55]:

- **Stage I (2021–30)** - The period to develop S&T as one of the key factors of the country's sustainable development and establish an effective NIS

    - Create an enabling environment for a partnership between state-science-production and businesses underpinned by a multisource financing system of research, development, and innovation in order to use knowledge as an economic asset

    - Expand the infrastructure for the development of STI priorities and set up a system to use knowledge as an economic asset

    - Reform incentives scheme for research, set up a national structure to prepare skilled scientists, and increase the opportunities for their participation in major international researches

- **Stage II (2031–40)** - The period to create appropriate setting for the introduction of national science and innovation products to the world market

  - Increase funding, resources, and other support to the priority areas of science and innovation, including nano, bio, information technology, and artificial intelligence (AI), and bring the standards of green, e-economy, intellectual production up to the regional requirements

  - Introduce incentives to prepare world-renowned scientists and expand opportunities for their participation in international research

- **Stage III (2041–50)** - The period to develop a S&T sector competitive on the world market

  - Bring the development of the following priority areas, such as nano, bio, IT, AI as well as green, e-economy, and intellectual industry up to world standards

  - Support the development of high technology research and increase the share of S&T products in the total export

In 2020, the government of Mongolia approved (Res. 95) "Priority areas of innovation activities, 2020-2025" and defined five leading technologies for development (Table 6.13) [56].

TABLE 6.13

MONGOLIA'S PRIORITY OF INNOVATION ACTIVITIES

No.	Priority Areas	Priority Technologies
1.	IT	Development of AI and products based on AI Big data processing, protection, and product development
2.	New material technology	Deep processing of leather, wool, and cashmere Production of insulation materials New fuel materials
3.	Biotechnology/industrial technology	Processing agricultural and natural raw materials into food, human medicines, vaccines, and products using modern biotechnology methods Making animal medicine reagents, vaccines, and plant protection preparations
4.	Renewable energy technology	Energy storage technology Buildings based on energy-saving and efficiency technology
5.	Cultural innovation and creative industry with national specifications	Content and cultural services based on digital technology (3D content and films with national features based on national history, heritage, culture, and tradition) Development of government and business products and services based on smart technology

In the innovation law of Mongolia, it is included that the government will support innovation activities in the following ways, including:

- Financing a certain percentage of the loan interest for the implementation of innovative projects

- Funding the cost of patenting innovative products to relevant domestic and foreign organizations

- Calculating accelerated depreciation of property for a start-up company that will exclusively engage in innovation activities

- Regulating the provision of services under preferential conditions to the company exclusively engaged in innovation activities with the laboratory equipment of the state-owned academic institution in accordance with the procedure approved by the government

- If 60% or more of the total cost of the project is financed with own funds, the remaining part will be financed irrevocably from the innovation financing organization and the local budget

- Issuing a guarantee from the Investment and Development Fund for the financing of export-oriented innovative product production

- Financing the cost of certification of international quality standards of innovative products aimed at export in whole or in part from the Investment and Development Fund

- Support of domestically produced innovative products through government procurement

- Organization of trade fairs, conferences, and seminars; organizing and financing activities to promote knowledge and culture of innovation in cooperation with public organizations

- Providing monetary incentives to patent holders engaged in innovative activities and created production and services of highly efficient social and economic products

- National innovation awards for innovative products and services that have made a significant contribution to social and economic development

With the Law on Innovation being enacted in 2012, innovation activities became legally regulated and started making significant progress. However, there are still some weaknesses pertaining to the regulation of document approval. Some of the identified shortcomings are:

- Concept of the first version of the law underwent some principal changes during the approval stage

- Issue of venture capital and venture fund formation, which are the main source of financing for innovative activities, is not fully covered (except for a special group)

- Enforcement of the Innovation law was inadequate due to the untimely or nonexisting link between the related laws and regulations

Therefore, it is necessary to introduce relevant amendments and changes to the Law on Innovation and improve its legal capacity. This law should clarify:

- Principles, management, and organization of innovative activities

- Innovation financing

- State support for the development of innovation

    - Legal basis of activities of government, scientific, educational, business organizations, and nongovernmental organizations operating in the sphere of economic circulation, ownership, and use of intellectual property

    - Constituents of the NIS consist of activities of the main subjects, such as the state, science, education, business organizations, and nongovernmental organizations, and the relationship between them should be clarified

The Law on Innovation should also reflect the best possible regulation for the entire invention process and activity, which is divided into four primary stages: knowledge creation, transfer, creation of innovation, and commercialization and use. Consequently:

- It should clarify the principles of innovation activities, management, organization, financing, state support, and legal regulations that will comprehensively solve the issues of economic circulation, ownership, and use of IP

- It should establish the legal basis for the activities of government, science, education, business organizations and nongovernmental organizations. It should also determine the participants in innovation activities and the constituents of the NIS as well as the relationship between them

Consideration should also be given to the problem of identifying the legal status of new organizations that create innovation infrastructure, such as academic and research institutions, technological companies, business incubators, and technical and scientific parks. The legal system falls short in this regard. To protect the interests of academic staff, researchers, and innovators as well as to develop S&T in the region while safeguarding the IP rights of discoveries, there is an urgent need to enhance the laws that define the status of these organizations, legalize them, and create a legal environment that allows their growth and operation.

Laws and regulations in the areas of depreciation, tax benefits, exemptions, and customs control serve as the legal foundation for the financial incentive to accelerate the development of the S&T and innovation sector. At present, Mongolia lacks an efficient system to promote S&T and innovation initiatives.

In light of the above, it can be concluded that while state policies and legal documents partially address the fundamental problems in advancing STI in the country, the legal framework for these areas still falls short of the necessary requirements.

There are numerous aspects that need to be evaluated, amended, and improved. However, the aforementioned legal actions significantly contribute to create a favorable environment for the growth of STI. It should be highlighted that despite the fact that the applicable rules and regulations have been developed to an appropriate level, there exists gaps from a number of typical flaws, including confusing or inadequate implementation procedures.

To address these shortcomings:

- Clarity is needed regarding the regulation of the right to use the results of research and IP funded by the state budget. Regulations should encompass the use of government information and unpublished scientific research results (scientific reports, scientific and technical documents, etc.) as well as provide legal protection for the copyright of scientific and technical information distributed through internet and other media channels

- Measures should be taken to improve the quality of research work and the quality of intellectual work by establishing a unified electronic database of academic works to be published domestically, register academic articles, research reports, postgraduate and doctoral dissertations, and other academic works. Professional review activities should conform to international standards and the issue of copyright protection should be more effectively addressed

- Statistical information and reporting system on scientific research and innovation, especially in the private sector, is not fully formed. The methodology for assessing IP and including it in the financial accounting balance sheet is not sophisticated and implementation is insufficient

- Necessary measures in the framework of tax incentives, customs, financial control, and technical regulation aimed at supporting STI activities are not implemented, including the approved laws and regulations are not properly executed

- Legal regulations to address problems related to the creation and trade of scientific and technological products and services, their development and supply, especially for government needs, through contracts and agreements for joint licensing and research and development (R&D) work, have not been established

- Conditions required for the creation and development of innovative venture-investment and leasing mechanisms are not well formed

- Conditions for innovation and technology transfer, commercialization, formation of IITs, and development of innovative entrepreneurship are not provided

- There is a significant lack of statistical information on innovation resources, capabilities, activities, and their results, especially within the private sector, and weak regulation of this aspect

Therefore, the government must improve the legal environment to intensify innovation activities, regulate interactions among system subjects, and protect their rights and interests, particularly the protection of IP rights as to establish and strengthen the NIS.

Innovation and NIS Performance in Mongolia

Country's Level of Innovation Development: International Comparison

WIPO has developed a methodology for assessing innovation indicator, the Global Innovation Index (GII), which ranks countries according to their innovation capabilities [53]. The GII consists of 80 indicators, grouped into innovation inputs and outputs, aiming to capture the multidimensional facets of innovation.

According to GII in 2021, Mongolia ranked 58th among the 132 countries, fifth among the 34 lower middle-income group economies, 12th among the 17 economies in Southeast Asia, East Asia, and Oceania (Table 6.14) [53].

TABLE 6.14

RANKINGS FOR MONGOLIA IN 2019–21

Year	GII	Innovation Inputs	Innovation Outputs
2021	58	65	55
2020	58	65	54
2019	53	73	44

Source: GII report, WIPO, 2021, Mongolia.

The GII report highlighted that Mongolia performed better in innovation outputs than innovation inputs in 2021, ranking 65th in innovation inputs, which was higher than 2019.

Table 6.15 gives an overview of the strengths and weaknesses of Mongolia in the GII 2021 [53].

TABLE 6.15

INNOVATION PERFORMANCE OF MONGOLIA IN 2021

Strengths			Weaknesses		
GII Article No.	Indicator	Rank	GII Article No.	Indicator	Rank
1.2.3	Cost of redundancy dismissal	18	1.3.2	Ease of resolving insolvency	120
3.2.3	Gross capital formation, % GDP	14	2.3.2	Gross expenditure on R&D, % GDP	104
4.1	Credit	15	2.3.3	Global corporate R&D investors, top 3, USD'million	41
4.1.3	Microfinance gross loans, % GDP	1	2.3.4	QS university ranking, top 3	74
5.1.2	Firms offering formal training, %	4	3.2.2	Logistics performance	116
5.1.5	Females employed w/advanced degrees, %	18	5.1.3	GERD performed by business, % GDP	87
5.3.4	FDI net inflows, % GDP	6	5.2	Innovation linkages	123
6.1.3	Utility models by origin/bln PPP$ GDP	1	5.2.4	Joint venture/strategic alliance deals/bln PPP$ GDP	114
7.1	Intangible assets	11	6.1.2	PCT patents by origin/bln PPP$ GDP	98
7.1.1	Trademarks by origin/bln PPP$ GDP	1	6.2	Knowledge impact	124
7.1.3	Industrial designs by origin/bln PPP$ GDP	1	6.2.5	High-tech manufacturing, %	99
7.2.2	National feature films/mn pop. 15–69	3	7.1.2	Global brand value, top 5,000, % GDP	80

Source: GII report, WIPO, 2021, Mongolia.

The country performs above the lower middle-income group average in six pillars, comprising Institutions; Human capital and research; Infrastructure; Market sophistication; Business sophistication; and, Creative outputs. It also performs above the regional average in two pillars, namely Market sophistication and Creative outputs.

Mongolia's Innovation Potential

The research carried out by the author's team indicates that Mongolia has a considerable number of resources for creating innovations, which are summarized in the Table 6.16 [47].

TABLE 6.16

INNOVATION POTENTIAL (INNOVATION INPUTS)

2007	2017
Human Resource Potential for Innovation	
- Population: 2,635,200 people - Labor resources: 1,642,200 people (62.3%); - Workforce: 1,054,000 people (40%) - Youth: 16–35 years old - 1,024,800 persons (38.9%), under the age of 35 -1,775,000 persons (67.4%); - Literacy rate: 97.6% - Human Development Index: 0.720 - Number of students: 733,200 persons (27.8%); - University students: 153,800 persons - University graduates: 22,900 persons	- Population: 3,177,900 people - Labor resources: 2,220,400 people (69.8%) - Workforce: 1,238,300 people (36.8%) - Youth: 16–35 years old - 1,078,700 persons (33.9%), under the age of 35 - 2,039,900 persons (64.2%) - Literacy rate: 96.2% - Human Development Index: 0.734 - Number of students: 1,020,600 persons (32.1%) - University students: 155,200 persons - University graduates: 29,100 persons

2007	2017
Innovation Human Resources	
- Number of research staff - 3,458 persons; - Scientists - 2,000 persons; - University professors and teachers - 6,900 persons; - Number of academic staff per 1,000 students - 1.3 lecturers; - Engineering students - 34,400 persons; agriculture and engineering students - 38,500 persons; - Number of higher education enrollment: about 18,400 (master's degree - 15,400; doctorate - 3,000)	- Number of research staff - 3,502* persons; - Scientists: 2,543 persons; - University professors and teachers - 6,917 persons; - Number of academic staff per 1,000 students - 1.14* lecturers; - Engineering students - 55,300 persons; agriculture and engineering students - 18,500 persons - Number of higher education enrollment: 24,640 students (master's degree - 20,345; doctorate - 4,295)
Scientific and Technical Capabilities	
- Number of state-owned academic institutions - 59 - Scientific publications: 5,828 works, of which 873 (15%) were published abroad;112 registered invention patents, including 4 foreign patents (0.04%)	- Number of state-owned academic institutions - 61 - Scientific publications: 9,735 works, of which 2,111 (21.7%) were published abroad; 105 registered invention patents, including 4 foreign patents (0.02%)[1]
Financial and Economic Capabilities	
- R&D Expenditure: MNT7,231** billion, 0.36% of the state budget; - Education expenses: MNT273,176 billion - 15.6% of state budget, 3.2% of GDP - FDI: MNT379.3 billion, share in investment in education, culture and science in FDI expenses - 0.04%	- R&D Expenditure: MNT32,829*** million, 0.46% of the state budget; - Education expenditure: MNT1,204.21 billion - 13.4% of state budget, 7.1% of GDP - FDI: MNT464.8 billion share in investment in education, culture and science in FDI expenses - 0.014%
Production Technology Capabilities	
- Number of industrial site: 4,928, 12.7% is for mining (628), 81.6% for manufacturing (4,029), 5.7% - energy (271) - Most of the industrial sectors are at the I and II generations of technology, capital-intensive production - 70.2%; labor-intensive production - 6.2%: technology-intensive production - 14.4%; production requiring low and low-medium skills - 98.8%; 86.7% of the total production of the sector has a low scientific capacity;	- Number of industrial site: 9,861, 38.8% is for mining (3,831), 58.6% for manufacturing (5,781), 2.6% - energy (249) - The majority of industrial sectors remain at the level of the I and II regimes, in terms of technology, capital-intensive production - 57.8%; labor-intensive production - 4.7%; technology-intensive production - 9.2%; production requiring low and low-medium skills - 98.1%; 92.5% of the industry's total production has little scientific capacity;
Management and Organizational Capabilities	
- **State institutions operating in the sector of S&T:** National Development and Reform Commission, National Council of S&T, Ministry of Education and Culture, S&T Foundation - **Academic institutions:** MAS and its institutes - 17, industry institutes - 9, science-industry corporations - 8, - **Universities:** Total 162 universities - 14 universities (11 state-owned, 3 private), 142 universities and colleges (36 state-owned, 106 public & private), 6 branches of foreign universities; - **Subjects of innovation infrastructure:** 1 NITP, 5 business - incubators, Technology Transfer Centers/under the MFALI, MAS, MUST, and MUA	- **State institutions operating in the sector of S&T:** National Development Agency, National Council of S&T, Ministry of Education Culture Sports Science and Technology, S&T Foundation - **Academic institutions:** MAS and its institutes - 10, sectoral institutes - 5 - **Universities:** Total 95 universities - 31 (13 state-owned, 18 private), 64 universities and colleges (4 state-owned, 56 public & private), 4 branches of foreign universities - **Subjects of innovation infrastructure:** 1 NITP, 3 industrial parks, 10 business incubators, 8 shared offices, Technology Transfer Centers/MFALI, MAS, MUST, and MUA

Source: Oyuntsetseg L. (2019).

The study's findings indicate that the industrial sector's degree of competitiveness is substantially lower than it once was, with technical and technological aspects are persistently lagging, and the majority of industries are still operating at the first and second generations of technology. In 2007, only 14.4% of the subsectors were technology-intensive while 70.2% were highly capital-intensive, 6.2% were labor-intensive, 98.8% required low and low-medium skills, and 86.7% were productions with little capacity for science or knowledge. By 2017, technology-intensive production had decreased to 9.2%, capital-intensive production had increased to 57.8%, labor-intensive production had decreased to 4.7%, low- and medium-skilled production had increased to 98.1%, and scientific or the proportion of production with low knowledge capacity had increased to 92.5%.

Mongolia's export structure has not significantly changed in the past, with raw materials and semi-finished goods continue to remain dominant. Export of traditional goods, like leather, sheepskin, carpets, and new items has not increased, and the quantity of processed products, like sewing and knitting, which made up a sizeable portion of exports, has fallen year after year. As of 2017, minerals and raw materials made up 80% of all exports, demonstrating that nontechnological products continue to dominate the export market. The percentage of nontech products in exports climbed from 72.2% in 1995 to 83.2% in 2016, and throughout this time, high-tech products only made up 0.1%–0.3% of exports, which is highly insufficient.

Evaluation of NIS

A comparative evaluation of Mongolia's Innovation development level in 2017 and 2007 was performed in accordance with the methodology explained in the earlier segment (A Conceptual Framework and Methodology for Assessing NIS). The results suggest that the indicator of innovation capacity, reflecting the supply of innovation resources in Mongolia, increased by 0.017 points from 2007 to 2017. The indicator of NIS function also increased by 0.039 points, the effectiveness of NIS operations by 0.095 points, the innovation environment of NIS by 0.01 points, and NIS performance (integral indicator) increased by 0.05 points (Table 6.17) [47].

TABLE 6.17

EVALUATION OF NIS PERFORMANCE OF MONGOLIA IN 2007 AND 2017

No	Indicators	Integral Assessment		Changes (-), (+)
		2007	2017	
1	NIS capabilities (F_{ipo})	0.352	0.369	+ 0.017
2	NIS function (F_{nis})	0.277	0.316	+ 0.039
3	NIS effectiveness (R_{nis})	0.468	0.563	+ 0.095
4	Environment: Innovation environment/Innovativeness of NIS environment (F_{si})	0.389	0.399	+ 0.01
5	**Integrated Index of NIS Performance (E_{nis})**	**0.361**	**0.411**	**+ 0.05**

Source: Oyuntsetseg L. (2019).
Note: KEI- data of 2012 (https://datasource.kapsarc.org/explore/dataset/knowledge-economy-index-world-bank-).

The overall performance or efficiency of the NIS was 0.361 in 2007, which indicates the level lower by 36% than the target set in 2015.

Results of the Regression Analysis of Productivity and Innovation Performance

As was already indicated, it is quite challenging to collect statistical data in Mongolia for a thorough examination of innovation and productivity evaluation. Efforts were made to perform regression analysis on the following variables: Labor productivity, Patent application, Patent award, R&D expenditure (percentage of GDP), R&D personnel, R&D expenditure by government, R&D stock, High-tech & IT service exports, and Trademark applications [2, 21, 47, 48, 53, 57].

TABLE 6.18

MONGOLIA'S PRODUCTIVITY AND SOME INDICATORS OF INNOVATION PERFORMANCE

	Patent Application	Patent Granted	R&D Expenditure (% of GDP)	R&D Personnel	R&D Spending by Government	R&D Stock	R&D Spending by Private Enterprises	High-tech Exports	IT Service Exports	Trademark Applications
1995	n/a	n/a	n/a	3,599	0.21	n/a	n/a	n/a	n/a	n/a
1996	n/a	n/a	n/a	3,411	0.26	n/a	n/a	n/a	n/a	n/a
1997	n/a	n/a	n/a	2,768	0.2	n/a	n/a	n/a	n/a	n/a
1998	n/a	n/a	n/a	2,936	0.22	n/a	n/a	n/a	n/a	n/a
1999	n/a	n/a	n/a	3,502	0.21	n/a	n/a	n/a	n/a	n/a
2000	n/a	n/a	n/a	2,755	0.34	n/a	n/a	n/a	n/a	n/a
2001	n/a	n/a	n/a	3,105	0.33	n/a	n/a	n/a	n/a	n/a
2002	n/a	n/a	n/a	3,562	0.31	n/a	n/a	n/a	n/a	n/a
2003	n/a	n/a	n/a	3,419	0.32	n/a	n/a	n/a	n/a	n/a
2004	n/a	n/a	n/a	3,219	0.35	n/a	n/a	n/a	n/a	n/a
2005	n/a	n/a	n/a	3,241	0.94	n/a	n/a	n/a	n/a	n/a
2006	n/a	174	n/a	3,387	n/a	n/a	n/a	n/a	n/a	n/a
2007	n/a	199	0.26	3,458	n/a	n/a	n/a	n/a	n/a	n/a
2008	n/a	159	0.28	3,656	0.76	n/a	n/a	n/a	n/a	n/a
2009	n/a	132	0.24	3,750	n/a	n/a	n/a	n/a	n/a	n/a
2010	179	96	0.26	4,045	0.7	n/a	n/a	n/a	n/a	2,226
2011	210	99	0.26	4,120	0.57	n/a	n/a	n/a	n/a	2,392
2012	229	115	0.24	4,071	0.63	n/a	n/a	0.4	8.9	2,588
2013	265	212	0.22	4,411	0.67	n/a	n/a	0.4	2	3,119
2014	243	216	0.2	4,374	0.61	n/a	n/a	0.3	0.3	3,780
2015	226	223	0.2	4,125	0.46	n/a	n/a	0.4	0.2	2,720
2016	203	118	0.49	3,502	0.781	n/a	n/a	0.5	0.2	2,813
2017	229	101	0.46	4,534	0.808	n/a	n/a	0.5	0.2	3,319
2018	159	76	0.51	4,277	0.836	n/a	n/a	n/a	n/a	n/a
2019	170	192	0.55	4,254	0.863	n/a	n/a	n/a	n/a	n/a
2020	148	124	0.55	6,926	0.891	n/a	n/a	n/a	n/a	n/a
2021	188	186	0.711	7,072	0.918	n/a	n/a	n/a	n/a	n/a
2022	192	118	0.749	n/a	0.945	n/a	n/a	n/a	n/a	n/a

Source: Compiled from NSO, Oyuntsetseg L. (2019); www.1212.mn; https://www.ipom.gov.mn; MECS statistics; GII Report 2010–2021.

Sequential data collection, however, was not feasible within the allotted period. The statistical yearbook's chapter on productivity should be revived, and the Mongolian government must prioritize data collection.

For the purpose of regression analysis, the labor productivity (GDP Per Employee) and Innovation Output Index from 2010 to 2020 were used.

The outcome demonstrates a substantial impact of Innovation Output on LP (p-value 0.008, R2 = 0.6), as shown in the following equation.

$$y_{LP} = 0.635 + 0.451\ I_{io}$$

Here, y_{LP} – Labor productivity (as a GDP per employee)

I_{io} - Innovation Output Index

The result of the regression analysis shows that the Innovation Output Index had a positive effect on labor productivity.

Development of Innovation Infrastructure block

The infrastructure for innovation in Mongolia has formed to some degree with the establishment of parks, business incubators, innovation centers, and shared offices. The number of these entities has been growing significantly in recent years.

The Law on Innovation, which was enacted by the Mongolian Parliament in 2012, defined the following entities as actors in the innovation infrastructure:

- Industrial technology park
- Technology transfer center
- Coworking office
- Technology incubator
- Management company
- Business incubator

However, as indicated by several studies, the participation of other key NIS actors may have been constrained by the law. The legislation also failed to sufficiently define their responsibilities or govern their relationships [46, 58].

In tandem with the law, the Ministry of Labor and Welfare initiated a program[2] in 2004 that laid the legal foundation for developing the business incubation service sector [59]. Another intervention program, initiated in 2007, played an important role in populating business support organizations (BSOs) [60]. Every year, the General Department of Labor and Welfare Services, which is this intervention program's administrative body, announces an open call for bids to choose the BSOs who would receive reimbursement of specified costs by the sum calculated by the predetermined tariff. In 2009, the ministry spent MNT1.3 billion (USD1.2 million[3]) on "Business incubation services and entrepreneurial skills mastery training" [61]. The SSSD program's primary objective, however, was to increase employment. As a result, the selection criteria and program end measurements were, and continued to be, the number of persons employed or paying social insurance premiums. The majority of BSOs emphasized business management knowledge and abilities in their curricula. Few people were able to successfully integrate the knowledge and abilities acquired from the certificate programs offered by BSOs to run their businesses [62].

2 Business Support Organization Development Program - One of the subprograms of "Social Security Sector Development (SSSD)" program jointly implemented by the government of Mongolia and the ADB.

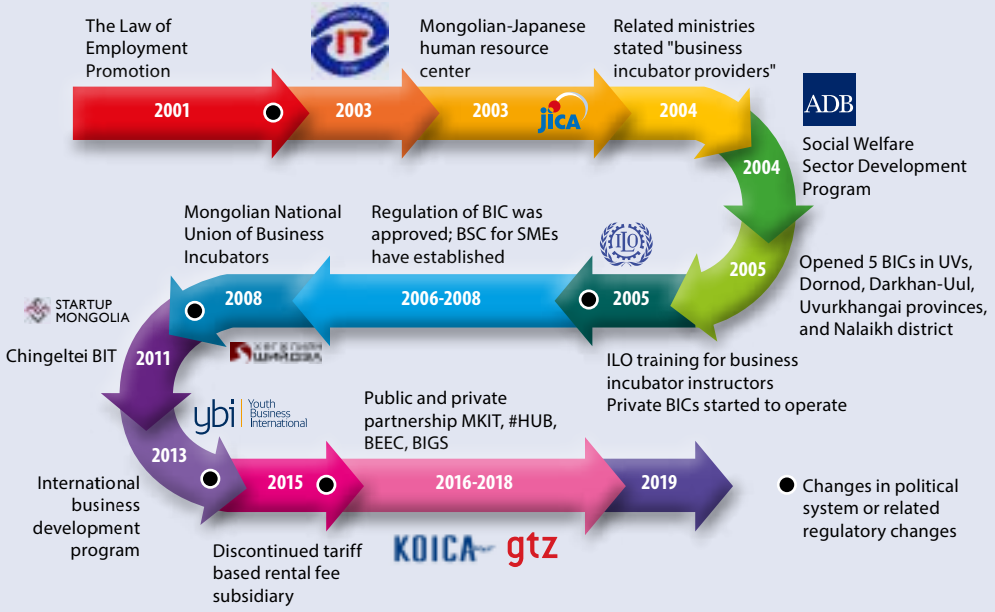
3 USD1=MNT1,064.712, the average exchange rate of 2010.

National Information Technology Park (NITP) is the first model technology park established in 2003. Its history, however, dates way back to 1972, when the first entity aimed to disseminate scientific and technology information to the public in Mongolia was conceived. NITP's main objective is to foster emerging IT businesses by providing business incubator services, such as providing rent-free office spaces, telecommunication services (free telephone, discount on high-speed Internet network charges: first year - 70%, following year - 50%), meeting rooms and equipment for conducting trainings, conferences, and seminars, organizing free trainings and seminars, and providing consulting services. On average, about 20 companies join the park every year, and they employ more than 200 people. Since 2003, more than 150 organizations were selected and about 60 of them graduated successfully, including pioneering tech companies specialized into diverse ICT services [63]. However, the park falls short on delivering all necessary support, such as locating business partners and investors, developing partnerships with academic research institutions, and safeguarding IP.

Figure 6.8 illustrates the timeline and important actors in the field of innovation infrastructure. From 2001 to 2019, Mongolia witnessed four parliamentary elections and underwent five major changes in legislations, along with restructuring of government ministries and agencies. As discussed earlier, this political instability has adversely affected the development of innovation infrastructure [64].

FIGURE 6.8

MONGOLIA'S BUSINESS INCUBATION SERVICE SECTOR TIMELINE



Source: B. Mandukhai et al. (2019).

Mongolian Start-up Ecosystem

In 2011, the NGO "Startup Mongolia" was established and the start-up business development program was introduced under the official authority of the "TechStars" organization. This initiative developed a new approach in the field of incubation services to support business development. The members and supporters were in their early 20s when the foundation was laid to foster a favorable start-up ecosystem. Today, they have matured and ascended to be prominent players in the ecosystem. The team acquired the capability to serve as the entry point for Mongolian start-ups looking to expand internationally when Startup Johor (Malaysian accelerator) merged [46].

The ecosystem's value was estimated by the study to be USD123.5 million (MNT423.9 billion), but the performance of the ecosystem could not be evaluated due to insufficient data. However, despite being in the early stages of the development, there have been notable success. For instance, firms from the survey that reported selling some of their shares had excellent records of exit valuations that were 12 times higher than their initial funding (MNT2.3 billion to MNT28.2 billion). Tech start-ups received an average initial investment of USD53,300 (MNT183 million) with an average annual revenue of USD291,400 (MNT1.0 billion). In terms of initial and follow-on fundings, the top three categories were fintech, blockchain, and AI, big data, & analytics [46].

There are 109 organizations included in the yearly Mongolian start-up ecosystem map (Figure 6.9), ranging from universities to venture capital and investment firms [65].

FIGURE 6.9

MONGOLIAN START-UP ECOSYSTEM MAP IN 2022

Source: https://startco.mn/mongolian-startup-eco-system-map.

Summary of Mongolia's Innovation and NIS Development

In terms of innovation capacity, Mongolia's level of innovation development lagged by approximately 30% below the global average in 2007 and around 35% below the target set for 2015 in the Ministry of Education and Culture's master plan and the country's overall national economic development master plan. As of 2017, it reached around 37% of the global average. According to the evaluation, it had achieved about 40% of the basic comparative parameters. From this, it can be inferred that over the past decade, there hasn't been much advancement in the development of innovation in the country. Mongolia's GII stood at 34.2 as of 2021, placing 58th out of 132 countries, representing 52.2% of the "max" score, which was 65.5 in Switzerland, and 1.9 points higher than the average level [30, 47].

The country has recently shown an increasing interest in implementing scientific and technological innovations in production and advancing STI. However, the country's use of its scientific, technological, and industrial capabilities is inadequate, and the process of updating them to meet modern requirements

is progressing slowly. Mongolia's scientific and technical base is significantly behind the rest of the world, and there is still a lack of adequate public statistics data on scientific and technological innovation in the private sector.

Results of study are summarized by SWOT analysis [30, 47].

The main advantages (S) of Mongolian STI development:

- Science and higher education institutions have accumulated considerable experience in research and training, and the scientific base has been formed at a commendable level
- Specific fields of basic science, such as agriculture, health, medicine, natural resources, R&D of raw materials, society, and humanities are relatively well developed
- An available pool of human resources, including scientists, researchers, engineers, and other specialists with a relatively high level of competence
- Educating young people in developed countries increases the capacity of human resources capable of transferring knowledge and technology from abroad and working at the international level
- The policy and legal environment of STI is progressing toward improved stage
- The number of elements within the innovation infrastructure, the methods of strengthening innovation and start-up business, and supporting and accelerating development have all increased, and their activities have become more stable
- Cooperation and partnership in STI are significantly intensifying with a trend toward further expansion and deepening
- Understanding and awareness of innovation have improved throughout the country, accelerating the process of formation of innovation and start-up business ecosystems, and the development of innovation culture in society

Weaknesses (W) of Mongolia's STI development:

- An effective mechanism for the implementation of state policy on innovation and technology has not yet been formed, and the results of implementation are insufficient
- Inadequate sources of financing for the development of STI, coupled with a low level of efficiency in scientific and research work carried out with state budget funds. A comprehensive control, analysis, evaluation, monitoring, and statistical information system of the sector is still not formed
- The maturity and development of the IP protection system is insufficient
- Efficient mechanisms for human resource provision, training, development, and innovation sector are not yet well-established
- Incomplete use of innovation resources and capabilities in the state and private sector results in low efficiency

- Innovation integration of industries and organizations is weak and innovation partnership of government, science, education, business organizations, and international innovation cooperation have not reached a satisfactory level

- The development of the national NIS is slow, and the government policies and activities in this direction are not stable

Opportunities (O) for the development of STI in Mongolia:

- Industry and business development requirements of the country are increasing, driving demand for scientific research results

- Increase funding for the STI sector, aligning with the Mongolia Sustainable Development Vision 2030, to develop technology and innovation

- Gradually increase funding for S&T research and testing to reach 3% of GDP

- Create additional sources of funding from the private sector, international development assistance, and cooperation sources, and effectively spending them

- Attract young people studying and working abroad, who make up a significant percentage of innovation human resource potential, by providing conditions for productive work

- Introduce, localize, and master the modern achievements and advanced technologies in STI development

- Develop and expand international cooperation in the field of STI

Threats (T) to Mongolia's STI sector:

- The country's lag in STI development, innovation, and advancement, lead to further isolation from the global landscape

- Slower accumulation of intellectual capital, intensified outflows, and potential intellectual decline, pushing the nation toward desolation and backwardness

- Decrease in the country's competitiveness and further lagging behind in development levels

- Facing a real threat to the country's independence and national security

POLICY INTERVENTIONS FOR ENHANCING PRODUCTIVITY AND BUILDING A ROBUST NIS

In the current legal documents, participants in scientific and technological activities should have clearly defined roles that foster cooperation in the field of science-education-business. Private sector involvement in the advancement of research, technology, and innovation should be improved, entrepreneurial ingenuity actively encouraged, and optimal engagement mechanisms employed. This includes incorporating clauses in the laws governing income and customs taxes to support organizations contributing to innovation, specifically by exempting or reducing the tax on sales of goods and services resulting from scientific research and testing. Customs duties on scientific research and testing

equipment and tools supplied through foreign cooperation and international organizations should be eliminated. Tax and other relevant laws must accommodate provisions, such as tax exemptions or reductions on investments, donations, and assistance made by business organizations for the development of S&T incubation and the introduction of innovations.

In general, an optimal legal system to regulate the specific relations of innovation activities is necessary. Innovation activity is a characteristic form of entrepreneurship and includes techniques, technologies, new materials, scientific and technical information, production methods (know-how), IP objects (inventions, trademarks) resulting from scientific and technological activities , product design, utility model, computer integrated circuits, software tools as well as engineering, patent-licensing, information and professional consulting services, and other scientific and scientific-technical services that are related to the circulation of consumer goods.

The need to carefully evaluate the legal framework for the advancement of innovation and the creation of NIS is based on the fact that various subjects participating in innovation activities represent all facets and spheres of society. To address this, it is still necessary to reform the legal system as a whole by creating new laws and making the necessary revisions and changes to the ones that already exist.

Mongolia's Innovation Law has already undergone a total of 49 modifications. Although it is not ideal to alter it frequently, they respond to the rapid changes in the country's social and economic environment, the development and innovation process, and the ongoing need for capacity building related to legal regulations.

The following issues should be taken into account when updating the law so that the valuable knowledge and technology generated by society can be introduced into production and practice as a useful innovation. This will help the country's industry, economy, and society prosper and increase its competitiveness. These considerations include:

- Incorporating terms relevant to innovation activities, such as entrepreneurship, innovation infrastructure, and start-up businesses

- Defining roles and responsibilities of participants in innovation activities, including the main subjects in the NIS that include the state, science, education, business organizations, and nongovernmental organizations. Consideration should be given to the full cycle of the innovation process, which occurs through the major phases, such as "introduction to consumer circulation"

- Promoting innovation activities within business organizations and the private sector. This is crucial for knowledge creation, collaboration with the science and education sectors to develop human resources for innovation, and for the inclusion of regulations to support investment activities

- Introduce regulations that encourage venture capital investment, and a primary source of funding for innovation should be included

Further, it is worth considering adjustments to tax and financial policies, and introduce frequently employed strategies and mechanisms that have proven effective in other countries to create the conditions to support and develop STI activities. These strategies and mechanisms include:

- Deducting current expenses allocated to R&D from manufacturers' annual taxable income, legalizing the absorption of costs related to the acquisition of new products and technologies into production costs, and providing a certain amount of tax relief, typically around 10%

- Allowing accelerated depreciation of fixed assets for R&D works (in other countries, the rate of depreciation is 50% for linear and amortized construction over a period of 3–5 years)

- Creating optimal systems and mechanisms for selecting STI projects, conducting independent scientific-technical and financial evaluations, and establishing risk insurance mechanisms for innovative projects

- Supporting international patent application activities by including related expenses in the state budget

- Conducting policy research related to the development of the country's socioeconomics and specific sectors, forecasting the prospects of STI, formulating major programs, and developing the technical and economic groundwork for important large-scale projects. These initiatives should involve specialized experts and scientists, with schools and academic institutions directly commissioned by the government and held accountable for results

- Preparing forecasts for future development of STI, and providing a basis for government and budget policies and activities

Currently, the legal system of Mongolia is composed primarily of a substantial number of laws that were drafted and passed while under the influence of political forces that ruled the country at the time. These laws aimed to achieve certain socioeconomic goals that, in some cases, were not sufficiently coordinated.

On the other hand, despite the fact that many policies and legal documents have been approved, there has been insufficient attention given to identifying the underlying causes of the problems. A rigorous analysis and evaluation of the outcomes of policy implementation, along with subsequent corrective measures, improvements, and resolutions are often overlooked. Not many effective steps are being taken.

In such a situation, it is equally important for law enforcers and legislators to make the legal system more sophisticated, systematic, and result-oriented.

CONCLUSION

Innovation accelerates the socioeconomic development of any given country, and boosts productivity and competitiveness. International evidence reveals that a NIS is one of the effective strategies for higher productivity output. In the contemporary knowledge economy, it becomes even more crucial to set up a robust NIS or institutional innovation ecosystem. This research uncovers the current state of Mongolia's NIS and its impact on national productivity growth. The researchers used the data from reports on productivity and innovation by the APO, the WEF, the WIPO, and the National Statistical Office of Mongolia. Further, Mongolian academics' research on productivity, innovation, and national innovation systems is highlighted.

The study reveals that Mongolia's innovation development has faced several challenges and opportunities within its NIS. The country's innovation capacity has improved over the years, yet it still lags behind the global average, indicating a need for concerted efforts to bridge this gap. Despite this, the establishment of "Startup Mongolia" under the guidance of TechStars has contributed significantly to the nurturing of a favorable start-up ecosystem and the integration of Mongolian start-ups into the global arena.

The SWOT analysis of Mongolia's STI development sheds light on the country's strengths, weaknesses, opportunities, and threats. Notably, the study identifies several strengths, such as the accumulated

experience in research and education, growing innovation infrastructure, and strengthening cooperation in STI. Conversely, identified weaknesses include insufficient funding, underdeveloped IP protection, and the need for more robust mechanisms in human resource development and innovation integration. The analysis also highlights potential opportunities, such as increased funding alignment with sustainable development goals, expanded international cooperation, and attracting skilled professionals from abroad. However, it also warns of potential threats, including a decline in competitiveness and isolation from the global landscape.

Further, the acknowledgment of Mongolia's "small" national economy underscores the country's flexibility and adaptability, which can be leveraged to foster a conducive environment for knowledge-based innovation. To achieve this, enhancing the scientific and industrial foundation, establishing an efficient NIS, and prioritizing knowledge-based innovation remain critical. The strategic pursuit of technological advancement and the effective implementation of the national innovation policy and strategy are vital for Mongolia's sustainable development and global competitiveness. By addressing the challenges and capitalizing on the opportunities, Mongolia can effectively position itself as a key player in the global innovation landscape.

The APO is a proactive, competent organization that has acquired a wealth of expertise on enhancing the productivity of economic sectors. Therefore, it may serve as a facilitator for sharing the best practices of Singapore, Japan, Republic of Korea, and other economies that are at the forefront of innovation and NIS development through collaborative projects. For instance, it would be advantageous to collaborate on a pilot technology transfer/business incubation facility in Mongolia that may serve as a gateway to the global market. A pragmatic approach to developing innovation human resources, institutionalizing stakeholders, and maturing the innovation market and its regulations form the basis of a robust NIS.

In the future, Mongolia needs to prioritize comprehensive data collection, registration, and statistical analysis as well as thorough compilation of productivity and STI statistics.

CHAPTER 7

PAKISTAN

INTRODUCTION ON PAKISTAN'S ECONOMY

Upon gaining independence in 1947, Pakistan faced significant economic challenges with limited resources. The majority of the population was made up of small farmers while the remaining population consisted of shopkeepers, impoverished peasants, and artisans. The country lacked skilled technicians and businessmen with only a small number of industries, such as cotton mills, railway repair shops, and a cement factory. The government machinery was also limited with only a few hundred civil servants opting to serve the country, working in makeshift and run-down offices.

Despite a difficult start, Pakistan has made significant economic progress over the years. Today, Pakistan's economy has grown to become the 24th largest in the world, according to the official exchange rate. Per capita income has also seen a significant increase from USD100 in 1947 to USD1,700 today. Additionally, Pakistan has experienced an overall growth rate of slightly above 5% per year for the past six decades. This growth has translated into a significant reduction in poverty with the poverty rate decreasing from 40% to around 20%.

Over the years, Pakistan's economy has undergone significant diversification. At the time of independence, agriculture was the primary sector, but it now contributes only around one-fifth, or 20%, of GDP. The manufacturing sector also provides around one-sixth of GDP. On the other hand, trade and services, which are the largest components of the economy, have grown significantly. The structure of Pakistan's economy now more resembles that of middle-income countries of East and Southeast Asia rather than the poorer countries of the Indian subcontinent. Pakistan's economic performance has been positive and compares favorably with that of many other developing countries as the country has maintained a sustained and steady annual growth rate.

In 1947, Pakistan, with a population of 30 million at the time, was unable to produce enough food to meet its own needs and had to import all its food from other countries. However, by 2016, Pakistani farmers had not only become self-sufficient in producing enough wheat, rice, sugar, and milk to meet the needs of its 200 million people at a much higher per capita consumption level, but they were also able to export these products to other countries. In fact, Pakistan has become the fourth-largest exporter of rice in the world.

Agricultural production in Pakistan has seen a significant increase over the years, rising more than fivefold. Cotton production, for example, has reached a peak level of over 14 million bales, compared to just one million bales in 1947. As a result, Pakistan has become a leading exporter of textiles. Additionally, a variety of other products that were not present at the time of independence are now manufactured for both the domestic and the global markets, such as steel, cement, automobiles, sugar, fertilizers, cloth, vegetable ghee, industrial chemicals, and refined petroleum.

The per capita electricity generation in Pakistan has also seen a significant increase, rising from 100 kWh in 1947 to 10,160 kWh today. This transformation is attributed to the construction of a vast irrigation network over the past six decades, which includes large storage reservoirs, dams, barrages, and link

canals. This network has effectively double the area under cultivation to 22 million hectares. Additionally, tubewell irrigation contributes almost one-third of additional water required to supplement canal irrigation.

The road and highway network in Pakistan has also seen a significant expansion with its length now spanning 260,000 km, which is more than five times its length in 1947. The country boasts modern motorways, superhighways, and four-lane national highways that link the entire country, complemented by a network of secondary and tertiary roads.

Natural gas was discovered in Pakistan in the 1950s, and over time, the supply has steadily increased. At its peak, almost 4 billion cubic feet/day of natural gas was generated, transmitted, and distributed for industrial, commercial, and domestic consumption, accounting for 40%–50% of the country's energy requirements.

As income levels in Pakistan have risen, private consumption standards have also kept pace. Today, there are 30 road vehicles for every 1,000 people, compared to just one vehicle for the same number of people in 1947. Additionally, mobile phone penetration stands at 88%, a substantial leap when there was 1% of landline telephones installed in Pakistani homes in the 1950s. Further, TV sets, which were nonexistent in the past, are now present in 122 out of every 1,000 houses.

The achievements in income, consumption, agriculture, and industrial production in Pakistan have been significant, uplifting millions of people out of poverty. However, there have also been missed opportunities, particularly since 1990. Pakistan has become a laggard in South Asia, experiencing episodes of boom and bust, and has had to approach the IMF for assistance for balance of payments crises 22 times in the last three decades. There are many factors that contribute to this reversal from a dynamic and vibrant economy to an externally dependent one, and some of the main reasons are highlighted here.

The most significant setback to the country has been the neglect of human development. Had the adult literacy rate been close to 100%, it is estimated that per capita income would have reached at least USD3,000. However, Pakistan ranks low in human development indicators with an adult literacy rate of only 60%, an average schooling duration of five years, and high infant and maternal mortality rates.

The respective roles of the state and markets have been distorted in Pakistan, leading to inefficiency and inequity. The markets, which should allocate resources efficiently, have been manipulated by a small elite class for their own benefit while the state, which should ensure equitable distribution of growth, has also fallen under the control of the same elite group. This results in the worst of both worlds, slowing down economic progress and creating a sense of deprivation among the population.

Another significant factor contributing to Pakistan's economic setback is the low savings rate and high consumption rate among both the government and households. The country imports more than it exports and maintains low investment rates in the private and public sectors while still aspiring to grow beyond its means. Addressing these recurrent imbalances in fiscal, trade, financial, savings, and investment gaps need to be bridged to improve the situation.

For Pakistan to resume its progress and overcome the challenges it faced in the last 35 years, it must vigorously pursue the structural reforms mentioned above. These reforms include addressing the neglect of human development, rectifying the distortion of the roles of the state and markets, and bridging the persistent gaps in fiscal, trade, financial, savings and investment [1].

PRODUCTIVITY ANALYSIS

Historically, Pakistan's economy has shown periodic 'boom-bust' growth cycles. These cycles are attributed to various economic challenges, such as limited fiscal resources, currency fluctuations, rising current account deficits, inflation, energy sector issues, and a lack of support for the private sector. Political instability in the country has further exacerbated economic uncertainty for individuals, businesses, and the government, negatively impacting overall economic growth. Over the past three to four decades, Pakistan's average economic growth rate has steadily declined, with growth spurts often preceded by crises.

The decline in economic growth in Pakistan is largely due to insufficient investment in physical and human capital as well as poor economic policies that fail to effectively utilize available resources. The state has also been hindered by corruption and rent-seeking behaviors as well as ongoing security issues, which have particularly plagued the country over the past several decades. Industries and firms with political connections are often shielded from competition, be it foreign and domestic, which curtail the productivity gains that heightened competition would otherwise bring. In addition, weak public services, including in areas, such as energy, urban development, health, education, and security, also negatively impact productivity. Furthermore, the country's growth trajectory is often disrupted by frequent macroeconomic crises [2].

Total Factor Productivity (TFP) - Definition and Assessment Methodology

TFP, also referred to as multifactor productivity, measures the efficiency with which the economy utilizes the various factors of production to generate output. TFP growth represents the part of GDP growth that is not caused by changes in inputs and reflects advancements in the production function as a result of technological advancements [2].

TFP can also contribute to economic growth by promoting a more efficient allocation and utilization of inputs, bringing production closer to the optimal combination of inputs and outputs. When a country is operating at the production possibility frontier, advancements in technology can expand the frontier and allow for increased output with the same factors of production. Essentially, TFP growth encompasses technical change and improvements in economic efficiency when it comes to factor inputs.

TFP can also boost economic growth by influencing the scale of operations through economies of scale. TFP not only measures technical efficiency but it can also be impacted by various sociopolitical and economic factors, such as government policies, institutions, market structure, and external shocks, such as weather, that affect the efficiency of factor utilization.

TFP can be estimated using the neoclassical production function [2]:

$$Y = F(A, K, L) \ldots\ldots (1)$$

where in equation 1, Y is real output, K is capital stock, L is the employed labor force, and A is the residual term, which is TFP.

Equation 1 can be written in growth form as:

$$g^Y = \alpha g^L + (1 - \alpha) + g^{TFP} \ldots\ldots (2)$$

Here g^Y denotes the growth rate of output, g^L represents the growth rate of labor, g^{TFP} signifies the growth rate of TFP, α is the share of labor in output, and (1-α) is the share of capital in output. According to equation 2, the output growth rate is a weighted average of growth in the employed labor force,

capital stock, and technological progress (given by the growth of TFP) and the weights are factors shares of labor and capital.

Assuming that output and inputs can be observed, the TFP can be calculated using the following equation:

$$g^{TFP} = g^{Y} - \alpha g^{L} - (1 - \alpha) \ldots\ldots\ldots (3)$$

TFP can be estimated using either regression techniques or the growth accounting framework. For the analysis in this chapter, the growth accounting framework is used, assuming that the output in the economy can be approximated by constant returns to scale Cobb-Douglas production function.

Following, Romer (1990), a human capital variable is also introduced in the model.

$$Y = AK\alpha\ (LH)^{(1-\alpha)} \ldots\ldots\ldots (4)$$

In the above equation, all the variables are the same as in equation 1, except for LH, which is the human capital-augmented employed labor force. This variable captures increases in labor productivity as a result of educational attainment and is calculated by using the mean years of schooling. It is assumed that an additional year of education raises the level of productivity by 7%, following López-Cálix et al. (2012). Writing equation (4) in the growth form, it becomes:

$$\Delta \ln (Y) = \alpha\ [\Delta \ln (K)] + (1 - \alpha)[\Delta \ln(LH)] + \Delta\ln(A) \ldots\ldots\ldots (5)$$

Using equation 5, TFP growth is estimated as:

$$\Delta\ln(A) = \Delta \ln (Y) - \alpha\ [\Delta \ln (K)] - (1 - \alpha)[\Delta \ln(LH)] \ldots\ldots\ldots (6)$$

Different studies assume different factor shares. For the benefit of this analysis, following the Asian Productivity Organization (APO) data, the share of capital is assumed to be 0.52 and that of labor 0.48 [2].

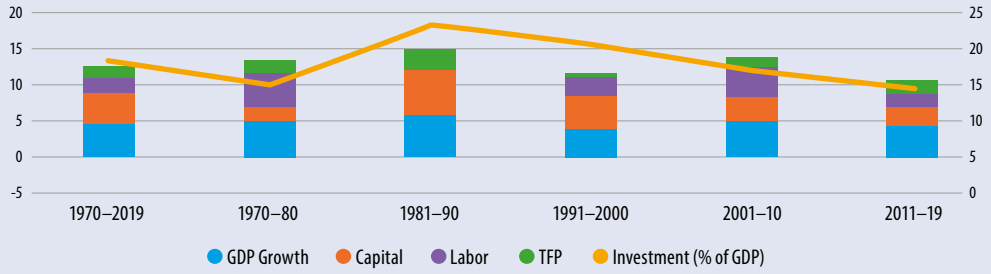
Development Trends of TFP, GDP, and Investment

Pakistan's economic growth from 1970 to 2019 has exhibited a cyclical pattern, characterized by alternating periods of high and low growths. Figure 7.1 illustrates the decreasing output and TFP growth rates in Pakistan since 1970. The data confirms that Pakistan's growth has been inconsistent and that the long-term growth rate has been decreasing. The current analysis confirms this trend. Figure 7.1 clearly demonstrates the decreasing trend in GDP growth rate, TFP growth rate, and investment as a percentage of GDP.

The downward trend in Pakistan's GDP and TFP growth rates since the 1970s illustrates the underlying structural issues that have affected its economy. Despite various reform efforts, supported by international organizations, the inconsistent economic performance remains a puzzle. This highlights the lack of effectiveness of these reforms in addressing structural weaknesses and enhancing economic efficiency. Table 7.1 presents the GDP and TFP growth rates for the overall period (1970–2019) and various decades.

FIGURE 7.1

SOURCES OF ECONOMIC GROWTH



Source: APO Productivity Databook 2022 [3].

TABLE 7.1

SOURCES OF ECONOMIC GROWTH

Period	Annual Average Growth (%)				Investment (% of GDP)
	GDP Growth	Capital	Labor	TFP	
1970–2019	4.81	4.11	2.21	1.62	18.32
1970–80	5.06	1.80	5.04	1.71	15
1981–90	6	6.25	-0.06	2.77	23.43
1991–2000	4.01	4.49	2.81	0.33	20.82
2001–10	5.06	3.32	4.21	1.31	17
2011–19	4.28	2.82	1.55	2.07	14.60

Source: APO Productivity Databook 2022 [3].

According to Table 7.1, the 1980s saw the highest rates of growth in GDP, TFP, and capital. The main accomplishment of this period was the reversal of nationalization policies from the 1970s and the resurgence of private industrial investment. While there were not many policy changes during the 1980s, the industrial policy framework emphasized the private sector and increased import liberalization of industrial materials. However, it is argued that this economic success was not due to effective policies or institutional reforms, but rather the result of large public-sector investments made in the 1970s, such as the Tarbela Dam and various fertilizer and cement factories. Investment plays a crucial role in economic growth as it enables innovation, research and development (R&D), and new technology, which in turn drives TFP growth.

Pakistan's economic history shows that fluctuations in growth have been influenced by political uncertainty and natural disasters. Periods of above-average growth in the 1960s and 1980s corresponded with economic reforms, political stability, and high levels of external aid. Conversely, during the 1970s and 1990s, slow economic growth was observed during times of political disruption, economic uncertainty, and regional tensions. Additionally, Pakistan is prone to natural disasters, particularly floods, which have a significant impact on the economy. This vulnerability has led to Pakistan being ranked seventh in the Long-Term Climate Risk Index (CRI) between 1996 and 2016.

A major challenge to Pakistan's long-term growth prospects is a low saving-investment equilibrium. The economy is experiencing a decline in both potential and actual growth. The inability to maintain growth over extended periods of time is a concern, but even more alarming is the consistent erosion of the economy's growth potential. One of the main factors limiting growth is low level of domestic savings, which continues to decline and is a significant policy concern.

Sectoral Output and TFP Growth

Agriculture

The agriculture sector has been a vital contributor to Pakistan's economy from 1970 to 2019, accounting for around 27% of GDP and employing almost 50% of the labor force. However, over the years, its share in the economy has gradually decreased. During the period of 2011–19, agriculture's share in GDP fell to around 20% and the labor force share dropped to 43%. Despite its declining share in output and employment, agriculture remains a crucial sector in Pakistan as it provides livelihood for a significant portion of the population, meets the country's food requirements, and serves as a source of raw materials for other industries. Additionally, it also maintains connections with small-scale industries, such as motorcycles and consumer goods.

Table 7.2 presents the sources of growth and the investment-to-GDP ratio in the agriculture sector. The decline in the agriculture sector typically coincides with an increase in TFP growth, but this is not the case in Pakistan. In the agriculture sector, TFP growth over the analyzed period was 1.42%. A closer look at the subperiods reveals significant variations in TFP growth, ranging from -0.79% in the 1970s to 1.66% in the 2010s [3].

TABLE 7.2

SOURCES OF GROWTH IN PAKISTAN'S AGRICULTURE SECTOR BETWEEN 1970–2019

Period	Annual Average Growth (%)				Investment (% of GDP)
	Output	Capital	Labor	TFP	
1970–2019	3.39	5.43	1.46	1.42	4.05
1970–80	2.68	-0.44	4.45	-0.79	1.20
1981–90	4.04	15.42	-0.23	1.14	7.55
1991–2000	4.18	3.86	3.13	0.90	4.97
2001–10	3.06	1.68	4.27	-0.70	3.19
2011–19	2.12	2.52	-0.05	1.66	2.95

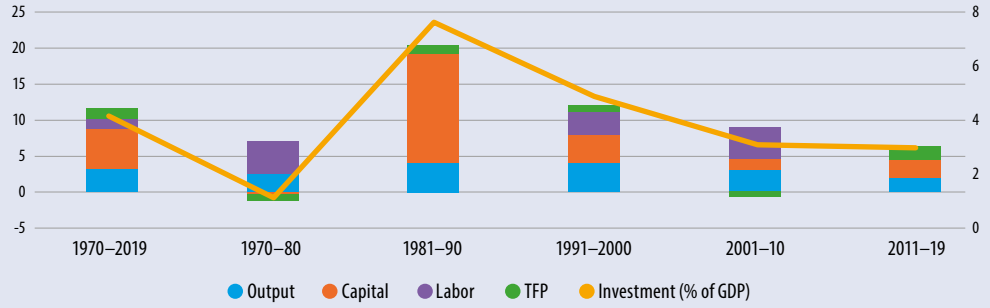
Source: APO Productivity Databook 2022 [3].

The TFP growth in agriculture sector turned positive in the 1980s, after experiencing negative growth in the 1970s. This negative growth in the 1970s can be attributed to the government's nationalization program, which controlled the production and distribution of key agricultural products, and the failure to transfer the benefits of Pakistani rupee (PKR) devaluation to the agriculture sector. Additionally, the sector was subject to export duties and government monopolies. However, in the 1980s, the sector performed better partially due to farmers' increased access to credit, especially for small farmers, which led to increased use of fertilizers and pesticides. Additionally, input distribution was liberalized, allowing private firms to produce and distribute inputs, which were previously under government control. The introduction of high-yield varieties in the 1980s also contributed to the sector's improved performance in the 1980s and 1990s.

Despite the respectable performance in the agriculture sector in both these decades, Figure 7.2 illustrates that the main drivers of agriculture output growth were capital input in the 1980s and labor input in the 1990s.

FIGURE 7.2

SOURCES OF GROWTH IN PAKISTAN'S AGRICULTURE SECTOR BETWEEN 1970–2019



Source: APO Productivity Databook 2022 [3].

In the period of 2001–10, the agriculture growth rate dropped to just over 3% and the TFP growth rate turned negative. One of the major reasons for this poor performance was drought-like conditions in the early part of the decade as well as high energy costs, which led to higher fertilizer prices. During the period of 2011–19, the agriculture sector grew at a modest 2.12% with investment comprising only 2.95% of GDP while TFP grew at 1.66%.

Low productivity in Pakistan's agriculture primarily stems from extensive government intervention in crop production and marketing, a low level of education among the rural population, and underdeveloped service interfaces that connect farmers to markets. The commercial interface between farmers and industry, known as the modern business farm sector, remains underdeveloped in Pakistan. In other countries, this interface enables farmers to focus on crop production while outsourcing supporting services, such as seed selection, fertilizers, pesticides, mechanical support, financing, transportation, and marketing to farmer cooperatives, associations, or private corporations.

Industry

The industrial sector, which includes manufacturing, is typically where the structural change takes place and is considered to be the focal point of the economic activity. However, in Pakistan, this has not been the case. The share of industrial output in GDP has modestly increased from about 15% in 1970 to 20% in 2019. Similarly, the total labor force employed by the industrial sector has increased from 17% to only 24.47% in 2019.

Table 7.3 shows the performance of the industrial sector since 1970 is characterized as docile, except for the 1980s when the industrial sector grew at 7.35% on average. The TFP growth rate for the entire period (1970–2019) is 2.37%.

TABLE 7.3

SOURCES OF GROWTH IN PAKISTAN'S INDUSTRIAL SECTOR BETWEEN 1970–2019

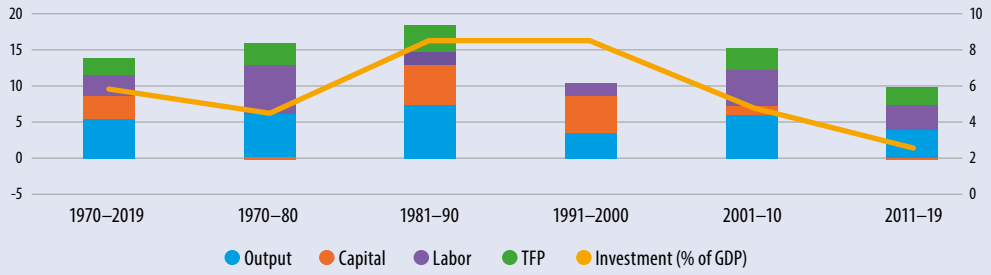
Period	Annual Average Growth (%)				Investment (% of GDP)
	Output	Capital	Labor	TFP	
1970–2019	5.42	3.13	2.96	2.37	5.85
1970–80	6.13	-0.19	6.85	2.94	4.49
1981–90	7.35	5.51	1.71	3.66	8.47
1991–2000	3.45	5.23	1.69	-0.08	8.43
2001–10	6.01	1.20	4.89	3.04	4.83
2011–19	4.00	-0.19	3.16	2.58	2.59

Source: APO Productivity Databook 2022 [3].

The 1980s marked the period of the highest output and TFP growth, which is also the period when the investment-GDP ratio was at its highest. In contrast, the 1990s saw a sharp downturn in industrial output growth with the TFP growth turning negative. Interestingly, the investment-GDP ratio was also quite high during this period, just a shade lower than in the 1980s.

FIGURE 7.3

SOURCES OF GROWTH IN PAKISTAN'S INDUSTRIAL SECTOR BETWEEN 1970–2019



Source: APO Productivity Databook 2022 [3].

During the 2001–10 decade, the output in the industrial sector grew at a rate of 6.01% while TFP grew at 3.04%. The reasons for this growth are somewhat unclear, as the investment-GDP ratio declined from 8.43% in the 1990s to 4.83%. Despite this decline, capital grew slightly at 1.2% while the labor force grew at 4.89%. One possible explanation for this growth could be the utilization of previously idle capacity resulting from the high investment-GDP ratio in the previous decade.

The following decade (2011–19) presents an even more perplexing scenario. During this period, although output growth in the industrial sector decreased to 4%, TFP growth while lower than the previous decade, remained at 2.58%. Additionally, the investment rate also declined to 2.59% of GDP. Despite the decline in output growth and investment, the contribution of TFP to output growth in the industrial sector has been consistently high, with the exception of the 1990s when it was negative [3].

Services

The services sector of Pakistan has become the most significant sector in terms of its contribution to GDP, increasing from about 49% in the 1970s to almost 60% in the 2011–19 period. It also employs 34.54% of the total labor force, up from 26.78% in the 1970s. From 1970 to 2019, the average output and TFP growth in this sector were 5.21% and 1.46%, respectively. The decade-wise patterns in this sector are similar to those observed in the industrial sector. The output growth rate was high at 6.46% in the 1980s, but dropped to 4.15% in the 1990s while the TFP growth rate also decreased to less than 1%. However, in the subsequent period, both the output and TFP growth rates showed improvement [3].

TABLE 7.4

SOURCES OF GROWTH IN PAKISTAN'S SERVICES SECTOR IN 1970–2019

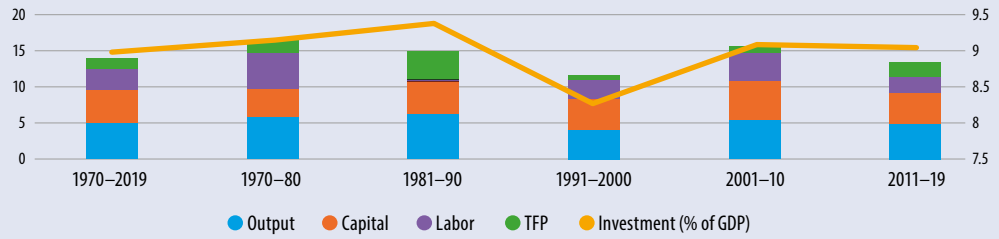
Period	Annual Average Growth (%)				Investment (% of GDP)
	Output	Capital	Labor	TFP	
1970–2019	5.21	4.47	2.96	1.46	8.99
1970–80	6.1	3.66	5.16	1.73	9.16
1981–90	6.46	4.47	0.14	4.07	9.37
1991–2000	4.15	4.23	2.85	0.58	8.30
2001–10	5.56	5.49	3.82	0.87	9.08
2011–19	5.12	4.15	2.30	1.86	9.06

Source: APO Productivity Databook 2022 [3].

Between 2011 and 2019, the growth rate of output in the services sector decreased slightly, but the growth rate of TFP increased from the previous decade of 2000s. This trend of decreased output growth and increased TFP growth is also seen in the overall economy as well as in the agriculture and industry sectors. On average, TFP contributed 28.04% to output growth in the services sector, indicating that output growth is primarily driven by inputs. However, TFP's contribution has fluctuated over time with the highest contribution in the 1980s and the lowest in the 1990s. On average, capital input has contributed more to output growth in the services sector than labor input.

FIGURE 7.4

SOURCES OF GROWTH IN PAKISTAN'S SERVICES SECTOR BETWEEN 1970–2019



Source: APO Productivity Databook 2022 [3].

Although the services sector has the highest investment-GDP ratio among the three sectors, its performance has been underwhelming. To understand why TFP growth in the services sector has been low compared to the agriculture and industrial sectors, it is important to examine the investment in the

subsectors under the services sector. The data reveals that the highest investment in the subsectors of the services sector is in the housing services sector and the general government services sector. For example, during the 2010s, investment in housing services and general government services accounted for an average of 60% of the total investment in the services sector. In contrast, the financial services sector, recognized to be one of the most productive among services, has the lowest investment in the services sector in Pakistan. Even though housing services and general government services have a significant share in the output, they are known to be low-productivity sectors. This may explain the relatively low TFP growth in the services sector, despite having the highest investment-GDP ratio [3].

Key Takeaways

Pakistan's GDP and TFP growth are on a decline, and the most critical challenge to Pakistan's growth lies in its abysmally low productivity. The key findings include:

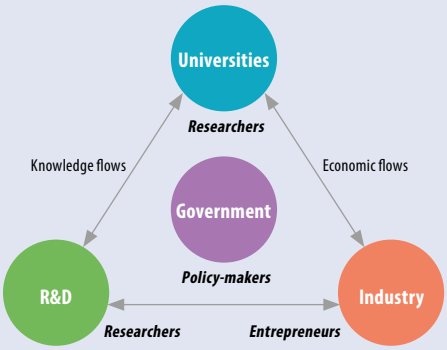
- On average, input accumulation has been the primary driver of growth in Pakistan. It was only in the 1980s and 2010s did TFP growth make a significant contribution to output growth, both in the overall economy and the industrial sector. In the other sectors, the main contributors to the output growth have been capital and labor
- Labor input has contributed the most in the agriculture output growth, except for in the 1980s
- In the services sector, capital input has been the primary contributor, except for in the 1980s
- There has been some revival in the TFP growth in the current decade (the 2010s), possibly due to the utilization of idle capacity and some reforms implemented in the previous decade

CONCEPTUAL FRAMEWORK OF NATIONAL INNOVATION SYSTEM (NIS)

The NIS of Pakistan is built upon the following four main elements, consisting of R&D organizations, universities, industry, and government.

FIGURE 7.5

PAKISTAN'S NIS



Source: APO Productivity Databook 2022 [3].

R&D organizations and universities serve as the core entities for knowledge generation while industry takes the lead in knowledge application and utilization. The government plays a crucial role in creating the conducive environment necessary for the functioning of these three components. Ultimately, society as a whole reaps the benefits of this NIS [4].

i) R&D organizations

In Pakistan, R&D organizations are at three different levels:

Level	R&D Organizations	Suborganizations	Working Under	Major Areas
Federal government	30	90	11 different federal ministries	Science & technology, Agriculture to Space technology
Provincial government	35	160	14 different provincial departments	Agriculture and related areas
Public sector	65	250	Public sector	Applied research

ii) Universities

The Higher Education Commission (HEC) is responsible for overseeing universities and degree-granting institutions in Pakistan. Currently, there are 229 HEC-recognized universities with 140 in the public sector and 89 in the private sector, all engaged in fundamental and applied research. A major portion of R&D activities is conducted in public-sector universities as compared to private-sector universities. There are more than 110 research institutes and 54 research-cum-educational institutes under the administrative control of various universities. While most universities are "multiple disciplinary" in nature, encompassing diverse fields of educational and R&D activities, there are also some "single discipline" universities that focus primarily on fields, such as agriculture, medical, engineering, and technology [4].

Nonetheless, one of the major challenges facing the higher education sector in Pakistan is the absence of an innovation-driven culture at the university level, which limits their ability to contribute to society by addressing real-world problems. Revenue generated through intellectual property rights (IPR) is minimal, making most universities dependent on public funding to sustain their operations. A shift is needed from "scholar-driven" to "demand-driven" research to optimize human and financial resources and build stronger connections with end-user industries.

The significance of university-industry collaborations has not been fully acknowledged in Pakistan. A recent study revealed that nearly half of the universities do not have a formal policy that permits faculty staff to participate in external activities, such as consulting work for industry. Factors, such as lack of rewards for academics working with industry, poor understanding of industry-relevant needs, limited experience in new product development and commercialization, and inadequate equipment and facilities, are the main obstacles for university researchers in developing university-industry linkages [4].

iii) Industry

According to the Pakistan Statistical Bureau's Census of 2015¬–16, there are more than 42,262 manufacturing industrial units in Pakistan. These units are categorized into 88% small units, 9% medium units, and 3% large units. Nevertheless, the industrial sector's share in the national GDP is less than 20%. Foremost among these manufacturing industries is the textile industry as the largest manufacturing industry in Pakistan and ranking as the eighth largest exporter of textile products in Asia. Cotton cultivation, textile production, and apparel manufacturing account for around 65% of merchandise exports and almost 40% of the employed labor force. The food and beverage processing industry is the second largest industry, accounting for 27% of value-added production

and 16% of employment in the manufacturing sector. Other significant industries include cement, fertilizer, edible oil, sugar, steel, tobacco, chemicals, and machinery.

Typically, family-owned businesses dominate the industry in Pakistan, where innovation often takes a back seat. As a result, the industry mainly operates at lower levels of technology and is not innovative. There is a lack of automation in production systems and little emphasis on R&D. These deficiencies are attributed to limited access to finances, a shortage of "industry-ready" university graduates, a lack of well-trained technician-level workforce required by the industry, and sometimes overregulation. Despite operating at lower levels of technology, the industry does not feel the need to collaborate with local universities or R&D organizations to upgrade its technology or develop new products. This reluctance may stem from the fact that Pakistani firms generally develop few new products, especially high-tech or high-quality products, or they do not consider universities to be reliable partners [4].

iv) Government

The primary role of the government is to provide conducive environment for the three elements of the NIS: R&D, universities, and industry. This facilitation hinges on addressing specific needs, as outlined below:

- **R&D environment** - Directly impacts the NIS's capacity and performance, this facet encompasses elements, such as Science Technology & Innovation (STI) policy, R&D funding mechanisms, R&D infrastructure, higher education policy, R&D incentives for industry, and intellectual property (IP) policy & law, which are dependent on government's directions and timely regulations

- **Technology business environment** - Consists of elements, including the innovation incentives for industry, start-up policy, venture capital market, technical standards, technology regulations, technology business infrastructure, and technology education & training system

- **General business environment** - The overarching framework guiding the NIS's performance, this aspect shapes the final outcome of the ecosystem. It is affected by the industrial policy, ease of doing business, monetary policy, energy policy & infrastructure, commerce & trade policy, financial market, labor market, communication & transport infrastructure, and education system, among other factors

- **International environment** - This sphere influences the NIS through environment elements, such as international competition, globalization, international regulations & treaties, and international trade compliance, among others [4]

POLICIES, PROGRAMS, AND REGULATIONS TO PROMOTE R&D AND INNOVATION ACTIVITIES

Today, "knowledge" has become the primary driving force for socioeconomic development. Countries that have invested in their human resources, nurtured the creativity of their youth, and utilized their potential for growth emerged as leaders in the global arena.

The challenge for Pakistan is to establish a sustainable competitive advantage on a global level, which will allow it to create, acquire, and utilize knowledge for socioeconomic development. The science, technology, and higher education sectors must play a critical role in transitioning toward a "knowledge economy." Effective government policies can catalyze the process of socioeconomic development, and acquiring the necessary knowledge and skills can improve living standards and provide a better future for the next generations.

As emphasized previously, the three main players in NIS and the development of a knowledge economy are universities, industry, and the government. The success of each of these entities depends on merit-based competitiveness within their systems and on the efficiency of their interactions with the other players. Developing a knowledge economy requires a comprehensive understanding of the dynamic relationship between research, invention, innovation, and economic growth, which allows for the modulation of these elements, according to the specific needs and challenges of the country.

The global innovation landscape is constantly changing, moving across geographical borders and shifting among civilizations. In the past three decades, numerous countries have achieved economic and social development by making structural adjustments to their economies, prioritizing education, particularly higher education, adopting foreign technology to produce high-value goods and services, and diversifying their economies from resource-based to knowledge-based. Public-private partnerships and public incentives for encouraging partnerships between local and international firms have played a crucial role in this transition.

A number of initiatives have been taken at different levels and in collaboration with various governments, nongovernment, public-private partnerships that have yielded significant benefits for various segments of the society [4].

RESEARCH FOR INNOVATION

Under the Research for Innovation program, the HEC has initiated several key programs. The following is a snapshot of them:

i) Office of Research, Innovation and Commercialization (ORIC)

ORIC was established in September 2011 as a central hub for research activities, aligned to HEC's policies, in making research a top priority for a sustainable economic growth and future knowledge economy. To date, ORIC has been established in 79 universities in Pakistan.

The purpose of ORIC is to serve as a pivotal point to encompass all the research activities, develop, expand, enhance, and manage universities' research programs and connect research activities directly to universities' educational, social, and economic priorities and its broader community, under a single umbrella. ORIC is also responsible in upholding the quality of research that reflects the highest international standards and advances [4].

ii) Business incubation centers (BIC)

HEC supports the establishment of business incubation centers (BICs) within higher education institutions (HEIs) in Pakistan. These centers provide essential infrastructure and necessary facilities for researchers and young entrepreneurs, nurturing early-stage business ventures with the goal of fostering self-sustaining, successful firms upon program completion.

Business incubators are organizations that support new and start-up companies during their initial development stage by providing a range of targeted resources and services. These services are either developed by the business incubator or arranged through its network of contacts. Graduates of the business incubator program create jobs, revitalize neighborhoods, commercialize new technologies, and strengthen local and national economies. This approach shifts the focus from creating job seekers to turning new graduates into job providers [4].

iii) Technology and innovation support centers (TISCs)

TISCs are established by the World Intellectual Property Organization (WIPO) to provide innovators in developing countries with access to high-quality, locally based technology information services and other related services. TISC offices have been set up at 39 universities in Pakistan through a collaboration between WIPO, HEC, and the Intellectual Property Organisation (IPO) of Pakistan, under ORIC.

The primary objective of the TISC network is to encourage the use of patent information among researchers, entrepreneurs, intellectual property (IP) managers, attorneys, government officials, and policy makers by making national and international IP databases accessible to them. These centers serve as a "one-stop-shop" for IP-related services, helping to reduce the technical and scientific knowledge gap between developing and least-developed WIPO member countries [4].

iv) Technology Development Fund

In line with its mission, HEC has initiated a Public Sector Development Program (PSDP) project called "Establishment of Technology Development Fund for scholars, researchers and industrialists to introduce new technologies in Pakistan". This innovative initiative aims to bridge the gap between academia and industry, which will have a positive impact on the socioeconomic conditions of Pakistan. The Technology Development Fund is a key approach to support the government of Pakistan's Vision 2025 to lead the country toward a knowledge economy. This program has already funded 200 joint academia-industry projects and over 160 licenses to industry players for mass scaling and commercialization [4].

v) University Industry Technology Support Program (UITSP)

UITSP, an initiative by HEC, is a significant step toward fostering strong cooperation between academia and industry. This cooperative effort aims to capitalize on emerging international demands for products and processes in discrete and continuous manufacturing, which will contribute to the national economy. The program is focused on the industrial sectors where the country already plays a major role in world trade. It aims to harness the potential of highly competitive sectors for international trade for local and international consumption. The program identifies competitive sectors as well as import and export trends by using publicly available local and international statistical data [4].

vi) National Research Program for Universities (NRPU)

The NRPU is a flagship research program of the HEC that allocates research grants based on competitive merit to fund high-quality and promising scientific research projects. These projects demonstrate strategic relevance and have the potential to impact the local industry and society, encompassing both basic and applied research. The goal of NRPU is to stimulate scientific excellence and the advancement of knowledge by giving researchers the freedom to formulate their own research concepts and methods.

The NRPU grant awards will be made to the host HEI of the lead academic faculty associated with the project and administered through the appropriate ORIC on campus. The Principal Investigator (PI) should be a faculty member at a higher education institution in Pakistan, and encouraged to submit proposals that are collaborative in nature, with teams, including junior and senior academic staff both male and female researchers, and appropriate sectoral/industrial collaborators. PIs are also encouraged to include students as part of the project team who have worked on the academic research underpinning the NRPU proposal.

NRPU awards will be selected competitively through a merit-based, independent, and transparent evaluation and selection process based on international standards. The process is outlined in the sections below and the full evaluation and selection protocol available on the HEC website [4].

vii) Problem Based Applied Inter-Disciplinary Research Program (PBAIRP)

HEC has initiated PBAIRP, an interdisciplinary research grant program to foster interdisciplinary research and generate solutions to the challenges facing Pakistan. The program is specifically designed to address contemporary issues in the country and to provide better and more relevant answers to current problems through an interdisciplinary approach. Interdisciplinary research and effective collaboration between people from different disciplines provide substantial benefits to scientists, policymakers, and other stakeholders in order to maximize the potential benefits of interdisciplinary research for future activities [5].

National Centers

During FY 2018–19, through PSDP, HEC established six national centers (consortia of multiple labs from different universities) on:

- National Center for Cyber Security (NCCS)
- National Center of Robotics and Automation (NCRA)
- National Center of Artificial Intelligence (NCAI)
- National Center for Cloud Computing and Big Data (NCBC)
- National Center for GIS and Space Applications (NCGSA)
- National Center for Livestock Breeding, Genetics and Genomics (NCLBG&G)

The primary purpose of the national centers is to focus on research & development and human resource development in the specialized field of cybersecurity, big data, cloud computing, artificial intelligence (AI), robotics and automation Problem Based Applied Interdisciplinary Research Programme, GIS and space applications, and livestock breeding genetics and genomic (LBG&G) as well as their practical applications which align with the objectives of Vision 2025 [6].

The key objectives of these centers are to:

- Enhance national capacity to carry out R&D in respective cutting-edge technology
- Provide innovative solutions to local problems
- Provide high-value shared services to academia and industrial partners
- Develop a skilled workforce through training and applied work
- Facilitate technology transfer and consultation to the industries, enabling them to shift toward Industry 4.0

- Establish a prominent global presence in contemporary skills-related R&D
- Address proficiency gaps and promote self-sustainability in these fields for Pakistan

United States-Pakistan Centers of Advanced Studies (USPCASS)

HEC, in collaboration with USAID, has established the USPCASS in the fields of energy, water, agriculture, and food security. These centers include:

- Center for Advanced Studies in Energy at the National University of Science & Technology (NUST) and University of Engineering & Technology (UET) Peshawar
- Center for Advanced Studies on Agriculture at the University of Agriculture Faisalabad
- Center for Advanced Studies on Water at Mehran University of Engineering and Technology, Jamshoro

These centers work closely with each other and with their United States of America (USA) partner, Arizona State University (ASU). They proactively pursue research across various fields, forming a nexus in energy, agriculture, and water.

The USPCASS centers provide cost-effective laboratory testing and other R&D services. They foster collaboration with industry and other stakeholders to provide a platform for introducing R&D to improve products and services. Additionally, these centers also provide technical expertise to start-up companies and businesses [6].

Centers Established through Federal Parliament

HEC, in close collaboration with Ministry of Federal Education and Professional Training, has 26 centers, comprising:

- 12 centers of excellence (CoEs)
- Six area study centers (ASCs)
- Six Pakistan study centers (PSCs)
- Two institutes of clinical psychology (ICPs)

These centers are at the forefront of pioneering, multidisciplinary, unconventional, and cutting-edge research within their respective assigned areas and fields. Their ultimate goal is to advance scientific development of the country, build a positive image of Pakistan, and position the country prominently in the diplomatic and international arena by providing research-based policy inputs and advice to relevant ministries, divisions, public institutions, and private organizations [6].

Digital Economy

In recent years, the Pakistani government has shifted its focus toward digitization and the development of a knowledge economy. Various ministries, regulatory bodies, ad-hoc committees, and task forces are working diligently to facilitate digital transformation of the nation. With over 64% of Pakistan's population being under the age of 30, there is enormous potential for successful digital adoption.

As efforts are being made to speed up digitization, regulatory concerns have become increasingly pressing, including regulations around cloud computing, data protection, and cybersecurity. Balancing protective regulation with an environment that encourages innovation and digitization will enable Pakistan to make the most of new technologies and build a strong knowledge economy [6].

National Incubation Center (NIC)

NIC is a Pakistan-based start-up incubation program under a public-private partnership with the Ministry of Information Technology and Telecommunication (MoTT) and other entities in Pakistan, including the Ignite National Technology Fund. Established in 2016, the NIC has, to date, incubated 230 start-ups and supported them in areas encompassing business development and investment readiness, along with other areas. They are given an opportunity to learn from Unicorn founders, seasoned entrepreneurs, and domain experts both from Pakistan and abroad. NIC Pakistan serves as an important "central inspiration and innovation point", helping drive ideas to execution and nudge Pakistan toward entrepreneurship. In the country's efforts to lead the way forward in terms of motivating the youth to be creative and find solutions to commonly shared problems, the NIC regularly hosts hackathons and innovation challenges in the areas of e-commerce, Ed-Tech, Health-Tech, e-agriculture, fintech, robotics, AI, and machine learning, to name a few [6].

Several initiatives have been kick-started, including:

i) NICK (National Incubation Center Karachi), stands as one of Pakistan's most esteemed and accomplished entrepreneur support organizations. In the last three years, NICK has conducted around 1,300+ training programs, webinars, and seminars to empower the whole entrepreneurial ecosystem of Pakistan. In addition to this, NICK is also serving as a hub for innovation for the tech and developmental sector, and has empowered hundreds of civil society organizations [6].

ii) Teamup is an incubation and acceleration platform working with young entrepreneurs and start-ups. It is an organization deeply invested in youth empowerment, providing consultancy and advisory services to the corporate and development sector [6].

iii) Ignite funds start-ups and innovative projects that leverage on fourth industrial wave tech to solve local problems and target global opportunities in health, education, energy, agriculture, telecom, finance, and other verticals. Ignite outreach activities seek to inform professionals, media, students, corporations, and media and policy makers on the challenges and threats posed by the new economy and the importance of innovation and seek to increase engagement [6].

Some examples of Ignite programs are:

- **Challenge-driven Innovation Fund (CIF)** - With projects funded under the Challenge-driven Innovation Fund, Ignite aims to build a portfolio of coherent projects with a medium- to long-term business goals and a technology-based strategic plan. It encompasses applied research, technology development and/or method/tool and integration, testing, and validation on a small-scale prototype in a laboratory or simulated environment. Project outcomes must also include top-level scientific publications as well as an adequate formal protection of the generated IP

- **Final Year Projects (FYP) Funds** - This program aims to assist final year undergraduate students of ICT-related disciplines by providing financial assistance for developing prototypes or working models of their FYP. This initiative promotes creativity, innovation, and practical engineering and development skills

- **DiGiSkills Program** - Launched by the MoTT, this nationwide Digital Skills (DigiSkills) Training Program has the goal of providing one million trainings in technology for the future of work. The Virtual University of Pakistan has been chosen to implement the program, which is being overseen by the MoTT through Ignite-National Technology Fund. The aim of the DigiSkills Program is to equip young people, freelancers, students, professionals, and others with the knowledge, skills, tools, and techniques needed to take advantage of online job opportunities both domestically and internationally, in order to earn a living or supplement their income

  Pakistan is the fourth largest provider of online freelancers in the world with an estimated number of registered freelancers in the hundreds of thousands. Much of the work done by these freelancers is for international clients, resulting in significant foreign remittances to the country. Although accurate data on the amount of money brought in by freelancers is not available, estimates range from USD500 million to USD1.3 billion per year [6].

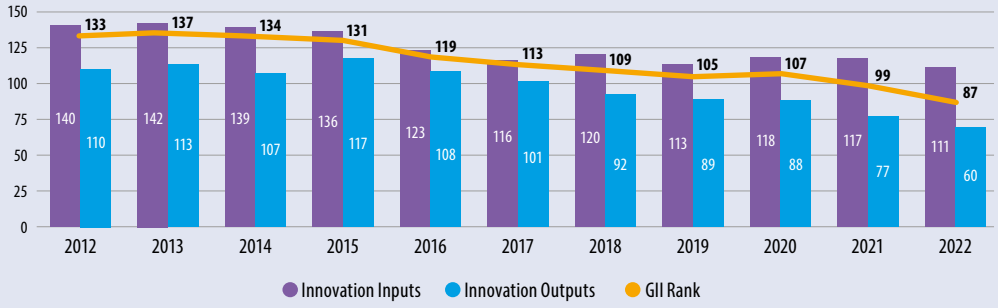
DYNAMIC ANALYSIS OF INNOVATION PERFORMANCE

The Global Innovation Index (GII) serves as a valuable tool that tracks global innovation trends in light of ongoing challenges, such as the COVID-19 pandemic and slowing productivity growth. GII is made up of around 80 indicators and is divided into two categories: innovation inputs and outputs. The goal of the GII is to measure the various dimensions of innovation and it ranks the world's economies based on their ability to innovate.

Pakistan has made significant strides, elevating its standing to 87th place among the 132 economies featured in the GII 2022, signifying a prominent ascent. Figure 7.6 shows Pakistan's GII rankings, the innovation inputs, and innovation outputs over the past decade.

FIGURE 7.6

PAKISTAN'S GII RANKINGS IN 2012–22



Source: WIPO [7].

The following encapsulates some of the country's successes:

- In 2022, Pakistan achieved a remarkable milestone by joining the group of Innovation Achievers for the first time by performing "above expectations" for innovation relative to its level of economic development

- Pakistan has steadily advanced, over the years, its position in the innovation rankings. Commencing at 133rd place in 2012, it has made commendable progress, culminating to the 87th spot in 2022. Notably, the most significant strides were observed in the three years, during which it has improved approximately 20 places

- Pakistan performs better in innovation outputs than innovation inputs, ranking 69th in innovation outputs and 111th in innovation inputs, an indication of latent innovation potential

Pakistan ranks 12th among the 36 lower-middle-income group economies. India leads the group with an overall global ranking of 40, followed by Vietnam and Islamic Republic of Iran (IR Iran), ranking 48th and 53rd global, respectively [7].

TABLE 7.5

LOWER-MIDDLE-INCOME COUNTRIES - GII RANKINGS

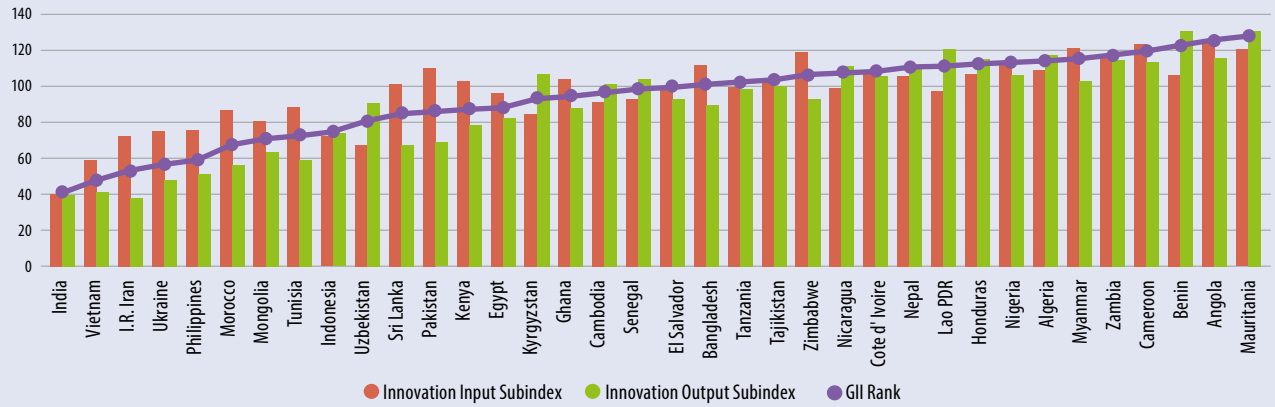
Lower-Middle-Income Countries - GII Rankings				
Income Rank	Country	GII Rank	Innovation Input Subindex	Innovation Output Subindex
1	India	40	42	39
2	Vietnam	48	59	41
3	I.R. Iran	53	73	38
4	Ukraine	57	75	48
5	Philippines	59	76	51
6	Morocco	67	87	56
7	Mongolia	71	81	64
8	Tunisia	73	89	59
9	Indonesia	75	72	74
10	Uzbekistan	82	68	91
11	Sri Lanka	85	102	68
12	Pakistan	87	111	69
13	Kenya	88	103	79
14	Egypt	89	97	83
15	Kyrgyzstan	94	85	108
16	Ghana	95	105	88
17	Cambodia	97	92	102
18	Senegal	99	93	105
19	El Salvador	100	101	95
20	Bangladesh	102	112	90
21	Tanzania	103	100	99
22	Tajikistan	104	104	101
23	Zimbabwe	107	120	93
24	Nicaragua	108	99	112
25	Cote d'Ivoire	109	109	106
26	Nepal	111	106	111
27	Lao PDR	112	98	122
28	Honduras	113	108	116
29	Nigeria	114	113	107
30	Algeria	115	110	118

Lower-Middle-Income Countries - GII Rankings				
Income Rank	Country	GII Rank	Innovation Input Subindex	Innovation Output Subindex
31	Myanmar	116	122	104
32	Zambia	118	118	115
33	Cameroon	121	124	114
34	Benin	124	107	131
35	Angola	127	129	117
36	Mauritania	129	121	132

Source: WIPO [7].

FIGURE 7.7

LOWER-MIDDLE-INCOME COUNTRIES - GII RANKINGS ON INNOVATION INPUT AND OUTPUT SUBINDEX



Source: WIPO [7].

TABLE 7.6

CENTRAL AND SOUTH ASIAN REGION COUNTRIES - GII RANKINGS

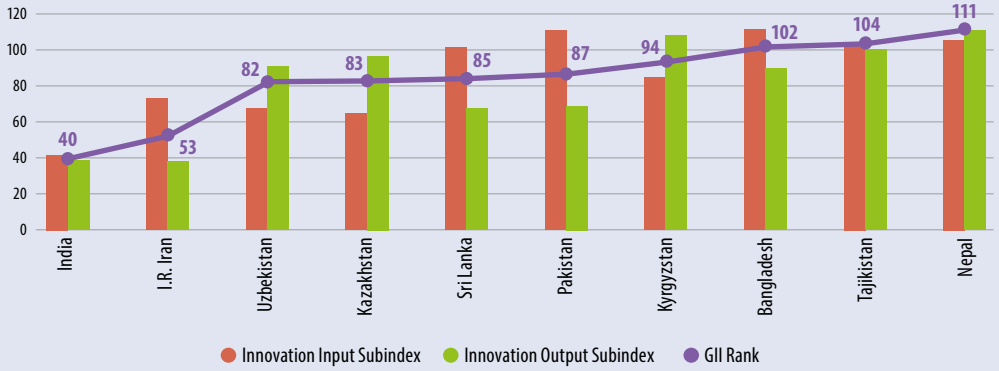
Central & South Asian Region Countries - GII Rankings				
Region Rank	Country	GII Rank	Innovation Input Subindex	Innovation Output Subindex
1	India	40	42	39
2	I.R. Iran	53	73	38
3	Uzbekistan	82	68	91
4	Kazakhstan	83	65	97
5	Sri Lanka	85	102	68
6	Pakistan	87	111	69
7	Kyrgyzstan	94	85	108
8	Bangladesh	102	112	90
9	Tajikistan	104	104	101
10	Nepal	111	106	111

Source: WIPO [7].

Pakistan ranks 6th among the 10 economies in Central and Southern Asia region. India leads the group with an overall global ranking of 40, followed by I.R. Iran and Uzbekistan having 53rd and 82nd global ranking, respectively.

FIGURE 7.8

CENTRAL AND SOUTH ASIAN REGION COUNTRIES - GII RANKINGS

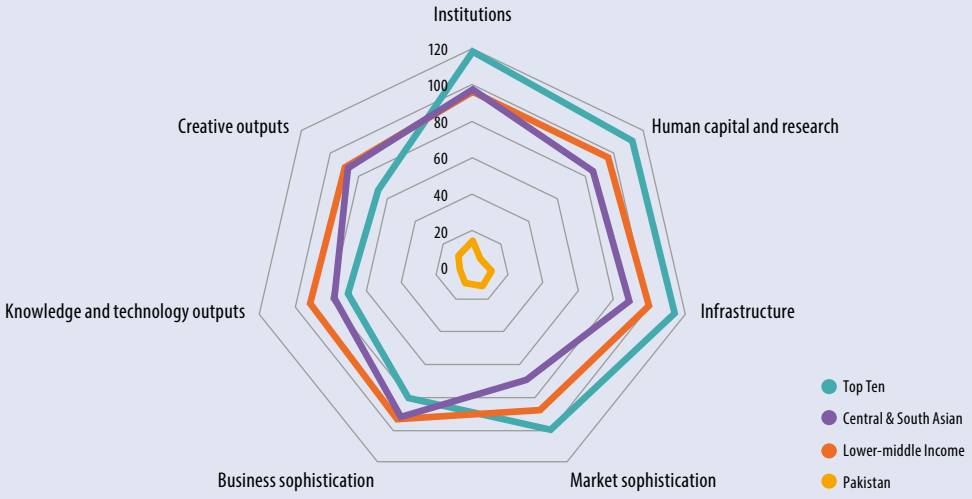


Source: WIPO [7].

Benchmarking against other lower-middle-income group economies and central and south Asian countries, as illustrated in Figure 7.9, Pakistan outperforms the lower-middle-income group average in three pillars, namely: Business sophistication, Knowledge and technology outputs, and, Creative outputs. Pakistan also surpasses the regional average in the same three pillars, namely: Business sophistication, Knowledge and technology outputs, and Creative outputs.

FIGURE 7.9

BENCHMARKING THE GII SEVEN-PILLAR SCORES OF PAKISTAN



Source: WIPO [8].

GLOBAL INNOVATION INDEX (GII) - CATEGORY ANALYSIS FOR PAKISTAN

The GII recognizes that innovation plays a crucial role in driving economic growth. The GII aims to provide a ranking of innovation and detailed analysis of approximately 130 economies. Over the past 10 years, the GII has become a reputable reference on innovation and a "tool for action" for governments and organizations, serving as a strategic guide for their innovation strategies.

The index provides a ranking of nations' innovation capabilities and results of world economies. It measures innovation based on criteria that include institutions, human capital and research, infrastructure, credit, investment, linkages, knowledge (creation, absorption, and diffusion), and creative outputs.

The GII has two subindices: the Innovation Input subindex and the Innovation Output subindex that encompasses seven pillars or categories, each consisting of three subpillars or categories.

Innovation Input Subindex

1. Institutions

Innovation Inputs - Institutions											
	Year										
Innovation Input	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1. Institutions	**122**	**135**	**135**	**134**	**124**	**124**	**121**	**100**	**109**	**99**	**118**
1.1 Political Environment	138	140	141	139	126	126	124	107	109	107	104
1.2 Regulatory Environment	122	125	125	122	113	113	110	113	116	116	118
1.3 Business Environment	69	103	107	111	111	101	89	62	53	55	107

Source: WIPO [8].

2. Human Capital and Research

Innovation Inputs - Human Capital & Research											
	Year										
Innovation Input	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2. Human Capital & Research	**141**	**141**	**139**	**134**	**122**	**121**	**117**	**116**	**118**	**117**	**113**
2.1 Education	141	141	141	136	124	120	120	122	124	121	117
2.2 Tertiary education	140	139	124	128	114	115	111	115	123	124	118
2.3 Research & development	88	61	68	68	68	67	65	62	62	63	53

Source: WIPO [8].

3. Infrastructure

INNOVATION INPUTS - INFRASTRUCTURE											
	Year										
Innovation Input	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
3. Infrastructure	**123**	**120**	**124**	**123**	**114**	**109**	**111**	**120**	**119**	**117**	**114**
3.1 ICT	105	109	134	114	106	109	110	109	111	104	98
3.2 General infrastructure	137	134	134	131	121	111	111	123	125	125	127
3.3 Ecological sustainability	101	103	98	99	108	104	109	108	94	96	111

Source: WIPO [8].

4. Market Sophistication

INNOVATION INPUTS - MARKET SOPHISTICATION											
	Year										
Innovation Input	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
4. Market Sophistication	**126**	**138**	**140**	**129**	**105**	**102**	**107**	**102**	**116**	**120**	**100**
4.1 Credit	93	115	119	129	122	113	118	118	124	123	102
4.2 Investment	77	102	107	97	70	83	80	83	100	107	62
4.3 Trade, diversification, & market scale	139	138	135	116	69	68	74	68	85	83	75

Source: WIPO [8].

5. Business Sophistication

INNOVATION INPUTS - MARKET SOPHISTICATION											
	Year										
Innovation Input	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
5. Business Sophistication	**127**	**131**	**133**	**131**	**97**	**78**	**100**	**96**	**87**	**88**	**81**
5.1 Knowledge workers	114	114	129	125	78	74	103	100	98	99	101
5.2 Innovation linkages	111	123	128	123	115	99	85	83	83	78	60
5.3 Knowledge absorption	110	116	99	97	91	78	76	68	72	69	71

Source: WIPO [8].

Category Analysis - Innovation Outputs

6. Knowledge and Technology

INNOVATION OUTPUTS - KNOWLEDGE & TECHNOLOGY											
	Year										
Innovation Input	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
6. Knowledge & Technology	**117**	**105**	**101**	**101**	**90**	**84**	**72**	**70**	**69**	**71**	**70**
6.1 Knowledge creation	124	73	79	82	71	69	62	59	63	65	54
6.2 Knowledge impact	106	104	105	107	87	62	68	68	81	74	77
6.3 Knowledge diffusion	71	99	103	100	99	102	99	91	81	71	77

Source: WIPO [8].

7. Creative Outputs

INNOVATION OUTPUTS - CREATIVE OUTPUTS											
	Year										
Innovation Input	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
7. Creative Outputs	**99**	**120**	**110**	**121**	**114**	**112**	**104**	**104**	**108**	**87**	**67**
7.1 Intangible assets	107	111	110	118	110	105	100	98	98	64	51
7.2 Creative goods and services	53	107	63	100	110	123	121	116	128	126	108
7.3 Online creativity	105	107	119	114	105	100	71	96	93	89	60

Source: WIPO [8].

PAKISTAN'S INNOVATION SYSTEM

There are a number of noteworthy insights into Pakistan's innovation input and output indicators.

Innovation Inputs

- **Expenditure on education** gradually increased from 1.6% to 2.9% of GDP, resulting in improving the rankings from 133 to around 100. However, due to reduced expenditure of only 2.5% of GDP, the ranking dropped to 116 in 2021

- **Research** showed a slow gradual increase and the rank is also following the same pattern. The results for 2021 was equal to 382.9 FTE/mn pop., equivalent to an indicator rank of 76

- **Gross expenditure on R&D** showed a direct relationship between the R&D expenditure and ranking, which was equal to 0.2% GDP in 2021 and equivalent to an indicator rank of 90

- **QS university ranking** improved to 29.5 in 2021, a 4-percentage point increase from the previous year, and equivalent to an indicator rank of 42

- **ICT access** showed a sharp increase in 2021 but no changes in the rank. The results for ICT access in 2022 was equal to 64.2, equating to an indicator rank of 108

- **Venture capital received** a substantial boost in 2021, amounting to USD300 million, marking a 612 percentage point increase from the year prior and an indicator rank of 79

- **Domestic industry diversification** surged in 2021, reaching 89.8, and corresponding to an indicator rank of 45

- **Knowledge-intensive employment** remained relatively stable at 11.8 million people in 2021, with little change from the previous year and an indicator rank of 102 [8]

Innovation Outputs

- **Patents by origin** increased by 8 percentage points from the previous year, equivalent to an indicator rank of 87

- **Citable documents H-index** was up by 26 percentage points from the year prior and equivalent to an indicator rank of 46

- **High-tech manufacturing** experienced a 26 percentage points from the prior year, equating to an indicator rank of 46

- **Intellectual property receipts** amounted to USD11 million in 2021, reflecting an infinite percentage points from the year prior and an indicator rank of 91

- **Production and export complexity** was lower in 2021 and equivalent to an indicator rank of 91

- **High-tech exports** in 2021 decreased by 35 percentage points from the earlier year, leading to an indicator rank of 77, showing weakness in last two years

- **Intangible asset intensity** was equal to 61.6% of total value in 2021 and equivalent to an indicator rank of 39, showing very good improvement

- **Cultural and creative services exports** was equal to USD54.2 million in 2020, marking a 2 percentage points increase from the previous year and an indicator rank of 79 [8]

TABLE 7.7

PAKISTAN INNOVATION STRENGTHS AND WEAKNESSES (GII 2022)

STRENGTHS			WEAKNESSES		
Code	Indicator	Rank	Code	Indicator	Rank
2.3.4	QS university ranking, top three	42	1.3.2	Entrepreneurship policies and culture	68
4.3.3	Domestic market scale, bn PPP$	23	2.1.1	Expenditure on education, % GDP	116
5.2.1	University-industry R&D collaboration	32	2.1.3	School life expectancy, years	114
5.2.2	State of cluster development and depth	35	2.3.3	Global corporate R&D investors, top 3, USD'million	38
5.3.2	High-tech imports, % total trade	22	3.2.2	Logistics performance	110
6.1.4	Scientific and technical articles/bn PPP$ GDP	40	3.2.3	Gross capital formation, % GDP	119
6.1.5	Citable documents H-index	46	3.3.2	Environmental performance	126
6.2.3	Software spending, % GDP	37	6.2.2	New businesses/th pop.	117
6.3.4	ICT services exports, % total trade	22	7.2.2	National feature films/mn pop.	77
7.3.4	Mobile app creation/bn PPP$ GDP	12	7.2.3	Entertainment and media market/th pop.	61

Source: WIPO [8].

Strengths and Weaknesses

Table 7.7 summarizes strengths and weaknesses of Pakistan innovation inputs and outputs on an indicator level.

Table 7.7 clearly shows that more focus is needed on fundamental policies, budget allocation, and performance improvement across various sectors. Encouragingly, positive results can be seen in areas, such as academia and industry collaboration, imports of high-tech products, spending on software, exports of ICT goods, and mobile app development. These areas should be further strengthened in the future.

POLICY INTERVENTIONS NECESSARY FOR ENHANCING PRODUCTIVITY AND BUILDING A ROBUST NIS

Fostering innovation is the need of the hour and critical for improving national productivity and competitiveness. Pakistan's success in the global economy depends on its investment in human capital development, promotion of R&D, and support for innovation throughout all stages, from ideation to commercialization.

Following are some recommendations to further enhance the performance of the already performing segments and steps to ensure a continuous learning process at the government, academia, public and private-sector institutions, and enterprises to create a culture of innovation.

Government (Policy-making)

- To ensure continuity of policy and promises, a cross-ministerial "National Innovation Task Force" should be formed to govern and control innovation policy as a "whole of government approach," reporting to the Prime Minister's Office

- Innovation should be made mandatory for all federal and provincial ministries, where their domain and its performance are measured at quarterly, biannually, and annually. Every year the best performing federal and provincial ministries should be acknowledged and rewarded both monetarily and with national and provincial awards

- Redefine Pakistan's NIS by incorporating and integrating the recently published ISO 56000 Innovation Management Systems series standards

- As ISO 56000 standards series tackles the subject of innovation in a holistic way and the different standards focus on subjects, including innovation management, collaboration, ideation, intelligence management, IP management, and innovation measurement. It is recommended that Pakistan's NIS is aligned in accordance to this new standard

- To create awareness of innovation and ISO 56000 innovation management system standard, training and consultancy at divisional, provincial, and federal government levels, at public and private sector levels, NGOs, profit and nonprofit bodies, SMEs, and corporate sectors should be provided

- Soon ISO 56000 series standards on innovation shall become a prequalification criterion and new benchmark at all entry levels, similar to the workings of ISO 9000 standard on quality in the past. For training, awareness, and certification, qualified people are required on a large scale. It is therefore imperative to introduce innovation management courses and subjects at university level. ORIC can play a vital role with its already established network at university level, efforts should be done for speedy deployment of such programs

Academia (Innovation, R&D)

- NIS aims to transform Pakistan's economy from an agriculture-based economy to a knowledge-based economy, which involves extensive interactions with a number of players. The academia will need to play a leading role in this transition through knowledge creation, its uses, and diffusion of new knowledge into the society through establishment of technology parks, business incubators, access to venture capital, and other such schemes

- Technology-related new knowledge drives the economic systems. Increasing the use of knowledge in the production processes and service industry will determine the growth of Pakistan's GDP in future. While the government should act as a facilitator, technology capabilities must accumulate in enterprises, and this will only be possible if the country's academia is strengthened and create effective linkages

- The link between innovation and economic and social progress is well established. The next generation of technologies in every field - from biotechnology, blockchain, and digital connectivity to materials science, AI, and more - promises to further reduce poverty and improve the lives of billions of people. Now, more than ever, innovation holds the key to this transformation

- The new world order requires Pakistan to prepare its future generation to face the challenges of the global economy. This involves a substantially different type of education, development of the various skills, such as the ability to think critically, innovate, communicate effectively, work effectively in teams, develop entrepreneurship and risk-taking skills, and the ability to face and manage changes in a flexible manner, among others

- A massive national effort focused toward development of high level S&T manpower is necessary to meet the critical shortage of teachers and researchers. Equally important is the investment in skill development at technical education and management levels and provision of quality education to the majority of Pakistan's population

- There is a need to develop and introduce a system of incentives that attracts the brightest youth toward scientific careers and a system that supports and rewards innovation. This would require investment in building an infrastructure for research and facilities, and training institutes for continued training to deepen the knowledge and development of the skills of researchers

- The country needs to strengthen and/or establish centers of excellence (CoE) in areas which are relevant to the social and economic requirements. These CoE should be equipped with facilities that are located in world-class institutions, including a top-class faculty with internationally comparable salary scales, and flexible working contracts allowing work at the industry for doing contract research

- Regional knowledge networks should be developed with collaboration of industrial clusters and the local universities to share knowledge on the latest production practices and quality management. Collaborations between local firms, public institutions, and multinationals are essential to transfer capabilities in jointly executed projects

Industry (Implementation)

- For any change in existing NIS or new policy-making, the task force should interact and consult with innovation actors from the private and public sectors, industry and academia, including start-ups, and relevant innovation clusters

- Mechanism for measuring innovation at different levels and for different sectors should be defined and made certain that the targets or actions of innovation policy are tangible, measureable, and that they are embedded as KPIs for individuals, departments, and organizations. They should also be regularly revisited and evaluated

- National industrial and trade policies must encourage local technology firms and engineering enterprises, through continuous upgrading of technology and skills, and access to markets. Small industry must be encouraged to convert into medium-sized ones and medium-sized industry into large ones

CONCLUSION

Pakistan's economy has experienced cycles of growth and decline. Political instability, high global fuel and commodity prices, and a large trade deficit have placed significant pressure on the country's foreign exchange reserves, leading to a significant depreciation of the Pakistani rupee against the USD, and resulting in high inflation.

An analysis of Pakistan's TFP and GDP growth from 1970 to 2019 shows that both TFP and economic growth have decreased over time. This trend is evident across all sectors, including agriculture, industry, and services. The analysis also reveals that efforts to deregulate and liberalize the economy have led to higher TFP growth and subsequently higher GDP growth. Additionally, macroeconomic and political stability also appear to be significant factors in driving higher TFP and GDP growth.

Innovation is essential for boosting productivity in low-income developing countries like Pakistan. Investment in technology, education, training, infrastructure, communications, the legal system, rule of law, housing, healthcare, professionalism, merit, and equal opportunities can increase people's productivity and result in higher economic growth. Unfortunately, several structural problems have hindered efforts to increase productivity in Pakistan and, if not addressed, it will prevent the country from achieving economic progress.

Despite the aforementioned challenges, Pakistan's innovation performance has significantly improved in the last two years. In 2020, Pakistan's innovation performance was in line with its level of development, but it has since moved to be among a group of countries that have performed above expectations for their level of development in 2021 and 2022. To maintain and improve this trend, policy changes need to be implemented at both national and provincial levels, and the country should aim to foster more innovation to drive economic growth and boost productivity.

CHAPTER 8

PHILIPPINES

INTRODUCTION

Science, technology, and innovation (STI) are fundamental components of economic growth and development. The ability of a country to create, distribute, and exploit knowledge has become a major source of competitive advantage, wealth creation, and improvements in the quality of life. In an OECD analysis on the role of STI in economic performance, multifactor productivity (MFP) has increased in several OECD countries, like Australia, Denmark, Finland, Ireland, Norway, and the United States of America (USA). The rapid MFP growth was attributed to three factors, but most importantly, to smarter and more innovative ways of producing goods and services [1]. This finding points out that for a country to achieve a sustained increase in its economic productivity and growth, it needs to heavily invest in STI, ensuring that scientific knowledge and technological know-how are successfully translated into actual products and services via research and development (R&D). As E. Carayannis and E. Grigoroudis (2012) puts it, a country's competitiveness is measured by the formation of intellectual capital and society's capacity to innovate [2]. With innovation, new ideas and technologies are developed which would expand productivity and generate greater output and value with the same input [3].

Innovation is an indispensable element in today's world as products, services, and technologies swiftly vie for a place in customers' hearts, thus generating enduring benefits and profits for firms and businesses. Innovation, which is normally defined as to create or improve products or services to produce something new, has been practiced by many successful firms to gain a competitive edge with existing rivals [4].

Innovation is divided into several dimensions, but according to literature, administrative, and technological innovation are the most frequently discussed aspects in numerous studies. The combination of administrative and technological innovation within firms bolster their competitiveness in their segment. It is aligned with resource-based view (RBV) theory, which highlighted that firms' innovativeness generally leads to improved firm performance, a fact that has been empirically proven by many previous studies.

At the macro level, innovation is seen as a driver of economic growth, productivity, and competitiveness. As Corarаton (1999) states that based on the chain of causality, research, and development translates into innovation, which in turn results in productivity and technological progress, ultimately culminating in economic growth and prosperity [5].

The objective of this chapter is to look into the state of STI in the Philippines, as measured by its levels of investment in R&D and innovation. Additionally, it endeavors to compare the Philippines' productivity trends and R&D investments with those of some ASEAN countries, particularly Indonesia, Malaysia, Singapore, and Thailand.

R&D investment was measured in terms of both human and financial resources while innovation was assessed by the number of registered intellectual property rights (IPR), particularly patents, trademarks, utility model, and industrial design. R&D financial resources was determined by the R&D expenditures

of five separate years in 2009, 2011, 2013, 2015, and 2018 whereas R&D human resources was measured by the number of R&D personnel over the same five years.

Meanwhile, innovation is defined by the number of registered IPR, including patents, trademarks, and utility models. Productivity, on the other hand, encompasses the productivity metrics for Asian countries drawn from the APO Productivity Database 2022, specifically covering variables, such as total factor productivity (TFP), output growth, capital growth, and capital deepening.

STI SYSTEM IN THE PHILIPPINES

During the period when most Asian nations were recovering from the aftermath of World War II, the Philippines was among the first to build the foundations for a progressive nation through the enactment of RA No. 2067, otherwise known as the Science Act of 1958. This legislation was designed to integrate, coordinate, and intensify scientific and technological R&D while fostering invention, providing funds, and for other related purposes. This legislation paved the way to the establishment of the National Science and Development Board (NSDB) on 13 June 1958.

In 1981, the Board underwent restructuring, evolving into the National Science and Technology Authority. Today, by virtue of Executive Order 128, which was promulgated on 30 January 1987, this government agency is named Department of Science and Technology (DOST).

DOST is the premiere science and technology body in the country, tasked with the dual mandate of: (i) providing central direction, leadership, and coordination of all scientific and technological activities; and (ii) formulating policies, programs, and projects to support national development.

The Intellectual Property Code (Republic Act 8293) was enacted and signed into law on 6 June 1997 to promote and foster innovation in the country,. This legislation serves as the cornerstone of the Philippine National Innovation System that protects the exclusive rights of scientists, inventors, artists, and other gifted citizens to their intellectual property (IP) and creations. Even prior to the enactment of RA 8293, the significance of inventions and their utilization had been recognized through RA 7459, the Inventors and Inventions Act of the Philippines, which was enacted into law on 28 April 1992. RA 7459 provides protective measures for inventors' exclusive rights to their inventions and grants them incentives in its development and commercialization.

More recently, RA 11293, also known as the Philippine Innovation Act of 2018, was enacted with the following primary objectives:

- Promoting a strategic planning and innovation culture
- Improving innovation governance by coordinating and eliminating fragmentation of innovation policies and programs across government
- Strengthening the role of micro, small, and medium enterprises (MSMEs) in the innovation system
- Removing obstacles to innovations
- Encouraging an entrepreneurial culture
- Exploring, promoting, and protecting traditional knowledge, traditional cultural expressions, and genetic resources

- Strengthening interactions and partnerships among public and private sectors, academia, MSMEs, R&D institutions (RDIs), and communities

The enactment of RA 11293 has paved the way for the establishment of the National Innovation Council, which adopts a "whole of government approach" that engages all government agencies to drive innovation across all areas. In addition to RA 11293, the Congress also enacted RA 11337, or the Innovative Startup Act, whose development plan includes programs, incentives, and benefits for start-ups and start-up enablers. The Philippine Council for Industry, Energy and Emerging Technology Research and Development (DOST-PCIEERD) serves as one of the host agencies along with the Department of Trade and Industry (DTI) and the Department of Information and Communications Technology (DICT). This law complements RA 11293 through its emphasis on MSMEs and its role in fostering the country's innovation.

THE STATE OF STI IN THE PHILIPPINES

The core data used to assess the state of science and technology (S&T) development in the country are: (i) proportion of national R&D expenditures to the country's GDP; (ii) number of R&D personnel per million population; and (iii) number of researchers per million population [6].

Recognizing the crucial role of S&T in driving the country's innovation and productivity, the Philippines has consistently, through the years, apportion a considerable amount of its resources to support the country's R&D activities. From the average expenditure of PHP590 million recorded in the 1980s, R&D expenditure increased to PHP58.9 billion, an increase of almost 100 fold in a span of four decades. Based on the General Appropriations Act, the allocation of public funds for R&D from 2017 to 2021 amounted to PHP92.43 billion for an average of PHP18,49 billion per year. This resulted in an annual average ratio of 0.58% of the national budget.

R&D Investment in Financial and Human Resources

The following tables present the investment in R&D financial and human resources in the country spanning from 2009 to 2018.

TABLE 8.1

NATIONAL R&D EXPENDITURE OF THE PHILIPPINES BY SECTOR OF PERFORMANCE IN SELECTED YEARS IN 2009–18

Sector of Performance	R&D Expenditures (PHP'million)				
	2009	2011	2013	2015	2018
All Sectors	8,779.16	11,383.97	15,914.71	21,868.61	58,853.60
Government*	1,392.69	1,749.35	4,731.59	5,303.03	13,461.26
Higher Education*	2,112.66	4,058.51	5,366.03	8,034.68	11,786.39
a. Public HEIs	1,745.32	3,403.44	4,810.96	6,243.37	9,620.20
b. Private HEIs	367.33	655.07	555.07	1,791.31	2,166.10
Private Nonprofit*	228.45	46.09	130.97	465.28	1,001.33
Private Industry**	5,045.37	5,530.02	5,686.12	8,065.62	32,604.62

Source: i) DOST Survey on R&D Expenditures and Human Resources in Government, Higher Education, and Private Nonprofit Sectors in 2009, 2011, 2013, 2015, 2018.
ii) PSA ASPBI, 2009, 2013, 2015, Private Industry R&D Expenditures data for 2011 was estimated from 2010 ASPBI; PSA CPBI, 2018.

Table 8.1 shows that the total national R&D expenditures continued to increase from 2009 to 2018. The biggest increase is seen from 2015 to 2018 in which the expenditure amounted to PHP21.9 billion in 2015 and PHP58.9 billion in 2018, showing a remarkable increase of 169% in a span of three years. All sectors showed promising growth, the most significant being in the private industry sector where it showed an increase of 304%, soaring from PHP8.1 billion in 2015 to PHP32.7 billion in 2018. This sector accounted for the majority (55.4%) of R&D expenditures.

TABLE 8.2

R&D EXPENDITURE OF THE PHILIPPINES BY FUNDING SOURCE AND BY SECTOR OF PERFORMANCE IN 2015 (PHP'000)

Funding Source	Total R&D Expenditures	Government*	Higher Education Institutions*		Private Nonprofit Institutions*	Private Industry*
			Public	Private		
Total R&D expenditures	21,868,611	5,303,028	6,243,373	1,791,310	465,284	8,065,616
Institutions' own funds	13,263,660	2,930,615	1,829,936	342,570	94,923	8,065,616
Government funds	7,880,267	2,264,378	4,170,246	1,339,513	106,130	
Private funds	236,559	48,455	100,427	56,558	31,119	
Foreign funds	393,487	53,145	105,727	40,317	194,298	
Other sources	94,638	6,435	37,037	12,352	38,814	

Source: DOST Survey on R&D Expenditures and Human Resources in Government, Higher Education, and Private Nonprofit Sectors in 2015; PSA ASPBI, 2015.

TABLE 8.3

R&D EXPENDITURE OF THE PHILIPPINES BY FUNDING SOURCE AND BY SECTOR OF PERFORMANCE IN 2018 (PHP '000)

Funding Source	Sector of Performance					
	Total R&D Expenditures	Government*	Higher Education Institutions*		Private Nonprofit Institutions*	Private Industry*
			Public	Private		
Total R&D expenditures	58,853,603	13,461,260	9,620,203	2,166,189	1,001,335	32,604,616
Institutions' own funds	45,577,972	9,972,872	1,720,254	1,132,082	148,148	32,604,616
Government funds	11,921,179	3,391,048	7,392,049	642,807	495,275	
Private funds	445,016	30,281	23,283	65,824	325,628	
Foreign funds	621,950	52,242	323,669	230,732	15,307	
Other sources	287,486	14,818	160,947	94,744	16,977	

Source: i) DOST Survey on R&D Expenditures and Human Resources in Government, Higher Education and Private Nonprofit Sectors conducted by UPLB INSTAT in 2018.
ii) PSA CPBI in 2018.

In terms of the sources of funds for R&D, as presented in Tables 8.2 and 8.3, most R&D projects and activities are implemented using the institutions' own funds for both 2015 and 2018. In 2018, 74% of the R&D expenditures of the government sector were funded through the agencies' own budgets while 25% relied on funding from other government agencies. In public higher education institutions (HEIs), 77% of their R&D expenditures were funded by other government agencies. Meanwhile, 52% of R&D expenditures in the private HEI sector were funded by the institutions themselves. The majority of funds in the PNPI sector were from government funds and other private funds.

TABLE 8.4

NATIONAL R&D PERSONNEL OF THE PHILIPPINES BY SECTOR OF PERFORMANCE IN SELECTED YEARS IN 2009–18

Sector of Performance	R&D Personnel (Headcount)				
	2009	2011	2013	2015	2018
All Sectors	16,673	18,110	22,848	25,021	75,037
Government*	3,063	3,082	3,774	3,802	13,642
Higher Education*	7,185	8,285	10,189	11,765	34,643
a. Public HEIs	5,493	6,311	7,647	8,248	24,860
b. Private HEIs	1,693	1,974	2,542	3,517	9,783
Private Nonprofit	387	125	227	578	1,865
Private Industry**	6,038	6,618	8,658	8,876	24,887

Source: DOST Survey on R&D Expenditures and Human Resources in Government, Higher Education and Private Nonprofit Sectors in 2009, 2011, 2013, 2015, 2018.
Note: **Private Industry R&D Personnel data for 2009 and 2011 R&D Personnel were estimated using previous year's R&D Personnel and R&D Expenditures to current year R&D Expenditures, i.e., 2009 and 2011 were estimated from 2010 PSA ASPBI; 2013 and 2015 R&D Personnel are actual PSA ASPBI results; 2018 PSA CPBI.

Table 8.4 shows that in 2015, the Philippines had a total of 25,021 R&D personnel. This was 10% more than the 2013 headcount of 22,848. The country saw a record-breaking increase as the number of R&D personnel tripled to 75,037 in 2018 compared to the 2015 figure. The growth of R&D personnel was notable in all sectors with a staggering growth rate of 199.89% in just three years.

TABLE 8.5

R&D PERSONNEL IN THE PHILIPPINES BY POSITION CATEGORY IN SELECTED YEARS BETWEEN 2009–18

Position Category	R&D Personnel				
	2009	2011	2013	2015	2018
Total	**16,673**	**18,110**	**22,848**	**25,021**	**75,035**
Researchers	13,091	14,169	18,020	20,239	37,699
Technicians	1,381	1,484	1,600	2,234	12,086
Auxiliary personnel	2,195	2,454	3,098	2,548	25,249
Not classified	7	3	131	-	-

Source: DOST Survey on R&D Expenditures and Human Resources in Government, Higher Education and Private Nonprofit Sectors in 2009, 2011, 2013, 2015, 2018.
Note: **Private Industry R&D Personnel data for 2009 and 2011 R&D Personnel were estimated using previous year's R&D Personnel and R&D Expenditures to current year R&D Expenditures, i.e., 2009 and 2011 were estimated from 2010 PSA ASPBI; 2013 and 2015 R&D Personnel are actual PSA ASPBI results; 2018 PSA CPBI.

Table 8.5 highlights the distribution of R&D personnel by position category. In 2015, researchers comprise 80.88% of the country's total R&D personnel. However, by 2018, this proportion had dropped to only half at 50.24%. In 2015, 10% of the R&D personnel were auxiliary personnel, a figure that surged to 34% of the total R&D personnel in 2018.

TABLE 8.6

NUMBER OF RESEARCHERS BY SECTOR OF PERFORMANCE IN 2009–18

Sector of Performance	Number of Researchers				
	2009	2011	2013	2015	2018
All Sectors	13,091	14,169	18,020	20,239	37,701
Government*	2,318	2,391	2,965	2,625	6,208
Higher Education*	6,676	7,559	9,508	10,574	25,408
a. Public HEIs	5,111	5,675	7,144	7,384	19,029
b. Private HEIs	1,565	1,884	2,364	3,190	6,379
Private Nonprofit*	325	85	179	383	724
Private Industry**	3,772	4,134	5,368	6,657	5,361

Source: DOST Survey on R&D Expenditures and Human Resources in Government, Higher Education and Private Nonprofit Sectors in 2009, 2011, 2013, 2015, 2018.
Note: **Private Industry R&D Personnel data for 2009 and 2011 R&D Personnel were estimated using previous year's R&D Personnel and R&D Expenditures to current year R&D Expenditures, i.e., 2009 and 2011 were estimated from 2010 PSA ASPBI; 2013 and 2015 R&D Personnel are actual PSA ASPBI results; 2018 PSA CPBI.

Table 8.6 presents a sector-wise breakdown of researchers by comparing the distribution of researchers by sector of performance. In 2015, about 13% of the researchers came from the government while 52.25% hailed from the HEIs. In 2018, there was a noticeable increase in the number of researchers with the figures rising to 16.46% for the government sector and 67.4% for HEIs. This represented an 86.28% increase in the number of researchers with all sectors except the private industry showing growth. Researchers in the private industry sector also decreased by 19.46% in 2018.

TABLE 8.7

R&D INDICATORS IN THE PHILIPPINES IN SELECTED YEARS IN 2009–18

Indicator	2009	2011	2013	2015	2018
Total R&D Personnel* (Headcount)	16,673	18,110	22,848	25,021	75,037
Total R&D Personnel* (FTE)	10,369	11,079	19,234	14,037	44,981
No. of Researchers* (Headcount)	13,091	14,169	18,020	20,239	37,701
Population Size (in million people)	92.2	94.8	98.2	100.98	106.04
No. of R&D Personnel per million population* (based on Headcount)	181	191	233	248	708
No. of R&D Personnel per million population* (based on FTE)	112	117	196	139	424
No. of Researchers per million population* (based on Headcount)	142	149	184	200	356
Gross Domestic Product (GDP) (current prices, in PHP'million)	7,678,917	9,708,332	11,548,191	13,307,265	18,265,190
Gross Expenditures on R&D (GERD) (current prices, in PHP'million)	8,779	11,384	15,915	21,869	58,854
R&D Expenditures as % of GDP	0.11	0.12	0.14	0.16	0.32
Public R&D Expenditures** (current prices, in PHP'million)	3,138	5,153	9,543	11,546	23,081
% share of public to total RDE	36%	45%	60%	53%	39%
Private R&D Expenditures*** (current prices, in PHP'million)	5,641	6,231	6,372	10,322	35,772

Indicator	2009	2011	2013	2015	2018
% share of private to total RDE	64%	55%	40%	47%	61%
RDE per R&D Personnel (current prices, in PHP'thousand)	527	629	697	874	784
RDE per Researcher (current prices, in PHP'thousand)	671	803	883	1,081	1,561

Source: DOST Survey on R&D Expenditures and Human Resources in Government, Higher Education and Private Nonprofit Sectors in 2009, 2011, 2013, 2015, 2018.

Table 8.7 presents a summary of R&D indicators from 2009 to 2018. In 2015, the Philippines' gross national expenditures on R&D as percentage of GDP was 0.16%. By 2018, this figure doubled to 0.32%. The number of R&D personnel (headcount) per million of population reached 248 while researchers per million population averaged at 200. Within three years, these numbers grew to 708 R&D personnel per million of the population and 356 researchers per million of the population.

In 2015, the public-to-private R&D expenditure ratio was 53:47. Public R&D included government and public or state universities while private R&D includes private industries, private universities, and private nonprofit institutions. In 2018, the balance shifted at 39:61, a noteworthy shift, especially considering that firms were operating in a globally competitive environment. Private firms have to intensify their R&D efforts to improve productivity and remain competitive in the global market. The increase in the private industry share in R&D spending would be a good indicator of improving competitiveness and productivity. R&D expenditures per researcher were estimated at PHP1.1 million in 2015 and PHP1.6 million in 2018.

Innovation Trends in the Philippines

Tables 8.8, 8.9, and 8.10 feature the progress of the nation in the field of IPR.

TABLE 8.8

IPR APPLICATIONS FILED BY TYPE IN 2015–19

Type	2015	2016	2017	2018	2019
Patent					
Resident	293	248	284	469	434
Nonresident Direct	190	243	243	550	367
PCT	2,856	2,609	2,559	2,943	3,223
Trademark					
Resident	14,771	15,258	18,561	21,614	23,445
Nonresident Direct	7,086	7,186	7,274	7,644	7,938
Madrid	5,255	4,744	6,138	6,416	8,016
Utility Model					
Resident	767	1,102	1,332	2,080	2,141
Nonresident Direct	46	46	62	66	86

Source: Intellectual Property Office of the Philippines (<https.'//www.ipophil.gov.ph/reference/statistics/>\).

It is noteworthy that applications for IPR continued to increase from 2015 to 2019, marking a significant 46.01% increase over the five-year period. Among the various types, Patent has the highest application, followed by Trademarks with Utility Models recorded the fewest applications.

TABLE 8.9

IPR REGISTERED AND GRANTED BY TYPE IN 2015–19

Type	2015	2016	2017	2018	2019
Patent					
Resident	24	31	18	29	35
Nonresident Direct	130	123	99	565	101
PCT	1,875	1,837	1,420	2,085	1,191
Trademark					
Resident	10,103	13,327	11,174	12,751	14,309
Nonresident Direct	6,853	8,360	5,990	6,786	7,083
Madrid	5,046	5,327	4,802	6,102	6,775
Utility Model					
Resident	489	555	504	1,052	969
Nonresident Direct	38	35	27	61	23

Source: Intellectual Property Office of the Philippines (<https.'//www.ipophil.gov.ph/reference/statistics/>\).

When comparing the number of registered IPR to the applications filed, it becomes evident that out of a range of 33% to 68% of the total applications for Patent, approximately 69% to 99% of the Trademarks and about 36% to 64% of the Utility Model were registered. The highest number of registered Patent and Utility Model were recorded in 2018 while the most number of registered Trademarks took place in 2016. Conversely, the lowest registration for Utility Models was recorded in 2015, for Trademarks in 2017, and for Patents in 2019.

TABLE 8.10

PHILIPPINES RANKING IN THE GLOBAL INNOVATION INDEX ACROSS SIX YEARS PERIOD (2017–22)

Year	Rank of the Philippines		
	Global Innovation Index	Innovation Inputs	Innovation Outputs
2022	59	76	51
2021	51	72	40
2020	50	70	41
2019	54	76	42
2018	73	82	68
2017	73	83	65

Source: Database of the GII 2022 Indicator https://www.globalinnovationindex.org/analysis-indicator.

In terms of ranking in the Global Innovation Index (GII), the Philippines experienced consistent improvement in both Innovation Inputs and Outputs between 2017 to 2020. In 2021, however, it started to deteriorate in Innovation Inputs. From a score of 70, it moved slightly back to 72, bringing down the GII rank from 50 to 51. Subsequently, a further decline was experienced in 2022, sharply decreasing the rank of the country from 51st spot in 2021 to 59th, which was brought about by the decline in the country's rank in both Innovation Inputs and Outputs (see Table 8.11).

TABLE 8.11

PHILIPPINES RANKING SEVENTH IN THE GII AREAS

GII Areas	2019	2020	2021	2022
Business Sophistication	32	29	33	39
Knowledge and Technology Outputs	31	26	24	41
Creative Outputs	63	57	65	58
Market Sophistication	110	86	86	78
Infrastructure	58	63	86	81
Human Capital and Research	83	86	80	86
Institutions	89	91	90	90

Source: Database of the GII 2022 Indicator (https://www.globalinnovationindex.org/analysis-indicator).

Among the seven GII areas, the Philippines performed best in knowledge & technology outputs from 2019 to 2021 and in business sophistication in 2022. Meanwhile, its weakest performance were observed from 2020 to 2022 in Institutions and Market Sophistication in 2019.

The State of STI of ASEAN Members

R&D Investment in Financial and Human Resources across ASEAN Member Economies

To assess how the country fared in comparison with other ASEAN countries, comparative R&D indicators among the ASEAN members are shown in Tables 8.12 and 8.13. The year of latest available data are shown for each ASEAN country. Singapore has the latest R&D report (2019 data) and was highest in terms of the ratio of Gross Domestic Expenditures on R&D (GERD) to GDP at 1.89%. Malaysia follows closely with 2018 data with GERD to GDP ratio at 1.44%. On the other end of the spectrum shows Myanmar recording the lowest GERD to GDP ratio of 0.03% in 2017.

TABLE 8.12

INVESTMENT IN R&D OF ASEAN MEMBERS - FINANCIAL RESOURCES

Country	Gross Domestic Expenditures on R&D (GERD) (in million local currency)	GERD as % of GDP	Business Enterprise Expenditures on R&D (BERD) (in million local currency)	GERD as % of GERD
Brunei Darussalam	51	0.28	0.049	2.33
	Y 2018		Y 2003	
Cambodia	86.811	0.12	11,726.06	13.51
		Y 2015		
Indonesia	33,583,094	0.23	2,464,847.48	7.34
		Y 2018		
Lao PDR	6,560	0.04	2,420	36.89
		Y 2002		
Malaysia	17,685	1.44	6,614.24	43.92
		Y 2018		
Myanmar	28,815	0.03	No data	
	Y 2017			
Philippines*				
		Y 2018		

Country	Gross Domestic Expenditures on R&D (GERD) (in million local currency)	GERD as % of GDP	Business Enterprise Expenditures on R&D (BERD) (in million local currency)	GERD as % of GERD
Singapore**	9,656	1.89	5,882	60.92
	Y 2019			
Thailand	155,143	1.00	124,110.00	80.00
	Y 2017			
Vietnam	26,368,582	0.53	19,260,884.14	73.04
	Y 2017			

TABLE 8.13

INVESTMENT IN R&D ON HUMAN RESOURCES AMONG ASEAN MEMBERS

Country	R&D Personnel	R&D Personnel (per million population)	Researchers	Researchers (per million population)	R&D Personnel	R&D Personnel (per million population)	Researchers	Researchers (per million population)
	Headcount				FTE			
Brunei Darussalam	842	1,963	547	1,275	140	396	102	283
	Y 2018				Y 2003		Y 200é	
Cambodia	2,810	181	794	51	1,895	122	471	30
	Y 2015							
Indonesia	194,633	727	166,690	623	74,895	280	57,815	216
	Y 2018							
Lao PDR	no data	no data	209	38	268	49	87	16
		Y 2002						
Malaysia	145,740	4,750	90,064	2,857	83,763	2,657	68,880	2,185
	Y 2018							
Myanmar	3,347	63	1,616	30	3,142	59	1,552	29
Philippines*	75,037	708	37,701	356	44,981	424	10,557	105
	Y 2018							
Singapore**	52,989	13,161	46,125	11,456	48,513	12,128	42,295	10,574
	Y 2019							
Thailand	217,258	3,139	150,175	2,170	138,644	2,003	93,457	1,350
	Y 2017							
Vietnam	172,683	1,825	136,070	1,438	84,133	896	66,953	Y08
	Y 2017							

In terms of investment in human resource, Singapore again presents the most recent R&D report (2019 data) and was highest in terms of the number of researchers per million population at 11,456. Malaysia follows suit with 2,857 researchers per million population, based on 2018 data. Ranking third is Thailand with 2,170 researchers, according 2017 data.

While the data on R&D expenditure in the Philippines has shown an upward trend from 2009 to 2018, it can still be identified as underinvesting in R&D as compared to Singapore, Malaysia, and Thailand. The

share of gross expenditure on R&D only amounted to 0.32% of GDP in 2018. Nevertheless, it surpasses R&D expenditure of Brunei, Cambodia, Indonesia, Lao PDR, and Myanmar.

In terms of number of researchers per million population, the Philippines ranked seventh with 356 researchers per million population. It has a lower number of researchers compared to Singapore, Malaysia, Thailand, Vietnam, Brunei, and Indonesia, but higher than Cambodia, Lao PDR, and Myanmar.

Table 8.14 highlights the ranking of select ASEAN countries in the GII.

TABLE 8.14

RANKING OF ASEAN COUNTRIES IN THE GII (HUMAN CAPITAL AND RESEARCH AND KNOWLEDGE AND TECHNOLOGY OUTPUTS)

		2022					2021					2020					2019				
		Phil	Mal	Sing	Thai	Indo	Phil	Mal	Sing	Thai	Indo	Phil	Mal	Sing	Thai	Indo	Phil	Mal	Sing	Thai	Indo
Overall Ranking in Innovation	Overall	59	36	7	43	75	51	36	8	43	87	50	33	8	44	85	54	35	8	43	85
	Innovation Input	76	35	1	48	72	72	36	1	47	87	70	24	1	48	91	76	34	1	47	87
	Innovation Output	51	37	14	44	74	40	34	13	46	84	41	36	15	44	76	42	39	15	43	78
Human Capital and Research	Overall	86	38	7	71	90	80	39	9	63	91	86	29	8	67	92	83	33	5	52	90
	R&D	63	38	17	44	49	74	40	15	47	57	73	29	13	46	58	72	27	13	41	63
	Researchers, FTE/mn pop.	84	38	5	41	75	87	37	5	48	80	87	35	6	47	81	78	36	5	48	86
	Gross expenditure on R&D, % GDP	75	40	19	36	80	95	37	19	39	89	95	24	17	36	85	98	23	13	46	109
Knowledge and Technology Outputs (Knowledge Creation)	Overall	41	39	13	43	78	24	31	13	40	74	26	38	14	44	71	31	34	11	38	82
	Knowledge Creation	69	67	24	45	92	55	69	28	47	81	65	70	28	54	101	64	71	27	54	101
	Patents by origin/bn PPP$ GDP	75	62	25	73	80	79	61	26	75	85	81	63	32	76	85	82	57	33	69	72
	Utility models by origin/bn PPP$ GDP	15	56	0	8	30	8	53	n/a	9	27	8	55	0	10	38	15	48	n/a	13	54

Source: Database of the GII 2022 Indicator (https://www.globalinnovationindex.org/analysis-indicator).

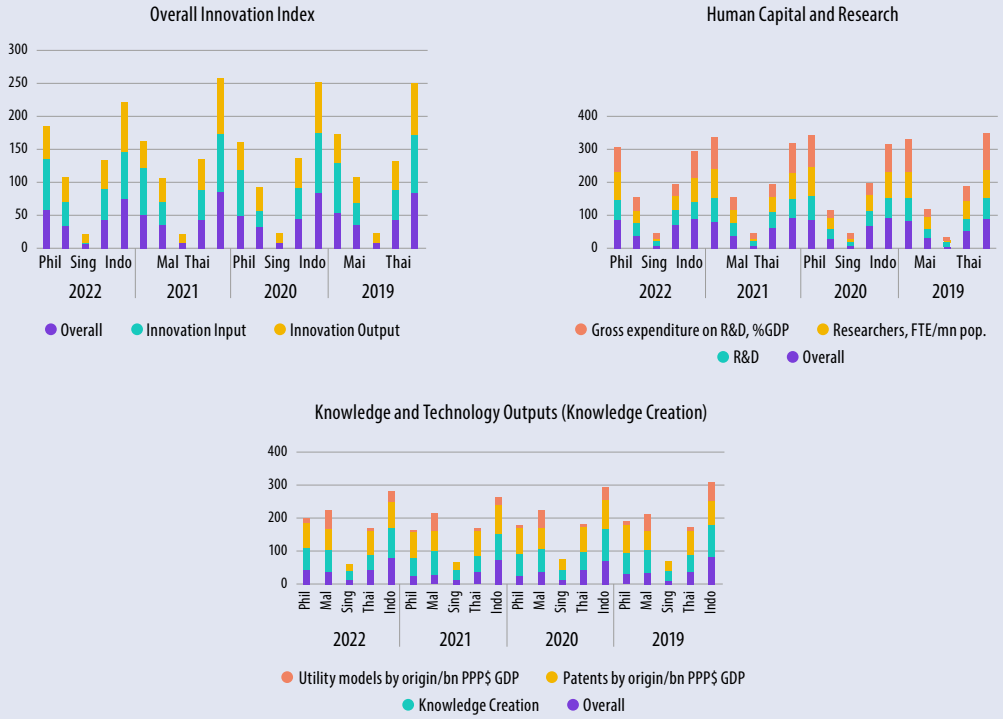
Comparing the ranking of the selected five ASEAN members in the GII, the data shows that Singapore consistently takes the lead in both Innovation Inputs and Outputs. It consistently ranks first in Innovation Input while ranking 13th to 15th in Innovation Output from 2019 to 2022.

Following next is Malaysia, positioning between 24th to 35th in Innovation Inputs and between 34th to 39th in Innovation Outputs. Meanwhile, consistently ranking last in both indicators are Indonesia and the Philippines. Indonesia held the lowest position from 2019 to 2021, but in 2022, it surpasses the Philippines in both aspects of innovation.

Similarly, in human capital and research, Singapore maintains its dominance. It secured an overall rank of between fifth to ninth from 2019 to 2022, placing between fifth to sixth in terms of the number of researchers per million population while it placed 13th to 19th in terms of GERD as a percentage of GDP.

FIGURE 8.1

INNOVATION INDEX AND ITS COMPONENTS



Malaysia closely follows Singapore's lead in all the indicators of human capital and research indicators while the Philippines and Indonesia lag behind. This time, however, Indonesia is ahead of the Philippines by outperforming in both number of researchers and GERD as a percentage of GDP.

In terms of knowledge and technology outputs (knowledge creation), Singapore consistently leads the rank, followed by the Philippines. The Philippines surpassed Malaysia from 2019 to 2021, however, Malaysia reclaims its position in 2022. Singapore again consistently leads the rank in terms of Patents while the Philippines top the rank in terms of Utility Models. Thailand and Indonesia are lowest in the rank in all Knowledge and Technology indicators.

Table 8.15 shows the performance of ASEAN nations on the productivity front. In terms of TFP growth, for a period of 10 years, the Philippines, Singapore, and Thailand show a steady growth with the Philippines recording the highest growth rate, except for 2017 and 2018 where it experienced a decline.

As to capital productivity, the Philippines, Thailand, and Singapore exhibited an upward trend. From 2010 to 2016, the Philippines led in capital productivity, but Thailand eventually surpassed it in 2018 and 2019. Indonesia, however, registered a steady decline from 2011 to 2019.

In terms of output growth, Singapore and Thailand initially recorded the highest scores. However, the Philippines exceeded Malaysia and Singapore from 2012 to 2019.

For capital deepening, all the countries showed a fluctuating trend without stable or increasing trends. Indonesia had the highest score from 2009 to 2011, but Thailand outperformed it in 2012 to 2013. Thailand overtook Indonesia in 2014. In 2017 and 2019, the Philippines obtained the highest score.

TABLE 8.15

PRODUCTIVITY AND OUTPUT GROWTH TRENDS IN SELECT ASIAN COUNTRIES IN 2010 –19

Productivity Variables	Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total factor productivity (TFP)	Philippines	1	1.01	1.03	1.05	1.07	1.07	1.07	1.1	1.1	1.09
	Malaysia	1	1	1.01	1	1.01	1.02	1.03	1.04	1.05	1.03
	Thailand	1	0.99	1.04	1.04	1	1.02	1.03	1.05	1.07	1.08
	Singapore	1	1.02	1.01	1	1.01	1.02	1.03	1.07	1.08	1.06
	Indonesia	1.00	0.99	0.98	0.96	0.96	0.94	0.91	0.91	0.92	0.90
Capital productivity	Philippines	1	1	1.02	1.03	1.04	1.03	1.04	1.03	1.02	1
	Malaysia	1	1	1	0.98	0.99	0.99	0.98	0.99	0.98	0.97
	Thailand	1	1	1.03	1.01	0.99	1	1.01	1.03	1.04	1.03
	Singapore	1	1.02	1.01	1	0.99	1	1	1.02	1.02	1
	Indonesia	1.00	1.00	0.99	0.98	0.96	0.93	0.92	0.90	0.89	0.87
Output growth	Philippines	7.53	5.64	5.42	5.75	5.94	5.56	7.66	6.85	6.41	5.34
	Malaysia	11.9	5.23	5.16	4.2	5.77	5.33	4.54	4.93	4.2	2.96
	Thailand	7.21	1	7.04	2.66	1.02	3.25	3.58	4.35	4.09	2.23
	Singapore	13.8	7.59	3.92	4.03	3.92	4	4.38	5.63	3.98	0.71
	Indonesia	5.92	5.89	5.75	5.30	4.82	4.68	4.81	4.76	4.82	4.67
Capital deepening	Philippines	0.17	2.07	1.98	0.96	2.99	2.09	-0.94	6.91	2.77	3.6
	Malaysia	-2.92	0.92	1.38	0.99	1.68	2.42	2.21	2.07	1.48	0.72
	Thailand	1.06	-0.34	3.17	3.76	4.02	3.84	1.54	1.8	1.63	2.78
	Singapore	-1.79	1.56	0.43	1.39	1.29	1.37	1.31	3.43	2.03	0.69
	Indonesia	2.03	4.17	3.44	3.15	3.70	3.96	1.88	1.91	3.31	0.87

POLICY IMPLICATIONS

The data in terms of the country's R&D expenditures have shown consistent growth over the years, indicating a favorable state of R&D in the Philippines. However, the 2018 ratio of 0.32% R&D expenditures to GDP while showing a leap up from the previous years, it remained low compared to other ASEAN members, like Singapore, Malaysia, and Thailand. To remain competitive, the Philippines should strive to have at least a 1% GERD to keep pace with other ASEAN members. This points to the necessity to sustain and further strengthen R&D investments from all sectors of the country, especially from the government. The fact that 61% of R&D expenditure come from the private sector is an indication of their recognition of R&D's contribution. Nevertheless, the government needs to put forward more favorable political and economic policies and conditions to incentivize private enterprises to invest in R&D and innovation activities.

In relation to human resources in R&D, the Philippines' number of R&D personnel, especially researchers, is very modest compared to some ASEAN members. Given that more researchers come from HEIs than other government agencies, the Philippines should increase researcher positions in the bureaucracy and offer more enticing employment benefits to attract more researchers and S&T professionals to stay and seek employment in the country. Subsidies for R&D facilities in the private sector and upgraded R&D facilities in government R&D institutions would also enhance the appeal for researchers and S&T professionals to work in both the government and private sectors. To sustain an increase in the supply of researchers and other S&T employment in the country, both the government and private HEIs could also increase funding for scholarship grants related to science courses. A considerable improvement in the number of researchers and other S&T professionals in the future would propel the country's innovation index, improving its position in both Innovation Inputs and Outputs.

The low rate of registration for IP outputs developed in the country from 2015 to 2019 indicates either a stringent registration process that discouraged IP developers/inventors or a failure to meet the requirements for registration. In either case, such occurrences hamper the commercialization and utilization of the IP outputs.

Economic productivity is an important indicator of a country's overall performance. The Philippines' TFP, based on 10-year trend, is positive. Strengthening the human resources and increasing capital investments are essential endeavors to sustain and further enhance the country's productivity. In this context, the important innovation policy considerations that might prove useful to enhance the state of STI in the Philippines, thereby improving and sustaining economic productivity include:

- Stimulating investment in R&D and innovation activities across all sectors of the country
- Foster effective partnership and collaboration between government and the private institutions in sustaining and increasing the number of researchers and S&T professionals in the country
- Facilitate the commercialization and utilization of IP outputs

CONCLUSION

The Philippines demonstrated a promising state of R&D with its growing trend in funding for R&D and innovation as well as increasing interest and recognition of the private sector regarding the contribution of R&D to their success. To enhance competitiveness and move the country's productivity to greater heights, it is imperative to fuel greater capital investments, aiming to achieve a GERD of at least 1% of the GDP, and aligning with the leading ASEAN members. Additionally, boosting the quantity of its R&D human resources will be instrumental in furthering the nation's progress.

CHAPTER 9

TURKIYE

INTRODUCTION ON TURKIYE'S ECONOMY

Turkiye is one of the world's largest economies, ranking 11th in terms of its overall economic strength when measured in terms of purchasing power (GDP, PPP, constant 2017 international dollars), and 19th when measured in current USD [1]. As a member of G20 and OECD, Turkiye enjoys a strategic geographical position, linking Asia, Europe, and the Middle East region that fosters robust international ties.

Turkiye has a population of around 85 million people with a youthful demographic at a median age of 33.1, which is lower than most of its trading partners. The working-age population rate is 67.9% while the employment rate stood at 45.2% in 2021. Table 9.1 highlights the recent trends for several key indicators of the Turkish economy. Despite navigating through severe challenges, such as the COVID-19 pandemic and political conflicts in its neighborhood, Turkiye has successfully maintained positive economic growth.

The country has achieved notable GDP growth in the last decade with real GDP growth rates consistently exceeding 3%, except for 2019 and 2020, when the contractionary impacts of the COVID-19 pandemic were felt. Turkiye also experienced a fast recovery in 2021, resulting in an average annual GDP growth rate of 5.1% for the period. The working-age population rate of Turkiye has remained stable, though the labor force participation rate showed a moderate increasing trend, except for 2020. Unemployment rate reached its peak at 13.7% in 2019 due to the negative effects of pandemic. Turkiye pursued ambitious reforms and enjoyed high growth rates up until the COVID-19 pandemic period that propelled the country to the higher reaches of upper-middle-income status and reduced poverty. Despite challenges like a 2016 coup attempt and the economic strain of hosting approximately 1.5 million Syrian refugees due to Syrian War, Turkiye maintained an average GDP growth rate of around 5.4% from 2012 to 2018. For this period, budget deficits and inflation rates also remained relatively stable.

TABLE 9.1

KEY INDICATORS IN TURKISH ECONOMY IN 2012–21

Indicator	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Real GDP growth (%)	4.8	8.5	4.9	6.1	3.3	7.5	3.0	0.9	1.8	11.0
Per capita real GDP growth (%)	3.5	7.0	3.6	4.7	1.9	6.2	1.5	-0.5	1.2	9.6
Population (in million)	75.6	76.7	77.7	78.7	79.8	80.8	82.0	83.2	83.6	84.7
Working age population rate (%)	67.6	67.7	67.8	67.8	68.0	67.9	67.8	67.8	67.7	67.9
Labor force participation rate (%)	47.1	48.0	50.2	51.1	51.8	52.6	53.1	52.9	49.1	51.4
Employment rate (%)	43.2	43.7	45.2	45.8	46.2	46.9	47.3	45.6	42.6	45.2
Unemployment rate (%)	8.3	8.9	9.9	10.3	10.9	10.9	10.9	13.7	13.1	12.0
Current account deficit (% of GDP current USD)	5.4	5.7	4.0	3.1	3.1	4.7	2.6	-1.4	4.4	0.9
Budget deficit (% of GDP current TL)	1.86	1.02	1.14	1.00	1.14	1.52	1.94	2.89	3.47	2.67
CPI inflation (%)	6.2	7.4	8.2	8.8	8.5	11.9	20.3	11.8	14.6	36.1

Source: Turkish Statistical Institute (TURKSTAT) and Central Bank of the Republic of Turkey (CBRT).

In response to the COVID-19 pandemic, Turkiye swiftly implemented economic policies aimed at maintaining positive growth. This focus prioritized loose monetary policies and rapid credit expansion. These measures supported economic activity, making Turkiye's economy one of the few in the G20 and OECD to experience growth in both 2019 and 2020. However, this approach also contributed to inflation, which increased to 31.6% in 2021. Government spending increases and several tax deduction packages aimed at boosting demand further strained budget balances, resulting in an average annual deficit higher than 3% for the 2019–21 period. Consequently, the challenges of increasing budget deficits, high inflation, and stagnant unemployment rates remain as the most notable challenges for the postpandemic recovery period [2–11].

PRODUCTIVITY ANALYSIS FOR TURKIYE

Trends in Labor and Total Factor Productivity (TFP)

Although there are several potential data sources and techniques [12–13] to conduct productivity analysis for Turkiye, in order to achieve consistent international comparisons, the APO Productivity Database will be used as the data source for this section. APO Productivity Databook, which includes the recent data existing in this database, is published periodically by the APO [14].

The Asian Economic Productivity Map (AEPM), derived from the APO Productivity Database, is an online tool that provides a comprehensive view of productivity and other economic data of 30 Asian countries and benchmarks from multiple economic groups across the world, including ASEAN, the Gulf Cooperation Council (GCC), South Asia, European Union (EU-15), and the United States of America (USA) [15]. For a deeper understanding of the indicators used in the APO Productivity Database, definitions are available in the AEPM website (https://www.asianproductivity.com/indicators.html#d01_01). The following are the definitions for the indicators used in this chapter:

Per-Hour Labor Productivity Growth [% (per year)] - This measure is the growth rate of GDP at constant prices per hour worked. The sources of data are official national accounts in each country and the APO Productivity Database. The estimates of GDP include adjustments made to harmonize GDP coverage better across countries in the APO Productivity Database.

Per-Worker Labor Productivity Growth [% (per year)] - This measure is the growth rate of GDP at constant prices per worker. The sources of data are official national accounts in each country and the APO Productivity Database. The estimates of GDP include adjustments made to harmonize GDP coverage better across countries in the APO Productivity Database.

TFP Growth [% (per year)] - TFP is defined as the output quantity index divided by the total input quantity index. The growth rate of TFP indicates the portion of real output growth which is not accounted for by increases in inputs of labor and capital, the two most fundamental factors of production. The source of data is the APO Productivity Database.

The historical growth patterns of these three productivity indicators for Turkiye are also calculated by decades on average and presented in Table 9.2.

TABLE 9.2

LABOR PRODUCTIVITY AND TFP GROWTH BY DECADES IN 1971–2020

Period	Labor Productivity (based on hours worked), % Change	Labor Productivity (based on number of employment), % Change	TFP, % Change
1971–80 average	1.2	1.3	-2.5
1981–90 average	2.1	2.5	0.8
1991–2000 average	2.9	2.9	-0.6
2001–10 average	2.4	2.8	-0.6
2011–20 average	5.4	4.2	1.4

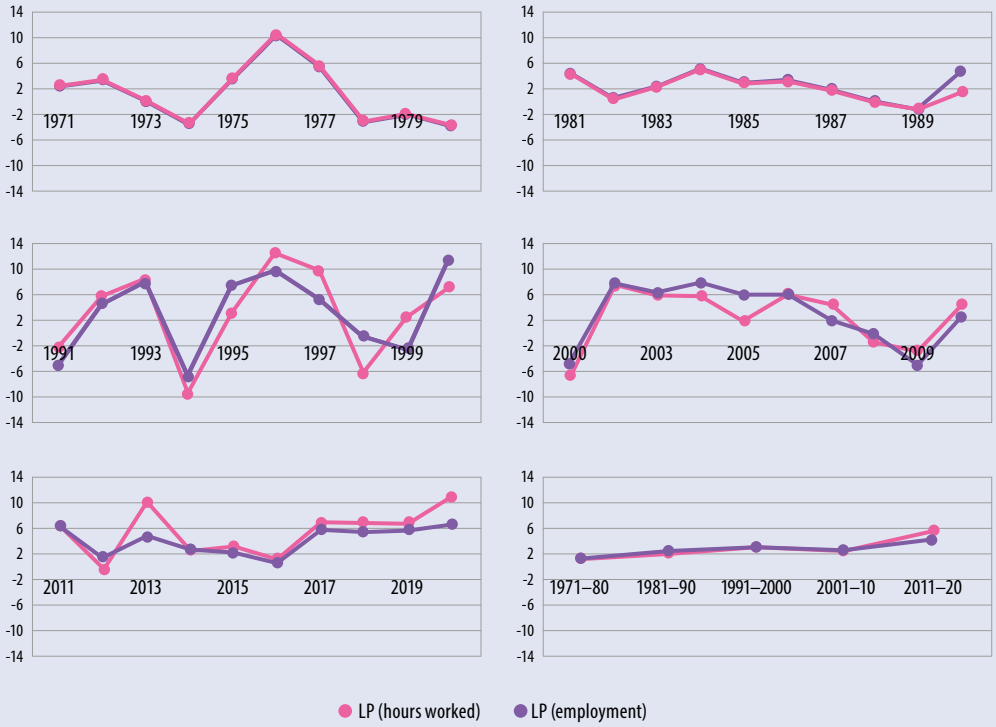
Source: APO Productivity Database (2022) [16].

Labor Productivity

Labor productivity exhibited a consistent upward trend throughout the period 1970–2020. The highest labor productivity growth is observed in the last decade of 2011–20 with average labor productivity growth rates of 5.4 and 4.2 per hour and per employee, respectively. Figure 9.1 provides a visual representation of labor productivity growth. While productivity growth rates increase after the 1990s, labor productivity became somewhat more volatile. Particularly sharp productivity declines are evident during the crisis years of 1974, 1980, 1994, 1999, 2001, and 2009.

FIGURE 9.1

LABOR PRODUCTIVITY GROWTH GROUPED BY DECADES



Source: Author's calculation based on APO Productivity Database (2022) [16].

In the 1970s, two significant oil crises, intertwined with political developments, significantly impacted Turkiye's labor productivity performance. The first was in 1974, stemmed from the oil crisis coinciding with an embargo imposed on Turkiye following the Cyprus Peace Movement, a measure that aimed at protecting the Turkish minority in Cyprus from violent actions on the island. Quadrupled oil prices severely affected Turkish economy that resulted in a contraction in economic activity and a decline in productivity. The second crisis took place in the 1980s, witnessing doubled oil prices followed a military coup on 12 September 1980 that resulted in negative GDP growth and reduced productivity.

The 1980s ushered in a calmer political environment which contributed to stability and ensuring steady increase in labor productivity. Turkiye's economic policy shifted from an inward-looking, import-substituting growth strategy to an export-oriented industrialization policy based on the free market mechanism. Privatization of public corporations and financial liberalization, especially in the second half of the decade, increased capital inflows into the country and supported economic growth.

The 1990s were years of weakened political stability and for most of the period, coalition governments ruled the country. Two severe crises, largely fueled by the vulnerabilities arising from rapid financial liberalization and speculative capital flows, occurred in 1994 and 1999 (the latter coincided with the Gölcük earthquake, one of the most devastating earthquakes in Turkish history), which saw undermined economic growth and declined labor productivity.

The 2000s began with a severe economic crisis in 2001, primarily catalyzed by the vulnerabilities emerged due to fast financial liberalization. The collapse of the pegged exchange rate regime policy with speculative attacks led to a rapid depreciation of the national currency, increased interest rates, and a 3% contraction in output. This sharp contraction also decreased labor productivity. However, the period from 2002–10 marked an important phase of recovery and institutional reform, characterized by political stability and mostly stable growth in output and productivity, with the exception of the effect of 2009 global financial crisis.

The 2010s were also years of continued political and economic stability up until COVID-19 pandemic in 2019. Labor productivity growth has been positive throughout the whole period, even during the pandemic. Government efforts to maintain positive economic growth with credit expansion and several support packages resulted in favorable economic growth and even higher growth rates in labor productivity due to some contraction in employment.

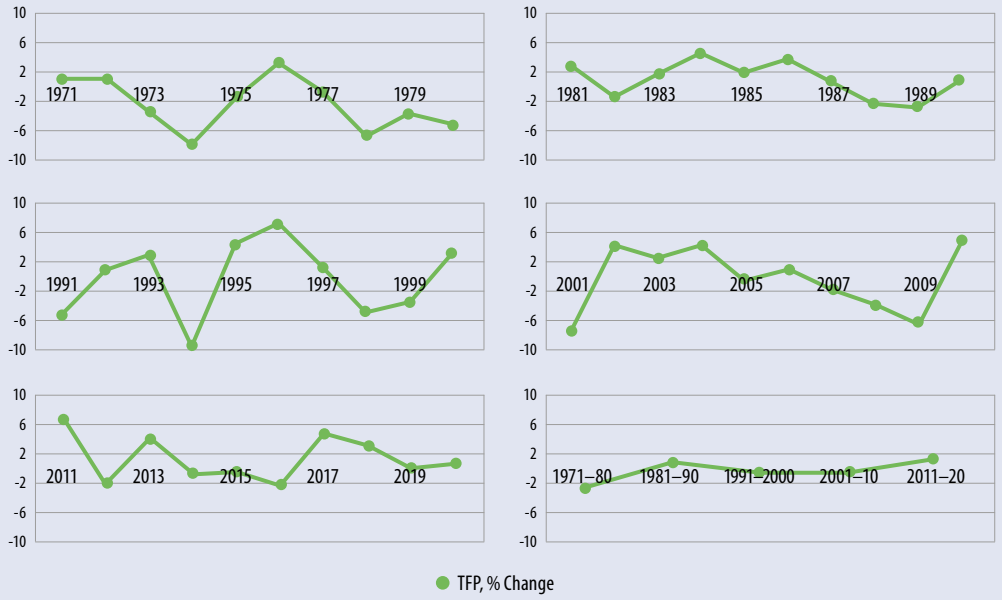
TFP

On TFP, there are no national official statistics published. There are some unpublished TFP analysis conducted by government institutions and academic researchers, estimating capital stock and TFP. To ensure consistency and to facilitate international comparisons, the APO Productivity Database was utilized as data source for conducting TFP analysis.

It is observed that TFP growth rate generally tended to be negative throughout the period 1970–2020. Positive average TFP growth was only observed in the 1980s and 2010s. Similar to the labor productivity indicators, the highest TFP growth was also observed in the last decade (2011–20) with an average TFP growth rate of 1.4%. Figure 9.2 provides a visual representation of this TFP growth. Throughout the entire period, TFP growth rates tended to be volatile. Mirroring the pattern in labor productivity, sharp TFP productivity declines were evident in the crisis years of 1974, 1980, 1994, 1999, 2001, and 2009.

FIGURE 9.2

TFP GROWTH GROUPED BY DECADES



Source: Author's calculation based on APO Productivity Database (2022) [16].

While the annual growth patterns of TFP is mostly consistent with the annual growth patterns of labor productivity, TFP growth is much more volatile. The negative effects of crisis years translated into more than 5% decrease in TFP levels in the crisis years of 1974, 1994, 2001, and 2009. Notably, while average annual growth rates for labor productivity remained positive for all decades within the 1970–2020 period, the average annual growth rate of TFP was positive only for the 1981–90 and 2011–20 periods. These two periods are characterized by relative economic and political stability. When the contribution of capital input to growth is netted out while calculating TFP, contractions in output growth rates translate to even higher decline rates in TFP.

The oil crises of 1974 and 1980 had resulted in sharper declines in TFP levels compared to labor productivity. However, the effect of 1978 domestic debt management crisis was even higher than the impact of the 1980 oil crisis in relation to TFP growth. The political stability of the 1980s was also reflected in TFP growth levels. Except from relatively small declines in the years 1982, 1988, and 1989, positive annual TFP growth rates were achieved. The weakened political stability of the 1990s resulted to an average annual decline in TFP growth, with especially sharp declines higher than 5% in the years 1991, 1994, and 1998. Although the 2000s were relatively more stable, the effect of the two big crises of 2001 and 2009 with declines higher than 5% in TFP levels resulted in negative annual average TFP growth for this period. Political and economic stability prevailed until the COVID-19 pandemic in 2019, and the subsequent credit expansion and several support packages within the pandemic period resulted in highest average annual TFP growth level of 1.4% for the 2010s.

Decomposition of Output Growth

In order to maintain consistency and enable international comparisons, the APO Productivity Database will continue to be used for the decomposition of output growth. The historical data for output decomposition by decades is presented in Table 9.3. When the average contributions by decades is

examined, the contribution of capital stock to output growth hovers around 3.5%, except for the period 1971–80, which boasts a 5.4% contribution level. Conversely, average employment contribution vary across decades. The highest employment contribution is observed in the 2001–10 period at a level of 1.4% while the lowest contribution is seen in the 1991–2000 period at 0.6%. Average TFP contribution is negative for the periods 1971–80, 1991–2000, and 2001–10. However, a considerable higher average TFP contribution of 1.4% is recorded in the 2011–20 period. Visual representation of the decomposition of output growth is also illustrated in Figure 9.3.

TABLE 9.3

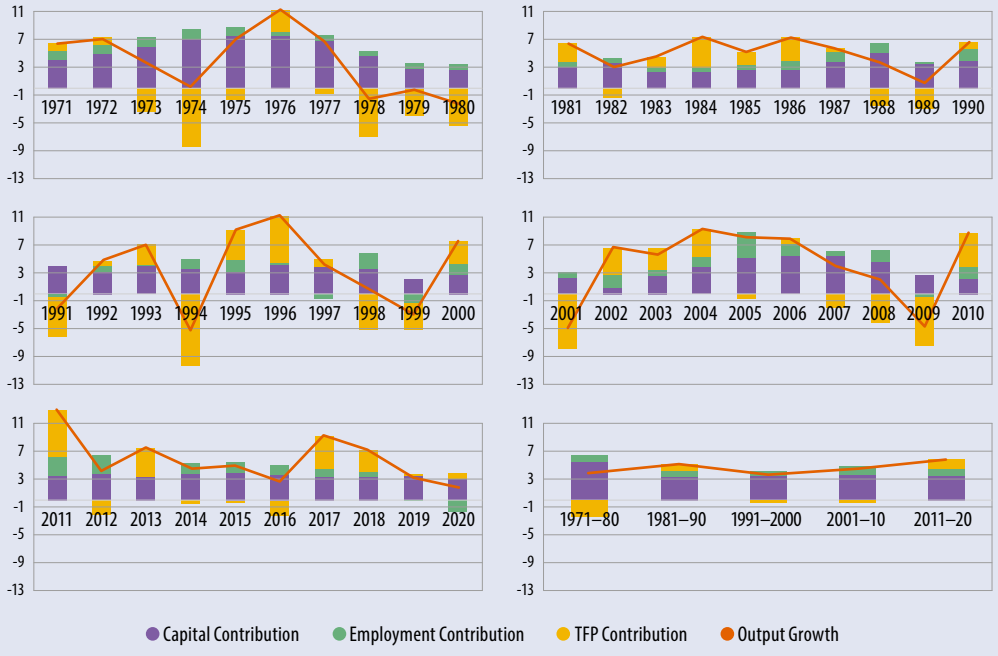
DECOMPOSITION OF AVERAGE OUTPUT GROWTH BY DECADES IN 1971–2020

Period	Output growth	Capital Contribution	Employment Contribution	TFP Contribution
1971–80 average	3.9	5.4	1.0	-2.6
1981–90 average	5.1	3.3	0.9	0.8
1991–2000 average	3.4	3.5	0.6	-0.6
2001–10 average	4.3	3.5	1.4	-0.6
2011–20 average	5.8	3.5	1.0	1.4

Source: APO Productivity Database (2022) [16].

FIGURE 9.3

DECOMPOSITION OF OUTPUT GROWTH GROUPED BY DECADES



Source: Author's calculation based on APO Productivity Database (2022) [16].

While the output growth contributions of labor and capital factors remain mostly positive throughout the whole period, the researchers observe volatile contributions from TFP. For nearly half of the years throughout the whole period, output growth contribution of TFP is negative. The highest contribution to output growth comes from the capital input with an average of 3.8%. Output contribution remains positive

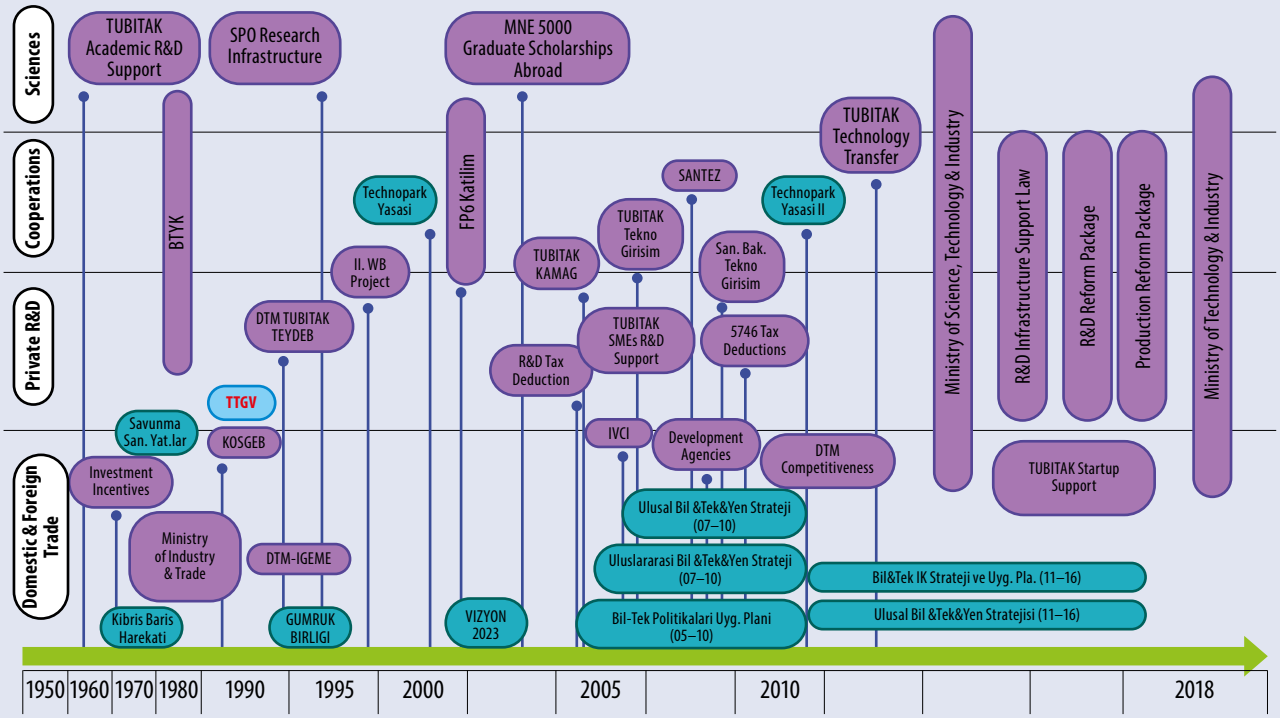
for the entire period. Employment contributes around 1% on average with a maximum level of 3.7% and a minimum level of -1.8%. Contribution of TFP input is sharply negative for the 1971–80 period. TFP contribution exhibits significant volatility, ranging from 6.8% to -10.3%. However, especially for the last decade, average TFP contribution increased to a level of 1.4%. Severe negative contributions to TFP growth are evident during the crisis years of 1974, 1978, 1980, 1994, 1999, 2001, and 2009.

CONCEPTUAL FRAMEWORK OF TURKISH NATIONAL INNOVATION SYSTEM

When the development of R&D, innovation and entrepreneurship policies in Turkiye is examined, it is observed that knowledge production was mostly carried out within universities. The synergy between industry and academy did not develop up until the 1990s. For a long period, R&D support was granted by TUBITAK (Scientific and Technological Research Council of Turkiye) that was established in 1963. In terms of policy development, the BTYK (Supreme Council of Science and Technology), which was established in 1983, held its first meeting in 1989 and convened only five times by the year 2000. The landscape began to transform with the establishment of KOSGEB (Small and Medium Enterprises Development Organization of Turkiye) and TTGV (Technology Development Foundation of Turkey) in 1990. These organizations initiated the first support programs, aiming to steer the private sector toward R&D initiatives. The momentum further intensified with the R&D support programs started by TUBITAK since 1994. The evolution of Turkiye's national innovation system throughout the time is schematized in Figure 9.4.

FIGURE 9.4

EVOLUTION OF TURKIYE'S NATIONAL INNOVATION SYSTEM



Source: Ministry of Development (2018) [17].

Since the beginning of the 2000s, policies aimed at increasing university-industry cooperation and supports encouraging R&D cooperation capabilities for companies to become more competitive, especially in high technology sectors, were on the agenda. The enactment of the Technology Development Zones Law created areas where private-sector organizations could work in closer proximity to universities, thereby reducing their R&D costs. From the mid-2000s onwards, many support programs have been implemented across all public institutions related to the field while several strategy documents and action plans were also published. In addition to these support programs; initiatives, such as tax deductions to reduce costs, programs to establish new technological initiatives, venture capital to support commercialization, programs to improve start-up funds, and sector-oriented programs executed by TUBITAK and relevant ministries were implemented during this period [17].

Regional Development Agencies have been established since the second half of the 2000s with a focus on reducing regional development gaps among regions. These agencies prepared regional innovation strategies that would guide the development of innovation-based economies within their respective regions. These strategies address innovation issue at the local and regional levels as part of ecosystem for R&D and innovation strategy development.

Research infrastructures have been established since 2014, based on the Law on Supporting Research Infrastructures (numbered 6550) and prepared by the Ministry of Development. One of the main objectives is to confer legal status to research infrastructures, allowing them to transform into more effective and sustainable entities through performance evaluation. The objective is to shape their management, finances, and human resources in accordance with the new legislation. Qualified research infrastructures gain the capability to establish companies, partner with established firms, engage in national and international arena or participate in collaborations, and benefit from various exemptions, discounts, and exceptions in terms of human resources and assets. These measures aim to transform their R&D activities into commercial value.

In the current landscape, a wide variety of institutions and organizations, particularly ministries, provide support to academicians, researchers, entrepreneurs, and companies to enhance the country's innovative capacity. The Ministry of Industry and Technology provides support to private sector R&D and design centers, Technology Developments Zones (TGB) that are also named as techno-parks, and investment incentives, mostly in the form of tax deductions, to facilitate the commercialization of R&D activities. TUBITAK supports academicians, researchers, and companies involved in R&D projects. The Presidency of Strategy and Budget (formerly the Ministry of Development) supports research infrastructures while YOK (Council of Higher Education) supports universities in mission differentiation and specialization, and increasing human resources with doctoral degrees. KOSGEB supports SMEs by compensating a wide range of infrastructure and business needs, R&D expenditures, and testing and analysis services in company laboratories through some service units. It also provides support for industrial applications, entrepreneurship, and interest-rate subsidies on loans. The Ministry of Trade provides support in areas, such as participation in foreign and international trade fairs, employment assistance, reducing environmental costs, branding, market research, market entry, international competitiveness, and product design.

R&D and design centers, within the scope of Law No. 5746 since 2008, aim to enhance the competitiveness of Turkish industry by boosting the R&D capabilities of domestic companies and enabling them to produce high-technology and high-value-added products. The following supports and exemptions are provided:

- Income and corporate tax exemptions

- Income tax exemption for R&D, design, and support personnel working in R&D and design centers (95% for those with a doctoral degree or at least a master's degree in one of the basic sciences, 90%

for those with a master's degree and a bachelor's degree in one of the basic sciences fields, and 80% for others)

- Income tax withholding incentive for the R&D and design personnel working in the R&D and design centers, corresponding up to the 100% of the wages of the time spent outside the center, limited by one and a half years for postgraduate students and two years for doctoral students

- Income tax withholding incentive for R&D and design personnel working in the R&D and design centers, corresponding to all wages related to the activities outside the center, provided that the activities are directly related to the R&D or design projects carried out by the center

- Half of the employer's share of the insurance premium calculated over the wages of the R&D, design, and support personnel working in the R&D and design centers (the number of support personnel cannot exceed 10% of the R&D and design personnel)

- Salary support equal to the gross minimum wage for two years given to the basic sciences graduates employed in the R&D centers (cannot exceed 10% of the total staff of the center)

Currently, there are a total of 1,576 R&D and design centers across Turkiye, of which 1,260 are R&D centers and 316 are design centers. A total of 75,117 individuals are employed in the R&D centers while 7,449 individuals in 316 design centers.

TGB, established under Law No. 4691 in 2001, serve as critical hubs for technological advancement and commercialization. These zones focus on: (i) generating technological information; (ii) commercialization of the produced information; (iii) raising product quality, standards, and production methods; (iv) developing innovations that will increase efficiency and reduce production costs; (v) ensuring the adaptation of small and medium enterprises (SMEs) into new and advanced technologies; (vi) creating job opportunities for researchers; and (vii) attracting foreign capital for advanced technology to increase industry competitiveness.

As of December 2022, a total of 97 TGB have been established, bringing together industrial firms, researchers, and universities to develop new products and production methods for technology-intensive production. Out of these, 81 of these zones are currently active while ongoing infrastructure work is continuing for the remaining 16 zones.

Numerous support and incentives are provided for the firms located in TGB, such as:

- Income and corporate tax exemption

- Income tax withholding support

- Customs duty exemption

- Stamp duty exemption

- Insurance premium employer's share support

- Value added tax (VAT) exemption

- VAT exemption for machinery and equipment purchases

- At least 50% rent discount for incubation companies
- 75% discount in rental fees for companies located in incubation centers having a publicly supported project
- Employment support with grant qualifications for companies employing R&D personnel with at least undergraduate degree in basic science fields as well as other fields that will be announced by the Ministry of Industry and Technology upon the recommendation of the Higher Education Council
- Ph.D. student employment support

Currently, 8,677 companies operate in the TGB that employ a total of 89,933 personnel, comprising 75,140 individuals in R&D, 1,213 individuals in design, 6,357 individuals in support roles, and 7,223 individuals in various capacities. These companies have completed 48,617 projects and are currently working on 13,564 ongoing projects. Since the establishment of the TGB, companies operating within these zones have recorded 1,578 patent registrations, submitted 3,235 patent applications, achieved TRY204 billion in domestic sales, and generated USD7.9 billion in exports.

Another crucial institution providing direct R&D support to corporations is Technology and Innovation Support Programs Presidency (TEYDEB) of TUBITAK. The following highlights a brief summary of the R&D support programs conducted by TEYDEB:

- **1501 - Industrial R&D Projects Support Program** - This initiative supports R&D projects aimed at creating new products, developing or improving existing ones, increasing product quality or standard, and developing new techniques and cost-efficient production technologies in all sectors. Its objective is to boost the international competitiveness and export capacities of SMEs, foster domestic technologies in foreign-dependent technology areas, and develop technological products with strong commercialization potential, and support project-based research, technology development, and innovation activities
- **1503 - Project Markets Support Program** - This program supports national and international activities where representation and active participation are sought from universities, research organizations, and the private sector in order to exchange information and opinions on project ideas within the framework of the project markets as well as to establish technological and financial collaborations related to R&D projects. With at least one university, provincial Chambers of Industry, Chambers of Commerce, Chambers of Commerce and Industry, or Exporters' Unions can apply to the program as partners
- **1505 - University-Industry Cooperation Program** - This program's objective is to support the transformation of knowledge and technology with universities, research infrastructures, and public research centers and institutes into commercial products or processes. These innovations are then transferred to industries that align with the needs of Turkish corporations. The collaborating entities include private-sector organization, referred to as the Client Organization, and universities, research infrastructures, or public research centers and institutes, referred to as the Executive Agency. These partners are expected to sign a Cooperation Agreement to jointly carry out the supported project
- **1507 - SME's R&D Startup Support Program** - This program focuses on promoting innovation within SMEs by offering grants for R&D projects. These projects can involve the creation of new products, the enhancement of existing products, the improvement of product quality or standards, or the development of cost-effective production techniques in various sectors and technology fields. The primary aim is to enhance the technological and innovative capabilities of SMEs, making them more competitive. This enables them to undertake systematic projects, create high-value-

added products, establish a corporate culture that emphasizes research and technology development, and actively participate in both national and international support programs

- **1509 - TUBITAK International Industry R&D Projects Support Program** - This initiative backs project-based research, technology development, and innovation activities offered by Turkish institutions under EUREKA (EUREKA Cluster, EUREKA Network, etc.), facilitating access to international resources and knowledge transfer. The program aims to increase the technical competence and knowledge in Turkiye, ensuring the access of organizations to international technology accumulation and technology transfer, to internalize the acquired technological knowledge and experience within the organization, to accelerate and guide the development of original technologies, and to contribute to the participation of organizations in international markets

- **1511 - Priority Areas Research Technology Development and Innovation Projects Support Program** The focus of this program is on producing medium-high and high technology products with added value. It also aims to bring new production capabilities to Turkiye and promote technological development in critical sectors. The goal is to implement investment projects that will contribute to the technological development needed by Turkiye with an end-to-end governance and support model. Currently, this program is being applied as the R&D branch of Technology Focused Industrial Move Program

- **1512 - Entrepreneurship Support Program (BIGG)** - This program is designed to provide assistance to entrepreneurs at various stages, starting from the conceptualization phase through to market implementation. It enables entrepreneurs to translate their technology and innovation-focused business concepts into enterprises that generate substantial value and have the potential to create high-quality employment. By doing so, the program encourages the development of qualified entrepreneurship and supports start-up companies in creating innovative, high-technology products and services with international competitiveness

- **1601 - Support Program for Capacity Building in the Fields of Innovation and Entrepreneurship (1512 Entrepreneurship Support Program (BIGG) - 1st Stage Implementing Organization Call)** - It is aimed to determine the Implementing Organizations that will carry out the first stage activities of the 1512 Entrepreneurship Support Program. It is aimed that Implementing Organizations will create and implement original, effective, and applicable mechanisms by which entrepreneurs will transform their business ideas into qualified business plans

- **1601 - Support Program for Capacity Building in the Fields of Innovation and Entrepreneurship (SME Mentor Interface Program (BIGG+) Call)** - This program aims to facilitate the establishment and implementation of mentoring mechanisms to increase the business development and innovation capabilities of SMEs. The main objective is to develop and implement a mentoring system that supports the commercialization of products and services by SMEs participating in TUBITAK TEYDEB Programs, enabling them to enter new markets and expand their export capacities

- **1513 - Technology Transfer Offices Support Program** - This initiative is designed to provide grant support to the Technology Transfer Offices (TTOs) which were established to facilitate the commercialization of IT produced in the higher education institutions. By turning them into practical solutions, it aims to create economic, social, and cultural values. This program seeks to establish collaboration between universities and private-sector organizations, increase existing partnerships, help the production of industry-relevant knowledge and technology within universities, promote the transfer of information and technology from academia to industry, and contribute to the development of concrete outcomes

- **1514 - Tech-InvesTR Venture Capital Support Program** - This program seeks to provide financial and technical support to early-stage technology-based companies during the commercialization of

products or technologies from R&D and innovation activities. It supports the participation of TTOs, TGB, and research infrastructures in Venture Capital Funds, allowing them to offer vital assistance to these emerging companies

- **1515 - Pioneer R&D Laboratories Support Program** - The objective of this program is to increase the research capabilities of Turkish scientists and position Turkiye as a global hub in specific science and technology fields. Grants will be provided to support certain expenses of R&D laboratories established in Turkiye by national and international corporations that produce pioneering scientific and technological knowledge

- **1702 - Patent-Based Technology Transfer Support Call** - The primary aim is to facilitate the transfer of patented technologies, resulting from research, development, and innovation projects carried out by higher education institutions, research infrastructures, public institutions, public-research centers and institutes, and early-stage technology companies, to capital corporations located in Turkiye through patent licensing or transfers

- **1707 - SME Support Program for Order-Based R&D Projects** - This program is geared toward supporting the SMEs, which constitute the majority of industrial establishments in Turkiye and intend to carry out R&D projects to develop innovative products or processes with customer organizations that have potential customers. The goal is to increase cooperation among corporations and optimize the use of public resources allocated for R&D support

- **1709 - EUREKA - Eurostars** - The objective is to establish a specialized R&D and innovation consortium led by the private sector with the cooperation of universities and the public sector to increase the technical competence and knowledge in Turkiye. This consortium aims to provide private-sector organizations access to international technology resources and technology transfer. Within the scope of the Eurostars-3 program spanning from 2021 to 2027, the evaluation and monitoring processes for national project applications submitted by organizations seeking international projects are carried out

- **Industry Innovation Network Mechanism (SAYEM) Program** - The SAYEM initiative seeks to foster the creation of high value-added products or product clusters by establishment of innovation networks that involve collaboration among the private sector, universities, and public entities. These networks are aligned with national high and medium-high technology targets. Through these network mechanisms, the program aims to enhance the effective utilization of R&D resources, and in turn, reduce the current account deficit by developing high and medium-high technology, high value-added products or product clusters

- **1711 - Artificial Intelligence (AI) Ecosystem Call** - This initiative's primary goal is to facilitate the transformation of AI technologies developed by companies in Turkiye. It does so by harnessing the expertise available within universities and public-research centers and institutes, which are committed to implementing project outcomes in Turkiye. These technologies are converted into products or solutions that meet the specific needs of other companies seeking AI solutions within their own operations

Another institution that extends grants and interest-free credits to SMEs is KOSGEB. A summary on KOSGEB's technology and innovation support programs are listed out as the following:

- **KOSGEB Research & Development (R&D), Product Development and Innovation Support Program** - This program is designed to provide assistance for R&D, product development (P&D), and innovation projects undertaken by SMEs. The program extends support to SMEs and entrepreneurs who are working on new ideas and inventions based on science and technology. It further aids in

the development of new products, new processes, and/or services. SMEs engaged in the creation of original, improved, or modified new products to align with the changing market demands and technological developments through P&D activities can receive support of up to TRY1.1 million per project

- **KOSGEB SME Technological Product Investment Support Program** - This initiative is aimed at supporting SME projects centered on production within medium-high and high technology sectors. It provides assistance for the production and commercialization of products resulting from R&D and innovation activities in the low and medium-low technology sectors with support capped at TRY1 million. For products in the medium-high and high technology sectors that contribute to reducing the current account deficit, support can go up to TRY6 million

- **KOSGEB Strategic Product Support Program** - This program's objective is to provide investments for products identified in the Ministry of Industry and Technology's priority products list. These products are characterized by their medium-high-technology and high-technology levels, critical importance, and high future potential for Turkiye. This program is currently applied as a branch of the Technology Focused Industrial Move Program, which falls under the governance of the Ministry of Industry and Technology

Finally, an important program launched in 2019, is **Technology Focused Industrial Move Program** which is managed by the Ministry of Industry Technology. It has been developed as a special program aimed at intensifying the support and incentives provided by the Ministry of Industry and Technology and its affiliated or related institutions (KOSGEB and TUBITAK) to sectors operating at the medium-high and high technology levels by managing them from a single window. It aligns with the aim of increasing value-added production in Turkiye. Within this program, 1511 - Priority Areas Research Technology Development and Innovation Projects Support Program serves as the R&D support branch. The KOSGEB Strategic Product Support Program functions as the project-based support branch for SMEs within this program. Additionally, the investment incentives schemes, which include the Strategic Investment Incentives Scheme (Decree no. 3305) and the project-based investments scheme (Decree no. 9495), constitute the physical investment support branch of the program.

An end-to-end project-based evaluation and support system is established for this program aiming to support the entire phases of product development, ranging from R&D, investment, commercialization, and marketing, with a single support decision. This program is regarded as a crucial program for commercialization of previously developed knowledge as well as knowledge and product development for potential future innovative technologies. A fine-tuned priority products list is determined with detailed data analysis, including 919 HS12 (Harmonized System 12-digit level) Codes and 210 innovative technology fields. This program only supports the product manufacturing with prioritized codes or projects related with innovative technology fields related to the product or production technology.

The program's pilot phase was initiated through the Machinery Sector Call, which currently supports 18 projects involving a total investment of TRY5.5 billion. In 2021, four thematic calls were introduced, named as Mobility Call, Structural Transformation in Production Call, Health and Chemical Products Call, and Digital Transformation Call. As for now, within the framework of these new calls, there are 167 projects representing a combined investment of TRY60.4 billion (Mobility Call: 40 projects, TRY21.2 billion; Structural Transformation in Production Call: 27 projects, TRY13.1 billion; Health and Chemical Products Call: 57 projects, TRY14.5 billion; Digital Transformation Call: 43 projects, TRY11.6 billion).

These calls are expanding the program's support to encompass all sectors operating at the medium-high and high technology levels. Wtih the completion of the evaluation processes for these calls, projects, each of which is of critical importance, are being executed currently. It's noteworthy that the products addressed by these calls contribute significantly to the current account deficit of USD51 billion.

As these supported projects reach the production phase, they have the potential to make significant progress in mitigating Turkiye's structural current account deficit.

DYNAMIC ANALYSIS OF TURKISH INNOVATION PERFORMANCE

The performance of the Turkish innovation ecosystem is analyzed by examining the dynamic trend in key indicators. It begins by examining the magnitude and structure of R&D expenditures. R&D expenditures/GDP levels for the period 2000–21 are shown in Table 9.4. Turkiye's R&D expenditure level relative to GDP shows a stable increase over the past 20 years. However, it still hovers just above the 1% mark and is targeted for further increase in the national policy documents.

The visual representation of R&D expenditures/GDP is also presented in Figure 9.5, which also includes the distribution by the institutional sector (public, private, academic). The most important aspect of the increase in R&D expenditures is the substantial growth in private-sector spending. While private-sector expenditures were only around 0.18% of GDP in 2001, they reached 0.8% level in 2021. This corresponds with an increase in the share of the private sector in R&D expenditures from 33.7% in 2001 to 70.7% in 2021. While the public sector and academic R&D expenditures relative to GDP have moderately decreased in the last five years, their share in total R&D expenditures has decreased even more due to the increase in private R&D expenditures.

TABLE 9.4

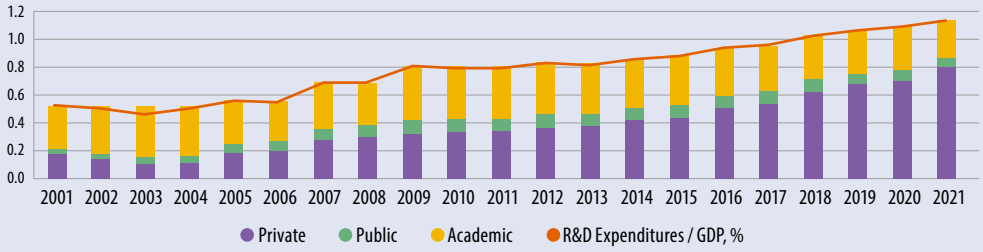
R&D EXPENDITURE AS PERCENTAGE OF GDP IN 1971–2020

Year	R&D Expenditure/GDP (%)
2001	0.52
2002	0.51
2003	0.47
2004	0.50
2005	0.56
2006	0.55
2007	0.69
2008	0.69
2009	0.80
2010	0.79
2011	0.79
2012	0.83
2013	0.81
2014	0.86
2015	0.88
2016	0.94
2017	0.95
2018	1.03
2019	1.06
2020	1.09
2021	1.13

Source: TURKSTAT.

FIGURE 9.5

DISTRIBUTION OF R&D EXPENDITURES AS A PERCENTAGE OF GDP BY INSTITUTION

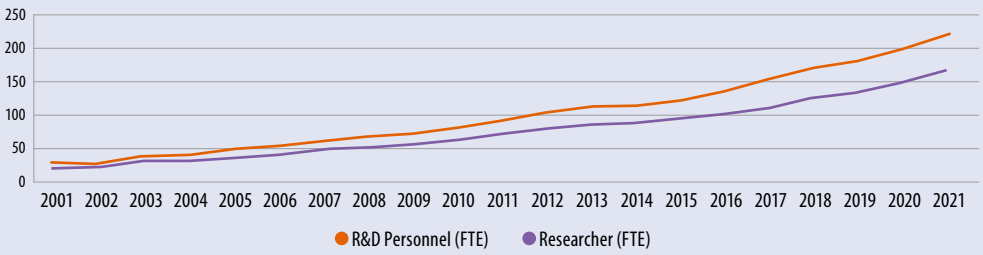


Source: TURKSTAT.

The evolution of full-time equivalent (FTE) R&D employee and full-time equivalent researchers is presented in Figure 9.6. A substantial increase is observed in both R&D personnel and researcher numbers in the last 20 years. The increased commitment to R&D in the private sector has had a considerable impact on this growth. While the share of the private sector in the full-time equivalent R&D personnel was 20% in 2001, it reached 67.4% in 2021. Similarly, while the share of the private sector in the full-time equivalent researcher was 14.9% in 2001, it reached 66.9% in 2021. Increased R&D human capital and expenditures share of the private sector is crucial for commercialization of knowledge.

FIGURE 9.6

R&D HUMAN RESOURCES (BY THOUSAND)



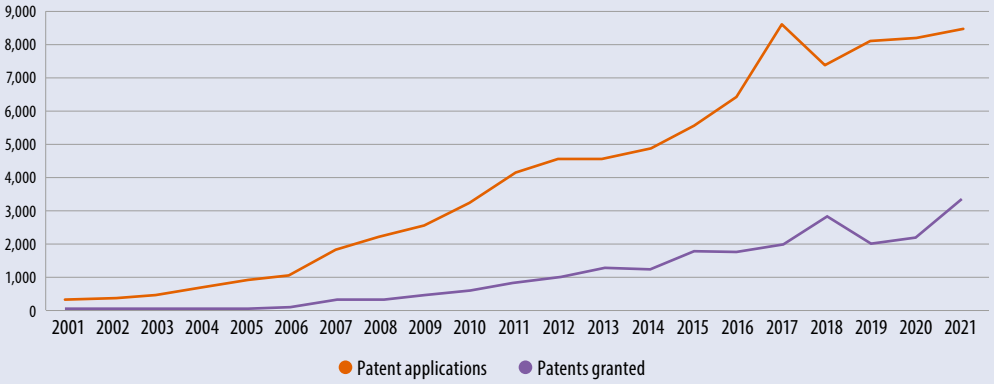
Source: TURKSTAT.

The number of patent applications and patents granted is an important outcome indicator demonstrating the potential benefits of innovation. Figure 9.7 shows the evolution of patent applications and patents granted indicators for the domestic entities.

There is a rapid increase in both patent applications and patents granted for domestic entities throughout the entire period. This implies an increasing awareness of the importance of protecting intellectual and industrial property rights.

FIGURE 9.7

PATENT APPLICATIONS AND PATENTS GRANTED

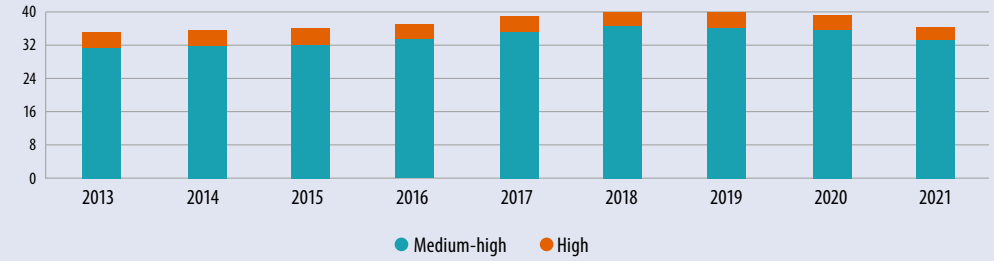


Source: TURKPATENT.

Another important outcome indicator is the share of high technology and medium-high technology exports in manufacturing exports. R&D and innovation is expected to increase the technological intensity of a country's exports. The evolution of the share of high and medium-high technology exports in manufacturing exports is presented in Figure 9.8. Despite increasing R&D expenditures, R&D human capital, and patents granted, Turkiye has not achieved a significant increase in the share of high and medium-high technology manufacturing exports. The total share of these two groups has not exceeded the 40% mark in 2013–21 period. This might be due to a lag in the diffusion effect of new innovations, but it also suggests potential issues with the commercialization of new inventions.

FIGURE 9.8

SHARE OF HIGH AND MEDIUM-HIGH TECHNOLOGY EXPORTS IN MANUFACTURING

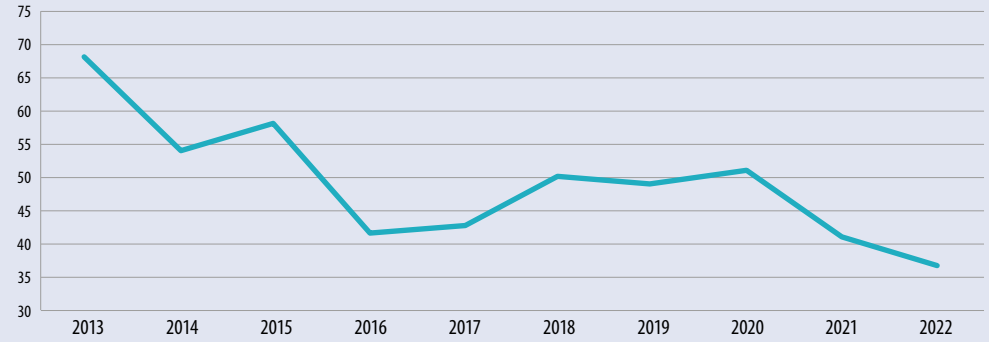


Source: TURKSTAT.

Finally, this section examines Turkiye's ranking performance in the Global Innovation Index (GII) published by World Intellectual Property Organization (WIPO) [18]. The evolution of Turkiye's GII ranking is presented in Figure 9.9. In line with the diversification and improvement of the country's R&D and innovation ecosystem, the GII ranking has shown considerable improvement. In 2013, Turkiye's ranking was at 68. It climbed to the 37th rung in 2022. This improving trend is consistent throughout the entire period, except for a slight deterioration in the 2018–20 period.

FIGURE 9.9

EVOLUTION OF TURKIYE'S GII RANKING



Source: WIPO.

ENHANCING TURKISH NATIONAL INNOVATION SYSTEM

Turkiye has successfully established a diverse R&D and innovation system over the past 20 years, as reflected in some key indicators, such as full-time equivalent R&D employment and granted patents. However, the increase in R&D expenditures as a percentage of GDP has been limited and the technology level of the country's exports hasn't changed significantly. This implies that there is still room for improvement in increasing the quality of R&D spending, promoting knowledge diffusion, and facilitating the commercialization of R&D activities.

In terms of commercializing R&D activities, the Technology Focused Industrial Move Program was legislated in 2019. This selective investment incentive program specifically supports high and medium-high technology level products. The primary goal of the program is to increase the country's mass production capacity in technology-intensive products. Currently, 185 investment projects are supported by this program, although the full positive effects of the program on key indicators are expected to manifest over time.

The Ministry of Industry and Technology also conducts impact evaluation studies to measure the impacts of several support and incentive programs on some key indicators. These impact assessments aim to evaluate the economic, social, and cultural effects of the investment incentives and support given by the Ministry of Industry and Technology and its affiliated institutions. Key findings from the impact evaluation studies conducted in 2021 and 2022 are outlined, as the following.

i) KOSGEB and TUBITAK R&D Supports (2021) impact assessment study

- Application criteria are found to be restrictive and applicants often require consultancy services
- Firms benefiting from support have difficulties in sustaining their R&D investments after the support period ends

ii) Techno-Enterprise Capital Support (2021) evaluation study

- Although the entrepreneurship culture strengthened with the TUBITAK 1512 Entrepreneurship Support Program and the initiatives established were successful in many different indicators,

it was observed that these initiatives were limited in scaling-up capabilities and had limited effects in generating employment

iii) Effectiveness of Technology Transfer Offices (TTOs) (2021) evaluation study

- Many TTOs have problems in finding experienced human resources, obtaining patents, commercialization, entrepreneurship, participation in EU projects, and internationalization

iv) Organized Industrial Zone (OIZ) Policies and Practices: TR41 Region (Bursa, Bilecik, Eskişehir) (2021) impact assessment study

- Although the net sales, foreign sales, and productivity performances of the companies operating within the OIZ generally outperform those outside, especially in consideration of the internal dynamism and the limited development speed of Bilecik OIZ, it performs much lower than other OIZs

v) Evaluation of Academic Initiatives (2021) study

- An average of 153 academic enterprises exit from TGB each year in the last five years
- 84% of the enterprises could not export and 22% could not achieve domestic sales

vi) Evaluation of Design Supports (2021) study

- Enterprises that receive design support have difficulties in scaling up
- A relatively small percentage, only one-fifth, of supported companies engage in design and design registration, despite the increase of numbers in the recent years

vii) Disruptive Technologies and Possible Effects of Digital Transformation on Employment (2021) study

- There is a high risk of job losses in the manufacturing industry due to automation
- Job loss risk due to digitalization varies between 30% and 63% in various countries with Turkiye estimated to be 59.5%

viii) Impact of Regional Investment Incentives on the Turkish Economy (2021) study

- Enterprises benefiting from investment incentives have a positive effect on numerous economic indicators, such as employment, investment, and added value, although the effects are often limited to the beneficiary enterprises

ix) Efficiency of Research Infrastructures in the Scope of Law 6550 (2021) evaluation study

- Research infrastructures face challenges in acquiring qualified human resources and ensuring financial sustainability
- While significant progress has been made in terms of physical and technical infrastructure opportunities in research infrastructures, problems may arise in terms of purchasing new devices, maintenances, and repairs of these devices

x) Effect of Model Factory Services: A Field Study on Firms (2022) study

- 90% of the companies that received Learn&Transform Program services stated that they benefited from services received
- All the companies that received project implementation services stated that they benefited from services received
- 93% of the participants found the training given on the sample production line in the model factory successful
- 94% of those who benefitted from the Model Factory services will recommend the services they received to other companies

xi) TUBITAK-1512 Entrepreneurship Support Program (BIGG) Impact Analysis (2022) study

- Technology start-ups, which were established under the 1512 Entrepreneurship Support Program, have grown to have 14.2 times the total asset size, 10.5 times the total net sales, and 3.4 times the foreign sales per one unit of support provided for them

xii) TUBITAK-1602 Patent Support Program Impact Assessment (2022) study

- Support creates a statistically significant difference in nine of the 13 sectors surveyed as a result of sectoral evaluations, and the sector with the highest impact is manufacturing sector (basic pharmaceutical products and pharmaceutical materials)
- The difference created with received support, when analyzed in terms of scales, shows a statistically significant difference in small- and medium-sized companies
- Evaluation in terms of technology level support creates a statistically significant difference, especially in companies at high technology level

xiii) Impact Assessment of Design Supports (2022) study

- In the following two years after the support, companies in the program achieved higher additional growth performances, as listed below, compared to the companies that did not benefit from the support:
  - 9.47% additional annual average growth in total assets
  - 22.62% additional annual average growth in sales
  - 8.97% additional annual average growth in number of employees
  - 15.58% additional annual average growth in employee wages

xiv) Impact Assessment of Organized Industrial Zone (OIZ) Policies and Practices (Across Turkiye) (2022) study

- When assessing the impacts of OIZs throughout the country during the period of 2015–19, it becomes evident that companies within OIZs have achieved higher additional growth performances compared to non-OIZ companies, as listed below:

- 62.8% additional increase in net sales
- 36.6% additional increase in total assets
- 19% less decrease in the number of employees

xv) Impact Assessment of Small Industrial Site (SIS) Policies and Practices (2022) study

- When assessing the impacts of SISs in İkitelli OIZ within the period of 2015–19, it becomes clear that companies within SISs have achieved higher additional growth performances than those outside of SISs, as listed below:
  - 52.4% additional increase in net sales
  - 35.6% additional increase in total assets
  - 25.1% less decrease in the number of employees

xvi) Possible Impacts of Green Deal Arrangements on Selected Sectors (2022) study

- If there is a 20% contraction or decline in exports to the EU, especially in sectors, such as iron and steel, aluminum, fertilizer, cement, and electricity generation that are identified in the European Green Deal, a loss in net sales is estimated as the following:
  - TRY13.8 billion due to direct impact
  - TRY8.2 billion due to indirect effect
  - TRY22 billion effect in total

xvii) Effect of KOSGEB Supports within the Framework of the Association Theory (2022) study

- SMEs, after initially receiving support from programs, like the SME Project Support Program, KOBIGEL - SME Development Support Program, New Entrepreneur Support Program and R&D, Innovation Support Program, continued to benefit from Business Development Support. The most frequently utilized subsupports within the scope of Business Development Support include:
  - Qualified personnel employment support
  - Domestic international specialization fair support
  - Domestic specialization fair support
  - International business trip support
  - System documentation support

xviii) KOSGEB Certification Support Impact Assessment (2022) study

- Implementation of Certification Support has a positive effect on net sales, international sales, and number of employees

- 93.2% of the enterprises benefiting from the Certification Support stated that their expectations were met

- While the general satisfaction level of the enterprises was calculated as 80.9%, 95% of the enterprises participating in the survey stated that they would recommend the Certification Support to other enterprises

xix) KOSGEB Domestic Fair Support Impact Assessment (2022) study

- Implementation of Domestic Fair Support has a positive effect on net sales, international sales, and number of employees

- 91.4% of the enterprises benefiting from the Domestic Fair Support stated that their expectations were met

- While the general satisfaction level of the enterprises was calculated as 72.1%, about 94% of the participating enterprises in the survey stated that they would recommend the Domestic Fair Support to other enterprises

The published impact evaluation studies provide valuable insights to enhance the implementation of support and incentive programs. New impact evaluation studies are also planned for 2023.

Turkiye's innovation ecosystem has made significant progress in the last decade, as highlighted in earlier sections. Notably, the country's position in the GII has shown considerable improvement, rising to 37th in 2022. However, in terms of enhancing the effectiveness of innovation activities, well-considered interventions remain pivotal to elevate the quality of innovation, promote knowledge diffusion, and facilitate the commercialization of R&D activities.

To enhance the quality of R&D programs, several policies are earmarked for implementation in both the Eleventh National Development Plan [19] and the Government Annual Program [11]. These policies are poised to:

- Prioritized R&D funding for innovation projects aligned with the Green Growth Technology Roadmaps in industries, such as iron-steel, aluminum, cement, fertilizer, chemicals, and plastics industries, to drive sustainable outcomes

- Promote the integration of doctoral students within the industry enterprises through the Industry Doctorate Program, fostering a stronger connection between academia and business

- Execute strategic projects aimed at developing and manufacturing new products in strategic areas, including defense, space, aerospace, AI, big data, cloud informatics, digital transformation, biotechnology, and pharmaceuticals

- Increase the number of research infrastructures within the context of Law 6550

- Introduce an Innovation Support Coupon Program tailored to SMEs which would provide cooperation of SMEs with universities, research centers and institutes, and public research infrastructures

- Facilitate the transfer of patented technologies developed in universities, research institutions, and technology development zones to the industrial sector by establishing the Patent-Based Technology Transfer Support

CONCLUDING REMARKS

Turkiye's national innovation system has witnessed significant progress over the past three decades. Historically, knowledge production was predominantly confined to universities, and collaboration between academia and industry remained limited until the 1990s. Hoever, the landscape began to change with the establishment of KOSGEB and TTGV in 1990, marking the first support programs targeting to direct the private sector to R&D endeavors. The momentum gained further traction with the introduction of R&D support programs initiated by TUBITAK since 1994.

The establishment of Technology Development Zones (TGB), development of support mechanisms for approved R&D and design centers, and local innovation projects sponsored by regional development agencies have collectively strengthened the innovation ecosystem. Currently, a wide variety of institutions and organizations, especially government ministries, provide their support to academicians, researchers, entrepreneurs, and companies, all with the common objective to improve the country's innovative capacity.

The impact of these improvements was also reflected in some key indicators, such as R&D expenditures as a percentage of GDP, the private sector's share of R&D expenditures, the number of R&D human resources, patent applications, granted patents, and the country's ranking in GII. However, with respect to technology level in exports and R&D expenditures/GDP indicators, there is still room for improvement, especially to increase the quality of R&D spending, facilitating knowledge diffusion, and expediting the commercialization of R&D activities.

An important program which has potential to create considerable improvement is the Technology Focused Industrial Move Program. Support-providing institutions try to maximize the positive effects of their programs through the judicious use of impact assessment and various surveys. Targeted policy interventions have the potential to propel Turkiye into the league of high-income countries.

CHAPTER 10

VIETNAM

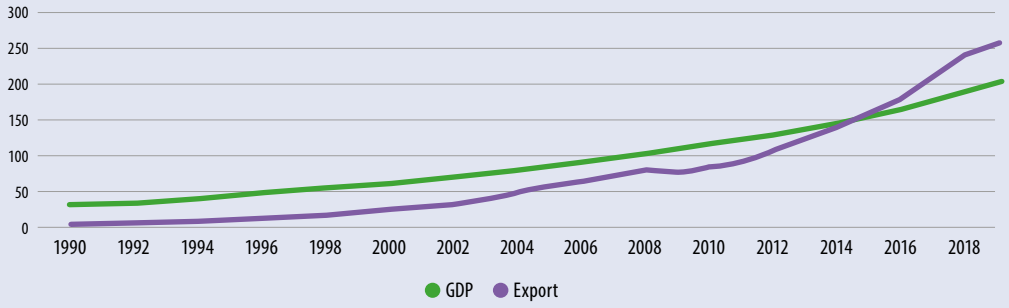
INSTITUTIONAL ECOSYSTEM FRAMEWORK IN VIETNAM

One of the most remarkable facets of Vietnam's economy over the past 30 years has been its astounding rate of economic growth. Since 1990, only PR China has surpassed Vietnam in terms of average growth rate among Asian countries. Vietnam's average growth rate reached an impressive 6.47% between 2000 and 2019 [1].

In 2019, Vietnam achieved a GDP growth rate of 7.02%, equivalent to VND6,037 trillion (approximately USD261.9 billion). Total investment in 2019 amounted to 33.9% of GDP, marking an increase of 101% compared to the previous year. This figure was largely driven by an increase in domestic demand. Further, Vietnam has become the 26th largest global exporter with its total export turnover reaching USD279 billion in 2019, reflecting an 8% increase over 2018 [2].

FIGURE 10.1

VIETNAM'S GDP AND EXPORTS (IN 2010 CONSTANT PRICES)



Source: World Bank.

By 2022, the scale of Vietnam's economy had expanded significantly, estimated at VND9,513 trillion (equivalent to USD409 billion) and positioning the country at the 42nd spot in the world rankings. The GDP per capita for 2022, based on current prices, was estimated at VND95.6 million per person or approximately USD4,110, showing an increase of USD393 compared to the previous year. According to IMF assessment, calculating using purchasing power parity, Vietnam's economy had an even more impressive scale, reaching USD1,278 billion. Its GDP per capita surged over USD13,075 per person, which is an increase of USD1,408 over the previous year.

Vietnam's GDP growth is projected to increase 8.02% year-on-year, reaching the highest rate within the 2011–22 period due to the recovery of the economy. This is also the highest growth rate in the region [3]. When considering the breakdown of total added value in the entire economy, the agriculture, forestry,

and fishery sector increased by 3.36%, contributing 5.11%; the industry and construction sector expanded by 7.78%, contributing 38.24%; the service sector rose by 9.99%, contributing a substantial 56.65%.

Remarkably, import and export turnover exceeded USD700 billion, setting a new record following the nearly USD670 billion achieved in the previous year. Additionally, foreign direct investment (FDI) capital realized reached nearly USD20 billion, marking the highest increase in the past five years. State budget revenue also witnessed an increase of nearly 8% compared to 2021. Further, the number of enterprises returning to operations was 1.5 times higher than those exiting the market, which indicated a positive trend in business activity.

Although GDP in 2022 grew rapidly and had strong macroeconomic indicators, the economy faced late-year pressures stemming from the risk of global recession. Exports, one of the main drivers of economic growth, were impacted. The number of orders gradually decreased, falling sharply in the last two quarters. The challenging situation was expected to persist until mid-2023, prompting businesses to scale down production and reduce mass labor. In addition, high production costs with congested capital mobilization channels remained prevalent, creating considerable difficulties for businesses. Also, despite its high growth rate, Vietnam's GDP per capita is still relatively low. From a low starting point, although per capita income has increased, Vietnam continues to remain within the category of low-middle-income countries. In addition, the nation's comparative advantage in exports still largely based on low labor costs, leading to Vietnam's development mainly through outsourcing to more advanced economies and consumer markets. These jobs create very little value added, which translates to Vietnam deriving marginal profit from its exports.

When per capita income is low, the limited value added from outsourcing still contributes significantly to both GDP growth and an improved quality of life. However, as incomes rise, especially when per capita income exceeds USD5,000, there is often a sharp deceleration in growth due to the law of diminishing marginal productivity of capital and low competitive advantage compared to more technologically advanced countries. Alternatively, these jobs may shift to less developed countries where labor costs are lower.

The Consumer Price Index (CPI) in 2022, as expected by the government, stands at 3.87%, which shows effective control of inflation that is below the 4% target set by the National Assembly. In comparison to many other countries in the region, Vietnam's CPI growth remains relatively low in the context of global inflation.

However, 2022 marks the highest level of CPI in six years (2017–22) and it is also the period when the inflation pressure is clearly felt by consumers through the escalation in prices of many everyday items. For instance, gasoline, an essential commodity for the people, continuously reached peak prices. The cost of many goods and services also increased as a result of higher gasoline price. Toward the end of the year, despite the stable prices of gasoline, the prices of many goods did not decrease.

For Vietnam to boost its GDP further, elevate people's income, and become a high-income country, it must pursue development strategies that are not based on increased inputs or dependent on the low-cost labor market or FDI.

Productivity Performance

i) **Labor productivity efficiency** - According to the General Statistics Office, the labor productivity of the entire economy in 2022 at current prices is estimated at VND188.1 million per worker. At constant prices, labor productivity in 2022 will increase by 4.81%. Vietnam's labor productivity in terms of nominal GDP for the same year is estimated at about USD7,398 per worker. In terms of purchasing power parity, Vietnam's labor productivity is estimated at about USD21,860 per worker.

The average labor productivity growth rate from 2011 to 2020 is approximately 5.29%/year, witnessing the highest growth rate from 2015 to 2019. However, in the three years from 2020 to 2022, the labor productivity growth rate was lower than in the previous period due to the impact of the COVID-19 pandemic.

ii) **Productivity efficiency from invested capital** - The realized social investment capital at current prices in 2022 is estimated at VND3,219.8 trillion, reflecting an 11.2% increase over the previous year. Within this, realized FDI capital in Vietnam reached nearly USD22.4 billion, up 13.5% that indicates a strong recovery in business activities [4].

Incremental Capital Output Ratio (ICOR coefficient) in Vietnam decreased from 6.0 in 2016 to 5.8 in 2019. On the average span of 2016–19, the ICOR coefficient reached 5.9, which is lower than the 6.25 recorded during the period of 2011–15. However, the COVID-19 pandemic's adverse effects in 2020–21 led to a standstill in the economy's production and business activities. Due to the stall, the government increased public investment, which increased the ICOR in 2020 up to 14.3 and 15.5 in 2021. Fortunately, in 2022, the ICOR coefficient has been reduced to 4.3.

iii) **Total Factor Productivity (TFP)** - In general, the increase in TFP has contributed significantly to Vietnam's economic growth in this period, owing to effective use of capital and labor forces to restructure the economy and renew the growth model in recent years.

According to the APO's assessment, in the decade from 2010 to 2020, Asia's economy has grown steadily with the growth rate of TFP at about 0.4% a year. While many economies have negative TFP growth rate (indicating a decline in TFP), Vietnam stood out as one of the countries with a positive TFP growth rate and ranked among the group of countries with the highest TFP increase.

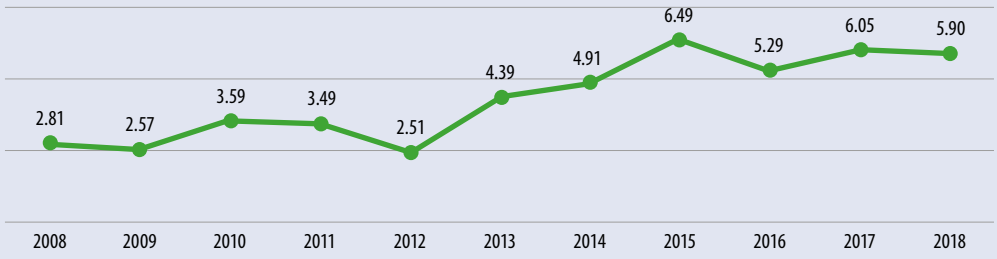
Need for Shift in Development Focus

The focus of Vietnam's development needed to shift toward increasing production capacity through technology adoption and overall factor productivity growth across all industries, based on TFP.

It is estimated that Vietnam will need to increase productivity, especially TFP, by 50% in the next 10 years to sustain rapid growth. Over the past three decades, Vietnam has had the highest labor productivity growth rate among ASEAN countries. From 2000 to 2018, Vietnam's labor productivity tripled (Figure 10.2).

FIGURE 10.2

VIETNAM'S LABOR PRODUCTIVITY GROWTH RATE IN 2008–18 [5]



Although Vietnam's labor productivity is still lower than that of ASEAN countries, the high labor productivity growth rate has shortened the gap between Vietnam and ASEAN countries. For example,

when compared to Singapore, the country with the highest labor productivity in ASEAN, the labor productivity gap has decreased from 21 times in 1990 to 12 times in 2018.

However, productivity will need to increase sharply for Vietnam to remain competitive and keep up with its neighbors in the fast-growing region. The transition toward increased composite factor productivity based on technology and innovation poses challenges. It requires substantial investment from the state, and as macroeconomic stability is also important in developing high-performing economies, the key to high growth will be maintaining a debt-to-debt balance. Efficient resource allocation is equally vital to create stability and maintain low inflation.

In addition, the new wave of digital technology is fundamentally reshaping the landscape of productivity enhancement and innovation. The development of digital-enabled general-purpose technologies (GPT), such as platforms, artificial intelligence (AI), big data, robotics, and unmanned vehicles serves as the premise for rapid development, particularly in automation through self-learning algorithms. As a result, the productivity growth rate increases markedly, but at the same time, it increases the complexity of innovation activities in enterprises.

The innovation process is becoming increasingly open and globalized with consumers positioned at the center of the innovation process. Borderless innovation is now gaining popularity, propelled by the growing power of digital platforms and open data systems. As a result, businesses are pressured to innovate, expand, and use data analytics and consumer-generated content to define markets and grow productivity.

Previous Guidelines and Policies

Over time, the party and state have had many guidelines and policies to develop productivity as well as build an innovation ecosystem in Vietnam.

In 2015, the Ministry of Science and Technology (MOST) made an important decision to consolidate the government's innovation activities for the period 2016–20. The main policies during this period focused on: (i) reforming innovation organization, management mechanisms, and activities; (ii) concentrating core resources for innovation development; (iii) enhancing the national innovation capacity; (iv) developing innovation markets, innovative businesses, and services; and (v) promoting innovation international integration.

In 2017, the government issued an action plan encompassing innovative policies and growth models, improving labor quality, and increasing the competitiveness of the economy. The action plan comprised 16 main tasks and 120 specific directives for ministries, branches, and units. The Ministry of Planning and Investment becomes the focal point to facilitate the action plan and reporting progress to the party and government bodies.

Within the business sector, private enterprises are also gradually receiving support to promote technology upgrading and innovation. Large domestic enterprises have established research and development (R&D) institutes, including Vin High-Tech Center of Vin Group, FPT Research Center, and the Haugiang Fisheries Academy (MOST Vista, 2019). To promote start-ups, numerous start-up accelerator programs have been initiated, such as CLAS - Expara Vietnam accelerator by Microsoft Vietnam and the start-up accelerator fund (VIISA), supported by FPT, Dragon Capital Corporation, Kanawha Korea, and BIDV Securities Company.

Grasping the new development trend, the prime minister issued a directive on capacity building for Industry 4.0 in May 2017. In the same month, the prime minister also signed the decision on the digitization of the Vietnamese Knowledge System. The ministries involved in the promotion of the

Industry 4.0 policy are the Ministry of Information and Communication, the Ministry of Science and Technology, and the Ministry of Industry and Trade.

However, the actual implementation of these policies still faces many difficulties. In the forthcoming period, to meet the goal of achieving high and sustainable growth in the context of the international environment's many risks, exacerbated by the COVID-19 pandemic, and to avoid falling into the middle-income trap, Vietnam needs to further improve the policy framework to develop the innovation ecosystem.

Economic restructuring associated with growth model innovation has made an important contribution to successfully realizing the dual objectives of maintaining macroeconomic stability, controlling inflation, and promoting economic growth.

The problem of revamping the growth model was officially raised by the XI Congress. The socioeconomic development strategy for the period 2011–20 defines the content of growth model innovation and economic restructuring as to transform the growth model from width to both depth and width based in order to raise productivity and competitiveness and to focus on improving quality, efficiency, and sustainability.

The 12th Congress continued to set out the task of restructuring the economy in association with the renewal of the growth model, specifically "continuing to accelerate the implementation of a synchronous and overall restructuring of the economy, sectors, and fields associated with growth model innovation, focusing on important areas: investment restructuring with a focus on public investment; restructuring the financial market with a focus on the commercial banking system and financial institutions, gradually restructuring the state budget; restructuring and effectively solving the problem of bad debts, ensuring public debt safety; restructuring state-owned enterprises with a focus on state-owned groups and corporations; agricultural restructuring…"

In pursuit of Vietnam's development goals and attain the status of a developed and high-income country by 2045, the party has charted a clear course for growth model innovation. For the upcoming years, the emphasis is to "continue to promote innovation of economic growth model, strongly shift the economy to a growth model based on increased productivity, scientific and technological progress, innovation and human resources, high-quality resources, economical and efficient use of resources to improve the quality, efficiency, and competitiveness of the economy…"

NATIONAL INNOVATION SYSTEM (NIS) IN VIETNAM

A dynamic, innovation-driven business sector is a decisive factor in the success of innovation ecosystems around the world. Concurrently, innovation plays a pivotal role in helping businesses to increase productivity, profits, and sustainable development. The concept of creating a driving force to promote innovation to develop the private economic sector, quickly and sustainably, contributing to the building of a socialist-oriented market economy, has also been thoroughly grasped in the Resolution of the 5th Central Committee, Course XII. This article focuses on assessing the innovation activities of Vietnamese enterprises in the past period, thereby, identifying policy implications for Vietnam in developing innovation for enterprises.

Innovation as Open Concept

Innovation is an inherently open concept that continually evolves with new scientific and technological advances, especially in digital technology.

According to OECD, innovation is defined as such: "The development or improvement of a product or a process (or both) that significantly alters the previous product or process and is put on offer to potential consumers (for the product) or used in units (for the process)" [6].

In essence, innovation capacity within enterprises is their ability to translate creative ideas and combine input resources into products that are suitable for the needs of the market. There are four main types of innovation:

1. **Product innovation** - This involves the introduction of new, technically improved products (goods or services) to potential customers, including, but not limited to, substantial improvements in technical characteristics, technology, components, materials, internal software, user-friendliness, or other functional characteristics.

2. **Process innovation** - Process innovation pertains to the development or improvement of production and business processes and methodologies, including methods of transporting and distributing products, in order to reduce production costs, and distribution costs and increase production efficiency, or create or distribute products. There are six main methods of process innovation: (i) manufacturing process innovation; (ii) innovation in distribution/logistics processes; (iii) innovation in marketing process; (iv) innovations in information technology application processes; (v) innovation in administrative and management processes; and (vi) process innovation in R&D development.

3. **Management system innovation** - This entails the application of new process methods in the management of enterprises, organizations, activities, or external relations.

4. **Marketing innovation** - This aspect of innovation is the application of new marketing methods involving changes in presentation, packaging, product communication, promotional messaging, or product pricing.

Compared with previous periods, the global definitions and classifications of innovation have undergone substantial changes, placing greater emphasis on process-related forms of innovation rather than traditional modes of creativity. This change in perspective can be attributed to the widespread application of technologies, digital platforms, foundational technology, and digital infrastructure over the past decade, which have radically changed business operations, especially in business innovation. In the era of the fourth industrial revolution (IR4.0), innovation activities no longer occur in isolation but consistently complement one other. While in the past, innovation could be evaluated from the perspective of specific individuals, businesses, or organizations, today, innovation invariably results from the interconnection of many stakeholders and diverse forms of innovation within the production and business processes.

Traditional innovation metrics, such as R&D investment or a number of patents granted only offer partial insight into a firm's innovation activities. Many innovation activities, especially those related to innovations in business models, processes, or innovation activities of start-ups, do not rely on traditional R&D channels.

In the current era, the importance of innovation activities for development is increasingly recognized by policymakers and leaders in Vietnam. Therefore, a series of policies related to encouraging and supporting innovation activities were issued.

The Science and Technology Development Strategy for the period 2011–20 affirms Vietnam's commitment to viewing science and technology (S&T) as the foundation for the country's sustainable development. Support policies for S&T activities are clearly stated in the Law on Science and Technology 2013 and Decree No. 87/2014/ND-CP dated 22 September 2014, as part of attracting foreign scientists

into the country. The government has also issued Decision No. 844/2016/QD-TTg, outlining support for the development of an innovative start-up ecosystem by 2025. More recently, a series of policies on digital economy development and digital enterprises has emerged, such as:

- Directive No. 16/CT-TTg 2017 on improving capacity to approach IR4.0
- Resolution No. 01/2019/NQ-CP approving the national strategy on the implementation of IR4.0
- Resolution No. 02/2019/NQ-CP on improving the business environment and national competitiveness from 2019 to 2021

The increasing number of new policies to support businesses shows the urgency and recognition of the Vietnamese leadership on the importance of promoting technology transfer and innovation in Vietnam.

In recent years, along with the concerted efforts of the party and government, Vietnam has seen many positive results in innovation.

TABLE 10.1

RANKING OF INDICATORS IN THE PILLARS OF VIETNAM'S BUSINESS DEVELOPMENT LEVEL

Business Development Pillars		2016 (128 countries)	2017 (127 countries)	2018 (126 countries)	2019 (129 countries)
1. Skilled workers		93	102	91	102
1	The share of employment in the service industry has a high knowledge content	94	94	95	117
2	Enterprises with formal training activities	31	69	69	70
3	R&D expenditure by enterprises	68	52	48	42
4	R&D expenditure funded by enterprises	54	36	13	8
5	Female workers with high professional qualifications	74	72	78	83
2. Links in innovation		101	100	88	86
1	University-enterprise cooperation	86	76	59	75
2	The scale of industrial cluster development	56	50	64	74
3	R&D spending is funded from abroad	72	82	68	64
4	Number of strategic joint-venture contracts	42	65	53	49
5	Number of patent applications filed in 2 countries	90	96	98	84
3. Absorption of knowledge		20	23	25	23
1	License purchase cost	-	-	-	-
2	Import high technology	6	3	4	1
3	Import of ICT services	120	124	122	126
4	FDI	29	26	25	23
5	Number of research staff in the enterprise	-	54	51	51
Overall ranking of pillars		72	73	66	69

Source: GII 2016–19 [8].

In 2019, Vietnam advanced to the 42nd position among 131 countries and economies in the WIPO (World Intellectual Property Organization) Global Innovation Index 2020 ranking, marking a substantial improvement from its 59th position in 2016 [7]. This achievement marked the third consecutive year of Vietnam rising in ranks, and the 42nd position is Vietnam's highest standing to date. In the group of 29 countries with the same income bracket, Vietnam ranked first and stood third in Southeast Asia.

Among the 12 pillars of WIPO's innovation index, in addition to assessing the macroeconomics innovation environment, the business development pillar places emphasis on evaluating innovation performance at the enterprise level. This pillar includes indicators of Vietnamese enterprises, including (i) skilled workers; (ii) links in innovation; and (iii) absorption of knowledge.

The index group of knowledge workers shows a positive and stable change in the investment made by Vietnamese enterprises in knowledge and technology. R&D spending has improved significantly, rising from 64th in 2012 to 9th in 2019. To date, Vietnam is only behind Thailand in the ASEAN region for this specific indicator. However, Vietnam is still limited in this index group, especially in the subindices measuring employment in the knowledge-intensive service industry as well as the number of enterprises with formal training.

Vietnam's innovation linkage index group is currently ranked 86th out of 129 countries with significant improvement in university-enterprise cooperation as the index shows an 11-place improvement from the 86th position in 2016 to 75th in 2019. While these advancements are noteworthy, it should be noted that Vietnam is still at the lowest level in the ASEAN framework, which is also on par with the Philippines.

In the business development level pillar, the knowledge absorption index group features showed the best ranking, securing the 25th spot in 2019. The advancement of this group of indicators is attributed mainly to the growth in the index of high-tech imports (total trade). Vietnam is currently leading the world in terms of the proportion of high-tech imports in total trade. In general, the value of high-tech imports has grown strongly in the past period.

Through the pillar of business qualifications, it can be seen that Vietnam has made many significant strides in investment and technology acquisition, especially through the import of technology from abroad. However, growth and productivity enhancement hinge not just on investment but also on the capacity to absorb and master technology. In short, enterprises need to possess the capacity for innovation. The assessment of factors affecting the ability of enterprises to absorb technology includes access to capital and quality of labor resources of enterprises.

In addition, innovation activities related to process innovation, innovations not derived from R&D, and technical improvement initiatives (improvement of imported technologies to suit the level of production) will be the decisive factors to increase productivity and business efficiency in Vietnam. These are factors that have not been carefully evaluated in the WIPO innovation index.

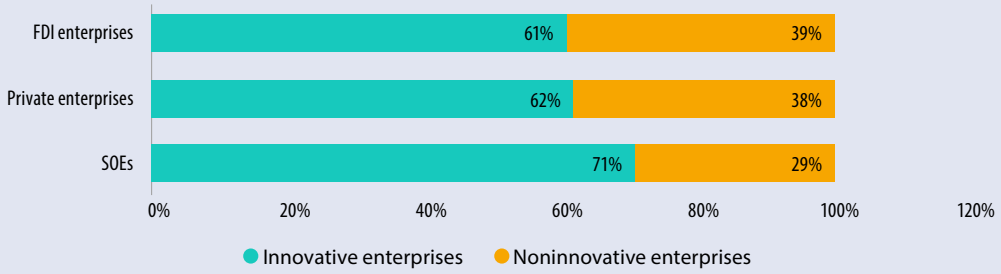
Further, the formulation of indicators based on macro data is also limited in fully assessing enterprises' innovation activities because these activities usually unfold unevenly across the economy. There is often a large variation in innovation efforts among different types and sizes of enterprises.

Recognizing this issue, the National Agency for Science and Technology, under the purview of MOST, took the task to conduct the 2017 Enterprise Innovation Survey. This can be regarded as the first enterprise innovation survey in Vietnam that encompasses 7,641 enterprises in the processing and manufacturing sector. The breakdown comprises 1,892 large enterprises (accounting for 67.84% of the total number of large-scale enterprises), 820 medium enterprises (accounting for 90.01%), and 4,929 small-scale enterprises (representing 26.25%).

Survey data shows that 61.6% of businesses made improvements between 2014 and 2016. This includes 58.5% of small enterprises, 64% of medium enterprises, and 68.8% of large enterprises, indicating that firms with larger workforces are more innovative (Figure 10.3).

FIGURE 10.3

STRUCTURE OF INNOVATIVE AND NONINNOVATIVE FIRMS BASED ON FIRM SIZE



Source: Innovation Survey, MOST in 2017 [9].

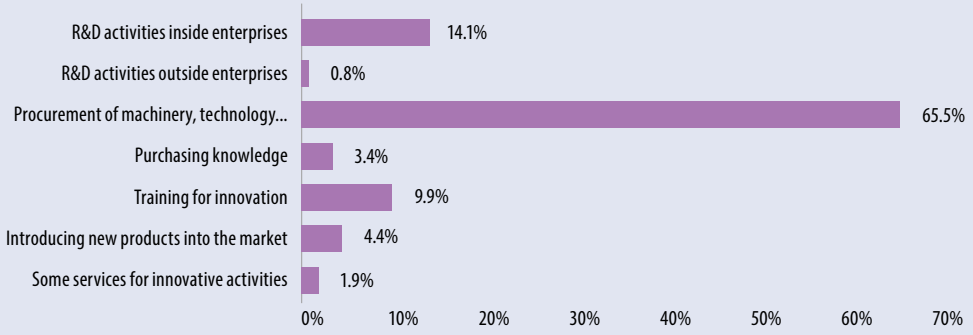
Comparing innovative enterprises with noninnovative counterparts, state-owned enterprises (SOEs) accounted for the highest proportion of innovative enterprises (71.04%), followed by private enterprises (61.69%) and FDI enterprises (60.61%). This shows that SOEs are relatively active in innovation, a departure from conventional perceptions.

Among the innovative firms, those engaged in process innovation were the most prevalent at 39.9%, followed by those focused on organizational innovation, then product innovation and marketing innovation, which occupied the last position at 28.6%. This pattern is not surprising, given that many businesses in Vietnam function as OEMs (original equipment manufacturers). These firms manufacture products according to specific designs and requirement by multinational corporations, thus directing the bulk of their innovation efforts toward process optimization. In the product group, only 31.1% of enterprises introduced a new or significantly improved product into the market. Medium and large enterprises demonstrated a more robust commitment to product improvement at 38.2% and 37.6%, respectively, compared to small enterprises at 29%. To enhance Vietnam's position on the global value chain, businesses need to place more emphasis on innovation in products and marketing, including brand development and international distribution networks.

In terms of innovation spending, a majority of the funds was allocated for the procurement of machinery and technology, equipment and software (65.5%). Other activities include in-house R&D activities (14.1%), acquiring R&D results from external sources (0.8%), and innovation-related training (9.9%). Additional components comprised the introducing of new products into the market (4.4%), purchase of knowledge assets, such as copyrights and patents (3.4%), and some services for innovative activities (1.9%) (Figure 10.4).

FIGURE 10.4

EXPENSE STRUCTURE FOR ENTERPRISES' CREATIVE ACTIVITIES



Source: Innovation Survey, MOST (2017).

The structure of innovation expenditure by enterprises also shows that innovative enterprises do not focus on investments in the self-development of new products or new technological processes. Instead, they mainly invest in technology through the purchase of equipment or upgrading existing machinery and equipment.

More than 80% of total spending on R&D and technology improvement activities is carried out by large-scale enterprises. FDI enterprises contribute a substantial 70% of total expenditure on R&D activities by enterprises and a remarkable 77% to the total expenditure on technological innovation activities. Non-SOEs account for 27% of the total funding allocated for R&D activities and 19% for technological innovations while SOEs represent only 3% of total R&D spending and 4% of total expenditure on technological innovation activities. This raises questions regarding why 71% of SOEs engage in innovation despite their modest contribution to the total expenditure on R&D and innovation.

In terms of the contribution of different types of innovation to revenue, product innovation accounted for 62% of enterprises' total revenue. The largest share is from FDI enterprises at 65.6%, followed by private enterprises at 59.1% while SOEs recorded 3.4%. Of the total revenue from innovation-based products, large enterprises constituted 86%, medium enterprises at 5%, and small enterprises at 9%. By type of business, FDI enterprises charted 64.2%, private enterprises at 32.4%, and SOEs at 3.4%. Evidently, Vietnamese enterprises face a greater challenge than foreign counterparts in converting innovation into revenue.

Looking at the government's support for innovation, the most supportive policy comes in the form of credit channels, mainly financial support through loans that benefit 15.1% of enterprises engaged in innovation activities. The second-highest support revolves around policies supporting technological innovation, encompassing tax deductions, allocation of funds for S&T development, and loans with lower interest rates. These benefit 12.1% innovation-driven industries. The third policy group is through technology consulting service channels with experts and scientists from public institutions, research centers, and public universities offering assistance to a mere 4.6% of innovative companies. Policies for implementing S&T tasks and programs to support innovative businesses account for the lowest proportion of the budget with only 3.2% of businesses receiving support.

On average, one in four innovative enterprises receive government support. The main reasons that make it difficult for businesses to access government support for innovation activities include: (i) businesses do not receive information about policies; (ii) the support provided does not meet the needs

of the business; (iii) procedures for registration and selection of support subjects are too complicated; and (iv) businesses do not know how to access resources.

Based on the findings from the innovation survey of the Ministry of Science and Technology, the focus of this chapter will be directed at several activities to promote innovation of enterprises, including:

(i) Fostering awareness and promotion of innovation activities to raise enterprises' understanding of innovation. Providing detailed and necessary information about innovation as well as to highlight the achievements of enterprises in innovation. Encouraging a culture of innovation in enterprises to create a healthy creative environment, respecting IP rights, and encouraging innovation. The state and society need to have the right awareness and proper assessment of enterprises' innovation activities and introduce suitable policies to promote the spread and development of the innovation culture.

(ii) Implementing policies to support enterprises in developing human resources for innovation. The survey results reveal that the lack of qualified human resources capable of participating in and carrying out technological innovation activities is one of the main reasons for limiting the innovation of enterprises. Policies should be developed to help enterprises to improve their capacity, such as:

- Strengthening cooperation with universities and research institutes in implementing innovation projects and assessing the extent and effectiveness of cooperation between academic research teams and enterprises as one of the criteria for evaluating, classifying, and ranking S&T organizations
- Reinforcing technical consulting services for enterprises
- Facilitating student internship and apprenticeships in suitable enterprises
- Offering incentives for engineers and researchers to transition to enterprise roles
- Implementing public-private partnership programs focused on R&D to leverage resources as well as strengthen cooperation between enterprises and S&T organizations

(iii) Paying more attention on policies targeting small and medium enterprises (SMEs) to encourage innovation. SMEs currently contribute a mere 14.2% of sales from innovative products, despite the numbers being seven times higher than large enterprises. Therefore, it is necessary to further promote the implementation of preferential policies for SMEs and further encourage innovation activities to gradually increase the revenue value of these enterprises.

(iv) Developing specific support policies for product innovation, especially for new products and technological processes. Presently, 32.08% of enterprises engage in product innovation. However, product innovation in Vietnam predominantly focuses on cost cutting for product with very few businesses focusing on developing new product features. Policies may include credit support, technology innovation assistance, expert guidance, technical advisory services for businesses, and building S&T programs into targeted programs to support innovation.

(v) Continuing to improve credit policies to facilitate businesses with more opportunities to access capital sources for technological innovation. Among the state's innovation support policies, the percentage of businesses benefiting from the credit policy is the highest. However, the majority of enterprises still consider a lack of capital as one of the biggest obstacles to investing in technological innovation. Therefore, it is necessary to carry out further studies and improve credit policies for businesses to better support enterprises in their technological innovation endeavors.

TFP Growth in Vietnam

TFP is a statistical indicator that reflects the efficiency of resources used in production. In addition, TFP also reflects the efficiency due to changes in technology, qualifications, skills of workers, management skills, and more. Improving TFP means improving production results with the same input. According to many studies, all factors, such as economic institutions, market factors, technological advancements, management mechanism, natural resources, and comparative advantage, among others, collectively influence growth and development. For example, scientific and technological breakthroughs that are materialized and applied to production fields become an important part of the production force that can significantly impact production efficiency.

In the process of development, inputs of both labor and capital typically increases, but the output experiences faster growth than these inputs, which is due to the substantial contribution of TFP growth. Sustainable development requires rational and effective use of two main resources - capital and labor - that is achieved by promoting the application of advanced S&T, innovating production management methods, and improving the quality of labor to increase TFP - a decisive factor for sustainable growth.

S&T also plays a pivotal role in enhancing capital utilization efficiency and transforming the quality of labor resources, gradually adapting to advanced and modern production methods. The evolution of S&T makes investment capital change radically, from investing in physical assets to investing in nonphysical assets, such as promoting education and training to improve professional competence and skills of workers, along with modern production and business management methods.

From the perspective of economic research, the TFP metric is often used as an indicator to represent technological progress affecting economic growth. Although TFP does not offer an entirely precise representation of technological progress' impact on economic growth due to numerous factors within TFP, it still partially underscores the impact relationship between technological progress and economic growth.

TFP is a crucial indicator, reflecting the efficiency and sustainable development of the economy. Therefore, restructuring the economy, renewing the growth model, and ultimately finding solutions to improve TFP's contribution to GDP growth are prime objectives. This currently holds top priority for all economies in general and each economic region in particular.

Vietnam has achieved remarkable economic growth since the country embarked on the comprehensive reform program known as Doi Moi, encompassing economic and societal aspects since the late 1980s. Following the footsteps of countries like Republic of Korea (ROK) and other East Asian countries, Vietnam initiated its industrialization and modernization journey by prioritizing light, labor-intensive industries and swift integration into the global market. This strategy has been very successful in increasing productivity and alleviating poverty. However, in the 2000s, labor productivity growth began to decelerate and increasingly leaning on capital intensity rather than productivity growth.

Productivity enhancement has been recognized as a key role in economic development in the 2011–20 period. Numerous productivity initiatives and programs were introduced, spanning from building a productivity movement to developing national productivity programs and resolutions aimed at boosting productivity in Vietnam. Notably, the national program "Improving Productivity and Quality of Products and Goods of Vietnamese Enterprises by 2020", as outlined in Decision No. 712/QD-TTg dated 21 May 2010, the prime minister stressed on the imperative role of productivity and quality in enterprises.

Emphasizing the importance of productivity improvement, in this Decision, the program's objective is to "contribute to increasing the contribution of total factor productivity (TFP) in the growth rate of total

gross domestic product (GDP) to 30% by 2015 and contributing of total factor productivity (TFP) in the growth rate of gross domestic product (GDP) to at least 35% by 2020."

On 1 November 2016, productivity improvement continued to be emphasized in Resolution No. 05-NQ/TW of the Fourth Conference of the 12th Party Central Committee, focusing on various major undertakings and policies to sustainably revamp the growth model, improve growth quality, labor productivity, and economic competitiveness of the economy. The resolution's objective was clear - "Total factor productivity (TFP) contributes to growth (GDP) average of about 30%–35% in the period 2016–20".

The resolution of the 13th National Congress of the party sets out the economic orientation for 2021–25. It aims for an average economic growth rate (GDP) of about 6.5%–7% per year with GDP per capita reaching approximately USD4,700–USD5,000 by 2025. The contribution of TFP to growth is targeted at about 45% while the average growth rate of social labor productivity should be over 6.5% per year. The urbanization rate is projected to reach about 45% with the proportion of processing and manufacturing industry reaching over 25% of GDP. Additionally, the digital economy is expected to account for about 20% of GDP.

The party's 10-year socioeconomic development strategy for 2021–30 has set out the following objectives: "The contribution of total factor productivity (TFP) to growth will reach 50%, with an average growth rate of social labor productivity is over 6.5% per year." The direction of tasks and solutions for socioeconomic development underscores the need to "strongly develop science, technology, and innovation in order to create breakthroughs to improve productivity, quality, efficiency, and the competitiveness of economies".

Implementing the policy set out by the party on 11 January 2021, the prime minister signed Decision No. 36/QD-TTg on promulgating the master plan to improve productivity based on science, technology, and innovation (STI) from 2021–30. The primary objectives of this plan are as follows:

- To elevate productivity as an important development engine across industries and fields, through the application of new scientific achievements, technology, application of management systems, advanced productivity improvement tools that are combined with research and training, and human resource development. This approach is in line with the trend of IR4.0

- To implement national S&T tasks and support enterprises in research, innovation, technology transfer, and productivity improvement. This includes formulating and implementing S&T tasks and plans to improve labor productivity and TFP based on STI

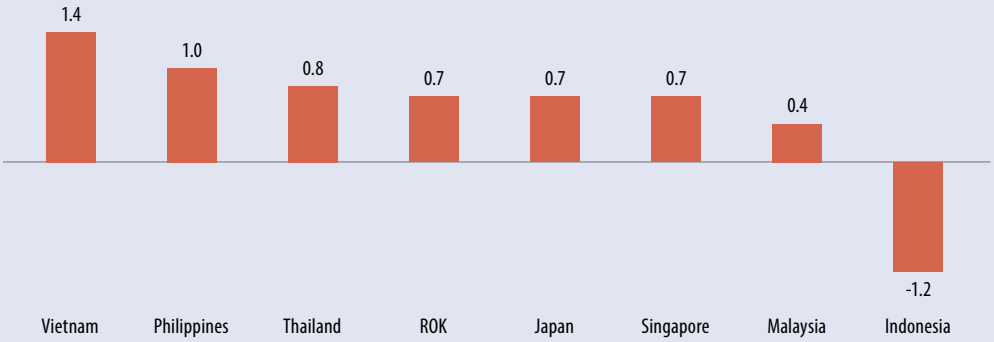
Numerous policies, programs, and activities have been undertaken by ministries, sectors, localities, and enterprises to boost productivity, which have recorded good results. TFP is constantly improving and have contributed significantly to economic growth. In the period between 2011–15, TFP growth accounted for about 33.5% of economic growth while during 2016–20, TFP growth contributed about 45.7% to economic expansion (as reported by the General Statistics Office of Vietnam). The contribution of TFP increase to economic growth has achieved the targets established in the prime minister's Decision No. 712/QD-TTg dated 21 May 2010 and Resolution No. 05-NQ/TW of the Fourth Conference of the 12th Party Central Committee.

In 2021, TFP is projected to continue to increase, making an estimated contribution of about 37% to economic growth. Overall, the substantial increase in TFP has played a pivotal role in propelling Vietnam's economic growth during this period. This success is attributed to solutions that effectively use capital and labor resources while reshaping the economy and revitalizing the growth model. According to the APO's assessment, from 2010 to 2019, Vietnam has not only sustained steady economic

growth but has also maintained a TFP growth rate of about 1% per year. While many economies experienced negative TFP growth rate, Vietnam stands out as one of the countries with a positive TFP growth rate and ranking among a group of countries with the highest TFP increase.

FIGURE 10.5

TFP INCREASE IN VIETNAM AND SELECTED ASIAN COUNTRIES IN 2010–19 (%) [10]



Vietnam stands out as the country with the most rapid TFP transformation in Asia at an average TFP growth rate of 1.4% per year during the period from 2010 to 2019 when compared to developed countries, such as Japan, ROK, Singapore, and others. Further, Vietnam's TFP growth is higher than other developing nations in the ASEAN region, including Thailand, Indonesia, and the Philippines. The high growth rate of TFP shows that S&T, technology, skills, labor qualifications, and management qualifications are clearly improved. These are positive results from recent efforts at transforming Vietnam's growth model.

BOX 10.1 A NEW APPROACH OF TFP MEASUREMENT FOR VIETNAM

The composite factor productivity index is used by economists to better understand the drivers of economic growth. This index has been used by many countries and research institutions for more than 50 years. TFP measures residual output growth that cannot be explained by increases in inputs, such as labor and capital. By comparing changes in labor and capital contributions with changes in GDP, insights can be gained on how improvements in technology or efficiency can help a country become richer and improve living standards.

However, traditional TFP does not provide the full picture, so developed countries are revisiting to assess the impact of pollutant emissions and natural resource extraction.

According to the traditional calculation, if a country exploits more natural resources, it will lead to increased productivity. GDP is traditionally considered the sole output of the economic activity. In reality, however, there are other by-products of economic activity, such as pollution. If pollution reduction is not seen as a benefit, it seems likely that pollution reduction efforts could result in lower productivity. Therefore, ignoring pollution emissions and natural resource extraction when assessing economic growth can lead to false conclusions about a country's growth prospects and potentially lead to major decisions.

TFP is increasingly used in economic policy, especially to calculate the potential output. Most measurements are based on the standard production equation that combines labor and capital to produce outputs, but outputs do not account for negative by-products of production, such as air pollution, which can have serious effects on health and productivity in the medium to long term. Failure to take into account the costs of environmental damage and the benefits associated with emissions reductions leads to a bias toward measures that promote TFP. Ignoring these aspects could give the wrong direction on the medium- and long-term growth prospects.

The costs of pollution, environmental treatment, and real output reductions are said to vary widely across economies, depending on countries' environmental regulations, the use of inefficient technologies, and the structure of the economy.

In general, the traditional TFP adjustment margin due to environmental pollution is relatively large, although it may still be within the allowable error range. However, calculating the impact of pollution results in a very different adjustment from country to country.

Economic growth and widespread urbanization accompanied by air pollution have been well recognized. The consequence is the rapid increase of CO2 and carbon concentration in the ASEAN region. ASEAN's share of global emissions is expected to increase rapidly in the coming years, reflecting rapid economic growth and urbanization, changing lifestyles, and higher energy demand. One of the main sources of air pollution is acid rain, which comes from too much sulfur dioxide (SO2) in the air. Acid rain leads to environmental degradation (especially in forestry and biodiversity) and can also pose health risks. SO2 emissions are increasing rapidly in most ASEAN economies, including Vietnam. Another prominent air pollutant in Asia is nitrous oxide (NOx), which most ASEAN economies have experienced a rapid increase over the past decade.

In terms of green productivity, the efficiency of using inputs, including labor, energy, and raw materials is taken into account. Due to its importance for sustainable development, in future, green productivity should also be considered as an important concept along with labor productivity, capital productivity, and TFP.

Source: OECD, Adjusting Productivity for Pollution in Selected Asian Economies, 2014 [11].

INSTITUTIONAL FACTORS OF PRODUCTIVITY IN VIETNAM

Macroeconomic Stability

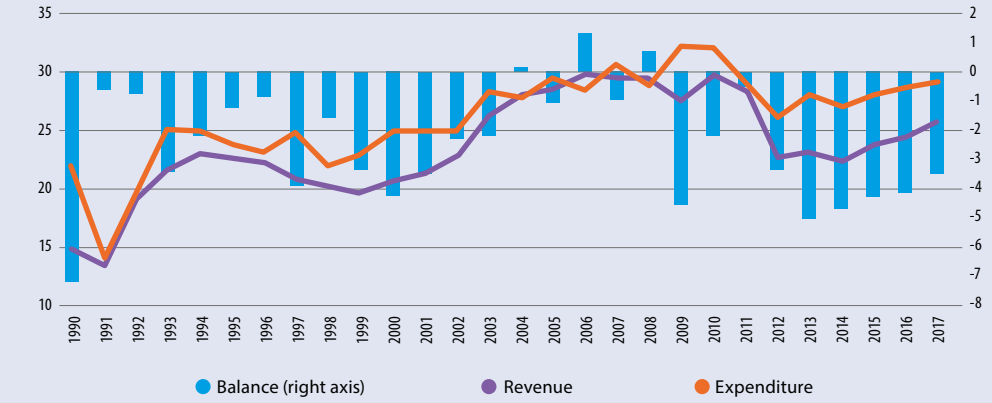
A stable macroeconomic environment, characterized by mild or moderate inflation, low levels of external liabilities and government debt, and stable but responsive exchange rates, is very important for investment, consumption, and other economic activities. As planned by the Vietnamese National Assembly, Vietnam's inflation in the consumer price index was kept below 4% during 2015–18, largely owing to the stabilization of international fuel prices and the slowdown of domestic credit growth. Further, the current account which had run persistent deficits also turned into a surplus in 2011 while the exchange rate remained stable as well. The only concern about macroeconomic stability stems from government debt and deficits. Vietnam has recorded large budget deficits, except in 2006 and 2008 (Figure 10.6), and the government's gross debt soared

from 31.4% of GDP in 2000 to 59.7% in 2016. In 2016, IMF issued a warning on Vietnam's chronic budget deficits and public debt, resulting in medium-term debt management program 2016–18 being introduced.

Vietnam has since kept the budget deficit at around 3.6% of GDP. On the revenue side, tax reforms planned for 2011–20 are being implemented with a view to increasing tax revenues and improving tax administration.

FIGURE 10.6

VIETNAM'S FISCAL BALANCE (% OF GDP)



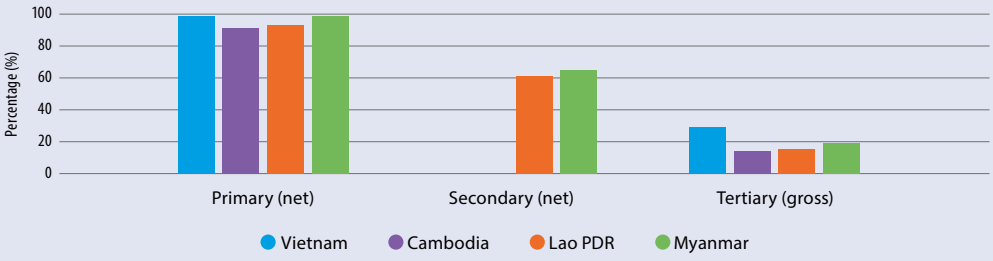
Source: EIU Database; IHS Market Database.

Human Resources

Human resources are the most important factor of production. Human development through education, healthcare, and other services is essential for productivity improvement. At the same time, human development is the ultimate goal of economic growth.

FIGURE 10.7

ENROLLMENT RATE (NET OR GROSS, 2018)



Source: EIU Database; IHS Market Database.
Note: The enrollment rate for secondary school is not available for Vietnam and Cambodia.

Figure 10.7 shows the enrollment rate in primary, secondary, and tertiary education. Primary schooling has now become universal in Vietnam, but the enrollment rates in lower and upper second education are not available in the country. This is unfortunate because, given Vietnam's current stage of development, secondary education (especially upper secondary) plays a pivotal role in supplying manpower for modern industrial sectors. As for tertiary education, the enrollment rate in 2018 was 28.5% in Vietnam, higher than in neighboring countries and similar to ROK's level in the 1980s.

UNDP's Human Development Index (HDI) focuses on three basic dimensions of human development: (i) the ability to lead a long and healthy life, measured by life expectancy at birth; (ii) the ability to acquire knowledge, measured by mean years of schooling and expected years of schooling; and (iii) the ability to achieve a decent standard of living, measured by gross national income per capita (UNDP Annual Report 2019).

In 2018, Vietnam ranked 118th (37.6 percentile from the bottom) out of 189 countries (Table 10.2). In particular, the expected years of schooling, which stands at 12.7, indicate that most children in Vietnam are not expected to enter college. Similarly, the mean years of schooling at 8.2 implies that most working-age populations have failed to complete lower secondary education. Considering the unmet demands for skills, there appears to be an urgent need to expand the opportunity for education further and improve its quality.

TABLE 10.2

UNDP HUMAN DEVELOPMENT INDEX IN 2018 [13]

	HDI Rank	Life Expectancy at Birth (years)	Expected Years of Schooling	Mean Years of Schooling	GNI Per Capita (2011 PPP $)
Vietnam	118	75.3	12.7	8.2	6,220
Cambodia	146	69.6	11.3	4.8	3,597
Lao PDR	140	67.6	11.1	5.2	6,317
Myanmar	145	66.9	10.3	5.0	5,764

Source: UNDP.
Note: The HDI rank is out of 189 economies.

Innovation

The creation of knowledge is a critical part of productivity improvement. One measure of the extent of knowledge creation is the number of patent applications. On this measure, Vietnam fares well above neighboring countries with more than 5,000 applications per year in 2014–18 (Table 10.3). Most of the applications are filed by nonresidents, but the applications by residents still number close to 700 per year.

TABLE 10.3

PATENT APPLICATIONS IN 2014–18 (AVERAGE)

	Nonresidents	Residents	Total
Vietnam	4,658.8	662.0	5,320.8
Cambodia	84.2	1.2	85.4
Lao PDR	64.4	1.4	65.8
Myanmar	-	-	-

Source: The World Bank Database [14].

Despite the large volume of patent applications, many problems exist in Vietnam's R&D system. The question would be how to encourage domestic R&D activities and accelerate the transfer and absorption of advanced technology from abroad.

Vietnam has achieved remarkable improvement in economic growth in the last three decades. In the context of the COVID-19 pandemic, many economies around the world had negative growth. However, Vietnam managed to maintain a positive GDP growth rate in 2020 that recorded 2.91%, making it one of the four economies with positive growth. In 2020, Vietnam's GDP per capita is estimated at VND64.5 million per person, an increase of 1.5 times compared to 2010. Vietnam's labor productivity at current prices in 2020 is estimated at VND117.9 million per worker (equivalent to USD5,081 per worker, an increase of USD290 compared to 2019). At constant prices, labor productivity increased by 5.4% over the previous year. Maintaining the labor productivity growth rate of 5.4% amid the complex global economic landscape is a significant achievement for Vietnam.

Intra-industry productivity growth has contributed significantly to labor productivity growth, up to 65.3% in the period 2011–20. The contribution of static restructuring is about 31.9% and that of dynamic restructuring (the shift of labor at the same time increases the labor productivity of the labor sector transferred to) about 4.8%. This notable productivity improvement has been attributed to the dynamism of Vietnam's private sectors. The ability to adopt best practices and adapt to specific business context and innovation has been the key of success for many Vietnam's enterprises. More recently, the rapid changes brought about by digital technology presented Vietnamese enterprises with different challenges and requirement to quickly adapt and innovate in order to maintain competitiveness in the international market. Nguyen, et al. (2008) provided evidence for the positive impact of innovation to Vietnamese SMEs' export [15]. Nham, et al. (2016) showed how different innovation types (product, process, marketing, organization innovation) significantly enhance firms; survival and growth through a survey of 118 enterprises in Vietnam [16].

According to a recent survey of innovation in enterprises under the FIRST-NASATI project (Vietnam's Ministry of Science and Technology), only nearly 14% of enterprises have cooperated with external units for product innovation research, with technology transfer activities from S&T organizations to enterprises are very low at just under 1%. This shows that the link between enterprises (the demand side in the S&T market) and institutes, universities, and scientists (the supply side) is still very limited. The survey results of MOST in 2018 showed that only about 30% of enterprises engage in innovative activities and about 4,000 innovative start-ups are still active. The WIPO in 2020 ranked Vietnam 42nd out of 131 countries and economies on the innovation index (up 20 places compared to 2016). Within the ASEAN region, Vietnam secured the third position and is first in the group of 26 low-middle-income countries on this index.

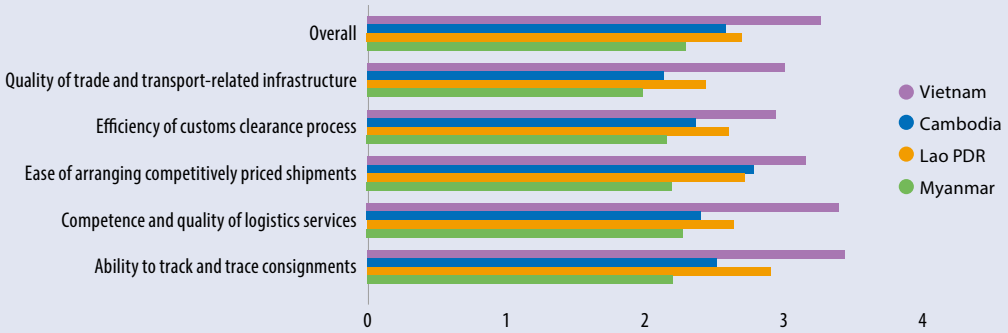
STI has been focused on investment and application, making an important contribution to helping the economy, industries, and enterprises overcome shocks, and continues to promote productivity growth even amid the economic crisis. The prime minister's Master Plan to improve productivity based on STI in the 2021–30 period, highlights the key tasks, such as implementing the ISO 56000 innovation management, adopting productivity improvement models and tools in specialized fields (public-service productivity, green productivity, sustainable productivity), and driving innovation across various sectors.

Logistics

Infrastructure is an important factor in production and its efficiency has a strong influence on productivity. Vietnam's logistics infrastructure is performing relatively well compared to those of neighboring countries (Figure 10.8). But its score for the overall logistics performance is only 3.3 out of a full score of five, indicating the need for further improvement. Scores are particularly low for the quality of trade and transport-related infrastructure and the efficiency of the customs clearance process both of which are under the direct responsibility of the government.

FIGURE 10.8

LOGISTICS PERFORMANCE INDEX IN 2018



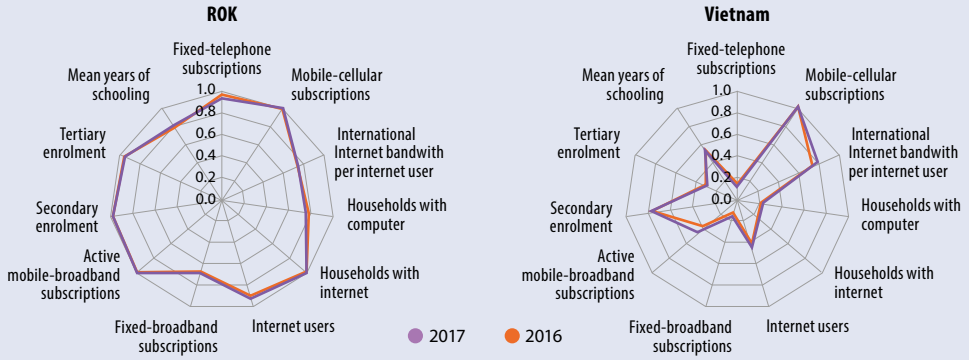
Source: The World Bank Database, World Development Indicators [17].
Note: The scale is from one (worst) to five (best).

ICT

ICT is an increasingly vital part of economic infrastructure across the world. While Vietnam's ICT environment has shown progress, there is still ample room to improve. In 2017, Vietnam ranked 108th among 176 economies in the ICT Development Index (IDI), as published by the International Telecommunication Union (ITU). Vietnam thus ranked above Cambodia (128th), Lao PDR (144th), and Myanmar (140th), but remained in the bottom 40% internationally. Vietnam's performance was particularly poor in the subcategories of fixed broadband subscriptions, fixed telephone subscriptions, households with computers, households with internet access, and tertiary enrollment (Figure 10.9).

FIGURE 10.9

ICT DEVELOPMENT INDEX



Source: International Telecommunication Union [18].

Business Environment

Vietnam's business environment has improved in recent years. Its ranking in the World Banks' Ease of Doing Business index rose from 82nd out of 190 economies (56.8 percentile from the bottom) in 2016 to

70th (63.2 percentile) in 2020. Its remaining weaknesses are evident in areas, such as starting a business, paying taxes, protecting minority investors, trading across borders, and resolving insolvency (Table 10.4). The weaknesses have negative implications for market competition, property rights protection, uncertainty reduction, and transaction costs cutbacks.

TABLE 10.4

RANKING IN THE EASE OF DOING BUSINESS INDEX OF THE WORLD BANK IN 2020

	Rank	Starting a Business	Dealing with Construction Permits	Getting Electricity Supply	Registering Property	Getting Credit	Protecting Minority Investors	Paying Taxes	Trading across Borders	Enforcing Contracts	Resolving Insolvency
Vietnam	70	115	25	27	64	25	97	109	104	68	122
Cambodia	144	187	178	146	129	25	128	138	118	182	82
Lao PDR	154	181	99	144	88	80	179	157	78	161	168
Myanmar	165	70	46	148	125	181	176	129	168	187	164

Source: The World Bank Database [19].
Note: The ranking is out of 190 economies.

Similarly, according to the 2015 World Bank Enterprise Survey, firms in Vietnam identify access to finance (21.8%), practices of the informal sector (17.0%), and inadequately educated workforce (10.7%) as the top three constraints in doing business (Table 10.5). When they are grouped into exporters and nonexporters, the former group considers an inadequately educated workforce is the biggest obstacle (22.4%), indicating the urgent need to improve education and training in Vietnam.

TABLE 10.5

BUSINESS ENVIRONMENT CONSTRAINTS (% OF FIRMS)

	All		Exporters		Nonexporters	
	2009	2015	2009	2015	2009	2015
Access to finance	24.7	21.8	19.4	12.0	25.4	22.7
Practices of the informal sector	19.3	17.0	10.2	11.9	20.8	17.6
Inadequately educated workforce	10.2	10.7	12.3	22.4	10.0	9.6
Transportation	13.3	10.2	11.4	5.3	13.7	10.7
Tax rates	3.5	9.4	1.6	1.6	3.8	10.1
Access to land	6.9	9.3	4.1	7.2	7.3	9.6
Customs and trade regulations	4.2	5.0	10.4	11.2	3.4	4.4
Labor regulations	0.9	3.4	2.7	3.8	0.6	3.4
Tax administration	6.4	3.2	4.2	2.9	6.6	3.3
Political instability	0.4	2.7	0.5	5.4	0.4	2.4
Corruption	3.3	2.6	4.0	6.6	3.2	2.2
Electricity	4.3	2.4	11.0	9.2	3.3	1.8
Crime, theft, and disorder	1.0	1.6	0.5	0.4	1.1	1.5
Courts	0.2	0.4	0.3	0.0	0.0	0.4
Business licensing and permits	1.4	0.2	7.3	0.0	0.5	0.2

Source: World Bank, Enterprise Surveys [20]

Institutions and Governance

Among economists, increasing attention has been paid to institutions as an important determinant of long-run growth. Institutions that provide adequate protection of property rights, equalize the opportunities for education and work, reduce uncertainty, lower transaction costs, and adapt themselves flexibly to changing circumstances are seen to encourage and facilitate economic activities.

The Worldwide Governance Indicator (WGI) measures the quality of institutions along six dimensions: (i) voice and accountability; (ii) political stability and absence of violence; (iii) government effectiveness; (iv) regulatory quality; (v) rule of law; and (vi) control of corruption. According to the most recent survey results, Vietnam is performing better than neighboring countries in most of these dimensions (Table 10.6). In particular, Vietnam's government effectiveness, political stability, and rule of law are above the global median. On the other hand, Vietnam scores low in regulatory quality and control of corruption, which have direct bearing on productivity. Improving Vietnam's institutions should be given a high priority.

TABLE 10.6

WORLDWIDE GOVERNANCE INDICATORS IN 2018 (PERCENTILE RANK)

	Control of Corruption	Government Effectiveness	Political Stability and Absence of Violence / Terrorism	Regulatory Quality	Rule of Law	Voice and Accountability
Vietnam	38.0	53.4	53.8	36.5	54.3	9.4
Cambodia	8.7	32.2	51.4	32.7	11.1	13.8
Lao PDR	15.4	24.5	60.0	20.7	18.8	4.4
Myanmar	30.3	12.5	10.5	22.6	15.4	23.6

Source: The World Bank [21].
Note: A small value of the percentile rank indicates poor governance.

FIGURE 10.10

PRODUCTIVITY IN THE SOE SECTOR

Source: World Bank (2011) [22].

SOEs

A significant impediment to market competition in Vietnam appears to be the prevalence of SOEs in many parts of the market. Despite continued efforts to equitize SOEs and reform their management,

their productivity is very low compared to those of private enterprises. The net turnover-to-capital ratio, a proxy for the productivity of capital, was only 1.1 on average for SOEs in 2008 while the entire enterprise sector charted 21 (Figure 10.10). Similarly, the net turnover-to-employee ratio, a proxy for labor productivity, was VND1.7 billion for SOEs and VND16.3 billion for the entire enterprise sector. Without a significant change in the SOE sector, it would be very difficult to improve the overall productivity of the Vietnamese economy.

QUANTIFICATION OF PRODUCTIVITY GAPS

From the discussion above, several important bottlenecks affecting productivity growth in Vietnam are identified, encompassing knowledge creation and absorption, factors of supply and allocation, institutional shortcomings, and competition.

First, innovative activities in Vietnam look strong as measured by the number of patent applications. Close integration into the global economy through trade and investment channels also bodes well for knowledge transfer and absorption. However, the low enrollment rate in higher education and the large gap in labor productivity between foreign-invested and domestic firms suggest remaining weaknesses in Vietnam's absorptive capacity.

Second, human resources as the most important factor of production need to be expanded further in both quantity and quality. Businesses, especially exporters, have difficulty finding skilled workers. Other input factors, such as logistics and ICT infrastructure, are relatively well developed but need continuous upgrading to support economic growth.

Third, some of the indicators on the business environment and governance reveal improving but still insufficiently robust institutions. Examples include issues with the protection of minority investors, insolvency resolution, regulatory quality, and control of corruption.

Fourth, in terms of boosting competition in the domestic market, a major challenge lies in scaling down the role of SOEs in the economy. SOEs in general suffer from low productivity. They also occupy a large segment of the economy. Without a comprehensive reform of the SOE sector, it looks difficult to improve the overall productivity of the Vietnamese economy.

Considering these challenges, this report will focus on four key areas: innovation, skills development, the linkage between foreign-invested and domestic firms, and SOEs.

Science, Technology, and Innovation (STI)

Unfulfilled Potentials in STI

Since the reform in the 1990s, Vietnam has made significant strides in transforming its innovation system and finding a sustainable pathway to growth. The Vietnamese government adopted a series of economic and social development plans and other sectoral strategies to mobilize national resources and bring together consensus from various stakeholders. Among other sectors, the STI sector is considered a fundamental pillar of economic growth and sustainable development. Within this framework, Vietnam's Socio-economic Development Strategy for the period 2011–20 has highlighted the importance of innovation and STI, especially motivated by the need for more advanced industrialization.

The strategy states: "Direct the focus of scientific and technological towards serving the industrialization, developing intensively and contributing to speeding up the productivity, quality, and effectiveness as

well as improving the competitiveness of the economy. Synchronously implement tasks of capacity enhancement, management mechanism innovation, and fostering scientific and technological application" [23].

The Law on Science and Technology also emphasized the importance of innovation, which is defined as: "the creation and application of scientific and technological achievements and solutions and management solutions in order to improve socio-economic development efficiency, and increase productivity, quality and added value of products and goods"[24].

In line with this law, MOST formulated a strategy for S&T development for the decade starting in 2011. However, this document did not specify the exact subsectors or technologies to be absorbed or developed, or commercialized, and any related financing and human resource development planning were also absent.

After the decade of the declaration of this strategy, Vietnam showed improved quantitative trends of R&D input, academic papers, and patents. However, in spite of the dedicated efforts of ministries and agencies, the input and output of R&D have brought little impact on innovation or remarkable productivity improvement. The evaluation of the implementation of the strategy does not seem to be satisfactory, as the document of the Five Year Plan of 2016–2020 highlighted the persistent weak aspect of the STI sector in Vietnam [25].

According to the document, "S&T has not really been a driving force to improve productivity and competitiveness to promote socio-economic development. There was a lack of a good enough solution to encourage businesses and private investment in research, innovation, and application of S&T."

The document further noted that:

- Reform of S&T management mechanisms, especially in the financing, autonomy, self-responsibility, and talent utilization, have progressed slowly. Budget is dispersed but ineffective

- Capacity of scientists remains limited with a notable shortage of leading figures. The number of patents and published works in renowned international journals is limited

- Quality of education and training, especially higher education and vocational training, improved slowly. A shortage of high-quality labor persists

- Programs, content, teaching and learning method, testing, examination, and other quality assessment methods have seen confusing and slow improvements

- Imbalance in industry structure and training levels has been gradually addressed, but training is not aligned to market demand

In addition, the seemingly sound economic performance, though without a substantial restructuring of S&T governance and major investments during the last decades, has actually lessened the pressure for policy reforms in coordination and resource allocation mechanisms. Since 2000, the state was supposed to allocate 2% or more of the total annual state budget expenditures for S&T, as stipulated in the Law on Science and Technology. However, the percentage of expenditure on S&T has consistently remained below 1% since 2008. Further, actual spending was only about half of the allocated budget. Lack of information on the actual state budget spending on S&T and capital spending hinders real-time assessment of the exact spending on R&D. In some local units, actual budget utilization was not allocated for the intended purposes and categories [26]. "How to manage the investment" is as important and critical as "how much money is put in". Without proper monitoring and evaluation systems in place, securing additional funds from taxpayers becomes a difficult task.

SOEs

The SOEs sector is one of the pillars of Vietnam's economy. SOEs account for approximately 31.8% of the GDP, taking up the lion's share of the country's economic activities (Table 10.7). SOEs generate more than half of the total revenue in almost all key sectors of the economy: electricity, minerals, petroleum, finance, food, and telecommunications [27].

TABLE 10.7

SOES IN VIETNAM IN 2017

	SOEs	Non-SOEs	FDI	Total
GDP	31.8	46.4	21.8	100.0
Capital	29.6	52.5	29.0	100.0
Investment	32.7	49.4	17.9	100.0
Number of enterprises	0.4	96.7	2.9	100.0

Source: GSO of Vietnam and CIEC database [28].
Note: : i) The share of output and investment is based on the constant 2010 price.
ii) The share of capital is calculated by annual average capital.

Although the number of SOEs only accounts for 0.4% of the total number of enterprises, they make up 29.6% of the whole country's capital and take up 31.8% of the country's investment. The average capital per SOE is VND3,821 billion, which is over 10 times greater than FDI and 100 times larger than domestic private sectors (Asian Development Bank Annual Report 2020). Out of the 500 largest enterprises of Vietnam, large SOEs, and State Economic Groups (SEGs) occupy seven of the top 10 list [29] (Table 10.8).

TABLE 10.8

TOP 10 COMPANIES OF VNR500 IN 2019

Ranking	Ownership	Sector	Top 10
1	Private FDI	Manufacturing	Samsung electrics in Vietnam
2	SOE	Electricity	Vietnam Electricity (EVN)
3	SOE	Gas	Vietnam National Oil and Gas Group (PVN)
4	SOE	Telecommunication	Military Industry and Telecoms Group (Viettel)
5	SOE	Petrol import and distribution	Vietnam National Petroleum Group (Petrolimex)
6	Private	Real estate	Vin Group
7	Joint-stock company	Oil exploitation	Binh Son Oil Refining - joint stock company (BSC)
8	SOE	Trading petrol	Vietnam Bank for Agriculture and Rural Development (Agribank)
9	SOE	Real estate	Bank for Investment and Development of Vietnam (BIDV)
10	SOE	Mining	Vietnam National Coal Mineral Holding Corporation (Vinacomin)

Source: VNR500 (various years).
Note: : i) VNR - Voluntary National Review.
ii) The efficiency of capital is calculated by the net turnover to capital ratio of the enterprise and based on the constant 2010 price.

However, despite aiming ambitious goals for SOE reforms, a number of barriers still exist that hinder the benefits of this reform. In particular, equitization and divestment of SOEs are considered the main driver for the restructuring of Vietnam's economy. Although the process of SOE equitization in Vietnam

unfolded over the past three decades, it remains a challenging task. The primary challenges of SOEs reform are presented as follows:

i) **Difficulty in the valuation of SOEs** - Valuation is a fundamental part of the equitization and divestment process that facilitates price negotiations between the government and investors. However, enterprise valuation is considered one of the most complicated, costly, and lengthy steps (Asian Development Bank Annual Report 2020).

ii) **Inconsistent valuation methodologies** - The equitization process begins only after the SOE valuation is completed. The value of SOEs varies depending on the valuation methodology applied. Overestimated SOE values result in a low level of interest by investors after equitization while underestimated values lead to loss of government assets. However, due to the lack of consistency in applying the methodology to the valuation of SOE, asset prices are measured differently. In particular, there is no harmonized methodology suitable for the characteristics of assets and liabilities, such as long-term debt, intangible assets, land use rights, intellectual property rights, business advantage, and inventories of SOE, resulting in different valuation between certified public accountants (CPA) and state auditor. The State Audit Vietnam is concerned about the underestimation of the SOE and often orders to adjust the price of SOEs higher than the initial quotes by CPA [30]. Since there is no consensus on the agreed methodology and applied appraisal criteria, this problem undermines the credibility of the equitization process. Further, the lack of detailed guidelines for valuing SOEs for equitization purposes, particularly for complex cases like the valuation of land use rights, lead to differences in price expectations due to varying valuation methodologies.

iii) **Unclear role of SEGs in innovation** - Vietnam has aimed to utilize the SEGs in key sectors as policy tools aligned with the national development strategy and SOE policies (Decree 101, Article 3). Notably, SEGs and large SOEs in Vietnam's vital sectors, such as energy, utility, and infrastructure (e.g., telecommunications, electricity, chemicals, mining, and petroleum) are categorized as wholly state-owned entities, according to Decree 58/2016/QD-TTg. However, SEGs have not clearly defined their roles as assigned by the state to act as driving forces in various economic fields and sectors. With the exception of Viettel group [31], other SEGs continue to maintain a monopolistic position, curtailing the potential benefits of competition. While these SEGs are in charge of investment and innovation in these key areas, their investment activities remain stagnant. Investment in key sectors related to SEGs is much lower than those of other sectors, such as the manufacturing sector. In 2017, the manufacturing sector had the highest investment levels in Vietnam. The state share of the investment in the manufacturing sector is the lowest in the total state investment. On the other hand, the key sector with high share of state investment receive limited overall investment with the electricity sector, in particular, has the highest state share of investment at over 89%.

iv) **Challenges in corporate governance** - SOEs, particularly large corporations and economic groups, play a central role in the Vietnamese economy. Thus their corporate governance is likely to have a substantial impact on the efficiency and competitiveness of the whole economy. Vietnamese SOEs have undergone several stages of reforms in corporate governance. This section will review past reform efforts and assess the current state of corporate governance in Vietnamese SOEs while identifying key challenges.

v) **Decentralized ownership structure and weak enforcement of regulations** - Vietnam has predominantly decentralized state ownership, in which state ownership is exercised by various entities, such as the Commission for the Management of State Capital at Enterprises (CMSC), State Capital Investment Corporation (SCIC), line ministries responsible for sector-specific policies and regulations, and a number of Provincial People's Committees that represent local governments. While CMSC functions as a coordinating agency under the decentralized structure, a number of ministries are involved in oversight and corporate decision-making.

TABLE 10.9

IMPLEMENTING RIGHTS AND RESPONSIBILITIES OF STATE OWNER'S REPRESENTATIVES IN VIETNAM

Institution	Rights and Responsibilities
Committee for Management of State Capital at Enterprises (CMSC)	• Prime minister's ministerial agency managing 19 SOEs, including SEGs • Having the right to request competent regulatory authorities to appeal to the government regarding the statutes of 19 SOEs • Establishing a restructuring strategy, establishing an online information disclosure system for SOEs, and designing evaluation indicators
State Capital Investment Corporation (SCIC)	• Under the purview of the Ministry of Finance, acting as a state holding company, managing the investment of state capital in a portfolio of over 148 SOEs
Ministry of Finance	• Appealing to the government to promulgate regulations, including (i) transformation of 100% SOEs into joint-stock companies; (ii) financial administrations, (iii) criteria for assessment of business performance; and (iv) supervision and inspection of investment, management, and use of state capital at enterprises • Preparing reports on investment, management, and use of state capital at enterprises nationwide for submission to the government • Reviewing SOEs' financial statements and making decisions on dividend levels
Ministry of Planning and Investment	• Responsible for promulgating regulations, including (i) information disclosure of business operation of SOEs; (ii) rules for performing tasks of comptrollers; (iii) incorporations, consolidation, acquisition, splitting, dissolution, and total sale of enterprises and transformation of SOEs into multiple-member limited liability companies • Approving investment projects of SOEs • Preparing reports on the management and evaluation of SOEs for submission to the government
Ministry of Home Affairs and Ministry of Labor, War Invalids and Social Affairs	• Responsible for promulgating regulations on recruitment, (re-) appointment, dismissal, grant of awards, and imposition of disciplinary actions on SOE executives
Other ministries and Provincial People's Committees	• Approving businesses, business plans, and development strategy of SOEs
Ministry of National Defense	• Appealing to the government on salary management statutes and regulations of the parent company, Viettel Military Industry, and Telecommunications Corporation
State Economic Groups (SEGs)	• Serves as a holding company for the subsidiaries of SOEs • The head of SEGs is vice minister-level • The SEGs are obliged to report to the government while prime minister and deputy prime minister do not take responsibility as shareholders

Source: Author's elaboration based on Decree No. 10/2019/ND-CP Implementing Rights and Responsibilities of State Owner's Representatives and OECD (2016).

As shown in Table 10.9, implementing rights and responsibilities of state owner's representatives are fragmented across diverse entities. According to OECD (2010), countries with a greater degree of centralization can be expected to apply more harmonized corporate governance requirements across the SOE sector in general. Undoubtedly, the decentralized ownership structure may affect the effectiveness of regulations on corporate governance. Given the decentralized ownership structure of Vietnamese SOEs, it can be expected that the regulations on SOE management are neither strongly enforced nor complied with by market participants. Sometimes they are not fully aware of complicated regulations and they undergo significant administrative burdens due to overlapping regulations of multiple agencies.

vi) **Complicated ownership and management structure within SEGs and inadequate protection of minority shareholders' rights** - A single SEG consists of various types of companies, such as SOEs, joint-stock companies, limited liability companies, and affiliates, each with varying levels of state capital ownership. The ownership structures of the unlisted joint-stock companies on equity

exchanges have become so complicated that it is difficult to measure the quality of capital invested in them. The parent company often faces difficulties in coordinating the conflicting interests among multiple subsidiaries (general corporations and other enterprises). While parent companies of SEGs are the controlling shareholder of their subsidiaries, there is little incentive for external investors to own shares of subsidiaries when they are equitized. Moreover, the rights of minority shareholders are often neglected, which deters outside investors from investing in subsidiaries of SEGs. This issue pertains to internal governance and the relationships between entities within SOEs, such as, those between the parent companies and subsidiaries within SEGs.

When SEGs (referred to as "91-corporations") were established by the decision of the prime minister in 1994, business management committees at parent companies of each SEG were responsible for formulating long-term development strategies for SEGs, making decisions on investment and asset sales, and determining the management structure of their subsidiaries. Since 2018, many management responsibilities within SEGs have shifted to the CMSC. The main tasks of CMSC include formulating plans for the development and investment of enterprises under its management, making decisions on capital injections, supervising and evaluating management performance, and determining executive compensation. However, neither CMSC nor the business management committees at parent companies in SEGs play significant roles in holding SEGs accountable, as line ministries still exercise ownership control through interference in selecting CEOs and board members.

Local Supplier with Multinational Enterprises (MNEs)

As previously discussed, Vietnam's dichotomous industrial structure is primarily attributed to the limited impact of technology transfer and productivity improvement through linkages between foreign-invested companies and local firms.

According to the World Bank report from 2017, the linkages between multinational enterprises in Vietnam and local firms are lower than those in neighboring countries. Foreign-owned firms in Vietnam utilized only 67% of domestic input within the country, whereas the figure exceeds 99% in PR China, Malaysia, and Thailand. In addition, 46% of multinational companies collaborating with domestic companies in Vietnam rely on imported intermediate goods, which is very high compared to neighboring countries - 8% in PR China, 4% in Thailand, and 32% in Malaysia.

This disparity implies that it is difficult to expect the spillover effects of technology and productivity through the connection between multinational enterprises and local firms in Vietnam. The main obstacle hindering these connections between multinational companies and domestic companies is the technical gap between foreign-invested companies and domestic companies, and the lack of capacity of domestic companies to absorb foreign technology.

Due to the low technology capabilities of local firms in Vietnam, there are constraints on cooperation and linkages with foreign companies that possess high levels of technology as well as the inability to grow as a supplier of intermediate parts. Nevertheless, local firms in Vietnam appear to invest mainly in process innovation rather than product innovation, which only marginally reduces the technological gaps and hinders efforts of improving productivity through the development of new products.

In addition, the prospects of acquiring and disseminating advanced technology are limited by the technical skills gap, lack of skilled workers, and the absence of professional and managerial positions in the labor supply side [32]. Further, investment in vocational training for Vietnam's local firms appears to be inferior to those made in foreign-invested enterprises, according to the reports from the World Bank (Annual Report 2017) [33].

Therefore, in order for Vietnam to advance its industries through the absorption of technology from foreign-invested companies, it is necessary to create an environment conducive to enhancing the absorption capacity of local firms.

Another issue is the lack of management capabilities and communication hurdles, particularly the challenges related to documentation-based communication, in the interactions between foreign-invested companies and Vietnamese local firms.

Solving the problem of asymmetry of information between local firms and multinational enterprises is imperative. Local firms lack access to information concerning the levels of technology required by multinational enterprises while the latter lacks insights into the technological proficiency of local firms and the reliability of technology levels in Vietnam.

In the process of Vietnam's foreign investors rapidly transitioning from low-value-added industries to high-value-added industries, it encounters the opportunity for rapid assimilation of cutting-edge technologies. However, due to the technological gap between domestic and foreign-invested companies, establishing connections with multinational companies are more challenging than it is for neighboring countries.

Nevertheless, Vietnam has the advantage of being able to jump from low-tech to high-tech industries faster than its neighboring countries, thus enabling integration into global value chains (GVC) through efforts to strengthen ties with foreign-invested companies. It is expected that strengthening the absorption capacity of Vietnamese local firms will play an important role in laying the foundation for productivity improvement and sustainable growth.

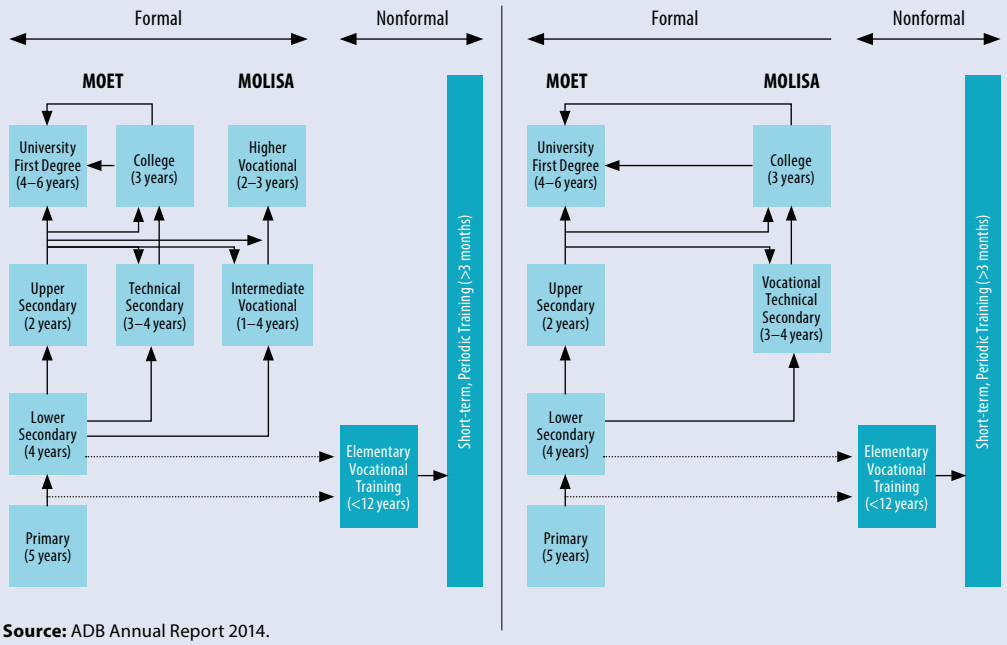
Therefore, creating an environment that facilitates collaboration between Vietnamese local firms and multinational corporations and strengthening their ability to absorb technology should be prioritized. This is especially relevant as Vietnam's manufacturing industry is transforming into high value-added industry, leading to enhanced international competitiveness.

Technical and Vocational Education and Training

Responsibility for technical and vocational education and training (TVET) has been among multiple entities, including the Ministry of Labor, Invalids and Social Affairs (MOLISA), Ministry of Education and Training (MOET), and other ministries and agencies, including SOEs and other enterprises. TVET was implemented on two tracks: professional and vocational school programs under MOET and MOLISA, respectively. This dualized system has led to complicated accreditation processes for institutions and duplication of contents. However, since 2016, efforts have been made to integrate these dual functions which were integrated with MOLISA taking on the role of supervising both vocational colleges and vocational secondary schools (Figure 10.11). MOLISA also oversees nonformal training programs, categorized into long term, elementary vocational training for less than 12 years, and short-term and periodic training for less than three months.

FIGURE 10.11

STRUCTURE OF THE TVET SYSTEM



Source: ADB Annual Report 2014.
Note: The left chart is described as a dualized system and the right is integrated.

The Directorate of Vocational Education and Training (DVET) under MOLISA is the implementing body for supervising and managing TVET institutions and curricula. Its responsibilities are: (i) developing strategies and plans for vocational training (VT) development; (ii) setting policy on curriculum, training quality, and national qualification framework (NQF); (iii) examinations; (iv) management of enrollment, degree, and certificate system; (v) improving teachers' quality; and (vi) managing infrastructure and equipment.

Another limiting feature of the TVET advancement system is that graduates of vocational school cannot advance to higher general education schools or universities. Once students step into training education, there are limited alternative career pathways within the existing education system. This means that for individuals who have completed primary or lower secondary school and subsequently enrolled in long-term training programs have no mechanisms available to transition back to general education. This creates a barrier to growing their skills high within the formal education system.

Vocational centers in this section refer to short-term training vocational centers that offer programs for less than three months as short-term programs are more commonplace than long-term programs. The number of training institutions increased rapidly in the 2000s. Most notable was the steep increase in vocational training. Public vocational colleges in 2018 increased by 109% compared to 2015 while private vocational secondary schools more than doubled. However, the number of vocational training centers declined sharply to around 20% of the 2015 figure in 2018. In particular, there exists substantial fluctuation, especially in the nonpublic vocational training centers, between 2015 and 2016. If this rapid change in the number of institutions was reflected in the quality of institutions, the government can be said to have managed institutions efficiently.

Many TVET institutions, however, have not completed the self-accreditation process. A high percentage of vocational training centers remain without completing self-accreditation. Specifically, 58.7% of

vocational colleges (111 colleges), 21.5% of vocational secondary schools (60 schools), and 8.9% of vocational training centers (92 centers) have conducted self-accreditation. This raises concerns about the assurance of quality training.

Cooperation with the private sector is the most important agenda for the government, as it allows to directly identify market needs and the qualifications required, especially for new jobs. This collaboration is important when developing the National Occupational Skill Standards (NOSS) and National Qualification Framework (NQF). TVET institutions can disseminate relevant content along with current market demands and respond to changes in market needs. Also, students can utilize industry-specific equipment aligned to their career aspirations.

Though there is an accreditation requirement for private-sector involvement in developing curriculum, only 32.8% of 88 TVET institutions have cooperated with firms on a regular basis while 6.9% have never engaged in such cooperation, as reported by the Directorate of Vocational Education and Training Report in 2016. TVET institutions provided various reasons for not cooperating with enterprises, which includes:

- Enterprises do not have the need to cooperate with TVET institutions (31%)
- Lack of specialized staff (25%)
- Unable to establish contracts (31%)
- Unable to meet requirements of enterprises (13%).

Only 12.3% of 79 enterprises have regular cooperation with institutions and 46.2% do not have cooperation in accordance with the survey conducted by National Institute for Vocational Education and Training and the Vietnam Chamber of Commerce and Industry (VCCI). Despite the existence of TVET laws that provide incentives for enterprises participating in vocational activities, effective from 2015 (Decree No. 12/2015/NĐ-CP dated 12 February 2015 and Circular No. 96/2015/TT-BTC dated 22 June 2015), such as tax deductions or exemptions and the provision of work spaces (infrastructure construction rental and land allocation), enterprises cite reasons for low engagement, including weak law enforcement, unattractive incentives considering the disruption to other workers, time consuming, a shortage of skilled workers, affordability issues, and other constraints, like limited facilities and insufficient manpower [34].

Government funding plays a decisive role in operating TVET institutions. The financial resources allocated for TVET between 2011 and 2016 were distributed as follows: 85.7% from the government budget, 10.4% from tuition and admission fees, and 3.9% from others sources, such as services offered by TVET institutions or domestic private sectors. For instance, Dongnai College of High Technology (a vocational college) reported that their financial resources are approximately 60% from the government budget and 40% from the number of students and tuition and admission fees (written survey from Dongnai College, March 2020).

While there has been increased investment in basic construction during 2010–16 [35], the predominant portion of government spending might explain the limited flexibility in financial management, which poses a significant obstacle for TVET institutions, preventing robust identification and application of market needs in training materials. Funding from the government has been provided through a quota system that sets a ceiling for enrollments for each institution and funds students on a per capita basis. Fees and per capita cost subsidies are set at low levels for all training programs, and institutions cannot raise fees or offer incentives for teachers. Schools run by SOEs also receive government funding while private schools rely on fees and income from entrepreneurial activities. Also, government regulations

have restricted service activities and utilization of the existing facilities and equipment for business purpose [36]. This direct interference could stifle the growth and development of TVET institutions.

TVET curriculum has developed in compliance with regulations on curriculum standard issues (Decision No. 01/2005/QD-GDDT), which includes the following components: (i) overall objective of the group of major; (ii) the function of graduates; (iii) knowledge, skills, and attitudes that help students to function well; (iv) the overall design of curricula, including basic knowledge of the specialized field; (v) teaching method; and (vi) evaluation procedure guidelines.

A more recent official guideline of the TVET program was updated in March 2017 (Circular No. 03/2017/TT-BLDTBXD by MOLISA). This latest guideline includes the process of constructing contents, organization of compilation, selection criteria, vocational education management guidelines, and evaluation of training curricula for vocational secondary schools and colleges. However, it is important to note that there are currently no legal requirements for private-sector involvement in developing curriculum.

DVET has developed TVET accreditation criteria in 2008 in accordance with the 2006 Vocational Training Law. The accreditation of TVET institutions is defined in Vietnam as the periodic process of quality evaluation and recognition of an institution or program that has already been granted a license to operate (ILO country paper). The Vietnam Vocational Training Accreditation Agency (VVTAA) under DVET mainly performs the function of counseling and assisting DVET with vocational training accreditation at the national level. The accreditation process involves three main components: self-study, external review, and decision-making with follow-up.

One major challenge is the absence of a clear incentive system. There are no direct awards (e.g., extra funding) or penalties (e.g., closure of the institution) based on the results of the accreditation system. The only award is the issuance of an accreditation certificate valid for five years, primarily used for marketing purposes. As of 2016, only 58.7% of the total vocational colleges (111 colleges), 21.5% of vocational secondary schools, and 8.9% vocational training centers are participating in the accreditation system, which is very low when considering the number of institutions. This low participation rate is caused by an inoperative incentive system and the absence of compulsory participation in the accreditation process. The government only requires monthly, quarterly, and year-end reports of the training results from the institutions. Also, each institution is expected to share information related to its operations and staff.

The second major challenge is the credibility of the accreditation process remains uncertain. Almost all of the external reviewers are staff from vocational training institutions with only a small number of experts in vocational training quality assurance. DVET is training these external assessors and accreditors, whom it recruits from the industry or within the TVET system , although the number of participants has been declining. Further, it has documented the accreditation procedure to comply with the set standards as stipulated in Circular No. 15/2017/TT-BLĐTBXH dated 8 June 2017, which outlines criteria and standards for vocational education quality accreditation issued by the Minister of Labor, Invalids and Social Affairs.

The third major challenge is the assessment criteria do not possess objective indicators related to performance, such as employment rates, graduate wages, and other information on their workplaces. The criteria of the accreditation score system include various categories, including whether TVET institutions: (i) fulfill objectives and duties; (ii) possess effective organizational and management structures; (iii) deliver high-quality teaching and learning activities; (iv) have qualified faculty and staff; (v) provide effective curricula and syllabus; (vi) offer good facility; (vii) manage finances; and (viii) provide adequate learner support services. Among these categories, the teaching and curriculum component carries the highest weight. The German Agency for International Cooperation (GIZ) has proposed a detailed strategy on the criteria of assessment of the TVET system through TVET reform projects.

Overall, Vietnam's accreditation system lacks a market-based approach, given the absence of a direct incentive system, criteria for measuring performance, and efforts to identify market needs.

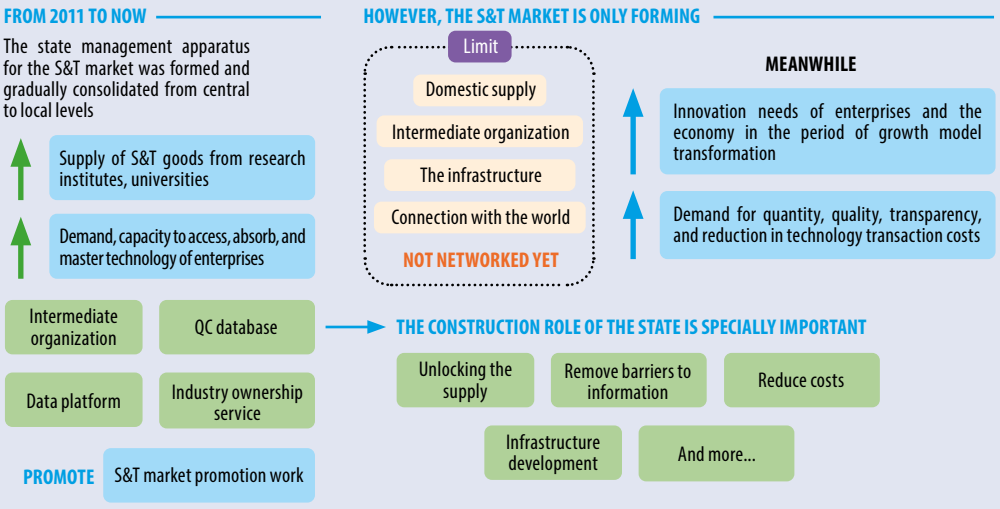
FOCUS ON THE NEXT STEP: DEVELOPING THE STI MARKET IN VIETNAM

The S&T market constitutes an integral part of the socialist-oriented market, which plays a key role in promoting S&T activities and innovation, improving labor productivity, elevating the quality of goods and services, and boosting the economy's competitiveness. From 2011 to present, the state management apparatus for the S&T market has been formed and has been gradually consolidated from the central to local levels, along with many relevant legal documents that have been promulgated. The supply of S&T products from research institutions and universities has increased significantly. Enterprises are showing increased capability and willingness to access, absorb, and master new and advanced technologies that are increasing and improving. Intermediary organizations within the S&T market were gradually formed, and the national database on S&T information as well as the data platform and industrial property services supported by MOST have been effectively developed and are operational. The promotion of the S&T market continues to be maintained and promoted.

However, in general, the S&T market in Vietnam is still in its infancy, just beginning to take form and develop. The supply of S&T goods in the country is still limited. The intermediaries, brokers, and infrastructure of the S&T market are still fragmented, sporadic, and lack links to support services networks in the market. The connection between the domestic S&T market and the global S&T market as well as other markets within the country (especially the labor market and the capital market) are still limited. Meanwhile, the innovation needs of businesses and the whole economy in the current growth model transformation period are increasing day by day. The quality and quantity of technology suppliers, the transparency of technology-related information, and the reduction of costs in technology purchase and sale transactions are urgent requirements to promote the process of technological innovation in enterprises. In addition, domestic enterprises, especially SMEs, do not have the capacity to actively seek and access information on technology supply and have not accumulated sufficient resources, especially capital and highly skilled human resources, to adopt new and advanced technology (Figure 10.12).

FIGURE 10.12

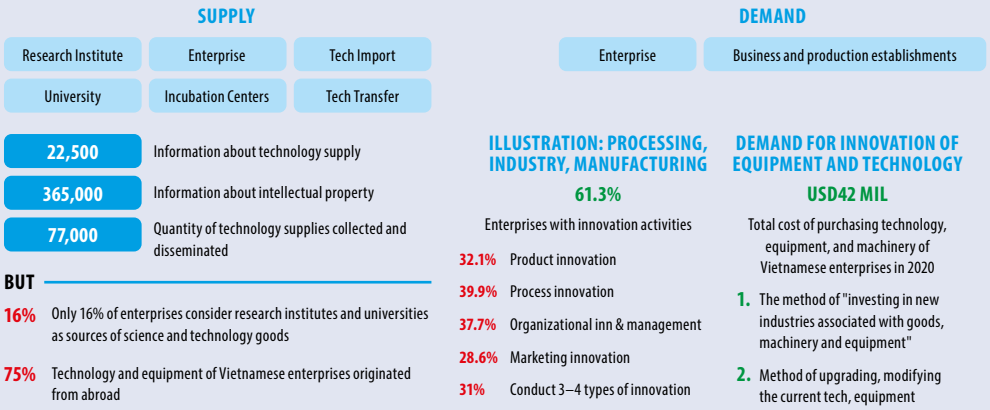
COMPONENTS OF MARKET-BASED INSTITUTION WITH A SOCIALIST ORIENTATION



In this context, the pivotal role of the state in encouraging the development of the S&T market, in general, and particularly, the development of components that make up the S&T market, plays an important factor. The focus lies in unblocking supply, removing barriers to information, reducing transaction costs in the purchase and sale of S&T goods, building and developing market infrastructure, and supporting development and certification organizations for appraisal, valuation, technology transfer consultancy, and more. Over time, significant effort has been concentrated to the building and refinement of institutions and policies aimed at developing the S&T market. To date, the policies on S&T market development are mainly regulated by four laws, six decrees, and 12 circulars. In essence, a legal environment has been created for transactions, transfers, and commercialization of scientific research results, technology development, and innovative start-ups (Figure 10.13).

FIGURE 10.13

VIETNAM'S LEGAL ENVIRONMENT



The following further discusses the main components: supply, demand, and intermediary activities:

i) **Supply** - The supply for the S&T market is formed from scientific research and technology development activities at research institutes, universities, technology incubation centers, and various economic entities. Additionally, technology import and transfer from abroad contribute to this. At present, the National Database on Science and Technology has about 22,500 pieces of information on technology supply and 365,000 pieces of information on intellectual property. According to statistics from technology and equipment exchanges operating in Vietnam, there are currently around 77,000 records of technology supplies collected and disseminated. However, according to the survey of innovation activities at processing and manufacturing enterprises conducted by the National Agency for Science and Technology Information in 2019, only about 16% of enterprises consider research institutes and Vietnamese universities as sources of S&T goods. Aggregated data from the General Statistics Office indicates that about 75% of the technology and equipment used by Vietnamese enterprises are from developed countries, such as the United States of America (USA), ROK, and the European Union showing a slight upward trend in recent years.

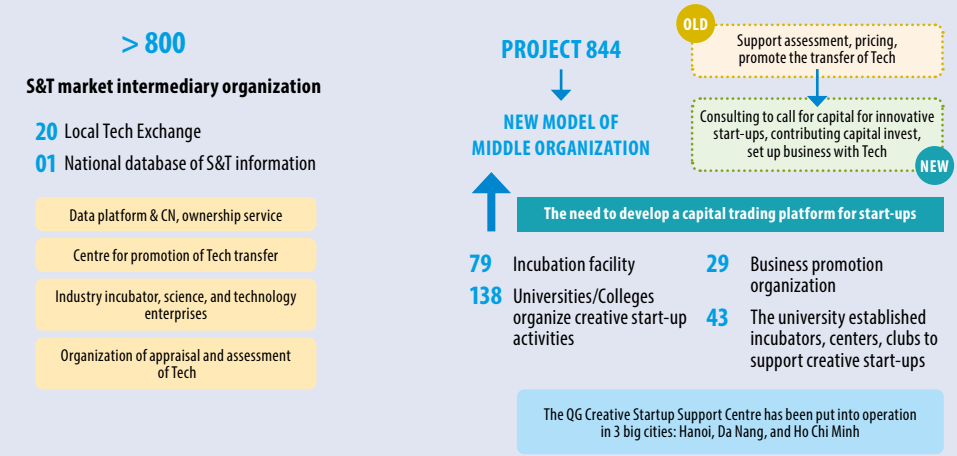
ii) **Demand** - The technology demand of the S&T market mainly comes from enterprises, production, and business establishments. The needs and means to meet the consumption needs of S&T goods among Vietnamese enterprises can be illustrated through an analysis of innovation activities in the processing and manufacturing industry based on data from innovation surveys conducted at Vietnamese enterprises in the period of 2014–16. Among these enterprises, 61.3% engaged in

innovation activities with the following breakdowns: 32.1% innovate products; 39.9% innovated processes, technologies, and equipment; 37.7% engaged in organizational and management innovation, and 28.6% pursued marketing innovation. Further, 31% of enterprises concurrently pursued several types of innovation (three to four). Demand for equipment and technological innovation within Vietnamese enterprises has witnessed rapid growth in recent years. According to aggregated data from the General Statistics Office and the General Department of Customs, the total cost of technology, equipment, and machinery procurement by Vietnamese enterprises in 2020 amounted to approximately VND1.1 quadrillion, an increase of nearly 1.5 times compared to 2016. Regarding the method of process, technology, and equipment innovation: (i) the vast majority of enterprises (79.1%) choose the method of "investing in new technologies associated with goods, machinery, and equipment" while "upgrading/modifying existing technology and equipment" is also the main method for technological process innovation; (ii) 7.3% through signing new labor contracts with people with skills and experience; (iii) 7.5% utilize technology and equipment provided by companies outside the parent company; (iv) 5.2% employ technology and equipment provided by other companies within the parent company.

iii) **Intermediary activities** - Currently, there are over 800 S&T market intermediaries of all kinds established nationwide, including more than 20 local technology exchanges and one trading floor in the Northern Coast region. These intermediaries encompass a range of entities, including the national database on S&T information, data platforms, industrial property service providers, technology transfer promotion centers, and industrial property representation service providers. These organizations facilitate activities, such as technology appraisal and assessment; technology incubation, and S&T business incubators.

FIGURE 10.14

ACTIVITIES IN THE S&T MARKET



In addition, since the implementation of Project 844, aimed to support the national innovative start-up ecosystem in 2025, the intermediary organizations within the S&T market have introduced a number of new models. These models not only provide assessments, valuations, and promotion of technology transfer, but also associated with capital acquisition for innovative start-ups. They contribute investment capital and establish businesses using technology. Currently, the need to develop capital trading floors for start-ups is associated with technology exchanges, essentially creating an investment capital market in conjunction with the growing technology market in major cities, aligning with global trends. Vietnam today has 79 incubators, 29 business promotion organizations, and approximately 138 universities and colleges dedicated to fostering creative start-up activities. Among them, 43 universities have established

incubators, centers, and clubs to support fundraising endeavors for creative start-ups. The National Center for Creative Startups is operational in three major cities: Hanoi, Da Nang, and Ho Chi Minh City. Numerous regions and localities have also taken strides in establishing their own innovation centers and supporting start-ups (Figure 10.14).

The demand for technological innovation in Vietnamese enterprises in the forthcoming period is very large. Central to meeting this demand is the consolidation of the S&T market, offering a long-term basis to support enterprises in technological innovation and upgrading their competitiveness. To develop the S&T market, MOST has implemented a number of key solutions as follows:

i) Fostering the growth of a network of intermediary organizations in the S&T market with a particular emphasis on nurturing organizations that play a focal role in the network, providing systematic public services. This entails reinforcing intermediary bodies within research institutes, universities, and enterprises, especially at national universities, regional educational institutions, educational training institutions, major S&T organizations and multidisciplinary engineering and technology consortia, and industry associations. Additionally, encouraging and supporting the development of intermediaries in the private sector and developing a network of intermediary organizations for key export industries while promoting the role of industry associations and investors. Moreover, organizing training programs, improving professional qualifications, and supporting the issuance of practice certificates to organizations and individuals participating in regulated brokerage activities in the scientific and technical market. Lastly, establishing, maintaining, updating, and developing databases, information portals, and websites on the S&T market.

ii) Developing the demand source of the S&T market and improving the enterprises' capacity to absorb, master, and innovate technology. The government is actively supporting enterprises in the investigation, statistics, and evaluation of technology demands. This includes evaluating the ability to supply and exploit intellectual property resources, conducting technology trend analysis reports, and creating competitive pressures in the business environment to promote enterprises to use technology and increase labor productivity. Further, the system of standards and regulations are expanded and improved to align with international standards.

iii) Promoting the development of supply in the S&T market, focusing on forming channels to import advanced technologies with an emphasis on sourcing technology from developed nations. Priority is placed on sourcing technology from developed countries. Supporting the import and decoding of high-tech, advanced technology, and clean technology with foundational value. Priority is given to supporting the commercialization of research results and intellectual property to meet the needs of mechanization and processing in agriculture, serving the development requirements of the rural, mountainous, island, and remote areas with limited access to land that face complex socioeconomic conditions. Targeted initiatives are implemented to effectively attract and promote talented foreigners and overseas Vietnamese to participate in innovation activities and develop the Vietnamese S&T market.

iv) In terms of connectivity, the approach is toward synchronizing the S&T market with commodity, labor, and financial markets. This includes supporting enterprises in mastering standards, technical regulations, protection, and exploitation of intellectual property to facilitate negotiation, transactions, purchases, and sales of scientific and technological goods. It also encompasses offering support activities to provide necessary information to help businesses grasp and overcome technical barriers in trade, policies, and tools for trade protection and defense when performing public purchase and sale transactions. Support is also provided to facilitate market penetration and market share expansion for products and services in relevant markets. Measures are in place to monitor and control technology transactions through customs, alongside the establishment and execution of a database of experts to support enterprises innovation activities and S&T market development. Policies are formulated to support enterprises in mobilizing financial and credit

resources from the securities market and commercial banks, specifically for projects focused on the commercialization of research results, technology transfer, and decoding of large-scale technologies within the program.

v) Foster a favorable legal environment and promote research on scientific and practical foundations for S&T market development. This includes researching and developing scientific and technological market analysis reports for a number of key export industries and proposing mechanisms and policies to link the S&T market with commodity markets, financial markets, and labor markets. Research and design efforts extend to analysis tools, technology transaction data processing, software design, and management tool. The collaborative approach also involves the creation of shared databases to support supply and demand parties and intermediary organizations within the S&T market.

vi) The commitment to fostering the development of national infrastructure within the S&T market. This includes the establishment and operation of three national technology exchanges in three regions of the country with a focus on fostering connections with local technology exchanges and similar platforms globally. Encouraging intermediary organizations to provide consulting and brokerage services within the S&T market is a priority. Investment is made in building a shared database and a portal on the S&T market. Resources are directed toward the development and application of tools for analysis, statistics, technology transaction data processing, management, and connection of shared databases. Digitization and data integration play a central role in the approach, along with the establishment of a network to connect and invest in building a database of talents, including foreigners and overseas Vietnamese, who participate in innovation activities and develop the Vietnamese S&T market.

vii) Promoting international cooperation activities, focusing on promoting technology transfer, mastery, and development from abroad to Vietnam in priority sectors and fields. At the same time, develop policies to encourage technology transfer from FDI enterprises to domestic supporting enterprises.

In addition to these solutions, it is recognized that the S&T market's role in trading basic research and social science results is of significant importance due to the public utility nature of research results in these fields. Acknowledging the challenges in finding buyers for such results within the framework of market economics, the state is committed to implementing policies that encourage and support research activities in these areas.

POLICY RECOMMENDATIONS

Key Insights into Vietnam's 2021 Productivity Ecosystem

i) In 2021, the global economy embarked on a path of recovery as countries stepped up on vaccination programs against the COVID-19 pandemic. Despite the ongoing challenges of affective economic growth posed by the pandemic, Vietnam experienced a notable turnaround. The GDP growth rate, though the lowest in 10 years at 2.58%, showed resilience. By October 2021, Vietnam had effectively managed the pandemic and gradually reopened its economy. As a result, the country's economy with negative growth in the third quarter has resurged in the fourth quarter with promising outcomes.

ii) Vietnam's economy was about USD368 billion, ranking 42nd in the world. The nominal GDP per capita reached USD3,742 per person. In terms of purchasing power parity, the size of Vietnam's economy scaled USD1,148 billion with GDP per capita exceeding USD11,667 per person, an increase

of USD912 compared to the previous year. This elevated Vietnam's global ranking to 105th in terms of GDP per capita.

iii) Vietnam's labor productivity at the current price in 2021 was estimated at VND171.3 million per worker (equivalent to USD7,398 per worker, an increase of USD538 compared to 2020). In terms of purchasing power, Vietnam's labor productivity is estimated at about USD21,860 per worker. Labor productivity in 2021 increased by 4.71%. Over the past decade, efforts focused on improving national labor productivity have yielded encouraging results in terms of productivity growth, providing an opportunity to gradually narrow the productivity gap with other countries.

iv) Capital intensity has seen consistent growth, which is one of the important factors affecting the increase of labor productivity in Vietnam in recent years. Capital intensity constantly increased with an average growth rate of 7.5% per year over the past decade between 2011–21. While the capital intensity increased, paradoxically, the capital productivity declined steadily, registering an average drop of 2.1% in the 2016–20 period. It further plummeted by 4.5% annually in 2020 and 2021. This decline in capital productivity was also a common trend in ASEAN countries.

v) TFP has enjoyed continuous improvement. Between 2011–15, the increase in TFP contributed 33.5% to economic growth. In 2016–20, the TFP's role expanded, contributing approximately 45.7% to economic growth. In 2021, TFP continued to increase and is estimated to contribute about 37% to economic growth. The boost in TFP has significantly contributed to Vietnam's economic growth during this period, driven by efficient use of capital and labor, economic restructuring, and innovation in the growth model.

vi) In 2021, the agriculture, forestry, and fishery sector saw a labor productivity growth rate of 3.52%. The labor productivity level reached VND63.1 million per worker, equal to about 50% of the national labor productivity.

vii) Labor productivity in the industry and construction sector experienced a rapid growth rate of 5.77% with productivity levels reaching VND209.7 million per worker. This sector acts as the growth engine of the whole economy. Among industries, the manufacturing sector contributed 58% to the total added value of the entire industry. With about 11.3 million employees, it accounted the largest labor force at 95% of the industry's labor force and roughly 21% of the overall national workforce.

viii) The service sector achieved a labor productivity level of VND197.4 million per worker, charting an increase of 5.11%. The COVID-19 pandemic's complex developments had seriously affected commercial and service activities, where negative growth of some service sectors reduced the overall growth rate and affected the whole economy.

ix) Labor productivity is influenced by a multitude of factors, including socioeconomic and cultural characteristics of the locality, region, geographical location, natural resources, climate conditions, soil, infrastructure, labor force, economic structure, investment policies for socioeconomic development, education and training development, and investments in scientific and technological development. Provinces and cities with high labor productivity are Ba Ria - Vung Tau, Quang Ninh, Ho Chi Minh City, Bac Ninh, Hai Phong, Hanoi, Binh Duong, Dong Nai, Vinh Phuc, Da Nang, and Thai Nguyen. These regions are generally characterized by highly developed industries and commerce. In addition, the provinces surpassing the national average labor productivity are Hung Yen, Lao Cai, Hai Duong, Long An, Ha Nam, Can Tho, Tay Ninh, Khanh Hoa, Ha Tinh, Binh Thuan, Ninh Binh, Quang Ngai, and Binh Phuoc. Other provinces exhibit lower productivity levels than the national average.

x) SMEs account for 98.1% of the total number of enterprises. The majority are small and micro enterprises while the number of medium-sized enterprises only accounts for 1.6% of the total SMEs. Due to its small size, this business sector faces numerous challenges, especially during the outbreak and spread of the COVID-19 pandemic. The SME sector experienced revenue declines with microenterprises being the hardest hit, followed by small enterprises, medium enterprises, and large enterprises. In order to improve product quality and labor productivity, SMEs need to increase investment in technology, innovation in product design, production process, and process management. Prioritizing investments in S&T, changing traditional business methods to digital transformation, and adopting e-commerce are key to helping enterprises overcome challenges posed by the COVID-19 pandemic while taking advantage of opportunities to recover and develop production and business.

Policies to Promote Innovation in Vietnam

Implement a Synchronized Approach to Productivity and Innovation Policies

Although the government recognizes the importance of both productivity and innovation, the concept of policy, content, and implementation of these issues remains fragmented. Productivity improvement agencies and policies tend to focus on labor productivity, such as programs to develop workers' skills and expertise, improve production capacity (such as Kaizen), and implementation of industry and technological standards in factories (e.g., ISO). Much of the productivity policy do not specifically mention the importance of innovation. The issue of improving the technological capacity of enterprises, not only in terms of improving production capacity and quality control but also in terms of advanced technical improvement, product and process design, and investment in R&D, has not yet been detailed and clarified in the overall productivity improvement plans and strategies.

On the other hand, the government's science, technology, and innovation policies have largely placed great emphasis on large investments in R&D infrastructure development, training of scientists and researchers, and global trending issues, such as smart cities and sustainable development goals (SDGs). Policies for improving productivity at the enterprise level, especially SMEs (a group of enterprises that account for a large proportion of the Vietnamese economy), are still lacking. Therefore, synchronization is needed, spanning from planning to the implementation of measures targeting productivity and innovation improvement. In the new era, the development of an IR4.0 strategy will be one of the effective channels to connect productivity growth and innovation. Although Vietnam has now developed an IR4.0 strategy, it is necessary to have a specific and timely implementation plan to capitalize on new development opportunities.

Strengthen Cooperation between Ministries and Sectors in Innovation Development

The idea of a national productivity council as the national coordinating body for productivity is consistent with Vietnamese policy practice and deserves consideration. However, for effective policy implementation, close cooperation between ministries and sectors is required. Ministries and agencies should cooperate without necessitating the intermediary role of the national productivity council. In particular, the cooperation mechanism between MOST, the Ministry of Industry and Trade, and the Ministry of Planning and Investment should be strengthened. The implementation of projects jointly developed and implemented by various agencies should be encouraged. Personnel rotation between ministries and regular discussion forums should be initiated and implemented regularly.

Developing and Scaling Up the Network of Innovative Businesses Beyond New Technology Start-Ups

Recent Vietnamese policies have focused heavily on the creation of high-tech start-ups through policies, such as the development of technology parks, incubators, and start-up accelerators. However, to improve the country's position in the global value chain, a sharp increase in the number of innovative

enterprises is imperative. An innovative enterprise doesn't necessarily need to be exclusively a start-up within high-tech industries, such IT, biotechnology, and nanotechnology. Traditional SOEs and SMEs can also be transformed to innovative enterprises. Support programs should focus more on enhancing technology absorption and innovation, especially in large enterprises and in traditionally "resource-based" and "labor-intensive" industries, such as coffee production, fishery, and textiles - the main export-producing sectors in Vietnam.

Prioritize the Development of Policy Instruments and Streamlined Implementation Mechanisms

Like many developing countries, the government of Vietnam spends a lot of time and financial resources discussing many new laws and planning policies. However, strategies for linking policies in the policy implementation phase, new policy tools, and coordinated policy enforcement mechanisms are still lacking. According to the innovation survey, the lack of government support is one of the three biggest barriers for businesses to innovate. For Vietnam today, the main policy tools are the development of S&T infrastructure, regulations, training in operational skills, and industry standards. The National Technological Innovation Program now provides matching grants of up to 30% to established SMEs, but its implementation is sluggish and the procedures are cumbersome. The number of enterprises receiving subsidies from the fund is quite small. Vietnam should consider adopting policy tools, such as financial support, appropriate subsidies for advanced technical development, product design, product/process/marketing innovation, and R&D, similar to models implemented in ROK, Republic of China, and Singapore.

Strengthening the policy implementation capacity of government agencies should be a high priority both at the central and local levels. Agencies at the local level play a pivotal role in policy implementation in Vietnam. More budget allocation to local agencies to build capacity, recruiting more qualified personnel, improving performance-based reward mechanisms, and streamlining outdated work processes are essential steps to improve policy implementation efficiency.

Enhance the Spillover Effect of FDI Enterprises

Every year, Vietnam attracts a large amount of FDI. The innovation survey confirms that the majority of total spending on R&D and innovation comes from FDI enterprises (transnational corporations). Samsung, for example, has set up three R&D centers in Vietnam. Overall, however, the transfer of knowledge, technology, and spillover effects from these foreign firms to SOEs and local SMEs is limited.

Vietnam must intensify efforts to develop policies that encourage technology transfer and increase spillover effects. Investment promotion policies should not only focus on attracting new investment and creating jobs, but should also encourage foreign enterprises to expand their operations, with greater emphasis on value-creating activities that go beyond conventional assembly and outsourcing activities. This approach empowers local businesses, including both SOEs and private SMEs to benefit more from the productivity improvement and technology transfer effects of FDI. Therefore, there is a need for a connection between policies that promote investment and improve productivity, and innovation policies. An example is the Singapore Local Industrial Upgrading Program (LIUP), wherein the government subsidizes the wage difference for engineers and technicians from transnational corporations who work for two years in local SMEs to develop important skills and knowledge that contribute to their technological and innovation capabilities.

In addition, it is necessary to focus on programs to improve the "absorption capacity" of local businesses and improve the capacity to select, use, and upgrade external technologies through different support channels. This may encompass organizing training courses and consulting services (dedicated to government-subsidized technology) that are conducted by foreign and local industry, rather than solely relying on university professors.

According to the World Bank, since 1960, only 13 countries, or 10% of world economies, have escaped the low-middle-income trap and become high-income countries. Vietnam is facing a significant challenge over the next two decades to avoid falling into the "middle-income trap". Together with synchronous solutions, improving productivity and innovation will be the way for Vietnam to maintain a high growth rate, overcome the low-middle-income period, and progress toward becoming an upper-middle-income nation in the near future, ultimately becoming high-income status.

CHAPTER 11

POLICY INTERVENTIONS FOR REVAMPING THE INSTITUTIONAL INNOVATION ECOSYSTEMS IN SELECT APO MEMBER ECONOMIES

Recognizing the crucial role of productivity in advancing sustainable economic growth and development, all APO member economies have established institutional ecosystems that drive innovation and productivity in the economy. These ecosystems include a gamut of organizations, policies, and programs designed to promote education and skills training, investment in research and development (R&D), and support for entrepreneurship and innovation activities. They also emphasize partnerships and collaborations among the private sector, academia, and government to facilitate knowledge transfer. By creating an enabling ecosystem in the form of national innovation system (NIS), member economies are making efforts to attract investment, create jobs, and enhance their competitiveness in the global marketplace.

However, success stories in establishing robust NIS models are currently limited to a handful of APO member economies. Economies like Japan, Republic of Korea (ROK), Republic of China (ROC), and Singapore, have made significant progress in developing their NIS by investing heavily in R&D, creating supportive regulatory environments, and fostering collaborations between industry, academia, and government. However, other member economies have struggled to develop effective NIS due to variety of reasons. As a result, there is a significant innovation gap within APO member economies, with some members leading the way in innovation and productivity while others lag behind.

This report offers a comprehensive overview of the institutional ecosystems of a subset of APO member economies, including India, Pakistan, Cambodia, Fiji, the Philippines, Mongolia, Indonesia, Turkiye, and Vietnam. It thoroughly examines the commonalities and issues faced by these member economies. The report also proposes policy interventions that could help these economies in addressing a number of issues, such as low R&D funding, poor infrastructure, nascent innovation culture, insufficient intellectual property protections, and insufficient human capital development. It has been noted that all the selected APO member economies have adopted the triple helix model as a means of promoting innovation and setting up the institutional ecosystem for driving the productivity gains. The triple helix model is a framework that describes the interactions and relationships between government, industry, and academia in promoting innovation and economic development. The model suggests that these three entities should work closely together to promote knowledge-based economic growth and development.

Interestingly, the selected APO member economies face several challenges in building robust institutional ecosystem for innovation and productivity. Some of the major challenges include limited resources to invest in R&D, weak intellectual property rights (IPR), a shortage of skilled workers for R&D,

limited collaboration between industry, academia, and government, inadequate physical infrastructure, weak legal and regulatory frameworks, and a shortage of educational institutions specializing in science and technology (S&T) education. Addressing these challenges requires a multifaceted approach, including investments in education and training, improvements in infrastructure, strengthening of IPR, and fostering collaboration between industry, academia, and government. Governments and other stakeholders in these economies must work together to create a supportive environment conducive to the flourishing of innovation and entrepreneurship.

The selected member economies recognize the necessity of boosting spendings in R&D to strengthen the institutional ecosystem. They are actively pursuing this objective by offering tax incentives, including tax credits or deductions for R&D expenditures, and providing grants, subsidies, and other forms of financial support for R&D activities. Moreover, they incentivize collaborations, establish public-private partnerships, and fund research consortia. They also provide funding for science and engineering education, vocational training programs, and programs that promote entrepreneurship and innovation. But the limited availability of resources seems to be the primary barrier in addressing the growing needs of the innovation ecosystem. Streamlining R&D regulations is a measure that all governments can adopt to reduce barriers to innovation. This can be done by simplifying the patent system, reducing bureaucratic red tape, and providing fast-track approval processes for new innovative products and services.

A strong institutional ecosystem is deemed essential for each of the selected APO member economies to drive productivity. The underlined ecosystem is made up of several institutions and policies that work together to create an environment that supports economic growth, job creation, and increased productivity. The success of this ecosystem depends on collaboration and coordination between many different actors, including government agencies, industry associations, labor unions, universities and research institutes, and civil society organizations. By working together, these actors can encourage innovation, investment, and entrepreneurship, which will help make the economy more productive and prosperous.

There is no one-size-fits-all set of policy interventions that can revamp the institutional system for innovation and productivity in selected APO member economies. However, a comprehensive approach that addresses multiple factors can prove effective. In this regard, reformulating the national innovation strategy with a clear vision for achieving medium- and long-term goals emerges as a crucial policy intervention to promote innovation, enhance productivity, and improve economic growth rates. This policy intervention requires a comprehensive review of the current strategy, evaluating its effectiveness in achieving its intended goals, alignment with the country's overall development goals, and the adequacy of the resources allocated to support innovation. Based on this comprehensive review, the reformulated strategy should clearly articulate specific, measurable, achievable, relevant, and time-bound (SMART) goals and objectives. They should also be aligned with the country's overall economic and social development objectives.

Furthermore, the strategy should identify key priority areas where the member economy has a competitive advantage or significant opportunities for innovation. These priority areas could be based on the country's natural resources, human capital, infrastructure, or existing strengths in specific industries or technologies. To usher an era for innovation and productivity growth, the new strategy should focus on creating an enabling environment for innovation, which includes policies and regulations that support R&D, entrepreneurship, and innovation. This may include incentives for private-sector investment in R&D, support for start-ups and small and medium enterprises (SMEs), and measures to protect IPR. In addition, efforts are needed to promote partnerships and collaborations between the private sector, academia, and government to foster innovation and promote knowledge transfer. This could include establishing innovation clusters, technology parks or incubators, and supporting collaborative research projects. Above all, the strategy should be dynamic in nature and incorporates a

robust monitoring and evaluation framework to measure progress toward achieving the defined goals and objectives. This could involve tracking key performance indicators (KPI), conducting surveys and evaluations, and making adjustments to the strategy as needed.

In addition to enhancing a supportive ecosystem through reformulating the existing NIS, there is a critical need to promote a culture of innovation. Policy measures that promote the use of technology and digitalization can be beneficial in increasing productivity gains. This can involve making infrastructure investments in digital platforms and high-speed internet as well as supporting the use of digital tools and technologies.

Greater collaboration and knowledge sharing via joint-research initiatives, exchange programs, and regional innovation networks can all play important roles in addressing the observed innovation disparities among APO member economies.

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ABBREVIATIONS AND ACRONYMS

AAP	Affirmative Action Programs
ADB	Asian Development Bank
AEPM	Asian Economic Productivity Map
AI	Artificial intelligence
AIIMs	All India Institutes of Medical Sciences
APBN	National Budget
APO	Asian Productivity Organization
ATMP	Assembly, Testing, Marking, and Packaging
BAF	Business Assistance Fiji
BATAN	National Nuclear Energy Agency of Indonesia
BI	Bank Indonesia
BIC	Business incubation centers
BPPT	Assessment and Application of Technology Research Organization
BPS	Central Statistics Agency
BRICS	Brazil, Russia, India, PR China, and South Africa
BRIN	National Research and Innovation Agency
BSOs	Business support organizations
BTYK	Supreme Council of Science and Technology
CAGR	Compound annual growth rate
CMIE	Centre for Monitoring Indian Economy
CMSC	Commision for the Management of State Capital at Enterprises
CoE	Centers of excellence
COSTI	Committee on Science, Technology and Innovation
CPI	Consumer price index
DiGiSkills	Digital Skills
DOST	Department of Science and Technology (Philippines)
DST	Department of Science and Technology (India)
DVET	Directorate of Vocational Education and Training
FBoS	Fiji Bureau of Statistics
FDB	Fiji Development Bank
FDI	Foreign direct investment
FJD	Fijian dollar (currency)
FNU	Fiji National University
FYPs	Final year projects
GDP	Gross domestic product
GERD	Gross domestic expenditure on R&D
GII	Global Innovation Index
GPT	General-purpose technologies
GRIs	Government research institutes
GTCI	Global Talent Competitiveness Index
HEC	Higher Education Commission

HEIs	Higher education institutions
ICOR	Incremental Capital Output Ratio
ICT	Information and communication technologies
IDR	Indonesian rupiah (currency)
IIT	Institute/s of Technology
ILO	International Labour Organization
IMF	International Monetary Fund
INR	Indian rupee (currency)
IoT	Internet of Things
IP	Intellectual property
IPO	Intellectual Property Organisation
IPR	Intellectual property rights
IR4.0	Fourth Industrial Revolution
I.R. Iran	Islamic Republic of Iran
IT	Information technology
KOSGEB	Small and Medium Enterprises Development Organization of Turkiye
LAPAN	National Institute of Aeronautics and Space
LIPI	Indonesian Institute of Sciences
LPDP	Education Fund Management Institution
M&E	Monitoring and Evaluation
MEPIR	Ministry of Employment, Productivity, and Industrial Relations
MFP	Multifactor productivity
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Scheme
MNC	Multinational corporation
MNEs	Multinational enterprises
MNT	Mongolian tugrik (currency)
MoE	Ministry of Education
MOET	Ministry of Education and Training
MOLISA	Ministry of Labor, Invalids and Social Affairs
MOST	Ministry of Science and Technology
MoTT	Ministry of Information Technology and Telecommunication
MSMEs	Micro, small, and medium enterprises
NCSMED	National Centre for Small and Micro Enterprise Development
NCSTI	National Council of Science, Technology & Innovation
NGO	Nongovernmental organization
NI	National innovation system
NIC	National Incubation Center
NICK	National Incubation Center Karachi
NIP	National Innovation and Productivity
NIS	National innovation system
NITP	National Information Technology Park
NPC	National Productivity Charter
NPMP	National Productivity Master Plan
NPR	National Productivity Report
NRPU	National Research Program for Universities
NSDB	National Science and Development Board
NSO	National Statistics Office

NTPC	National Training and Productivity Centre
OECD	Organization for Economic Cooperation and Development
OIZ	Organized Industrial Zone
ORIC	Office of Research, Innovation and Commercialization
P&D	Product development
PBAIRP	Problem Based Applied Interdisciplinary Research Programme
PCIEERD	Philippine Council for Industry, Energy, and Emerging Technologies Research and Development
PHP	Philippines peso (currency)
PI	Principal Investigator
PICs	Pacific Island Countries
PKR	Pakistani rupee (currency)
PLI	Production-linked incentive
PPP	Public-private partnership
PPP	Purchasing power parity
PSA ASPBI	Philippine Statistics Authority's Annual Survey of Philippine Business and Industry
PSA CPBI	Philippine Statistics Authority's Comprehensive Survey of Philippine Business and Industry
QALI	Quality-adjusted labor input
R&D	Research and development
RBF	Reserve Bank of Fiji
RBI	Reserve Bank of India
ROK	Republic of Korea
S&T	Science and technology
SCIC	State Capital Investment Corporation
SEGs	State Economic Groups
SMEs	Small and medium enterprises
SOEs	State-owned enterprises
STEM	Science, technology, engineering, and mathematics
STI	Science, technology, and innovation
STP	Science and Technology Policy
TBI	Technology Business Incubator
TDB	Technology Development Board
TEYDEB	Technology and Innovation Support Programs Presidency
TFP	Total factor productivity
TGB	Technology Development Zones
TICs	Technology and innovation support centers
TIE	Top innovation economies
TRY	Turkish lira (currency)
TTGV	Technology Development Foundation of Turkey
TTOs	Technology Transfer Offices
TUBITAK	Scientific and Technical Research Council of Turkiye
TURKSTAT	Turkish Statistical Institute
TVET	Technical and vocational education and training
UAE	United Arab Emirates
UITSP	University Industry Technology Support Program
UNDP	United Nations Development Programme

USPCASS	United States-Pakistan Centers of Advance Studies
VND	Vietnamese dong (currency)
WEF	World Economic Forum
WIPO	World Intellectual Property Organization
WTO	World Trade Organization
YOK	Council of Higher Education
YoY	Year-on-year
ZED	Zero Defect Zero Effect

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