Economic Outlook for 2023 and the Medium-Term

[Growth and Finance]

NATIONAL ASSEMBLY BUDGET OFFICE

국회예산정책처
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The Economic Outlook for 2023 and the Medium Term II

– Growth and Finance –

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“Economic Outlook for 2023 and the Medium Term” belongs to a series of reports that present the economic outlook concerning the GDP growth rate and other important areas of the national economy over the next five years, based on objective and expert analysis of the economic conditions in South Korea and abroad. This report is published and distributed for use by the National Assembly when reviewing government budget proposals and bills and when setting items of agenda.

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- Growth and Finance -

2022

국회예산정책처
National Assembly Budget Office

This report has been produced in accordance with Article 22-2 of the National Assembly Act and Article 3 of the Act on the National Assembly Budget Office to support the activities of the members of the National Assembly. It was published after a review by NABO's Report Publication Review Committee (September 27, 2022).

Foreword

At the time of writing this report in 2022, the South Korean economy was overloaded with difficulties due to increased uncertainties in the domestic scene as well as overseas due to the ongoing Russia-Ukraine war, the increasing strength of the dollar due to the US raising its base interest rate, and worsening inflation. In particular, the hike in the US's base interest rate may lead to capital outflows if the interest rates of South Korea and the US become reversed, while increases in the exchange rate may also lead to higher import prices. Against this backdrop, NABO has published the four-volume report titled "The Economic Outlook for 2023 and the Medium Term". Based on an objective and expert analysis of the economic conditions in South Korea and abroad, the report provides forecasts of the South Korean economy for the next five-year period. The report is intended to be used as a reference material by the members of the National Assembly when they conduct legislative activities related to budget bills and legislative reviews among other matters.

For this year's forecasts, NABO has expanded the scope of its projections in order to analyze from a new angle the factors that affect the economy, such as the potential for growth, changes in the industrial structure, income distribution, and demographic changes, in addition to the past approach of focusing on expenditures. Thus, Volume 1, Expenditures, contains projections of GDP, consumption, investment, and expenditure items like foreign trade and consumer prices; Volume 2, Growth and Finance, contains projections of potential growth rates, total factor productivity, interest rates, and greenhouse gas emissions; Volume 3, Production, contains projections of value-added production in key industries like manufacturing and services; and Volume 4, Income and Population/Employment, contains projections for the income variable and the population/employment variable, such as gross national income, employee remuneration, and operating surplus.

If our economy is examined from the perspectives of growth and finance, the growth rate is showing a declining trend after a period of high growth, and the potential growth rate is also declining. On the other hand, the interest rate is predicted to exhibit a different behavior from the low interest trends of the past - primarily due to the high inflation rates and tight monetary policies of key countries. What we need now are policy measures that will secure growth engines for our economy while reducing the negative impacts that instabilities in the financial markets could have on our economy. Indeed, it is high time we took measures to secure growth engines for our economy and reduce the negative impact of financial market instability on the economy.

At a time when uncertainties are growing in domestic and overseas economies, we hope that this report will serve as a useful reference material when the members of the National Assembly have to make important legislative decisions.

October, 2022

Chief of NABO　Cho Euysup

[NABO's Outlook for Growth and Finance in 2023 and the Medium Term]

(Units: %, KRW/$)

		2021	2022	2023	2024	2025	2026
Growth	Potential growth rate	2.4	2.1	2.2	2.3	2.2	2.3
	Total Factor Productivity (Average of all industries)	0.8	4.4	0.2	-	-	-
	Level of GHG emission	3.5	0.4	-1.8	-	-	-
Finance	Treasury bonds (3 years) interest rate	1.4	3.0	3.0	2.8	2.6	2.6
	Corporate bonds (3 years, AA-) interest rate	2.1	3.8	3.5	3.0	2.9	2.8

Source: NABO, Bank of Korea.

Summary

I. Economic Growth

- ❑ Economic growth is the phenomenon whereby a country's gross domestic product tends to increase over a long period of time.
  - As of 2021, South Korea's real GDP was KRW 1,916 trillion, representing a 65-fold increase since 1960, when it was just KRW 29 trillion.
    - However, the economic growth rate, which measures the speed of increase of GDP over time, entered a declining trend in the 2000s, recording a an average annual growth rate of 4.1% during the period 2000-2010.
  - As regards potential GPD and potential growth rate, they represent the level of production and the growth rate that an economy could achieve if available technological conditions and production factors were utilized continuously.
    - South Korea's potential growth rate fell from an average of 5.5% during the period 2001-2005 to around 2.6% during the years 2016-2020.

- ❑ The factors that determine economic growth are increases in the level of input factors such as labor/capital and increases in productivity.
  - In traditional growth accounting analyses, the 'production function approach' is used to break down growth into a part that is achieved through changes in input factors and a part that is achieved through total factor productivity, which is the residual part.
    - With this approach, it is possible to measure the contributions of the production factors inputted and estimate the potential GDP.
  - However, in order to break down total factor productivity into technological efficiency, advancements in technology, and the effects of scale and examine them separately, the 'stochastic frontier analysis' must be utilized.
    - If the technological combination of labor and capital or changes in the input ratio affect the level of production by improving productivity, they also have a structural impact on economic growth.
    - Therefore, to study the factors that determine economic growth in more detail, the total factor productivity must be decomposed and examined using the stochastic frontier analysis.

- A reduction in the growth rate of GHG emission can also impact economic growth.
  - If low-carbon technology is used in the supply, use and consumption of energy to reduce the growth rate of GHG emission, a ripple effect is created throughout the economy, such as alternative investments that take place during the process. Hence, a reduction in the growth rate of GHG emission can affect economic growth.
- Finance can also affect economic growth.
  - Financial markets can affect capital formation and economic growth by changing the savings rate or redistributing savings. Financial markets can also affect economic growth by changing the pace of technological innovation.
  - Furthermore, finance can affect economic growth and raise productivity by using key factors that impact economic growth in the long run (for example physical capital, human capital, knowledge and technologies) as the medium.

II. The Outlook for Growth and Finance

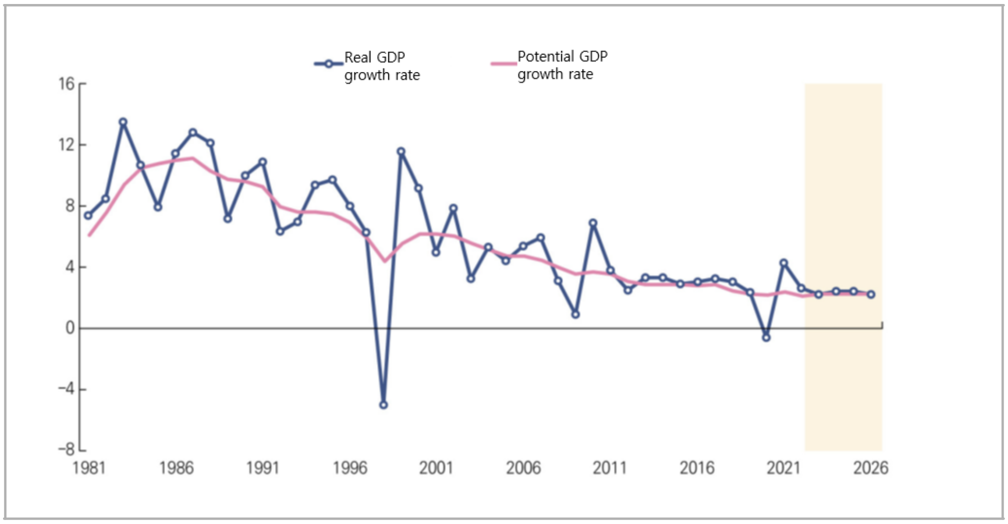
1. Potential growth rate

❑ During the five-year period 2022-2026, the potential growth rate of the South Korean economy is projected to be 2.2% on average each year.

- The potential growth rate of South Korea's economy as measured using the production function approach method is projected to be 2.2% (annual average), a 0.3%p drop from the 2.5% level of five years ago.
  - The contribution to potential growth by total factor productivity is on a clear declining trend, while the contribution of labor is on a rising trend.
  - Contributions of each input factor (annual average, %p): 0.3 for labor, 1.1 for capital, 0.8 for total factor productivity.
  - The declining trend of the potential growth rate that started in the early 2000s is expected to persist for the next five years.
- In the post COVID-19 era, labor's contribution to potential growth is expected to start increasing again thanks to increased participation in economic activities, a falling unemployment rate, and a slowed decline in the amount of working hours per week.
- Capital's contribution to potential growth expected to fall by an average annual rate of 0.3%p from the 1.45%p level recorded in the previous five-year period due to slowed increase rate of total fixed capital investments (mostly from facility investments).
- The contribution to potential growth by total factor productivity will increase at an average annual rate of 0.8%, which is 0.7% lower than the 1.5% recorded in the previous five-year period.

[Real GDP growth rate and potential GDP growth rate]

(Units: %)



Source: NABO’s projections made using data released by the Bank of Korea.

❑ Real GDP gap, which shows the state of the economy, will maintain a negative value in 2023 and afterwards.

- The real GDP gap is defined as the gap (%) between real GDP and estimated potential GDP. If the real GDP gap is positive, it means that there is upward inflationary pressure arising from an excess of aggregate demand. If, however, the real GDP gap is negative, it means that there is downward inflationary pressure arising from a deficiency of aggregate demand.
- The real GDP gap will reach zero in 2022 as real GDP approaches potential GDP in value, but it is anticipated to become slightly negative in 2023.
- Afterward, during the period 2024-2026, real GDP gap will maintain a small negative gap.
  - When compared to the previous five-year period, the negative margin will be reduced.

[Real GDP gap]

(Units: %)

Source: NABO's own projection.

2. The outlook for total factor productivity by industry/factor

❑ Total Factor Productivity is a valuable index for evaluating the efficiency of production and innovation.

- Labor productivity, which is a single factor of productivity, only represents the efficiency of labor and hence is somewhat limited in representing the technological combination of labor and capital and its efficiency.
- Total factor productivity is viewed as an index that represents the technological efficiency, technological innovation, and growth potential of an economy.

❑ The total factor productivity of services is expected to be lower when compared to that of manufacturing.

- In 2023, the total factor productivity is projected to be 0.628 for the services industry and 0.967 for the manufacturing industry.
- Despite the total productivity of services being relatively lower than for manufacturing, more labor required and there is less infusion of capital in services. For this reason, it could be said that the total factor productivity is low.

❑ The difference in labor productivity between the services industry and the manufacturing industry will create a gap in total factor productivity.

- If the labor input in sectors with low productivity levels is decreased and the capital input is increased, the total factor productivity could be enhanced. In reality, however, there was more labor input and less capital input (investments) in services than in manufacturing, relatively speaking.

- During the period 2021-2023, labor productivity in manufacturing increased by 5.3p from 120.5 to 125.8; however, the labor productivity in services increased by 0.9p from 107.6 to 108.5.

- 2023 will be another year in which increased labor input will be disproportionately concentrated in the services sector. However, capital input (investments) in services will be relatively small.
- If the current trends in labor input and capital input are maintained throughout 2022-2023, the increase rate of labor productivity in the service industries will slow down.

❑ The gap in total factor productivity between service and manufacturing is predicted to narrow.

- The increase rate of the TFP of the services industry is predicted to rise higher than that of manufacturing or the average of all industries.
  - In 2023, the average increase rate of the TFP for all industries is projected to be 0.15%, while for manufacturing industry it is projected to be 0.08%, and for services 0.85%.

3. The outlook for the growth rate of GHG emission

❑ In 2023, the GHG emission of South Korea is predicted to decline by 1.8% from the previous year's level.

- Such a decline will largely be due to the effects of the government's policies to increase the share of low carbon energy sources (nuclear, renewables, etc.), coupled with better management of energy demand and improved energy efficiency.
- The government has announced its 2030 reduction target at 40% (291.1 million tons) compared to the 2018 peak (727.6 million tons) and suggested a linear reduction route of -4.1% per year for 12 years (2019-2030).

4. The outlook for the finances of South Korea

❑ The treasury bond (3-year) yield rate in 2023 is projected to remain at the same level as in 2022 (3.0%).

- The treasury bond (3-year) yield rate is expected to head in a downward direction after peaking in the 1st half of 2023 due to the tight monetary policies pursued by the central banks of major countries, including the US Federal Reserve.
  - The likelihood of an economic downturn in 2023, adjustment pressure due to a steep rise in market interest rates, and a lessening of uncertainties surrounding the monetary policies of key countries are factors that will limit the upward pressure on the yield rate.
- During the period 2022-2026, the treasury bond (3 year) yield rate is projected to be 2.8% per year on average.
  - In the medium-term, the treasury bond (3-year) yield rate is anticipated to decline due to the effects of the falling economic growth rate and changes in the monetary policy of key countries.
  - After 2023, the treasury bond(3 year) yield rate is expected to display an overall declining trend. However, due to quantitative reduction steps taken by the US Federal Reserve, the margin of decline will likely be limited.
- The corporate bond (3-year, AA-) yield rate in 2023 is projected to be 3.5%, a decline from the previous year's level.
  - This is mainly attributable to lower demand for funding, which is a consequence of the economic downturn and the uncertainties surrounding the monetary policy adopted by the central banks of key countries.
  - During the period 2022-2026, the corporate bond(3-year, AA-) yield rate is projected to be 3.2% per year on average. After 2023, this figure is expected to decline due to the slowdown in economic growth.

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대한민국 국회

국회예산정책처

Part I

Economic Growth

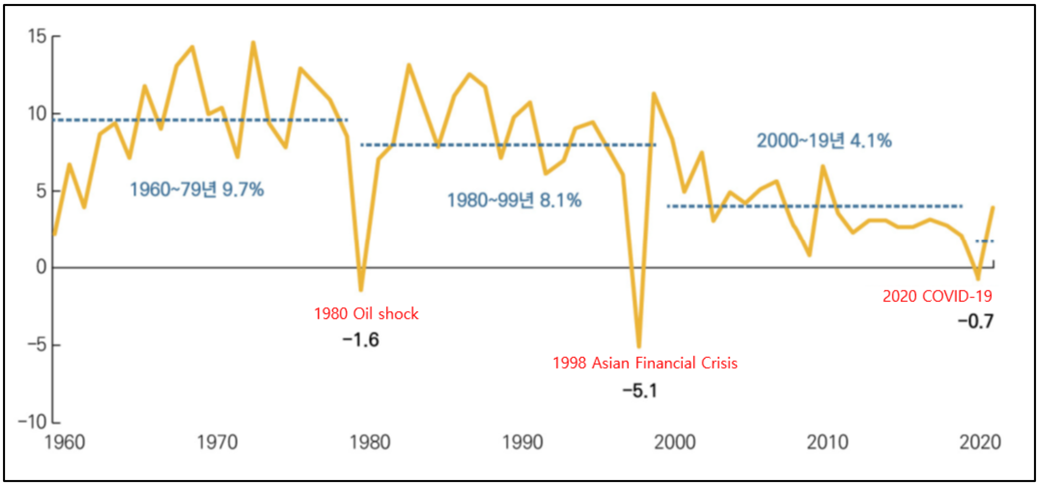
National Assembly Budget Office

Part I Economic Growth

Economic growth is the phenomenon whereby a country's gross domestic product tends to increase over a long period of time. The economic growth rate, which measures the speed of growth, is estimated with the increase rate of real GDP, which is defined as the amount of increase of the total level of production during a one-year period. As of 2021, South Korea's real GDP was KRW 1,916 trillion, representing a 65-fold increase since 1960, when it was KRW 29 trillion. However, the economic growth rate (the speed of growth) entered a declining trend in the 2000s. A closer examination shows that in the 1960s and '70s, South Korea's economy grew at an average annual rate of 9.7%, while its growth rate fell to 4.1% during the period 2000-2010.[1)]

[Figure I-1] Real GDP growth rate

(Units: %)



Source: Bank of Korea ECOS

Potential GDP and potential growth rate are defined as the level of production and the growth rate that could be reached that an economy could achieve if available technological conditions and production factors were utilized in a sustained manner. In the past, potential GDP was defined as the maximum level of production that could be reached with the production factors available for use or the level of production with full employment (Okun, 1962). However, recently, it has been defined as the sustainable production level that could be reached in the long run without producing negative effects such as inflation.

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1) However, a declining economic growth rate could be viewed as a natural part of economic development when a country transitions to an advanced economy.

Potential GDP provides a benchmark (through estimation of the GDP gap, which is the difference between real GDP and potential GDP) for evaluating the degree of economic fluctuations and demand side pressures on the inflation that occurs in the short term. And, in the long term, potential GDP could serve as a benchmark for evaluating the growth potential of the economy. This is because real GDP can be decomposed into input factors like labor, capital, and total factor productivity; and each factor's contribution to potential growth can be analyzed and utilized when setting policies related to growth potential. South Korea's potential growth rate has been on a continuous decline for some time now, falling from 5.5% during the period 2001-2005 to 4.1% during the period 2006-2010, 3.1% in 2011-2015 period, and 2.6% in 2016-2020.

[Table I-1] Potential growth rate and contribution to potential growth by input factor

(Units: average for the period, %, %p)

Period	Potential Real GDP Growth rate	Contribution to potential growth by input factors		
		Labor	Capital	Total Factor Productivity
2001-2005	5.5	0.3	2.3	2.9
2006-2010	4.1	-0.2	1.9	2.4
2011-2015	3.1	0.4	1.4	1.2
2016-2020	2.6	-0.5	1.5	1.5

Source: NABO.

Recently, external uncertainties have been rising due to global inflation, the tightened monetary policy of the US Federal Reserve, and the prolonged war in Ukraine. These developments have affected the South Korean economy in the form of greater downside risks for growth, including spiking interest rates and foreign currency exchange rates. Furthermore, the shock caused by the COVID-19 pandemic and the ensuing drop in participation in economic activities, and interruptions in the global supply chain have acted as factors that bring down the potential GDP by decreasing the levels of labor and capital input and the total factor productivity.

Therefore, the nation's economic and financial conditions must be reviewed from the perspective of growth and the direction must be examined. To this end, an estimation of the potential growth rate of South Korea's economy is made first of all by using the traditional production function approach method. This is followed by a stochastic frontier analysis to project the total factor productivity for each industry, after which the projected levels are decomposed into technology advancement, technological efficiency and scale effects, and the implications are derived. Next, to investigate the areas of finance that affect economic growth, first the conditions in the domestic and overseas financial world must be studied and then projections must be made about interest rates.

Chapter 1 Factors that Determine Economic Growth

An increase in economic growth can generally be divided into a part attributable to increased levels of input factors, such as labor and capital, and a part attributable to increased productivity. In traditional growth accounting analyses, growth is decomposed (using the production function approach method) into a part due to changes in the amounts of the production factors (labor, capital, etc.) inputted and into a part due to total factor productivity[1], an effect that cannot be explained by the input of production factors like technology innovation, human capital, and efficiency of investments. Measuring and forecasting the relative contributions to growth by production factor inputs and total factor productivity are essential for generating a more refined estimation of economic growth. By using this approach, it is possible to estimate the potential GDP that a country's economy can achieve if production factors are inputted at sustainable levels.

In this way, if labor, capital and total factor productivity are the factors that determine economic growth, then with the production function approach method, the increase rate of total factor productivity is defined as the remaining portion (residual) after subtracting the weighted average of the increase rates of the input factors from the increase rate of the total production output, under the assumption that the production function takes the form of the Cobb-Douglas function[2] and that there is perfect competition and constant return to scale. However, the production function approach method does not take the flow of time into consideration. Therefore, estimation using the production function approach method is not capable of showing the changes in total factor productivity by decomposing it into the productivity (technological efficiency) that could be attained by technically combining labor and capital, the technological progress that would allow an economy to achieve - with the passage of time - even greater production levels with the same levels of labor and capital input as before, and the scale effect.

However, if improved productivity (achieved by technically combining labor and capital or adjusting the input proportions) can affect the production level, it can also have a structural impact on economic growth. Therefore, in order to analyze the factors that determine the growth of the economy more closely, it is necessary to decompose total factor productivity into technological efficiency, technological progress, and the scale effect.

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1) Total Factor Productivity is also called Solow's residual.

2) The Cobb-Douglas function is a linear production function that represents the relationship between production function input levels and production output levels. If each production factor is increased at the same rate simultaneously, the output level also increases at the same rate.

Meanwhile, efforts made to fight climate change can limit the maximum production level that an economy can reach. In other words, the transformation of an economy to a low-carbon economic structure for the purpose of fighting climate change requires the adoption of low-carbon technology in the supply, use and consumption of energy so as to reduce the greenhouse gas emission rate[3)]. This process turns existing assets into stranded assets[4)], and substitute investments are made, entailing other repercussions for the entire economy. Therefore, efforts to reduce greenhouse gas emission rates can also affect economic growth.

This report examines the outlook for the potential growth rate and total factor productivity, the two factors that determine economic growth, and also the greenhouse gas emission rate, which is a factor that affects economic growth.

First, in the chapter dedicated to the outlook for the potential growth rate, the report provides projections on total labor input, which is a production factor, production capital stock and total factor productivity increase rates. The report also provides projections of the potential growth rate and estimations of each input factor's contribution to potential growth. Next, in the chapter on the outlook for total factor productivity for 2023, the form of production function is changed to a translog production function, and projections of total output, total labor input and total capital levels are made for each industry using the stochastic frontier analysis. Projections are also made about total factor productivity by decomposing it into technological efficiency, technological advancements, and scale effect. Lastly, in the chapter dedicated to the outlook for the greenhouse gas emission rate in 2023, the report presents the estimates of the greenhouse gas emission rate that it produced by adopting a regression analysis of GDP per capita and the greenhouse gas emission rate.

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3) The greenhouse gas emission rate is the total amount of emissions of six greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbon, perfluorocarbon, and sulfur hexafluoride) that produce the greenhouse gas effect. The emission rate of each gas is converted to the equivalent carbon dioxide emission rate and is then added to the aggregate of the six gases.

4) Stranded assets are assets that depreciate or turn into a liability due to the changing environment, such as climate change. Assets that fall into this category include fossil fuel-based oil refining, petrochemicals, shipbuilding and automobiles, as well as other industries like the steel, cement and plastic industries that generate large amounts of greenhouse gases. Reserves of resources or facilities owned by these industries will decline in value and hence are called stranded assets. The International Energy Agency (IEA) defines a stranded asset as "an asset for which an investment has already been made, but which no longer yields a return before the end of its life".

Chapter 2 Economic Growth and Finance

The endogenous growth theory explains how an economy can grow continuously through labor, capital and technological advances (innovations). The theory of endogenous growth could be integrated with the functions of finance that cushions the frictions in the market and improves efficiency in the distribution of resources. With such integration, the theoretical link between economic growth and the financial market can be solidified. There are two functions of the financial market that affect economic growth: the accumulation of capital, and technological advancement. From the accumulation of capital aspect, financial markets can influence the formation and growth of capital by changing the savings rate in the financial market or by redistributing savings[1]. From the technological advancement aspect, financial markets can influence economic growth by changing the pace of technological innovation [2]. In addition, there are other important factors like physical capital, human capital, knowledge, technology, entrepreneurial mentality, political environment and population structure that influence economic growth, and finance can increase productivity and affect growth by using these factors as agents.3)

The process by which finance gets linked to economic growth through the path of capital accounts (investment, etc.) can be explained in the following way. Savings (surplus), which constitute a portion of the income generated by actual production activities, are linked to investment through finance (banks). In addition, finance contributes to economic growth by providing investment opportunities to those with surplus funds and through the efficient allocation of resources (i.e. by providing funds to places where they are needed). The figure below illustrates how finance links up with savings and investment to contribute to the growth of the economy and the accumulation of total capital.

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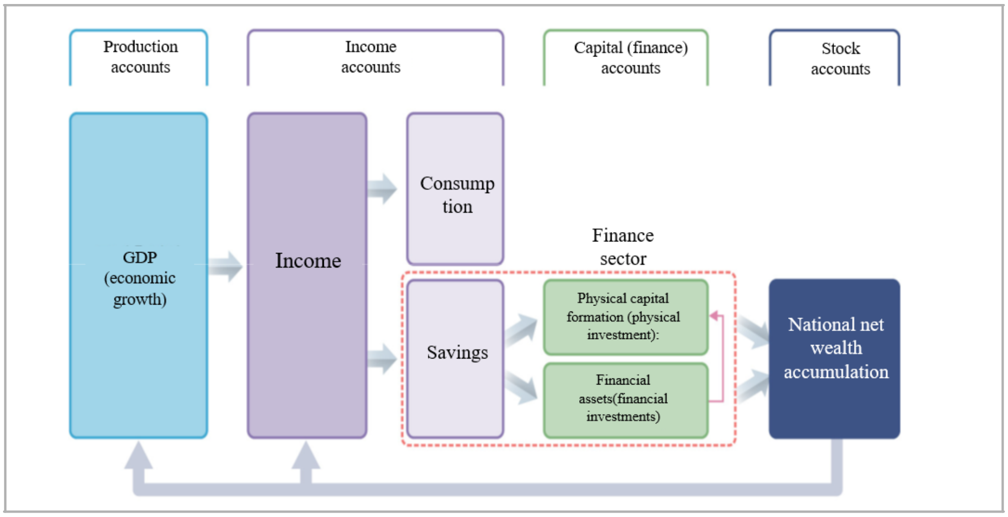
1) Romer, Increasing Returns and Long-Run Growth, 1986, Lucas, On the mechanics of economic development, 1988.

2) Romer, Endogenous technological change, 1990.

3) King and Levine, Financial intermediation and economic development, 1993.

[Figure I-2] Economic growth and finance



Source: Created by NABO using data released by the Bank of Korea.

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Part II

The Outlook for Growth and Finance

National Assembly Budget Office

Part II The Outlook for Growth and Finance

Chapter 1 The Outlook for the Potential Growth Rate

Section 1 Projection of each input factor's contribution to growth (based on the use of growth accounting)

- During the five-year period 2022-2026, when compared to the input factors' contributions from the previous five-year period, the contribution of labor increased while those of capital and total factor productivity decreased.

(Annual average, %, %p)

	2022	2023	2024	2025	2026	'17~'21	'22~'26
Economic growth rate	2.5	2.1	2.3	2.3	2.1	2.3	2.3
- Labor	2.3	-0.3	0.1	0.2	0.2	-0.8	0.5
- Capital	1.1	1.1	1.1	1.2	1.2	1.4	1.1
- Total Factor Productivity	-0.9	1.3	1.0	0.9	0.7	1.7	0.6

In this section, the contribution of each input factor to economic growth was estimated and projected using growth accounting analysis. In traditional growth accounting analysis, growth is decomposed (using the production function approach method) into a part due to changes in the amount of production factors (labor, capital, etc.) inputted and into a part due to total factor productivity. This latter part, also called Solow's residual, is a growth component that cannot be explained by the inputting of simple labor and capital, such as technology innovation, human capital, investment efficiency, and governmental efficiency. In this section, the growth factors were analyzed using time series data from 1981 to 2021, and, with the estimated levels of production factors to be inputted in the future, the potential level and the potential growth rate of the economy were projected for each input factor until the year 2026.

For the next five-year period, the economic growth rate is projected to be 2.3% per year, which is the same as that recorded in the previous five-year period, but the contribution of each input factor will exhibit a different trend from the past.

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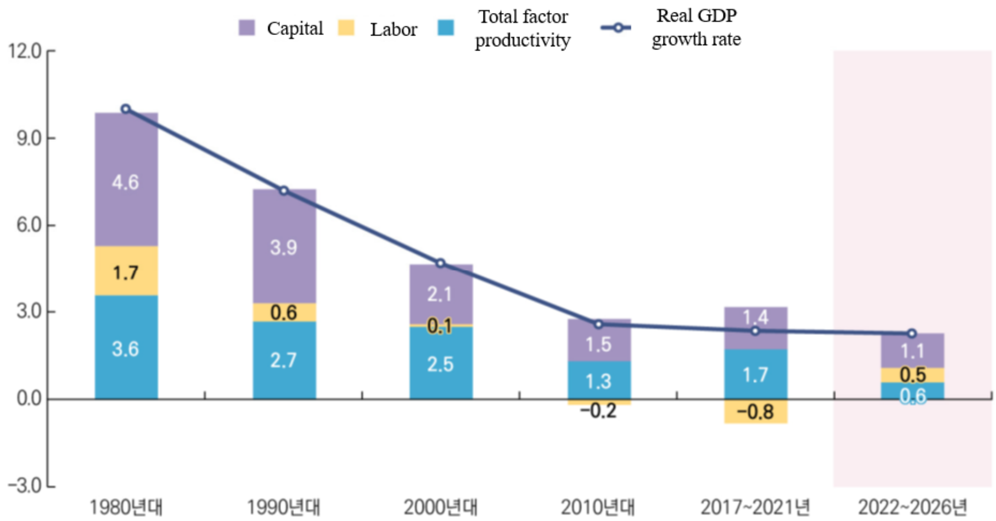
Labor's contribution to economic growth over the next five years is projected to average 0.5%p per year, a significant increase (1.3%p) from the -0.8%p recorded in the previous five-year period. Capital's contribution to economic growth for the next five years is projected to average 1.1%p per year, a slight decline (0.3%p) from the 1.4%p recorded in the previous five-year period. Meanwhile, the contribution to growth of total factor productivity is anticipated to decline from 1.7%p to 0.6%p.

[Figure II-1] Trend and projection of contribution to the real GDP growth rate by input factor

(Units: %, %p)



Source: Estimations by NABO using Bank of Korea's ECOS data.

The projected rise in labor's rate of contribution to economic growth over the next five-year period is attributable to the significant rise in the total labor input rate to an annual average of 0.9% compared with the -1.3% recorded five years ago. The total labor input rate is expected to increase because rising participation in economic activities and falling unemployment rates will lead to an increase in the number of employed, while a slowed reduction in the number of working hours per week is also expected to play a role.

Total labor input is measured by the total number of working hours and is determined by such factors as working age population, economic activity participation rate, unemployment rate, and average working hours per week. First, for the working population aged 15 and above, total labor input is predicted to increase at an annual average rate of 0.4% over the next five years, showing a significant slowdown from five years ago. If the figures are analyzed by period, then, during the period 2006-2010, the total labor input for this working population increased by 1.4% (annual average), whereas, during the previous five-year period, the total labor input did increase, but at the dramatically reduced rate of 0.7%.

The number of employed is projected to increase by 0.9% (annual average) despite the slowing increase rate of the working population because more elderly people and women are expected to participate in economic activities and because of falling unemployment rates. The increase rate of 0.9% is 0.3%p higher than the 0.6% increase rate recorded in the previous five-year period.

The slowing decline in working hours per week is also expected to contribute to an increase in total labor input. Due to the adoption of the 52-hour working week, working hours per week declined by 2.0% per year on average during the period 2017-2021. However, the number of working hours per week, which had shown a declining trend, started climbing again in 2022, but it is expected to decline moderately after 2023 until 2026.

[Table II-1] Trend and projection of total labor input

(Units: Compared to the previous year %, annual average)

Period	Increase rate of total labor input	Trend in determinant factors				
		Working age population	Number of employed	Participation in economic activities (%)	Unemployment rate (%)	Working hours per week
2001-2005	0.5	1.0	1.5	61.9	3.7	-1.0
2006-2010	-0.2	1.4	1.0	61.6	3.4	-1.3
2011-2015	1.1	1.2	1.7	62.0	3.4	-0.6
2016-2020	-1.6	0.7	0.6	63.0	3.8	-2.2
(previous) 2017-2021	-1.3	0.7	0.6	63.0	3.8	-2.0
(next) 2022-2026	0.9	0.4	0.9	64.2	3.5	0.0

Note: 1) Average for the period.
2) Working hours per week is based on the entire population of employed persons.
Source: Estimations made by NABO using data released by KOSTAT.

The drop in capital's contribution to growth is attributable mainly to stagnating growth in production capital stock, a result of slowing total fixed capital investments mainly in facility investments. Production capital stock is determined by total fixed investment and depreciation rates. [Table II-2] shows the trend and projection for each type of fixed capital investments (which determine production capital stock) and the input rates of production capital stock. The total fixed capital investment/GDP ratio was 29.9% in 2021, but it is expected to drop to 28.6% in 2022 and again to 28.5% in 2023 as growth in facility investments and construction investments decreases. After that, it will begin to increase moderately, rising to 29.8% by 2026.

[Table II-2] Trend and projection of capital input

(Units: Compared to the previous year %, annual average)

Period	Production capital stock	Fixed investment for each type of capital			
		Total fixed capital investment	Facility investments	Construction investments	Investments in knowledge property products
2001-2005	5.7	3.8	1.6	4.6	7.6
2006-2010	4.6	2.9	6.8	-0.1	6.2
2011-2015	3.6	2.5	2.6	1.7	4.8
2016-2020	3.7	3.1	3.5	2.5	4.3
(previous) 2017-2021	3.6	2.4	4.8	0.2	4.4
(next) 2022-2026	2.9	2.2	1.7	1.4	4.5

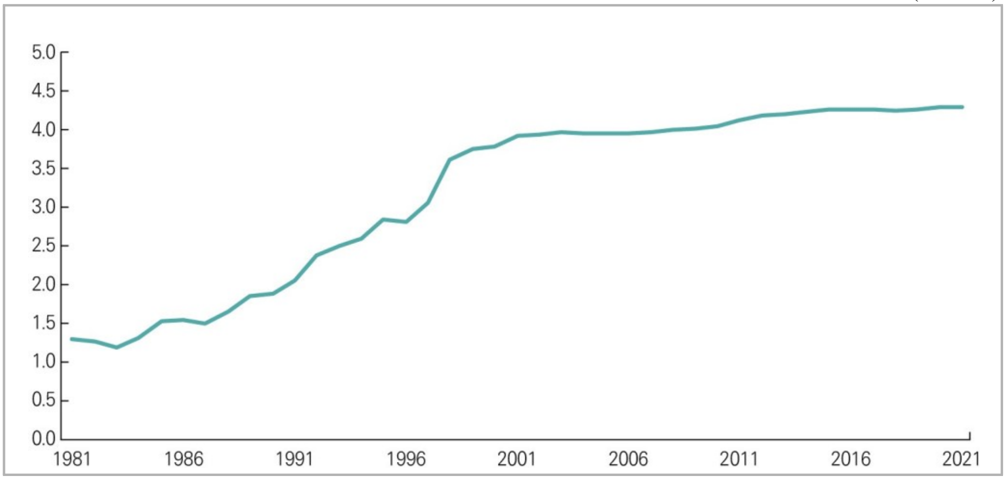
Note: 1) Average for the period.
2) The figures for the years up to 2021 are actual performance data, while the figures for the years after 2021 are projections.

Source: NABO, Bank of Korea.

The depreciation rate for the next five-year period will maintain an average annual rate of 4.3%, the same level as that recorded in the previous five-year period. This is a reflection of the modest increasing trend that has persisted since the 2000s. The depreciation rate increased from 1.3% in 1981 to 4.0% in 2003, but thereafter it rose more gently, reaching 4.3% in 2021.

[Figure II-2] Trend in the depreciation rate (δ_t)

(Units: %)

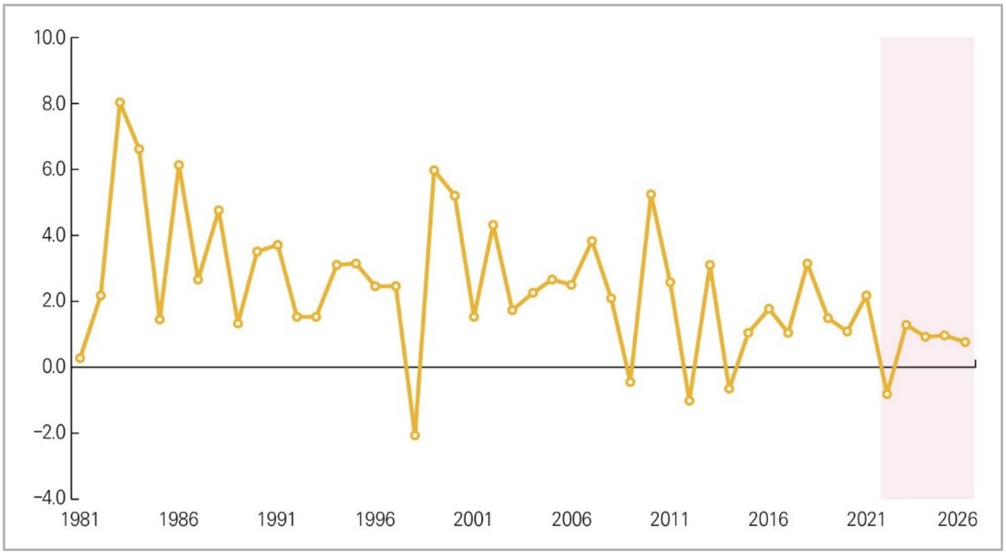


Source: Estimations made by NABO using data released by Bank of Korea's ECOS.

For the next five-year period, total factor productivity is projected to increase at an average annual rate of 0.6%, a significant decline from five years ago when it was increasing at a rate of 1.7% per year. When the projection of total factor productivity is segmented by year, after recording a -0.9% in 2022, it will fall from 1.3% in 2023 to 0.7% in 2026 during the subsequent four-year time span.

[Figure II-3] Trend and projection of the total factor productivity increase rate

(Units: %)



Source: NABO’s own estimations.

[BOX 1] Growth accounting and the production function approach method

The production function approach method starts with assumptions about the form of the production function that expresses the technical relationships between the production factors (capital, labor, etc.) inputted for real GDP and production. In general, a Cobb-Douglass type of production function is assumed, and real GDP (Y_t) is expressed as a function of total factor productivity (At), labor input level (Lt) and capital input level (Kt), as shown in the equation below.

$$(1) \quad Y_t = A_t L_t^{\alpha} K_t^{1-\alpha}$$

In this equation[1], the CES (constant elasticity of substitution) of capital and labor are 1, and, under the assumption of perfect competition and constant return to scale, α represents labor's share of income and (1- α) represents capital's share of income. Here, since technological advancement is expressed by proportionally increasing the productivity of labor and capital, it is called total factor productivity (TFP).

Changing the value of the natural logarithm in the above equation (1) into lowercase letters and then rearranging them yields the following equation (2) below:

$$(2) \quad y_t = a_t + \alpha l_t + (1-\alpha) k_t$$

For a given labor share of income, total factor productivity can be estimated as Solow's residual, as shown below:

$$(3) \quad a_t = y_t - \alpha l_t - (1-\alpha) k_t$$

$$A_t = \exp(a_t)$$

The labor input rate(Lt) can be measured differently depending on the values of total labor hours or number of employed. Capital can be measured differently depending on the value used for production capital stock available for use and operating rate.

The labor input rate is measured in terms of total labor input hours.

Labor input rate (Lt) = Number of employed × working hours per week × (365/7)
* Number of employed = Working age population aged 15 or above × participation rate in economic activities × (1-unemployment rate)

The capital input rate (Kt) is measured by production capital stock, which is estimated by the Bank of Korea. Production capital stock is determined by total fixed capital investments and the rate of depreciation (δ_t) of existing production capital stock. In South Korea, where the production capital stock (using the investment time series and the year-efficiency function) and the net capital stock (using the investment time series and the year-price function) are estimated separately, the depreciation rate (δ_t) can be understood as a measurement of the degree to which the production efficiency of production capital deteriorates.

(4) $$K_t = I_t + \delta_{t-1}K_{t-1}$$

If the labor input rate and capital level measurement in the above equation are substituted into the production function (1), (1) can be written as (5).

(5) $$Y_t = A_t[P_t^{15}L_t^{pr}(1-ur_t)wh_t(365/7)]^{\alpha}K_t^{1-\alpha}$$

Here, P_t^{15} refers to working age population aged 15 or above, L_t^{pr} refers to participation in economic activities, ur_t refers to unemployment rate, wh_t refers to working hours per week.

If one takes the natural log of both sides, equation (5) could be changed to (6) below.

(6) $$\ln(Yt) = \ln(At) + \alpha\ln([P_t^{15}L_t^{pr}(1-ur_t)wh_t(365/7)]) + (1-\alpha)\ln(Kt)$$

The potential GDP(y_t^P) can be measured using the production function by measuring the potential levels of labor(l_t^P), capital (k_t^P), and total factor productivity(a_t^P) and then substituting them into the production function of equation (1) and equation (2).

(7) $$Y_t^p = a_t^p + l_t^p + (1-\alpha)k_t^p$$

If this is transformed into an equation 6) type of expression, as follows:

(8) $$Ln(Y_t^p) = ln(A_t^p) + \alpha ln([P_t^{15} L_t^{prp}(1-ur_t^p) wh_t^p (365/7)]) + (1-\alpha) ln(K_t^p)$$

Different estimations for the potential level input factors can be derived by using different assumptions for the variables used to measure each input factor and by using a different statistical method to derive the trends.

NABO identifies the long-term trend in labor variables by using the HP filter[3)] and assumes them to be the potential levels. This is the same method used by the OECD and the IMF[2)]. NABO also makes predictions about the long-term trend in the unemployment rate (ur_t^p) by setting a structural model in combination with the traditional Phillips curve. The potential capital stock was assumed to be the same as the actual value of the production capital stock. Potential total factor productivity was estimated using the actual total factor productivity estimate produced using the HP filter, in the same way as the labor input variable.

1) Maximum productivity of labor MPL= $\partial Yt/\partial Lt = \alpha Yt/\partial Lt$, Maximum productivity of capital MPK = $\partial Yt/\partial Kt = (1-\alpha)Yt/\partial Kt$.
2) Chalaux, T. and Y. Guillentette (2019), "The OECD Potential Output Estimation Methodology," Economics Dept.'s working paper, No. 1563, OECD.
3) In the HP filter, x_t^p (long-term trend of x_t) is defined as the year in which the square of the difference between x_t^p and x_t reaches its minimum level. The larger the value of the smoothing parameter (λ), the smaller the range of variation. If λ =0, the actual value becomes equal to the projected value. It is known that due to the filtering calculation structure, the trend of the last sample (end-point bias) tends to be overestimated (Harvey and Jaeger (1993).

Section 2 Outlook for the potential growth rate [4]

- During the five-year period 2022-2026, the potential growth rate is projected to be 2.2% per year on average.
  – When compared to the previous five-year period (2017~2021), it will drop by 0.3%p each year.

(Compared to the previous year, annual average, %)

2022	2023	2024	2025	2026	2017-21	2022-26
2.1	2.2	2.3	2.2	2.3	2.5	2.2

During the period 2022-2026, South Korea's potential growth rate is projected to reach 2.2% (annual average), which is 0.3%p lower than the average recorded during the previous five-year period. The declining trend in the potential growth rate, which began in the early 2000s, is expected to be sustained for the next five years. One year before the start of the global financial crisis in 2007, the potential growth rate of South Korea's economy was 4.5%, but it fell to 3.7% in 2010 after the country was impacted by the 2008 financial crisis. Afterwards, the country's economy struggled to rebound, and with slowing investments and the sluggish growth of the labor supply, the potential growth rate fell to around 2% after 2013. If one examines the trend in the potential growth rate for the most recent five-year period (2017-2021), one can see that the 2016 boom in the construction and semiconductor industries continued well into 2017, fueling investments by businesses and marginally increasing the contribution of capital to the potential growth of the economy. However, labor's contribution to potential growth declined due to decelerating growth of the working population aged 15 and above as well as rising unemployment. During the period 2018-2019, both facility investments and construction investments declined for two consecutive years, and labor input also decreased by a wider margin due to the effects of continuously slowing population growth, and reduced working hours, resulting in reduced contributions to potential growth by both capital and labor. In 2020, labor's contribution fell, while that of capital remained at the same level as in previous years. This contrast could be explained in the following way: Although real GDP posted minus growth due to the employment shocks triggered by the COVID-19 pandemic and reduced consumption by the general public, fixed capital investments actually exhibited solid growth, thanks to booming exports in key manufacturing industries like semiconductors and automobiles, aided by improving external conditions and aggressive investments in new growth industries. In 2021, with recovering employment numbers cushioning labor's declining contribution to economic growth, steady increases in fixed capital investments (led by facility investments and investments in knowledge property products) have been credited for the slight rise in the potential growth rate when compared to the previous year.

4) Potential growth rate refers to the increase rate of an economy's output when the given technological conditions and production factors are used at a sustainable level. Recently, the potential growth rate has been slowing down due to population aging, faltering investment, and declining efficiencies in the economy as a whole. In circumstances like today's, projections about the potential growth rate could be used as reference data for developing measures to deal with such low growth rates.

An analysis of the contributions to potential growth of each input factor over the next five-year period shows that the contribution of labor will rise and that of total factor productivity will fall. However, the margin of the drop in the contribution of total factor productivity is expected to be relatively larger.

[Table II-3] Potential growth rate and contribution to potential growth rate by input factor

(Units: average of the period, %, %p)

Period	Potential real GDP growth rate	Potential contribution to growth of each input factor		
		Labor	Capital	TFP
2001-2005	5.5	0.3	2.3	2.9
2006-2010	4.1	-0.2	1.9	2.4
2011-2015	3.1	0.4	1.4	1.2
2016-2020	2.6	-0.5	1.5	1.5
(previous) 2017-2021	2.5	-0.5	1.4	1.5
(next) 2022-2026	2.2	0.3	1.1	0.8

Note: 1) Average for the period.
2) The figures for the years leading up to and including 2021 are the actual levels, while the figures after 2021 are projections.
Source: NABO.

Despite the sluggish economic growth and the slowing growth of the working age population, the contribution to potential growth by labor is projected to rise due to the following reasons. Economic activities are returning to their pre-pandemic levels, participation in economic activities by women and the elderly are increasing and their unemployment figures are also dropping, and working hours per week are also falling, albeit at a slower rate. Taken together, these trends are driving up the labor input level.

Capital's contribution to potential growth is expected to fall by 0.3%p on average each year from the average level of the previous five-year period. This is because the growth in the level of total fixed capital investments is slowing, with most of the slowdown occurring in facility investments, and also because the growth in production capital stock is expected to slow down from the growth rate recorded during the previous five-year period.

The real GDP gap for the next five-year period, which shows changes in the state of the economy, is expected to become negative after 2024. The real GDP gap is defined as the percentage difference between real GDP and potential GDP estimates. Therefore, if the real GDP gap is positive, it is an indication that there is upward pressure on prices due to a surplus in aggregate demand and, conversely, if it is negative (-), it is a sign that there is downward pressure on prices due to insufficient levels of aggregate demand.

The real GDP gap will approach zero in 2022 because it will come close in value to the potential GDP level, but it is anticipated to turn negative in 2023. This implies that the ongoing high inflationary pressure is caused by supply-side shocks, such as soaring oil prices and continued problems in the supply chain, rather than demand-side issues.[5] Afterwards, during the period 2024-2026, it is projected to maintain a small negative (-) gap, but this will be reduced when compared to the previous five-year period. The real GDP gap before the start of the COVID-19 pandemic (i.e. the years 2017-2019), maintained a relatively large positive gap. However, the shock of the pandemic in 2020 caused the economy to shrink, and the real GDP gap fell by the largest margin since the global financial crisis of 2008. Although the margin of reduction was significantly minimized in 2021, the real GDP gap was still negative.

[Figure II-4] Trend and projection of the real GDP gap

(Unit: %)

Note: real GDP gap = [(real GDP-potential GDP)/potential GDP]x100.
Source: NABO's own estimations.

5) Some view that the recent rise in inflation was precipitated by quantitative easing policies such as the interest rate cuts and large fiscal spending by key countries like the USA in response to the COVID-19 shock, which resulted in the excess supply of liquidity that triggered the inflation. In a situation where liquidity is abundant, a faster than expected rebounding economy could lead to a boom in employment and temporary problems in supply, which could in turn create more inflationary pressure.

[Table II-4] shows the estimated potential level and future projected levels for the key labor-related variables that determine the potential labor input rate: working age population, participation rate in economic activities, unemployment rate, and working hours per week. As explained earlier in BOX 1, the potential levels of key labor variables were calculated using the estimation method (HP filter) described in the box, i.e. by extracting the long-term trend of the variables and using the values as the potential levels. The difference between the actual value of each variable and its long-term trend value is the cyclical change value in which the economic factors are reflected. The potential level of the participation rate in economic activities is projected to average out at 64.2% during the next five years. This is an increase of 0.9%p when compared to that of the previous five-year period (63.1%).

The potential level of the unemployment rate could be interpreted as the natural unemployment rate and, over the next five years, its average annual value will be 3.6%, a slight decline from the average of 3.7% during the previous five-year period. In the long term, the value of the working hours per week is predicted to decline by 0.3% each year. In fact, when compared to the previous five-year period (-1.6%), the decline rate is projected to slow down substantially. [6]

[Table II-4] Trend and projection of total labor input and potential levels of its determinant variables

(Units: Compared to the previous year %, annual average)

Period	Potential labor input	Potential levels of determinant factors in potential labor input				
		Working age population	No of employed	Participation in economic activities (%)	Unemployment rate (%)	No. of working hours per week
2001-2005	0.5	1.0	1.4	61.9	3.8	-0.9
2006-2010	-0.2	1.4	1.2	61.7	3.4	-1.3
2011-2015	0.7	1.2	1.5	62.0	3.4	-0.8
2016-2020	-0.8	0.7	0.8	63.0	3.7	-1.6
(previous) 2017-2021	-0.8	0.7	0.8	63.1	3.7	-1.6
(next) 2022-2026	0.4	0.4	0.7	64.2	3.6	-0.3

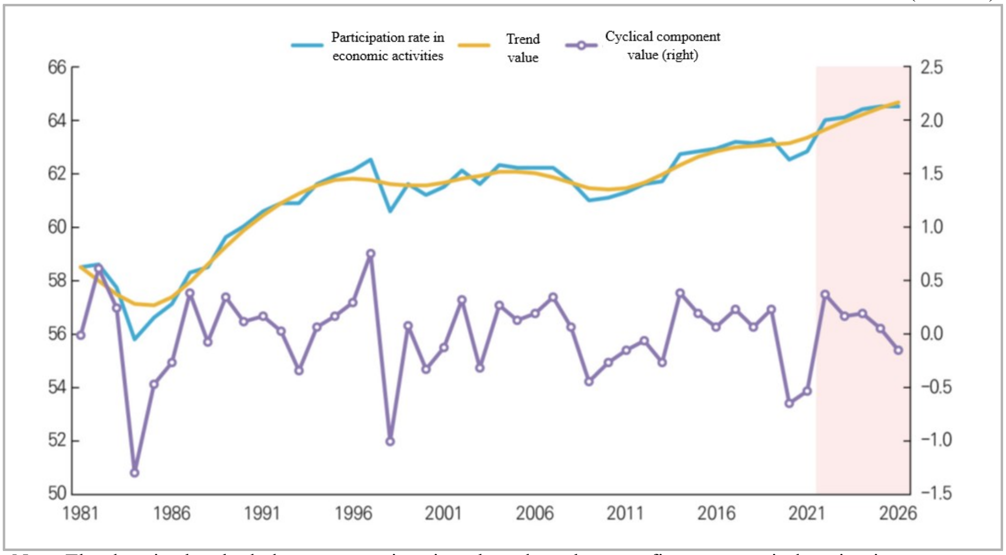
Note: 1) Average for the period.
2) The figures for the years leading up to and including 2021 are the actual levels, while the figures after 2021 are projections.
Source: NABO, KOSTAT.

[Figure II-5] to [Figure II-7] below show the participation rate in economic activities, unemployment rates and working hours per week derived using the actual values and the projected values for the years 1981 to 2026.

6) More detailed information about the outlook for participation rates in economic activities and unemployment are described in "The Economic Outlook for 2023 and the Medium Term IV: Income and Population/Employment".

[Figure II-5] Long-term trend and cyclical component of the participation rate in economic activities

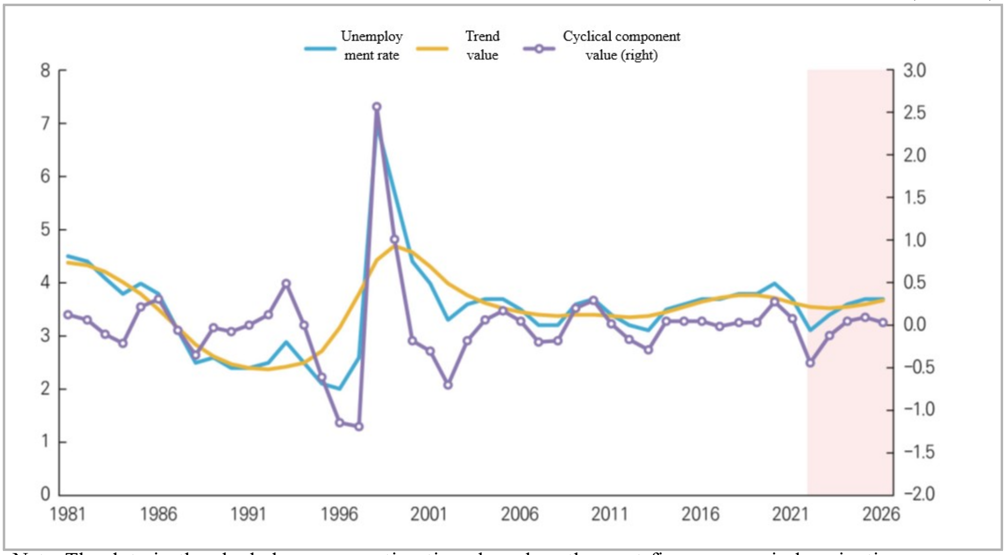
(Units: %)



Note: The data in the shaded area are estimations based on the next five-year period projection.
Source: NABO's own calculations using data released by KOSTAT.

[Figure II-6] Long-term trend and cyclical component of unemployment

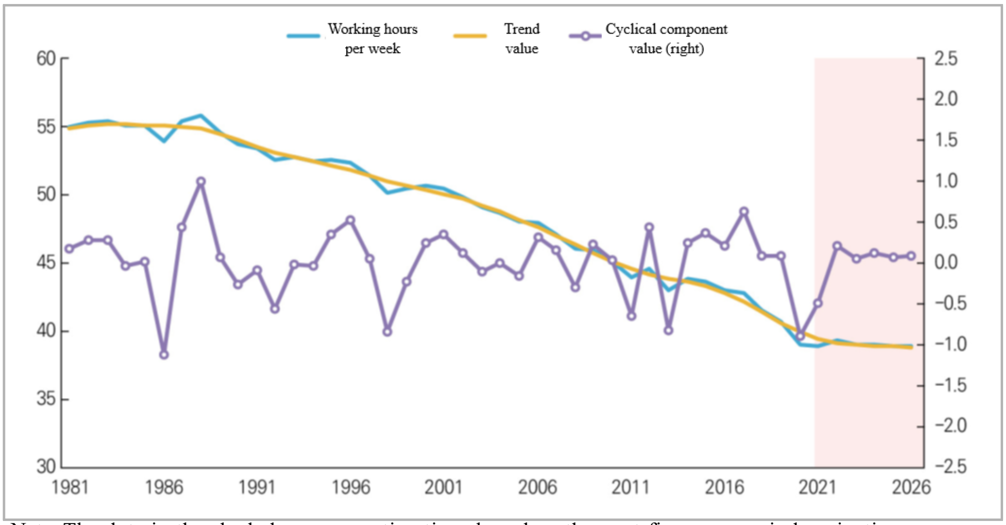
(Units: %)



Note: The data in the shaded area are estimations based on the next five-year period projection.
Source: NABO's own calculations using data released by KOSTAT.

[Figure II-7] Long-term trend and cyclical component of working hours per week

(Units: %)



Note: The data in the shaded area are estimations based on the next five-year period projection.
Source: NABO's own calculations using data released by KOSTAT.

Potential total factor productivity is projected to increase at an average annual rate of 0.8% for the next five years, a rate that is 0.7%p lower than the average increase rate from the previous five-year period (1.5%). The increase rate of the potential total factor productivity is predicted to decline continuously from the 1.0% recorded in 2022 to 0.7% in 2026. During this same period, the increase rate of real total factor productivity is projected to be 0.6% per year on average, smaller than that of potential total factor productivity.

[Table II-5] Total Factor Productivity

(Units: Compared to the previous year %, annual average)

Period	Total Factor Productivity Increase rate	Potential total factor productivity increase rate
2001-2005	2.5	2.9
2006-2010	2.6	2.4
2011-2015	1.0	1.2
2016-2020	1.7	1.5
(previous) 2017-2021	1.7	1.5
(next) 2022-2026	0.6	0.8

Note: 1) Average for the period.
2) The figures for the years leading up to and including 2021 are the actual levels, while the figures after 2021 are projections.
Source: NABO.

[BOX 2] Potential growth rate estimation method

Potential growth rate refers to the rate of increase of an economy's output when the given technological conditions and production factors are used at a sustainable level. In the past, the potential growth rate was defined as the maximum level of production that could be reached with the production factors available for use or the level of production with full employment (Okun, 1962). However, recently, it has been defined as the sustainable level of production that could be reached in the long run without producing negative effects like inflation.

Potential GDP provides a benchmark (through estimation of the GDP gap, which is the difference between real GDP and potential GDP) for evaluating the degree of economic fluctuations and demand side pressures on inflation that occur in the short term. It serves as an important criterion used by authorities when setting policies aimed at stabilizing the economy. The GDP gap is calculated as the difference between real GDP and potential GDP. If the GDP gap is positive, labor and capital are used excessively at abnormal levels, exerting upward pressure on both production factor prices and the prices of goods and services. Changes in important macroeconomic price variables such as inflation, interest rates, and wages are linked to changes in real GDP (unemployment rate) through the GDP gap (or unemployment rate gap). This is because, in the short term, price variables are not flexible enough. When aggregate demand increases, production increases first, creating a gap with the potential level or the balanced level, and - through changes in price variables - is adjusted to a level where the economy becomes balanced.

Furthermore, in the long term, potential GDP can serve as a benchmark for evaluating the growth potential of the economy, and can also provide basic data for policy directions aimed at improving the growth potential of the economy in the future. This is because real GDP can be decomposed into input factors like labor, capital, and total factor productivity, and each factor's contribution to potential growth can be analyzed and then utilized when setting policies related to growth potential.

In budget policy related areas, potential GDP could be used in evaluating the medium-term fiscal policy stance by estimating the economy-neutral budget balance (structural budget balance). As a budget balance that matches the potential GDP level, the structural budget balance could be used to determine whether reforms of government expenditures or taxes are sustainable in the medium term and to assess the feasibility of achieving the medium-term goals of budget management. This is because when the budget balance is in surplus or deficit, it becomes important to understand whether it is due to a temporary economic recession or an upturn, or due to an increase or decrease in potential GDP.

Potential growth rate estimation methodologies are broadly divided into the ① univariate time series approach, ② multivariate time series approach, and ③ production function approach. As a variable that cannot be observed, the potential growth rate must be estimated based on economic theory or statistical methods, and thus it could be claimed that the estimation is bound to contain huge uncertainties caused by differences in the assumptions or definitions, the model, or the estimation method used. In the univariate time series approach, there is the trend extraction method and the univariate unobserved component model. For linear trends, the non-stochastic trend obtained by conducting a regression analysis of real GDP using the constant term or time as the variable is calculated (simple univariate technique) as the potential GDP. The linear trend is a simple single-variable technique that calculates the non-stochastic trend obtained by a regression analysis of real GDP as a constant term or time as potential GDP. The HP filter method is commonly used to derive a smooth time series trend. The univariate unobserved component model uses a statistical method by which real GDP is decomposed into potential GDP with an abnormal stochastic trend and a normal economic cyclical factor.

The multivariate time series approach method is a model that combines the structural relationships between key variables. First, in the multivariate unobserved component model, time series variables like inflation, unemployment, and production output levels are combined with structural relationships like Phillips' curve or Okun's law to decompose real GDP into its stochastic trend part and cyclical variable part. [7)8)]

With the structural vector autoregressive model (structural VAR), potential GDP is estimated by adding structural constraints to the reduced form VAR model set up to predict potential GDP. For example, Blanchard and Quah (1989) estimated potential GDP by applying structural constraints that reflected the characteristics of varying potential GDP levels to a 2-variable VAR model of real GDP and the unemployment rate. In other words, long-term trend variations were estimated by decomposing real GDP variations into short-term variations, such as currency variations triggered by shocks in demand, and long-term variations caused by shocks to supply, such as technological evolutions. In the long run the aggregate supply curve is shifted only by variations in productivity, whereas in the short term it is almost a vertical line. Therefore, variations caused by short-term shocks to real GDP must be seen as the result of changes in the aggregate demand curve.

In the production function approach method, the potential growth rate is estimated by first estimating the form of the production function which expresses the technical relationships among production factors (estimated level of real production output, capital spent to produce this output, labor, etc.). Then, labor and capital input rate values corresponding to the natural unemployment rate and the level of capital utilization are substituted into the function in order to derive the potential growth rate. Both the OECD and the IMF use the production function approach when estimating potential GDP, because factors like the contribution to the potential growth rate of each production factor and demographic changes can be explicitly considered.

The weakness of this method lies in the fact that there are large uncertainties in the assumed production function or labor income share ratio and that a separate statistical method must be used to estimate the potential level for each production input factor.

7) Clark (1989) estimated the potential GDP using Okun's law, unemployment rate, and the bivariate unobserved component model. Kuttner (1994) estimated the potential GDP that doesn't accelerate inflation using a bivariate unobserved component model composed of the inflation rate and GDP.

8) Hwang Jong-ryeul (2009), in "The Global Financial Crisis and South Korea's Potential Growth Rate", compared the country's potential growth rates using the production function approach method, the univariate unobserved component, and the multivariate structural unobserved component model.

Chapter 2 The Outlook for Total factor Productivity by Industry/Factor [1]

Section 1 The meaning of total factor productivity and its current status

Labor and capital are important production factors that determine production output (level). Therefore, if the input level of each factor and the production output level can be found, it is possible to obtain the average labor productivity and the average capital productivity that represent the production output level for the given input level of each production factor.

When one measures productivity, single factors of productivity such as labor productivity and capital productivity are used as indicators of productivity. However, because production is determined not only by the input of individual production factors but also by the interactions among those production factors, it is impossible to measure the overall improvement in efficiency of the production process with just a single factor of productivity alone. For example, even when there is no change in the labor input, if additional machinery or devices are installed (additional capital infusion) resulting in an increase of the output level, then labor productivity will increase. Even if there is no change in capital input, capital productivity can increase due to the increased level of labor input. Therefore, with a single factor of productivity alone, it is impossible to measure the efficiency of the entire production process.

Total Factor Productivity refers to productivity that cannot be traced to single factors like labor or capital, and instead appears when the output level is increased(decreased) as a result of combining production factors or adjusting their input levels. More specifically, total factor productivity can be viewed as an enhancement of productivity brought about by a technical combination of labor and capital or by technological innovation and/or an increase in production factors (a change of production level resulting from economy of scale) that delivers (after the passage of time) higher levels of production with the same amount of labor and capital as before.

A change in total factor productivity, in other words, a change in productivity shows up as a shift in the production function. This shift is a sign either of technological efficiency or technological progress. In a broader sense, such a shift can be thought of as a reflection of increased production realized through improved machinery and equipment, improved quality of labor force, improved labor-management relations, and management innovations. Therefore, an increase of total factor productivity may be viewed as an improvement in the overall efficiency of the production process.

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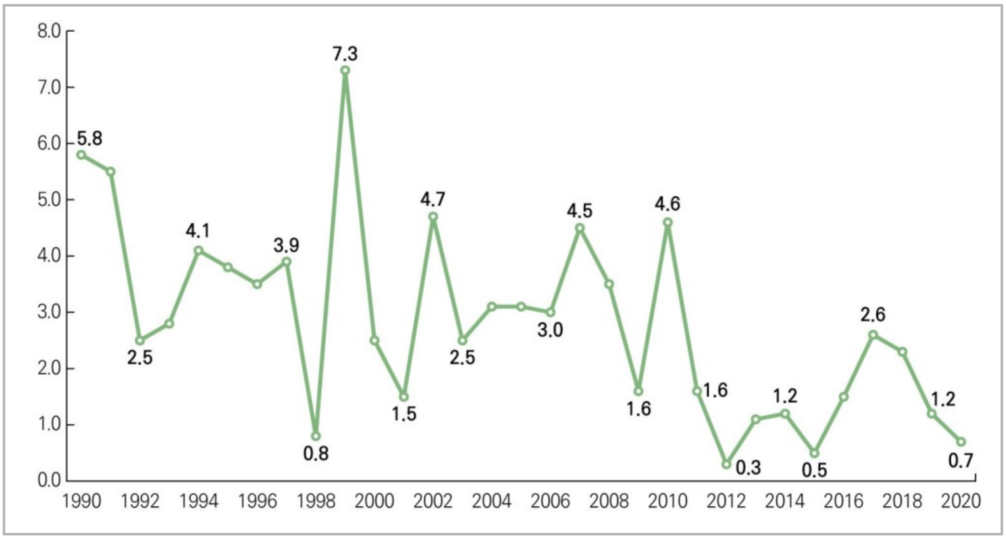
1) Total Factor Productivity represents the overall level of efficiency of the production process, which is impossible to measure with a single factor of productivity such as labor productivity, for example, a production output increase effect achieved through improved quality of labor, innovation of production technology, improved labor-management relations, and management innovations. Measurements and projections of total factor productivity for each industry and factor could be used as reference data when formulating growth strategies and establishing industrial policies aimed at improving productivity and promoting technology innovations.

Total factor productivity was measured by subtracting the contributions of labor and capital from the total increase in economic growth. The resulting amount is called the “residual”. If the rate of increase of total factor productivity is measured with this residual concept, South Korea’s rate of increase is found to be on a long-term decline; and, at the time of the financial crisis, the margin of decline in the total factor productivity was large, but within two years from the end of the economic crisis, a drastic increase in total factor productivity was observed.

As revealed in [Figure II-8], right after the Financial Crisis of 1997-1998, the increase rate in total factor productivity in 1998 fell to 0.8%, but then soared up to 7.3%. In the 2000s, the increase rate generally hovered around the 3% level, but right after the Global Financial Crisis of 2008, it fell to 1.6% before climbing back up again to 4.6% in 2009. In 2011, the increase rate of total factor productivity fell to the 1% level, rose again and peaked at 2.6% in 2017, and then started declining again, falling to 1.2% in 2019 and to 0.7% by 2020.

[Figure II-8] [Figure II-8] Trend in the total factor productivity increase rate of South Korea

(Units: %)



Note: Total factor productivity is estimated as the residual left over after subtracting the contributions of the labor input increase rate and the capital input increase rate from the annual economic growth rate.

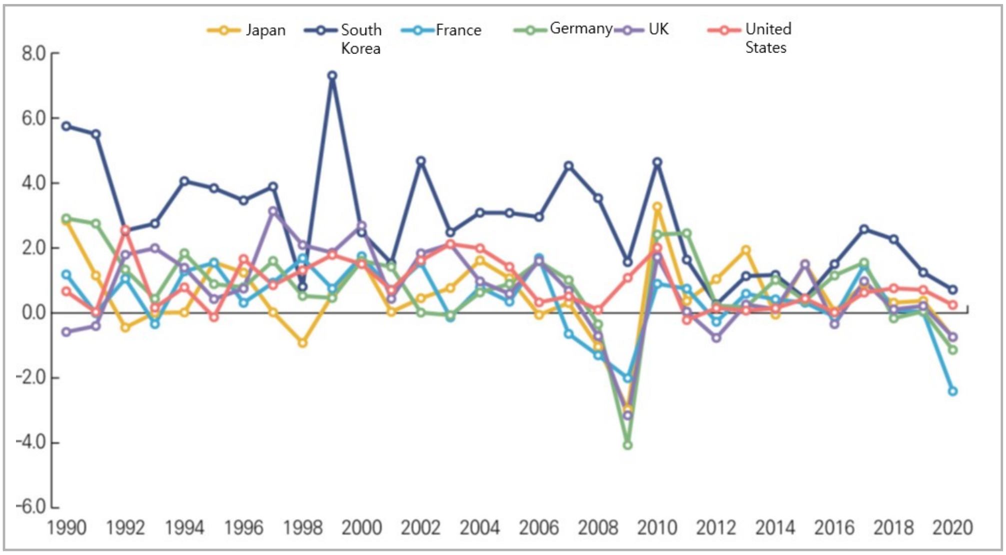
Source: OECD.

In the long run, in South Korea and most other OECD countries, the increase rate of total factor productivity is on a declining trend. Also, during a financial crisis, most OECD countries show the same pattern wherein total factor productivity falls rapidly before rebounding again.

If the increase rate of total factor productivity for South Korea is compared with that of other key OCED countries, it could be concluded that South Korea's increase rate was greater than that of the OECD countries until about 2010, after which it remained at roughly the same level as the other OECD countries until the mid-2010s, before beginning to exceed once again that of other key OECD countries in the last years of the decade.

[Figure II-9] Trend in the total factor productivity increase rates of key OECD countries

(Units: %)



Note: Total factor productivity is estimated as the residual left after subtracting the contributions of the labor input increase rate and the capital input increase rate from the annual economic growth rate.
Source: OECD.

Total factor productivity impacts economic growth in two different ways depending on a country’s level of economic development. According to Pyo Hak-gil and Song Sae-rang (2014)[2], in the early stages of economic development, such as in the case of South Korea from the 1960s to the 1980s, a country’s economy experiences input-led growth, where total factor productivity’s contribution to economic growth is relatively smaller than the contributions of input factors such as labor and capital.

2) Pyo Hak-gil, Song Sae-rang (2014), “Estimates of South Korea’s capital stock and potential growth rate in each quarter (1981-2012)”, Analysis of South Korea’s Economy, Volume 20, Issue 3, Korea Institute of Finance.

On the other hand, when the economy reaches a certain level and the growth rate converges to that typical of advanced countries, it has been reported that the contribution by total factor productivity becomes relatively greater because the labor input increase rate will slow down due to the low birth rate and population aging, and that the capital input increase rate will decline due to the law of diminishing returns.

To make projections about future levels of total factor productivity, projections must be made about the individual input rates of the production factors that contribute to production. Therefore, in this chapter, a projection for total factor productivity was made by separating gross domestic product (GDP) into gross output level, and labor and capital into total labor input and total production capital stock, respectively. In addition, total factor productivity could be decomposed into technological progress, technological efficiency, and scale effect, etc. by converting the form of the production function to a translog production function and applying the stochastic frontier analysis. Through the decomposition of total factor productivity, it is possible to anticipate which factors will make the largest contributions to changes in productivity. Furthermore, by evaluating the total factor productivities of six major industries (agriculture, fishing, mining, manufacturing, water supply, electricity, gas, construction, and services), instead of one total factor productivity for the entire industry of the country, industries with low productivity levels can be distinguished from those with high productivity levels, and consequently these distinctions can provide implications about the economic growth strategies needed for the future.

Section 2 Outlook for output and factors of productivity inputted by industry

1. Outlook for output by industry, 2023

- In 2023, manufacturing output and the output of service industries are projected to increase by 2.6% and 2.5%, respectively, from the previous year.
  –Agriculture and fishing is projected to increase by 2.9% and gas/electricity/water-supply by 3.4%, while mining and construction are projected to decline by -5.2% and -0.3%, respectively.

(%)

	2021	2022[f]	2023[f]	2017-2021	2022-2023[f]
Agriculture and fishing	-0.1	0.6	2.9	0.4	1.8
Mining	0.6	8.3	-5.2	-4.7	1.6
Manufacturing	7.0	4.2	2.6	2.6	3.4
Electricity/ Water-supply/Gas	4.7	5.8	3.4	2.2	4.6
Construction	-0.5	1.2	-0.3	0.2	0.5
Services	4.1	2.5	2.5	2.5	2.5

This report makes projections about total factor productivity in terms of total output. To estimate the total factor productivity at the industry level, this report presents projections for the output, labor input and capital level (real capital stock) of each industry. Projections for industry are also generated by grouping industries into the six categories of agriculture and fishing, mining, manufacturing, water-supply/electricity/gas, construction, and services. The output of each industry was obtained from the input-output tables of the national accounts, showing differences from the amount of value added produced by each industry (projected in Volume III of this report). In this report, the 2023 figures were forecast using the Korea Productivity Center's data on the real total output of each industry (KIP DB). Thus the real total output of each industry was projected using the autoregressive distributed lag model (ARDL) based on the premise that a stable relationship is maintained among the real total output of each industry, the real GDP of each industry, and total GDP.

The results of the projections (mainly the manufacturing and service industries) for 2022 and 2023 are presented in the following paragraphs.

In 2022, the output of the manufacturing industry is expected to increase by 4.2% from the previous year, while that of the services industry is expected to increase by 2.5% from the previous year. In 2022 the rate of increase of output in both manufacturing and services is predicted to slow down when compared to 2021. This prediction fully takes into account the drop in consumer confidence and the corresponding contraction in production levels caused by rising prices as well as the hikes in the base interest rate introduced in 2022.

Next, the output of the manufacturing industry in 2023 is projected to increase by 2.6% from the previous year's level and the output of the services industry in 2023 is projected to increase by 2.5% from the previous year's level. The outputs of agricultural and fishing industries are projected to increase by 2.9%, while those of the electricity, gas and water supply industries are projected to increase by 3.4%. On the other hand, the output of the mining industry is projected to decrease by 5.2% and that of the construction industry by 0.3%.

When compared with the annual average increase rates for the previous five-year period (2017-2021), the output increase rate for both manufacturing and services in 2023 is expected to be similar to the average increase rate recorded over the previous five-year period at 2.6% and 2.5% respectively.

2. Outlook for labor input by industry, 2023

- In 2023, the labor input level in manufacturing is projected to decrease by 4.0% compared with the previous year while that of services is projected to increase by 2.2% from the previous year.

(%)

	2021	2022f	2023f	2017-2021	2022-2023f
Agriculture and fishing	-4.5	-1.6	-1.6	0.9	-1.6
Mining	-5.6	-10.6	-12.9	0.4	-10.6
Manufacturing	-0.3	-3.8	-4.0	-1.4	-3.9
Electricity/ Water-supply/Gas	-14.9	44.5	31.8	-2.3	38.2
Construction	-6.0	0.2	-0.8	-1.0	-0.3
Services	-0.1	0.6	2.2	-0.6	1.4

The next topic concerns the projections for the labor input of each industry. The total labor input level for a specific year (t) and a specific industry (i) is calculated by multiplying the average number of employed per month with the number of working hours per month and 12 (months)[3). To estimate and forecast the actual labor input levels and projected labor input levels, the data used included actual data on the number of employed (for each industry) found in KOSTAT's Economically Active Population Survey and the working hours per month data (for each industry) found in the Ministry of Employment and Labor's Survey on Working Conditions by Type of Employment.

3) Labor input level (L_{it}) = No. of employed per month × working hours per month ×12

Figures on the number of employed in each industry could be obtained using the input-output tables of the national accounts, but the output levels for each industry recorded in the input-output tables are difficult to convert into real GDP. For this reason, KOSTAT's Economically Active Population Survey was used. The real total output of each industry was projected using the autoregressive distributed lag model (ARDL) based on the premise that a stable relationship is maintained between the real total output of each industry and total GDP. Separate projections were also made for the labor input levels expected in the six major industry groupings (agriculture, fishing, mining, manufacturing, water supply/electricity/gas, construction, and services).

The results of the projections (mainly the manufacturing and service industries) for 2022 and 2023 are presented in the following paragraphs.

In 2022, the labor input level in the manufacturing industry is expected to decrease by 3.8% from the previous year, while that in the services industry is expected to increase by 0.6% from the previous year. Next, the labor input level in the manufacturing industry in 2023 is projected to decrease by 4.0% from the previous year's level, whereas that in the services industry in 2023 is projected to increase by 2.2% from the previous year's level.

In 2022, despite the positive employment conditions evidenced by significant increases in the number of employed when compared to the previous year, labor input in the manufacturing industry is expected to decline compared with the previous year while that in the services industry is expected to increase only slightly. The reasons for this are twofold. First, the average number of working hours per month are steadily decreasing in both manufacturing and services. Second, most of the increase in the number of employed comes from the services sector while the contribution from the manufacturing sector is relatively small.

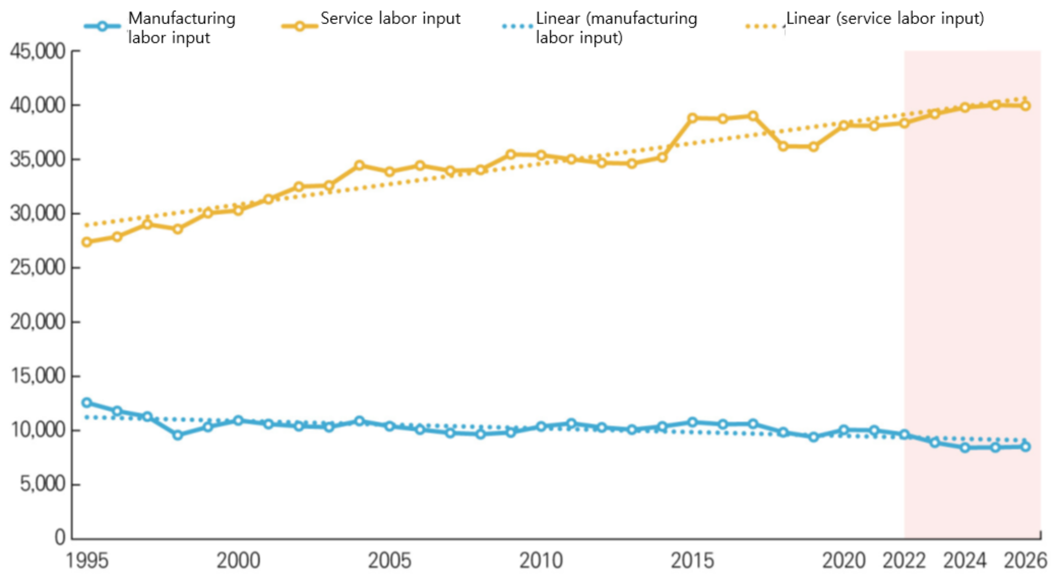
Due to these two effects, labor input in manufacturing is declining because the margin of decline in the number of working hours is greater than the increase in the number of newly employed. Conversely, in the services sector, the labor input level is increasing because the increase in the number of newly employed is greater than the margin of decline in the number of working hours.

The services industry, as the industry with the highest labor input per year, is expected to see increasing labor input levels until 2025. In 2026, the increasing trend will dip slightly, but, overall, the labor input level will follow the long-term increasing trend during the years 2022-2026. On the other hand, in the case of manufacturing, the labor input level will fall below the long-term trend and decline during the period 2022-2024, after which it will follow the long-term trend and increase from the previous year's level during the years 2025-2026. However, during the period 2022-2024, the margin of decline in the labor input level will be so large that it will bring down the yearly average for the entire five-year period (2022-2026).

In this way, the overall trend in manufacturing labor input is a declining one while the overall trend in service labor input is rising. Furthermore, the speed of decline of the labor input level in manufacturing is anticipated to be greater than the speed at which the labor input level will increase in services. Due to these factors, as examined in the next section, the gap in labor productivity will continue to appear between the manufacturing and service industries.

[Figure II-10] Long-term trend in the labor input levels of the manufacturing and service industries

(Units: 1 million hours)



Source: Created by NABO using data released by KOSTAT.

3. Outlook for capital input by industry, 2023

- In 2023, the capital stock in the manufacturing and service industries is projected to increase by 4.7% and 1.0%, respectively, from the previous year's level.

(%)

	2021	2022[f]	2023[f]	2017-2021	2022-2023[f]
Agriculture and fishing	-7.9	1.8	2.0	1.2	1.9
Mining	-8.8	-12.6	0.5	-0.1	-6.1
Manufacturing	5.1	5.3	4.7	4.7	5.0
Electricity/ Water-supply/Gas	0.3	2.0	1.2	2.5	1.6
Construction	3.1	3.5	3.4	3.8	3.5
Services	0.6	1.8	1.9	2.7	1.9

The next topic is the projection for the total capital (input) of each industry. The total capital (K_{it}) of a specific industry(i) in a specific year(t) is measured with production capital stock. Production capital stock is determined with the depreciation rates(δ_t) of total capital investment(I_{it}) and existing production capital stock(K_{it}). [4)]

Since the depreciation rate and future estimates are determined by technological factors, this report, for the sake of convenience, forecast production capital stock by extrapolating the past values of production capital stock to future years. For the projections of production capital stock, the real data in the national account's input-output table were used. The production capital stock of each industry was projected using the autoregressive distributed lag model (ARDL) on the premise that stable relationships are maintained between the real total output of each industry, total GDP, and production capital stock. Separate projections of production capital stock were made for the six major industry groupings (agriculture, fishing, mining, manufacturing, water supply/electricity/gas, construction, and services).

The projection results show that the production capital stocks in manufacturing and the services industries in 2022 are expected to grow by 5.3% and 1.8%, respectively. Compared to the previous five-year period from 2017 to 2021, the rate of increase for manufacturing will rise, whereas it will decrease slightly for services.

Overall, the capital stock increase rate in the manufacturing sector is predicted to be higher that in the services sector. This is the complete opposite of the situation concerning labor input because, compared to the services sector, the rate of increase of labor input was relatively smaller in manufacturing.

4) $K_{it} = I_{it} + \delta_{it}K_{it-1}$

Section 3 Outlook for total factor productivity by industry/factor

1. The meaning of total factor productivity

When measuring the overall efficiency of the production process, it is essential to measure the efficiency of input factors (and not single factors like capital or labor), which manifests itself through input costs and the technological merging of capital and labor. As a mark of efficiency in the whole production process, total factor productivity is the contribution to total production minus the direct contributions made by labor and capital. Consequently, total factor productivity is a concept that encompasses the technological efficiency realized through the merging of labor and capital, the technological changes that occur with the natural passage of time, and the effects of changes in scale. It should be distinguished from labor productivity, which can be realized only through a single factor called productivity.

Labor productivity is calculated by dividing the total production or total output by the total population of workers or total labor input hours. It is a measurement of the efficiency of labor as the sole input factor of production. Therefore, with just labor productivity by itself, it is impossible to determine how effectively labor and capital are being combined and how efficiently they are being used to increase output. Therefore, total factor productivity could be considered a more useful indicator for evaluating the efficiency of production and innovation than labor productivity. Generally, total factor productivity is viewed as an indicator of an economy's technological efficiency, technological innovation, and growth potential.

In past research works, total factor productivity was measured using the growth accounting model. Growth accounting is a method of analyzing the factors driving economic growth that consists in calculating the contributions of each factor by decomposing the economic growth rate of a country into the respective portions contributed by labor, capital, and total factor productivity. For instance, if a country's economy grew at an average annual rate of 7% for ten years, its growth could be dissected to show that 2% of that growth rate is due to labor input, 2.3% is due to capital accumulation, and 2.7% is due to increased total factor productivity. In the growth accounting model, total factor productivity is calculated as the residual left over when the contributions made by labor and capital are subtracted from the economic growth rate.

However, when measuring total factor productivity using the growth accounting model, total factor productivity is defined as a residual, which is a limitation when innovations and efficiencies have to be measured. For instance, with the growth accounting model, total production is set as $y = f(x;\beta)+\varepsilon$ and the residual ε is defined as total factor productivity. But ε is affected not just by technological change (innovation) but also by other unobserved factors. In other words, output may change because of a probability error that is unrelated to productivity, but such a change in output could be mistakenly attributed to a change in productivity.

For this reason, when an increase in total factor productivity is observed while using the growth accounting model, it should not be concluded that the increase is an indication that growth is occurring thanks to innovation or technological progress.

2. Decomposition of total factor productivity

Due to the shortcomings of the growth accounting model in producing a more accurate picture of total factor productivity, the authors of this report turned to the stochastic frontier analysis as the method of choice for measuring total factor productivity and generated a medium-term outlook for total factor productivity in each industry.

The stochastic frontier analysis resolves the issues in measuring total factor productivity as a residual by establishing a production frontier. This production frontier is the maximum production volume that can be achieved through various combinations of production factors. Then, the residual is estimated in two parts; one part that lies outside the production frontier and another part taken from an arbitrarily chosen area. If the residual is estimated using the two separate parts, probability errors can be minimized and growth due to technological efficiencies and innovations can be distinguished.

Next, the production function was established in a form[5)] that takes into account the effects of combinations of production functions, and then the stochastic frontier analysis was applied to decompose total factor productivity into ① technological progress, ② technological efficiency, and ③ scale effect.

① Technological progress (TP) refers to increases in the level of production that appear with the passage of time even when the quantity or input proportion of input factors remains unchanged. If a production function moves upward overall over time, this movement is an indication of technological progress.

② Technological efficiency (TE) refers to productivity enhancements that result from technological combinations of production factors or changes in the input proportions, irrespective of how much time has passed.

③ Scale effect (SE) refers to increases in the level of production that are attributable to the overall increase in production factors like labor and capital.

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5) To be more specific, if the production function is set as a translog production function, it is possible to identify a contribution to production that comes from the combination of labor and capital. For more details, refer to Box 4.

Total factor productivity is the aggregation of technological progress, technological efficiency and scale effect and should be regarded as a barometer of productivity and technological innovation. This report makes projections for the total factor productivity of each industry based on the projections (Section 2) made about output, labor input and capital stock levels during the period 2022-2023. In addition, the report uses stochastic frontier analysis to decompose total factor productivity of each industry into parts attributable to technological progress, technological efficiency and scale effect, and comparisons were made with real data from the previous year.

[BOX 3] Stochastic Frontier Analysis

o Growth accounting model: Total production is set as $y = f(x;\beta)+\varepsilon$ and total factor productivity is defined as the residual term or ε.

- y is the output vector, x is the vector of production factors (labor and capital), and β is the parameter.
- ε is affected not only by technological changes (innovations) but also by other unobserved factors.
- The output could be changed by probability errors which are unrelated to productivity. It can be a problem if such a change in output is mistaken for a change in productivity.

o Stochastic frontier analysis(SFA): The production function is established by treating ε as two separate parts, one part that lies outside the production frontier and another random part.

- SFA production function: $y = f(x;\beta) \bullet \exp(\nu) \bullet \exp(-\mu),\ \mu \geq 0$ (1)
- ν is the random part of the error, μ is the part that has been deviated downward by a production change.
- $y = f(x, \beta) \bullet \exp(\nu)$ is the stochastic frontier of production. Differences could exist depending on the industry, region, and country.
- Differences in productivity by industry and country and technological efficiency can be measured using the differences in changes in probability.

o Estimation of technological efficiency: technological efficiency is estimated by adding a natural log to both sides of the equation (10) and separating the general error term from the technological efficiency (inefficiency) term.

- $y_i = \alpha_0 + x'_i\beta + \varepsilon_i = \alpha_0 + x'_i\beta - \mu_i + v_i$ (2)
- x is the production input factor, μ_i is technological inefficiency, and v_i is the general error term.
- ε is estimated by separating it into technological inefficiency and general error terms
- μ_i estimated with equation (2) can be viewed as the contribution of part i to the growth of technological efficiency (innovation).

[BOX 4] Decomposition of total factor productivity

- Total Factor Productivity is decomposed into technological progress, technological efficiency, and scale effect.
- Equation (2) in [Box 3] incorporates the time as a variable and a translog production function.

  - $$\ln y = \alpha_0 + \sum_{j}^{J} \alpha_j \ln x_{jit} + \alpha_t t + \beta t^2 + \sum_{j}^{J} \sum_{k}^{K} \beta_{jk} \ln x_{kit} \ln x_{jit} + \sum_{j}^{J} \beta_{tj} t \ln x_{jit} + v - u \quad (3)$$

  - Here, i is the industry term, t is time, and j and k are labor (L) and capital (K), respectively.

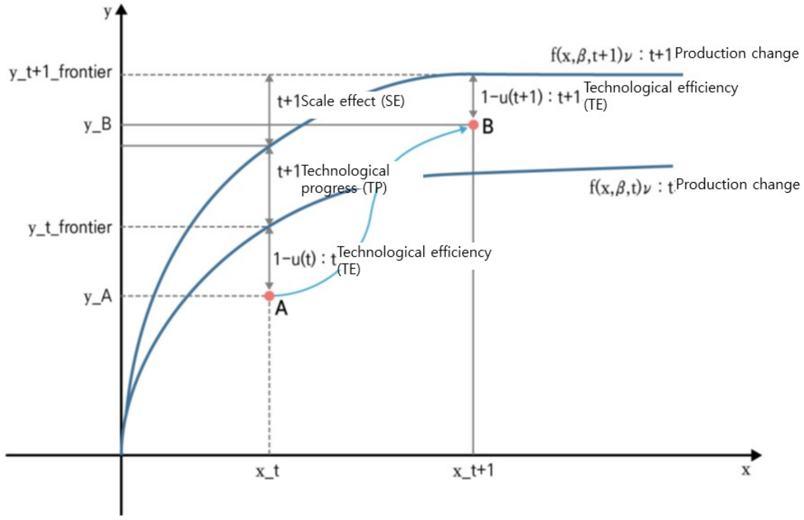
    I=1,…,N, t=1,…,T, j,k = L,K

- Equation (3) is decomposed into production output change due to passage of time, output change due to technological efficiency and output change due to scale effect.

  - ① Technological progress (TP): $TP = \frac{d\ln f}{dt} = \alpha_t + 2\beta_{tt} t + \sum_{j}^{J} \beta_{tj} \ln x_j$
  - ② Technological efficiency (TE): $u_{it} = \exp\{-\eta(t-T)\} u_i$
  - ③ Scale effect (SE): $\epsilon_j = \frac{d\ln f}{d\ln x_j} = \alpha_j + \sum_{j}^{J} \beta_{jk} \ln x_k + 2\beta_{jj} \ln x_j + \beta_{tj} t$

- Total Factor Productivity is represented as the sum of technological progress, technological efficiency, and scale effect.

  - ④ Total factor productivity (TFP): TFP=TP+TE+SE



3. Outlook for technological efficiency by industry

- In 2023, the average technological efficiency of all industries is expected to be 0.563. In the manufacturing and services industries, it is expected to be 0.979 and 0.625, respectively.
  – A technological efficiency gap of 0.354p will show up between services and manufacturing.

	Average of all industries	Agriculture and fishing	Mining	Manufacturing	Electricity/ gas/water-supply	Construction	Services
2021	0.553	0.320	0.285	0.978	0.326	0.794	0.613
2022f	0.558	0.327	0.292	0.978	0.333	0.798	0.619
2023f	0.563	0.335	0.299	0.979	0.341	0.801	0.625
2017-2021	0.542	0.306	0.271	0.977	0.312	0.787	0.601
2022-2023f	0.560	0.331	0.295	0.979	0.337	0.800	0.622

- In 2023, the technological efficiency of the manufacturing industry is expected to increase by 0.04% from the previous year's level and that of the services industry by 0.93%.
  – The technological efficiency of the services industry will increase at a faster speed than that of manufacturing.

<Trend of and outlook for the increase rate of technological efficiency by industry>

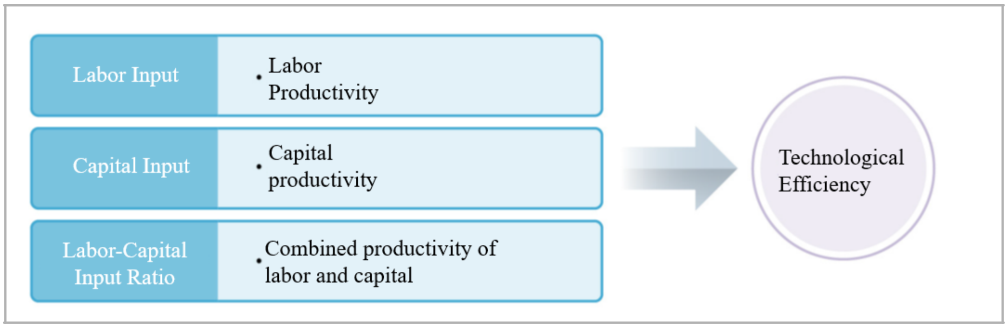
(%)

	Average of all industries	Agriculture and fishing	Mining	Manufacturing	Electricity/ gas/ water-supply	Construction	Services
2021	0.94	2.25	2.49	0.04	2.22	0.45	0.96
2022f	0.93	2.21	2.44	0.04	2.17	0.44	0.94
2023f	0.92	2.17	2.39	0.04	2.13	0.43	0.93
2017-2021	0.96	2.32	2.57	0.04	2.28	0.47	0.99
2022-2023f	0.92	2.19	2.42	0.04	2.15	0.44	0.93

Total Factor Productivity can be separated into the three components of technological efficiency, technological progress, and scale effects. In this section, the levels of technological efficiency in each industry are projected along with their respective rates of increase. Technological efficiency is a productivity enhancement that manifests itself, irrespective of time, in the form of technological pairing of production functions or changed input proportions. It is the largest component of total factor productivity. The level of technological efficiency for each industry in 2022-2023 was projected using the values of industry output, labor input and production capital stock as estimated in Section 2.

The technological efficiency of each industry is determined by labor productivity, capital productivity, and the combined productivity of labor and capital during the process of inputting capital and labor. The relationships between the key variables and technological efficiency are illustrated below.

[Figure II-11] Relationship between technological efficiency and determinant factors for each industry



The projection results reveal the average technological efficiency in 2023 to be 0.563 for the entire industry, an increase of 0.005p over the previous year. If one examines the projected technological efficiency for each industry, it will be 0.979 for manufacturing (an increase of 0.001p from the previous year), and 0.625 for services (an increase of 0.006p from the previous year). The 2023 projections for other sectors show 0.801 for construction, 0.341 for electricity/gas/water-supply, 0.335 for agriculture and fishing, and 0.299 for mining.

From these results, it can be concluded that technological efficiency in the service industries will remain at a lower level than in manufacturing. Based on the figures for 2023, a technological efficiency gap of 0.354p will show up between services and manufacturing. The technological efficiency levels of all six major industry groupings will increase from the previous year's levels, but differences in the technological efficiency levels are expected to appear continuously among the different categories. The services industry's share of the national economic output and total employment is over 50%, yet its technological efficiency level is projected to be lower than that of manufacturing. The reason for this paradox could be explained as follows: heretofore, the rate of increase of labor productivity in the service industry was always lower than in manufacturing, but the rate of increase of labor input in services was higher, and that of capital input lower, than in manufacturing. These trends are expected to continue to appear in 2023.

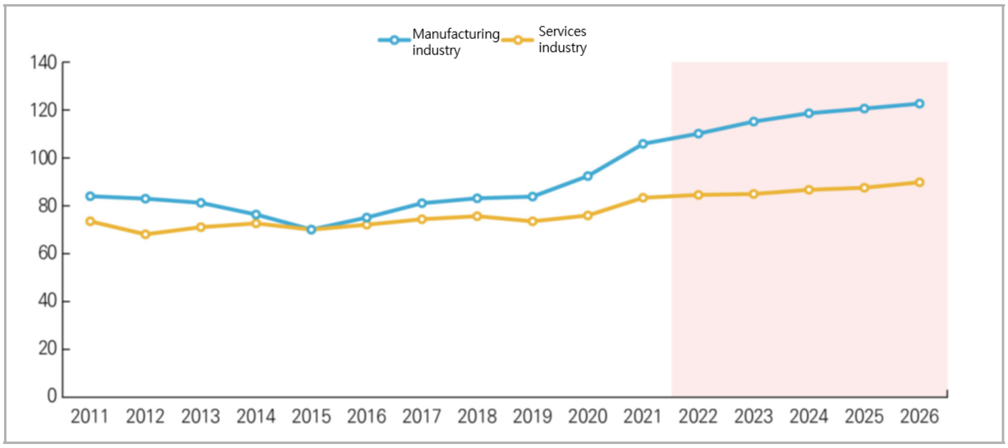
Using the projections for the labor input level and output for each year and industry generated in the preceding section, labor productivity levels were estimated at the industry level for each year. During the period 2021-2023, the labor productivity (based on total output) of the manufacturing industries is anticipated to rise by 5.3p from 120.5 to 125.8, while that of the service industries is anticipated to rise by 0.9p from 107.6 to 108.5.

[Table II-6] Projection for the labor productivity index of the manufacturing and service sectors

	2021	2022	2023	2024	2025	2026
Manufacturing	120.5	122.9	125.8	127.8	128.9	130.1
Services	107.6	108.3	108.5	109.5	110.0	111.3

Note: The labor productivity index was calculated by dividing the total output index by the total labor input index (using 2015 data).

[Figure II-12] Trend and projection of the labor productivity index based on the index calculated for the manufacturing and service industries



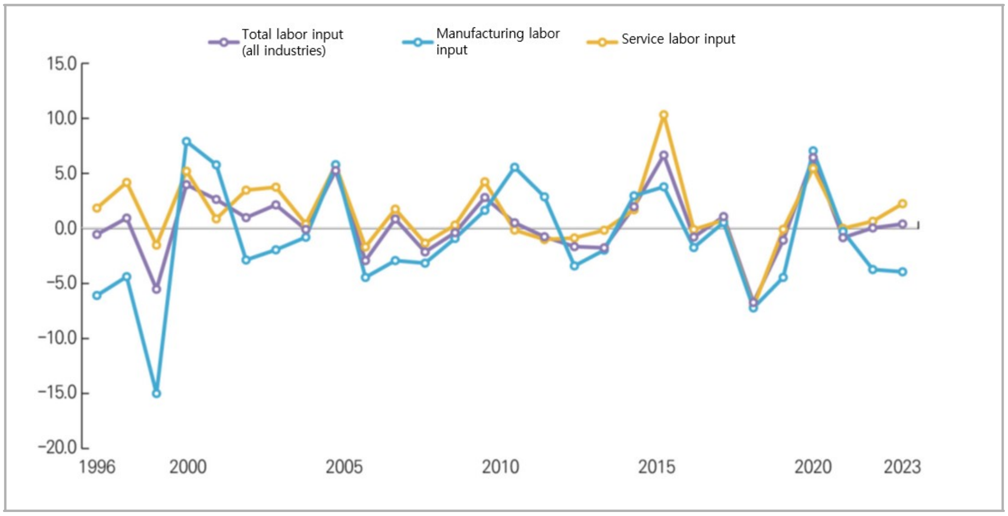
Source: Created by NABO using data released by KOSTAT.

The reason for the large gap between the labor productivity indexes of manufacturing and services predicted for the years 2021-2023 is related to trends in the output and labor input of each industry. Despite increasing output, the average levels of labor input (labor input per hour) in manufacturing are projected to decline, whereas in the services sector, the average levels of labor input (labor input level per hour) are projected to increase together with the rising output. Consequently, labor productivity (which is calculated as the output per hour of labor input) in the manufacturing sector will not only be higher than that of the services sector, but the gap will widen in the future.

To improve technological efficiency (which consists of technological pairings of labor and capital), the labor input increase rate in the service sector (where labor productivity is increasing at a slower rate than in the service sector) must become lower than in manufacturing, and the capital input increase rate in services must become relatively higher than in manufacturing.

However, as can be observed in [Figure II-13], with the exception of a few periods in the 2000s, the labor input increase rate was always higher for services than it was for manufacturing. In the projections made for the period 2022-2023, the labor input increase rate is expected to be higher (on average) in the services industry than in the manufacturing sector.

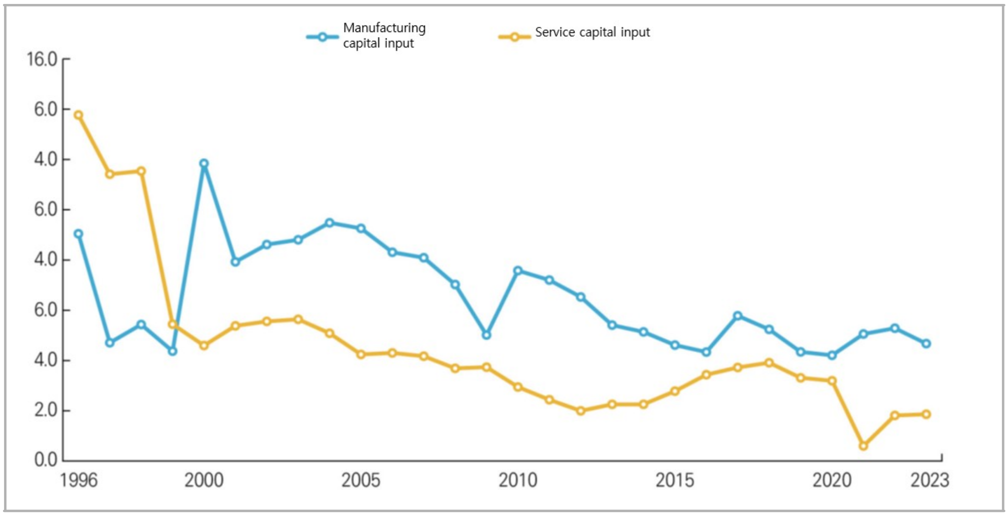
[Figure II-13] Comparison of the projection and trend of labor input growth rates in the manufacturing and service industries



Source: NABO's own estimates.

When it comes to capital input, as can be seen in [Figure II-14], from the time when South Korea had to seek financial assistance during the Asian Financial Crisis of the late 1990s up until the present day, the capital input increase rate of the services industry has always been smaller than that of manufacturing. It is also expected to remain below (on average) the capital input increase of manufacturing during the years 2022-2023.

[Figure II-14] Comparison of the projection and trend of capital input growth rates in the manufacturing and service industries



Source: NABO's own estimates.

In 2023, the gap is anticipated to narrow slightly despite forewarnings that the technological efficiency gap between manufacturing and services will be huge. This is because the technological efficiency increase rate of the services industry will be higher than that of manufacturing. If projections are made about the technological efficiency increase rates for the period 2022-2023, the increase rates of the manufacturing and service sectors come out as 0.04% and 0.93%, respectively. Thus, it is predicted that the relatively higher technological efficiency increase rate of the services sector will narrow the gap between the manufacturing and service sectors.

Next, during the period 2022-2023, the mining sector is expected to show the highest rate of increase of technological efficiency (2.42%), followed by agriculture and fishing (2.19%) and electricity/gas/water supply (2.15%). these three industries are small players in the national economy, the pace of technological innovation in these industries is expected to be quite fast. At the opposite end of the spectrum, the services industry is expected to record a technological efficiency increase rate of 0.93% during this period, followed by the construction industry (0.44%) and the manufacturing industry (0.04%).

4. Outlook for technological progress by industry

- In 2023, the average level of technological progress for all industries is expected to be –0.013, with the levels for manufacturing and services predicted to be -0.003 and 0.002, respectively.

	Average of all industries	Agriculture and fishing	Mining	Manufacturing	Electricity/ gas/ water-supply	Construction	Services
2021	-0.011	-0.013	-0.032	-0.002	-0.015	-0.010	0.003
2022[f]	-0.012	-0.014	-0.034	-0.002	-0.014	-0.011	0.003
2023[f]	-0.013	-0.014	-0.036	-0.003	-0.014	-0.011	0.002
2017-2021	-0.010	-0.012	-0.031	0.000	-0.013	-0.009	0.004
2022-2023[f]	-0.012	-0.014	-0.035	-0.003	-0.014	-0.011	0.002

The technological progress described in this report is the kind of progress wherein production output increases over time even though the quantity and input proportions of factors do not change.

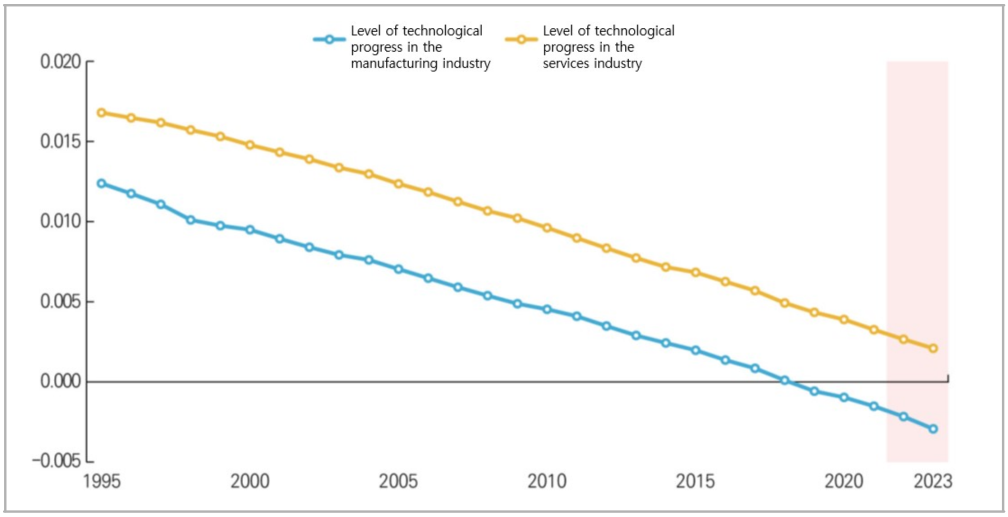
The level of technological progress for all industries will be equal to -0.013 on average in 2023. The level of technological progress will be -0.003 for manufacturing and 0.002 for services. The difference does not appear to be too enormous but, in general, the level of technological progress in the services industry will be higher than in manufacturing.

When industries are ranked on the level of technological progress for the years 2022-2023, the services industry comes out on top at 0.002, followed by manufacturing (-0.003), construction (-0.011), agriculture and fishing (–0.014), electricity/gas/water supply (–0.014), and mining (–0.035).

Therefore, during the years 2022 to 2023, without more labor and capital inputs, sectors like manufacturing, construction, electricity/gas/water supply, agriculture and fishing, and mining will experience a decline in their production output. The service industry is the exception here because it shows the highest level of technological progress. The reductions in production output will be most severe in the mining industry and in agriculture and fishing.

If the levels of technological progress in the manufacturing and service sectors are projected and compared, it would appear that manufacturing has, since 2019, been in a state in which the level of production output cannot increase unless other additional production factors are inputted. In the case of the service sector, even without the need to input additional production factors, with the passage of time it will be possible for the output level to rise during the period 2022-2023. This implies that the service industry is more likely to grow as a result of technological progress than the manufacturing industry.

[Figure II-15] Comparison of the projection and trend of technology advancements in the manufacturing and service industries



Source: NABO's own estimates.

5. Outlook for the scale effect by industry

- In 2023, the average scale effect for all industries is expected to be 0.005, with the scale effect for the manufacturing and service sectors predicted to be -0.009 and -0.003, respectively.

	Average of all industries	Agriculture and fishing	Mining	Manufacturing	ectricity/ gas/ water supply	Construction	Services
2021	-0.010	0.019	-0.059	-0.010	-0.010	0.000	-0.001
2022[f]	0.009	-0.001	0.068	-0.010	0.006	-0.006	-0.003
2023[f]	0.005	-0.001	0.050	-0.009	0.001	-0.005	-0.003
2017-2021	-0.007	-0.002	-0.009	-0.010	-0.009	-0.007	-0.005
2022-2023[f]	0.007	-0.001	0.059	-0.010	0.003	-0.006	-0.003

The scale effect is defined in this report as the increase in total output when the scale of production factors are increased, without making any changes to the input proportions of the production factors.

In 2023, the average scale effect for all sectors is expected to be 0.005, a 0.004p decline from the previous year. The scale effect will be –0.009 for the manufacturing sector and –0.003 for the service sector. If the scale effect is greater than 0, it means that the output level is increasing at a greater rate than the increase in scale, which could be interpreted as increasing returns to scale. Conversely, if the scale effect is less than 0, it means that the output level is increasing at a rate that is less than the increase in scale and could be interpreted as decreasing returns to scale.

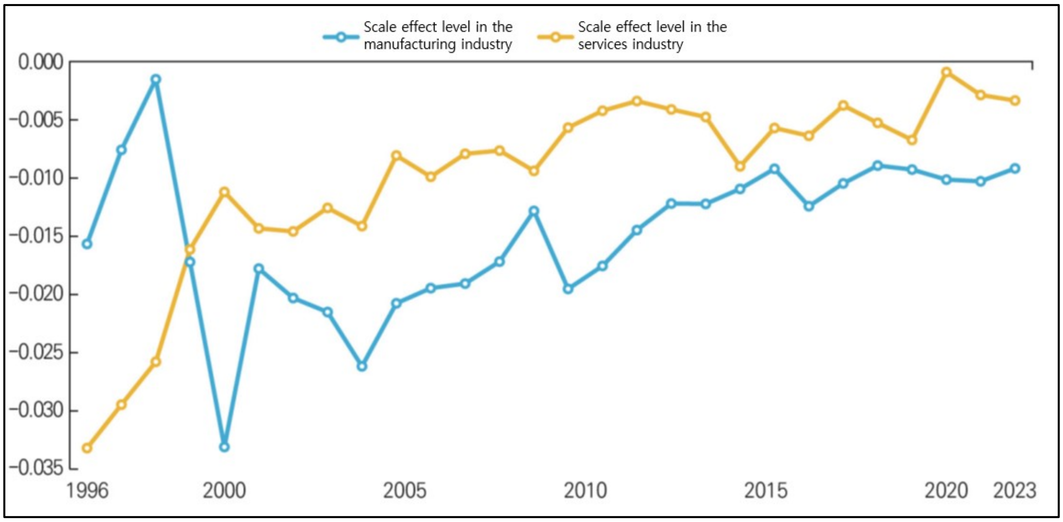
South Korea is a country that benefits from increasing returns to scale when seen from the average of all industries. In the years 2022 to 2023, the increasing returns to scale will be sustained. However, even if the increase in total output is due to the law of increasing returns to scale, the magnitude of the effect will only be 0.005 in absolute value, which is miniscule.

If the industrial sectors are ordered based on the magnitude of their expected scale effect levels for the years 2022-2023, mining comes out on top with an average scale effect of 0.059, followed by electricity/gas/water supply (0.003), agriculture and fishing (-0.001), services (-0.003), construction (-0.006) and, finally, manufacturing (-0.01).

Therefore, throughout 2022 and 2023, the scale effects in the mining and electricity/gas/water supply sectors will be small, but they will enjoy the benefits of increasing returns to scale.

If the levels of the scale effects in the manufacturing and service sectors are projected and compared, the scale effects in the services industry have been greater than in manufacturing ever since the 2000s. In the period 2022-2023, the scale effects in the services industry are projected to remain greater than in manufacturing.

[Figure II-16] Comparison of the projection and trend of effects of scale in the manufacturing and service industries



Source: NABO's own estimates.

6. Outlook for total factor productivity by industry

- In 2023, the average level of total factor productivity for all industries is expected to be 0.556, with the level for the manufacturing and service sectors being 0.967 and 0.623, respectively.

  – The productivity gap between the manufacturing and service industries is expected to continue into 2023.

[Outlook for and trends of total factor productivity by industry]

	Average of all industries	Agriculture and fishing	Mining	Manufacturing	Electricity/ gas/ water supply	Construction	Services
2021	0.531	0.326	0.194	0.966	0.302	0.784	0.615
2022^{f}	0.555	0.313	0.326	0.966	0.325	0.781	0.619
2023^{f}	0.556	0.319	0.313	0.967	0.327	0.785	0.623
2017-2021	0.525	0.293	0.231	0.966	0.290	0.771	0.601
2022-2023^{f}	0.555	0.316	0.319	0.966	0.326	0.783	0.621

- In 2023, the average increase rate of total factor productivity for all industries is expected to be 0.15%. The increase rate for the manufacturing and service sectors will be 0.08% and 0.76%, respectively.

  – The rate of increase of total factor productivity for the service industries will be greater than that of the manufacturing sector; hence the gap in total factor productivity is forecast to narrow in the future.

[Outlook for and trends of the increase rate of total factor productivity by industry]

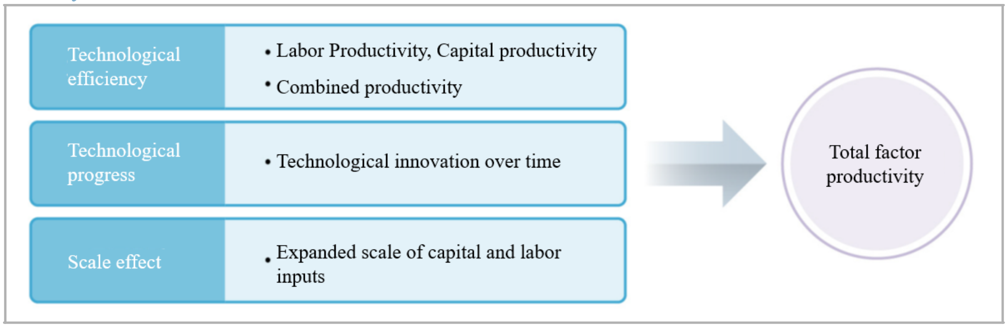
(Annual average, %)

	Average of all industries	Manufacturing	Services
2021	0.83	-0.10	1.82
2022^{f}	4.43	-0.04	0.52
2023^{f}	0.15	0.08	0.76
2017-2021	0.68	-0.03	2.04
2022-2023^{f}	2.29	0.02	0.64

If the earlier projections of technological efficiency (TE), technological progress (TP) and scale effect (SE) are combined, the total factor productivity (TFP) of each industry is obtained. In the following pages, projections are made about total factor productivity by industry, and their significance is examined.

As depicted in the figure below, the total factor productivity of each industry is determined by technological efficiency, technological progress, and scale effect, while technological efficiency is determined by labor productivity, capital productivity, and combined productivity. Technological progress is the level of technological innovation over time irrespective of the factor input levels. Total factor productivity is determined by these three effects.

[Figure II-17] Relationship between total factor productivity and determinant factors for each industry



The projection results are as follows. In 2023, the average total factor productivity level for all industries is projected to be 0.556, an increase of 0.001p over the previous year. The total factor productivity will be 0.967 for the manufacturing sector, and 0.623 for the service sector, indicating that the productivity gap between the manufacturing and service sectors will continue to exist in 2023. [6)]

If the average total factor productivity of all industries in the period 2022-2023 is broken down into its components, then technological efficiency was 0.542, technological progress was –0.01, and scale effect was 0.007, which gives a total factor productivity of 0.555, i.e. the combined effect of all three components. By applying the same method to the manufacturing and service industries in 2022-2023, the average total factor productivity levels are projected to be 0.966 and 0.621, respectively. Because the level of technological efficiency is so much greater than that of technological progress and scale effect, total factor productivity is projected to be slightly less than technological efficiency.

6) The total factor productivity levels presented in this report are the estimations for the six major industry groupings. Therefore, the total factor productivity of each industry is not the absolute value of total factor productivity, but rather a relative value.

In the case of manufacturing and services, technological efficiency is expected to increase continuously throughout the year, but the total factor productivity level, which contains technological progress and scale effects as additions, is expected to fall below the technological efficiency level.

[Table II-7] Trend and projection of total factor productivity for all industries, manufacturing and service industries

		Technological Efficiency (TE)	Technological Progress (TP)	Scale effect (SE)	Total Factor Productivity (TFP)
All industries	2022	0.558	-0.012	0.009	0.555
	2023	0.563	-0.013	0.005	0.556
Manufacturing	2022	0.978	-0.002	-0.010	0.966
	2023	0.979	-0.003	-0.009	0.967
Services	2022	0.619	0.003	-0.003	0.619
	2023	0.625	0.002	-0.003	0.623

Source: NABO's own estimates.

However, in the case of the service sector, because technological progress is forecast to maintain a positive value throughout the period 2022-2023, the level of output is projected to increase over time without any additional input of production factors, so the magnitude of the decreasing returns to scale will be greater than that of manufacturing. For this reason, when only technological progress and scale effects are considered, the reduction effect of total factor productivity is relatively smaller than that of manufacturing. Therefore, the rate of increase of total factor productivity will be greater for services than for manufacturing, thus reducing the total factor productivity gap between the manufacturing and service sectors.

When the increase rates of total factor productivity are projected, the average for all industries is expected to be 4.43% in 2022 and 0.15% in 2023. In 2022, rising input levels of total labor and total capital along with a rising level in technological efficiency will result in a much greater level of total factor productivity than in the previous year. However, in 2023 the amount of input increase in total labor and total capital will be smaller than in 2022 and the rise in the level of technological efficiency will also be more tempered, resulting in an increase in total factor productivity of smaller magnitude than that recorded in the previous year.

[Figure II-18] Trend and projection of the total factor productivity increase rate for all industries, manufacturing, and service industries

Source: NABO's own estimates.

The increase rate of total factor productivity in manufacturing is projected to be -0.04% and 0.08% in 2022 and 2023, respectively, while that for services is projected to be 0.52% and 0.76% in 2022 and 2023, respectively. Therefore, the total factor productivity gap between the manufacturing and service sectors is expected to be reduced because total factor productivity is increasing at a faster pace in the services sector than in the manufacturing sector (although the level is higher in manufacturing).

Total Factor Productivity is a comprehensive concept wherein productivity is determined not by a single factor but by the combination of capital and labor. In this sense, the productivity of the services industry is lower than that of manufacturing. Since the mid-1990s, the rate of increase of labor productivity in the services industry has always been lower than in the manufacturing sector. This was also true internationally.[7)] Because the rate of increase of labor productivity in the services industry is low, the strategy for reducing labor input and increasing capital input should have elevated the level of total factor productivity in the services. However, what actually happened was that more labor entered the service industry while the infusion of capital declined, resulting in a level of productivity (estimated as total factor productivity) that was worse overall than that of manufacturing. One of the specific reasons for the decline in labor productivity in the service sectors was the migration of low-grade workers into the services while capital investments remained at low levels.

If this trend in labor input and capital input remains the same in the years 2022-2023, the rate of increase of labor productivity in the service sector will decline. In the future, therefore, the productivity of the services industry will continue to lag behind manufacturing; but, on the positive side, the gap in total factor productivity between the service and manufacturing sectors will shrink somewhat because the rate of increase of total factor productivity in the service sector will outpace that of manufacturing.

As a strategy for growing its national economy, South Korea needs to come up with ways of increasing labor productivity and attracting more capital investments in the services sector.

7) According to the Bank of Korea (Jan. 2022), *An Analysis of South Korea's Changed Employment Structure, with the Focus on Job Shifting Between Industries*, BOK Issue Notes, the increase rate of labor productivity in the service industries fell from 1.2% in 1986 to 0.2% in 2018, and the level of labor productivity in the service sector (as of 2018) is only 53.2% of construction/manufacturing (compared with 85.8% in other OECD countries).

Chapter 3 Outlook for the growth rate of GHG emission

- In 2023, South Korea is expected to record an increase in its growth rate of GHG emission of -1.8%, 2.2%p lower than the previous year's 0.4%.

(Compared to the previous year, %)

2021p	2022f	2023f
3.5	0.4	-1.8

- Key factors behind changes

Upside Factors	Downside Factors
Increasing economic activity	Decreasing industrial production
Increasing production output in industries that consume a lot of energy	Improved energy utilization efficiency
Delays in the renewable energy supply schedule	Expanded use of low carbon energy sources and renewable energy technologies
Extreme weather events such as cold snaps and heat waves	Favorable climate environment

Section 1 Status in 2021

In 2021, South Korea emitted 679.6 million tons of greenhouse gases (hereafter, GHG), an increase of 3.5% from the previous year.[1] The level of GHG emission had been on the decline for two years from 2018, but it increased in 2021 due to the effects of the recovery in industrial production activities and increasing demand for transportation. Increasing level of GHG emissions is now a global trend as the world continues to recover from the COVID-19 pandemic. However, South Korea's growth rate of emission (3.5%) is relatively low when compared to the global average (5.7%) or that of other key countries (6.2% for the USA, 7.0% for the EU, 4.8% for China). Furthermore, the emission level as of 2001 is 6.5% lower than the peak emission level recorded by South Korea in 2018.

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1) Ministry of Environment, "South Korea expects to generate 679.6 million tons of GHG emissions in 2021", press release dated 27.06.2022.

[Table II-8] GHG emission of South Korea for the past 5 years

(Units: 1M tons, %)

Year	2017	2018	2019	2020	2021
Emission level	711	727	701	657	680
growth rate	2.5	2.3	-3.5	-6.4	3.5

Source: NABO.

In 2021, the largest increase in national GHG emissions came from the energy sector. The weight of the energy sector over national GHG emissions in 2020 was 86.8%. In 2021, energy sector's GHG emissions increased by 3.61%, so its contribution to the total increase was 3.14%p. In other words, most of the total increase in national GHG emissions (3.50%) was due to the increase in energy sector's emissions. Industrial processes, agriculture, and waste materials contributed 0.38%p, 0.03%p and -0.05%p, respectively, to the total increase (as of 2021). To reflect these patterns properly, the forecasting model for national GHG emissions incorporates variables closely related to energy consumption.

[Table II-9] Sectoral contributions to the change of national GHG emissions

(Compared to the previous year, %, %p)

Sector	Weight	Change	Contribution
Total emission rate	100.0	3.50	3.50
Energy	86.8	3.61	3.14
Industrial processes	7.4	5.15	0.38
Agriculture	3.2	0.95	0.03
Waste materials	2.6	-1.75	-0.05

Source: NABO.

Section 2 Outlook for 2022-2023[2)]

The basic hypothesis used when making projections of national GHG emissions is the Environmental Kuznets Curve (EKC), which states that the relationship between a country's national GHG emissions and its per capita income can be expressed as an inverted u-shaped curve. According to this hypothesis, environmental pollution and per capita income are positively correlated in the early stages of a country's economic development, but the relationship between the two variables eventually becomes negatively correlated once the country's economic development reaches a certain threshold. The EKC hypothesis has been widely used to determine the relationship between economic growth and environmental pollution since it was first used in empirical analysis reports published by the National Institute of Economic Research (NBER), the World Bank (WB), and the International Labor Organization (ILO).[3)] Summarizing the empirical analysis results for the EKC hypothesis, the shape of EKC (slope and curvature, peak amplitude, income threshold, etc.) can vary depending on a country's national characteristics (industrial structure, citizens' preference towards environmental protection, and related technology level, etc.). [4)] A recent empirical study on Korean data also shows that EKC is inversely u-shaped for consumption-based emissions as well as production-based emissions. [5)] Meanwhile, GHG emissions (C) can be decomposed into ① carbon intensity of the energy source mix (C/E), ② energy intensity of the economy (E/G), ③ per capita GDP (G/P), and ④ population (P).[6)]

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2) The national GHG emission is the indicator widely used in discussions related to policy design and implementation (including the Nationally Determined Contributions, the Basic Plan for Long-term Electricity Supply and Demand), and analyses on GHG emissions. First, the reduction target set by the government is 4.1% per year for 12 years (2019-2030). When choosing this target, the government considered the purposes behind the "Framework Act on Carbon Neutrality and Green Growth for Coping with the Climate Crisis" as well international trends and domestic conditions. Since, in the past two years (2021~2022), the country has deviated from this linear path to achieving the target, discussions can take place on how to strengthen the reduction efforts. Furthermore, based on the 10th Basic Plan for Long-term Electricity Supply and Demand, the government is planning to adjust the energy source mix in order to meet the reduction target (149.91 M tons) for energy sector set out in the "Upward Adjustment Plan for the 2030 NDC" proposed by the government in October of last year. In the future, if the energy source mix is adjusted according to the government's plan, carbon intensity will be reduced, and the adjustment will contribute towards reaching the reduction targets.

3) Grossman, G.M., Krueger, A.B., (1991) *Environmental impacts of the North American Free Trade Agreement*, NBER Working paper 3914; Shafik, N., Bandyopadhyay, S., (1992) *Economic Growth and Environmental Quality: Time Series and Cross-Country Evidence*, Background Paper for the World Development Report, World Bank, Washington, DC.; Panayotou, T., (1993) *Empirical tests and policy analysis of environmental degradation at different stages of economic development*, ILO, Technology and Employment Programme, Geneva.

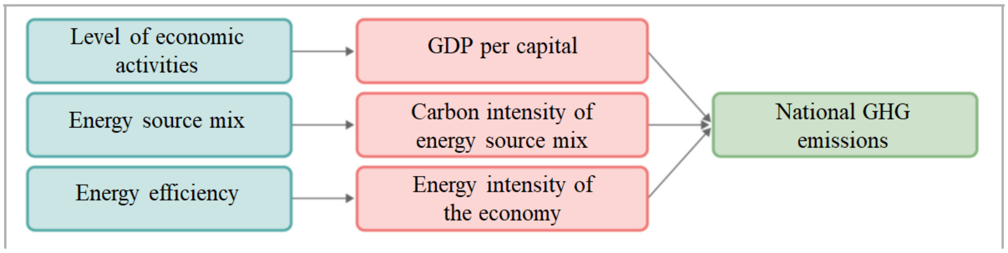
4) Dinda, S., (2004) *Environmental Kuznets Curve Hypothesis: A Survey*, Ecological Economics, 49, 431-455.

5) Cho Heung-jong, (2022) "*A Study on a Methodology for Calculating Greenhouse Gas Emissions: International Comparison of Production-Based Emissions and Consumption-Based Emissions*," NABO Policy Research Report.

Here, C represents GHD emissions, P represents population, G represents per capita GDP, and E represents the level of primary total energy consumption.

C, the level of GHG emissions, is an index that is tied to the NDC target and thus is subject to institutional framework like the emission trading system and the target management system. In addition, components ① and ② respond to policy tools used by the government to reduce the national GHG emissions. For example, carbon intensity of the energy source mix (C/E) shows the ratio of GHG emissions to the primary energy supply, and is closely tied to the share of renewable energy and nuclear power energy in the total energy supply. As another example, energy intensity of the economy (E/G) is an indicator that shows the energy efficiency of the national economy. Taking the above points into consideration, variables related to energy policy are added to the Environmental Kuznets Curve, and the national GHG emissions are estimated using the derived equation.[7)] When referring to the above theoretical background, the relationships between national GHG emissions and key determinant factors can be expressed as shown in [Figure II-19].

[Figure II-19] Relationship between national GHG emissions and key determinant factors



Source: NABO.

For the data to be used in the forecasting model, observations collected over a period of forty-two years (1980-2021) were used. The sources of the data are as follows: the Greenhouse Gas Inventory and Research Center of Korea for national GHG emissions; the Bank of Korea's ECOS system for real GDP and population; and the Korea Energy Statistical Information System (KESIS) for energy consumption.

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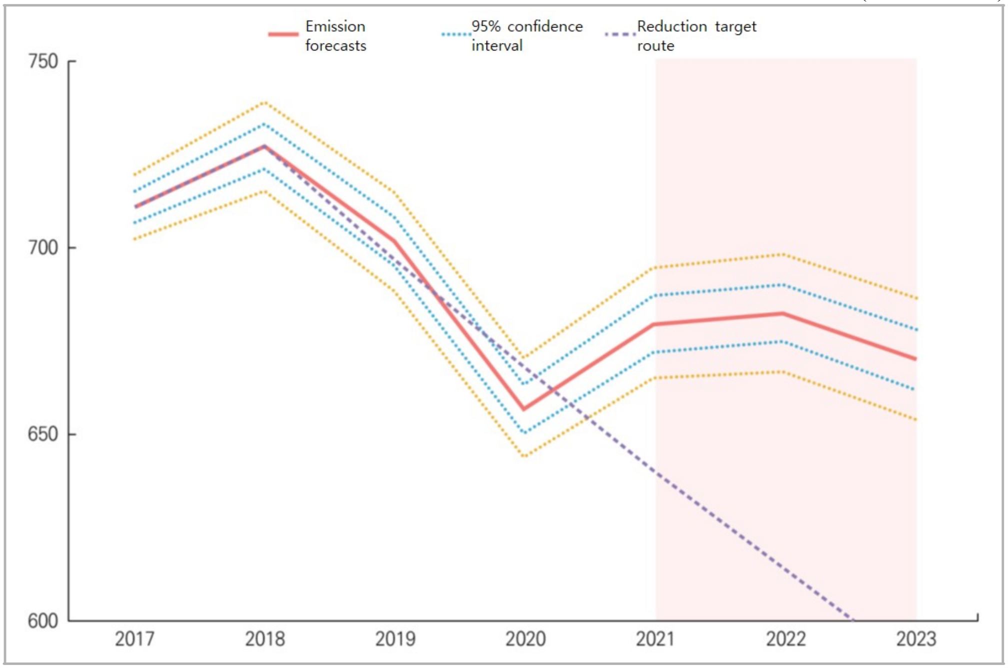
6) In other words, a Kaya Identity as shown below is established.
C = (C/E) x (E/G) x (G/P) x P.
IPCC, Emissions Scenarios, Intergovernmental Panel on Climate Change, Cambridge University Press, UK, 2000.

7) After the policy-related variables on both sides of the Kaya Identity equation are log-transformed, they are added to the Environmental Kuznets Curve. In other words, the log value of carbon intensity and the log value of energy intensity of the economy are used as the explanatory variables of the regression equation.

The forecasting results show that the national GHG emission in 2022 is expected to increase by 0.4% from the previous year's level because the shortage in the supply of gas for heating in winter will lead to increased consumption of coal, which in turn will increase GHG emissions in the energy sector. However, the GHG emission in 2023 is projected to decline by 1.8%. Such a decline will largely be due to the effects of the government's policies to increase the share of low carbon energy sources (nuclear, renewables, etc.), coupled with better management of energy demand and improved energy efficiency. The government has announced its 2030 reduction target at 40% (291.1 million tons) compared to the 2018 peak (727.6 million tons) and suggested a linear reduction route of -4.1% per year for 12 years (2019-2030). [Figure II-20] shows the predicted values and confidence intervals, combined with the linear route for the reduction target.

[Figure II-20] The forecasts of national GHG emissions

(Units: 1M tons)



Source: NABO.

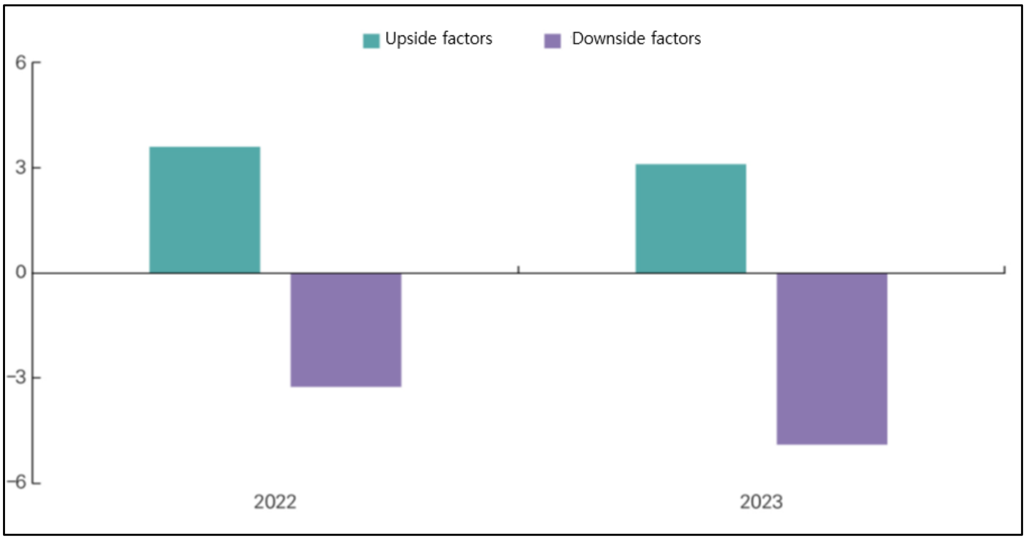
Referring to [Figure II-20], the upside and downside factors that could affect the projected levels in 2023 are as follows. First, once the COVID-19 quarantine measures have been relaxed and economic activities become more vibrant, GDP per capita will increase and this could affect the GHG emission. While the government takes steps to change the energy source mix, whether the plan is implemented as scheduled, the implementation speed and the change in carbon intensity could affect the national GHG emission accordingly.

The predictions in Figure II-20 are based on the assumption that the adjustment pace of the energy source mix will remain constant each year according to the adjustment plan[8)] announced by the Government. Thus, any adjustment accelerated than announced could become a downside factor that ultimately lowers the projection levels in 2023. In addition, by strengthening energy demand management and promoting investments aimed at making energy more efficiently used, the government is planning to gradually reduce the energy intensity. As these policies take effect, the resulting decline in energy intensity could act as another downside factor.

[Figure II-21] below illustrates the degrees to which the downside and upside factors could contribute to altering the national GHG emission. In 2022, the scale of contribution due to the upside factors will be roughly the same as that of the downside factors. In 2023, the contribution to the change in the GHG emission caused by the downside factors will be greater than that attributable to the upside factors.

[Figure II-21] Contribution of upside/downside factors to changes in the national GHG emission

(Units: %)



Source: NABO.

8) The Ministry of Trade, Industry and Energy releases the general subcommittee work plan for the 10th Basic Plan for Long-term Electricity Supply and Demand, press release dated 30.08. 2022.

Section 1 External and internal financial conditions

1. Global financial conditions

A. Global financial market trends

Since the 2nd half of 2021, the yield rates of the treasury bonds of key countries have shown a continuous rising trend overall. From the 2nd half of 2021 to the 1st quarter of 2022, treasury-bond yields rose because national economies began recovering as countries resumed their normal economic activities with the easing of the COVID-19 pandemic. On the other hand, after the 2nd quarter of 2022, the rapid rise in the treasury-bond yield rates of key countries is attributable to the monetary tightening policies pursued by the central banks of these countries (led by the US Federal Reserve) in response to price instabilities. The yield rate of US treasury bonds with a maturity period of ten years increased from 1.2% in July 2021 to 3.2% in August 2022, a rise of 2.0%p. During this same period, the yield rate of EU treasury bonds (with 10-year maturity) increased from –0.5% to 1.5, while that of Japanese treasury bonds rose from 0.0% to 0.2%. Meanwhile, the US Federal Reserve raised the base interest rate from 0.25% in July 2021 to 2.5% in August 2022, an increase of 2.25%p.

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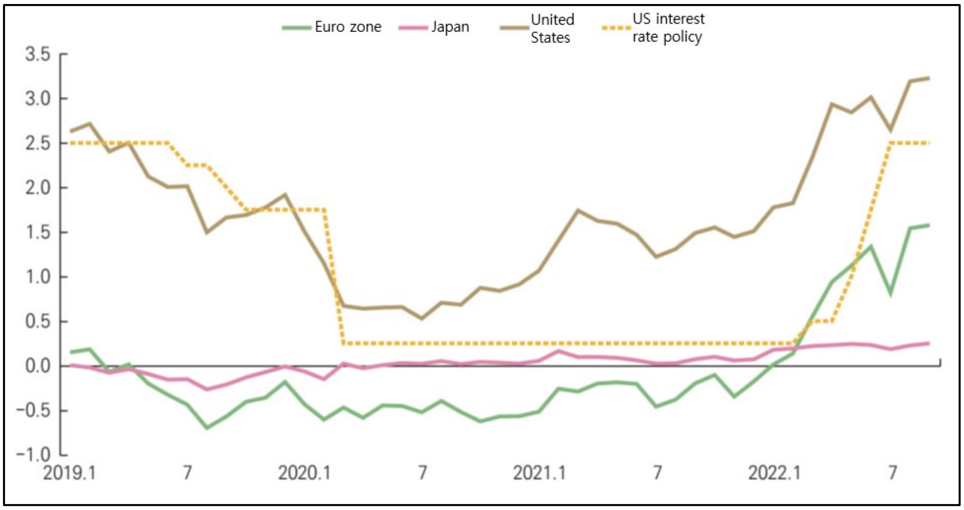
[Figure II-22] Trend in global treasury bonds (10-year)

(Units: %)

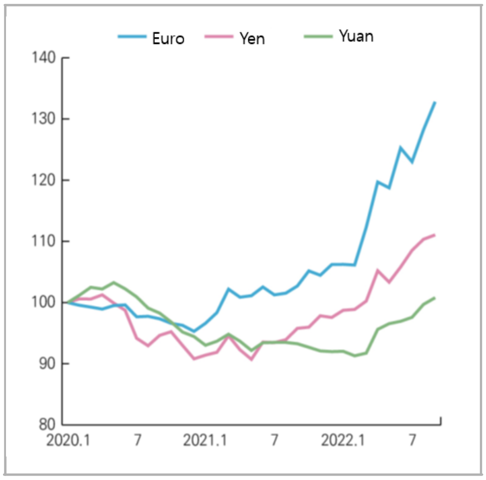


Source: Datastream.

Recently, the exchange rates of currencies against the dollar have been climbing in key countries. After the outbreak of the COVID-19 pandemic, the currencies of key countries rose in value against the dollar in 2020 as a result of the quantitative easing measures taken by the US Federal Reserve. However, the value of the Japanese yen began to fall in the first half of 2021, followed by the euro in the second half of 2021 and the yuan in 2022. This seems to be result of both the quantitative tightening pursued by the US Federal Reserve and a preference for safe assets at a time of i66ncreasing external uncertainties. As of the end of August 2022, the dollar to euro exchange rate was 10.3% higher than it had been at the end of January 2020, and the dollar to yen exchange rate was 28.3% higher than it had been at the end of January 2020. By contrast, the renminbi exchange rate declined by 0.3% during this same period. Entering 2022, the value of major currencies against the dollar fell by an even greater margin and, by the end of August 2022, the value of the euro had fallen by 13.1%, the yen by 20.8%, and the renminbi by 8.4% from their levels at the end of 2021.

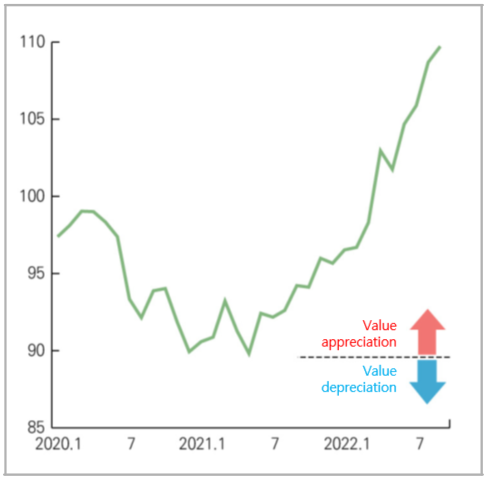
Meanwhile, the dollar index, which represents the value of the dollar against the value of other major currencies, was 108.7 at the end of August 2022, after climbing 11.6% points from the 90.6 recorded at the end of January 2020. This value of the dollar index at the end of August 2022 was 17.6% points higher than the value measured at the end of June 2021, and 11.6% points higher than that measured at the end of December 2021.

[Figure II-23] Changes in the exchange rates of key countries



Source: Datastream.

[Figure II-24] Trends in the dollar index



Source: Datastream.

The emerging market bond spread (global credit risk index)[1] and the US corporate bond spread[2] started showing a rising trend in 2022 because of the continuing war in Ukraine and the strengthened monetary tightening adopted by the central banks of major countries, including the US Federal Reserve - factors that drove up volatility. The emerging market bond spread was 386bp at the end of 2021 before climbing to 556bp at the end of February 2022. It dipped to 368bp at the end of March, but rebounded to reach 439bp at the end of August. The US corporate bond spread was 186bp at the end of 2021, but it began to fluctuate at the start of 2022. With uncertainties about the economy spreading (inflation), the growing preference for safe assets, the US corporate bond spread recorded 235bp at the end of August 2022.

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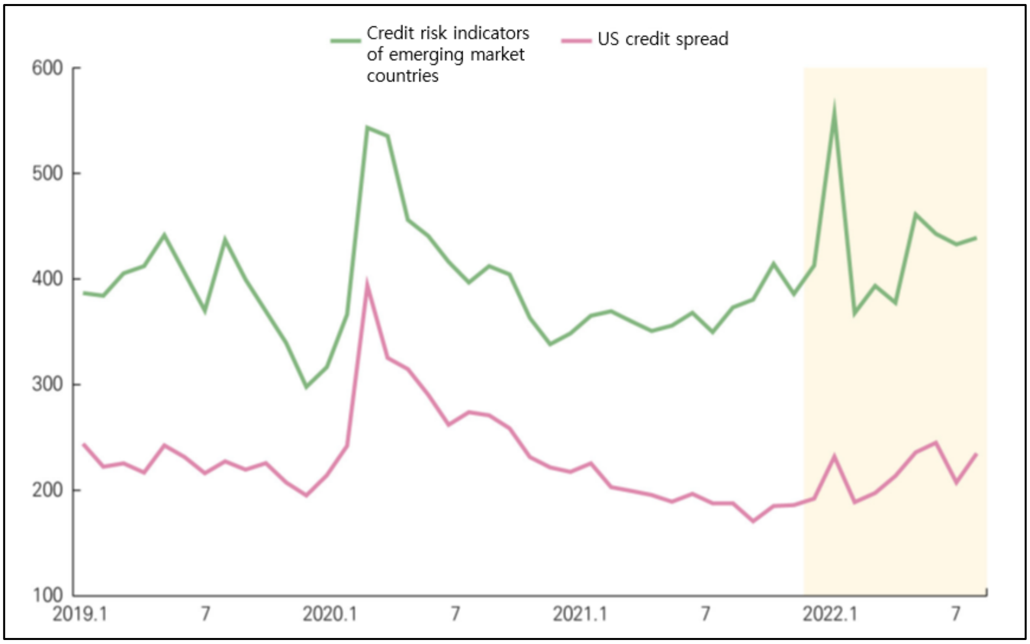
1) The emerging market bond spread is the difference in yield rate between the emerging market bond index (EMBI) and the developed market bond index, the latter being viewed as a safe asset. The emerging market bond spread increases when financial markets are unstable because people prefer safer assets and decreases when the financial markets stabilize.

2) The US corporate bond spread is the difference in the yield rates of US Baa rated corporate bonds (10 year maturity) and US treasury bonds (10 year maturity). When financial market risks emerge and the preference for safe assets increases, this spread widens.

[Figure II-25] Trend in the global credit risk indicator

(Units: bp)



Source: Datastream.

B. Monetary policy trends in major countries

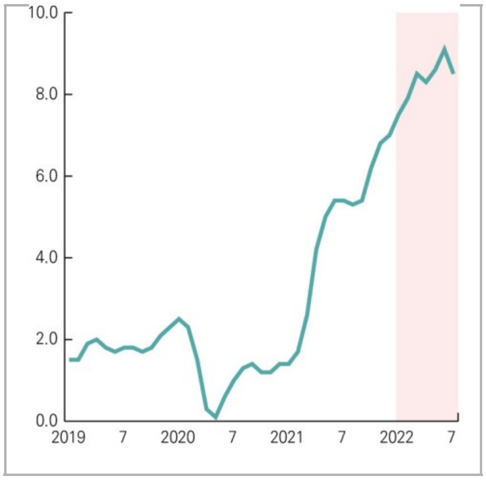
The central banks of major developed countries such as the United States, countries in the Eurozone[3] and Japan are strengthening their tight monetary policies to ward off the global price instability precipitated by expansionary monetary policies and supply chain disruptions after the start of the COVID-19 pandemic.

First, in November 2021, the US Federal Reserve announced tapering to reduce the scale of quantitative easing as the US economy appeared to recover from the shocks of the pandemic in mid-2021 and the economy seemed to be resuscitating. As price instability began to spread in 2022, the US Federal Reserve began to strengthen its stance on monetary tightening.

3) "Eurozone" refers to a country or region that has adopted and uses the euro as its national currency. The euro is the single currency of the European Union.

[Figure II-26] Trend in the increase rate of US consumer prices

(Unit: %)

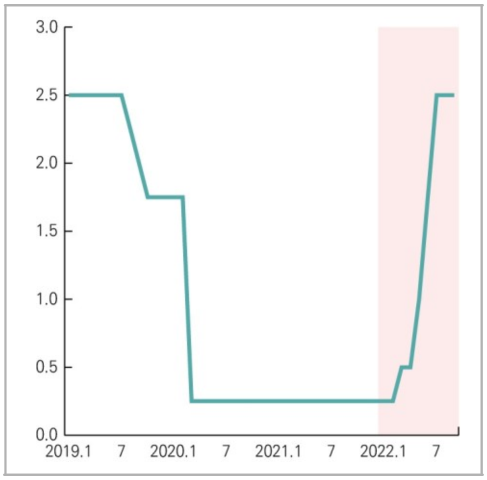


Note: Compared to the previous year.

Source: Bank of Korea.

[Figure II-27] Trend in the US base interest rate

(Unit: %)



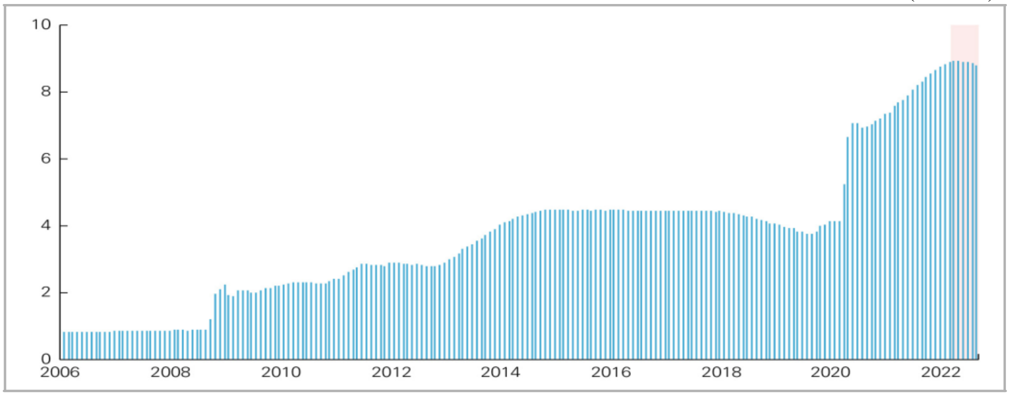
Source: Bank of Korea.

When US consumer prices began to rise steeply with the start of the year 2022, reaching a level of 7.9% in February, the US Federal Reserve hiked up the base interest rate by 0.25%p, which had been maintained at the upper level of 0.25% since the outbreak of the COVID-19 pandemic, on March 16, 2022. Afterwards, however, when US consumer prices began to climb at an even faster pace, ultimately exceeding 8%, the US Federal Reserve raised the base interest rate to 1.00% in May, to 1.75% in June, and to 2.50% in July. Meanwhile, the upward inflationary pressure in the US remained unabated, with the increase rate of consumer prices reaching 8.3% (compared to the rate recorded in August of the previous year) in August. As a result, at the meeting of the Federal Reserve's Federal Open Market Committee (FOMC) scheduled for September, November and December of 2022, and there is a high probability for further hikes in the base interest rate.

Furthermore, when the COVID-19 pandemic began to spread widely in 2020, the US Federal Reserve introduced additional quantitative easing measures, injecting $4.5 trillion into the economy in a bid to boost economic conditions. But when inflation risks began to grow in 2022, the Federal Reserve began to pursue quantitative tightening in June of that year to reduce liquidity. To that end, the US Federal Reserve sold off $ 30 billion of treasury bonds and $ 17.5 billion of mortgage-backed securities (MBS) every month from June 2022. In September, it will further reduce its holdings by selling $60 billion of treasury bonds and $35 billion of mortgage-backed securities every month.

[Figure II-28] Trend in total assets held by the US Federal Reserve

(Units: %)

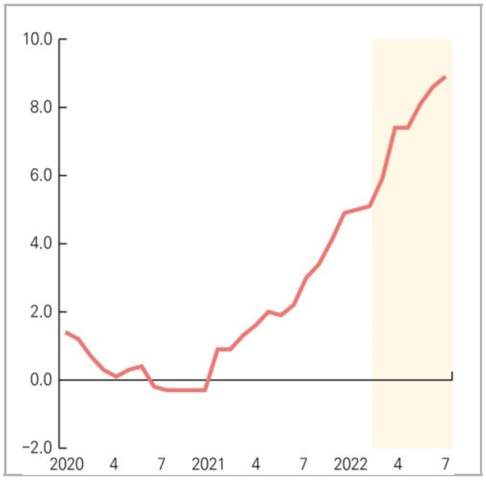


Source: Bank of Korea.

The countries of the Eurozone are also experiencing high inflation rates due to the quantitative easing measures adopted to deal with the COVID-19 pandemic and rising prices, namely those of raw materials, caused by the war in Ukraine. The consumer inflation rate in Eurozone countries was (compared to the previous year) 6.1% and 8.0% in the 1st and 2nd quarters of 2022, respectively, rising to 9.1% in August 2022. The European Central Bank (ECB) responded to this by raising the base interest rate, which had been kept at 0.0%, by 0.50%p in July 2022, and raised it by a further 0.75%p to 1.25% in September 2022.

[Figure II-29] Trend in the increase rate of consumer prices in the Eurozone

(Unit: %)

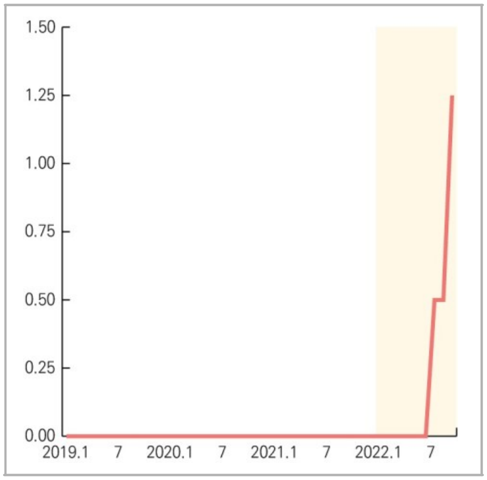


Note: Compared to the previous year

Source: OECD.

[Figure II-30] Trend of the base interest rate in the Eurozone

(Unit: %)



Source: Bank of Korea

The European Central Bank (ECB) sets the base interest rate at a monetary policy meeting attended by six permanent executive members and the central bank governors of nineteen member states. Therefore, this is a structure wherein the decisions reached on currency policies could affect the economic conditions of not only the whole Eurozone but also the individual economies of the member countries. The nineteen member states in the Eurozone reported the following inflation rates from January to July of 2022: France, Germany and Italy reported relatively low rates of 4.7%, 6.8%, 6.5%, respectively. On the other hand, Slovakia, Estonia and Latvia reported inflation rates of 11.3%, 17.4%, 14.1% respectively. So there is clearly a gap between countries. This kind of situation no doubt influences both the margin and the speed of the hike in the basic interest rate that the ECB might decide to enforce. On a related note, future monetary policy meetings at the ECB are scheduled to be held in October and December 2022.

In the case of Japan, the central bank is maintaining the basic interest rate at -0.10% until September 2022 because the inflation rate is not as high as it is in the United States and the Eurozone. Moreover, the Bank of Japan decided at its monetary policy meeting held in July 2022 to maintain the quantitative easing policy of purchasing assets and freezing the base interest rate. However, inflation is showing signs of a slightly rising trend because, while the inflation rates in the 3rd and 4th quarters of 2021 (compared to the same period in the previous year) were -0.2% and 0.5%, respectively, the inflation rates in the 1st and 2nd quarters of 2022 (compared to the previous year) were 0.9% and 2.5%, respectively. And in July 2022, the inflation rate stood at 2.6%, indicating a rising trend.

[Figure II-31] Trend in the increase rate of consumer prices in Japan

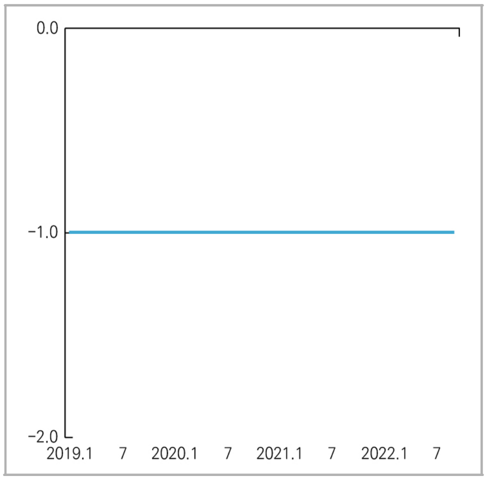
(Unit: %)

Note: Compared to the previous year.

Source: OECD.

[Figure II-32] Trend in Japan’s base interest rate

(Unit: %)



Source: Bank of Korea.

2. Domestic financial conditions

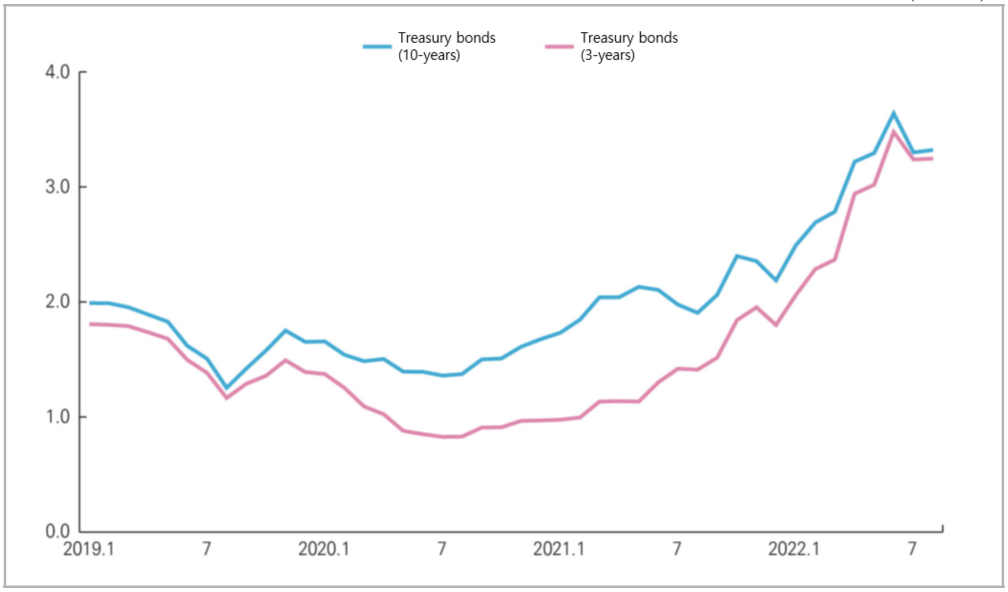
A. Domestic financial market trends

After the 2nd half of 2021, the yield rates of South Korea's treasury bonds displayed an overall rising trend due to expectations that the economy is recovering. But as the country entered the year 2022, the yield rates began rising even faster after the Bank of Korea increased the base interest rate in response to global price instabilities. The yield rates of South Korea's treasury bonds (3-year maturity) increased from 1.4% in July 2021 to 3.2% by August 2022, an increase margin of 1.8%p. During this same period, the yield rates of treasury bonds with 10-year maturity increased by 1.3%p from 2.0% to 3.3%.

Meanwhile, the short-term/long-term spread in the yield rates of 10-year maturity treasury bonds and 3-year maturity treasury bonds was reduced from 0.6%p in July 2021 to 0.1%p in August 2022 due to widespread growing uncertainty about the economy.

[Figure II-33] Trend in the yield rate of South Korean treasury bonds

(Unit: %)



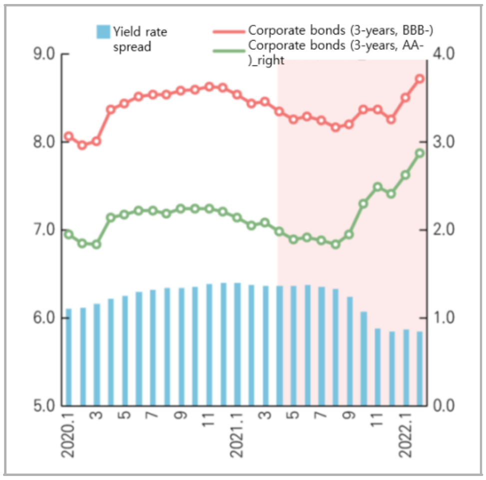
Note: The yield rate for treasury bonds is the average monthly yield rate.
Source: Bank of Korea.

Along with the rise in the yield rate of treasury bonds, market yield rates like corporate bond yield rates and the interest rate on loans are also on the rise. With the start of 2022, the Bank of Korea and the US Federal Reserve each tightened the money supply in response to the growing instability in price levels, which led to rising yield rates of domestic corporate bonds. For example, in August 2022, the yield rate of AA-rated corporate bonds (3-year maturity) was 4.2% and that of BBB-rated corporate bonds (3-year maturity) was 10.1%. Thus, compared to the previous year, the yield rates of these bonds rose by 1.8%p each. The yield rate of 4.2% for AA-rated corporate bonds (3-year maturity) is the highest level since May 2012, while the yield rate of 10.1% for BBB-rated corporate bonds (3-year maturity) is the highest level since March 2012.

In 2022, the interest rates on corporate loans and mortgage loans were also on the rise. As of July, the interest rate on loans to large corporations was 3.8%, up 98bp from the end of last year, while the interest rate on loans to SMEs was 4.4%, up 99bp from the previous month's level. In July 2022, the interest rate on mortgage loans for households was 4.2%, up 53bp from the end of the previous year.

[Figure II-34] Trend in the yield rate of South Korean corporate bonds

(%, %p) (%)

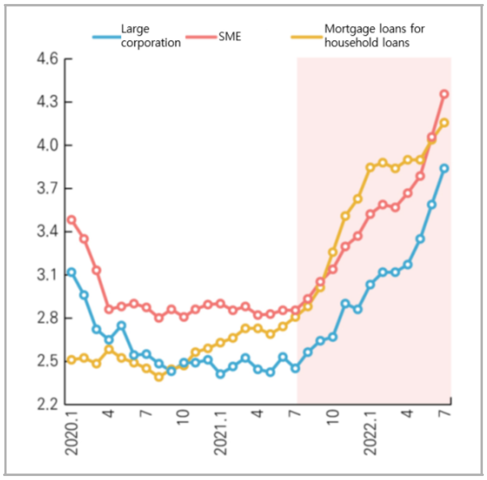


Note: Corporate bonds yield rate is average monthly yield rate.

Source: Bank of Korea.

[Figure II-35] Trend in corporate and household loan interest rates

(Unit: %)



Note: 1) Deposit bank loan basis.
2) New loan basis.
Source: Bank of Korea.

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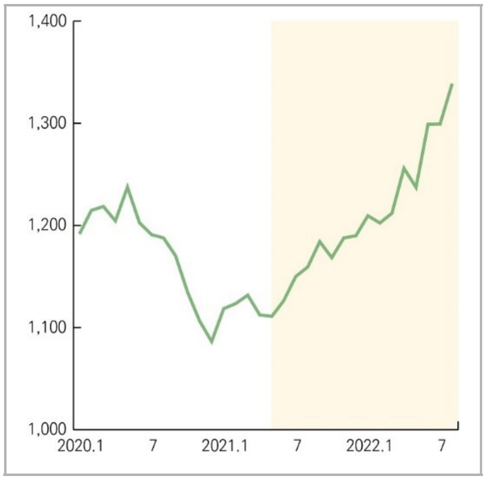
The won to US dollar exchange rate is showing a continuously rising trend. At the end of August 2022, the value of the won against the US dollar had declined by 12.5% (when compared to the level at the end of last year) due to increased external uncertainties, namely the war in Ukraine and the quantitative tightening imposed by the US Federal Reserve.

Since 2020, South Korea's credit risk indicators have been declining at a stable rate.

However, from the start of 2022, the range of volatility began widening due to geopolitical risks and increased monetary tightening by the central banks of key countries. South Korea's CDS premium[4] recorded 19.1bp at the end of December 2021, before starting to increase, reaching 53.3bp by the end of June 2022, and then falling to 32.7bp as of the end of August 2022.

[Figure II-36] Trend in the Korean won exchange rate

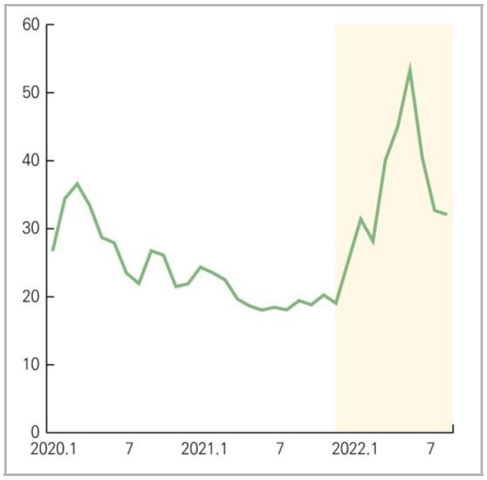
(Unit: KRW/$)



Source: Datastream.

[Figure II-37] Trend in South Korea's CDS premium

(Unit: bp)



Source: Datastream.

4) Credit Default Swap (CDS) is a financial derivative product that returns the principal if a company or country that has issued bonds goes bankrupt. The CDS premium rises if the credit risk of the institution or country that has issued bonds increases, and falls if the credit risk decreases.

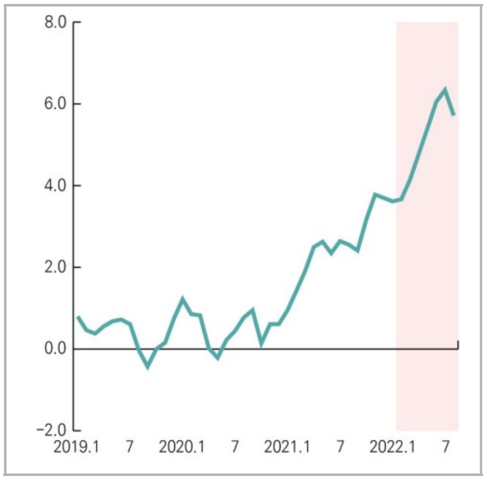
B. Monetary policy trends in South Korea

South Korea's Bank of Korea, like the US Federal Reserve and the European Central Bank (ECB), is strengthening its tight monetary policy to fight the recent global price instabilities. In 2022, due to the liquidity expansion policies adopted by the central banks of major countries to cope with the pandemic and the rising prices of raw materials triggered by the war in Ukraine, the South Korean economy suffered from high inflation rates. South Korea recorded a consumer price increase rate of around 2.5% in 2021, but in the 1st and 2nd quarters of 2022, the increase rate was 3.8% and 5.4%, respectively. By August, the consumer price increase rate had risen to 5.7%.

In 2021, as South Korea's economy appeared to be escaping from the negative effects of the COVID pandemic and firmly back on the path to recovery, the Bank of Korea raised the basic interest rate by 0.25%p from the 0.5% (the lowest level in the country's modern history) recorded in August 2021. In November of the same year the Bank of Korea raised the interest rate by another 0.25%p. In 2022, as the uncertainty surrounding consumer prices began to spread, the bank raised the base interest rate by 0.25%p in January, April and May, and then raised it again in July (by 0.5%p) and August (by 0.25%p), resulting in a base interest rate of 2.5% as of September 15, 2022.

[Figure II-38] Trend in the increase rate of consumer prices

(Unit: %)

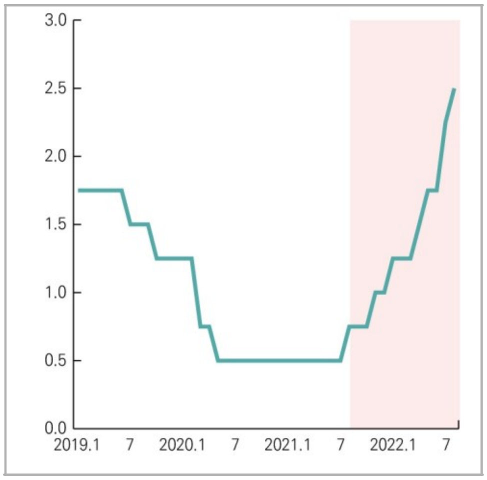


Note: Compared to the previous year.

Source: Bank of Korea.

[Figure II-39] Trend in the Bank of Korea's base interest rate

(Unit: %)



Source: Bank of Korea.

Section 2 Outlook for the yield rates of treasury bonds and corporate bonds

1. Outlook for 2023

- In 2023, the yield rate of treasury bonds (3-year maturity) is projected to be 3.0%, the same level as the previous year.

(Compared to the previous year, %)

2021	2022			2023
Annual	1st half	2nd half[f]	Annual[f]	Annual[f]
1.4	2.7	3.3	3.0	3.0

Note: f means forecast.

- In 2023, the yield rate of corporate bonds (3-year maturity, AA-) is projected to be 3.5%, a decrease of 0.3%p from the previous year

(Compared to the previous year, %)

2021	2022			2023
Annual	1st half	2nd half[f]	Annual[f]	Annual[f]
2.1	3.4	4.3	3.8	3.5

- Factors behind key changes

Upside factors	Downside factors
• Continuing uncertainty about prices	• Sluggish economic growth
• Tight monetary stance in South Korea and abroad	• Adjustment pressure in response to steep rising trend
	• Decline in consumption and investment due to growing uncertainties

In the 1st half of 2022, the yield rate of treasury bonds (3-year maturity) rose from the previous year's rate of 1.4% to 2.7% after a rise of 1.3%p. Such a large jump in the yield rate is usually the consequence of tight monetary measures such as a hike in the base interest rate introduced by the central banks of key countries (the Bank of Korea in the case of South Korea) to deal with worsening price instability.

The yield rate of treasury bonds (3-year maturity) is anticipated to keep on rising rapidly in the 2nd half, reaching a level of around 3.3%. Thus, the average annual yield rate of treasury bonds (3-years) in 2022 will be 3.0%, i.e. twice the rate of the 1.4% recorded in the previous year. As the global economy began to show signs of recovering from the pandemic and to pacify global price instabilities, the US Federal Reserve quickly moved at the beginning of the year to strengthen its monetary tightening measures. This and rising domestic prices spurred the Bank of Korea to accelerate its introduction of a hike of the base interest, causing the yield rate of treasury bonds to rise sharply.

With the US Federal Reserve quickly enforcing quantitative tightening and raising the US interest rate, there are concerns that foreign capital will flow out of South Korea if the US interest rate rises above South Korea's interest rate, while upside pressure on the yield rate of treasury bonds is predicted to persist in the 2nd half and well into next year. However, given that the yield rate of treasury bonds (3-years) has risen steeply and the spread between the treasury-bond (3-years) yield rate and the base interest rate has widened, there is a possibility that the steep rising trend will face certain obstacles. Furthermore, the possibility that a steep hike in the interest rate next year might help slow down the rise in prices and, as a result, reduce the uncertainties related to the currency policies of the US Federal Reserve could act as a factor that increases the downside pressure on the interest rate. Based on this logic, the yield rate on treasury bonds (3-year maturity) in 2023 is predicted to reach its apex in the 1st half of 2023 before declining to its 2022 level. In 2023, the average annual yield rate of treasury bonds (3-years) is projected to become 3.0%, the same level as in 2022.

In the 1st half of 2022, the yield rate of corporate bonds (3-years, AA-) was 3.4%, an increase of 1.3%p from the 2.1% of 2021. This is attributable to the hike in the base interest rate introduced by the central banks of key countries, including South Korea, which drove the rise in the yield rates of treasury bonds. In the 2nd half of 2022, the yield rate of corporate bonds (3-years, AA-) is projected to reach 4.3% as the rapid rising trend continues unabated. Consequently, the average annual yield rate of corporate bonds (3-years, AA-) in 2022 is expected to reach 3.8%, an increase of 1.7%p from the average rate for the previous year. In 2023, the average annual yield rate of corporate bonds (3-years, AA-) is expected to fall by 0.3%p from the 2022 level to 3.5%. This fall will largely be attributable to reduced uncertainties surrounding the monetary policies of the central banks of key countries as a result of decreased global inflation risks and the slowdown in demand for funds, which is an outcome of the economic downturn. However, inflation, coupled with uncertainties surrounding the monetary policies of the central banks of key countries, could act as factors that limit the downside pressure on the bond yield rates.

The credit spread[5)] between the yield rate of corporate bonds (3-years, AA-) and that of treasury bonds (3-years) is expected to narrow as external uncertainties, such as concerns about global inflation, disappear. In 2022, the credit spread between corporate bonds (3-years, AA-) and treasury bonds (3-years) is projected to be 0.8%p, but this will decline to 0.5%p in 2023. Meanwhile the credit spread between corporate bonds (3-years, AA-) and treasury bonds (3-years) in the period (2017-2019) immediately preceding the outbreak of the COVID-19 pandemic was 0.5%p, but over the next three years (2020-2022) it expanded to 0.9%p.

An "expansion in credit spread" means that the difference between the yield rates of corporate bonds and treasury bonds has widened. This occurs because higher yield rates are expected for corporate bonds when compared to treasury bonds.

5) Credit spread is the yield gap between treasury bonds and corporate bonds. When a credit spread expands, it generally means that it is tougher for corporations to borrow money. In the case of South Korea, the most commonly used credit spread index is the one that describes the gap between the yield rates of treasury bonds with 3-year maturity and AA- rated corporate bonds with 3-year maturity.

Higher yield rates are expected for corporate bonds because it is thought that when economic conditions worsen or uncertainties about the economy increase, there is a greater likelihood that people will default on their debt obligations. The credit spread shows a tendency to expand when uncertainties regarding the economy increase and people believe that economic conditions will worsen, whereas it tends to contract when the economic outlook improves or uncertainties regarding the economy decline.

2. Outlook for the medium term[6)]

- During the period 2022-2026, the yield rate of treasury bonds (3-years) is projected to be 2.8% per year on average.
  – It is expected to rise by 1.2%p from the level of the previous five-year period (2017-2021).

(Annual average, %)

2022	2023	2024	2025	2026	2017~2021	2022~2026
3.0	3.0	2.8	2.6	2.6	1.6	2.8

- During the period 2022-2026, the yield rate of corporate bonds (3-years, AA-) is projected to be 3.2% per year on average.
  – It is expected to rise by 1.0%p from the level of the previous five-year period (2017-2021).

(Compared to the previous year, annual average, %)

2022	2023	2024	2025	2026	2017~2021	2022~2026
3.8	3.5	3.0	2.9	2.8	2.2	3.2

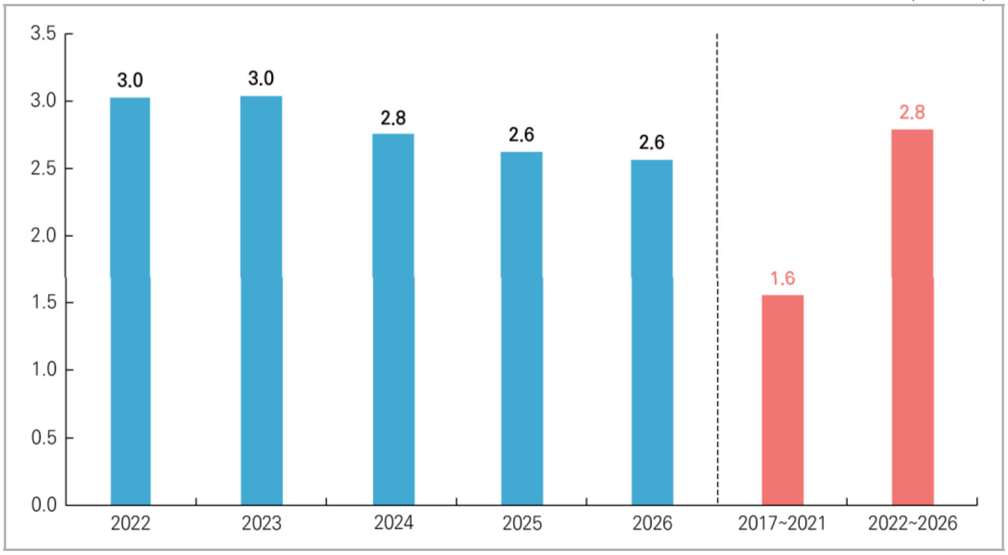
The yield rates of treasury bonds (3-years) and corporate bonds (3-years, AA-) for the five-year period 2022-2026 were estimated, taking into consideration empirical relationships such as the financial environment of South Korea and abroad, the marginal productivity of capital, and economic fundamentals. The results indicate that the yield rate of treasury bonds (3-years) will be 3.0% in 2022 and 3.0% in 2023, after which it will start to decline, falling to 2.8% in 2024 and to 2.6% in 2025-2026.

As for the average annual yield rate of treasury bonds (3-years) during the period 2022-2026, it is projected to reach 2.8%, an increase of 1.2%p from the 1.6% recorded during the previous five-year period (2017-2021). The increase will mainly be the result of hikes in the base interest rate taken by the Bank of Korea and the central banks of other key countries, as well as quantitative easing by the US Federal Reserve.

6) The yield rate is one of the most widely used economic indexes because it enables people to read the direction of the financial market as well as the risks. It has a close correlation with numerous economic variables such as consumption and investment.

[Figure II-40] Projected yield rate of treasury bonds (3-year) in the medium term

(Unit: %)



Projections of the yield rate of corporate bonds (3-years, AA-) for the period 2022-2026 indicate that the yield rate will hit the 3.8% mark in 2022. Afterwards, it will decline, reaching 3.5% in 2023, 3.0% in 2024, 2.9% in 2025, and 2.8% in 2026.

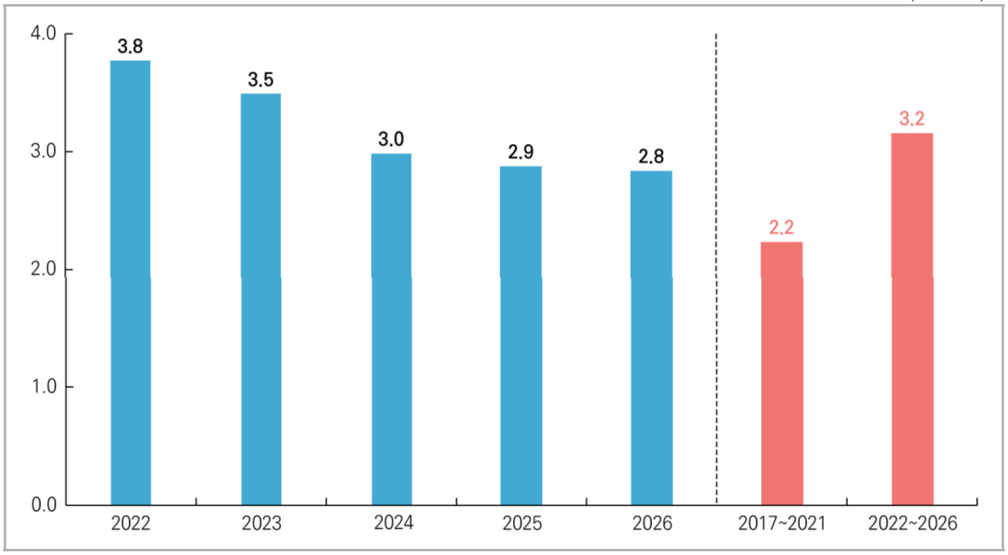
The average annual yield rate of corporate bonds (3-years, AA-) during the five-year period 2022-2026 is projected to be 3.2%, an increase of 1.0%p from the 2.2% recorded during the previous five-year period (2017-2021). The increase in the yield rate during the years 2022-2026 will be due to hikes in the basic interest rate hike taken by the Bank of Korea and the tight monetary policies of the US Federal Reserve and the central banks of key countries.

Because of external uncertainties, the credit spread[7)] between corporate bonds (3-years, AA-) and treasury bonds (3-years) during the period 2022-2026 is expected to fall from 0.8%p in 2022 to around 0.2%p by 2026.

7) Credit spread is the yield gap between treasury bonds and corporate bonds. When a credit spread expands, it implies that it is tougher for corporations to borrow money. In the case of South Korea, the most commonly used credit spread index is the one that describes the gap between the yield rates of treasury bonds with 3-year maturity and AA- rated corporate bonds with 3-year maturity.

[Figure II-41] Projected yield rate of corporate bonds (3-year, AA-) in the medium term

(Unit: %)



The factors that determine the market interest rate (i.e., yield rate) in the medium term could be explained in the following way. Marginal productivity of capital is the basic factor that determines the interest rate. The theory that best explains the interaction between the productivity of capital and the interest rate is the Ramsey (1928) model. [8) 9)] In Ramsey's model, the real interest rate is identical to the marginal productivity of capital. Thus, as growth in productivity slows down, the overall marginal productivity of capital in the economy gradually declines, leading to a decline in the real interest rate.

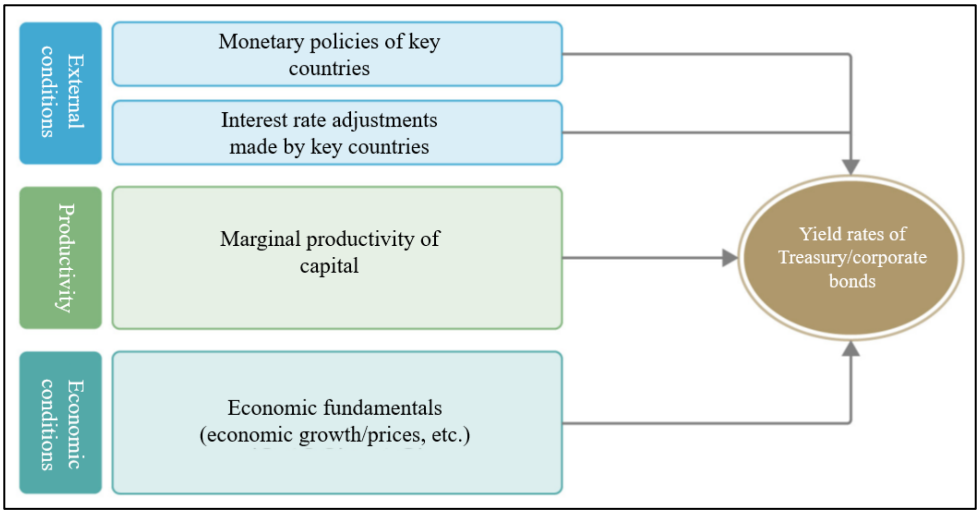
Furthermore, taking into account the global connectivity of the financial market, the movement in the yield rate of the US treasury bonds was selected as the forecast variable because US treasury bonds have the largest influence in financial markets. If the gap between the yield rates of South Korea and the US is reduced or reversed, foreign investors will lose the incentive to invest in South Korean bonds and capital will likely flow out of the country, and this will act as a downward pressure on the yield rate of South Korean treasury bonds and the value of the won. In addition, since the market interest (rate) is the nominal interest rate, economic fundamentals such as inflation also impact the yield rate of South Korean treasury bonds.

[Figure II-42] below illustrates the relationships between economic and financial factors that affect the bond market and the yield rates of treasury bonds and corporate bonds.

8) Ramsey, 1928, A Mathematical Theory of Saving.

9) Ramsey (1928) argued that a slowdown in the productivity increase rate leads to declining consumption and increased savings, and that this will in turn lower the interest rate. This means that the productivity increase rate and interest rates are positively correlated.

[Figure II-42] Connectivity between the yield rates of treasury corporate and bonds and the key determinant factors

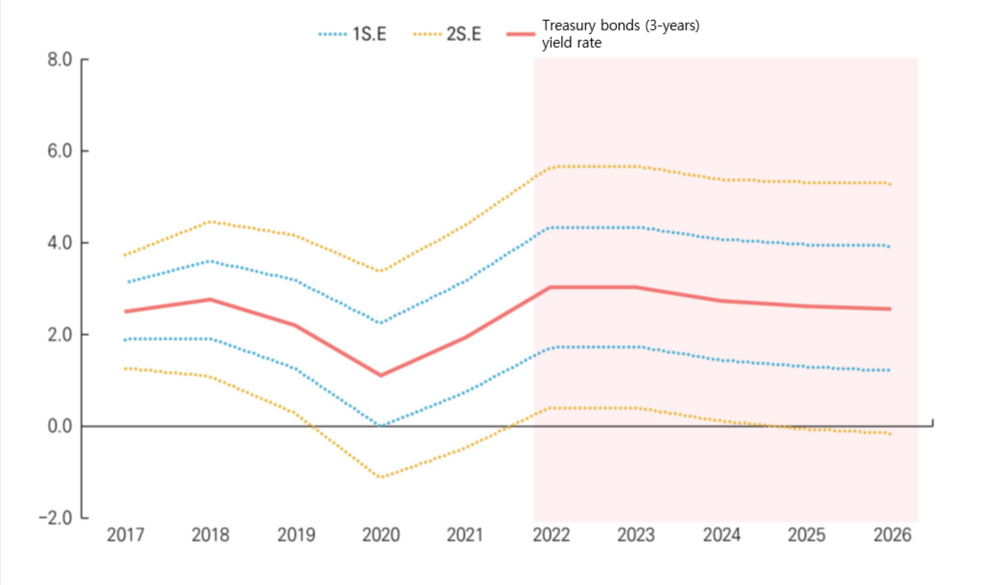


Source: NABO.

[Figure II-43] below shows the estimated levels of the yield rates of treasury bonds (3-years) and the corresponding confidence interval generated with the forecasting model. According to this model, the yield rate of treasury bonds (3-years) will rise by a large margin in 2022 due to increased monetary tightening by the US Federal Reserve and the hikes in the interest rate adopted by South Korea in response to price level instabilities, and this rising trend will extend into 2023. However, from 2024 this decline in the yield rate will stabilize. In the case of the projected yield rates of treasury bonds (3-years) for the period 2022-2026, the projected values are expected to be very similar to the estimations generated by the model.

[Figure II-43] Projected yield rate of treasury bonds (3-years) in the medium term

(Unit: %)



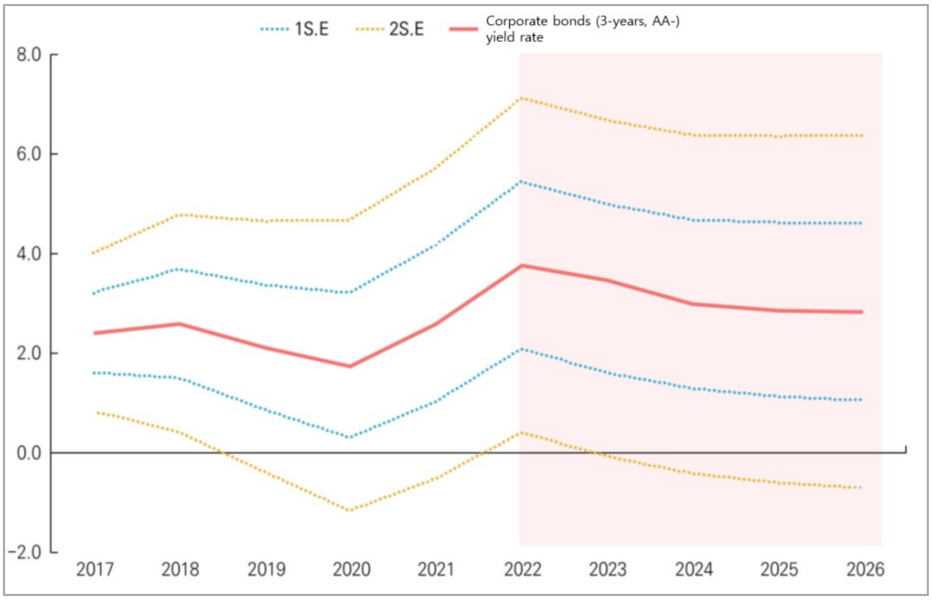
Note: S.E refers to standard error. [10)]

[Figure II-44] below shows the estimated levels of corporate bonds (3-years, AA-) yield rates and the corresponding confidence interval generated with the forecasting model. According to this model, the yield rate of corporate bonds (3-years) will rise by a large margin in 2022 due to increased monetary tightening by central banks of key countries including South Korea in response to price level instabilities as well as increased external uncertainties. This trend (external and domestic uncertainties related to the monetary policies of central banks) is expected to remain unchanged in 2023 and so the yield rate of corporate bonds (3-years, AA-) was slightly adjusted upwards from the level predicted by the model. During the 2024~2026 period, due to the effects of global price instability becoming less severe and more stable monetary policies pursued by central banks, the yield rate of corporate bonds is expected to exhibit an overall declining trend. During this period, the projected values are expected to be very similar to the yield rate estimations produced by the model.

10) The standard error is a number that indicates how much the mean of the population differs from the standard mean. It is defined as the standard deviation of the sample means.

[Figure II-44] Projected yield rate of corporate bonds (3-years, AA-) in the medium term

(Unit: %)



Note: S.E indicates Standard Error.

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- Growth and Finance -

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