28th AIM International Workshop
September 13, 2022

The impact of demographic structural changes on CO2 emission: Case of Korea

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Published in Jung et al. 2021. The impact of demographic changes on CO2 emission profiles: Cases of East Asian countries. *Sustainability. 13(2). 677*

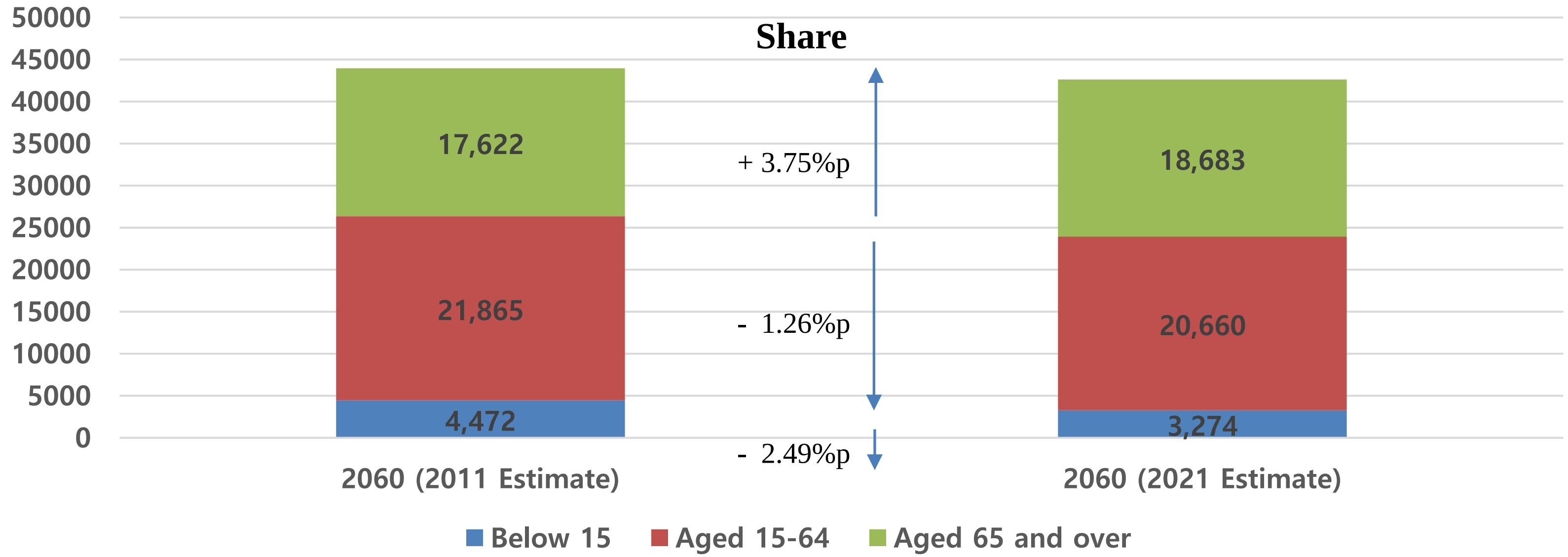
Research Background

Rapid Demographic Structural Change in Korea

- One of the fastest countries heading towards aged-society
  - Experienced a negative population growth in 2020 (due to COVID-19, low birth rates, etc.)
  - Decreasing youth and working-age population while increasing aged-population

Population Prospects in 2060 (2011 vs. 2021 Estimate)

Unit: Thousand



Source: KOSIS.2011.Korea and World Population Prospects; KOSIS. 2021. Population Prospects: 2020-2070

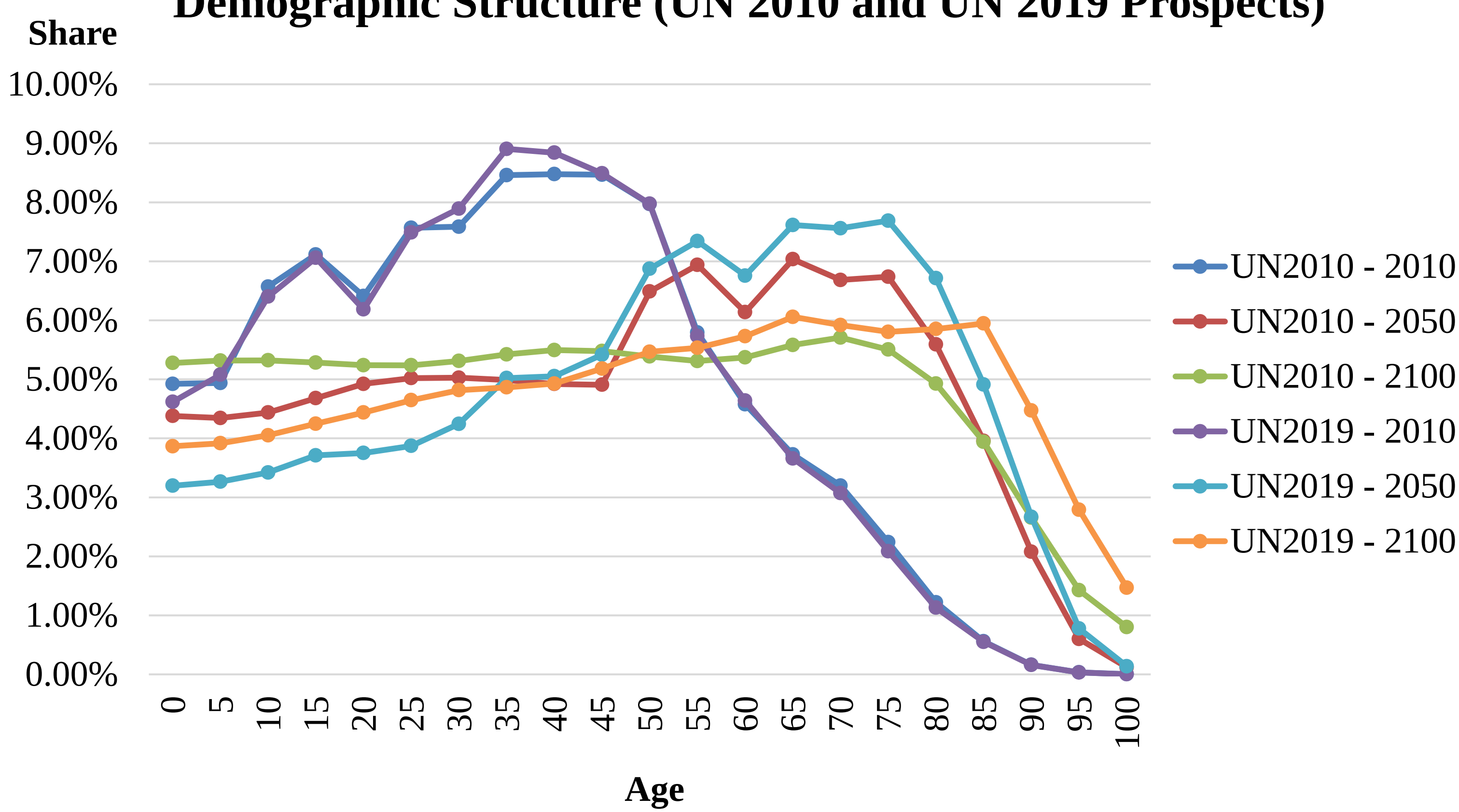
Research Background

Rapid Demographic Structural Change in Korea

- The comparison between UN Population Prospects in 2010 and 2019
  - ➢ The share of the population aged 65 or older in 2050

    ※ 32.8% (2010 Prospect) ➔ 38% (2019 Prospects)

Demographic Structure (UN 2010 and UN 2019 Prospects)



Research Background

Rapid Demographic Structural Change in Korea

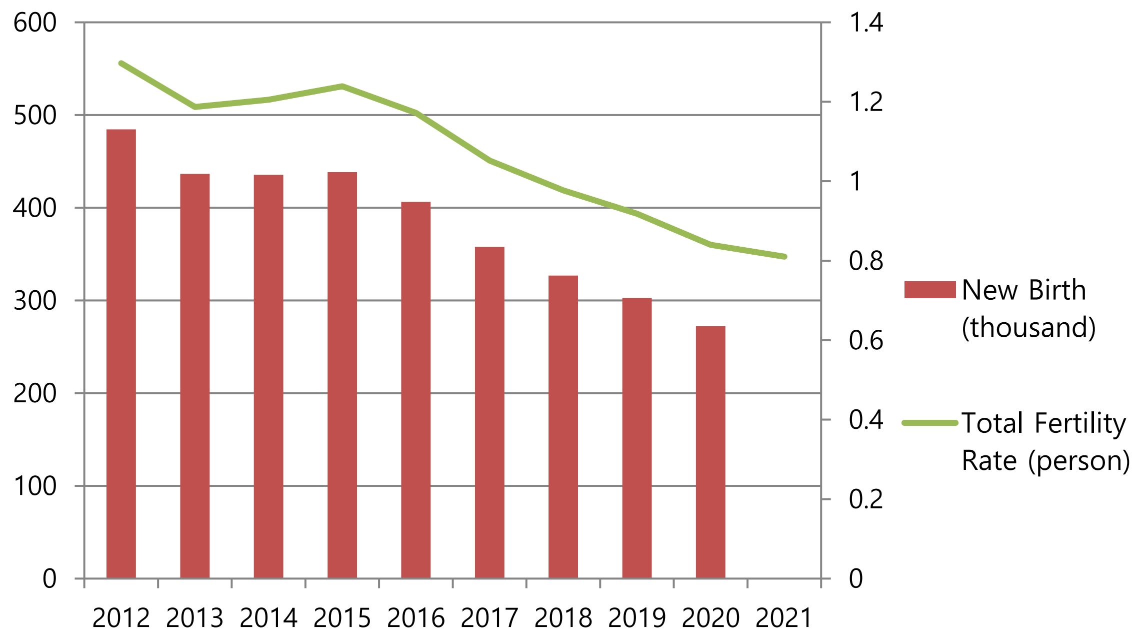
- Significant drop in birth rates

※ Total Fertility Rate: 1.297 (2012) ➔ 0.81 (2021)

※ Old-age dependency ratio (Number of people aged 65 and over per 100 people of working age (20-64))

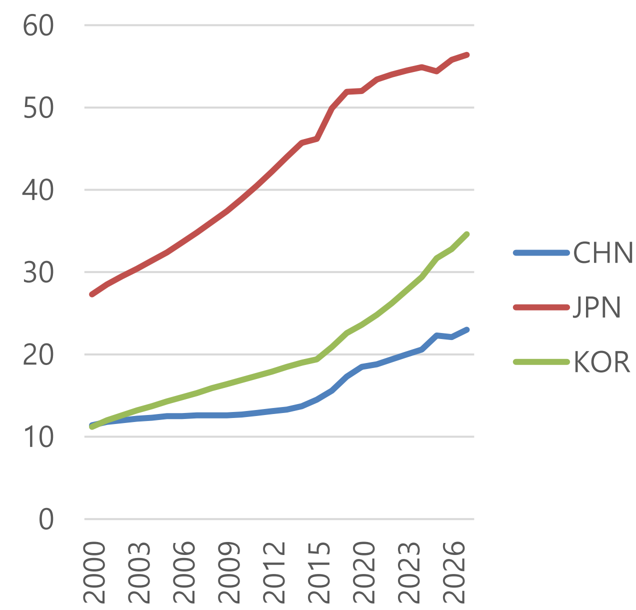
: 24.8% (2021) ➔ 47.5% (2050) [OECD Forecast]

New Birth and Fertility Rate



Source: KOSTAT. (2021). Total Fertility Rate; number of new birth
KOSIS. (2022). Number of new birth

Old-age dependency Ratio



Source: OECD. (2022), Old-age dependency ratio (indicator). doi: 10.1787/e0255c98-en (Accessed on 06 September 2022)

Previous Studies

Studies	Key Findings
Okada (2012)	• 26 countries (OECD/IEA countries, Japan) between 1978 and 2008 • A quadratic relationship between carbon emission per capita and aged population (emission per capita starts to decrease when the share of the aged population of a country reached a certain point)
Yu et al. (2018)	• Analyzed the changes in demographic characteristics affect the future energy consumption and carbon emissions of households in China. • Suggested that the decreasing trends of household size and the increasing aging population would lead to energy demand increase.
Noh and Lee (2013)	• Found a positive impact of the aging population on electricity consumption.
Keum et al. (2018)	• Identified a negative effect of the aging population ratio on the residential electricity consumption
Shin (2018)	• Identified that the aging population leads to make income elasticity more inelastic but price elasticity more elastic.

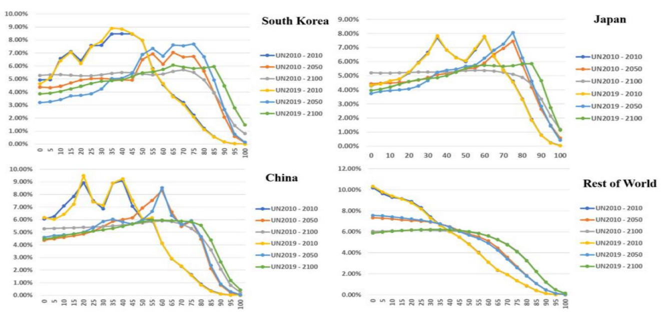
Research Outline

Research Objectives

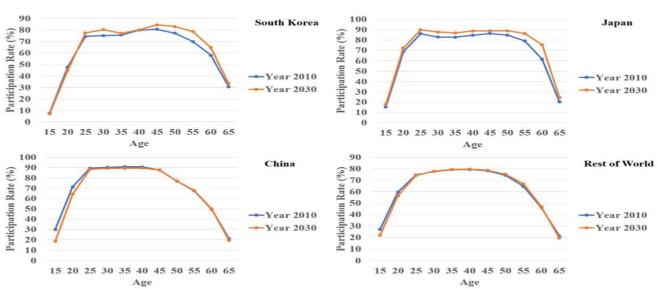
- To analyze how the demographic structure changes led by aging population and less working age population affects the national GDP and CO_2 emissions in East Asian Countries, including Korea.

Research Design

UN Population Prospects (2010 vs. 2019)

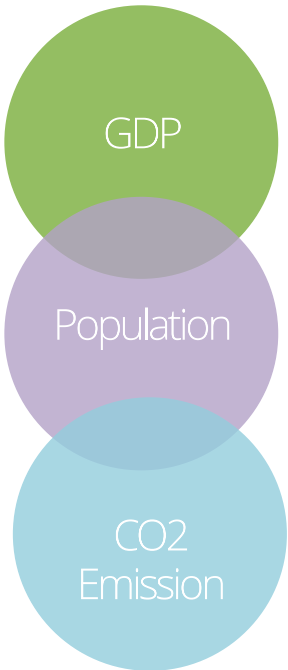


Labor force Participation Rate



- 9 Region (incl. Korea, Japan, China); 13 Sectors
- SSP2 Scenarios
- UN Population Scenario, ILO Labor force participation rate, GTAP 10 Database

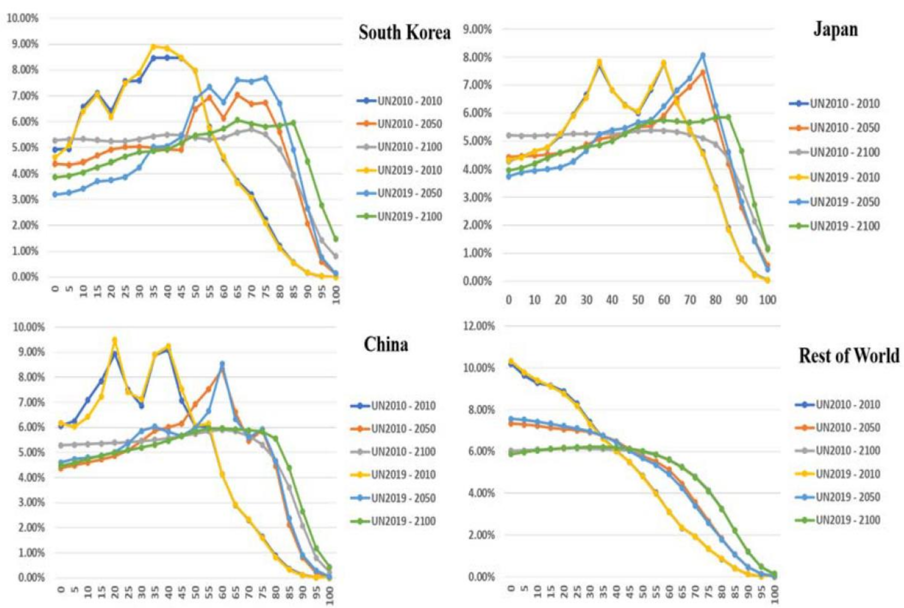
Global CGE Model



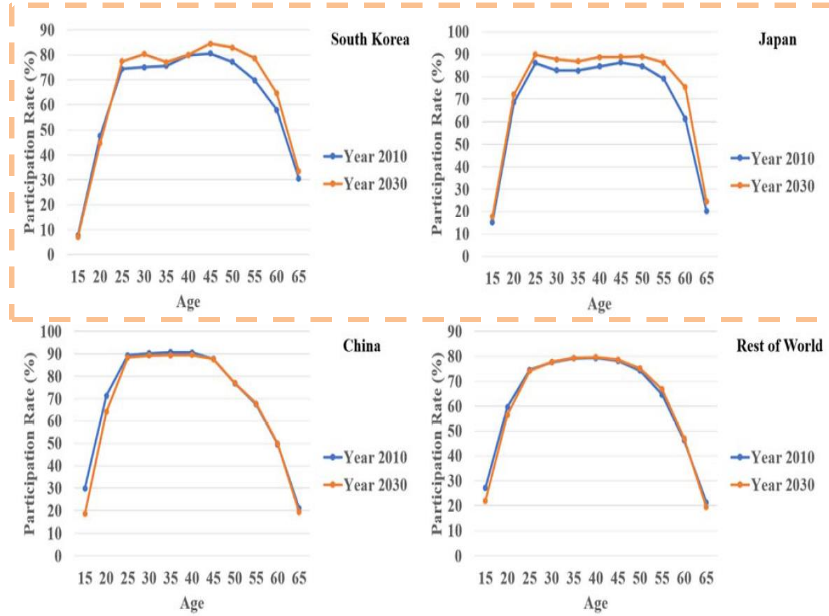
Research Outline

Key Data (UN Population Prospects, ILO Participation Rate)

UN Population Prospects (2010 vs. 2019)



Labor force Participation Rate

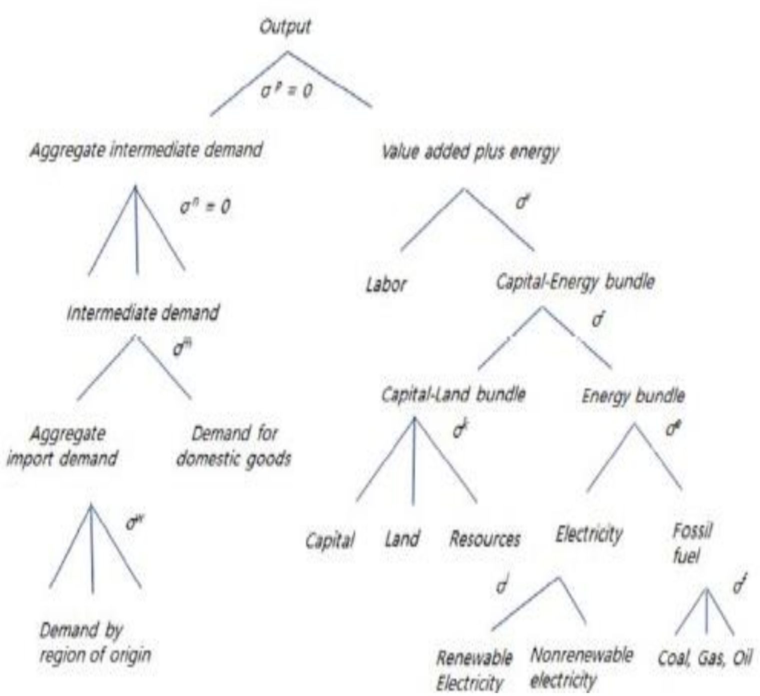


Methodology

CGE Analysis

CGE Model

Nesting Structure (Production Technology)



CES Production Function

$$Q = \bar{Q}\left[\sum_i \theta_i \left(\frac{\lambda_i X_i}{\bar{X}_i}\right)^{\rho}\right]^{1/\rho};\quad X_i = \lambda_i^{\sigma-1}\bar{X}_i \frac{Q}{\bar{Q}}\left(\frac{\beta}{\bar{\beta}}\frac{\overline{P_i}+\bar{t}_i}{P_i+t_i}\right)^{\sigma}$$

- θ_i: input value share; λ_i: technology; $\sigma = \left(\frac{1}{1-\rho}\right)$: elasticity of substitution; t_i: tax rate on input i

Balance of Budget

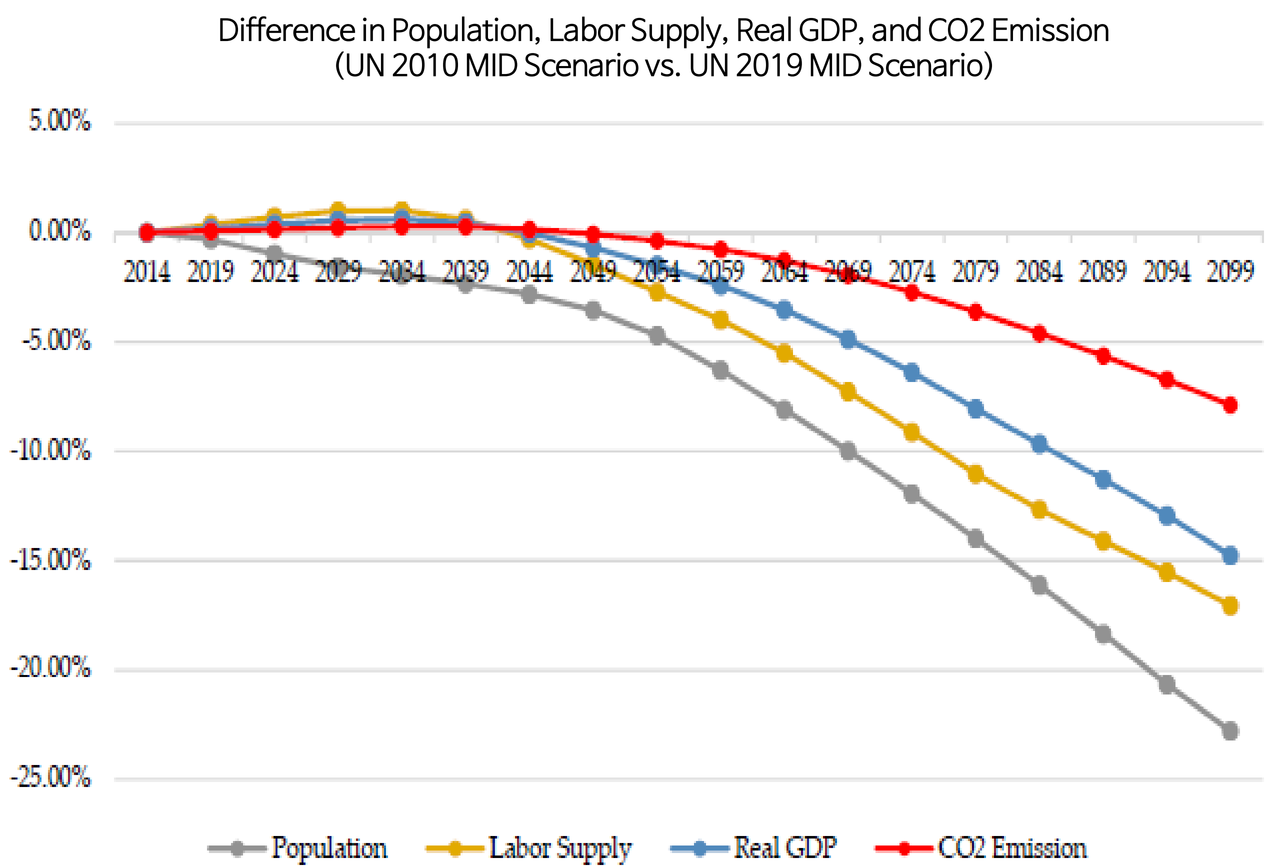
$$(1-ti)\cdot\sum_f PF_f QF_f = \sum_i P_i \cdot (1+tc_i)\cdot QC_i + Household\ Saving$$

$$\sum_f tf_f QF_f + ti\sum_f PF_f QF_f + \sum_i\left(tc_i QC_i + tp_i QP_i + \sum_j t_{ij} QAP_{ij}\right) + \sum_{(r',i)} tariff_{r',r,i} Qtrade_{r',r,i} = \sum_i P_i QG_i + Government\ Saving$$

$$\sum_i P_i QINV_i = Household\ Saving + Government\ Saving + Foreign\ Saving$$

Results

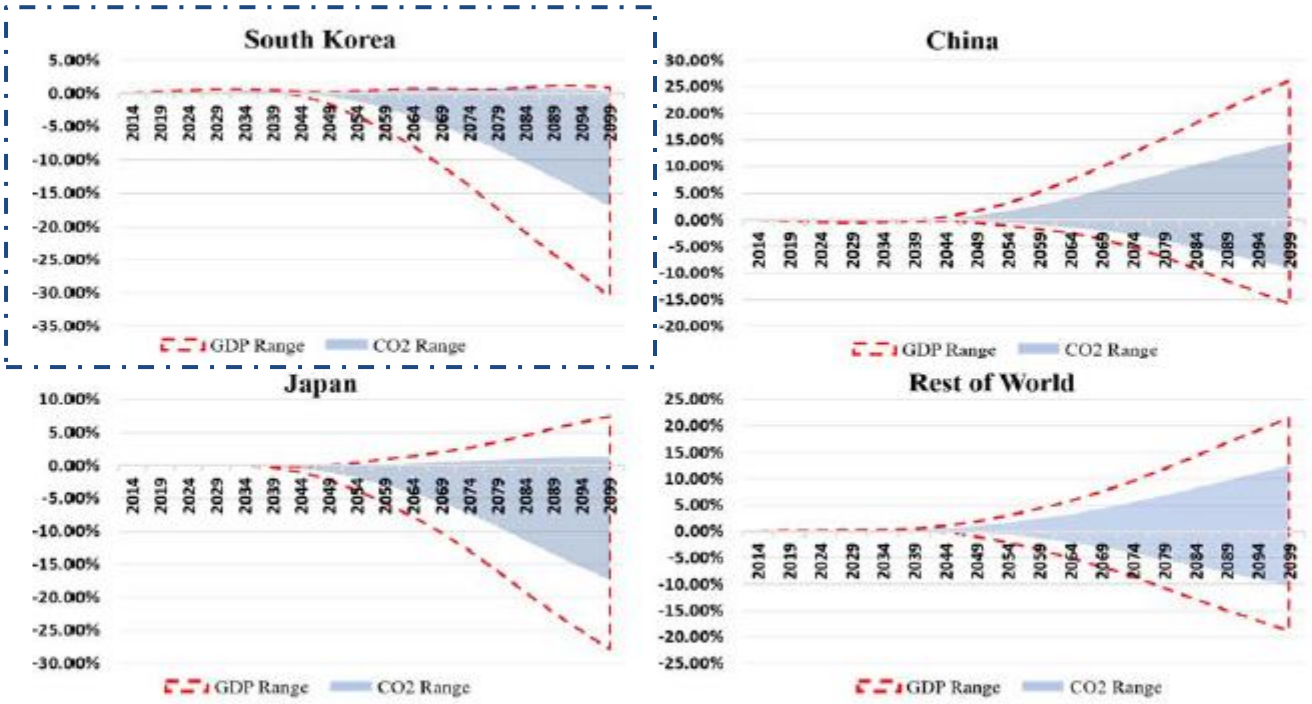
Changes in Population, Labor, GDP, and CO2 Emission



Results

Changes in Population, Labor, GDP, and CO2 Emission

Range of GDP and CO2 Emissions (Difference compared to the base scenario) by Population Scenario



Note: Applied High, Mid, Low UN Population Scenarios published in 2010 and 2019 and compared the GDP and CO2 emissions ranges

Key Implications

- Population and Labor participation rates are important drivers of the CO2 emission projection. It is necessary to consider both the demographic changes, such as changes in the share of each age group, and the population changes.
- The low fertility rate and aging population in Korea would lead to the decrease of the Korean population in the future. However, the increase in the labor participation rate may lead to a relatively gradual decreasing trend of GDP and CO2 emissions compared to decreasing trends of population
- Aging factors may reduce the greenhouse gas emissions. However, more labor force participation somewhat offsets the reductions in the working labor force caused by low-birth rates and aging population