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경제학박사 학위논문

Demographic Change and Korean Unification

인구구조 변화와 통일의 효과

2023년 8월

서울대학교 대학원

경제학부 경제학 전공

김 남 재

Demographic Change and Korean Unification

지도교수 김 영 식

이 논문을 경제학박사 학위논문으로 제출함
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Be strong and courageous.

Do not be frightened,

and do not be dismayed,

for the Lord your God is with you wherever you go.

Joshua 1:9

Demographic Change and Korean Reunification

Namje Kim*

Abstract

This paper investigates the economic impact of population integration between the two Koreas. The model takes demographic changes into account and focuses on how considering the dynamics can generate differences in the result. An overlapping-generation dynamic stochastic general equilibrium model with two counties are constructed, and a pay-as-you-go (PAYG) pension system is added. The The model considers four different integration regimes, which are distinguishable by level and speed of the integration: No integration (R1, baseline), Partial Integration (R2), Rapid unification (R3), and Gradual unification (R4). The result indicated that South Korea's working population, once a victim of unification when demographic issues are not considered, becomes the beneficiary when these dynamics are factored in. Furthermore, the life-time utility analysis by cohort from 1970 to 2040 revealed that while other integration regimes may generate intergenerational disagreements, under the gradual unification regime (R4), all generations prefer unification over division in South Korea. Meanwhile, when a demographic shock occurs, In North Korea after unification, the benefit of unification might be mitigated. from a South Korean perspective. If skill differences in the labor market are taken Taken into account, unification could be even more advantageous to South Korea.

Keywords : Demographic Change, Economic Integration

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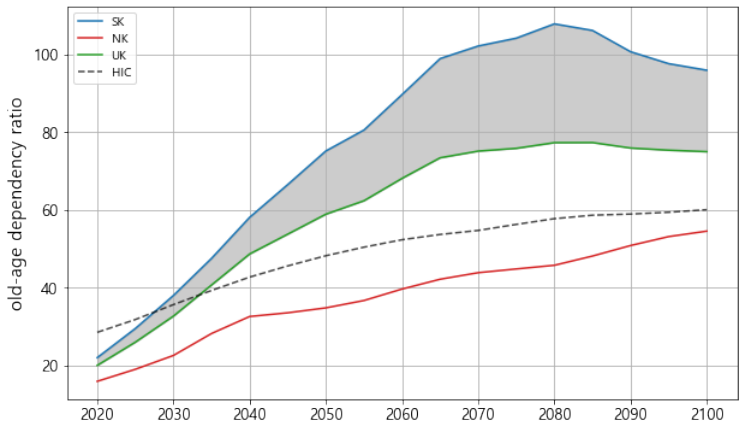
1 Introduction

According to the Unification Consciousness Survey 2021, young South Koreans are increasingly opposed to unification. The primary reason for this objection is "economic concerns about unification." Unification is an event that entails both costs and benefits from various sources. Although numerous studies have been conducted in recent years to explore the advantages of unification, it seems these efforts have not been sufficient to alleviate the concerns of the young generation in South Korea. In this research, I focused on the potential reduction in the old-age dependency ratio resulting from population integration as a key factor that could help reduce economic apprehensions about unification.

The old-age dependency ratio is the proportion of the population aged 65 and over to the population aged 15–64. South Korea, with the world's lowest fertility rate and rapid population aging, is experiencing a drastic increase in the dependency ratio. Generally, a higher ratio in a society places a greater burden on its younger generation. According to the World Population Prospect 2022, South Korea's dependency ratio begins at 22 in 2020 and peaks at 108 during the projection period from 2020 to 2100. In comparison to the average ratio of high-income countries, which starts at 28 in 2020 and rises to 60 in 2100, the severity of South Korea's situation is evident. South Korea's dependency ratio indicates that current and future generations will be expected to shoulder the immense cost of supporting their elderly. However, assuming unification occurs and the population is integrated, the old-age dependency ratio could be significantly reduced. North Korea has a much more favorable demographic structure due to a higher fertility rate and lower life expectancy. The old-age dependency ratio of North Korea begins at 16 in 2020 and increases to 55 in 2100. Additionally, a hypothetical unified Korea has a ratio of 20 in 2020, which rises to 77 in 2100. From South Korea's perspective,



Source: World Population Prospect 2022, UN

Figure 1: Old-age Dependency Ratio

population integration leads to a considerable reduction of the ratio, corresponding to the shaded area in Figure 1. However, the economic impact of the shaded areas has not been studied. The reduction in the dependency ratio is expected to have a significant effect on the welfare of the working-age population. Taking these demographic dynamics into account, it is worth examining whether young South Koreans can indeed become beneficiaries of unification.

In part I, to explore the impact of population integration, I constructed an overlapping-generation dynamic general equilibrium model for two countries, incorporating a public pension system. The inclusion of overlapping generations in the model is vital for accurately reflecting the population structure by differentiating the ages of economic agents. Furthermore, analyzing a dynamic model is crucial, as the effect of population integration should not be confined to a specific point in time, but rather understood as a continuous and dynamic process that considers the ongoing changes in population structure. Given that the analysis examines the integration of South and North Korea, a two-country model has been implemented. Lastly, the pension system was in-

corporated to allow shifts in the dependency ratio to affect the economy. The model economy is composed of goods markets, capital markets, labor markets, and pension finance. To analyze the effects of population integration, assumptions about the economic integration process need to be introduced, resulting in a total of four integration regimes, which are analyzed separately. The integration regimes are classified into No integration (R1), Partial integration (R2), Rapid unification(R3), and Gradual unification(R4), based on the level and speed of economic integration. In the static analysis, I depicted the effect of demographic change by comparing the steady states of South Korea under R1 in 2020 and in 2100. Additionally, I illustrated the impact of population integration in an aging society by comparing the steady states of South Korea in 2100 with those of the integrated economies of South and North Korea in 2100. In the transitional dynamics analysis, I demonstrated the effect of population integration between the two Koreas, considering demographic dynamics, the gradual catch-up process of the North Korean economy, and their human capital accumulation. Moreover, I highlighted the necessity of incorporating demographic dynamics in economic research on Korean unification by comparing two versions of the model: a pop-fixed version, which maintains the population structure as it was in 2020, and a pop-change version, where the population structure adapts according to the population projection data from the World Population Prospect 2022. In Part II, factors not considered in the standard model are further analyzed. Firstly, additional scenarios for North Korea's total factor productivity progress are introduced, with the results compared to the standard model. Secondly, scenarios for North Korea's population change, considering the demographic shock of unification, are introduced and the results are compared with the model using the existing population estimate. Lastly, a model incorporating qualitative differences in the labor market is used to analyze differences in the effects of economic integration with the standard model.

The research referenced in this study can be divided into three categories. The first category includes studies that analyzed the economic effects of the economic integration or unification of North and South Korea within a macroeconomic framework, such as Moon et al. (2018) [14], McKinnin et al. (2018) [13], St. Brown et al. (2012) [4], Funke and Strulik (2005) [7] and Noland et al. (1999, 2000a, 2000b) [15][16][17] , Auerbach et al (2004) [1], The second category involves research on the impact of Korea's demographic change on macroeconomy in heterogeneous-agent macro model framework, such as Hong and Kang (2015) [9], Kim et al. (2021, 2022) [2][3]. The third category includes studies on the demographic shock of unification and population projection of the both Koreas, such as Eberstadf (1994) [6], Stephen (2016) [18], Choi (2017) [5], Hong (2020) [8].

The paper is organized into two parts. Part 1 outlines the framework, calibration, and presents the results of static, dynamic, and welfare analyses. In Part 2, sensitivity analysis on additional TFP and projection scenarios, and model extension considering skill difference are conducted. Lastly, it wraps up with the Conclusion.

Part I

Economic Effect of Population Integration

2 Framework

2.1 Model

The model economy consisting of two countries: South Korea and North Korea, denoted by

$$i \in \{sk, nk\}$$

Each region comprises an economy made up of heterogeneous households, a representative firm, and a government that manages a public pension system. To match population projection data, one period in the model is set to 5 years. Households are differentiated by region(i), age(j), and wealth(a). A household enters the economy at age 25, survives based on probabilities, and is certain to die at age 100. The working population includes those under the retirement age(J_R) of 65. Labor supply is inelastic; therefore, all the working population earns labor income and contributes a fraction(τ_i) of their income to the pension system. The retired population, aged 65 and older ($j \geq J_R$), receives no labor income but pension benefits(b_i) and pays no taxes since the only tax in the model is the pension contributions.

Households solve the following utility maximization problem:

$$V(i,j,a;\mu_i) = \max_{c,a'} \left\{ \frac{c^{1-\gamma}-1}{1-\gamma} + \beta\psi_{i,j} V(i,j+1,a';\mu_i') \right\} \tag{1}$$

subject to

$$\begin{aligned} c + a^{'} &= (1+r_i)\, a + w_i \varepsilon_j l_j h_i (1-\tau_i) \mathbb{I}_{j<J_R} + b_i (1 - \mathbb{I}_{j<J_R}) \\ a^{'} &\geq 0 \\ c &> 0 \\ \mu' &= T(\mu) \end{aligned}$$

where μ_i is the regional distribution of the households, γ is the relative risk aversion, $\psi_{i,j}$ is the regional conditional

survivor rate by age, a is the asset holdings, c is the consumption, r_i is the regional real interest rate, w_i is the regional real wage, ε_j is the age-specific labor productivity, l_j is the age-specific labor supply and h_i is the region-specific human capital level.

A representative firm exists in each region and has a standard Cobb-Douglas production function:

$$Y_i = Z_i K_i^{1-\alpha} L_i^{\alpha}$$

where Z_i is the regional total factor productivity(TFP), K_i is the regional physical capital stock, L_i is the regional efficiency unit of labor supply, and α is the labor income share. Firms aim to solve the following profit maximization problem:

$$\max_{\{K_i, L_i\}} \left\{ Z_i K_i^{1-\alpha} L_i^{\alpha} - (r_i + \delta) K_i - w_i L_i \right\} \tag{2}$$

By the first order conditions, regional real interest rates and real wages are determined

by:

$$r_i = (1-\alpha)\frac{Y_i}{K_i} - \delta$$
$$w_i = \alpha\frac{Y_i}{L_i}$$

where δ is depreciation rate of physical capital stock.

Governments primarily manage public pensions and handle accidental bequests. To directly account for intergenerational support in the model, the public pension is assumed to be a pay-as-you-go scheme. This scheme derives pension funds from the current working population and pays pension benefits to the current retired population. It is also assumed that the government maintains a balanced budget :

$$\tau_i w_i L_i = b_i N_i^r \tag{3}$$

In reality, South Korea has a partially funded pension system, while North Korea has a non-functioning pay-as-you-go system. South Korea's public pension fund is expected to be depleted, leading to debates about pension reform. Simplifying the pension system should not pose problems, as the current South Korean system is unsustainable and the North Korean system is non-functional. where $L_i = \int \varepsilon_j l_j h_i d\mu_i$ is the regional labor supply in terms of efficiency unit and $N_i^r = \int_{j \geq J_R} d\mu_i$ is the number of the retired.

In the economy, accidental bequests persist as households face a probabilistic risk of death. The government is assumed to collect all such bequests, allocating a portion to newly entering households as initial wealth and spending the remaining portion for government spending, which does not impact the overall utility of the economy.

$$AB_i = \int a' \left(1 - \psi_{i,j}\right) d\mu_i = \int a_i^{init} d\mu'_{i,j=0} + G_i \tag{4}$$

where a' is savings, and $(1-\psi_{i,j})$ is conditional probability to death for age j in region i, and a_i^{init} is the regional initial wealth, and G_i is the government spending.

2.2 Equilibrium

For region $i \in \{sk, nk\}$, a competitive equilibrium is given by a sequence of demographic distribution $\{\mu_{i,t}\}$, consumption and saving choices $\left\{c_{i,j,t}, a'_{i,j,t}\right\}$ for individuals of region i, age j, at time t, factor inputs $\{K_{i,t}, L_{i,t}\}$,pension benefit $\{b_{i,t}\}$, factor prices $\{r_{i,t}, w_{i,t}\}$ and pension contribution rate $\{\tau_{i,t}\}$ such that for all t household's consumption and saving choices solve Equation 1 , firm's factor inputs solve Equation 2, pension system satisfies Equation 3 , consistency between individual and aggregate variables is achieved[1], and all markets clear.[2].

2.3 Integration Regimes

To analyze the economic effects of integration, assumptions about the integration process are required. Integration regimes are distinguished based on the level and speed of integration. In this study, a total of four integration regimes are considered : No integration(R1, baseline), Partial integration(R2), Rapid Unification(R3), and Gradual Unification(R4). The level of integration depends on the number of markets being integrated among the goods market, capital market, labor market, and pension system that constitute the model economy. Aligned with literature, three levels of integration can be identified: no integration, integration of goods and capital markets only, and integration of all markets and the pension system. Meanwhile, cases such as integrating the labor market without integrating the capital market were excluded from considera-

[1](Aggregate Capital Supply) $\int a d\mu_i = K_i^s$, (Aggregate Labor Supply) $\int \varepsilon_j l_j h_i d\mu_i = L_i^s$

[2](Goods market) $K_i' + C_i = Y_i + (1-\delta) K_i$, (Capital market) $K_i^s = K_i^d$, (Labor market) $L_i^s = L_i^d$

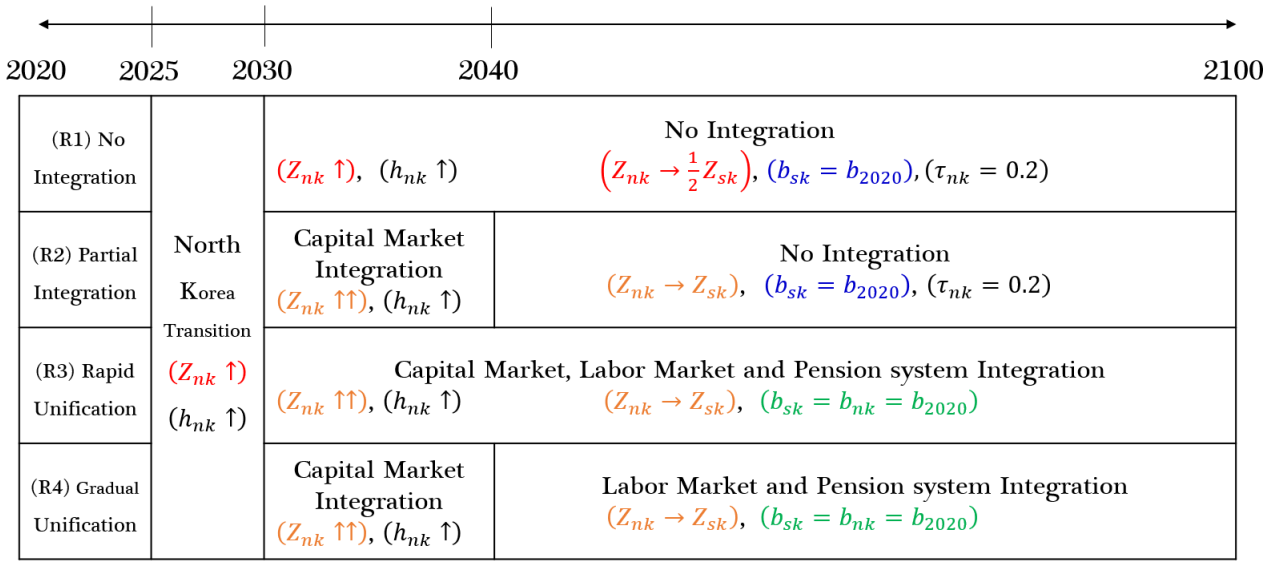


Figure 2: Integration Regimes

tion. 'Sequencing' is a critical issue in the field of economic integration, and such a case is inconsistent with the literature.[3]. And the speed of integration is based on whether markets are integrated simultaneously or sequentially.

R1 assumes a situation where economic integration does not occur, and the two Koreas remain separate and coexist. R2 considers a scenario where only the goods market and the capital market are integrated, which can be seen as North Korea accepting limited assistance from South Korea while retaining its power. R3 envisions a situation where all markets and the pension systems are instantly integrated, possibly due to political pressure or strong demands for unification from North Koreans. Lastly, R4 describes a scenario where the goods market and the capital market are integrated first, and the labor market and the pension system are integrated after 10 years, a policy aimed at minimizing the negative economic impact of unification on South Korea. Regimes from R1 to R3 align with the integration regimes in Moon et al. (2018), and R4 is the integration regime mentioned in this study as requiring additional research.

The model begins in 2020, and it is assumed that North Korea starts its economic transition from a centrally planned economy to a market economy in 2025. Economic integration cannot be discussed without considering North Korea's regime transition[4]. During this period, North Korea experiences TFP growth and human capital improvement. The TFP growth rate is assumed to be similar to that of past transition economies[5]. Improvements in human capital occur as a new generation with reformed education enters the economy, or as the older generation's human capital is enhanced by the effect of learning-by-doing when the labor market is integrated. Assumptions related to specific numerical values are outlined in the calibration section. Figure 2 summarizes the events

[3]Byung-Yeon Kim (2017), *Unveiling The North Korean Economy*[12], Byung-Yeon Kim(2015), Book Chapter, *Transition and Integration : Scenarios, Strategies and Policies* [11]

[4]Kim(2017)

[5]Iradian (2007) [10]

in each regime according to the timeline.

Since R4 is the key integration regime, I would like to specially dedicate space here to provide a detail of it. Particularly, R4 is constructed based on Byung-Yeon Kim's "Gradual Transition and Gradual Integration Scenario"[11]. Kim argues that before the economic integration between the two Koreas, North Korea should implement minimal incentive reform to enable its own economic growth. If this minimal reform is not implemented, the compatibility of the two economic systems could become a serious issue. Kim emphasized the necessity of sequential integration, stating that it should start with areas where the negative economic impacts on the South Korea are relatively small and that the initial integration areas should assist in promoting further integration. He divides the transition process into three stages (Early, Middle, and Late) and the economic integration process into four stages (Preparation, Beginning, Advancement, and completion)[6]. During the begining stage, the South Korean goods market is opened to the North but not vice versa, since high-quality South Korean goods imported to the North might weaken North Korean industries at this point. In the Advancement stage, the goods market is integrated, and restricted capital movements, like social capital investments, are permitted. In the Completion stage, free mobility of capital and labor is attained, and institutional integration takes place. Projecting this scenario onto the model, the integration sequence can be simplified to :

$$\text{the goods market} \rightarrow \text{the capital market} \rightarrow \text{the labor market} \rightarrow \text{the pension system.}$$

In 2030, the integration of the goods market and the capital market takes place, which is 5 years after the start of the North Korean eoconomic transition process. As the two economies integrate, some of South Korea's capital is invested in North Korea. This capital inflow would also bring advanced technologies, which stimulate TFP growth

[6]Kim (2017), p.290

and make it converge to the level of the South over the next 30 years. The integration of the capital markets equalizes the regional real interest rates:

$$r = r_{sk} = r_{nk}$$

The markets clearing condition becomes:

$$\int ad\mu_{sk} + \int ad\mu_{nk} = K_{sk}^{s} + K_{nk}^{s} = K_{sk}^{d} + K_{nk}^{d}$$

$$(C_{sk} + C_{nk}) + r\left(K_{sk} + K_{nk}\right) + w_{sk}L_{sk} + w_{nk}L_{nk} = (Y_{sk} + Y_{nk}) + (1-\delta)\left(K_{sk} + K_{nk}\right)$$

As the labor markets and pension systems integrate in 2040, the regional real wage(w_i), regional pension contribution rate(τ_i) and pension benefits(b_i) is equalized :

$$w = w_{sk} = w_{nk}$$

$$\tau = \tau_s = \tau_n$$

$$b = b_{sk} = b_{nk}$$

As all factor markets become integrated, the previously separated economies merge into one, and the production functions are combined.

$$Y = ZK^{1-\alpha}L^{\alpha}$$

where $Z = \zeta Z_{sk} + (1-\zeta)\, Z_{nk}$, $K = K_{sk} + K_{nk}$, $L = L_{sk} + L_{nk}$, and $\zeta = L_{sk}/L$. From the South's perspective, full integration means the South Korean economy absorbs the less efficient capital and labor of the North. This absorption incurs some efficiency loss,

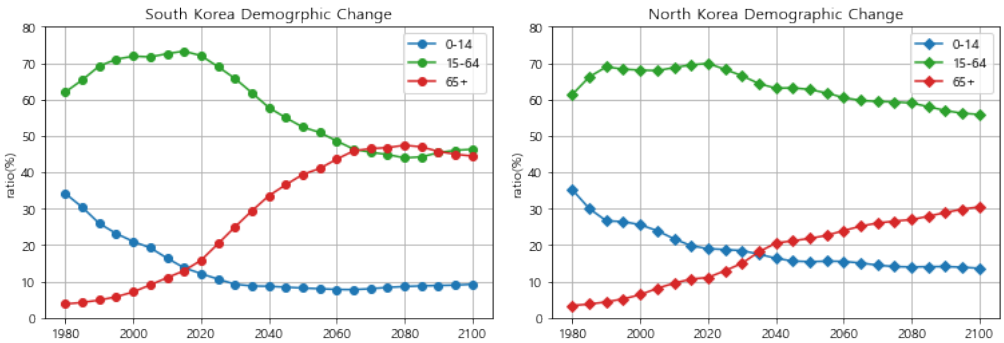
Table 1: Parameters

Exogenous Parameters			
	Description	Value	Reference
$N_{sk,0}$	2020 SK population	1.000	WPP 2022
$N_{nk,0}$	2020 NK population	0.436	
h_{sk}	SK human capital	1.21	Moon et al. (2018)
$h_{nk,0}$	NK initial human capital	0.82	
$\tau_{sk,0}$	SK Pension Contribution Rate	0.09	Data
$\tau_{nk,0}$	NK Pension Contribution Rate	0.2	East Germany
γ	Relative Risk Aversion	2	Literatures
α	Labor Income Share	2/3	Choi and Brown (2015)
δ	Capital Depreciation	0.05	Literatures
z_j	Age-Specific Labor Productivity	0.943-1.021	Regional Employment
l_j	Age-Specific Labor Supply	0.197-0.264	Survey 2020
Endogenous Parameters			
	Description	Values	Target
β	Discount Factor	0.9718	$r = 0.03$
Z_{sk}	SK Total Factor Productivity	3.1563	$Y_{sk,0} = 1.000$
$Z_{nk,0}$	NK Total Factor Prodectivity	0.5263	$Y_{nk,0}/Y_{sk,0} = 0.017$

the TFP shock, which is modeled as the weighted average of the two regions' TFP.

3 Calibration

In this section, I discuss exogenous parameters from data and literature, as well as endogenous parameters to be calibrated in the categories of demography, technology, endowments, tax, and transfer. The parameters utilized in the model are summarized in Table 1



Data: World Population Prospect 2022, UN

Figure 3: Demographic Dynamics

3.1 Demography

In the model, the populations of South and North Korea change based on the population projection data from the World Population Prospects 2022. According to the model's assumptions, only data for the population aged 25 and over is used. The total population of South Korea in 2020 is normalized to 1, $N_{sk,2020} = 1.000$, so the total population of North Korea in 2020 becomes $N_{nk,2020} = 0.436$. For the regional conditional survivor rate($\psi_{i,j}$), the survivorship ratios (Sx) of WPP 2022 are used. Due to the fact that South Korea has a higher life expectancy than North Korea, resulting in higher regional conditional survival rates for South Korea compared to North Korea across all age groups during the entire simulation period.

3.2 Technology

To set up the production function, the labor income share α is set to $2/3$, which is the standard value from the literature. About α of North Korea, it is aligned with the literature: Kim et al. (2007) followed Bergson's (1989) estimates from Soviet data and applied 0.675; Choi and Brown (2015) and Choi and Kim (2017) used a value of $2/3$;

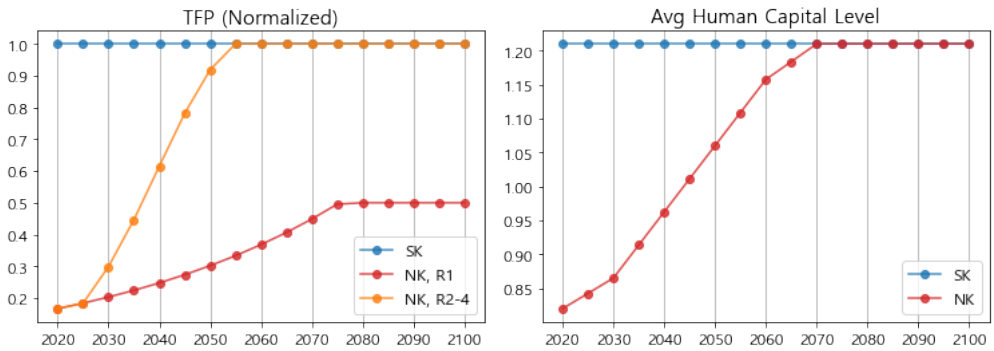


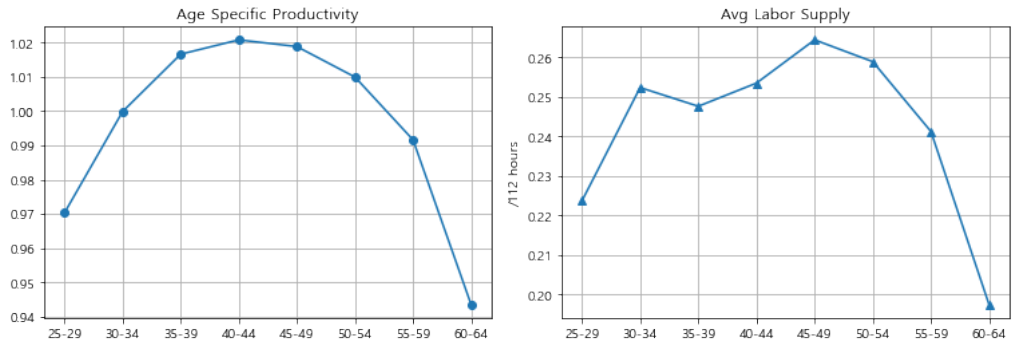
Figure 4: Total Factor Productivity and Human Capital

and Moon et al. (2018) adopted 0.6. In addition, setting the production functions of the South and the North identically has the benefit of ensuring that the total factor productivity has the same meaning. South Korea's TFP is assumed to be constant, and the value is calibrated to target 2020 GDP of South Korea to be 1. The initial TFP level of North Korea is calibrated to satisfy the 2020 South-North GDP ratio of 0.17, according to data from the Bank of Korea. Under R1, the rate of TFP growth in North Korea is assumed to be 2% following Iradian (2007)[7] and converge to 50% of the TFP level in South Korea. Under R2-R4, the TFP growth rate $g(t)$ following functional form as Moon et al.(2018) :

$$g(t) = b_1 (t - 1 + b_2)^{-b_3} - 1$$

and impose three requirements to find b_1, b_2 and b_3. For the case of integration occures(R2-4), first requirement is that the first year's growth rate be 10%, $g(1) = 0.1$. The growth

[7]According to Iradian(2007), TFP growth rate of the transition economies from 1996 to 2016 estimated to CIS-12: 2.3%; Baltics-3: 3.0%, CE-5: 1.6%, SEE-6: 0.8%. CIS-12 incdudes Armenia, Azerbaijan, Berlarus, Georgia, Kazakhstan, Kyrgyzstan, Moldoca, Mongolia, Russia, Kajikistan, Ukranie and Uzbekistan.r Baltics-3 includes Estonia, Latvia and Lithuania, CE-5 includes Czech Republic, Hungary, Poland, Slovakia and Slovenia. And SEE-6 includes Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia and Romania.



Data : Regional Employment Survey 2020, Statistics Korea

Figure 5: Age-specific Labor Productivity and Labor Supply

rate becomes zero after $T = 30$ years, $g(T) = 0$. Finally, productivity of the North reaches $\zeta = 100\%$ of the South after T years :

$$Z_{nk,0}(1 + g(1)) \cdots (1 + g(T)) = \zeta \times Z_{sk}$$

the values is set to be $b_1 = 14.057$, $b_2 = 146.108$, $b_3 = 0.509$.

The human capital improvement in North Korea occur throgh two channels. Fristly, as new generations that has completed post-reform education enters the economy and the old generation retires, resulting in a generational shift to cohorts with higher human capital. Second, in the case of a labor market opening, current generations of North Koreans experienced human capital improvement through learning-by-doing as labor interaction intensified. Therefore, North Korea's human capital accumulation path varies as shown in the Figure 4 depending on whether and when the labor market is integrated.

Table 2: Human Capital Accumulation in North Korea

	2020	2025	2030	2035	2040	2045	2050	2055	2060	···	2100
25-29	0.82	1.00	1.00	1.21	1.21	1.21	1.21	1.21	1.21	···	1.21
30-34	0.82	0.82	1.00	1.00	1.21	1.21	1.21	1.21	1.21	···	1.21
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
55-59	0.82	0.82	0.82	0.82	0.82	0.82	0.82	1.00	1.00	···	1.21
60-64	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	1.00	···	1.21

3.3 Endownment and Preference

Households enter the economy with an initial wealth equal to 24.5% of the regional average asset. Following Kim and Hong (2022), age-specific labor supply and age-specific labor productivity are estimated using data from the Regional Employment Survey 2020. The coefficient of the age group dummy from log wage is employed to estimate age-specific labor productivity (ε_j). The average weekly work hour is normalized by 112 (16 hours x 7 days) to calculate the age-specific labor supply(l_j). Figure 5 displays the results of the estimation.

Human capital, as defined by Moon et al. (2018), is assumed to be determined by years of schooling. Twelve years of education are normalized to a human capital level of 1, and following Hall and Jones (1999), each year of schooling beyond eight years is converted to a human capital rate of return of 6.8%. In South Korea, it is assumed that 30% have 12 years of schooling and 70% have 16, resulting in an average human capital level of 1.21. As North Korea is assumed to have an average of 9 years of education, its average human capital level is calculated as $1 \times 0.068^{-3} = 0.82$.

North Korea's education system is expected to undergo reforms during the transition process. By 2025, cohorts already in middle and high school are assumed to have 12

years of education. After this cohort, it is assumed that 30% of North Koreans will have 12 years of schooling, and 70% will have 16, mirroring the situation in South Korea.

Under R3 and R4, as the labor market integrates, cohorts with nine years of schooling experience a 2% annual improvement in human capital due to the learning-by-doing effect. This effect arises because labor market integration enhances labor mobility and intensifies interaction between North and South Korean workers. The human capital accumulation process is depicted in Figure 4.

3.4 Tax and Transfer

This model has the simplest tax system, with the government only in charge of the public pension system. The pension contribution rate in South Korea will be 9% in 2020, matching the current South Korean pension system. The implied pension benefits show an income substitution rate of 34.5%, which is close to the reported rate of 31.4% by OCED (2021). During the examined period, South Korea is assumed to maintain the pension benefits at 2020's level, thus the pension contribution rate needs to change to balance the budget. Before integration, North Korea had a fixed contribution rate of 20%, which is the same as East Germany at the time of German unification, and pension benefits are determined by the value that balances the budget. Following the integration of pension systems, North Korea will adopt South Korea's system.

4 Analysis

4.1 Steady State Analysis

The study conducted a static analysis to examine the initial and final equilibrium of the two Koreas, and to analyze the economic effects of demographic change on the South Korean economy, particularly in an aging society with population integration. Specifically, the study compared the steady state of the South Korean economy under R1 in 2020 and under R1 in 2100, to understand the economic impact of demographic change. Additionally, the study compared the steady state of the South Korean economy under R1 in 2100 to the integrated economy under R4(or R3) in 2100 to assess the potential population integration effect on the country's aging society.

4.1.1 Initial Steady States

Table 3: Initial Steady States

2020	N	N_r/N_w	Y	C	K	L	r	w	τ
SK	1.000	0.261	1.000	0.701	0.586	0.233	0.159	2.862	0.090
NK	0.436	0.199	0.017	0.014	0.006	0.073	0.515	0.153	0.200

Table 3 represents the initial steady states of South and North Korea. It is assumed that both South and North Korea are in equilibrium in 2020. South Korea's 2020 population was normalized to 1, and North Korea's population size is less than half. As for the old-age dependency ratio, South Korea's level is relatively higher than North Korea's ($0.261 > 0.199$). The ratio of South and North Korea's gross domestic product is 0.017, which is calibrated to the Bank of Korea's estimation. The real interest rate in South Korea is 3% per year, and North Korea's is about 8.67% per year. The ratio of total

capital between South and North Korea is about 1%, which is in line with previous studies. It is confirmed that the ratio of real wages between the two Koreas is 18.7 times, slightly less than the actual 27.4 times (as of 2020). In the case of South Korea, 9% was used for the pension contribution rate, reflecting the reality. In the case of North Korea, the pension system was not operating by institutionally targeting an pension contribution rate of about 9% and an income substitution rate of 70%, therefore, 20% that East Germany's pension contribution rate that had used until the German Unification is adopted.

4.1.2 Final Steady States

The final equilibrium state is divided into the case where South and North Korea remain independent economies under R1&2, and the case where North and South Korea achieve an integrated economy under R3&4. In the case of R1&2, population integration does not occur and the labor market and pension system are operated separately. Therefore, there is a difference in the old-age dependency ratio faced by each country in these regimes. On the other hand, in R3&4, the population is integrated and the two Koreas have a common dependency ratio, which is lower than that of South Korea alone. The ratio of North Korea's TFP to the South, 0.500 for R1, 0.800 for R2, and 1.000 for R3&4, implying that the level of North Korean economic growth can ultimately vary depending on the level of economic integration.

4.1.3 The Effect of Demographic Change

The first steady states comparision analysis examines the impact of demographic change on the economy of South Korea. In order to do this, the steady states of South Korea under R1 in 2020 and in 2100 were compared. The result is summarized in Table 5A

Table 4: Final Steady States

	2100	N	N_r/N_w	Z/Z_{sk}	Y	C	K	L	r	w	τ
R1	SK	0.449	1.250	1.000	0.246	0.198	0.140	0.058	0.176	2.820	0.442
	NK	0.398	0.661	0.500	0.106	0.079	0.062	0.070	0.165	1.007	0.200
R2	SK	0.499	1.250	1.000	0.251	0.202	0.135	0.058	0.155	2.873	0.433
	NK	0.398	0.661		0.303	0.228	0.192	0.070			0.200
R3&4	SK	0.499	0.929	1.000	0.550	0.229	0.197	0.058	0.161	2.857	0.323
	NK	0.398				0.202	0.124	0.070			

Table 5: The Effect of Demographic Change in South Korea

SK	N	Y	C	K	L	r	w	τ
2020	1.000	1.000	0.701	0.586	0.233	0.159	2.862	0.090
2100	0.449	0.246	0.198	0.140	0.058	0.176	2.820	0.442
$\Delta\%$	-55.1	-75.4	-71.8	-76.1	-75.1	+10.7	-1.5	+391.1
SK	N_r/N_w	y	c	c_w	c_r	K/L	k	l
2020	0.261	1.000	0.701	0.715	0.645	2.516	0.586	0.233
2100	1.250	0.547	0.440	0.451	0.431	2.406	0.311	0.129
$\Delta\%$	+378.9	-45.3	-37.2	-36.9	-33.2	-4.4	-46.9	-44.6

change in population composition is the only difference between the two equilibria. First, the overall population in 2100 will be at 45% of the level in 2020, and the old-age dependency ratio will increase by almost 379 percentage points. In other words, severe population aging and population reduction occur simultaneously. A decline in the overall population causes a decline in the work force, which in turn decreases the total labor supply. The explanation for the comparatively significant decline in labor supply is that the decline in the population of working age is higher than the decline in the total population due to population aging. In the meantime, the quick rise in the dependency ratio raises the pension burdens on the working population. This effect decreases the disposable income of workers, which in turn decreases consumption and savings. In this instance, the working population reduces their savings more than their consumption. As a result of the reduction in savings and the shrinking population, aggregate capital supply and, subsequently, aggregate production decline. The drop in the aggregate capital supply is greater than the decrease in the aggregate labor supply; hence, the degree of capital intensity falls, resulting in a decline in wages and an increase in interest rates. The relatively small change in wages is due to the fact that the effects of a decline in capital intensity and a decline in labor supply offset out each other.

Table 6: The Effect of Population Integration in South Korea

2100	N	Y	C	K	L	r	w	τ
R1	0.449	0.246	0.198	0.140	0.058	0.176	2.820	0.442
R4	0.848	0.550	0.431	0.322	0.128	0.161	2.857	0.323
Δ%	+88.9	+123.6	+117.7	+130.0	+120.7	-8.5	+1.3	-26.9
2100	N_r/N_w	y	c	c_w	c_r	K/L	k	l
R1	1.250	0.547	0.440	0.451	0.431	2.406	0.311	0.129
R4	0.929	0.649	0.508	0.541	0.483	2.504	0.379	0.151
Δ%	-25.7%	+18.6	+15.5	+20.0	+12.1	+4.1	+21.9	+17.1

Meanwhile, the per capita consumption of working population falls by 37.6%, while the per capita consumption of the retired falls by 33.4%, since the effect of higher interest rates is bigger for retired population. In conclusion, as a result of the economic consequences of population decrasing and aging, South Korea's per capita output and consumption will drop by 45.7% and 37.3%, respectively, and the decline in per capita consumption of working population is greater than that of retired population.

4.1.4 The Effect of Population Integration

Table 6 shows the analysis results of the effect of population integration between South and North Korea in an aging society. To analyze this, the South Korean economy under R1 in 2020's population and the integrated economy of South and North Korea under R4(or R3) in 2100's population were compared. Notably, this exercise examines the impact of demographic integration from a South Korean perspective. Population integration increases the overall population by 88.6% while reducing the old-age dependence ratio by 25.7%. An increase in the total population leads to an increase in the labor force. The reason why the increase in total labor supply is greater than the

increase in population is because a relatively large number of people of working age are inflow due to population integration. Moreover, the reduction in the dependency ratio decreases the pension burden of working population, hence increasing disposable income. A rise in disposable income boosts both spending and saving, which increases saving more than consumption. As savings and population increase, aggregate capital supply and capital intensity increase, causing interest rates to fall and wages to rise. The relatively modest increase in wages is due to the fact that the impacts of a rise in capital intensity and an increase in labor supply balance out one another. The rise in consumption per capita is 20.7% for working population and 10.0% for retired population. This asymetry is due to the fact that improving demographic structure has a direct impact on the working population by reducing the pension burden, while the drop in real interest rates affects the retired population greatly. In conclusion, per capita production in South Korea increases by 19.7% and per capita consumption by 16.4% in an aging society due to population integration, and the increase in consumption of working population is greater than that of the retired.

4.2 Transitional Dynamics

The results from the previous section confirm that, from a South Korean point of view, demographic change reduces both per capita production and per capita consumption; in particular, the increase in pension burden due to population aging has a significant negative effect on the consumption of working households. Moreover, in an aging society, the effect of population expansion and the reduction of the dependency ratio as a consequence of population integration between the two Koreas is substantial, resulting in a rise in per capita output and consumption. Specifically, it is proven that working households' per capita consumption grows comparatively strongly. However, it is not

appropriate to interpret the static analysis results in terms of the effect of population integration between the two Koreas right away. Population dynamics is a gradual and continuous process, as are North Korea's economic growth and human capital accumulation. Therefore, in order to correctly examine the effect of population integration, it is vital to account for this dynamic process while analyzing the effects. This section is about an analysis of the transitional dynamics of the integration.

4.2.1 The Role of Demographic Change

In this section, I would present the effect of population integration between two Koreas and demonstrate why demographic dynamics must be taken into account in economic research on Korean unification. To do this, I compare results from two versions of the model: the pop-fixed version, in which the demographic structure is fixed at 2020 and remains unchanged, and the pop-change version, in which the demographic structure is changing according to the projection data. If the results of the two versions do not differ much, it may not be necessary to consider demographic dynamics within the model. Nonetheless, if the difference in outcomes is evident, it can be considered that reflecting the demographic change produces results closer to the real unification impact. To demonstrate this, the transition paths from 2020 to 2100 under R1 and the paths under R4 were derived from the pop-fixed version and the pop-change version, respectively. I define the effect of population integration as the difference in consumption per catipa paths between R1 and R4 and compute the effect of two models to see how the results differ.

Figure 6 shows the difference of the population changing between the pop-fixed and pop-change versions. In the pop-fixed version, the population structure in 2020 is maintained. This means that under R1, the total population and the old-age dependency ratio remain

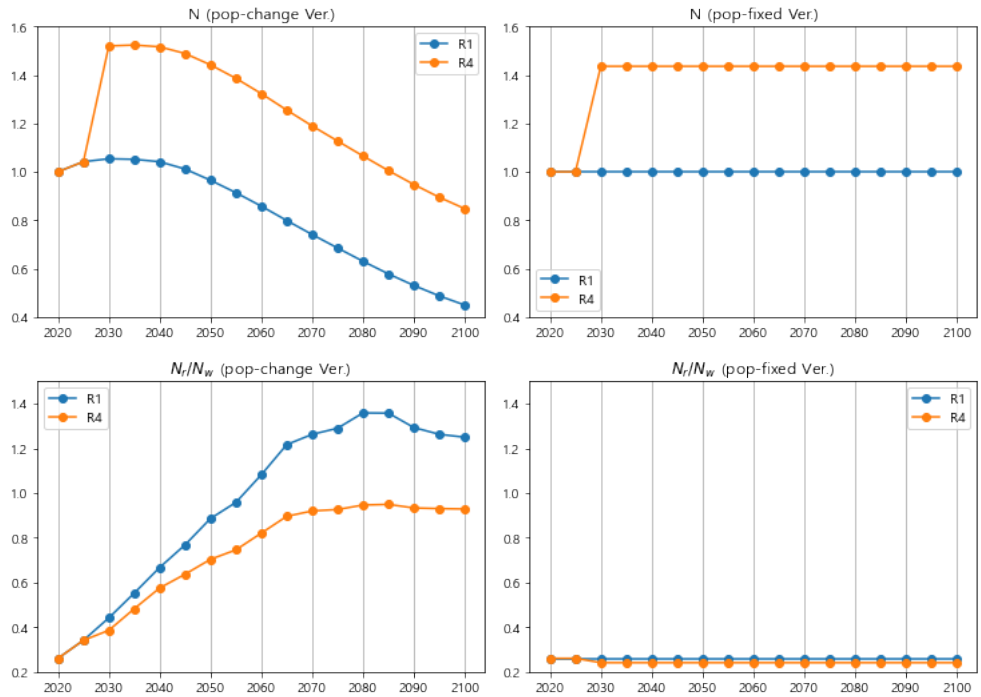


Figure 6: Total Population and Dependency Ratio

the same. Under R2, as the population is integrated, the total population increases while the dependence ratio lowers slightly and is maintained. In contrast, in the pop-change version under R1, South Korea's total population will increase until 2030 and then fall, while the old-age dependency ratio will soar dramatically. When the population is integrated at R2, the population expands and begins to drop, and the dependency ratio reduction is large compared to the pop-fixed version.

The economic effect of population integration is measured by the difference in per capita consumption path from R4 to R1. In order to put the results of two versions on the same plane, I normalize the paths of R4 by R1 in each version. Figure 7 presented the normalized price paths of the two versions. Figure 8 shows the normalized path of conumption per capita of the two verions. After the population integration, the interest rate increases until 2050, and then it starts to decline and converges to a higher (or lower) level than the initial interest rate level in the pop-fixed (pop-change) version. The increase in the interest rate is because the growth in the labor force due to population integration and North Korea's human capital accumulation increased the marginal productivity of capital. Wages fall as a result of the TFP shock caused by economic integration, but as North Korea's TFP converged to that of South Korea, wage levels gradually recovered. Meanwhile, the pension contribution rate rises as a result of the wage decrease and then falls as a result of the decrease in the dependency ratio. In terms of price change, the two versions are showing the same direction. The wage movements are similar except for the final convergence; however, the movements in interest rates and pension contribution rates are showing a much larger change in the pop-change version.

The consumption per capita paths are a summary of the price fluctuations. The difference in consumption per capita paths from R4 to R1 is interpreted as the dynamic

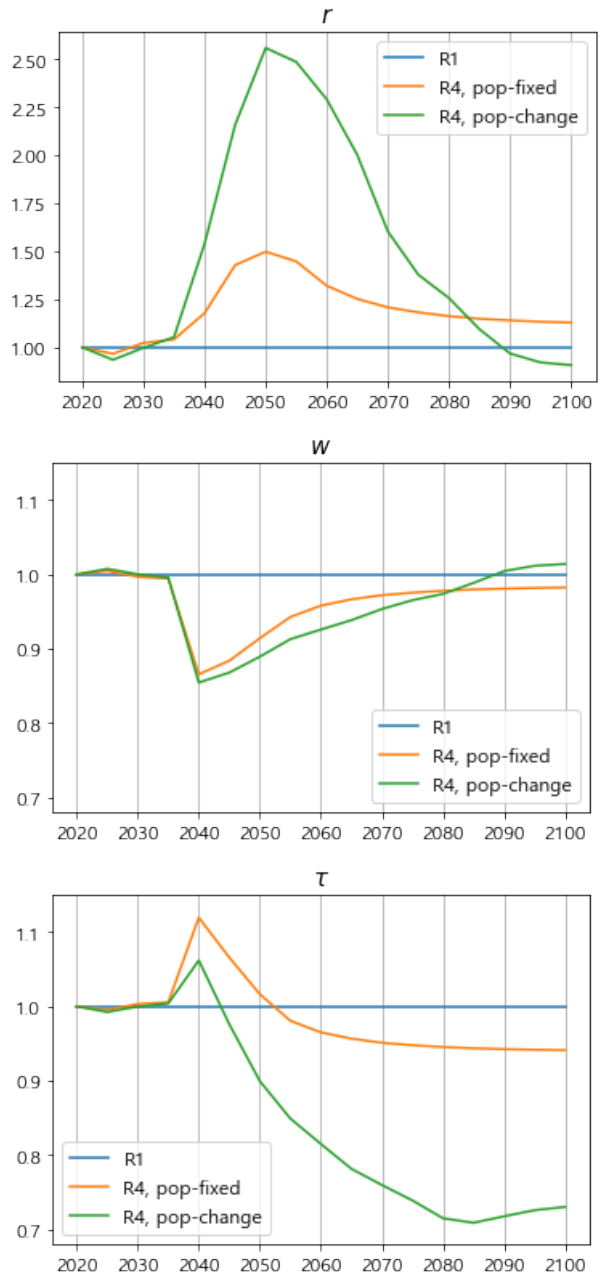


Figure 7: Price Dynamics

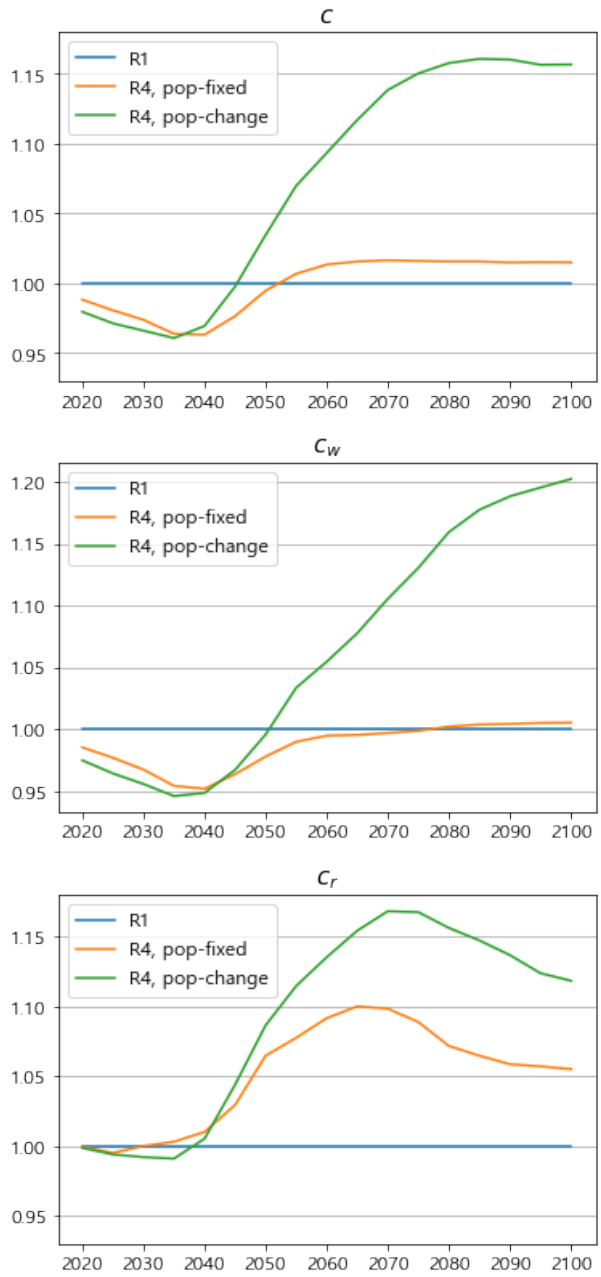


Figure 8: Consumption Per Capita by Demographic Dynamics

effect of the population integration. In pop-fixed version, the consumption per capita path under R4 is yearly on average 0% higher than that of R1. On the other hand, the pop-change version shows a yearly on average 7.3% higher consumption path due to the population integration. The consumption path of the working and retired population under R4 in pop-fixed version are -1.3% and 5.1% higher than those under R1, respectively. The consumption path of the working and retired populations under R4 in pop-change version are 6.3% and 9.0% higher than those under R1, respectively. In case of the retired population, the effect of the population integration both have positive effect on consumption, only difference in the volume of the effect. On the other hand, in the case of the working population, it can be said that the results of the two versions show a very large difference because there is a difference in sign as well as size. The large difference between the results of two versions means that taking demographic changes into account is important in a study like this.

4.2.2 Comparision by Regimes

As highlighted in the previous section, the potential impact of unification on the welfare of the working population in South Korea was shown to be heavily influenced by demographic changes. In this section, the study delved deeper into this issue by examining the effects of unification on various integration regimes while also taking into account the changing population dynamics. By accounting for these important factors, the study aimed to provide a more comprehensive and accurate understanding of the potential effects of unification on South Korea and its population.

Figure 9 displays the price dynamics under four different integration regimes : No Integration(R1), Partial Integration(R2), Rapid Unification(R3), and Gradual Unification(R4). The prices sequences of alternative regimes(R2-R4) are normalized to the

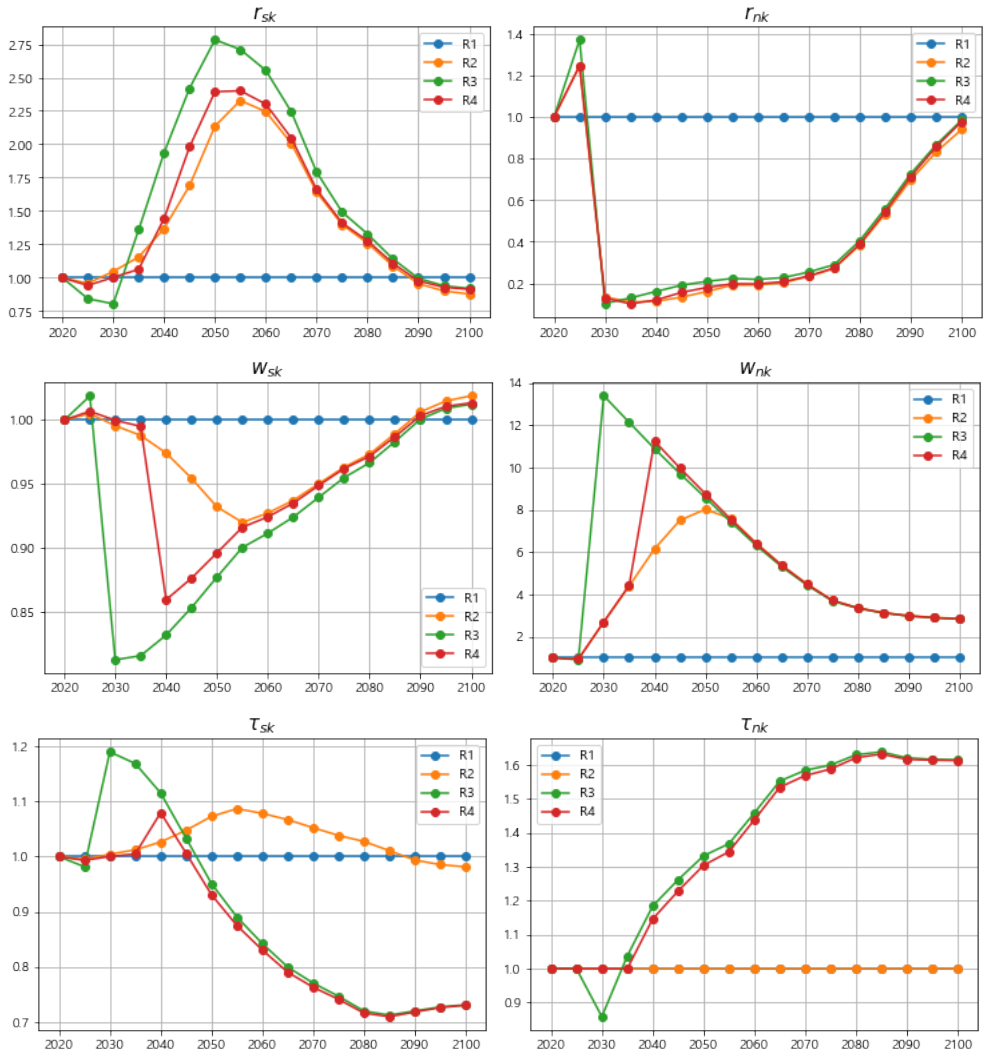


Figure 9: Price Dynamics by Regimes

baseline regimes(R1), in the same manner of the previous sections.

In the case of South Korea, price changes under each regime exhibit the following characteristics. Under R1, South Korea experiences a steep decline in interest rates, which begins to recover after 2060. In contrast, the recovery of interest rates occurs earlier in other regimes. This is due to the fact that, as capital mobility between North and South Korea becomes possible, capital that would have been invested within South Korea is instead invested in North Korea, which has relatively higher capital productivity, resulting in higher interest rates. Specifically, in R3 and R4, interest rates increase even more because labor supply increases as the labor market between North and South Korea integrates, leading to a decrease in capital intensity and an increase in the relative value of capital.

Regarding South Korean wages, the integration of the labor market results in wage shocks. This is partly due to an increase in the total labor supply, but also because the inefficient capital and labor in North Korea are absorbed by South Korea, leading to productivity shocks. Notably, the faster the labor market integration progresses, the greater the impact on the South Korean economy. On the other hand, in R2 where the labor market is not integrated, wages are lower compared to R1, as capital in South Korea is invested in North Korea, causing a decrease in capital intensity and a relative decrease in labor value.

Lastly, the path of pension contribution rates is similar between R1 and R2, where population integration does not occur, while R3 and R4 exhibit similar paths, where population integration does occur. The reason why there is a slight difference in pension contrubution rates between R1 and R2 in South Korea is due to the variation in real wages. As mentioned earlier, the model uses a fixed pension benefit for South Korea over the entire model period, so if there is a decrease in wages, for the purpose of fiscal

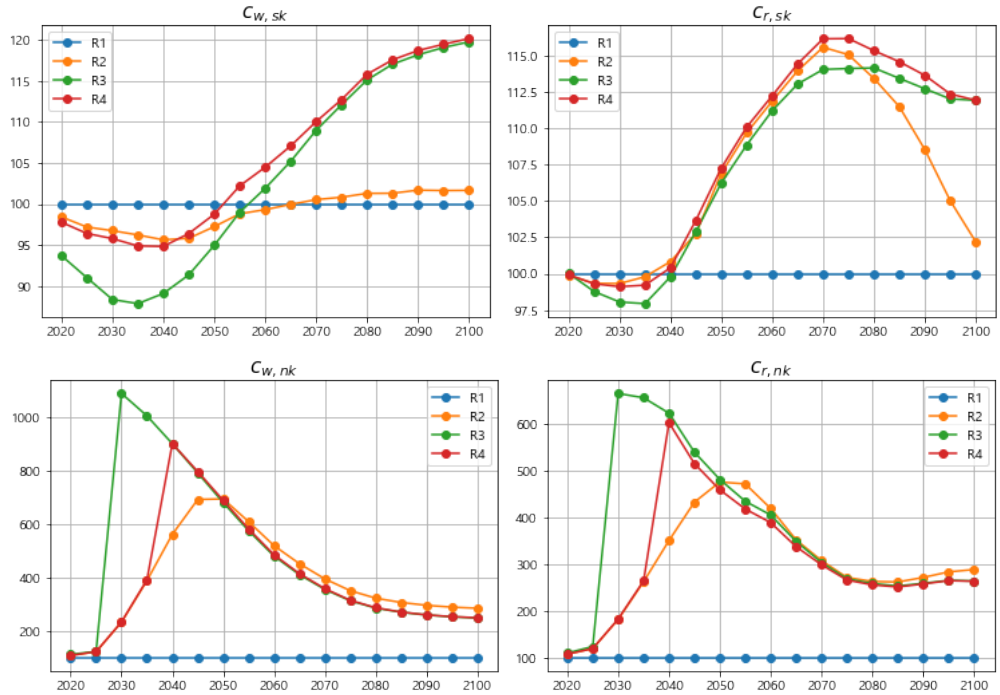


Figure 10: Consumption Per Capita by Regimes

balance, higher pension contribution rates need to be applied.

Figure 10 illustrate the consumption per capita path by regimes in South Korea. The top-left graph shows the consumption per capita path of the working population in South Korea under four regimes. It indicates that R2 has a small decrease in consumption in the first half but a small increase in the second half. Meanwhile, R3 and R4 have a substantial initial decline but a subsequent substantial gain, with R4 showing a smaller initial decline compared to R3 and higher consumption at all times. It can be interpreted that the working population of South Korea would strongly prefer R4 over R3. Using the same criterion as in the previous section, the study calculates the average difference in per capita consumption of each regime relative to R1. For the working

population in South Korea, the consumption per capita under R2 is 0.93% lower, under R3 is 3.09% higher, and under R4 is 6.07% higher on average annually compared to R1. For the retired population in South Korea, the consumption per capita under R2 is 6.81% higher, under R3 is 7.62% higher, and under R4 is 8.58% higher on average annually comapred to R1. For the working population in North Korea, the consumption per capita under R2 is 291% higher, under R3 is 381% higher, and under R4 is 296% higher on average annually compared to R1. For the retired population in North Korea, the consumption per capita under R2 is 202% higher, under R3 is 269% higher, and R4 is 210% higher on average annually compared to R1.

4.3 Welfare Analysis

One of the reasons for using macrostructural models is that they can directly analyze the utility of economic agents. In the previous section, consumption per capita paths for the working and retired populations under various regimes were investigated, focusing on the differences between alternative regimes(R2-R4) and the baseline(R1). However, as such approachs may fall short when it comes to understanding the impact of unification from an individual's perspective. An individual goes through a life cycle of entering the economy at a young age, working, retiring as they age, and finally concluding their life. The point and duration at which each person experiences unification vary, meaning that an analysis solely based on the consumption paths of working and retired households cannot fully grasp the impact of unification on each individual. Therefore, we aim to delve into a more detailed analysis of the significance of unification for each individual through cohort-based lifetime discounted utility analysis. This analysis will offer a more comprehensive understanding, enabling us to better address the initial question posed in this paper: "Can young South Koreans be the beneficiaries of unification?"

Table 7: Consumption Equivalence

Unit : %

Cohort		1970	1980	1990	2000	2010	2020	2030	2040
SK	R2	2.06	3.25	3.53	2.42	-0.84	-4.18	-4.65	-2.15
	R3	2.21	0.94	-0.55	-2.30	-3.05	1.40	7.53	13.58
	R4	2.24	3.04	2.78	2.32	0.72	3.26	8.96	14.73
Cohort		1970	1980	1990	2000	2010	2020	2030	2040
NK	R2	262	164	124	147	349	426	357	269
	R3	267	178	146	193	466	407	307	224
	R4	241	157	128	160	372	413	311	226

The consumption equivalence (ϕ) represents the percentage of consumption that needs to be added to the baseline regime so that the individuals can experience the same utility level as they would in the alternative regime. In other words, the consumption equivalence is the value that equalizes the following equation:

$$\sum_{j=0}^{J} \beta^j u\left(c_j^{Base}\left(1+\phi\right)\right) = \sum_{j=0}^{J} \beta^j u\left(c_j^{Alt}\right) \tag{5}$$

where c_j^{Base} represents the consumption level under the baseline regime, while c_j^{Alt} signifies the consumption level under the alternative regime. By calculating the consumption equivalence, we can ascertain the required adjustment to attain equivalent utility levels in both regimes, enabling a more nuanced comparison between the two scenarios. If consumption equivalence is positive, it means that the alternative regime is preferred. And the higher the value, the greater the degree to which an alternative regime is preferred.

Table 7 summarizes the utility analysis results of both Koreas, covering the cohorts from 1970 to 2040. It can be observed that preferences towards unification vary across

cohorts depending on the integration regime.

Under R2 where the capital market is integrated in 2030 while labor market and pension system remain separate. In this regime, cohorts born up to 2010 prefer unification, but those born after 2020 tend to prefer separation. This phenomenon occurs because North Korea achieves economic development with the help of South Korean capital investment and human capital accumulation, leading to a relative decrease in real wages in South Korea as some capital is directed to North Korea, and intensifying the burden of supporting the elderly for future generations. On the other hand, under R3, the rapid integration regime where capital market, labor market, and pension system are integrated at once in 2030. During this time, working households in South Korea experience a wage shock, resulting in a decrease in utility throughout the shock's duration. Consequently, cohorts born between 1990 and 2010 prefer separation, while those born after 2020 prefer unification. In other words, there exists a generation that must bear the costs of unification. Lastly, R4 first opens the capital market, followed by the labor market after ten years, significantly mitigating the wage shock experienced by South Korean working households. Although the wage shock is not entirely eliminated, when the consumption after retirement is converted to present value, all cohorts in R4 prefer unification. This suggests that, from South Korea's perspective, a unification that satisfies everyone is possible depending on the approach taken. Notably, it is evident that not pursuing population integration results in highly unfavorable outcomes for future generations.

Part II

Sensitivity Analysis and Model Extension

In Part II, I aim to specifically analyze how the results can change when the premises of several factors, which have a significant influence on the outcomes of the standard model presented in Part I, are altered. Firstly, I will analyze the change in the effects of unification by varying the assumptions related to North Korea's total factor productivity progress. Secondly, I will examine the effects of demographic shock in North Korea due to unification. Lastly, among the direct shocks caused by unification, there was a wage shock due to labor market integration. We will proceed with an additional analysis to see how the effects of unification can change through a model that reflects skill level differences in labor.

5 Additional TFP Progress Scenarios of North Korea

In this section, I analyze the differences in the effects of unification according to the path of total factor productivity. The economic outcome of unification is heavily influenced by how quickly North Korea's total factor productivity, i.e., the efficiency of the economy, increases after unification. However, predicting the path of North Korea's productivity after unification is challenging. One method could be to apply the total factor productivity growth rate of China or Vietnam, socialist countries like North Korea that have achieved economic growth. However, there are doubts about whether using their historical paths is a reasonable choice, given the significant differences in their economic

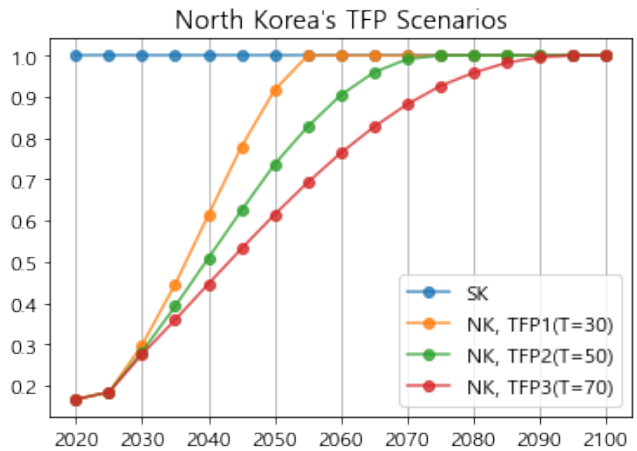


Figure 11: Total Factor Productivity Progress Scenarios

operations compared to North Korea, despite being socialist countries. Another method is to construct various scenarios for the transition path, accepting a few common facts experienced by past transition countries, and analyze each scenario. This is a method used in the preceding study by Moon and others (2018), and this study applies the same approach.

The scenarios introduced here are set in three ways: when the period for North Korea's TFP to converge to the level of South Korea is 30 years, 50 years, and 70 years. I calculated how much difference the effect of gradual unification would make in response to changes in TFP assumptions.

As already explained in the basic model, it is assumed that the growth rate of North Korea's TFP follows the following function.

$$g\left(t\right) = b_1 \left(t - 1 + b_2\right)^{-b_3} - 1$$

The TFP path for North Korea was generated in the same manner as described in

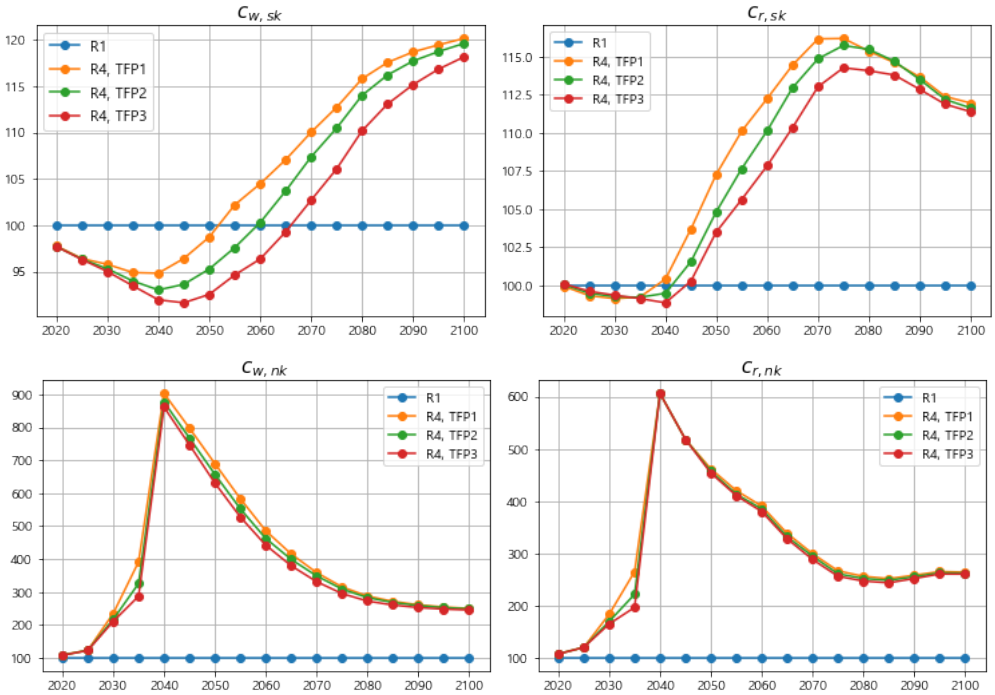


Figure 12: Consumption Per Capita by TFP Scenarios

Part I. Under the no integration regime (R1), North Korea experienced an annual 2% growth in TFP and eventually converged to half of South Korea's TFP level. In the case of integration regimes (R2-R4), the basic model assumes a 10% growth rate in the first year after unification and convergence to the level of South Korea over 30 years to calculate the TFP growth path of North Korea. In this case, b1 = 14.057, b2 = 146.108, and b3 = -0.509, and from now on we call it scenario 1. Two additional scenarios on North Korea's TFP path have been set. For scenario 2, it is assumed that North Korea's TFP will converge to the level of South Korea over the next 50 years. Here are b1 = 1.229, b2 = 8.853, and b3 = -0.051. Finally, scenario 3 assumes convergence to the level of South Korea over 70 years, resulting in b1 = 1.120, b2 =1.947, and b3 = -0.026.

In this exercise, consumption per capita paths under the gradual unification regime (R4) in each scenario were compared with consumption per capita paths under the no integration regime (R1), and the results are listed in the order of scenarios 1, 2, and 3. For South Korea, the working population's average annual increase rate of consumption per capita under R4 compared to under R1 is 6.05%, 4.16%, and 1.82%, respectively. For the retired population, the average annual increase rate of consumption per capita is 8.58%, 7.78%, and 6.80%, respectively. For North Korea, the working population's average annual increase rate of consumption per capita is 296%, 280%, and 266%, respectively. For the retired population, the average annual increase rate in consumption per capita is 210%, 204%, and 199%, respectively.

Intuitively, it is obvious that the speed of North Korea's TFP increase would affect the consumption of North Korean households. However, the result shows that it also has a significant impact on the consumption of South Korean households. This is because the slower the increase in North Korea's TFP, the slower the recovery of the interest rate and the wage rate in South Korea following the unification shock. This, in turn, results

in the persistence of higher pension contribution rates, which act as a constraint on the consumption of South Korean households.

In the meantime, the type of integration regime can have a big impact on the speed at which TFP increases. In the case of a radical unification regime (R3), there would be a large shock to the economy, but it is expected to show a relatively fast TFP growth rate. On the other hand, under the partial integration regime (R2), where only limited areas are integrated, the TFP growth of North Korea may be slower than other integration regimes.

6 Additional Projection Scenarios Considering Demographic Shock

In the previous part of the research, the model is based on projections of the UN WPP 2022 "medium scenarios", which is assume medium fertility rate of the countries. However, as pointed out by Stephen (2013, 2016) and Choi (2017, 2020), unification is an event that directly affects population dynamics, so using existing estimates may not be appropriate. In the standard model, we looked at the economic effects of integration with and without population dynamics, and also the effects of various integration regimes while considering population change. So far, demographic change has meant that the population structure of South and North Korea changes according to the WPP 2022 population projections. In this chapter, population projection that considering unification shock is adopted. The goal of this chapter is to determine the how different the effect of unification is from the main model's results when the demographic shock of unification is taken into account. For this purpose, I asummed there is only the gradual unification regime(R4) as the alternative regime and applied three differenct population

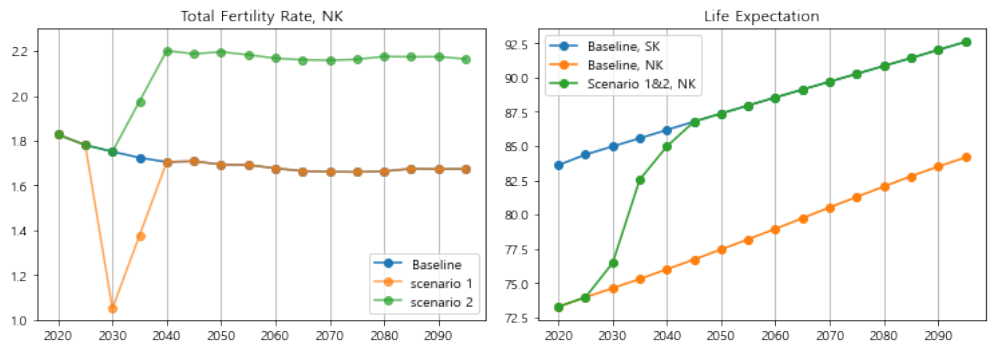


Figure 13: Total Fertility Rate and Life Expectation

projection under varying conditions. The new population projections used in this chapter were directly estimated using Choi (2017)'s methodology. It was assumed that North Korea would experience similar variations in demographic factors that occurred in East Germany at the time of unification. In the case of German unification, East Germany experienced a sharp drop in fertility rate and a rapid convergence of life expectancy with the West. Therefore, using existing population projections that do not consider the unification shock may overestimate the effect of reducing the elderly dependency ratio due to population integration. Thus, we aim to estimate the effect of unification more rigorously using more realistic estimates.

The cohort component method is a methodology for population projection that estimates the total population based on births, deaths, and migration across international borders. The United Nations, which provides World Population Prospect, and Statistics Korea, which publishes long-term population projections of two Koreas, employ the same methodology. The population projections that consider the unification shock are the projection data generated by modifying assumptions on fertility rate and life expectancy that reflect unification effects.

Choi (2017, 2020) assumes that the demographic factors in South Korea will not change

due to reunification. This assumption is not unreasonable, given that during the German reunification, West Germany did not experience significant changes in birth rates and life expectancy. Howerver, there are some important differences between South Korea and West Germany at the time of unification that deserve to be mentioned. Before German reunification, the birth rates in both West Germany and East Germany were about the same, 1.52. Only East Germany was shocked right after reunification, where the East's birth rate dropped sharply while the West's didn't change much. On the other hand, South Korea has one of the lowest fertility rates in the world and much lower than North Korea (0.88 vs 1.91). Therefore, it can be seen that there is a considerable possibility that population integration and regional migration might increase the fertility rate in the South. Even though this is a important topic for research, it is not being looked at in this study because it is out of the scope of this research. For North Korea, it is expected that life expectancy will converge to the South due to reunification, and that there will be an initial shock to the fertility rate, that similar to East Germany. This chapter provides two more population projection scenarios beyond the baseline scenario, WPP 2022 "medium" scenario. Figure 13 shows the assumptions about the path of North Korea's fertility rate and the path of life expectancy in each scenario. In the case of the fertility rate of North Korea, in scenario 1, it is assumed that there will be a 40% drop in fertility rate in North Korea right after unification and that it will recover to the baseline scenario's fertility rate path in the next 10 years. This mimics German unification and the experience of the East. In scenario 2, the fertility rate of the North is assumed to be converged to the WPP 2022's "high (fertility)" scenario's fertility rate path. Recent studies on North Korea's low birth rate show that "despair about the political system" and "economic hardship" play a significant role in women's refusal to give birth. North Korea's low birth rate problem has different aspects from the South's; therefore, there is a possibility that birth rates will increase if this problem

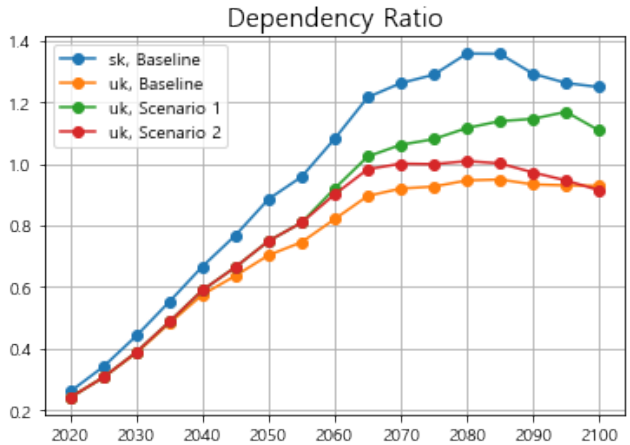


Figure 14: Old-age Dependency ratio by Projection Scenarios

is resolved due to unification. The optimistic prospect for Scenario 2 is founded on these discussions. Furthermore, in case of the life expectancy of the North Korea is assumed to converge with the South's for 20 years after unification in both additional scenarios.

Figure 14 depicts the old-age dependency ratio of South Korea in the baseline projection and of Unified Korea in the baseline, scenario 1 and scenario 2 projections. The dependency ratio is the key feature of the population structure in the model, as it affects the pension contribution rate and, consequently, the consumption. The blue dotted line and orange dotted line are identical to Figure 6 (c). Between these two lines, the green (scenario 1) and red (scenario 2) lines are located, which means that the effect of dependency ratio reduction is reduced as the projection reflecting unification shock is applied. Scenario 1 is based on a pessimistic prospect of the North Korea's demographic change, where the population aging would become faster and the fertility rate would demaged. Therefore, the green line is located halfway between the blue and orange lines, and it can be interpreted as the dependency ratio reduction effect being halved. On the other hand, Scenario 2 is based on an optimistic prospect of North Korea's population

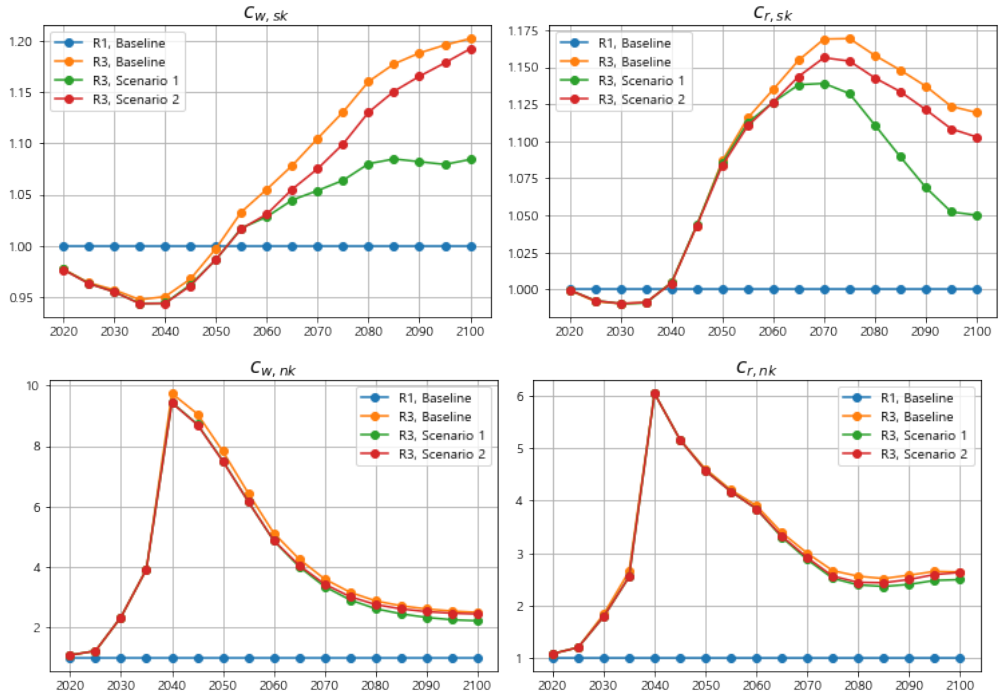


Figure 15: Consumption Per Capita by Projection Scenarios

dynamics. Even though life expectancy increases, the fertility rate is also projected to increase, which means that the population aging speed stays relatively constant. As a result, the red line lies between green and orange line, getting closer to orange (baseline) line as time goes on. From 2040 to 2055, the dependency ratio of scenario 1 and 2 is almost identical. This suggests that in the near future, the dominant factor affecting population aging in North Korea will be the improvement in life expectancy. Fertility rate variation, on the other hand, will have a much longer-term effect. In addition, it suggests that strategies to prevent fertility shock in North Korea and even promote fertility rate are essential for maximizing the benefits of population integration.

By running the model with the baseline and two additional projection scenarios, the

consumption per capita path of the South Korean working population is calculated. The result is presented in Figure 18. The orange line was the main finding of my research, which is based on the existing population projections, WPP 2022 "Medium" scenario, the consumption per capita path increases by annually on average of 6.39%. It is evident that the effect of consumption improvement would be reduced as the unification shock is reflected on North Korea's population projection. The results of the analysis are consistent with this expectation, the green(scenario 1) and red(scenario 2) line lie below the orange(baseline) line. In Scenario 1, the consumption per capita path is increased by an average of 2.05%, whereas in Scenario 2, increased by an average of 4.84%. In conclusion, the positive effects of population integration are evident, even under the pessimistic projections. However, they can be reduced if the demographic shock of reunification in North Korea leads to a rapid population aging. An increase in life expectancy in North Korea is inevitable, therefore, in order to preserve the positive effects of population integration policies that minimize the shock to the birth rate and actively promote an increase in the birth rate should be harmoniously implemented.

7 Extension: Incomplete Market and Skill Difference

7.1 Framework

The basic model lacks consideration for the differences in worker quality. Although there are quantitative differences in human capital levels between North and South Korean workers, they are not qualitative. For instance, the statement that South Korean workers have higher human capital than North Korean workers means that if a South Korean worker can produce 50 bricks in one hour, a North Korean worker can only produce 10. Qualitative differences in labor can be described as the contrast between a laborer

performing manual work and another expertly operating heavy machinery at the same construction site. Similarly, a computer assembler and a computer parts designer would have a qualitative rather than a quantitative difference in their labor. At present, experts predict that there is a significant qualitative gap between North and South Korean workers. North Korea's universities are factory-based and located within business establishments, resulting in lower levels of education compared to South Korea, mainly due to the low graduation rate from high school and the low proportion of higher education in North Korea. Therefore, when dividing workers into skilled and unskilled categories, it is expected that the proportion of skilled workers in South Korea will be significantly higher than that in North Korea. As a result, labor market integration would have a different effect on each skill type. If the proportion of unskilled workers in North Korea is higher, the integration of the labor market may result in a relatively higher wage shock for unskilled labor in South Korea. Thus, the expected decline in wages for all South Korean workers, as predicted in the basic model due to labor market integration, may differ from the actual situation. To provide a more nuanced understanding of the phenomenon, this chapter introduces different skill types to the labor market and incorporates idiosyncratic labor productivity shocks to expand the model's scope. The aim is to analyze the impact of labor market integration in greater detail, taking into account the heterogeneous effects and their directions among South Korean workers. In contrast to the basic model, which depicts labor market integration as a disadvantageous event for labor households, this revised model accounts for the heterogeneous effects of labor market integration.

Labor skills are divided to Skilled(S) and Unkilled(U), $e \in \{S, U\}$. The households utility maximization problem is defined as follows :

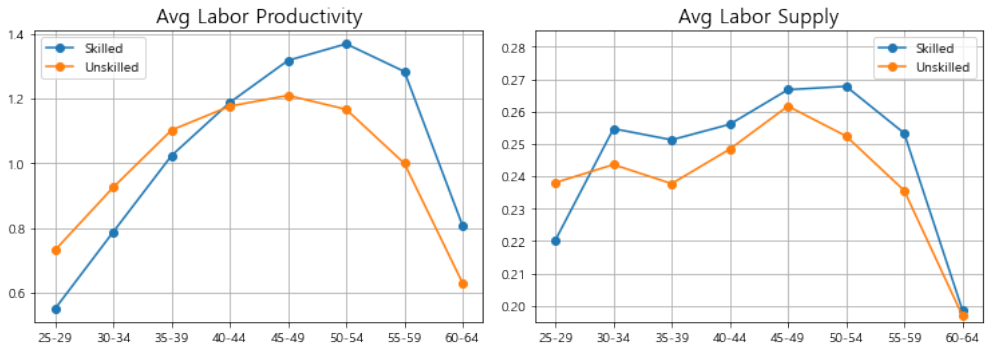


Figure 16: Age-specific Labor Supply and Labor Productivity by Skills

$$\max_{c} \mathbb{E}\left[\sum_{j=0}^{J} \psi_j \beta^{j-1} \frac{c_j^{1-\gamma}}{1-\gamma}\right] \qquad \text{s.t.} \tag{6}$$

$$\begin{aligned} c + a^{'} &= (1+r)\, a + w^{e} x \varepsilon_j^{e} l_j^{e} \left(1-\tau_i\right) \mathbb{I}_{j<J_R} + b_i \left(1 - \mathbb{I}_{j<J_R}\right) \\ a^{'} &\geq 0 \\ c &> 0 \\ \mu^{\prime} &= T\left(\mu\right) \\ where,\ x^{\prime} &= \rho x + \varepsilon_x \end{aligned}$$

The superscript h is in the real wage w, the age-specific labor productivity ε_j and age-specific labor supply l_j. Which means that wages for skilled and unskilled workers are determined in separated labor markets, and the age-specific labor productivity and labor supply are also considering the skill difference of the skill type. The variable x represents an uninsurable idiosyncratic shock and is assumed to follow an AR(1) process following Tauchen (1986).

According to the methodology of Hong and Kim (2021), there are now differences in labor productivity and labor supply by skill level, in addition to age. Using the Regional Employment Survey 2020, we estimated labor productivity and labor supply by both skill level and age. We defined skilled and unskilled labor based on educational attainment, with high school graduates or lower classified as unskilled labor and those with higher education as skilled labor. The estimated result is presented in Figure 16. In terms of labor supply by age, unskilled labors showed a higher supply in the age group of "25-29", but a lower supply overall compared to skilled laborers. This seems to be due to the fact that unskilled labors have shorter education periods and enter the labor market earlier than skilled labors. After the age of 30, the supply hours of skilled labors were relatively higher, and after the age of 50, the decline in working hours was more gradual. This appears to be because skilled labors have relatively higher level of job stability compared to unskilled labors.When it comes to labor productivity by age, skilled labors start at a relatively low level, peak at 50-54 years old. On the other hand, unskilled labors start at a relatively high level and peak at 45-49 years old. This indicates that skilled labors experience a stronger increase in productivity due to work experience than the decline in productivity due to aging, compared to unskilled labors. In other words, we can understand that work experience plays a stronger role in productivity for skilled labors.

With the introduction of labor skill into the model, some adjustments to the production side are made. The production function of the representative firm follows standard Cobb-Douglas function with regional TFP included.

$$Y = ZK^{\alpha-1}L^{\alpha}$$

As the difference in labor skills is introduced into the model, labor supply is divided

into skilled and unskilled labor supply. Total effective labor supply is combined through a CES production function, in which skilled and unskilled labor are combined with a constant elasticity of substitution :

$$L(\mu) = \left[\theta U(\mu)^{\rho} + (1-\theta) S(\mu)^{\rho}\right]^{1/\rho}$$

where $\sigma = \frac{1}{1-\rho}$ represents the substitution elasticity between skilled and unskilled labor, while θ represents the weight of unskilled labor. As a special case, if ρ approaches 1, then skilled and unskilled labor become perfect substitutes and the total labor supply becomes the sum of skilled and unskilled labor. The wages of each skill type is determined by the following conditions :

$$w^U = MP_U = MP_L(\partial L/\partial U) = MP_L\theta(U/L)^{\rho-1} \tag{7}$$

$$w^S = MP_S = MP_L(\partial L/\partial S) = MP_L\theta(S/L)^{\rho-1} \tag{8}$$

Equation 7 and 8 implies the wage of each worker is equal to the marginal productivity of their repective skill type. The equilibrium is defined as follows.

For region $i \in \{sk, nk\}$, a competitive equilibrium is given by a sequence of demographic distribution $\{\mu_{i,t}\}$, consumption and saving choices $\left\{c_{i,j,e,t}, a'_{i,j,e,t}\right\}$, for individuals of region i, age j, skill e, at time t, factor inputs $\{K_{i,t}, L_{i,t}, U_{i,t}, S_{i,t}\}$,pension benefit $\{b_{i,t}\}$, factor prices $\left\{r_{i,t}, w^U_{i,t}, w^S_{i,t}\right\}$ and pension contribution rate $\{\tau_{i,t}\}$ such that for all t household's consumption and saving choices solve Equation 6, firm's factor inputs solve Equation 2 , pension system satisfies Equation 3, consistency between individual and aggregate variables is achieved[8], and markets clear[9].

[8](Aggregate Capital Supply) $\int a d\mu_i = K^s_i$, (Aggregate Labor Supply) $\int x\varepsilon^U_j l^U_j d\mu_i = U_i$, $\int x\varepsilon^S_j l^S_j d\mu_i = S_i$

[9]Goods market) $K'_i + C_i = Y_i + (1-\delta)K_i$, (Capital market) $K^s_i = K^d_i$,(Labor market) $\left[\theta {U_i}^{\rho} + (1-\theta) S^{\rho}_i\right]^{1/\rho} = L^d_i$

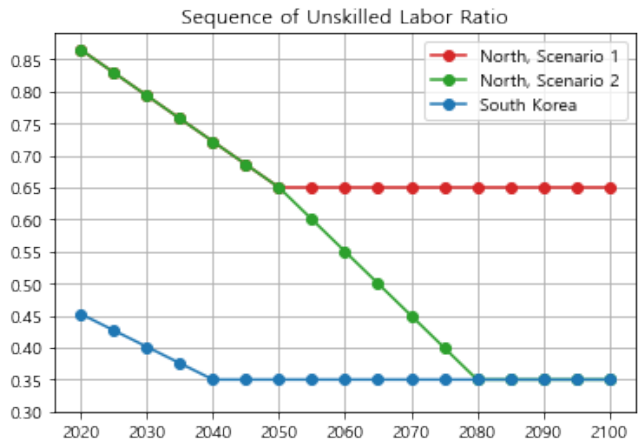


Figure 17: Unskilled Labor Ratio Scenarios

7.2 Calibration

The sequence of the demographic distribution $\{\mu_t\}$ in the extension model is equivalent to the demographic sequence in the main model. This means that the same population dynamics are being modeled and analyzed in both model. The distributions of skilled and unskilled labor in South and North Korea is a key parameter of the model. According to the regional employment data 2020, the proportion of high school dropouts or less among the working population is 45.2% in South Korea. In the case of North Korea the most recent available data about education level of the population is 2008 census data. North Korea's education levels are classified as follows: preschool, elementary school, middle school, vocational school, technical college, and university/doctoral program. In this study, I defined the unskilled labor in North Korea to those with less than a technical college degree, which accounted for 86.5% in 2008. Let's denote the unskilled labor ratio as η, and $\eta_{sk,0}$ =45.2 and $\eta_{nk,0}$ =86.5% is determined. Since the model is a dynamic model, the sequence of $\{\eta_{sk,t}, \eta_{nk,t}\}$ needs to be determined. In the previous research, Kim and Hong (2022, in Kor) assumed that the unskilled labor ratio in the benchmark

Table 8: Additional Parameters

Paramter	Description	Value	Target
ρ_x	Persistency	0.8	Moon et al.(2018)
ε_x	Dispersion	0.3	
θ	weight of unskilled labor	0.373	unskilled labor wage ratio
σ	elasticity of substitution between labor skills	2.0	Kim and Hong (2022)
ε_j^e	Age Specific Labor Productivity	Figure 16	Regional Employment Survey 2020
l_j^e	Age Specific Labor Supply		
$\eta_{j,t}$	Sequence of Unskilled Labor ratio	Figure 17	RES 2020 and North Korean Census(2008)

economy remains unchanged. Alternatively, it can be assumed that the unskilled labor ratio of new cohorts remains unchanged over time. In this case, the unskilled labor ratio will ultimately converge to the ratio of the new cohort of 2020. For example, the unskilled labor ratio of age group 25-29 at 2020 is 0.192. The dotted line in the figure 17 represents the sequence of the unskilled labor ratio of South Korea under alternative method, and it gradually converges to 0.192. In the real world, economic agents respond to changes in the economic structure, such as the demand for skilled and unskilled labor, by choosing the optimal level of education. Therefore, the proportion of unskilled labor would be determined endogenously and the result would not be as extreme as suggested. Therefore, I arbitrarily assume a relatively moderate sequence $\{\eta_{sk,t}, \eta_{nk,t}\}$ to derive the results : the proportion of unskilled labor in North Korea converges to 65% over 30 years from the initial level($\eta_{nk,0}$) and remains constant thereafter, while in South Korea, it converges to 35% over 20 years from its initial level($\eta_{sk,0}$) and remains constant thereafter. Table 8summarizes newly adopted parameters in the extended environment.

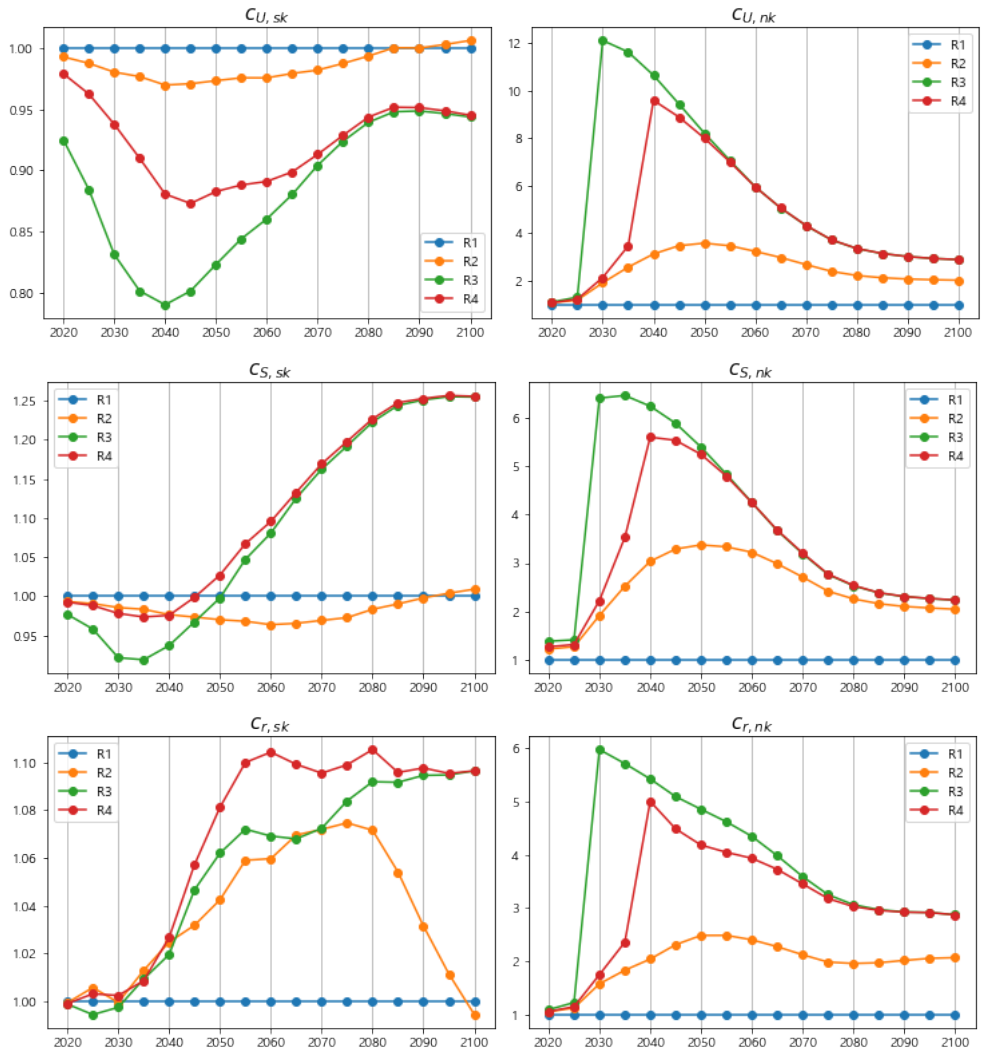


Figure 18: Consumption Per Capita by Skills

7.3 Analysis

Figure 18 is a graph of per capita consumption paths by age and skill level. In the previous main model, there was no distinction in labor skill level, so the graph was integrated into per capita consumption paths for working households. However, with the introduction of labor skill levels, we can now separately represent the per capita consumption paths of unskilled and skilled workers. The per capita consumption path of working households in the main model is located between the per capita consumption paths of skilled and unskilled workers in the extension model. Notably, in the consumption per capita of South Korean skilled workers, R3 and R4 have both increased their minimum and maximum levels compared to the consumption per capita of South Korean workers in the main model. This confirms that when considering labor skills, skilled workers in South Korea are indeed at a greater advantage. On the other hand, South Korea's unskilled workers face significant wage declines as they compete with North Korea's relatively abundant unskilled workers. Therefore, it can be seen that they are worse off than maintaining division under all integration regimes at almost every point. However, this can be understood as the normalization of overvalued unskilled labor wages as the shortage of unskilled labor supply in South Korea is resolved on a macro level. In addition, as the supply of skilled workers in South Korea becomes excessive and the North and South Korean economies integrate, demand increases, leading to the effect of rising undervalued wages. From North Korea's perspective, the increase in the supply of skilled labor, which was seriously lacking in North Korea, can be seen as boosting the driving force of economic growth. While the wage shock caused by labor market integration in the main model has a broader impact to all working popluation, distinguish the heterogeneous effects by skills lead us go closer to the reality.

To directly compare with the results of the standard model, the difference of consump-

tion per capita for each regime to the baseline regime(R1) is calculated. In the case of South Korea, in R2, the partial integration regime, consumption per capita for unskilled workers decreased by an annual average of -1.43%, for skilled workers it decreased by -1.80%, and for retired households, it increased by 3.61%. In R3, the rapid integration regime, consumption per capita for unskilled workers decreased by an annual average of -11.81%, for skilled workers it increased by 8.89%, and for retired households, it increased by 5.66%. Lastly, in R4, the gradual integration regime, consumption per capita for unskilled workers decreased by an annual average of -7.74%, for skilled workers it increased by 10.79%, and for retired households, it increased by 6.87%. In the case of North Korea, under R2, consumption per capita for unskilled workers increased by an annual average of 149%, for skilled workers it increased by 146%, and for retired households, it increased by 99%. Under R3, consumption per capita for unskilled workers increased by an annual average of 464%, for skilled workers it increased by 274%, and for retired households, it increased by 276%. Finally, under R4, consumption per capita for unskilled workers increased by an annual average of 346%, for skilled workers it increased by 224%, and for retired households, it increased by 211%. It can be compared with the result of the standard model, that for the working population in South Korea, the difference in consumption per capita under R2 is 0.93%, R3 is 3.64% and R4 is 6.39%.

Meanwhile, to compare the consumption per capita of the working population in cases where the proportion of unskilled labors ultimately converges or does not converge, the consumption per capita paths of 'Unskilled' and 'Skilled' were compared under R4. In South Korea, the consumption per capita of unskilled labors decreases annually by -8.9% and -1.0% respectively in cases of non-convergence and convergence of the proportion of unskilled labors. On the other hand, skilled labors see an annual increase of 10.4% and 7.1% respectively in cases of convergence and non-convergence. Thus, in South Korea,

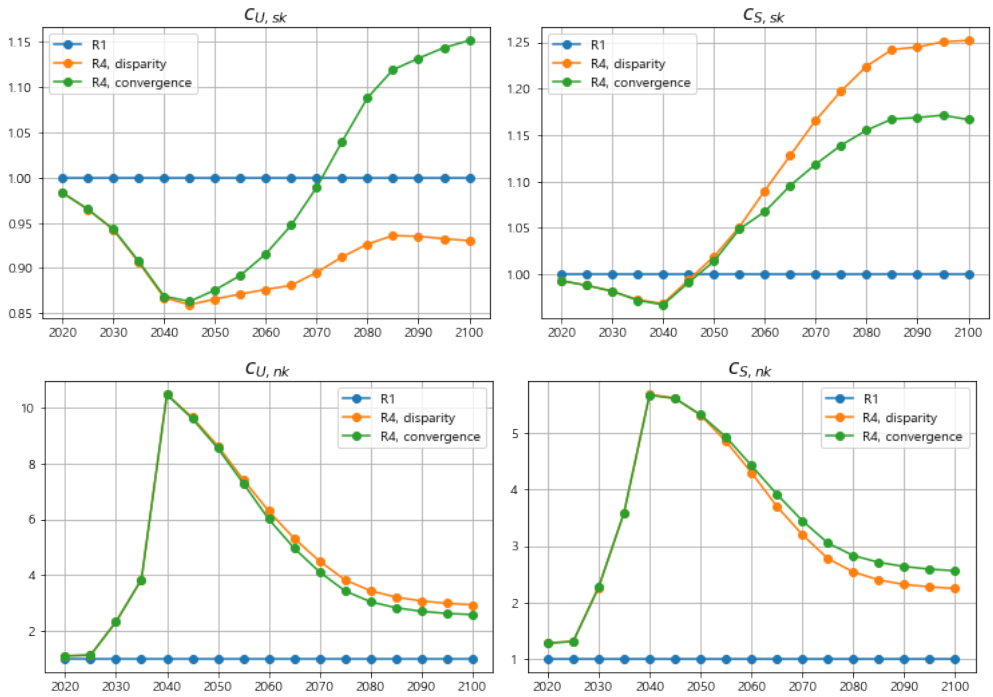


Figure 19: Consumption Per Capita, Persistent Disparity(R4) VS Convergence(R4)

if the proportion of unskilled labors in North Korea decreases to South Korean levels, meaning the average level of education increases, the decline in the annual consumption of South Korea's unskilled laborers significantly lessens, while the size of the annual consumption increase of skilled laborers slightly decreases. This produces effects that are beneficial for unskilled labors and relatively unfavorable for skilled labors. In previous analyses, it was determined that the effects of unification will be more pronounced as the proportion of skilled labors in South Korea increases. If the labor structure between North and South Korea converges, the magnitude of these effects will relatively decrease. In North Korea, the consumption path of unskilled labors increases annually by 371.2% and 350.3% respectively in cases of convergence and non-convergence of the proportion of unskilled labors. Meanwhile, skilled laborers see an annual increase of 227.5% and 242.0% respectively in cases of convergence and non-convergence. Thus, if the proportion of unskilled labors in North Korea decreases to South Korean levels, there will be effects that are unfavorable for unskilled laborers and beneficial for skilled labors.

7.4 Referendum

In the previous section, the differences in consumption per capita by working and retired populations were analyzed according to integration regimes. One of the differences between the main model and the extension model is the introduction of idiosyncratic productivity shocks, which prevent the degeneration of household asset distribution. Therefore, I examine the positions on unification by dividing them by skill level, age, and assets. The method is to conduct a referendum where each economic agent votes based on the advantages and disadvantages of each regime at the time just before the period when integration occurs. To conduct a referendum, the differences in value functions between the alternative and baseline regimes for each economic agent are cal-

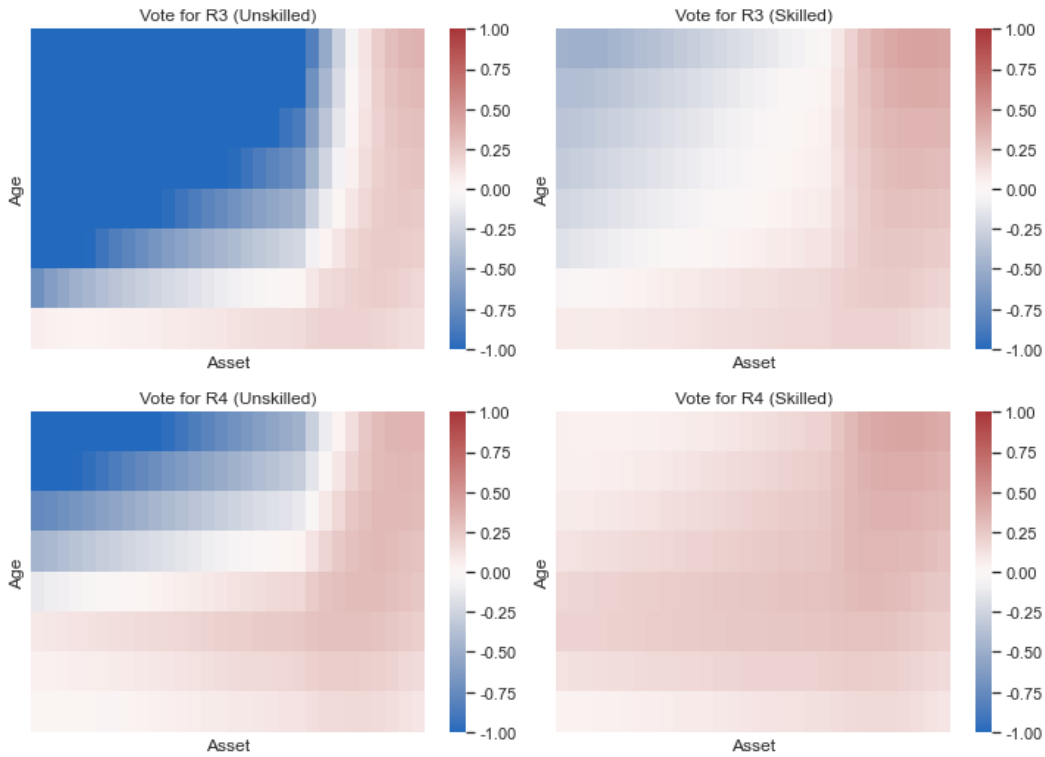


Figure 20: Referendum Result

culated. Since the value function is the expected discounted value of all future utilities calculated by each economic agent at the current point, if the value function of an alternative regime is greater than that of the baseline regime, it means that the agent can achieve higher utility under the alternative regime. If we were to grant voting rights to such an economic agent, we might expect them to vote in favor of the alternative regime.

The focus of this excersize is to gauge the likelihood of unification by examining the positions of different generations, assets, and skill levels before unification, as well as to analyze the positions on unification based on the state variables just before unification. In the model's assumptions, unification is assumed to occur in 2030, so I assume a national referendum is held in 2025. The results of the national referendum are shown in the Figure 20. Under the partial integration regime (R2), there are almost no differences by skill level, and no differences in positions by generation or assets. This is because there is no wage shock, and the decrease in the interest rate is mitigated by the influx of some capital into North Korea, making it not particularly disadvantageous for South Korea.

In contrast, the results of the radical unification (R3) and gradual unification regime (R4) show clear differences by skill level. In all cases, the more assets one has, the more favorable their position on unification. This is because the marginal productivity of assets increases when the economy is integrated compared to when South Korea maintains a separate economy, resulting in an increase in interest rates. The increase in interest rates means an increase in asset income, and the more assets one has, the more significant the effect they can experience, which explains why those with more assets are more favorable towards integration. On the other hand, the younger the age, the more likely they are to oppose unification, as they are exposed to wage shocks caused by

unification for a longer period. The wage shock from the integration of the labor market consists of both productivity shocks and an increase in labor supply. In particular, since the productivity shock has a structure that gradually recovers as North Korea's total factor productivity converges with South Korea, those who stay in the labor market longer have to experience the entire recovery process after the shock, which may make them more averse to unification.

Furthermore, there is a clear distinction between the positions of unskilled and skilled workers. The heatmap of unskilled workers shows a much wider blue area compared to skilled workers. This is because the wage shocks caused by labor market integration asymmetrically affect workers depending on their skill level. Lastly, we can once again confirm that more agents prefer gradual integration over radical integration by looking at the heatmaps, where the bottom heatmap has a larger red area than the top heatmap. Considering these model results, it is more likely that the younger generation in South Korea, especially those with a higher proportion of skilled workers and more assets, will support unification. On the other hand, since those in their 20s and 30s have not been in the economy for a long time, they are relatively lacking in capital accumulation, making it more likely that a majority of them will have a negative stance on unification.

The voting results are as follows. For R2, the approval rate among unskilled workers is 64.8%, skilled workers 75%, and retired households 88% (counted as approval in case of indiscriminate voting). Considering the population distribution, the total approval rate is 74.5%. For R3, the approval rate among unskilled workers is 17.8%, skilled workers 37.0%, and retired households 69.5%. Considering the population distribution, the total approval rate is 38.1%. Finally, for R4, the approval rate among unskilled workers is 43.5%, skilled workers 100%, and retired households 78.1%. The total approval rate recorded is 73.4%. The model's findings are aligned with the Unification Consciousness

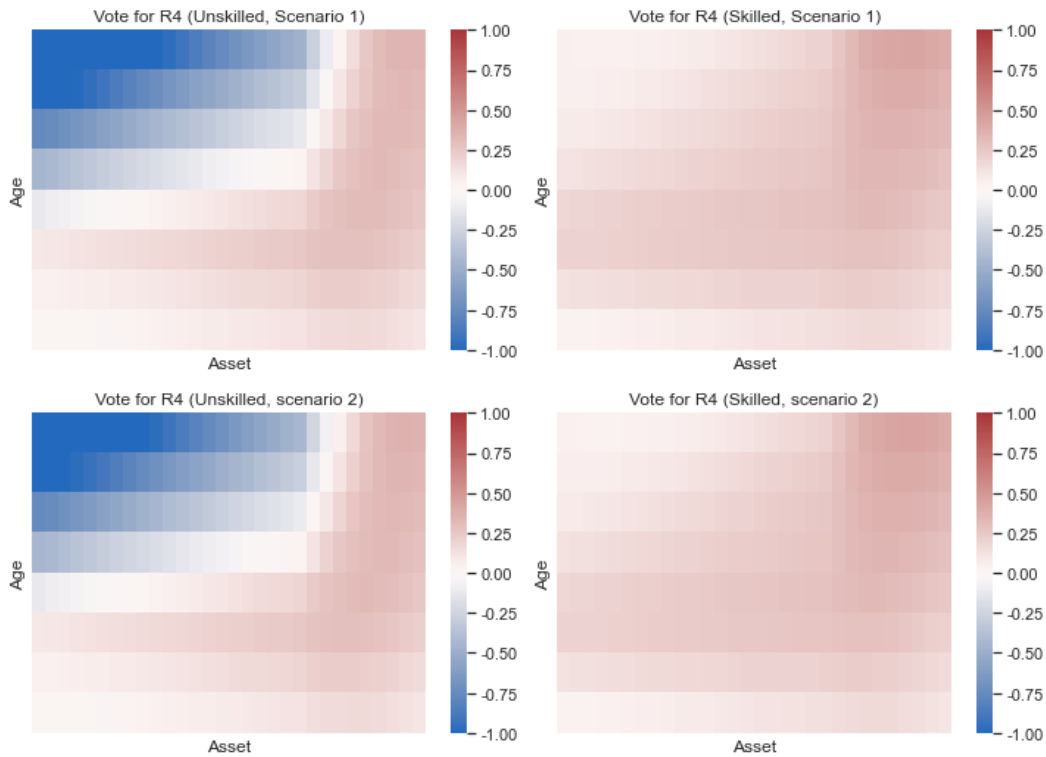


Figure 21: Referendum Result by Unskilled Labor Ratio Scenarios

Survey 2022, conducted by the Institute for Peace and Unification Studies, Seoul National University. The response to questions about reunification in the survey shows that 35.4% of respondents prefer maintaining the division, which can be interpreted as R2, similar to the German-style reunification that comes to mind when our citizens think about reunification.

Even when assuming that the proportion of unskilled workers in North Korea converges to South Korea, the national vote on R4 appears completely the same. In the case of the national vote before unification, it seems that the speed of convergence will have more influence than the level at which the proportion of unskilled workers among North

Korean workers converges.

8 Conclusion

In this paper, I investigate the economic effects of integration between the two Koreas, focusing on the role of demographic dynamics. The experiment comparing the results of the pop-fixed and pop-change versions shows that the impact of the unification can vary depending on whether or not population change is taken into account. This factor makes a big difference especially for the welfare of South Korean workers.

In the pop-fixed version, the impact of unification is negligible for South Korea. However, when population dynamics are taken into account, the consumption per capita of the total population under R4 (gradual unification) increases by 7.3% annually on average compared to that under R1 (no integration). For South Korean workers, they are worse off by -1.3% annually on average in the pop-fixed version because of the integration, while in the pop-change version they are better off by 6.3% annually on average in consumption per capita. For South Korean retirees, they are better off with integration in both versions, with improvements of 5.1% and 9.0% annually on average, respectively.

The exercise of the comparison by regimes shows that South Korean workers gain from R2, R3, and R4 relative to R1 by 0.93%, 3.09%, and 6.07% respectively in consumption per capita annually on average, and South Korean retirees gain by 6.81%, 7.62%, and 8.58% in consumption per capita. For North Korean worker, they gain by 291%, 381% and 296% respectively, amd North Korean retirees gain by 202%, 269% and 210% repectively. What we found here important is, on the measure of average consumption per capita of population groups, South Korea would prefer the gradual unification regime and North Korea would prefer the rapid unification regime.

At the end of Part I, the lifetime discounted utility analysis by cohort from 1970 to 2040 is conducted. This analysis shows that all cohorts in South Korea prefer integration over separation under the gradual integration regime (R4), with consumption equivalence ranging from 0.72% to 14.73%. While there was generational disagreement toward other integration regimes. The interesting result from North Korea is that cohorts who were born before 2010 prefer the rapid unification regime most; however, cohorts who were born after 2020 started to prefer R2, the partial integration regime, which means that at some point after unification, which means North Korea has already developed enough and no more assistence from South Korea is needed, they started to refuse sharing the burden of supporting South Korean retirees.

Using current population projection data, as in the standard model, may be problematic since it does not take into account potential demographic shocks during unification. For example, a steep drop in North Korea's fertility rate and the convergence of life expectancies between the two Koreas By applying alternative population projections that consider these factors, the benefits of population integration may diminish. For example, the consumption per capita for South Korea's working population, which was better off by 6.3% on average annually, is reduced to 2.1% under the pessimistic population projection. However, there is also a possibility that unification could boost fertility in both Koreas. In this optimistic projection, the consumption per capita of South Korea's working population becomes 4.8%.

Finally, taking into account skill differences in the labor market, the negative wage shock for South Korean workers could be limited to skilled labor but become more severe for unskilled labor. Under the gradual integration regime (R4), skilled labor in South Korea is better off by 10.8% annually on average, while unskilled labor is worse off by -7.74% annually on average. Moreover, an exercise on the referendum in the period

right before integration shows that as individuals have more wealth and are older, they tend to prefer integration under the gradual integration regimes. It is also clear that skilled labor prefers integration more than unskilled labor. Therefore, if South Korea's working population has a higher proportion of skilled labor and more wealth, population integration could be more beneficial.

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요약 (국문초록)

이 논문은 남북 간 인구 통합이 경제에 미치는 영향을 분석한다. 본 모형은 인구구조의 변화를 고려하고, 인구의 동학에 대한 고려가 모형 결과에서 가져오는 차이점에 주목한다. 이를 위해 중첩세대 동태적 일반균형 2국가 모형을 도입하고, 세대 간 부양문제를 고려하기 위해 부과식 (Pay-As-You-Go) 연금제도를 모형에 추가하였다. 경제 통합은 통합의 수준과 속도에 따라 네 가지 통합 레짐으로 구분한다: 분단유지 (R1, 기준레짐), 부분 통합 (R2), 급진 통일 (R3), 그리고 점진 통일 (R4). 분석결과는 인구변동이 고려되지 않은 모형에서 남한의 근로자는 통일의 피해자였으나, 인구변동이 고려된 모형에서는 수혜자가 되었다. 이에 더하여, 1970년생부터 2040년생까지의 세대별 생애할인기대효용을 이용해 대등소비를 계산한 결과 여타의 통합레짐에서는 통일에 대한 세대 간 의견이 불일치하지만, 점진통일 레짐 하에서는 남한의 모든 세대가 분단유지보다 통합을 선호하는 것으로 나타났다. 한편, 통일로 인해 북한 내 인구충격이 발생한다면 통일의 효용은 기존 결과에 비해 감소할 수 있는 것으로 분석되었다. 마지막으로 노동자의 숙련도를 고려한 확장 모형을 통해 남한에 숙련 노동자의 비율이 높을수록 통일의 효용은 기존 모형의 결과보다 더 높아질 수 있다는 결론이 도출되었다.

주요어 : 인구구조 변화, 경제 통합

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