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On the Effects of National Debt on the Distribution of Household Assets†

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This study examines the long-term effects of higher national debt in South Korea on asset distribution. Using an overlapping generations general equilibrium model, we focus on two key channels: rising interest rates and falling wage rates, both driven by the crowding-out effect of capital. Higher interest rates increase asset dispersion, benefiting older groups with more accumulated assets, while younger groups with fewer assets gain less. Falling wage rates reduce the capacity to save money across all age groups, partially offsetting the dispersion effects of higher interest rates. A simulation of a 50% increase in national debt reveals a decline in the Gini coefficient of asset holdings, driven by the diminishing marginal increase in future assets relative to current holdings. However, widening cross-sectional dispersion proved more welfare-relevant: older age groups, which experienced greater gains in average assets, saw increases in average welfare, whereas early life-cycle cohorts with low asset levels experienced welfare losses. Given this trade-off associated with higher national debt, initial asset transfers as a counteracting measure can enhance lifetime welfare overall, mitigate the rising asset dispersion, and improve the asset Gini coefficient.

Key Words: National Debt, Government Debt, Asset Inequality, Asset Distribution, General Equilibrium, OLG
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I. Introduction

The idea of a country accumulating significant debt is generally perceived negatively. This concern is also relevant in the case of South Korea, which underwent painful structural adjustments to repay the funds borrowed from the International Monetary Fund (IMF) during the 1997 financial crisis. Given this historical experience, the notion of a rising level of national debt remains a significant and concerning issue. One can easily imagine a scenario in which the government suddenly issues large amounts of government bonds, leading to a sharp increase in interest rates and subsequent concerns over debt repayment. However, if we set aside situations related to economic crises, is a consistently high national debt ratio necessarily problematic if the country can refinance it? Unlike corporate or personal debt, national debt is relatively easier to refinance. Due to this characteristic, the government debt of OECD countries reached 110.5% of OECD's total GDP in 2023 (OECD, 2025). With the South Korean government projecting that ITS national debt-to-GDP ratio could rise from around 47.8% to 173.0% by 2072 (NABO, 2025), this study examines the long-term effects of maintaining higher level of national debt ratio on Korea's domestic economy.[1]

When assuming an overlapping generations general equilibrium model in a closed economy, there are two primary channels through which rising national debt can affect long-term economic equilibrium. The first channel is the capital market. In a simplified model of the capital market, household assets are divided into two categories: capital used by domestic firms and national debt. Therefore, any change in national debt must be accompanied by a change in capital, assets, or both. For example, if household assets remain fixed, an increase in national debt has a crowding-out effect, reducing available capital. As a result, capital becomes relatively scarce compared to labor used by firms, leading to higher interest rates and lower wage rates.

Of course, if we assume a complete (financial) market in which households increase their assets by an amount that matches precisely the rise in national debt, then higher national debt would have no impact on the capital market. In economics, this situation—where government bond issuance does not affect real markets—is commonly referred to as the Ricardian Equivalence Theorem (Barro, 1974). However, in a more realistic scenario where financial markets are incomplete and many households remain financially constrained even as national debt increases, the Ricardian Equivalence Theorem serves only as a theoretical starting point rather than an accurate depiction of reality. Due to similar reasons, in practical settings such as the overlapping generations model—where individuals have limited assets in the early stages of their life cycle and tend to deplete their assets toward the end—capital crowding-out is inevitable.

The second channel through which rising national debt can impact long-term equilibrium is via an increase in interest costs. When the real interest rate exceeds

[1]Therefore, this paper abstracts from a detailed examination of both reasons behind the rise in national debt and the transitional dynamics toward long-term equilibrium.

the economic growth rate, a rise in national debt instills a growing interest burden in terms of the ratio to GDP, necessitating higher tax rates to satisfy the government budget equation and maintain long-term equilibrium. However, if the real interest rate is close to or below the economic growth rate, national debt has little impact on tax rates.[2] Given this consideration, this study will largely set aside the channel of government budget pressure to focus on other mechanisms.[3]

Ultimately, as national debt rises, households will experience its effects primarily through higher interest rates and lower wage rates. How do households respond to these price changes? This study aims to analyze this issue by focusing on the asset accumulation process over the life cycle. First, as interest rates rise, cross-sectional asset dispersion tends to broaden. In particular, the age group with the highest asset holdings—typically just before retirement—benefits the most, while those in the earliest and latest stages of the life cycle, who hold the fewest assets, experience little benefit from higher interest rates. This situation arises because those with assets accumulated over their working years will see their compounded returns grow more significantly, whereas those without assets remain less affected by interest rate levels. Not only does this broaden asset dispersion across age groups, but asset dispersion within the same age group may also broaden. Even minor early-life asset differences can result in greater dispersion as higher interest rates compound over time. Consequently, rising interest rates may contribute to an overall increase in asset dispersion.

Conversely, lower wage rates reduce the saving capacity of all age groups, thereby decreasing total asset accumulation. Wage declines not only affect the working-age population but also reduce pension benefits, leading to lower lifetime earnings across all age groups. Consequently, the effects of a capacity reduction in can accumulate over time, offsetting the dispersion-broadening impact of rising interest rates. Ultimately, it remains unclear as to how rising national debt quantitatively alters the dispersion of household assets – a gap in the literature this study aims to fill.

The model used in this study primarily references Woo (2022), one of the most recent paper in the South Korean macro-fiscal literature, and is based on the standard closed economy macro-fiscal general equilibrium framework. Households are assumed to begin with zero initial assets and decide on consumption and savings over their life cycle. Before retirement, they endogenously determine their labor hours while facing idiosyncratic labor productivity shocks. Upon retirement, they receive pension benefits, which are also linked to wage rates. Firms are assumed to follow a Cobb-Douglas production function, and the government budget constraint is satisfied primarily through adjustments in consumption tax rates.

The model's parameterization largely follows the macro-fiscal economics literature on South Korea. Among the parameters, the most critical for the topic here is the constant relative risk aversion (CRRA) coefficient, which governs household saving behavior. After a brief theoretical discussion, we conclude that within the range

[2]In Korea, the average nominal growth rate from 2015 to 2024 (4.69%) exceeded the three-year government bond yield (2.09%).

[3]This study focuses on asset accumulation in a life-cycle setting. Assuming log period utility of consumption and a flexible consumption tax that satisfies the government budget constraint, government budget pressure does not affect asset and labor choices, although it still influences consumption and welfare.

commonly used in the literature (1 to 1.5), the main results would remain robust.

An experiment that compared two stationary general equilibria before and after a 50% increase in national debt level was conducted.[4] The results indicate that while the gap between the 75th and 25th percentile of asset holdings ("asset gap") widened after the increase in national debt, the Gini coefficient—another common measure of inequality—actually decreased. This outcome is closely linked to changes in household asset policy functions. Specifically, when national debt rises, those with higher asset levels tend to increase their assets more significantly in the following year, but the rate of increase diminishes. This finding aligns with the observed decline in the Gini coefficient, indicating that the direction of inequality depends on the chosen metric. Similarly, within the same age group, the asset gap widened, while the Gini coefficient generally decreased.

However, the implications of changes in the cross-sectional asset distribution, well summarized by variations in average assets by age group, are more significant from a welfare perspective. Specifically, age groups that experienced a greater increase in average assets due to rising national debt also saw higher value functions (welfare measure in terms of utility), whereas those in the early stages of the life cycle, who consistently have little to no assets, experienced a decline in their average value function.[5] Although more than 80% of households experienced an increase in value functions overall, the decline in value functions during the early life cycle stages raises concerns from a social welfare perspective, given that only the ex-ante value function includes welfare at all ages.

These findings motivated a policy experiment that increased initial asset transfers to the youngest age group as a direct means of enhancing the ex-ante value function. As initial assets increase, the total asset supply rises, resulting in lower interest rates. Consequently, the value function of younger households improves, while that of older households declines. Despite this trade-off, this study finds that an appropriate rise in initial assets can fully offset the loss in the ex-ante value function caused by higher national debt, while simultaneously keeping the value functions of the majority of age groups better off.

This study further finds that both measures of asset inequality, which move in opposite directions in response to rise in national debt level, improve as initial assets increase. Asset dispersion, measured by the "asset gap", declines as higher capital offsets the price effects of higher national debt, while the asset Gini coefficient falls because fewer individuals hold extremely low (zero) assets.

Care must be taken when interpreting the results of this policy experiment. Fundamentally, in terms of the ex-ante value function, an increase in national debt is undesirable,[6] whereas initial asset transfers are considered beneficial. Therefore, the key takeaway from this study is that if an increase in national debt is inevitable,

[4]This analysis abstracts from other specific fiscal or macroeconomic shifts that could be closely associated with the increase in national debt.

[5]On the other hand, with-in age group asset distribution had little implication. For example, although asset gap increased for individuals nearing retirement, their average assets rose significantly, leading to an improvement in their simulated value functions. Also, the value functions of individuals just entering the labor market declined, even though their assets were commonly zero.

[6]Even when initial assets are positive yet not unrealistically high at the outset, an increase in national debt lowers the ex-ante value function.

compensating for its effects through initial asset transfers may serve as an appropriate policy measure.

Research on the long-term effects of increasing levels of national debt within a heterogeneous household model was introduced initially by Aiyagari and McGrattan (1998). Since then, various studies have followed this approach, with Lim (2011) adapting the framework to the context of the Korean economy. More recently, Shin (2022) extended the analysis beyond long-term effects to examine the general equilibrium impacts that may arise during the transition to an increased level of national debt. A common feature in these studies is their focus on infinite-horizon households, whereas this study differs by adopting a life-cycle model.

There is no definitive answer as to whether the infinite-horizon household model or the life-cycle model is superior. In reality, individuals exhibit age-based heterogeneity over their life cycle, yet there also exists a long-term intergenerational characteristic where descendants behave as a single household over time. Both assumptions hold significant implications with regard to a general equilibrium analysis of national debt. This study primarily focuses on the economic differences across households of different ages and further contributes by analyzing the policy effects of initial asset transfers in the early stages of the life cycle.

This study is closely related to numerous papers that analyze fiscal effects using the overlapping generations (OLG) model. The foundational work in this field was conducted by Auerbach and Kotlikoff (1987), and later, Nishiyama (2003) and Nishiyama and Smetters (2014) extended the model by incorporating idiosyncratic shocks, allowing it to become widely used in macroeconomic distribution research. In Korea, studies by Moon and Lee (2013) and Woo (2022) have built upon this model to analyze fiscal policy. Unfortunately, this study makes only a modest methodological contribution. That said, its significance lies in how it focuses more specifically on how an increase in national debt affects asset distribution.

Section 2 outlines the model used in the analysis and explains the parameterization methods. Section 3 discusses the theoretical framework for how asset accumulation evolves over the life cycle in response to an increase in national debt within a general equilibrium setting. Section 4 presents the quantitative results of rising national debt and derives corresponding policy implications.

II. Model

This section explains the model used in the analysis and the methods used for parameterization. The model primarily references Woo (2022) and assumes an overlapping generations (OLG) general equilibrium framework encompassing households, firms, and the government. Households maximize utility, firms maximize profits, and the government adjusts the consumption tax rate to satisfy the government budget constraint. The analysis is conducted within a stationary equilibrium where the distribution of aggregate variables remains constant over time. The parameters are primarily calibrated to reflect the economic and demographic conditions of 2023.

A. *Model Setting*

1. Household's Utility Maximization Problem

The household utility maximization problem is formulated under a life-cycle model framework. Heterogeneous households exist continuously and participate in economic activities at each age $i \in \{1,\cdots,I\}$. Due to an exogenously and independently given mortality probability γ_i, households may not transition to the next age $i+1$ and instead face death. At the final age $i=I$, the probability of death is set to $\gamma_I = 1$.

Households enter the labor market at age $i=1$ and can work only until $i=i_R-1$. The age group within the range $i \in \{1,\cdots,i_R-1\}$ is referred to as the "working-age" population. Given the labor productivity shock x, age-specific labor productivity ε_i, and the equilibrium wage w, households determine their labor hours l, which results in labor income given by $y_i^l = w\varepsilon_i x l$. The idiosyncratic labor productivity shock follows an AR(1) process and evolves according to the following process:

$$ln\left(x'\right) = \rho_x ln\left(x\right) + \nu_x,\ \nu_x \sim \left(0,\sigma_x{}^2\right).$$

For a given asset level a, capital income is ra, and households pay a capital income tax of $\tau_k ra$. They also contribute to the national pension system by paying a payroll tax of $\tau_{ss} y_i^l$. Taxable income is given by $y_i = (1-\tau_k)ra + (1-\tau_{ss})y_i^l$.[7] Households then pay an income tax of $\tau_w y_i$ on this taxable income.

Given disposable income and the current asset level a, households decide on next-period assets a' and consumption c, while also paying a consumption tax of $\tau_c c$. Households face incomplete market restriction $a' \geq 0$.

The age group $i \in \{i_R,\cdots,I\}$ is referred to as the "retirement-age" population. During this period, households do not earn labor income and therefore do not pay contributions to the national pension system. Their income consists of interest income ra and pension benefits $pen(x)$. The pension benefit $pen(x)$ is assumed to be determined by the productivity shock in the final year of the working period, following the approach of Woo (2022). Households pay a capital income tax of $\tau_k ra$, and their taxable income is given by $y_i = (1-\tau_k)ra$. An income tax of $\tau_w y_i$ is then levied on this taxable income.[8] Households determine their next-period assets and consumption based on their disposable income and current asset holdings, while also paying a consumption tax.

The national pension benefit is defined as follows:

[7]The capital income tax is interpreted as corporate tax. Therefore, similar to real-world tax structures, income tax is levied after the capital income tax has already been applied.

[8]In reality, pension benefits are also subject to income tax. However, since tax deductions on pension income are significantly larger compared to labor income, this study chooses to disregard them for simplicity.

$$pen(x) = \xi w(0.5 + 0.5x)N / \sum_{i=1}^{i_R-1} \mu_i .$$

$\xi = 0.4$ represents the income replacement rate of the current national pension system. N denotes the total labor supply, and μ_i represents the population at age i. The following equation is designed to reflect the redistributive function of the national pension system as accurately as possible given the state variables.

The period utility function $u(c,l)$ for each age group is given as follows:

$$u(c,l) = \frac{c^{1-\sigma_u} - 1}{1-\sigma_u} - \varphi \frac{l^{1+\frac{1}{\sigma_l}}}{1+\frac{1}{\sigma_l}} .$$

The utility decreases as labor hours increase, reflecting the disutility of labor. This utility is discounted over time by a factor of β.

The value function $V_R^{\,i}(a,x)$, which solves the utility maximization problem for retirees, can be expressed using the Bellman equation as follows:

$$\begin{aligned} V_R^{\,i}(a,x) &= \max_{c,a'} u(c,0) + \beta(1-\gamma_i)(1+g_z)^{1-\sigma_u} V_R^{\,i+1}(a',x) \qquad s.t. \\ (1+\tau_c)c + a'(1+g_z) &= a + (1-\tau_k)ra + pen(x) - \tau_w y_i , \\ y_i &= (1-\tau_k)ra , \\ a &\geq 0,\ I \geq i \geq i_R . \end{aligned} \tag{1}$$

Here, g_z is the adjustment factor for the growth rate of per capita variables, driven by the growth of total factor productivity z.[9] Along with the population growth rate g_n, the term $(1+g_z)(1+g_n)$ represents the overall economic growth rate.

The value function $V^i(a,x)$, which solves the utility maximization problem for the working-age population, can be expressed using the Bellman equation as follows:

$$\begin{aligned} V^i(a,x) &= \max_{c,a',l} u(c,l) + \beta(1-\gamma_i)(1+g_z)^{1-\sigma_u} E_{x'|x} V^{i+1}(a',x') \\ &\quad s.t. \\ (1+\tau_c)c + a'(1+g_z) &= a + (1-\tau_k)ra + (1-\tau_{ss})y_i^{\,l} - \tau_w y_i , \\ y_i^{\,l} &= w\varepsilon_i x l , \\ y_i &= (1-\tau_k)ra + (1-\tau_{ss})y_i^{\,l} , \end{aligned}$$

[9]Total factor productivity z grows each year by a factor of $(1+g_z)^{1-\theta}$.

$$ln\left(x^{'}\right)=\begin{cases}\rho_x \ln\left(x\right)+\nu_x,\ \nu_x \sim N\left(0,\sigma_x{}^2\right) & if\ i<i_R-1\\ \ln\left(x\right) & o.w.\end{cases},$$

$$V^{i_R}\left(a,x\right)=V_R{}^{i_R}\left(a,x\right),$$

$$a\geq 0,\ i<i_R. \tag{2}$$

2. Firm's Profit Maximization Problem

Firms operate under the following Cobb-Douglas production technology:

$$Y=\mathrm{zK}^{\theta}N^{1-\theta}.$$

In this equation, K represents capital input, N represents labor input, z denotes total factor productivity, and θ is the capital income share. Using the production technology described above, the GDP, denoted as Y, is generated. Firms solve the following optimization problem:

$$\max_{K,N}\left\{\mathrm{zK}^{\theta}N^{1-\theta}-\left(r+\delta\right)K-wN\right\}. \tag{3}$$

Here, δ represents the depreciation rate, r denotes the interest rate, and w represents the wage rate.

The optimality conditions derived from solving this optimization problem are as follows:

$$w=\left(1-\theta\right)\mathrm{zN}^{-\theta}K^{\theta},$$

$$r+\delta=\theta\mathrm{zN}^{1-\theta}K^{\theta-1}.$$

This implies that the wage rate corresponds to the marginal product of labor, while the sum of the interest rate and the depreciation rate corresponds to the marginal product of capital. When the relative capital-to-labor ratio K/N decreases, capital becomes relatively scarce, and labor becomes more abundant, leading to a decrease in w and an increase in r. Conversely, when K/N increases, the opposite occurs—wages rise while the interest rate declines.

Furthermore, these equations can be used to demonstrate that the income distribution ratio remains unchanged.

$$\theta Y=\left(r+\delta\right)K,$$

$$\left(1-\theta\right)Y=wN.$$

3. Government Budget Constraint

$\psi^i(a,x)$ represents the density function for age i. The government finances its revenue T through consumption taxes, capital income taxes, income taxes, and death taxes, with the process expressed as follows:

$$T = \sum_{i=1}^{I} \mu_i \int \left[\tau_c c + \tau_w y_i + \tau_k r a + \frac{\gamma_{i-1}}{1-\gamma_{i-1}} a \right] d\psi^i(l,a,x),$$
$$\gamma_0 = 0.$$

In this equation, μ_i represents the population at age i. Given government revenue T, government consumption G, the current national debt D, and the next-period national debt D', the following government budget constraint holds:

$$G + (1+r)D = D'(1+g_z)(1+g_n) + T,$$
$$G = \bar{g} \times \sum_{i=1}^{I} \mu_i . \tag{4}$$

Under stationary equilibrium, $D' = D$ holds. Government spending is assumed to be proportional to the total population, following a constant parameter $\bar{g}$. The government adjusts the consumption tax rate to achieve fiscal balance. The fiscal condition of the national pension system is omitted to focus on the pure effects of national debt in the current economic environment.[10]

4. Market Clearing Conditions

The total labor supply for each age i is expressed as follows:

$$N_i = \mu_i \int \varepsilon_i x l d\psi^i .$$

The labor market clearing condition is given as follows:

$$N = \sum_{i=1}^{i_R - 1} N_i . \tag{5}$$

For the capital market, the national debt D and firms' capital demand K must be

[10]If the financial condition of the national pension system deteriorates, as projected for Korea in the future, general government resources would need to be injected as compensation under a formal stationary equilibrium. However, under the assumptions of log utility of consumption and a flexible consumption taxes, such general government pressures do not affect households' asset, labor, or before-tax consumption choices.

fully funded by households' capital supply A.

$$A = D + K,$$
$$A = \sum_{i=1}^{I} \mu_i \int ad\psi^i(l,a,x). \quad (6)$$

5. Definition of Stationary Equilibrium

A state of stationary equilibrium normally satisfies the following conditions:

1. Households maximize utility.
2. Firms maximize profits.
3. The government satisfies its budget constraint.
4. The capital market and labor market clear.
5. The macroeconomic distribution maintains dynamic consistency.

Stationary equilibrium for this model is defined as the set of variables and functions $a^{i*}(a,x)$, $c^{i*}(a,x)$, $l^{i*}(a,x)$, r, w, τ_c, N, K, and $\psi^i(l,a,x)$ such that $a^{i*}(a,x)$, $c^{i*}(a,x)$, and $l^{i*}(a,x)$ solve (1) and (2) given r, w, and τ_c; firms solve (3) given r and w; the government satisfies (4); and the markets clear through (5) and (6). In this study, the concept of dynamic consistency is modified. Under a standard stationary equilibrium, economic agents accurately predict future demographic structures using mortality rates, ensuring that the aggregate distribution remains unchanged over time. However, in this model, mortality rates and population structures may not be fully consistent. For example, in a true stationary equilibrium, the condition $\gamma_i = \mu_{i+1} / [\mu_i \times (1+g_n)]$ must hold. However, given that this model directly incorporates γ_i, μ_i, and g_n as exogenous inputs from data, this equation may not necessarily hold. To maintain the essence of dynamic consistency, this study defines μ_i as an age-specific weight used in the construction of aggregate variables. Economic agents take this as given, and their decisions lead to a macroeconomic distribution that remains unchanged over time. While this approach does not fully align with a rational expectations-based macroeconomic model, it is considered sufficient for capturing the key macroeconomic effects analyzed in this study.

This study assumes a population structure where $\sum_{i=1}^{I} \mu_1 = 1$ and adjusts for the population growth rate g_n. As a result, all macroeconomic variables, except for rate-based variables such as the interest rate r, are interpreted as per capita values and are assumed to grow annually by a factor of $(1+g_z)$. Additionally, although μ_i remains constant in the model, the population at each age group is interpreted as increasing by a factor of $(1+g_n)$ each year.

B. *Parameterization*

The specific source for parameter selection is summarized in Table 1. The following parameter values are predetermined, independent of the model solution, and are commonly used in the Korean macroeconomic literature: $\sigma_\mu = 1,\ \ \sigma_l = 0.4,$ $\sigma_x = 0.05,\ \ \rho_x = 0.92,\ \ \theta = 0.36,\ \ \delta = 0.08.$ The income replacement rate of the national pension system is set at 40%, leading to $\xi = 0.4.$ Regarding the life cycle, the model assumes that age $i = 1$ corresponds to 20 years old, $i = i_R$ corresponds to 65 years old (retirement age), and $i = I$ corresponds to 98 years old (the terminal age).

The parameters calibrated to match the economic and demographic conditions of 2023 are as follows: $g_z = 0.0132$ and $g_n = 0.0008.$ The values for μ_i and γ_i are extracted from the 2021 Population Projections. For convenience, μ_i is adjusted so that the total population sum equals 1. The national debt D is set to ensure that the debt-to-GDP ratio, given by $D(1+g_z)(1+g_n)/Y,$ equals 50.4%.

Assuming $Y = 1$ and $N = 1$, and applying optimality conditions for firms, the following equations are derived:

$$K = \frac{\theta - \tau_k rK}{\delta + (1-\tau_k)r},$$

$$z = \frac{1}{K^\theta},$$

$$R = \frac{\theta}{K},$$

$$r = R - \delta.$$

Setting $\tau_k rK$ as the capital income tax-to-GDP ratio to 3.35% and $(1-\tau_k)r$ as the real government bond interest rate to 1.673%,[11] the values for K, z, R, r, and τ_k are sequentially determined.

[11]The 2023 nominal government bond interest rate (three-year maturity) of 3.573% is adjusted by subtracting the GDP deflator growth rate of 1.9%.

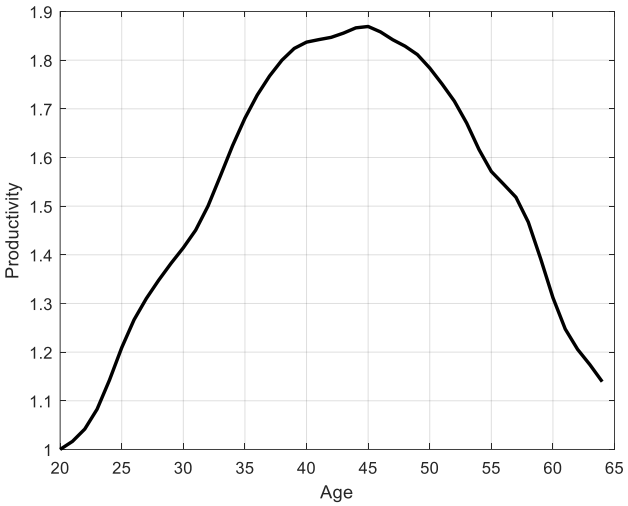

FIGURE 1. LABOR PRODUCTIVITY BY AGE

Note: Standardized by dividing by the productivity at age 20.

The relative magnitude of age-specific labor productivity ε_i is extracted from the 2019 Korean Labor & Income Panel Survey,[12] as shown in Figure 1. This is calculated by dividing the average income by the average working hours for each age group. The overall level of ε_i is exogenously adjusted so that $N=1$ holds if every households sets $1=1/3$ before solving the model. The parameter φ is estimated so that $N=1$ after solving the model.

The consumption tax rate τ_c is estimated to ensure that the consumption tax-to-GDP ratio is 3.073%. The income tax rate τ_w is set so that the income tax-to-GDP ratio is 4.82%, and the payroll tax rate τ_{ss} is determined to match the pension revenue-to-GDP ratio of 2.43%.

During calibration, the government budget constraint is first satisfied by determining $\bar{g}$. In the policy experiment where the national debt ratio increases, the budget constraint is adjusted through τ_c rather than $\bar{g}$.

[12]Because labor market conditions after 2019 may not have fully recovered from the impact of COVID-19, the year 2019—the last year unaffected by COVID-19—is chosen for the analysis.

TABLE 1—PARAMETER SETTINGS

Variable	Description	Value	Source
σ_u	CRRA coefficient	1	Woo (2022)
σ_l	Labor elasticity	0.4	Woo (2022), Kwon (2016)
β	Time discount factor	1.0084	ECOS three-year government bond interest rate
φ	Disutility of labor coefficient	60.8	Set to satisfy N=1
ε_i	Age-specific average labor productivity	-	Korean Labor & Income Panel Survey (2019) wage and working hours data N=1 if all l=1/3
γ_i	Age-specific mortality rate	-	Population Projections (2021)
μ_i	Age-specific population share	-	
σ_x	Variance of idiosyncratic labor productivity shocks in AR(1) process	0.05	Lee *et al*. (2019)
ρ_x	Autoregressive coefficient of labor productivity shocks in AR(1) process	0.92	
θ	Capital income share	0.36	Lee *et al*. (2019)
z	Total factor productivity	0.6454	Set to satisfy Y=1
δ	Depreciation rate	0.08	Lee *et al*. (2019)
g_z	Per capita growth rate	0.0132	JipyoNuri (2023)
g_n	Population growth rate	0.0008	
τ_k	Capital income tax rate	0.3723	e-Nara Indicators, corporate tax
τ_c	Value-added tax rate	0.054	e-Nara Indicators, consumption tax
τ_{ss}	National pension contribution rate	0.038	e-Nara Indicators, national pension revenue
τ_w	Income tax rate	0.0708	e-Nara Indicators, income tax
D	National debt-to-GDP ratio	0.497	e-Nara Indicators, national debt ratio
G	Government spending	0.133	Government budget equation
ξ	National pension income replacement rate	0.4	Set to match a 40% income replacement rate

III. Theoretical Discussion

The primary focus of this study is the long-term impact of rising national debt on household assets. Thus, the key question concerns the factors that influence households' asset choices; i.e., if national debt increases but the exogenous variables perceived by households remain unchanged, then household assets will also remain unaffected. This section examines the theoretical impact of rising national debt on price variables (interest rates and wages) and tax rates.

The capital market is the primary market directly affected by national debt. Under a state of closed-economy stationary equilibrium within an overlapping generations model, an increase in national debt has a crowding-out effect, resulting in higher interest rates. This can be demonstrated using the following reasoning: (1) Capital demand is downward-sloping. (2) Capital supply is upward-sloping. (3) An increase in national debt shifts the capital supply curve to the left.

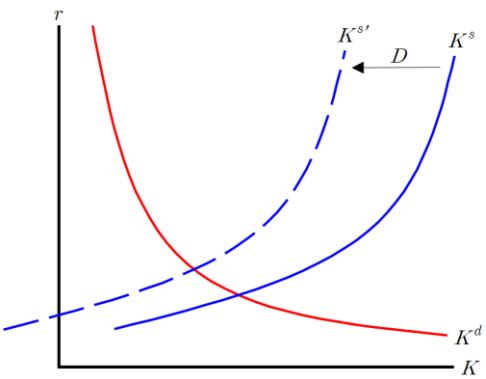

FIGURE 2. SUPPLY AND DEMAND OF CAPITAL MARKET

The total asset supply of households, A, is divided between firms' capital demand, K, and national debt, D. The partial equilibrium interest rate r of capital market is determined by the interaction of this supply and demand. If firms follow a Cobb-Douglas production function, their optimal condition with respect to capital demand is given by

$$r + \delta = \theta z N^{1-\theta} K^{\theta-1}.$$

Without loss of generality, we assume that the total labor N remains fixed. Then, capital demand is downward-sloping, as illustrated in Figure 2.

Does the capital supply curve shift to the left as D increases? If $D = 0$, the market-clearing condition $A = K$ implies that the asset supply curve for A is identical to the capital supply curve. If D increases, because the tax rates and prices other than interest rates faced by households remain unchanged, the asset supply curve itself does not shift. However, according to the new market-clearing condition, $A = K + D$, the portion of A allocated to national debt D reduces the capital

available for firms. As a result, as illustrated in Figure 2, the capital supply curve shifts leftward by exactly D.

The most complex issue is whether the asset supply curve is truly upward-sloping under general equilibrium. In a partial equilibrium setting where wages are fixed and the firms' optimality condition with respect to labor does not apply, it is more likely that an increase in the interest rate would lead to an increase in asset holdings (and thus in capital supply via the capital market clearing condition) of households due to the income effect on savings. However, under general equilibrium, the relationship is not as straightforward. Based on firms' both optimality conditions, the following inverse relationship holds between wages and interest rates:

$$w = \frac{z^2(1-\theta)\theta}{r+\delta}.$$

From this equation, we can infer that if the interest rate increases, the wage rate decreases, potentially reducing the ability of households to accumulate assets. This raises the possibility that the capital supply curve may not be upward-sloping.

However, we show that if the intertemporal elasticity of substitution in the utility function is sufficiently high, the compounded accumulation of assets over a working life of approximately 45 years outpaces the decline in wages. As a result, the total asset supply ultimately increases despite the wage drop. To illustrate this, we consider a simplified $N-$period life-cycle model, excluding labor supply decisions and any uncertainty.

$$\max_{\{c_t, a_{t+1}\}_{t=0}^{N}} \sum_{t=0}^{N} \beta^t \frac{c_t^{1-\sigma_u} - 1}{1-\sigma_u}$$

$$s.t.$$

$$c_t + a_{t+1} = (1+r)a_t + \mathrm{wl}_t,$$

$$a_{t+1} \geq 0,\ a_0 = 0.$$

The dynamics of a_t for this problem can be expressed as follows:

$$a_{t+1} = a_t(1+r) \times \frac{\beta^{1/\sigma_u}(1+r)^{(1/\sigma_u-1)} + \cdots + \beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u-1)}}{1+\cdots+\beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u-1)}} + \frac{\mathrm{wl}_t\beta^{1/\sigma_u}(1+r)^{(1/\sigma_u-1)} + \cdots + \beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u-1)}}{1+\cdots+\beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u-1)}} - \frac{w[1_{t+1}(1+r)^{-1} + \cdots + 1_N(1+r)^{-(N-t)}]}{1+\cdots+\beta^{\frac{N-t}{\sigma_u}}(1+r)^{(N-t)\left(\frac{1}{\sigma_u}-1\right)}} \quad \text{for} \quad t < N.$$

TABLE 2—ASSET BY AGE AS INTEREST RATE $\rightarrow \infty$

σ_u	$w = \bar{w}$	$w = \frac{z^2(1-\theta)\theta}{r+\delta}$
$\sigma_u < 0.5$	$a_t \rightarrow \infty$ for $t \geq 1$	$a_t \rightarrow \infty$ for $t \geq 1$
$\sigma_u = 0.5$	$a_t \rightarrow \infty$ for $t \geq 1$	$a_1 \rightarrow \bar{a_1},\ 0 < \bar{a_1} < \infty,$ $a_t \rightarrow \infty$ for $t \geq 2.$
$0.5 < \sigma_u < 1$	$a_t \rightarrow \infty$ for $t \geq 1$	$a_1, a_2 \rightarrow 0,$ $a_t \rightarrow \infty$ for $t \geq 3.$
$\sigma_u = 1$	$a_1 \rightarrow \bar{a_1},\ 0 < \bar{a_1} < \infty,$ $a_t \rightarrow \infty$ for $t \geq 2.$	$a_1 \rightarrow 0,$ $a_2 \rightarrow \bar{a_2},\ 0 < \bar{a_2} < \infty,$ $a_t \rightarrow \infty$ for $t \geq 3.$
σ_u in gerenal	Assume $\sigma_\mu = k.$ $a_t \rightarrow 0$ for $t < k,$ $a_k \rightarrow \bar{a_k},\ 0 < \bar{a_k} < \infty,$ $a_t \rightarrow \infty$ for $t \geq k+1.$	Assume $\sigma_\mu = k/2.$ $a_t \rightarrow 0$ for $t < k,$ $a_k \rightarrow \bar{a_k},\ 0 < \bar{a_k} < \infty,$ $a_t \rightarrow \infty$ for $t \geq k+1.$

From this equation, we can infer that as long as the asset level a_t in a given period t does not converge to zero, an infinitely increasing r will also cause next-period assets a_{t+1} to diverge to infinity. Also, we can summarize, as in Table 2, whether assets at each age diverges as r diverges to infinity, with a detailed solution provided in the appendix. We observe three important points. Firstly, as σ_u increases (i.e., as the intertemporal elasticity of substitution decreases), a greater number of younger age groups do not experience asset divergence. If interest rates rise and lifetime income diverges to infinity, households with a stronger preference for complementarity between present consumption and future consumption will tend to increase their current consumption along with higher average life cycle consumption, but because initial assets are nearly zero, individuals in the early stages of life must reduce their savings to increase current consumption. Secondly, if we incorporate the labor market clearing condition and assume wages as the inverse of the interest rate, the tendency to reduce savings becomes even stronger.

However, an important point to note is that the commonly used values of σ_u in the macroeconomic literature are between 1 and 1.5. Within this range, asset levels begin to diverge as early as age $t \geq 4.$ Of course, whether the capital supply curve is always upward-sloping across all interest rate levels or whether it is strictly upward-sloping for all parameter values requires further analysis. However, given that the life cycle spans 79 years, the period during which assets can compound at the interest rate is significantly long. Thus, the likelihood that the capital supply curve is upward-sloping remains high.

Lastly, how does an increase in the national debt-to-GDP ratio affect tax rates?

$$G + D[1 + r(1-\tau_k)(1-\tau_w) - (1+g_z)(1+g_n)]$$

$$\approx \sum_{i=1}^{I} \mu_i \int [\tau_c c + \tau_w y_i^l + \frac{\gamma_{i-1}}{1-\gamma_{i-1}} a] d\psi^i(l,a,x) + [\tau_w(1-\tau_k) + \tau_k] rK$$

Let us examine the factors that cause fiscal conditions to deteriorate using the government budget equation. If the after-tax interest rate is significantly higher than the economic growth rate, an increase in national debt can directly worsen fiscal conditions through the budget constraint. Additionally, K declines as observed under the capital market equilibrium state, leading to an overall economic contraction, which in turn reduces revenue from capital income taxes, consumption taxes, and labor income taxes. As a result, the pressure to raise tax rates increases, which may lead to a certain amount of household savings contraction.

Meanwhile, as D increases, the capital market clearing condition implies that the entire increase in D is absorbed into household assets. Consequently, the total assets of households are likely to increase. As household assets grow, death tax revenue rises. Additionally, due to the crowding-out effect, an increase in r leads to higher capital income tax revenue amounts, which can partially offset the rising interest burden on national debt. Depending on the specific parameters, the final tax rate may either increase or decrease.

In this study, we assume a special case in which $\sigma_u = 1$ and the consumption tax rate τ_c is adjusted to meet the government budget constraint. When only looking at the household's utility maximization problem, changes in τ_c do not affect the choices of $(1+\tau_c)c$, a', or l, as the change in τ_c is offset by the change in c. As a result, the condition to meet the government budget constraint does not affect household asset choices. In this study, to focus more on the impact of an increase in national debt on the capital and labor markets, we assume that $\sigma_u = 1$ and that the government budget constraint is met by adjusting the consumption tax rate.[13]

IV. Model Analysis

In this section, first we examine the asset distribution in the baseline model before the increase in national debt, after which we examine how macroeconomic variables and the asset distribution change when the national debt increases. Next, we explore how the household value function changes, and finally we derive policy implications.

[13]What would happen if $\sigma_u > 1$? The complementarity between consumption and leisure increases; hence, if τ_c decreases, c rises and l falls.

A. *Baseline Model*

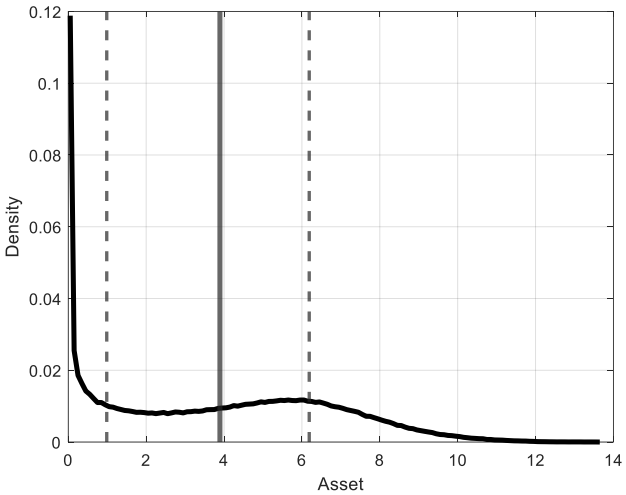

FIGURE 3. ASSET DENSITY FUNCTION IN THE BASELINE

Note: The bold vertical line represents the median, and the dashed lines indicate the 75th and 25th percentiles.

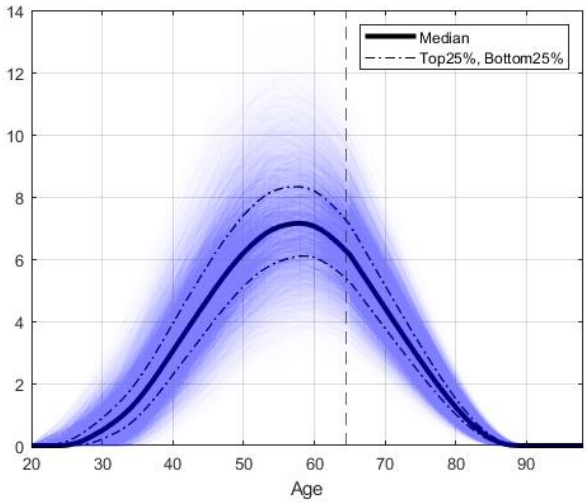

FIGURE 4. ASSET SIMULATIONS IN THE BASELINE

Note: The vertical dashed line represents the retirement point. The thin lines denote 10,000 simulation results.

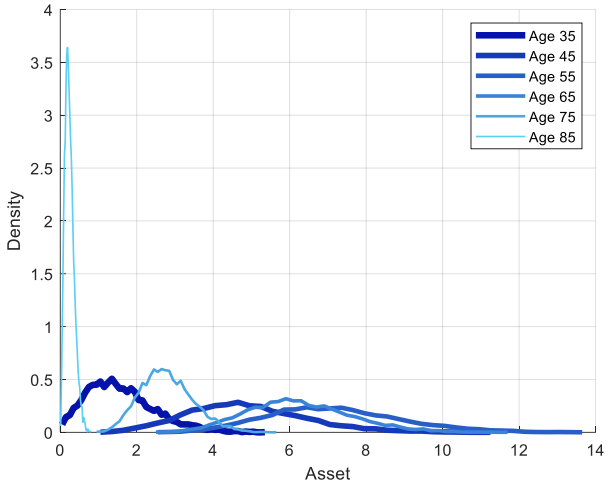

FIGURE 5. ASSET DENSITY FUNCTION BY AGE IN THE BASELINE

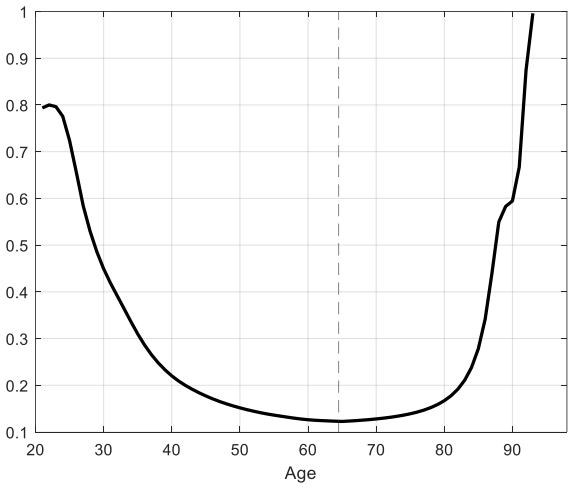

FIGURE 6. ASSET GINI COEFFICIENT BY AGE IN THE BASELINE

Note: The vertical dashed line represents the retirement point.

First, we examine the asset distribution in the baseline model. As shown in Figure 3, the highest density is around asset 0. This occurs because we assume that each household enters the labor market with $a_0 = 0$. The distribution is skewed to the right, similar to real-world data. In the figure, it can be observed that the density near 6 is higher than the density near 2, arising because the population of retired individuals holding assets around 2 is smaller than the population of middle-aged individuals holding assets around 6.

Figure 4 shows the life-cycle results of the asset simulation. It can be seen that households accumulate assets until retirement to prepare for the decline in income at retirement age. In the late 50s, assets peak on average, and the difference between

the 75th and 25th percentiles (the "asset gap") also reaches its maximum. After retirement, because there is no uncertainty for individuals in the model, the life-cycle trajectory of assets does not intersect with the asset trajectories of other households.

The asset density function by age group is presented in Figure 5. Even when examining the distribution by age, it can be observed that it is slightly right-skewed because households with more assets benefit more from the compounding effect through interest rates, which increases the dispersion in asset accumulation. As expected, the asset variance is visually largest around the mid-50s.

What does the Gini coefficient look like by age group? While the asset gap by age group peaks in the late 50s, as shown in Figure 4, Figure 6 reveals the opposite for the Gini coefficient. At the beginning and end of the life cycle, most households have no assets, leading to very high Gini coefficient. When only a few households hold positive assets in a situation where most have none, those few households hold all of the assets for that age group, causing the Gini coefficient to be very high. On the other hand, the Gini coefficient is at its lowest around retirement. This is basically due to the high average assets around retirement relative to the asset dispersion. Note that if the average increases while the variance remains the same, the Gini coefficient decreases. Ultimately, it is difficult to determine with certainty the direction of inequality along the life cycle.

B. *Experimenting with a Rise in National Debt*

TABLE 3—RISE IN NATIONAL DEBT

	Baseline	D ↑
Debt-to-GDP	0.5040	0.7616
GDP	1.0000	0.9926
Asset	3.8720	4.0452
Capital	3.3754	3.2996
Labor	1.0000	1.0012
K/N	3.3754	3.2957
Consumption	0.5693	0.5676
Interest Rate	0.0267	0.0283
Wage Rate	0.6400	0.6345
Consumption Tax Rate	0.0540	0.0523
Capital Income Tax	0.0335	0.0348
Income Tax	0.0482	0.0484
Consumption Tax	0.0307	0.0297
Death Tax	0.0219	0.0230
Real Debt Interest	0.0014	0.0028
Consumption (Labor)	0.4453	0.4417
Consumption (Retirement)	0.1240	0.1260
Ex-ante Value Function	-29.8128	-29.9350

What changes in macroeconomic variables occur when the national debt increases by 50% such that the national debt-to-GDP ratio rises from 50.4% to 76.2%? As shown in Table 3, GDP decreases, which can be attributed to the reduction in capital, primarily caused by the crowding-out effect in the capital market. Although total labor increases, the extent of the increase is small and the final total output thus decreases.

Why does total labor increase? Let's examine the optimal conditions for labor.

$$l = [\frac{1-\tau_{ss}-\tau_w}{1+\tau_c} \times w\varepsilon_i x \times \frac{1}{c^{\sigma_u}\varphi}]^{\sigma l}.$$

Accordingly, when the wage rate decreases, there is a direct substitution effect where labor decreases. However, if $(1+\tau_c)c^{\sigma_u}$ decreases, there is also the outcome of labor increasing due to the wealth effect. Ultimately, according to Table 3, the reduction rate of $(1+\tau_c)c^{\sigma_u}$ in the working-age population is, on average, greater than the reduction rate of the wage rate, meaning that the wealth effect is more significant. As a result, K/N decreases, leading to an increase in the final interest rate and a decrease in the wage rate.

It can be observed that the consumption tax rate decreases, suggesting that the final fiscal burden decreases. While the rise in the national debt-to-GDP ratio increases the real debt interest burden, $D[(1+r)(1-\tau_k)-(1+g_z)(1+g_n)]$, the increase in capital income tax and death tax results in a decrease in the consumption tax rate. However, under the assumption of $\sigma_u = 1$ in this study, these fiscal burden changes do not affect the assets or labor supply choices of households.

TABLE 4—PRICE EFFECTS OF A RISE IN NATIONAL DEBT

	Baseline	D ↑	r ↑	w ↓
Interest Rate	0.0267	0.0283	0.0283	0.0267
Wage Rate	0.64	0.6345	0.64	0.6345
Consumption Tax Rate	0.054	0.0523	0.054	0.054
Assets	3.872	4.0452	4.0832	3.8389
Labor	1.0	1.0012	1.0012	1.0
Consumption	0.5693	0.5676	0.5715	0.5644
Asset Gap 75%-25%	5.2001	5.3194	5.3687	5.1557
Asset Gini Coefficient	0.4315	0.4244	0.4243	0.4315

How does asset change when the national debt rises? We compare the general equilibrium effects with partial effects when only the interest rate rises and when only the wage rate decreases.[14] As shown in Table 4, total assets increase, and as shown in Figure 7, assets increase for nearly all age groups under general equilibrium. This is primarily due to the effect of the increase in interest rates. For example, if only the interest rate rises while the wage rate remains unchanged, assets increase more significantly compared to the general equilibrium effect. On the other hand, if only the wage rate decreases while the interest rate remains unchanged, the ability to save assets diminishes. For those in their late 50s, the effect of the decreased wage rate accumulates more, resulting in a larger reduction in assets. Ultimately, because the effect of rise in the interest rate is stronger, the final assets increase under general equilibrium.

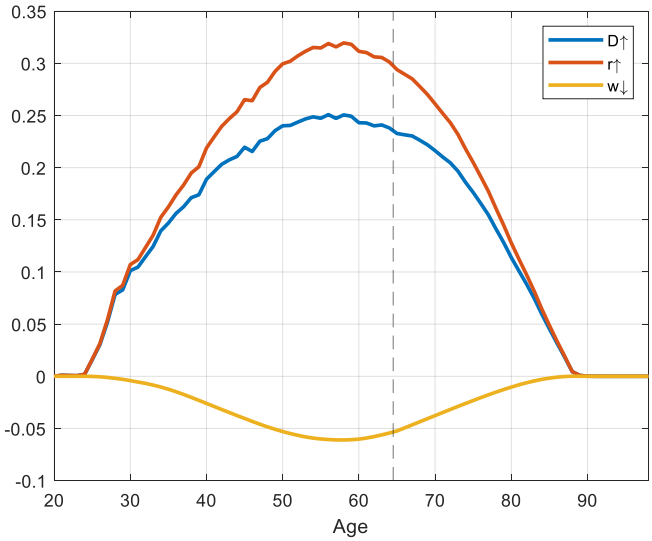

FIGURE 7. CHANGES IN AVERAGE ASSETS AFTER A RISE IN NATIONAL DEBT

Note: The vertical dashed line represents the retirement point.

[14]The price change magnitudes of partial equilibria are determined by those of the general equilibrium. Under partial equilibria, we only consider the household utility maximization problem and disregard market clearing conditions and government budget constraints.

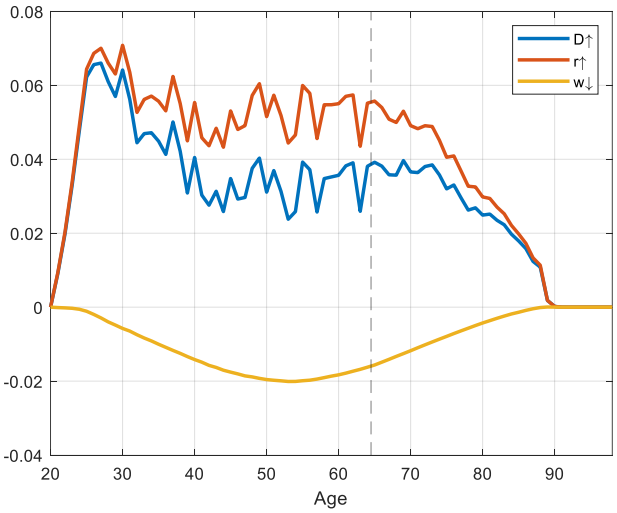

FIGURE 8. CHANGES IN THE 75-25 PERCENTILE ASSET GAP DUE TO A RISE IN NATIONAL DEBT

Note: The vertical dashed line represents the retirement point.

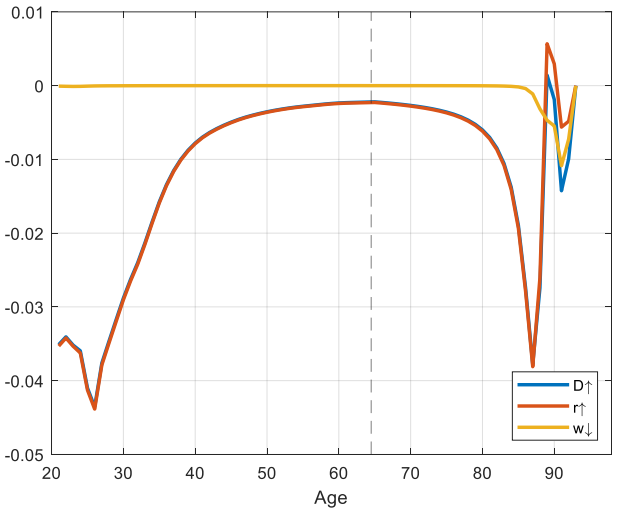

FIGURE 9. CHANGES IN THE GINI COEFFICIENT AFTER A RISE IN NATIONAL DEBT

Note: The vertical dashed line represents the retirement point.

How does the asset distribution change? As shown in Table 4, when the national debt increases, the asset gap between the 75th and 25th percentiles actually widens. When decomposing this into each price effect, we can observe that when only the interest rate rises, the asset gap widens further, but the effect is offset somewhat by the decrease in the wage rate. This phenomenon can be observed across all age groups in Figure 8.

On the other hand, when looking at the Gini coefficient of assets, the opposite trend appears. As shown in Table 4, the overall Gini coefficient of assets actually decreases. This effect is entirely due to the rise in interest rates, while the decrease in wage rates has little impact on the Gini coefficient. This phenomenon is similarly observed across all age groups in Figure 9. Except for those in their late 80s who have almost no assets, the decrease in the asset Gini coefficient due to the rise in national debt and that due to the rise in interest rates are nearly identical across all age groups, while the decrease in wage rates has little effect on the Gini coefficient.

We have observed that inequality varies significantly depending on the index chosen to measure it. Let's explore why this difference arises through the asset policy function. Figure 10 shows the asset decision function (also known as "policy function") averaged over age and labor productivity shocks in the baseline scenario. It indicates how much asset households are expected to choose in the following year based on their current assets. This function is nearly a straight line. Compared to a 45-degree line, we can observe that its y-intercept is positive, and the slope is a positive number less than 1. The greater the current assets, the more assets will be chosen in the next year. However, because the life cycle is limited, households will eventually deplete their assets, suggesting that they do not accumulate assets infinitely.

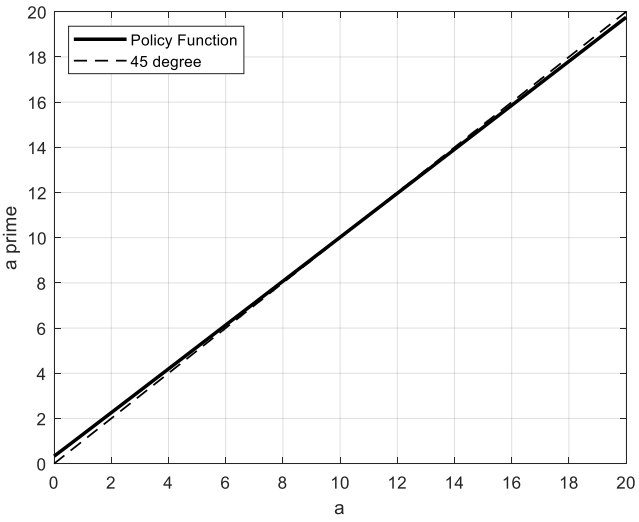

FIGURE 10. AVERAGE ASSET POLICY FUNCTION IN THE BASELINE

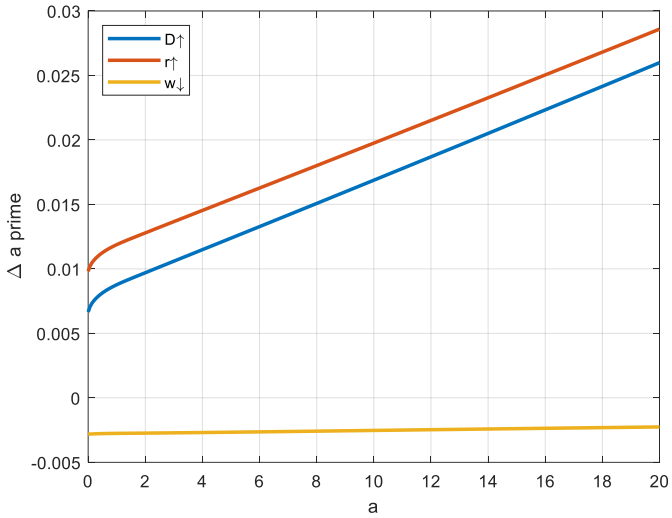

FIGURE 11. CHANGES IN THE ASSET POLICY FUNCTION AFTER A RISE IN NATIONAL DEBT

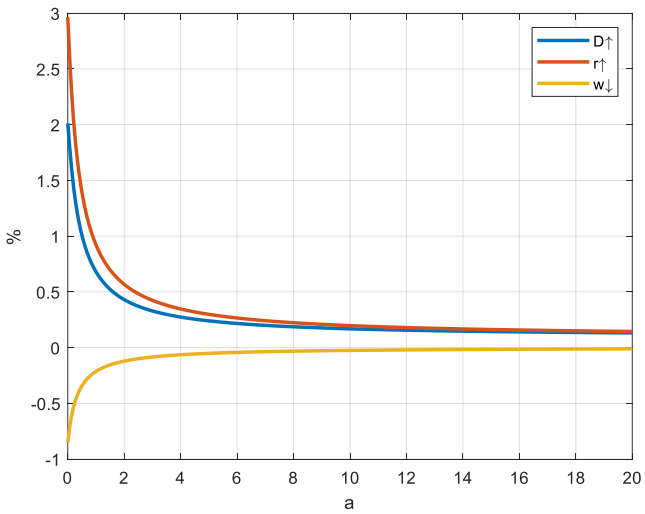

FIGURE 12. CHANGE RATES IN THE ASSET POLICY FUNCTION AFTER A RISE IN NATIONAL DEBT

How does the average asset policy function change with a rise in national debt? As shown in Figure 11, when the national debt increases, the amount of assets for the following year increases across all asset states. However, it does not increase by the same amount for all asset states. In other words, the asset policy function does not shift upward in a parallel fashion. Instead, the greater the current assets, the larger the increase in assets for the following year; i.e., the slope of the asset policy function becomes steeper, indicating that asset dispersion increases in absolute terms.

It can also be seen that most of these effects stem from the rise in interest rates. As shown in Figure 11, when only the interest rate rises, households save more across

all current asset states. However, if the wage rate simultaneously decreases, the interest rate effect is somewhat offset. Ultimately, the broadening of the asset gap across all age groups is primarily due to the rise in interest rates.

Meanwhile, as touched upon earlier, what matters during the calculation of the Gini coefficient is not the change in assets but the rate of change. Figure 12 shows the change rate of the asset policy function for each asset state. First, when the national debt increases, we can see that households with lower levels of current assets increase their assets by a larger percentage in the following year. This change is qualitatively identical to the asset policy function change when only the interest rate rises. On the other hand, if only the wage rate decreases, there is an opposite effect where households with lower levels of current assets reduce their assets by a larger percentage in the following year. Ultimately, the improvement in the asset Gini coefficient when the national debt rises is due to the greater interest rate effect on the asset policy function.

Lastly, it is important to acknowledge that the interpretations via the asset policy function are not entirely clear-cut in their implications for asset dispersion and the asset Gini coefficient, as it does not account for compounding effects over the life cycle. Nonetheless, a broad interpretation is possible: an increasing upward shift in the asset policy function can be viewed as a sufficient condition for broadening asset dispersion, whereas a declining rate of increase in the policy function is a necessary condition for a reduction in the asset Gini coefficient.

C. *Welfare Analysis*

Let's examine which age groups benefit more when the national debt increases. Households whose value function increases when the national debt rises will be considered to "support" the rise in national debt, while households whose value function decreases will be considered to "oppose" it.[15] Partial changes in the interest rate or wage rate will be omitted, as it is clear that when only the interest rate rises, all households will support it, and when only the wage rate decreases, all households will oppose it, given the constraint $a_t \geq 0$.

Figure 13 shows the level of support for the rise in national debt by each age group. The overall support ratio is 88.9%. The support ratio for 20-year-olds, who have no assets, is 0%, but it increases sharply with age, reaching 100% at the age of 40. As assets near depletion in old age, the support ratio declines sharply, and by the age of 90, it approaches 0% again.

The first implication drawn from Figure 13 is that, as seen earlier, while the asset gap increases with the rise in national debt, households, despite being risk-averse, are not significantly affected in terms of their value function. In particular, households aged 40 to 85, despite the fact that their wages have decreased due to the decline in wage rates, see a greater increase in average assets, leading all of them to support the rise in national debt. In general equilibrium models based on life-cycle

[15]Interpretation of the support ratio requires caution. Because this model is a general equilibrium analysis, it is preferable to interpret it as a change in welfare for a specific age group rather than interpreting it as the actual 'support' of a specific household or generation during the equilibrium transition process. For example, it is not appropriate to use this analytical tool to discuss electoral engineering through democracy.

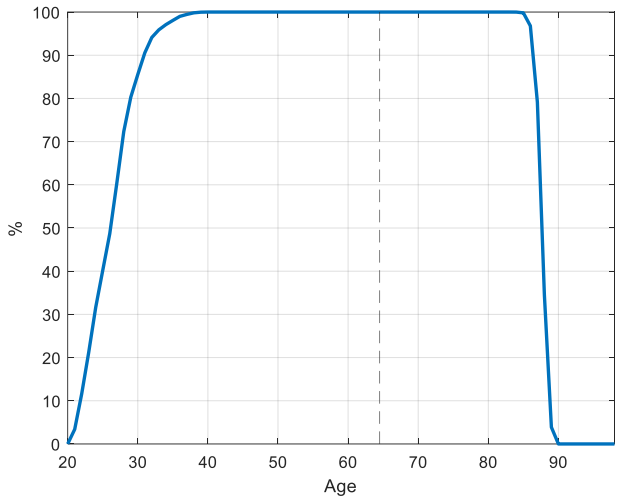

FIGURE 13. SUPPORT RATIO OF A RISE IN NATIONAL DEBT

Note: The vertical dashed line represents the retirement point.

models, the welfare implication of average values by age is stronger than that of idiosyncratic uncertainty or distributions.[16] Shortly, it is easier for asset-rich age groups to support the rise in national debt.

Another important consideration is the significant gap between the support ratio and the ex-ante value function as social welfare measures. In this model, the only age group whose value function encompasses value functions of all ages is the 20-year-old group, i.e., at the first age of the life cycle, individuals consider their entire life cycle, but afterward, they no longer reflect on their past. Of course, in real-world democracies, as policy decisions are not made by simply considering the life cycle of younger people, the support ratio also serves as an important social welfare measure. However, because the ex-ante value function, which has greater suitability as a social welfare function, decreases, it is challenging to interpret the rise in national debt positively.

D. *Policy Analysis*

Next, we discuss policies to address the problem of the declining ex-ante value function due to a rise in national debt. One idea that can be derived from Figure 13 is to increase initial assets through taxes. The following effects could arise theoretically. First, wealth is simply transferred through initial assets, meaning that younger age groups benefit more, while older age groups suffer. Second, if the interest rate is fixed, the total assets across the life cycle increase. Third, there is a general equilibrium effect by which the capital supply increases, leading to a decrease in the interest rate. Age groups that had more assets previously benefit less

[16]If we consider an infinite-horizon household model, such as the Aiyagari model, the main motivation for savings would be a precautionary motive due to uncertainty, which could lead to different results. In other words, the results here may stem from the fact that the model does not consider the descendants of each household.

from the compound interest effect, resulting in greater losses. Fourth, the decrease in the interest rate is accompanied by an increase in the wage rate, especially benefiting assetless groups, as they are freed from financial constraints. In summary, the beneficiaries of increased initial asset transfers are the younger age groups, while the middle-aged groups suffer, while the benefits for assetless elderly groups are uncertain. Through such a policy, we can moderate the polarized support ratios by age groups shown in Figure 13. Let's examine whether it is possible to increase the ex-ante value function with an appropriate increase in initial asset transfers, while not significantly reducing the support ratio.

TABLE 5—EFFECTS OF A RISE IN NATIONAL DEBT WITH AN INITIAL ASSET TRANSFER

	Baseline	$D\uparrow$ $a_0 = 0$	$D\uparrow$ $a_0 = 0.2$	$D\uparrow$ $a_0 = 0.4$	$D\uparrow$ $a_0 = 0.7$
Debt-to-GDP	0.5040	0.7616	0.7612	0.7604	0.7588
GDP	1.0000	0.9926	0.9932	0.9943	0.9964
Asset	3.8720	4.0452	4.0608	4.0818	4.1186
Capital	3.3754	3.2996	3.3153	3.3362	3.3731
Labor	1.0000	1.0012	0.9994	0.9976	0.9947
K/N	3.3754	3.2957	3.3172	3.3444	3.3910
Consumption	0.5693	0.5676	0.5677	0.5680	0.5686
Interest Rate	0.0267	0.0283	0.0278	0.0273	0.0263
Wage Rate	0.6400	0.6345	0.6360	0.6379	0.6411
Consumption Tax Rate	0.0540	0.0523	0.0571	0.0621	0.0697
Capital Income Tax	0.0335	0.0348	0.0344	0.0339	0.0331
Income Tax	0.0482	0.0484	0.0483	0.0483	0.0483
Consumption Tax	0.0307	0.0297	0.0324	0.0353	0.0396
Death Tax	0.0219	0.0230	0.0229	0.0227	0.0225
Real Debt Interest	0.0014	0.0028	0.0026	0.0023	0.0019
Consumption (Labor)	0.4453	0.4417	0.4426	0.4438	0.4458
Consumption (Retirement)	0.1240	0.1260	0.1251	0.1242	0.1228
Ex-ante Value Function	-29.8128	-29.9350	-29.8045	-29.6822	-29.5175
Asset Gap 75%-25%	5.2001	5.3194	5.2655	5.1936	5.0737
Asset Gini Coefficient	0.4315	0.4244	0.4186	0.4110	0.3979

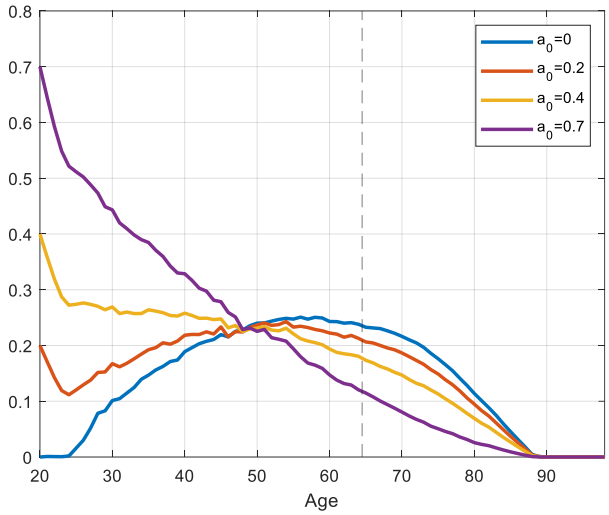

FIGURE 14. CHANGES IN AVERAGE ASSETS AFTER A RISE IN NATIONAL DEBT WITH AN INITIAL ASSET TRANSFER

Note: The vertical dashed line represents the retirement point.

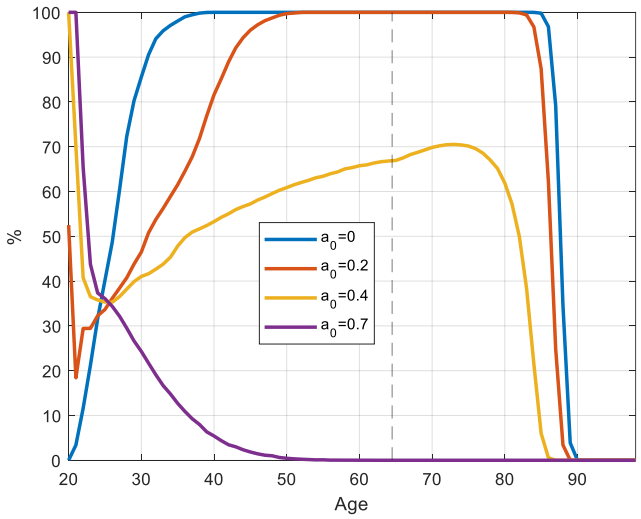

FIGURE 15. SUPPORT RATIO OF A RISE IN NATIONAL DEBT WITH AN INITIAL ASSET TRANSFER

Note: The vertical dashed line represents the retirement point.

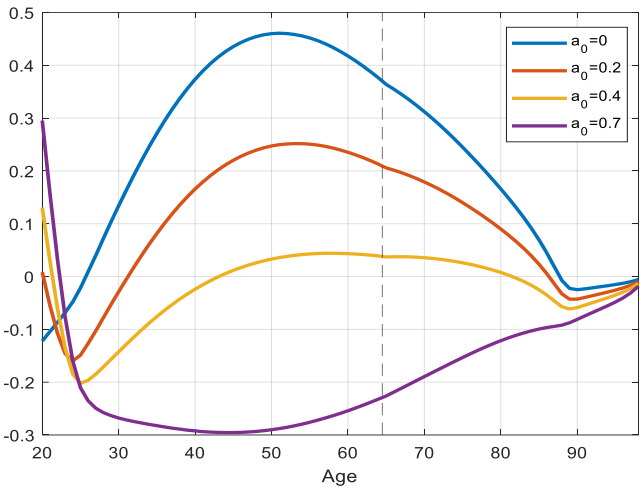

FIGURE 16. CHANGES IN THE VALUE FUNCTION AFTER RISE IN NATIONAL DEBT WITH AN INITIAL ASSET TRANSFER

Note: The vertical dashed line represents the retirement point.

The changes in key macroeconomic variables according to various initial asset levels, while maintaining the increased level of D, are shown in Table 5. When initial assets are increased, the interest rate falls and the wage rate rises, while the ex-ante value function increases. Despite the decline in the ex-ante value function due to the rise in national debt, in the range of $a_0 \geq 0.2$, the final ex-ante value function actually increases. Notably, in the scenarios for $a_0 = 0.2$, and $a_0 = 0.4$, although consumption for working-age groups decreases and consumption for retirement-age groups increases compared to the baseline, the ex-ante value function still rises. This suggests that the ex-ante value function is highly suitable as a social welfare measure.

The effects of these changes in initial asset policies on average assets by age group can be observed in Figure 14. When initial assets increase, assets rise for those in the early stages of entering the labor market. However, from the late 50s onward, it can be seen that assets generally decline. This occurs because the compound interest effect of the interest rate decreases more significantly as age increases.

Most importantly, we can observe through Figure 15 and Figure 16 that the age groups with larger increases in assets tend to increase value function more easily. Figure 15 especially shows that the support ratios before and after the mid-20s move in completely opposite directions with respect to changes in the initial asset level. This suggests that an appropriate adjustment of the initial asset level is required to avoid a polarization of opinion.

Meanwhile, how does the cross-sectional asset distribution change? As shown in Table 5, when national debt rises without initial asset transfers, the asset gap and the asset Gini coefficient move in opposite directions. However, when initial assets increase, both the asset gap and the asset Gini coefficient decline, indicating an overall improvement in asset inequality. The asset gap narrows as the price effects—particularly the rise in interest rates—are offset by increased savings and capital. Meanwhile, the Gini coefficient decreases because fewer individuals, especially

among younger age groups, hold extremely low or zero assets. Results regarding distribution changes within age groups are provided in the appendix.

Finally, we discuss the practicality of implementing such a policy. In South Korea, various forms of initial asset transfer policies are actively debated, either directly or indirectly. These include proposals to reduce inheritance taxes, subsidize national pension contributions for young adults, and expand youth loan programs. However, several challenges must be addressed to make such policies politically viable. First, policymakers often lack a deep understanding of general equilibrium effects. There is little recognition that the current set of youth support policies may serve as partial offsets to the interest rate effects of rising public debt in a general equilibrium context. Second, in a super-aged society such as South Korea, expanding youth-targeted asset transfer policies through democratic majority rule is politically difficult. Such policies offer limited or no direct benefits to older generations, who comprise a large share of the electorate. Third, politicians tend to focus on short-term policies, whereas initial asset transfers aim at generating long-term outcomes. Despite these challenges, the primary contribution of this study lies in how it highlights the potential role of initial asset transfers as a viable policy response to the increase in asset dispersion and lower social welfare caused by rising national debt—a perspective that, to the author's knowledge, has not been explicitly addressed in the existing literature.

E. *Aging Population*

South Korea is expected to face the worst aging population era due to the lowest fertility rate among OECD countries. Analyzing the impacts of increasing the national debt in such a demographic environment is also an important topic.

The results of the simulation conducted by changing the population structure to 2070 and assuming a population growth rate of -1.8% per year are shown in Table 6. Qualitatively, the results are largely similar to those from the analysis conducted before population aging in Table 5. However, two differences emerge when increasing the initial assets alongside the rise in national debt. First, unlike the analysis before population aging, total consumption decreases as initial assets increase. As with the analysis in Table 5, in Table 6, consumption for working-age groups increases and consumption for retirement-age groups decreases as initial assets rise; however, in Table 6, due to population aging, the proportion of the retirement-age group increases, which results in a decrease in total consumption.

Another difference is that the GDP is affected non-linearly as initial assets increase. When the initial assets are increased from zero, GDP decreases, but when additional assets are increased further, GDP actually increases. When initial assets are increased by small amount from zero, the phenomenon of households excessively supplying labor under financially constraint in the early stages of the life cycle is eased, which leads to a relatively sharp decrease in labor supply. However, as initial assets are increased further, the effect of financial constraint relief diminishes.

As a result, while the effects on GDP and total consumption may differ depending on whether the population is aged, the qualitative implications with regard to benefits by age group and the ex-ante value function due to changes in national debt or initial assets remain the same.

TABLE 6—EFFECTS OF A RISE IN NATIONAL DEBT AND AN INITIAL ASSET TRANSFER, UNDER AN AGED POPULATION

	Baseline	$D\uparrow$ $a_0 = 0$	$D\uparrow$ $a_0 = 0.2$	$D\uparrow$ $a_0 = 0.4$	$D\uparrow$ $a_0 = 0.7$
Debt-to-GDP	0.4713	0.7112	0.7116	0.7118	0.7118
GDP	0.5058	0.5028	0.5025	0.5023	0.5024
Asset	2.2241	2.3063	2.3076	2.3104	2.3176
Capital	1.9845	1.9469	1.9482	1.9510	1.9582
Labor	0.4648	0.4654	0.4648	0.4642	0.4633
K/N	4.2696	4.1833	4.1914	4.2026	4.2266
Consumption	0.3920	0.3911	0.3906	0.3903	0.3897
Interest Rate	0.0118	0.0130	0.0129	0.0127	0.0124
Wage Rate	0.6965	0.6914	0.6919	0.6925	0.6940
Consumption Tax Rate	0.1611	0.1626	0.1662	0.1698	0.1753
Capital Income Tax	0.0087	0.0094	0.0093	0.0092	0.0090
Income Tax	0.0232	0.0233	0.0232	0.0232	0.0232
Consumption Tax	0.0632	0.0636	0.0649	0.0662	0.0683
Death Tax	0.0103	0.0109	0.0108	0.0108	0.0107
Real Debt Interest	0.0030	0.0048	0.0047	0.0047	0.0046
Consumption (Labor)	0.2035	0.2013	0.2016	0.2020	0.2027
Consumption (Retirement)	0.1884	0.1898	0.1890	0.1883	0.1871
Ex-ante Value Function	-35.4379	-35.8953	-35.7614	-35.6444	-35.4805
Asset Gap 75%-25%	4.6435	4.7586	4.7491	4.6903	4.5926
Asset Gini Coefficient	0.5183	0.5122	0.5106	0.5083	0.5035
Support Ratio (%)	NaN	53.9344	42.5881	11.8614	0.9453

V. Conclusion

This study analyzes the long-term economic effects of increases in national debt, focusing on the process of household asset accumulation. When national debt rises, interest rates can increase when capital contract, and wages can decrease. These two effects are conflicting, but the impact of an increase in the interest rate was assessed as being stronger. As a result, the absolute dispersion in asset holdings over the life cycle broadened, particularly between early and late working ages. Additionally, the asset gap within the same age group also broadened. Although the asset Gini coefficient, another common inequality measure, showed a tendency to improve, the age groups benefiting from the rise in national debt were those who already held

more assets, while the value function of those with no assets in the early life cycle decreased. To address this, appropriately increasing initial asset transfer expenditures can help alleviate the phenomenon of concentrated benefits and losses in specific age groups, while also increasing the ex-ante value function.

Care must be taken when interpreting these welfare results. This policy experiment of increasing initial asset transfer aims to compensate for the decrease in the ex-ante value function due to a rise in national debt. From a welfare perspective, it is preferable to avoid a rise in national debt, whereas increasing initial asset transfer expenditures should be considered for implementation regardless of the national debt. However, this study emphasizes that the long-term damage caused by the rise in national debt can be effectively targeted and mitigated through initial asset transfers.

Lastly, although this study emphasizes that rising national debt leads to greater asset dispersion and lower social welfare, these findings should not be viewed as the primary reasons to avoid increasing national debt. Rather, the more realistic and fundamental concern could lie in whether the government can actually refinance the debt—issues such as national default risk and the emergence of risk premiums, which this study abstracts from. Accordingly, this study focuses on the additional consequences and policy implications of higher national debt, under the assumption—commonly made by many governments—that refinancing is not a constraint. The extent to which refinancing is actually feasible remains an important subject for future research.

APPENDIX 1

We derive the solution to the following problem for a fixed condition of $\{l_t\}_{t=0}^{N}$.

$$\max_{\{c_t,a_{t+1}\}_{t=0}^{N}} \sum_{t=0}^{N} \beta^t \frac{c_t^{1-\sigma_u}-1}{1-\sigma_u}$$

$$s.t.$$

$$c_t + a_{t+1} = (1+r)a_t + \mathrm{wl}_t\,,$$

$$a_{t+1} \geq 0,\ a_0 = 0.$$

Assuming that the financial constraint of $a_{t+1} \geq 0$ is ignored, the present value budget constraint for each age is as follows for $t < N$:

$$c_t + \cdots + \frac{c_N}{(1+r)^{N-t}} = a_t(1+r) + w\left[l_t + \cdots + \frac{l_N}{(1+r)^{N-t}}\right].$$

By using the Euler equation $c_{t+1} = [\beta(1+r)]^{1/\sigma_u} c_t$, the solution for $\mathrm{c_t}$ can be derived.

$$c_t\left[1 + \cdots + \frac{[\beta(1+r)]^{\frac{N-t}{\sigma_u}}}{(1+r)^{N-t}}\right] = a_t(1+r) + w\left[l_t + \cdots + \frac{l_N}{(1+r)^{N-t}}\right].$$

When combined with the original budget constraint, the dynamics of a_t can be expressed as follows:

$$a_{t+1}^{*}(r,a_t) \equiv a_t(1+r)$$

$$\times \frac{\beta^{\frac{1}{\sigma_u}}(1+r)^{\left(\frac{1}{\sigma_u}-1\right)} + \cdots + \beta^{\frac{N-t}{\sigma_u}}(1+r)^{(N-t)\left(\frac{1}{\sigma_u}-1\right)}}{1 + \cdots + \beta^{\frac{N-t}{\sigma_u}}(1+r)^{(N-t)\left(\frac{1}{\sigma_u}-1\right)}}$$

$$+\mathrm{wl}_t \frac{\beta^{1/\sigma_u}(1+r)^{(1/\sigma_u-1)} + \cdots + \beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u-1)}}{1 + \cdots + \beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u-1)}}$$

$$-\frac{w\left[1_{t+1}(1+r)^{-1} + \cdots + 1_N(1+r)^{-(N-t)}\right]}{1 + \cdots + \beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u-1)}}$$

When expressed in asymptotic notation as $r \to \infty$, it is as follows:

$$a_1 \approx w(1+r)^{1/\sigma_\mu - 1}$$

$$a_{t+1} \approx a_t (1+r)^{1/\sigma_\mu}$$

$$a_t \approx w(1+r)^{t/\sigma_\mu - 1}$$

If $w = \bar{w}$ is fixed, then a_t does not converge to 0 or diverge to infinity when $\sigma_\mu = t$. If $w = z^2(1-\theta)\theta/(r+\delta)$, then $\sigma_\mu = t/2$ is required for a_t to neither converge to 0 nor diverge to infinity.

Finally, does a case in which $a_{t+1}^*(r, a_t) < 0$ exist? For sufficiently large r, it can be seen that for $1 \le j \le N - t$, the expression $l_t \beta^{\frac{j}{\sigma_u}} (1+r)^{\frac{j}{\sigma_u}} - l_{t+j} > 0$ holds, meaning that even when $a_t = 0$, $a_{t+1}^*(r, a_t) > 0$ will always be true.

Of course, in reality, r does not tend to infinity, meaning that there may be cases in which $a_{t+1}^*(r, a_t) < 0$. However, assuming that $\beta(1+r) \approx 1$ or even $\beta(1+r) > 1$, and considering that, as in real life cycles, pension income decreases relative to labor income after retirement, we assume that at some age $\bar{t}$, for all $1 < j \le N - \bar{t}$, the condition $l_{\bar{t}} > l_{\bar{t}+j}$ holds. In this case, the following holds:

$$\mathrm{wl}_t \frac{\beta^{1/\sigma_u}(1+r)^{(1/\sigma_u - 1)} + \cdots + \beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u - 1)}}{1 + \cdots + \beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u - 1)}}$$

$$> \frac{w\left[1_{t+1}(1+r)^{(-1)} + \cdots + l_N(1+r)^{-(N-t)}\right]}{1 + \cdots + \beta^{(N-t)/\sigma_u}(1+r)^{(N-t)(1/\sigma_u - 1)}}.$$

In this case, even if $a_{\bar{t}} = 0$, $a_{\bar{t}+1} > 0$. Assets at higher ages increase as r increases. Of course, the age at which the above condition starts to hold is likely to be lower than $t < \bar{t}$. It is sufficient for $a_{t+1} > 0$ to hold at age t, where the current salary is higher than the weighted average of future salaries; accordingly, it is not necessary always to satisfy $l_{\bar{t}} > l_{\bar{t}+j}$.

APPENDIX 2

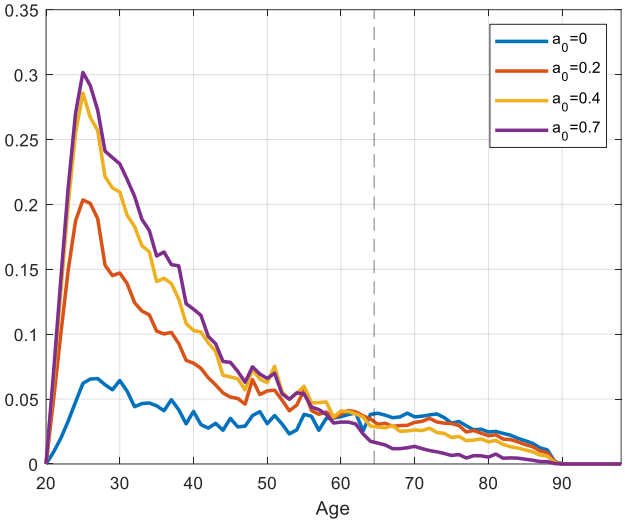

FIGURE A1. CHANGES IN THE 75-25 PERCENTILE ASSET GAP AFTER RISE IN NATIONAL DEBT AND THE INITIAL ASSET TRANSFER

Note: The vertical dashed line represents the retirement point.

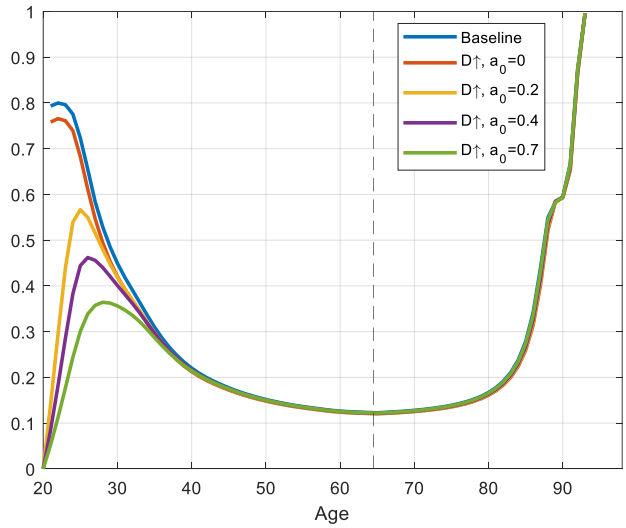

FIGURE A2. GINI COEFFICIENT BY AGE WITH AN INITIAL ASSET TRANSFER

Note: The vertical dashed line represents the retirement point.

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