# A Framework for Macroeconomic Analysis focusing on Net Lending/Borrowing across the Government, Private, and Overseas Sectors*,**

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## Abstract

This paper develops a framework for macroeconomic analysis with a particular focus on net lending/borrowing across the government, private, and overseas sectors, which enables comprehensive and consistent analyses of the external balance of a country as well as the debt sustainability of public and private sectors. Specifically, we construct a partial equilibrium model for the Japanese economy that incorporates the linkages across sectors—government, households non-financial corporations, financial institutions and overseas—including both flow and stock variables. This model estimates the projection of income and outlay accounts for the public and private sectors based on a set of macroeconomic assumptions, including demographic trends, exchange rates, prices, and interest rates, and presents a consistent picture of how net lending/borrowing across sectors is expected to evolve over the long-run. The analysis of public debt sustainability, for example, can clearly illustrate the advantage of this model by presenting the long-term projection of public sector together with the overall picture of the economy, including the long-term projection of private and overseas sectors in a consistent manner.

We present an illustrative scenario based on Japan's current macroeconomic variables, including economic growth. In this scenario, the model shows that the current account surplus is projected to be sustained over the long-run, as an increase in the overseas earnings of corporate sector is expected to compensate for a gradual decline in households' net lending and a gradual increase in fiscal deficit associated with an aging population. However, the continued current account surplus relies on corporations' rate of return on external investments, suggesting the vulnerability to shocks from overseas economies. In contrast, under an alternative scenario that assumes increases in consumption propensity by households and

* This article is based on a study first published in the Financial Review No. 154 pp. 106-129, Shun Maruyama, Toyo Hosoe, Kazuaki Miyachi, 2023, "A Framework for Macroeconomic Analysis focusing on Net Lending/Borrowing across the Government, Private, and Overseas Sectors" written in Japanese.

** We are very thankful for many valuable comments by Mr.Hideaki Matsuoka, Mr. Junji Ueda, Mr. Yasunori Kamada.

investment propensity by corporations and consequent higher economic growth, the long-term projection of current account balance turns to a deficit due to a decline in net lending in the private sector and an increase in the fiscal deficit. This leads to the decline in the domestic absorbing capacity of government bonds, suggesting the increasing vulnerability of fiscal positions to interest rate shocks.

Finally, this paper also employs a stochastic approach by using the probability distribution of macro variables, such as exchange rates, prices, and interest rates, for analyzing the implications of changes in these variables on the flows and stocks in each sector. The results show extremely large variations in the projections of external balances due to fluctuations in the respective macro variables and underscore the need to pay adequate attention to uncertainties associated with changes in parameters.

Keywords: Framework for macroeconomic analysis, Partial equilibrium model, Net lending/borrowing across sectors, Long-term projections for the Japanese economy

JEL Classification: C32, H68, D14

## I. Introduction

In analyzing a country's macroeconomic prospects over the long term, the external balance of the country, as well as the debt sustainability of the government and private sectors, are the primary concerns.

The IMF, for instance, employs an analytical framework, referred to as Financial Programming, with the aim of forecasting and evaluating member countries' external balance, taking into account sectoral interrelations. However, the analysis only covers short to medium terms. The Stock Flow Consistent Model by Godley and Lavoie (2007), akin to this paper, evaluates sector vulnerabilities by consistently detailing net lending/borrowing across the government, private, and overseas sectors. Yet, few previous studies have empirically applied this model within the context of a single country's economy. While there are some preceding studies, like Burgess et al.'s (2016) scenario analysis of the UK's medium- to long-term financial outlook and Barbieri Hermitte et al.'s (2022) study on Italy's sovereign risk impact on the macroeconomy, it is difficult to assert that the model is extensively used as a tool for assessing individual countries' economic sustainability.

With regard to the government sector, there is both domestic and global progress in analyzing long-term fiscal projections considering future demographic trends and other factors, as seen in the EU's Fiscal Sustainability Report and Ueda (2012). These analyses have the advantage of illustrating simple and intuitive relationships between the assumptions for simulations (such as economic growth rates) and outputs (such as fiscal balance and government debt). However, models focused solely on the government sector often miss the dy-

namics of net lending/borrowing (flows) and assets/liabilities (stocks) across other sectors, making it challenging to grasp the overall picture of the economy.

Against this backdrop, this paper develops a partial equilibrium model that accounts for inter-sectoral linkages in flow variables constituting net lending/borrowing and stock variables, such as assets/liabilities, within the government, households, non-financial corporations, financial institutions and overseas sectors. In addition, by calibrating the model to the Japanese economy, this paper conducts scenario analysis, focusing on lending/borrowing relationships across sectors under different macroeconomic assumptions. The objective is to derive both academic and practical insights from the following three perspectives:

(1) Deepening the Understanding of External Balance Outlook

In our model, analyzing net lending/borrowing across public and private sectors allows us to provide a long-term projection of a country's external balance and its factor decomposition. For instance, increased net borrowing by the public and private sectors results in a worsening of the external balance, leading to a greater role of foreign investors who might demand higher risk premiums. Conversely, a significant improvement in external balance, driven by increased net lending from both sectors, could indicate excessive savings due to sluggish domestic consumption and investment.

(2) Evaluating the Sustainability of Government Sector within the Overall Picture of the Economy

Assessing the sustainability of the government sector is a pivotal concern in both academic and practical macroeconomics, prompting numerous studies. Among these, partial equilibrium models used in long-term fiscal projections referred to as "accounting methods" by Ueda and Sugiura (2010), offer the advantage of having relatively simple relationships between macroeconomic assumptions and fiscal outcomes such as fiscal balance and government debt, making the implications easily comprehensible. Moreover, these models enable detailed calculations grounded in actual data, including estimates of social security-related expenditures reflecting demographic forecasts, thus allowing for more realistic future predictions. This paper references prior studies, such as Ueda (2012), in modeling the government sector. However, as mentioned earlier, the implications of the assumptions used in these long-term fiscal projections for the flow and stock variables of households, non-financial corporations, financial institutions and overseas sectors are often not explicitly clarified. Therefore, by examining trends in these flow and stock variables outside the government sector, we can gain a more accurate understanding of the government sector's sustainability within the overall economic context and evaluate the validity of the underlying assumptions.

(3) Enhancing the Comprehension of Uncertainty Stemming from Variations in Assumptions

A sensitivity analysis is already widely adopted in fiscal projections, as exemplified by the IMF's Debt Sustainability Analysis (IMF, 2023), examining the implication of various uncertainties stemming from macro variables such as interest rates and prices. However,

such uncertainties arising from fluctuations in macro variables can significantly impact not only the government sector but also the private sector. Furthermore, changes in the consumption and investment propensities of the private sector can have reciprocal effects on the government sector. This interconnectedness across sectors underlines the advantage of our model in analyzing macroeconomic uncertainties by incorporating inter-sectoral lending/borrowing relationships in a consistent manner.

## II. Partial Equilibrium Model with Linkages Across Sectors

This paper formulates a partial equilibrium model tailored to the Japanese economy. The model integrates flow variables constituting net lending/borrowing, as well as stock variables such as assets/liabilities, across government, households, non-financial corporations, financial institutions and overseas sectors, with due consideration of their interconnections. A key advantage of utilizing this partial equilibrium approach is the relatively simple relationship between inputs like economic growth rates and outputs, including the long-term forecasts of inter-sectoral lending/borrowing, thus enhancing the clarity of its implications.

The partial equilibrium approach has been widely used in analyses related to the sustainability of the government sector, as seen in previous studies like Ueda (2012). What sets this model apart is its comprehensive and consistent analysis, encompassing households, non-financial corporations, financial institutions, and overseas sectors alongside the government sector. While Ito and Tsuri (2006) independently estimated net lending/borrowing for each sector, the distinctive feature of this paper's model lies in its explicit modeling of linkages across sectors.

Alternatively, for an analytical approach that considers inter-sectoral connections, a general equilibrium model could be employed, incorporating a mechanism wherein economic activities converge to a steady state, assuming the optimal behavior of representative agents in each sector. The general equilibrium models have advantages in analyzing the economic and policy interaction. However, a partial equilibrium model is more suitable from the viewpoint of calibrating the model to empirical data without presuming a specific steady state and analyzing long-term inter-sectoral lending/borrowing relationships under various assumptions.

### *II-1. Entire Economy*

#### II-1-1. Flow Variables

The real Gross Domestic Product (GDP) of a country in period $t$ is described by the Cobb-Douglas production function:

$$GDP_t = A_t K_{t-1}^{\alpha} L_t^{1-\alpha} \tag{1}$$

Here, $A_t$ is the total factor productivity (TFP), representing the technological level. $K_{t-1}$ is the capital stock at the end of the previous period, $L_t$ is the working-age population, and $\alpha$

is the capital share (with $1-\alpha$ representing the labor share).[1] Additionally, the GDP is converted to a nominal value using an exogenously determined deflator.[2] Note that the model in this paper uses pre-FISIM adjustment data for the calculation of interest payments and receipts, and the GDP is recalculated accordingly.[3]

From the expenditure side, GDP can be expressed as the sum of consumption *C*, investment *I*, and net exports *NX*:

$$GDP_t = C_t + I_t + NX_t \tag{2}$$

Moreover, from a distribution side, GDP can be expressed through the components of operating surplus *OS*, compensation of employees *W*, and taxes on production and imports *TPI*[4]:

$$GDP_t = OS_t + W_t + TPI_t \tag{3}$$

### II-1-2. Stock Variables

The financial portfolio of each sector is comprised of cash and deposits, loans, government bonds, corporate bonds, stocks, external assets, and other assets and liabilities. For considering exchange rate effects, foreign assets are calculated assuming all assets are in dollars and then converted to yen using the prevailing exchange rate. Financial liabilities are calculated separately for domestic and overseas holdings. Fluctuations in prices are not accounted for in the estimation of financial assets and liabilities. Table 1 displays the matrix of financial assets and liabilities held by each institutional sector. Notably, external assets are estimated values.[5]

The return on asset is determined exogenously for each asset item, including deposit interest rates, lending/borrowing rates, government and corporate bond interest rates, and dividend yields. Furthermore, for foreign assets, the yields are specified separately for those related to interests/dividends and for reinvested earnings on foreign direct investment.

Finally, the capital stock *K* of each sector at the end of period *t* is calculated by adding the investment *I* for period *t* to the capital stock at the end of period *t*-1, with sector-specific rates of depreciation δ.

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

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[1] The model in this paper sets $\alpha$ to 1/2 and assumes that capital and labor input have equal contributions.

[2] The model in this paper calculates other parameters using nominal values.

[3] FISIM (Financial Intermediation Services Indirectly Measured) represents the value of financial intermediation services offered by financial institutions where fees are not explicitly charged. These services encompass aspects like receiving high interest from borrowers and paying low interest to lenders. Consequently, pre-FISIM adjustment implies that such services are not recognized as added value, leading to a decrease in GDP by the corresponding amount.

[4] The model in this paper omits subsidies and statistical discrepancies for the sake of simplicity.

[5] After calculating the external assets for each sector, including the balance of foreign direct investment and sector-specific borrowings recorded in overseas sectors as derived from the flow of funds statistics, the discrepancy is apportioned based on the total values of each sector.

Table 1: Stock Matrix by Institutional Sector (estimated values as of the end of 2019)[6]

(Unit: trillion yen)

| | General government | | Households | | Non-financial corporations | | Financial institutions | | Overseas | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Assets | Liabilities | Assets | Liabilities | Assets | Liabilities | Assets | Liabilities | Assets | Liabilities | |
| Cash and deposits | 72 | - | 1,045 | - | 275 | - | 648 | 2,051 | 11 | - | 0 |
| Loans | 23 | 154 | 3 | 349 | 35 | 485 | 1,314 | 578 | 190 | - | 0 |
| Government bonds | 67 | 1,110 | 22 | - | 13 | 7 | 1,036 | 170 | 150 | - | 0 |
| Corporate bonds | 6 | 1 | 12 | - | 21 | 77 | 123 | 121 | 37 | - | 0 |
| Stocks | 158 | 14 | 273 | 13 | 381 | 1,016 | 374 | 385 | 242 | - | 0 |
| External assets | 256 | - | 26 | - | 210 | - | 592 | - | - | 1,084 | 0 |
| Other assets | 51 | 57 | 562 | 17 | 286 | 314 | 227 | 833 | 99 | - | 4 |
| Total | 628 | 1,331 | 1,943 | 379 | 1,214 | 1,892 | 4,226 | 4,051 | 729 | 1,084 | 4 |
| Net financial assets | -703 | | 1,564 | | -678 | | 176 | | -355 | | 4 |
| Fixed assets | 657 | | 432 | | 898 | | 10 | | - | | 1,997 |

Source: Created by the authors based on the Bank of Japan's "Flow of Funds Accounts Statistics"

## *II-2. Government Sector*

The government sector provides public services, including social security, to each sector while collecting taxes from them. Additionally, it makes interest payments to each sector based on the outstanding amount of government bonds issued. Considering these factors, the government sector's net lending/borrowing relationship is denoted as $NLB_t^g$:

$$NLB_t^g = \left(TPI_t^g + INTR_t^g + DIVR_t^g + WPRI_t^g + TIW_t^g + SSC_t^g + otherR_t^g\right) - \left(INT\_D\_P_t^g + INT\_W\_P_t^g + SB_t^g + C_t^g + I_t^g + otherP_t^g\right) \quad (5)$$

In this context, $TPI_t^g$ represents the tax on production and imports, subdivided into consumption tax and other taxes. The consumption tax is presumed to be a fixed rate of households' final consumption expenditures, while other taxes are considered constant as a percentage of GDP.

$INTR_t^g$, $INT\_D\_P_t^g$, and $INT\_W\_P_t^g$ represent interest received from domestic sources, interest paid to domestic sources, and interest paid to foreign sources, respectively. $DIVR_t^g$ denotes dividends received from domestic sources, and $WPRI_t^g$ signifies property income from foreign sources. Each of these figures is calculated by multiplying the respective asset value by the effective yield exogenously determined for each asset item.[7]

$TIW_t^g$ represents current taxes on income, wealth, etc., encompassing the aggregate of

[6] Other totals that do not add up to zero are statistical discrepancies.

income taxes and corporate taxes paid by each sector.

$SSC_t^g$ denotes the social contributions, while $SB_t^g$ refers to social benefits other than social transfers in kind. It is assumed that $SSC_t^g$ remains a constant percentage of the sum of $SB_t^g$ and ${ST_{pm}}_t^g$—the latter represents social transfers in kind (purchased market production).

$C_t^g$ indicates the final governmental consumption expenditures, further categorized into collective consumption expenditures and individual consumption expenditures. The latter can be subdivided into social transfers in kind (purchased market production) and social transfers in kind (non-market output).

Collective consumption expenditures and social transfers in kind (non-market output) are assumed to remain constant as a percentage of GDP. On the other hand, ${ST_{pm}}_t^g$ consists of medical expenses $HC_t^g$ and long-term care expenses $LTC_t^g$, and is estimated as follows:

$$ {ST_{pm}}_t^g = HC_t^g + LTC_t^g \tag{6}$$

$$ HC_t^g = \sum_i (hc_{i,t} \times pop_{i,t}) \tag{7}$$

$$ hc_{i,t} = hc_{i,0} \times \prod_{j=1}^{t} \left( \frac{GDP_j/pop_j}{GDP_{j-1}/pop_{j-1}} \right) \tag{8}$$

$$ LTC_t^g = \sum_i (ltc_{i,t} \times pop_{i,t}) \tag{9}$$

$$ ltc_{i,t} = \prod_{j=1}^{t} \left( \frac{W_j^h}{W_{j-1}^h} \right) \tag{10}$$

In this analysis, $hc_{i,t}$ represents the per capita medical expenses for age group $i$, and $pop_{i,t}$ indicates the population of age group $i$. It is assumed that $hc_{i,t}$ increases at the growth rate of GDP per capita. Then, $HC_t^g$ is calculated by summing up the medical expenses for each age group. Similarly, $LTC_t^g$ is determined by aggregating the expenses for each age group, obtained by multiplying the per capita long-term care expenses $ltc_{i,t}$ with $pop_{i,t}$. Note that $ltc_{i,t}$ is projected to increase at the rate of employee compensation growth.[8]

$I_t^g$ denotes public investment and is presumed to be constant as a percentage of GDP. Additionally, $otherR_t^g$ and $otherP_t^g$, representing other items, are assumed to remain constant at their most recent values throughout the estimation period.

(Relationship between flow and stock)

The model posits that the fiscal deficit, represented by the negative portion of $NLB_t^g$, is

[7] To simplify domestic receipts and payments, effective yields are set for each asset item domestically. However, due to an initial misalignment with the actual values at the start of the estimation, an adjustment term is introduced to consistency. Comparable adjustments are also applied to other sectors. Furthermore, because the effective yield on external assets is predetermined for each sector, discrepancies are absent, obviating the necessity for such adjustments.

[8] Refer to Ueda (2012) for the basic concept regarding the long-term projection of medical expenses and long-term care expenses, etc.

financed through the issuance of government bonds. Concurrently, it is anticipated that all property income from foreign resources denoted as $WPRI_t^g$, will be accumulated in external assets denominated in dollars. The actual volume of government bonds issued is thus calculated as $NLB_t^g - WPRI_t^g$. Other assets and liability categories are held constant throughout the estimation period.

### *II-3. Household Sector*[9]

The household sector receives compensation of employees and social security benefits from other sectors and engages in consumption and housing investment. Additionally, the household sector pays taxes and social contributions to the government sector. Considering these factors, the household sector's net lending/borrowing relationship is expressed as $NLB_t^h$:

$$\begin{aligned} NLB_t^h = &\left(W_t^h + SB_t^h + INTR_t^h + DIVR_t^h + OS_t^h + otherR_t^h\right) \\ &-(C_t^h + PIT_t^h + INTP_t^h + SSC_t^h + I_t^h + otherP_t^h) \end{aligned} \tag{11}$$

$W_t^h$ represents the compensation of employees, which is obtained by estimating the per capita compensation of employees $w_{i,t}$ for age group $i$ and then multiplying it by $pop_{i,t}$ (refer to Appendix 1 for the method of estimating per capita value). Note that $w_{i,t}$ is projected to increase at the growth rate of GDP per capita for the working-age population.

$$W_t^h = \sum_i (w_{i,t} \times pop_{i,t}) \tag{12}$$

$$w_{i,t} = w_{i,0} \times \prod_{j=1}^{t} \left( \frac{GDP_j / L_j}{GDP_{j-1} / L_{j-1}} \right) \tag{13}$$

$SB_t^h$ denotes social benefits other than social transfers in kind, consisting largely of pension benefits. $sb_{i,t}$, the per capita amount received for age group $i$, is estimated and then multiplied by $pop_{i,t}$. Regarding $sb_{i,t}$, it is assumed to remain constant as a percentage of GDP for those under 65. For those 65 and over, considering the macroeconomic slide $m$, the rate of increase from age 65 to 67 aligns with the rate of increase in compensation of employees, while the rate of those aged 68 and over corresponds to the rate of inflation.[10] However, if the growth rate of compensation of employees is lower than the inflation rate, it is uniformly at the growth rate of compensation of employees for those aged 65 and older.

[9] Includes private non-profit institutions that provide social services to households. The data also includes private unincorporated enterprises based on the National Accounts of Japan.

[10] In the macroeconomic slide, the adjustment rate is set to the rate of decline in the labor force population under the assumption of a constant average life expectancy. The labor force population is calculated by multiplying the population aged 15 and over by the labor force participation ratio in 2019. Furthermore, macroeconomic slide is implemented as long as the pension revision rate does not become negative, and any portion that cannot be implemented in a given year is carried over to the subsequent year.

$$SB_t^h = \sum_i (sb_{i,t} \times pop_{i,t}) \tag{14}$$

$$\begin{aligned} sb_{i,t} &= sb_{i,0} \times \prod_{j=1}^{t} \left( \frac{GDP_j}{GDP_{j-1}} \right) && i < 65 \\ &= sb_{i,0} \times \prod_{j=1}^{t} \min \left( max \left( \frac{w_{i,j}}{w_{i,j-1}} - m, 0 \right), \frac{w_{i,j}}{w_{i,j-1}} \right) && 65 \le i < 68 \\ &= sb_{i,0} \times \prod_{j=1}^{t} min \left( max \left( min \left( \frac{w_{i,j}}{w_{i,j-1}}, \frac{CPI_j}{CPI_{j-1}} \right) - m, 0 \right), \right. \\ &\qquad \left. min \left( \frac{w_{i,j}}{w_{i,j-1}}, \frac{CPI_j}{CPI_{j-1}} \right) \right) && 68 \le \mathrm{i} \end{aligned} \tag{15}$$

$INTR_t^h$ and $INTP_t^h$ represent interest received and interest paid, respectively, and $DIVR_t^h$ indicates dividends received. These series are calculated by multiplying the respective asset value by the exogenously given effective yield.

$OS_t^h$ denotes operating surplus and mixed income, assuming that the recent proportion to the operating surplus for the total economy is maintained.

$SSC_t^h$ represents social security contribution and is derived from the amount received by the government and financial institution sectors.

$PIT_t^h$ indicates the current taxes on income and wealth. It is calculated by estimating the per capita payment $pit_{i,t}$, and then multiplying it by the $pop_{i,t}$ Additionally, $pit_{i,t}$ is calculated by applying the effective tax rate $\varphi_i$ for each age group to per capita income, including property income.[11] In addition to per capita compensation of employees $w_{i,t}$, as determined in equation (13) and per capita social benefits other than in-kind social transfers $sb_{i,t}$ as calculated in equation (15), the estimations of per capita income also include per capita interest received $intr_{i,t}$, dividends received $divr_{i,t}$, operating surplus and mixed income $os_{i,t}$, and other receipts $otherr_{i,t}$.

$$PIT_t^h = \sum_i (pit_{i,t} \times pop_{i,t}) \tag{16}$$

$$pit_{i,t} = \varphi_i \, (w_{i,t} + sb_{i,t} + intr_{i,t} + divr_{i,t} + os_{i,t} + otherr_{i,t}) \tag{17}$$

The final household consumption expenditure $C_t^h$ is determined by estimating per capita consumption expenditure $c_{i,t}$ for age group $i$, then multiplying it by $pop_{i,t}$. $c_{i,t}$ is calculated by multiplying per capita disposable income $yd_{i,t}^h$ by the consumption propensity $\mu_i$ for each age group. Note that real consumption is at least maintained at the level of the previous peri-

[11] Because it is difficult to calculate effective tax rates for each income group in a manner consistent with the model in this paper, effective tax rates for each age group were used. However, it should be noted that the model does not adequately take into account a progressive tax rate structure.

od, as shown in equation (19). $yd^h_{i,t}$ is derived as described in equation (20) after estimating per capita interest paid $intp_{i,t}$, social security contribution $ssc_{i,t}$, and other payments $otherp_{i,t}$.

$$C^h_t = \sum_i (c_{i,t} \times pop_{i,t}) \tag{18}$$

$$c_{i,t} = \max\left(\mu_i \times yd^h_{i,t}, c_{i,t-1} \times \frac{CPI_t}{CPI_{t-1}}\right) \tag{19}$$

$$\begin{aligned} yd^h_{i,t} = &\left(w_{i,t} + sb_{i,t} + intr_{i,t} + divr_{i,t} + os_{i,t} + otherr_{i,t}\right) \\ &-(pit_{i,t} + intp_{i,t} + ssc_{i,t} + otherp_{i,t}) \end{aligned} \tag{20}$$

$I^h_t$ denotes housing investment and is presumed to be constant as a percentage of GDP. Additionally, $otherR^h_t$ and $otherP^h_t$, representing other items, are assumed to remain constant at their most recent values throughout the estimation period.

(Relationship between flow and stock)

The portion of housing investment that represents new investment, excluding the depreciation of fixed capital, is assumed to be financed through borrowings.[12] Subsequently, the increase or decrease in $NLB^h_t$, excluding this new investment, is reflected in each asset item based on their current actual values.

### *II-4. Non-financial Corporation Sector*

The non-financial corporation sector engages in production activities and pays taxes to the government sector, compensation of employees to the household sector, and dividends to each sector. Additionally, it undertakes foreign investments and earns income from overseas. Based on these factors, the non-financial corporation sector's net lending/borrowing relationship is expressed as $NLB^c_t$:

$$\begin{aligned} NLB^c_t = &(OS^c_t + INTR^c_t + DIVR^c_t + WPRI^c_t + WREI^c_t + otherR^c_t) \\ &-(INT\_D\_P^c_t + INT\_W\_P^c_t + DIV\_D\_P^c_t + DIV\_W\_P^c_t \\ &+ CIT^c_t + I^c_t + otherP^c_t) \end{aligned} \tag{21}$$

$OS^c_t$ represents operating surplus, assuming that the recent proportion to the operating surplus for the total economy is maintained.

$INRP^c_t$, $INT\_D\_P^c_t$, and $INT\_W\_P^c_t$ denote interest received from domestic sources, interest paid to domestic sources, and interest paid to foreign sources, respectively. $DIVR^c_t$, $DIV\_D\_P^c_t$, and $DIV\_W\_P^c_t$ indicate dividends received from domestic sources, dividends paid to domestic sources, and dividends paid to foreign sources, respectively. $WPRI^c_t$ and $WREI^c_t$ represent income from foreign sources and reinvested earnings on foreign direct investment, respectively. Each of these series is calculated by multiplying the respective asset

[12] It is assumed that if the portion of new investment is negative, the amount of borrowing will decrease accordingly.

value by the exogenously given effective yield.

$CIT_t^c$ denotes the current taxes on income and wealth, calculated by multiplying revenue by the effective tax rate.

$I_t^c$ represents capital investment and is presumed to be constant as a percentage of GDP. Additionally, $otherR_t^c$ and $otherP_t^c$, representing other items, are assumed to remain constant at their most recent values throughout the estimation period.

(Relationship between flow and stock)

The portion of capital investment that represents new investment, excluding the depreciation of fixed capital, is assumed to be financed through borrowings, bond issuances, and stock issuances based on current actual values. Subsequently, the increase or decrease in $NLB_t^c$, excluding this new investment, is reflected in each asset item, also based on the current actual values. However, all reinvested earnings on foreign direct investment are accumulated in foreign assets denominated in dollars.

### *II-5. Financial Institution Sector*

Financial institutions record the cash and deposits of each sector as liabilities, paying interest on them. On the asset side, they record loans and government bonds, undertaking their management and operation. Additionally, they engage in foreign investments and earn income from foreign sources. Taking these factors into account, the financial institution sector's net lending/borrowing relationship is expressed as $NLB_t^f$:

$$\begin{aligned} NLB_t^f = \big(&INTR_t^f + DIVR_t^f + WPRI_t^f + WREI_t^f + otherR_t^f\big) \\ &- (INT\_D\_P_t^f + INT\_W\_P_t^f + DIV\_D\_P_t^f + DIV\_W\_P_t^f \\ &+ CIT_t^f + I_t^f + otherP_t^f) \end{aligned} \tag{22}$$

$INTR_t^f$, $INT\_D\_P_t^f$, and $INT\_W\_P_t^f$ represent interest received from domestic sources, interest paid to domestic sources, and interest paid to foreign sources, respectively. $DIVR_t^f$, $DIV\_D\_P_t^f$, and $DIV\_W\_P_t^f$ denote dividends received from domestic sources, dividends paid to domestic sources, and dividends paid to foreign sources, respectively. $WPRI_t^f$ and $WREI_t^f$ indicate income from foreign sources and reinvested earnings on foreign direct investment, respectively. Each of these values is calculated by multiplying the held assets by the exogenously given effective yield.

$CIT_t^f$ represents current taxes on income and wealth, calculated by multiplying revenue by the effective tax rate.

$I_t^f$ signifies capital investment and is presumed to be constant as a percentage of GDP. Additionally, $otherR_t^f$ and $otherP_t^f$, representing other items, are assumed to remain constant at their most recent values throughout the estimation period.

(Relationship between flow and stock)

The cash and deposit assets of each sector are reconciled with the cash and deposit lia-

bilities of financial institutions. Subsequently, considering the changes in the liability side and $NLB_t^f$, the flow is reflected in each asset item based on the current actual values.

However, it is assumed that financial institutions investment behavior is constrained by the financing needs of each sector.[13] If the demand for further investment in a certain asset is fully satisfied, the extra funds will be allocated to other assets. For instance, this could involve investing in government bonds with substantial funding needs or external assets with no special constraints imposed in the model. It is also presumed that all reinvested earnings on foreign direct investment are accumulated in foreign assets denominated in dollars.

### *II-6. Overseas Sector*

The net lending/borrowing in the overseas sector, denoted as $NLB_t^w$, represent the external balance and is the inverse of the aggregate net lending/borrowing of the other sectors.

$$NLB_t^w = -(NLB_t^g + NLB_t^h + NLB_t^c + NLB_t^f) \tag{23}$$

Furthermore, regarding the stock of the overseas sector, it is assumed that the liability side comprises the sum of external assets held by each sector, while the asset side consists of the portion of domestic liabilities that cannot be financed within the domestic market.[14]

## III. Scenario Analysis

Utilizing the model described in the previous chapter, this chapter conducts scenario analyses focusing on inter-sectoral lending/borrowing relationships under different macroeconomic assumptions.

### *III-1. Data*

The flow and fixed assets of each institutional sector are obtained and estimated from actual data of the "National Accounts for 2021 (2008SNA, benchmark year = 2015)" published by the Cabinet Office. The actual data are used up to 2019 in order to remove the impact of COVID-19 (Appendix 2 examines the specificity of the actual figures for 2020 and 2021 available at the time of writing this paper). Subsequent values from 2020 onward are projected based on the model. Furthermore, data from the Bank of Japan's "Flow of Funds Accounts Statistics" are used for financial assets and liabilities.

The medical and long-term expenses in the government sector's social transfers in kind (purchased market production) are estimated based on data from the "Estimates of National

[13] For example, the upper limit on loans for financial institutions is constrained by the total amount of borrowings from each sector.

[14] For instance, the portion of the accumulating government debt that cannot be financed by domestic sectors is assumed to be purchased by the overseas sector. Additionally, it is assumed that there is always a certain level of demand for inward investment, and thus, the assets of the overseas sector are not expected to fall below the current actual level.

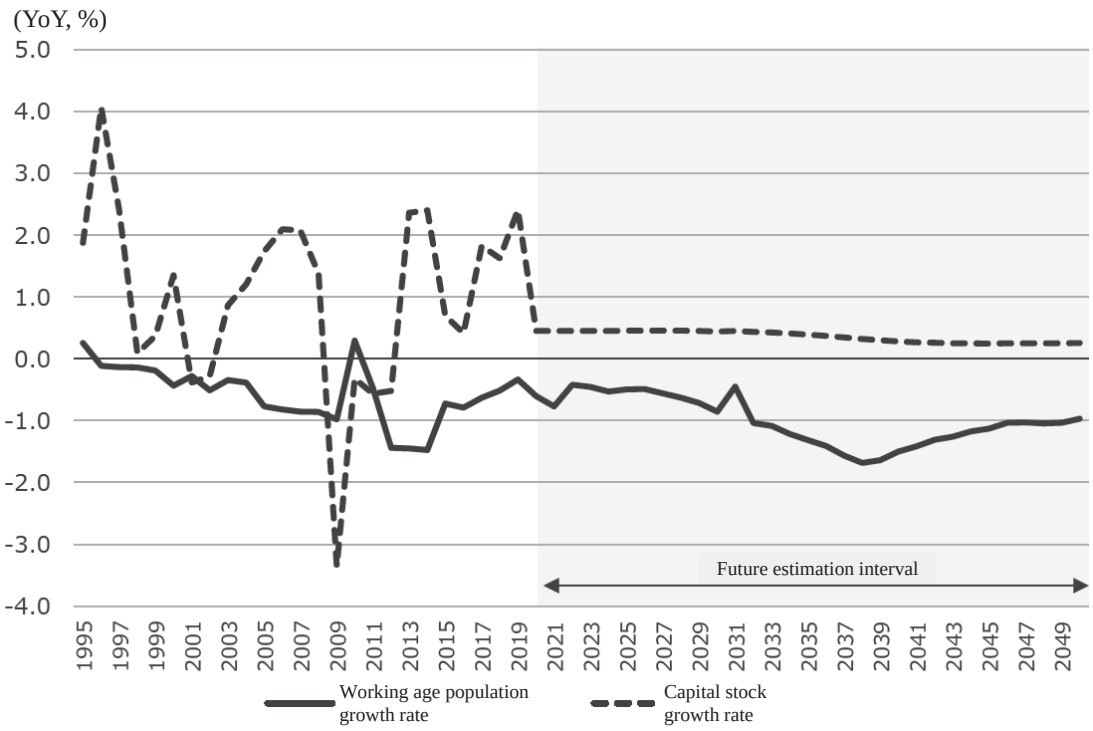
Medical Care Expenditure" and the "Statistics of Long-term Care Benefit Expenditures" published by the Ministry of Health, Labour and Welfare. Additionally, the per capita receipts and payments for calculating the household sector's flow are estimated based on data from the "2019 National Survey of Family Income, Consumption and Wealth" published by the Ministry of Internal Affairs and Communications.

In terms of demographic data considered in the estimations, this paper relied on the medium fertility (medium mortality) projections from the "Population Projections for Japan: 2021 to 2070" by the National Institute of Population and Social Security Research.

### *III-2. Status Quo Scenario*

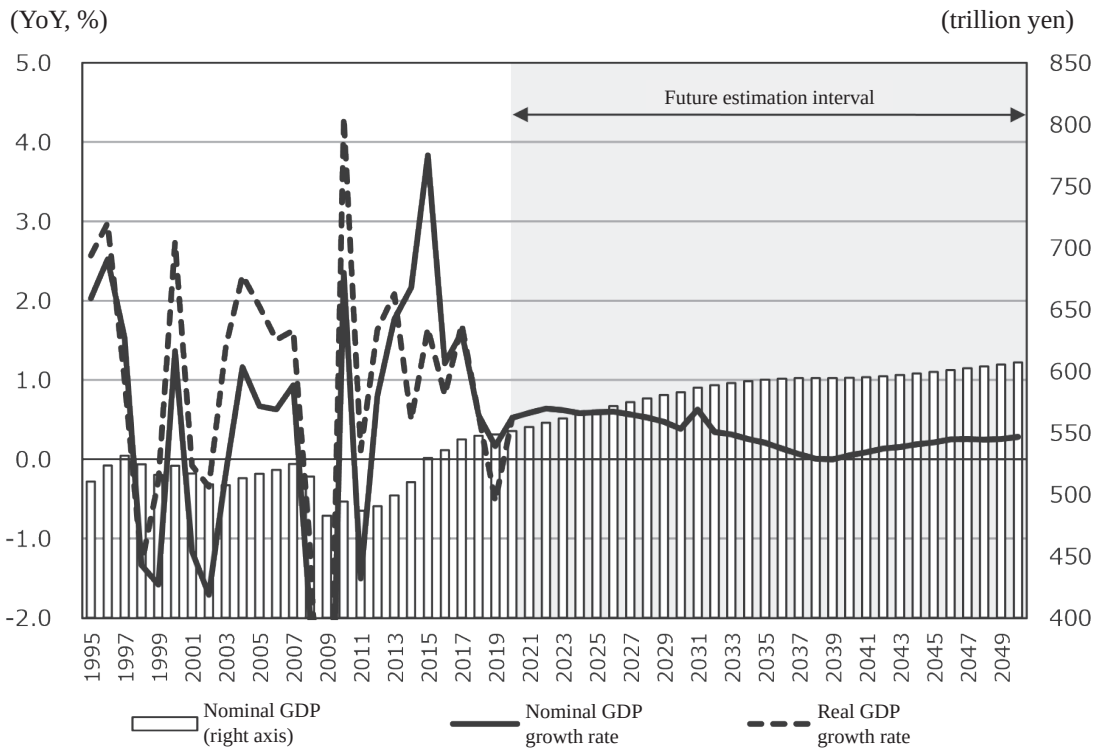
Initially, a "status quo scenario" is contemplated based on the current economic growth rate and other factors. The TFP contribution and GDP deflator, necessary for estimating nominal GDP, are set at annual rates of 0.7% and 0.0%, respectively, based on average figures of the 2010s, and are assumed to remain constant throughout the estimation period. Consequently, as shown in Figure 1, with Japan's working-age population showing a trend decline and capital stock only experiencing a moderate increase, the GDP growth rate calculated from equation (1) is projected to be sluggish, as illustrated in Figure 2, resulting in a

Figure 1: Working Age Population and Capital Stock Growth Rate




Source: Created by the authors

Figure 2: GDP (status quo scenario)




Source: Created by the authors

moderate increase in terms of levels as well.

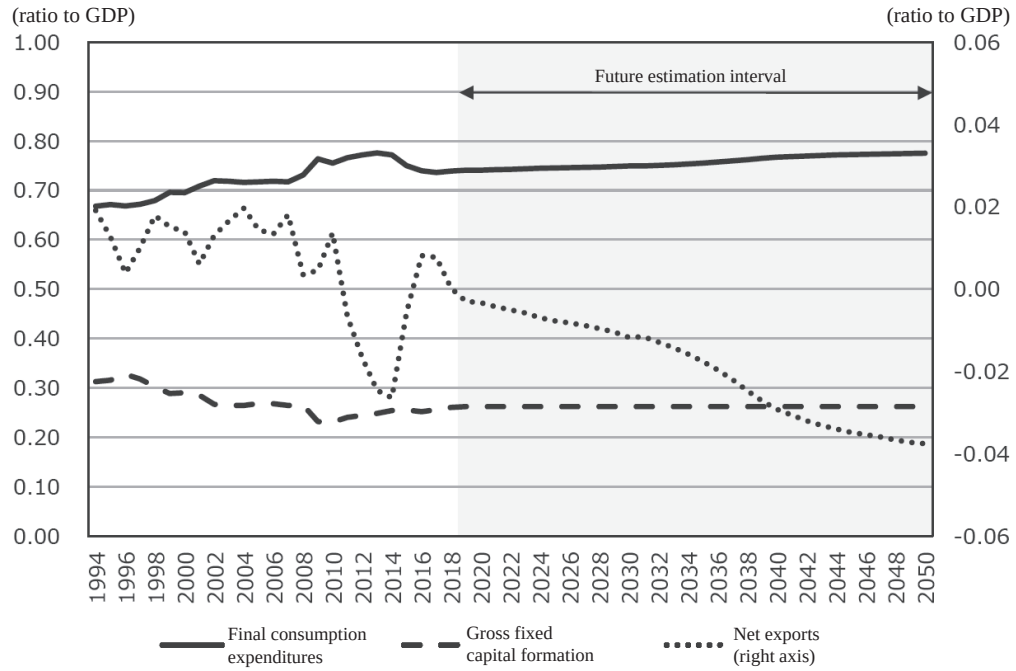
The Consumer Price Index (CPI) growth rate is set at 0.5% per year, based on the 2010s average, and is assumed to remain constant throughout the estimation period.

Nominal effective interest rates for each asset item are established at 0.5% for deposits, 1.5% for loans, 0.8% for government bonds, and 1.0% for corporate bonds. These rates are based on the relationship between the current stock and interest expenses and are held constant throughout the estimation period. Furthermore, the dividend yields are set such that the dividend payout ratios for non-financial corporations and financial institutions remain constant at their current actual values over the estimation period. Finally, considering recent actual values and the global trend of declining interest rates, the rates of return for foreign investments are set for each sector, assuming a decline of approximately 1.5 percentage points by 2050 in the non-financial corporations and financial institutions.[15]

Figure 3 illustrates the GDP shown in Figure 2 from the expenditure side using equation (2). Since gross fixed capital formation is presumed to be constant as a percentage of GDP, the moderate increase in final consumption expenditure resulted in a decrease in net exports.

[15] Bonfatti et al. (2022) estimate that global interest rates will decrease by about 1.5 percentage points from around 3.5% around 2020 to around 2% around 2050.

Figure 3: GDP from Expenditure Side (status quo scenario)




Source: Created by the authors

This can be interpreted as the rise in final consumption expenditure is not covered by domestic production but met by an increase in imports.

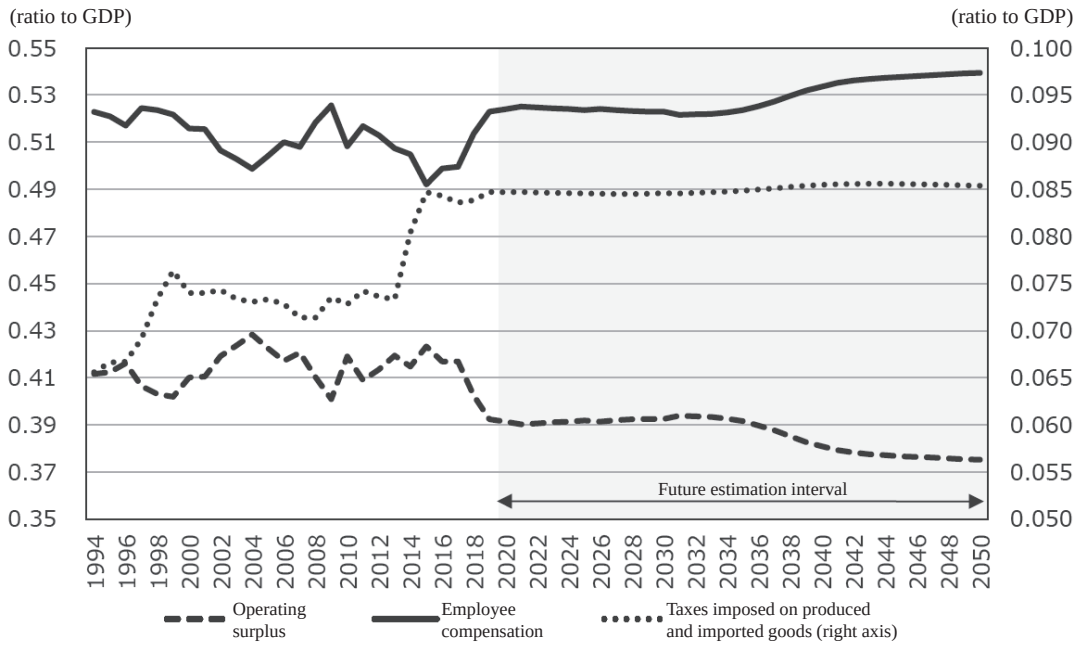
Subsequently, Figure 4 shows GDP from the distributional side, based on equation (3). Since taxes on production and imports generally remain constant relative to GDP, the increase in the compensation of employees results in a decrease in the operating surplus.

Figure 5 presents the trends in each component of government expenditures as derived from equation (5). Social benefits other than social transfers in kind exhibit a leveling-off over the long-run with a slight decline by the end of the projection period, supported by the macroeconomic slide shown in equation (15). Conversely, spending on medical and long-term care insurance continues to rise, driven by increases in personnel costs, resulting in an overall upward trend in age-related expenditures. The non-age-related expenditures, other than interest payments, are assumed to remain constant relative to GDP throughout the estimation period and thus show no change.

Based on the above, Figure 6 illustrates the trends in net lending/borrowing by each institutional sector.

The government sector's fiscal deficit is projected to gradually increase, driven by rising medical and long-term care expenses, as well as increased interest payments. Furthermore, around 2040, the government sector is expected to run a deficit in the overseas sector due to an increase in interest payments to foreign entities resulting from a rise in the foreign ownership ratio of government bonds.

Figure 4: GDP from Distribution Side (status quo scenario)




Source: Created by the authors

Figure 5: Government Expenditures (excl. Interest Payments) (status quo scenario)

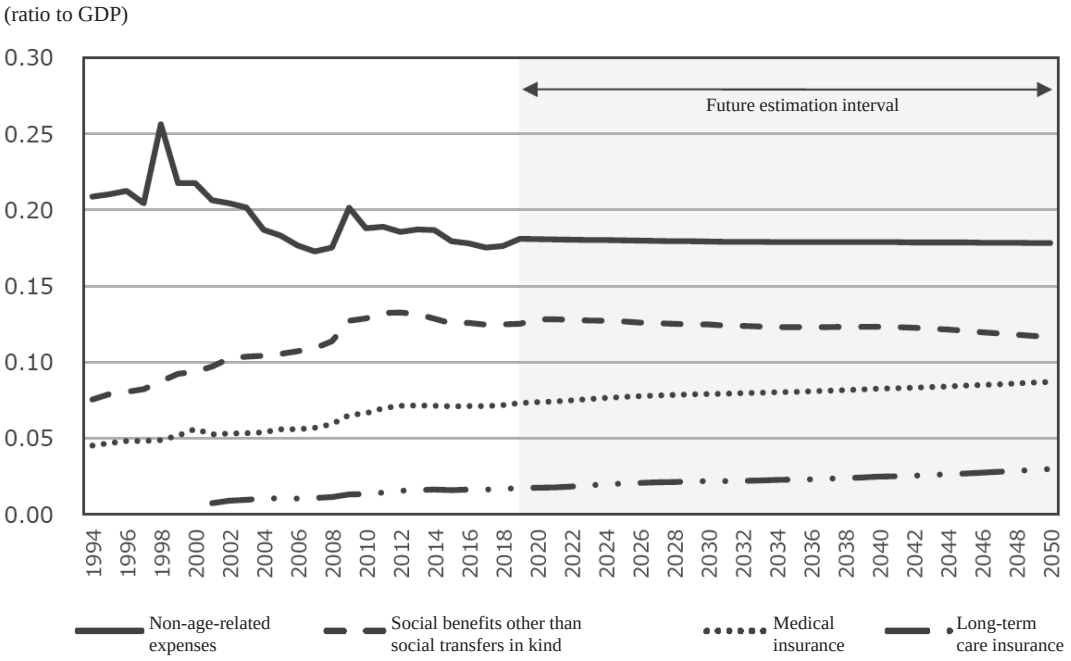



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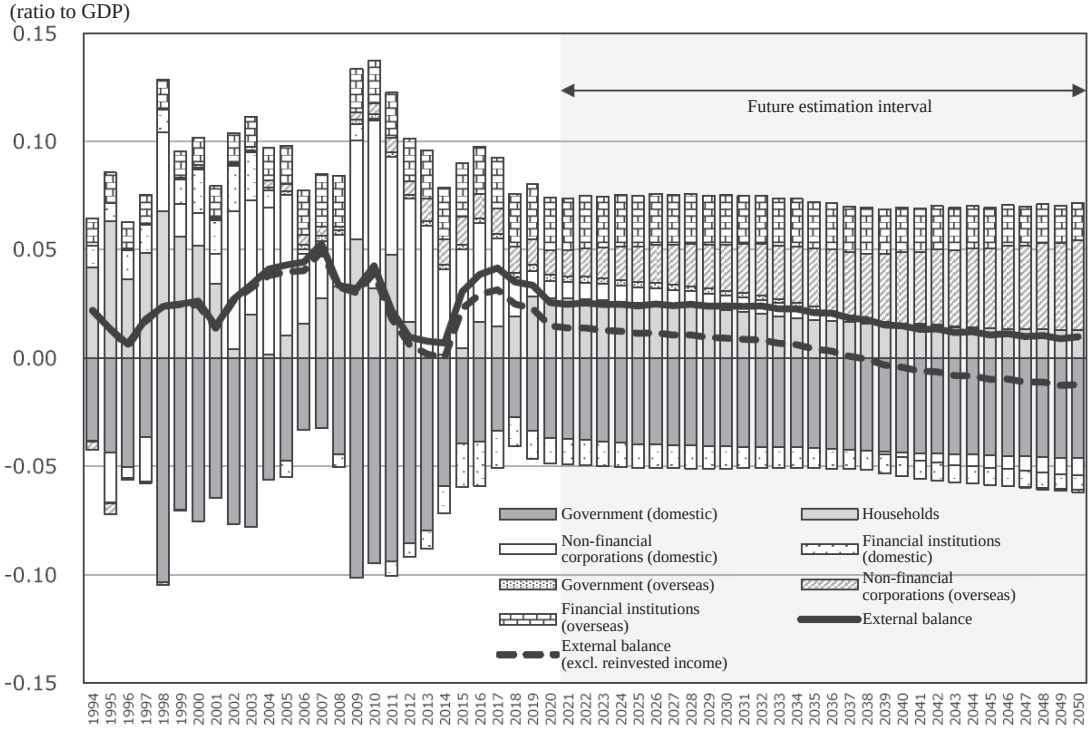
Figure 6: Net Lending/Borrowing by Institutional Sector (status quo scenario)




Source: Created by the authors

In the household sector, despite increasing wages, net lending is anticipated to gradually decline each year. This trend is attributed to the expanding population of elderly individuals with a higher propensity to consume, coupled with an increase in social burdens. Nevertheless, the sector is projected to sustain a surplus during the projection period.

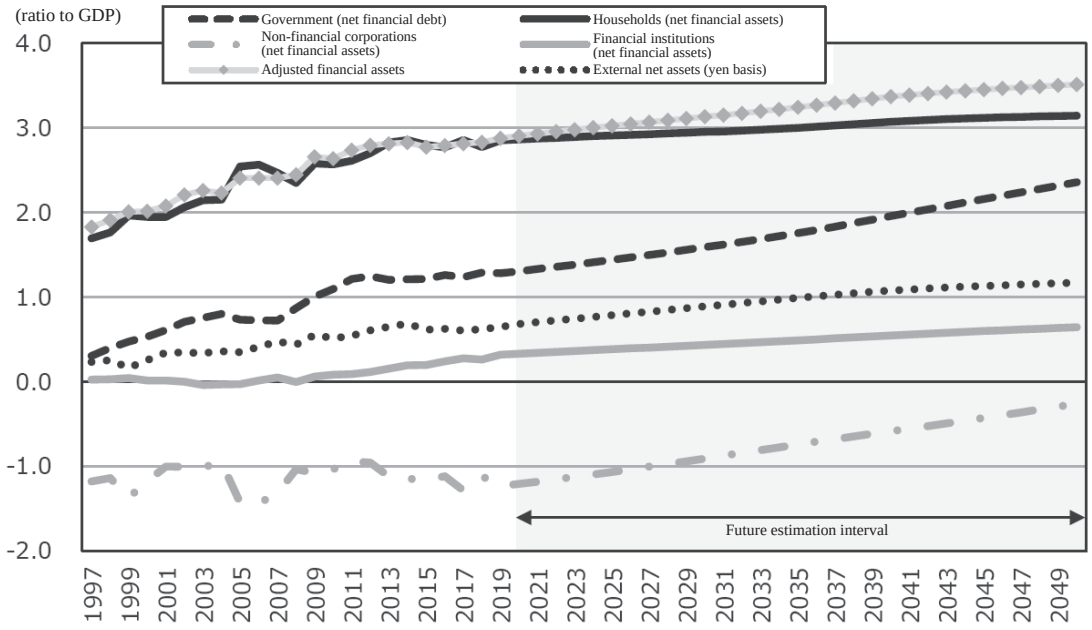
For the non-financial corporation sector, amid ongoing low domestic growth, the expansion in operating surplus is limited. However, an increase in foreign earnings, driven by the accumulation of external assets, leads to an increase in domestic tax and dividend payments, making the sector a net borrower around 2040 domestically. Nonetheless, the increase in foreign earnings significantly expands net lending vis-à-vis the overseas. As a result, the non-financial corporation sector as a whole is projected to increase its net lending to other sectors throughout the estimation period.

In the financial institution sector, domestic earnings remain sluggish under a long-term low-interest environment, resulting in continued net borrowing against domestic sectors. Net lending vis-à-vis the overseas is projected to decline over the long-term, as the pace of external asset accumulation is moderate compared to the non-financial corporations, while the rate of return on foreign investment is expected to gradually decrease. Consequently, the financial institution sector as a whole is expected to maintain a surplus but with a declining trend over the projection period.

The external balance of a country, representing the sum of net lending/borrowing of each institutional sector, is projected to maintain a surplus over the estimation period. However, such results significantly depend on external assets and their rates of return, suggesting increased vulnerability to economic shocks from overseas. Furthermore, while reinvested earnings on foreign direct investment are recorded as income receipts, the funds are not necessarily repatriated into the country. The adjusted external balance, by excluding these reinvested earnings, turns into a deficit around 2040.

Figure 7 illustrates trends in stock by institutional sector, reflecting the dynamics of net lending/borrowing. Hoshi and Ito (2012) focused on a potential scenario where the net financial liabilities of the government exceed the net financial assets of the private sector. They suggested that under such a circumstance, the government is forced to rely on foreign investors who could call for higher risk premiums, raising the government's financing cost. In their study, Hoshi and Ito (2012) concluded that the government sector's net financial liabilities could surpass the private sector's net financial assets as early as the mid-2020s. However, the model in this paper indicates that, despite an increase in the government sector's net financial liabilities, the net financial assets of the household and non-financial corporation sectors also increase. As a result, the government sector's net financial liabilities do exceed the private sector's net financial assets within the estimation period. Moreover, even when considering the adjusted financial assets of the private sector, as defined by Hoshi and Ito (2012),[16] it is shown that they also surpass the government sector's net financial liabilities. The primary reason for the deviation from Hoshi and Ito (2012) is that the "status quo

Figure 7: Assets/Liabilities by Institutional Sector (status quo scenario)




Source: Created by the authors

scenario" in this paper assumes the continuation of a low-interest-rate environment and does not anticipate a progressive increase in government debt and interest payments due to rising interest rates, as seen in Hoshi and Ito (2012). Additionally, the model in this paper incorporates that a portion of the government sector's fiscal deficit is transferred to the private sector, including through social benefits to the household. As a result, even though not as rapid as the government debt accumulation, private sector assets are also expected to increase, contributing to the different estimation outcomes.

### *III-3. Higher Consumption and Investment Propensity Scenario*

Next, we consider the "higher consumption and investment propensity scenario," where the consumption propensity of household sector and the investment propensity of non-financial corporation sector increase, leading to an improvement in the economic growth rate.

In this scenario, the TFP contribution is assumed to be 1.2%,[17] remaining constant throughout the estimation period. Moreover, it is presumed that up to 2030, the CPI inflation rate will reach 2.0%, and the GDP deflator will also rise in line with CPI. The nominal effective interest rate on government bonds reflects the higher interest rate on newly issued government bonds in line with the higher GDP growth, considering the average remaining maturity. The effective interest rates for other asset items were assumed to be aligned with the government bond yield.

For consumption in the household sector, the annual savings of the working-age population is assumed to be a constant in the real term at the level of an initial period, and any savings exceeding this amount are directed towards consumption. Finally, the investment propensity of non-financial corporation sector is assumed to be equivalent to one of the 2010s when the investment propensity recorded an increasing trend.

Based on the above assumptions, the GDP growth rate calculated from equation (1) is shown in Figure 8. It is demonstrated that, against the backdrop of improvements in TFP, an increase in capital stock, and the rise of the GDP deflator, the nominal growth rate is projected to improve significantly compared to the "status quo scenario."

Next, Figure 9 illustrates trends in net lending/borrowing by the institutional sector.

Compared to the "status quo scenario," the government sector is expected to experience an increase in consumption tax revenues due to improvements in the consumption propensity of the household sector. However, an increase in interest rates leads to a widening deficit,

[16] Hoshi and Ito (2012) define private sector financial assets compared to government debt as "Net financial assets of the household sector ― Value of shares and other equities held by the household sector + Cash, deposits, government bonds, and public corporate bonds held by the private nonfinancial sector." It should be noted that the exact definition in this paper differs. Our model includes both households and private non-profit institutions serving households in the household sector, takes into account financial institutions, and does not distinguish between the private and public components within the non-financial corporation sector.

[17] According to the "Japan Industrial Productivity Database 2021" published by the Research Institute of Economy, Trade and Industry, the average annual growth rate of labor productivity from 2010 to 2018 was recorded at 1.2% in capital-intensive manufacturing industries. In this scenario, it is assumed that the TFP of the entire macroeconomy will increase at a rate equivalent to the productivity growth observed in the manufacturing industry.

Figure 8: GDP (higher consumption/investment propensity scenario)

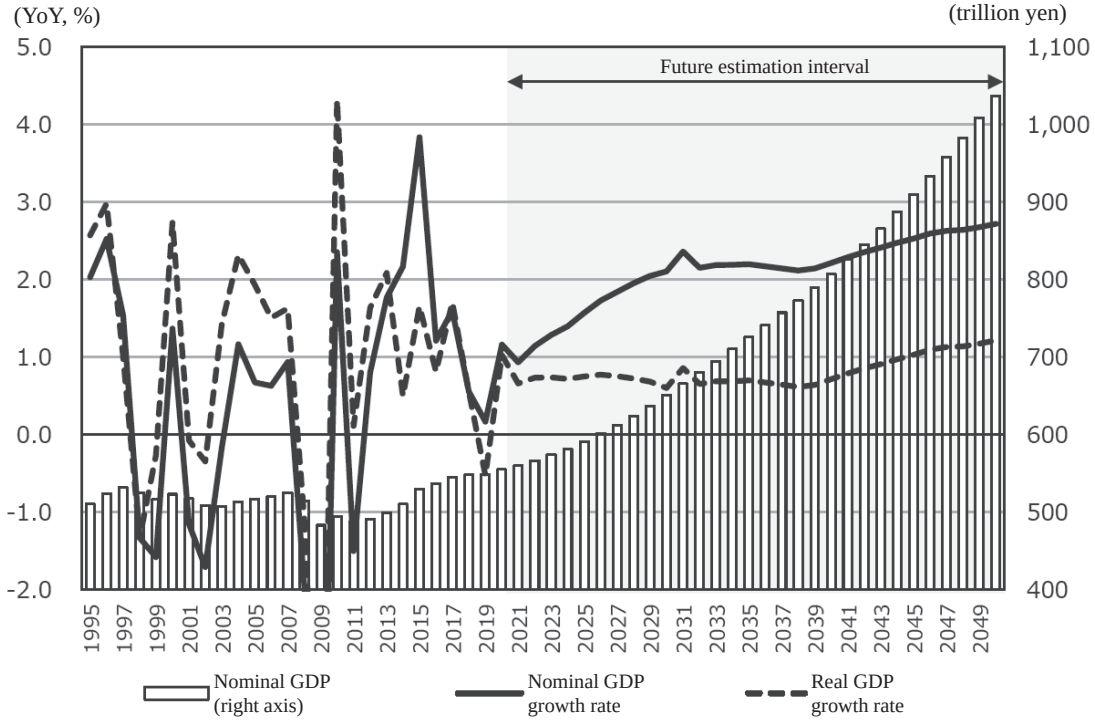



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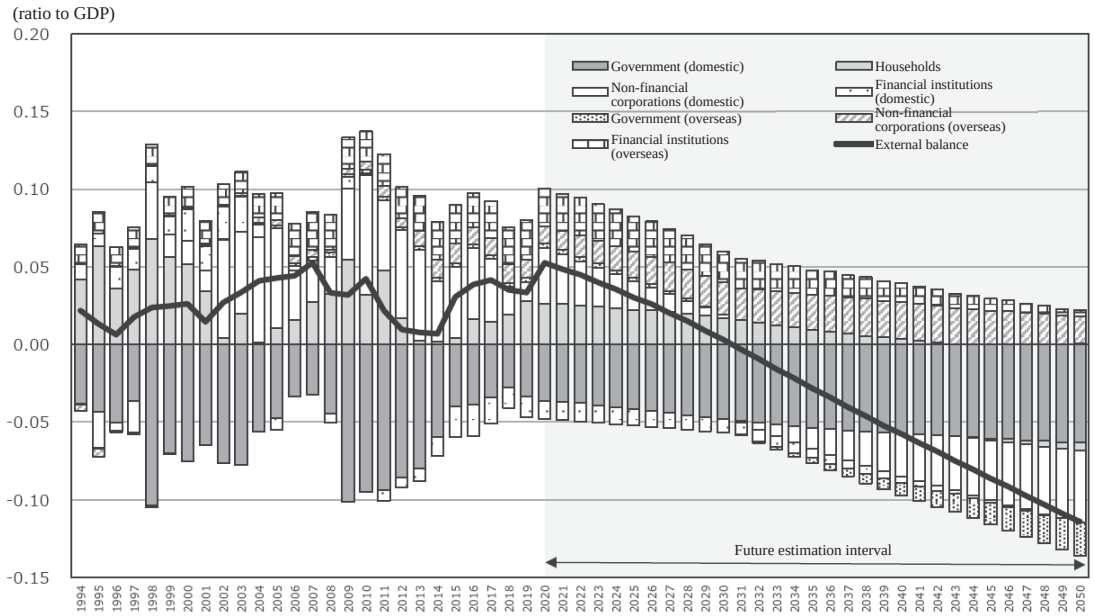
Figure 9: Net Lending/Borrowing by Institutional Sector (higher consumption/investment propensity scenario)




Source: Created by the authors

particularly against the overseas sector, due to the increased foreign ownership ratio of government bonds.

In the household sector, net lending continues to decline, reflecting a higher propensity to consume, resulting in the sector becoming a net borrower around the mid-2040s.

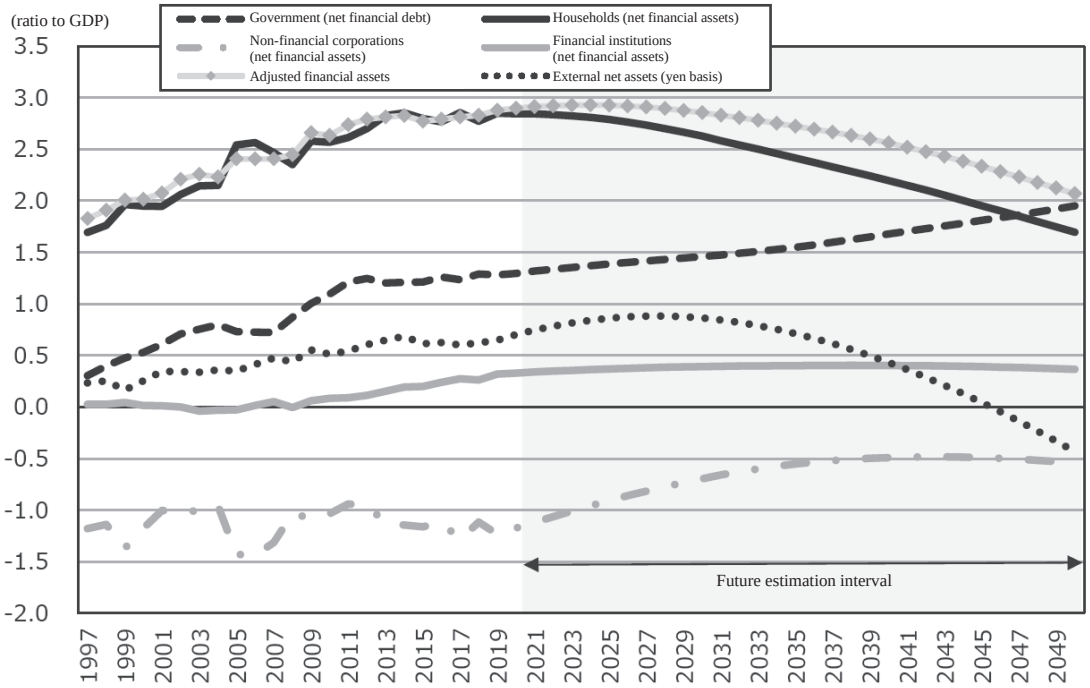
For the non-financial corporation sector, an increase in investment propensity leads to a rise in domestic capital investments, making it a net borrower around 2040. Net lending vis-à-vis the overseas is not projected to increase substantially, unlike the "status quo scenario." The anticipated increase in domestic investment leads to larger borrowings from overseas and corresponding higher payments of interest and dividends. Furthermore, larger domestic financing needs limit the pace of external asset accumulation.

Regarding the financial institution sector, net borrowing shrinks as the domestic profit environment improves due to a rise in domestic interest rates, leading to a nearly neutral position around 2050. On the other hand, as domestic lending increases, the accumulation of external assets is limited, and foreign earnings are expected to decline faster compared to the "status quo scenario."

The external balance of the country, which is the sum of the net lending/borrowing from each of these sectors, is projected to fall into a deficit around 2030. Subsequently, the deficit is expected to continue widening.

Finally, Figure 10 shows the trends in stocks by each institutional sector.

Figure 10: Assets/Liabilities by Institutional Sector (higher consumption/investment propensity scenario)




Source: Created by the authors

The net financial liabilities of the government sector are projected to increase and surpass the financial assets of the household sector by 2050. Additionally, the net financial liabilities of the government sector and the adjusted financial assets of the private sector are expected to reach a nearly equal level by 2050. Notably, net foreign assets begin to decrease as the external balance turns into a deficit around 2030, resulting in external liabilities surpassing external assets by 2050.

This outcome implies that the ratio of foreign holdings of government bonds is projected to increase amid the decline in the domestic absorbing capacity of government bonds over time. The "higher consumption and investment propensity scenario" indicates that, despite its improved growth outlook, there is also a heightened risk of interest rate increases and the associated vulnerability of fiscal positions to interest rate shocks.[18]

### *III-4. Results Considering Fluctuations in Macroeconomic Variables*

In the "status quo scenario" and the "higher consumption and investment propensity scenario" discussed earlier, the projections are produced without considering fluctuations in exchange rates, prices, and interest rates. However, in reality, these macroeconomic variables can fluctuate in response to various shocks and be adjusted to changes in net lending/borrowing. Therefore, further study of the interaction between these variables and net lending/borrowing is necessary.

To this end, this section employs the method proposed by Berti (2013) and conducts estimations that consider the probability distribution of these variables, incorporating the correlations between each variable as illustrated in Table 2 (refer to Appendix 3).

Figure 11 presents a stochastic projection for the external balance in the form of confidence intervals based on the probability distribution that factors in the correlation coefficient

Table 2: Correlation Coefficient between Each Variable (1985 to 2019)[19]

| | GDP deflator | Foreign exchange | Short-term interest rate | Long-term interest rate | CPI |
|---|---|---|---|---|---|
| GDP deflator | 1.0 | | | | |
| Foreign exchange (yen depreciation) | 0.3 | 1.0 | | | |
| Short-term interest rate | 0.5 | 0.4 | 1.0 | | |
| Long-term interest rate | 0.3 | 0.3 | 0.8 | 1.0 | |
| CPI | 0.5 | 0.3 | 0.5 | 0.4 | 1.0 |

Source: Calculated by the authors based on the "National Accounts" by the Cabinet Office, OECD Statistics, and the "Central Government Debt" by the Ministry of Finance.

[18] Matsuoka (2022) showed that the risk of interest rate hikes sharply increases when the share of JGBs held by private-sector foreign investors exceeds 20% of the total. In the model in this paper, foreign ownership reaches about 50% in 2050, but the breakdown of foreign investors is not estimated.

[19] Annual data is used to calculate the correlation coefficients. Note that the correlation between all variables weakens when quarterly data is used, but the direction of the correlation is consistent.

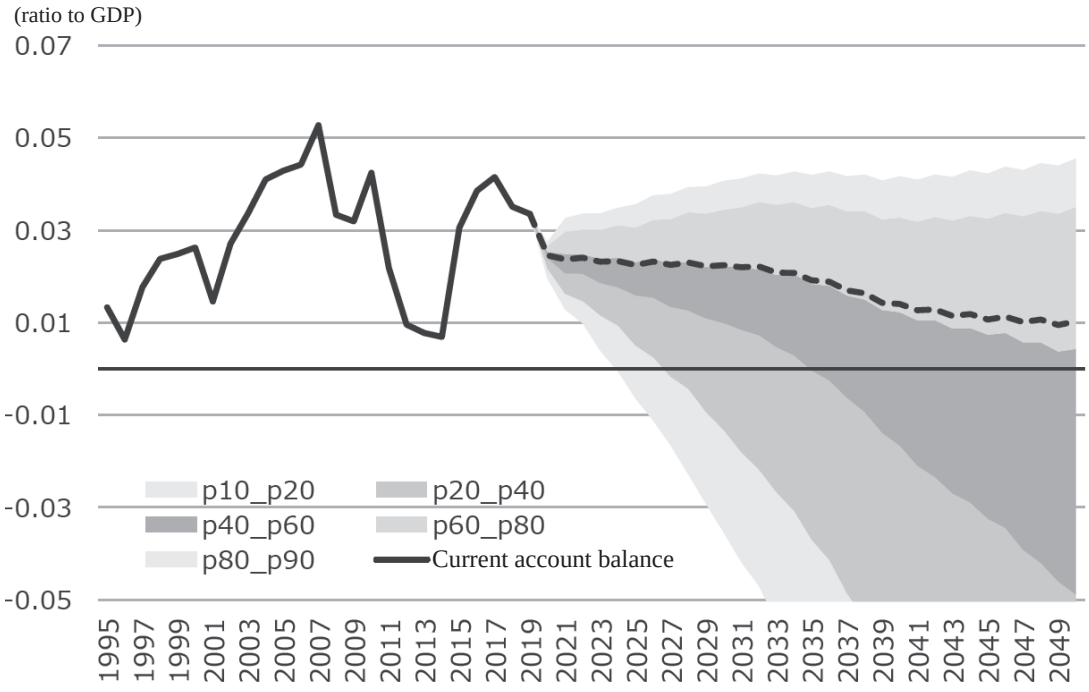
between each variable. While Figure 6 shows that the current account surplus is projected to be sustained until 2050, Figure 11 reveals significant variations in the projections of external balance due to fluctuations in these variables. For instance, around the mid-2030s, it is indicated that the external balance might shift to a deficit within the 40th to 60th percentile range.

In long-term projections using partial equilibrium models, each variable is typically provided exogenously, and the projections are frequently conducted without fully accounting for the impacts of these fluctuations. Nevertheless, as illustrated in Figure 11, when interpreting the projection results within the context of specific scenarios and their implications, it becomes crucial to give ample consideration to the uncertainties linked to fluctuations in the macroeconomic variables.

In this exercise, the main driver behind the asymmetrical shifts in the external balance is the volatility in interest rates. Currently, the effective interest rates for various asset items are low, with limited room to decrease further. On the other hand, the external balance can exhibit an asymmetric shift towards a deficit due to an increase in fiscal deficits driven by rising interest rates. However, it is important to recognize that other variables also change in accordance with their correlations, indicating that the determination of the external balance is influenced by a complex interplay of factors.[20]

For example, based on the correlation coefficients, the potential risk of a deterioration in the external balance illustrated in Figure 11 can be interpreted as follows:

Figure 11: Fan Chart of External Balance




Source: Created by the authors

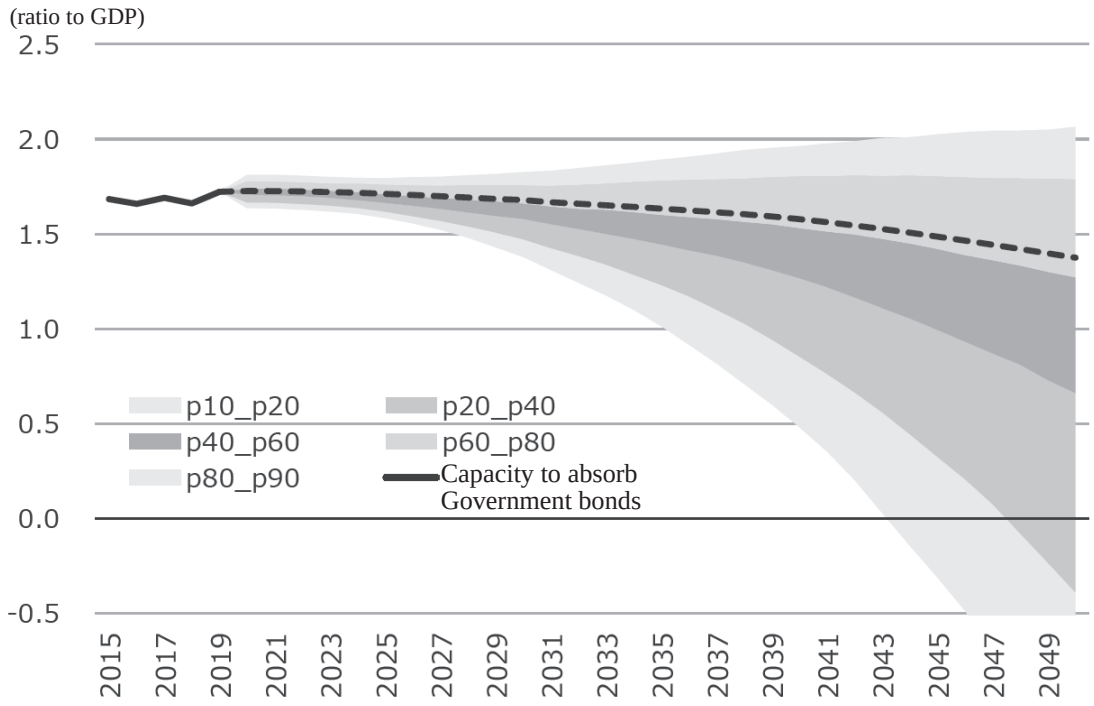
1. A depreciation of the yen leads to an increase in CPI.
2. The household sector, in an effort to maintain real consumption levels, increases consumption propensity, resulting in a reduction in net lending.
3. Simultaneously, an increase in interest rates exacerbates the fiscal position of the government sector.

These factors are possible transmission channels that are consistent with the outcome of Figure 11.

It is also useful to revisit the relationship between government debt and private financial assets, which is the main focus of Hoshi and Ito (2012). As shown in the previous section, in the "status quo scenario," government debt does not surpass private financial assets within the estimation period. In order to gauge the potential impacts of fluctuations in macroeconomic variables, Figure 12 shows a fan chart of a variable of "domestic absorbing capacity for government bonds" obtained by subtracting government debt from adjusted private financial assets. Figure 12 indicates that government debt could exceed private financial assets within the 20-40 percentile range after the mid-2040s.

Unlike the findings by Hoshi and Ito (2012), our status quo scenario does not necessarily

Figure 12: Fan Chart of Domestic Absorbing Capacity for Government Bonds




Source: Created by the authors

[20] In the context of this estimation, an increase in interest rates is likely to coincide with rises in the GDP deflator, exchange rate (meaning yen depreciation), and CPI. While the increase in interest rates tends to shift the external balance towards a deficit, the depreciation of the yen in exchange rates can elevate the value of foreign assets in terms of Japanese yen. Consequently, this can shift the external balance toward surplus through an increase in foreign earnings.

support an economic and fiscal situation in which the domestic absorbing capacity of government bonds becomes constrained within the next decade as the main scenario. However, it is evident that a significant level of uncertainty exists when fluctuations in macroeconomic variables are considered.

## IV. Conclusions

This paper developed a framework for macroeconomic analysis with a particular focus on the net lending/borrowing relationships across the government, private, and overseas sectors, aiming for comprehensive and consistent analyses of the external balance of a country as well as the debt sustainability of the public and private sectors. Specifically, we formulated a partial equilibrium model for the Japanese economy that incorporates the linkages across sectors—government, households non-financial corporations, financial institutions and overseas—encompassing both flow and stock variables.

The scenario analysis conducted using this partial equilibrium model yielded several insights, emphasizing the usefulness of the model: (1) Deepening understanding of the medium- to long-term projection for the external balance, (2) Evaluating the sustainability of the government sector within the overall economic picture, and (3) Enhancing comprehension of the uncertainty due to fluctuations in assumptions.

In the "status quo scenario," based on current macroeconomic variables, including economic growth rate, the current account surplus is projected to be sustained throughout the estimation period amidst continued economic low growth. This outcome is attributed to the increase in foreign earnings from non-financial corporation and financial institution sectors, which compensates for the gradual decline in households' net lending due to an aging population and a moderate increase in fiscal deficit, driven by escalating medical and long-term care expenses as well as interest payments in the government sector. However, the current account surplus is primarily attributed to the increase in foreign earnings from the corporate sector and, therefore, is more vulnerable to shocks from overseas economies. Regarding stock dynamics, while the government sector's debt rises, the private sector's assets also steadily increase and remain above the level of government debt throughout the projection period up to 2050.

In the "higher consumption and investment propensity scenario," increases in household consumption and corporate investment help achieve an improved economic growth rate. At the same time, the household sector turns into a net borrower due to increased consumption, and the non-financial corporation sector expands its net borrowings for capital investment. These factors, together with a widened fiscal deficit stemming from rising interest rates, contribute to a shift in the external balance toward a deficit. Furthermore, the public sector debt continues to increase while the private sector assets decrease, bringing the two to approximately the same level by 2050. These findings suggest a potential increase in the vulnerability of fiscal positions to interest rate shocks as the domestic absorbing capacity for government bonds diminishes.

Finally, employing the methodology proposed by Berti (2013), this paper analyzed the impact of fluctuations in macroeconomic variables, such as exchange rates, prices, and interest rates, on the flows and stocks of each sector based on their probability distributions. The results indicate significant variations in the projections of external balances and the absorbing capacity of government bonds. This highlights the necessity for prudential analysis and policy management that adequately consider the uncertainties associated with these parameter fluctuations.

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## Appendix 1: Estimation Methodology for Per Capita Income/Expenditures

When estimating the household sector in our model, per capita income and expenditures by age group and category are used. However, data from the "2019 National Survey of Family Income, Consumption and Wealth" by the Ministry of Internal Affairs and Communications are only available for household-level and, therefore, need to be converted to individual-level data is necessary.

To achieve this, drawing on the method proposed by Tsuri (2016), household-level data are converted to individual-level data based on factors such as average household size and population composition. Additionally, given that our model builds on national accounts, macro-level data derived from multiplying individual-level data by population across age groups are matched with data from national accounts.

The concrete steps are outlined as follows:

(1) Estimation of the number of individuals in each age group within each household, categorized by the head of the household's age group. Note that individuals under the age of 18 are excluded from this model.
- The age group of the household head is a published value and allocated to the respective age group.
- The number of individuals aged 65 and above is a published value and distributed to each age group of 65 and above based on the population ratio in 2019.
- The number of individuals aged 18 to 64 is calculated by deducting the number of individuals under the age of 18 and those aged 65 and above from the total household members. Subsequently, this figure is allocated to specific age groups within 18 to 64, according to the population ratio in 2019.

(2) The average income and expenditures per household, encompassing wages and consumption expenditures, are multiplied by the number of households to calculate macro-level income and expenditures categorized by the head of the household's age group. Similarly, macro-level amounts are also estimated for assets such as deposits and stocks, as well as liabilities.

(3) Building on (1) and (2), the macro-level income and expenditures, as well as assets and liabilities, categorized by the head of the household's age group, are distributed according to the number of individuals in each age group within the households. This process estimates macro-level income and expenditure, as well as assets and liabilities, categorized by age group.

(4) While retaining the ratio of macro-level income and expenditure for each age group, these are reconciled with national accounts data. Regarding mixed-income, the allocation is based on the estimated number of members in "other" households (those not classified as working or unemployed households) by each age group. Other received/paid amounts are allocated according to the population ratio within each age group.

(5) Per capita income and expenditure are estimated by dividing the macro-level

amounts, which are aligned with the national accounts data as obtained in (4), by the population of each age group.

## Appendix 2: Comparison of Actual and Estimated Values for 2020 and 2021

In this paper, data up to 2019 are treated as actual data, and subsequent years from 2020 onwards are estimated in order to remove the impact of the COVID-19 pandemic from the long-term projection. In this appendix, a comparison is made between the latest available actual data for 2020 and 2021 at the time of writing this paper and the estimated values for the same period under the "status quo scenario." This comparison aims to assess the impact of the COVID-19 pandemic on inter-sectoral net lending/borrowing.

From 2020 onwards, in response to the COVID-19 pandemic, various measures such as a "Declaration of a State of Emergency" and "Priority Measures to Prevent the Spread of COVID-19" were implemented nationwide in Japan, artificially suppressing domestic economic activities. Concurrently, the government disbursed subsidies and financial support to households and businesses adversely affected by the pandemic. Similar policy measures were observed in overseas economies, leading to large fluctuations in both domestic and international data during this period.

A comparison of the actual values of net lending/borrowing by each sector in 2020 with the estimated values reveals the following: in the household sector, due to suppressed consumption and cash transfers from the government, the actual value diverges from the estimated value by approximately 29.0 trillion yen towards net lending. Conversely, the government sector deviates towards net borrowing by approximately 30.2 trillion yen. In the non-financial corporation sector, the operating surplus declines, and external income falls due to a decrease in the rate of return (with estimates using an average of 6.5% from the 2010s, but the actual value for 2020 dropped to 5.1%), but an overall divergence is relatively moderate amounting to approximately 1.7 trillion yen towards net lending, supported by transfers from the government. In the financial institution sector, almost no deviation was observed. Consequently, there was no significant discrepancy between the estimated and actual figures for the overall external balance, with a slight shift towards a surplus of approximately 0.6 trillion yen.

For 2021, with the normalization of economic activity, the household sector's deviation towards net lending reduced to approximately 16.0 trillion yen, and the government sector's deviation towards net borrowing also decreased to approximately 14.9 trillion yen. In the non-financial corporation sector, despite the operating surplus remaining at a low level, a rebound in the rate of return on external investments (rising to 8.1% in 2021) leads to the divergence of approximately 4.0 trillion yen towards net lending, compared to the estimated value. The financial institution sector also deviates towards net lending by approximately 3.8 trillion yen, driven by an increase in receipts from overseas. As a result, the gap between the actual and estimated values of the external balance is larger, amounting to 8.9 trillion yen.

The fluctuation of the rate of return on external investments for 2020 and 2021 are likely to be largely temporary impacts of the COVID-19, and their long-term projection implications are limited. However, it reinforces a key insight of this paper—vulnerability to overseas shocks increases as the weight of foreign earnings in the external balance increases.

Additionally, close attention is needed to discern whether there are any structural changes in the consumption propensity of the household sector as a result of their experiences with COVID-19. In a broader context, the substantial fluctuations in net lending/borrowing across sectors underscore the need for prudential analysis and policy management that considers the uncertainties associated with changes in macroeconomic variables, as highlighted in III-4.

## Appendix 3: Stochastic Projection

In III-4, we estimated the stochastic projection for the current account balance, taking into account fluctuations in exchange rates, prices, and interest rates. This appendix provides an explanation of the estimation methodology used in this paper, which is based on the approach proposed by Berti (2013).

Firstly, to generate annual shocks from the annual time-series data spanning from 1985 to 2019 for the GDP deflator, exchange rates, short-term and long-term interest rates, and inflation rates, a series of shocks δ was calculated from the time series data for each macroeconomic variable x.

$$\delta_t^x = x_t - x_{t-1} \tag{i}$$

Next, a random shock $\varepsilon_t^x$ with a mean value of zero was derived via a Monte Carlo simulation from a joint normal distribution, sharing the variance-covariance matrix identical to that of the time series data for δ.

The shocks calculated above are assumed to be temporary, excluding those for interest rates, and are added to each variable annually. For instance, the annual GDP deflator can be expressed as follows, and a time-series that considers shocks for exchange rates and price increases is also created.

$$GDP\_deflator_t = \overline{GDP\_deflator_t} + \delta_t^{gdp\_deflator} \tag{ii}$$

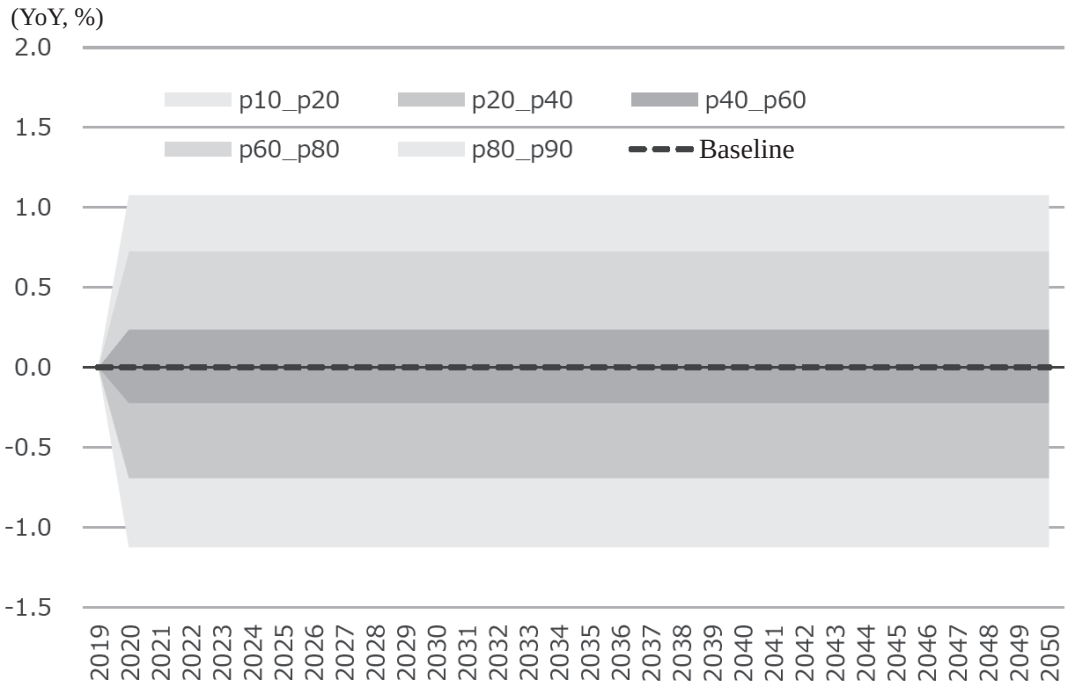
On the other hand, given that interest rate fluctuations tend to exhibit continuity, we adopt Berti's (2013) "permanent shock scenario" for interest variations. Under this approach, a shock is applied to the previous year's interest rates as follows. The interest rate shocks are calculated for long-term rates by considering the remaining duration of bonds and then applying a weighted average based on the proportion of short-term and long-term debt relative to outstanding debt.

$$r_t^{gdebt} = r_{t-1}^{gdebt} + \delta_t^{gdebt} \tag{iii}$$

In our model, we generate 1,000 random shocks for each series. For instance, Appendix Figure 1 illustrates the GDP deflator incorporating shocks. The baseline is set at an annual change of 0.0%, but it is evident that the 10th and 90th percentile values can fluctuate by approx. ±1%. Moreover, in the case of interest rates, where shocks accumulate over time, the fluctuation ranges become more pronounced, as depicted in Appendix Figure 2, with the 90th percentile value reaching approximately +5%. It is important to note, however, that the spread of the downward trend in interest rates is limited due to the zero-interest rate constraint.

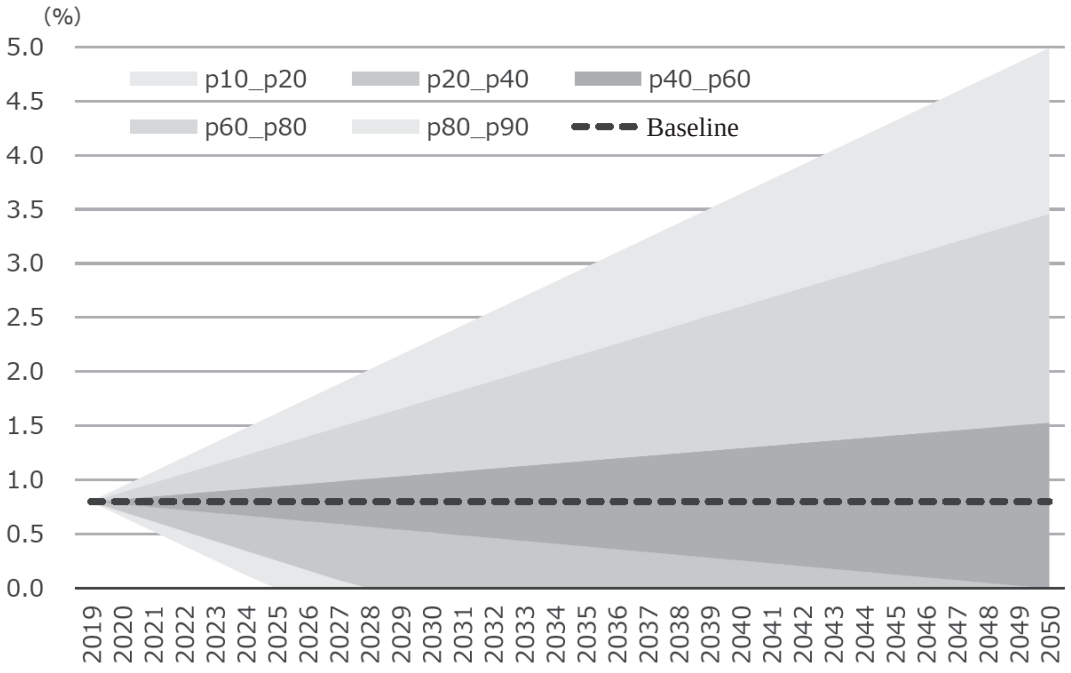
Thus, from 1,000 random shocks, we calculated 1,000 patterns of current account balances and so forth, creating stochastic projections by plotting fan charts.

Appendix Figure 1: Fan Chart of GDP Deflator




Source: Created by the authors

Appendix Figure 2: Fan Chart of Government Bonds Interest Rates




Source: Created by the authors