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Fiscal and Social Security Systems Design in the Midst of Demographic Change

Editor's Introduction

Kazumasa Oguro

We are pleased to present a special issue of *Journal of International Economic Studies* (JIES), entitled "Fiscal and Social Security Systems Design in the Midst of Demographic Change." Japan's outstanding public debt (relative to GDP) has skyrocketed due to the expansion of social security expenditures associated with the declining birthrate, aging population and the ever-increasing budget deficit. Although reductions in social security spending and tax increases, as well as fiscal and social security reforms have been proposed, the correction of intergenerational disparities will not easily progress.

It has been pointed out that one of the reasons for this may be the "silver democracy hypothesis," which states that politics preferentially selects policies that consider the majority elderly population. However, it is necessary to consider fiscal and social security systems that can adapt to demographic changes from a wider perspective. This includes the election system and fiscal control, which form the foundations of democracy. In addition, some countries in East Asia and other parts of the world are expected to experience rapid demographic changes, which could exert a significant impact on their economic, financial, and political systems.

In this context, the papers in this special issue summarize the results of the "Fiscal and Social Security Systems Design in the Midst of Demographic Change" project conducted by the Institute of Comparative Economics, Hosei University, from FY2017 to FY2020, with the aim of analyzing both empirical and theoretical economics, including the direction of reform of electoral systems and fiscal controls, in order to discover hints for fiscal and social security reform and the correction of intergenerational disparities.

We believe that this special issue will provide deeper insights into this field of research. The specific organization is as follows.

The first treatise, entitled "An Analysis of Fiscal Governance: Why Japan fails Fiscal Consolidation?" is written by Hideaki Tanaka. This paper points out that to date, Japan has failed in every attempt to consolidate its public finances, leaving the balance of government debt to move in an upward direction in terms of GDP. Among several reasons, weak budgetary institutions and poor fiscal transparency are the most possible candidates for explaining why Japan fails. This can be also applied to other countries, since some countries are successful in maintaining fiscal discipline while others are not, and thus such differences can be explained by budgetary institutions. Budgetary institutions include many things, but those which could strengthen fiscal governance matter are, in particular, fiscal rules, medium-term fiscal frameworks, and independent fiscal institutions. Thus, the objective of this paper is to analyze Japan's fiscal governance by comparison with other OECD countries. This type of assessment cannot exclude arbitrariness, but the analysis provides evidence that, among advanced countries, fiscal governance is at a low level in Japan. The problem with Japan's budgetary institutions is especially the lack of a mechanism for the oversight and observance of rules as well as the absence of post hoc evaluation and verification. Reforms of budgetary institutions are urgently required to strengthen fiscal governance, but policymakers are always reluctant to implement them. Since the collapse of the bubble economy in Japan, efforts have been

made for reforms intended to strengthen its political and administrative governance, such as the overhaul of the electoral system and the restructuring of ministries and agencies. A prime minister can currently exercise much more political power than before, but this power is not used for strengthening fiscal governance. Ultimately, this is a political problem in Japan.

The second treatise, "Borda Count Method for Fiscal Policy - A Political Economic Analysis -," is authored by Ryo Ishida and Kazumasa Oguro. This paper firstly notes that survey data reveal that government budgets tend to go into the red. Public Choice economists as well as public finance economists have been interested in this phenomenon and have come up with several explanations such as fiscal illusion. This paper presents a new explanation for this tendency from the political economic point of view; the current voting system might have a tendency to bring about a budget deficit. If policy choices only deal with the current tax rate and do not take into account the intertemporal tax rate, it is difficult to choose a budget-balanced choice. Even if voting choices take into account intertemporal aspects, as there exist so many options for increasing tax rates to reimburse government deficits, votes from people who support a balanced budget are split and therefore a budget-balanced choice is unlikely to be chosen under the relative majority rule even if a balanced budget is supported by a majority of voters. The authors further demonstrate that the Borda count method, known to mitigate splitting votes problems, might overcome this issue.

The third treatise, "Why Fiscal Reform Makes no Progress in Japan," is authored by Manabu Shimasawa. This paper uses the Overlapping Generations Model with intergenerational heterogeneity to analyze the preferred form of taxation to achieve the fiscal reform necessary to maintain fiscal sustainability in Japan. The paper assumes two forms of taxation, i.e. the consumption tax increase or the progressive labor income tax increase, and uses utility criteria and the existing voting system for its analysis. The results show that support for a consumption tax increase is limited to the upper income bracket in generations younger than middle-age, rendering implementation of the fiscal reform policy impossible. Thus, the paper assumes a utilitarian government and confirms that the consumption tax increase option would be favored in a case in which the sum of utility changes in all the people alive in the year fiscal reform is launched. However, a utilitarian government is equivalent to forcing other income groups to make sacrifices solely for the benefit of the high-income group and calls into doubt whether such a choice is fair.

The fourth treatise, "Effects of Fiscal Integration of the Public Pension System in Japan," is authored by Seiichi Inagaki. Japan's public pension system has introduced a "macroeconomic slide," which automatically reduces benefits to maintain pension finances. However, the reduction rate for the basic pension (28.0%) is much higher than that for the earnings-related pension (2.6%). Financial integration of the National Pension Plan and the Employees' Pension Plan is being considered to align these rates, but detailed results have not been released. The fiscal effects of the macroeconomic slide are clarified in this article and it is estimated that the reduction rate after fiscal integration is 9.0%. Furthermore, it is shown that financial support from the Employees' Pension Plan to the National Pension Plan through fiscal integration would be 0.4 trillion yen in 2020. The future national subsidy would also increase by 26.4% (2.3 trillion yen in 2063 at FY2019 prices).

The fifth treatise, "FY2019 Financial Verification and Public Pension Finance: Evaluation of the Total Factor Productivity Growth Rate, An Economic Assumption," is authored by Kazumasa Oguro. After constructing a simple stochastic model using data on the rate of increase in Total Factor Productivity (TFP) over the past 30 years, the authors use the Monte Carlo simulation method to estimate the probability of realization of the rate of increase in TFP assumed by each case in the FY2019 Financial Verification and examine the economic assumptions and pension finance issues. Until the FY2014 Financial Verification, information on which scenarios were probable and which were not was lacking. However, in the FY2019 Financial Verification, frequency distributions based

on historical data for key parameters (e.g., the rate of increase in TFP), which form the core of the data, were included as part of the reference materials, and the assumptions for each scenario were clarified as to where they were positioned in the frequency distribution and what percentage of the frequency distribution they covered. While including frequency distributions is commended, the coverage rate does not match the probability of realization of the TFP increase rate assumed by the Financial Verification. This suggests the importance of using a stochastic model to evaluate the rate of increase in TFP, which is an assumption for the Financial Verification.

The sixth treatise, "Reconsidering Aging and Financial Markets in East Asia" is authored by Takashi Kihara. This paper consists of a study of demography and macroeconomic variables in East Asia. Amid the concern over detrimental effects of rapid aging in East Asia, the impacts of its demography on macroeconomic variables have been estimated since the early 2000s. A recent example is IMF (2017) which estimated several macroeconomic variables by using panel data of demographic variables and a number of newly introduced explanatory variables, such as "financial openness" and expected "aging speed." IMF (2017), however, defines the range of ages in the "working age population" differently from those commonly used. In this chapter, the author estimates macroeconomic and financial variables by using explanatory variables similar to those of IMF (2017), but with commonly used demographic definitions, and with an increased number of countries during extended periods. The estimated results are different from those of IMF (2017) but similar to those found in previous literature. "Youth dependency ratio," "old-age dependency ratio" and "expected aging speed" have significant impacts on interest rates and stock return, the impacts of which, however, can be mitigated by increased "financial openness." Empirically revealed relationships between "aging speed" and savings as well as financial variables is a "conundrum" which is not consistent with the Life Cycle/Permanent Income hypothesis, but can be explained by using "behavioral economics." The resulting shortage of savings after retirement can be rectified by introducing "Saving More Tomorrow" type pension plans which incorporate behavioral economics and are widely available in the United States. Similar plans may provide solutions against the expected shortage of savings in East Asia, including Japan.

The seventh treatise, "Effects of Fiscal Rules on the Fiscal Policy Reaction to the Government Indebtedness" is authored by Kazuki Hara. It is well known that fiscal policy is prone to react to the public debt in order to ensure fiscal sustainability. This paper examines whether and how fiscal rules would exert an influence on this relationship. The dataset consists of 28 OECD member countries over the period from 1985 to 2015. Empirical evidence suggests that the reaction of fiscal policy to the public debt is likely to weaken or even disappear when strong fiscal rules are in place. At the same time, fiscal rules exert significant disciplinary effects unless the public debt exceeds a certain level. Governments need to lower the public debt to a certain level in order to ensure the disciplinary effects of both the fiscal rules and the public debt itself.

The eighth treatise, "A Comparison of Behavior-Restriction and Test-and-Isolate Policies using an Epidemiological Model" is authored by Keiichiro Kobayashi and Kengo Nutahara. In this study, the authors analyze the effects of behavior-restriction and test-and-isolate policies on disease spread and the macro economy using a model that combines an epidemiological model (the Susceptible-Infected-Recovered [SIR] model) and an economic growth model (the Solow model). The authors firstly compare the changes in the spread of disease using three types of behavior-restriction policy and policy durations: 80% contact reduction over 30 days, 70% contact reduction over 60 days, and 60% contact reduction over 360 days. In each of these cases, policy adoption quickly suppresses the spread of the disease, but the disease spread resumes sometime after the policy lapses. To significantly reduce the total number of deaths in the 1,000 days following the beginning of the outbreak, behavioral restrictions would have to remain in place for considerable periods, such as a

full year, and the economic losses from such a duration would be very serious. Secondly, the authors show that shortening behavioral restrictions and introducing a test-and-isolate policy can reduce the spread of disease while reducing economic losses. The authors specifically derive an optimal policy for minimizing economic losses, excluding the cost of testing, with an upper limit on the total number of deaths associated with the disease: In the baseline analysis, the authors find the optimal scenario to be behavioral restrictions producing an 80% reduction in contact (equivalent to an approximate 55% reduction in excursions) implemented over about 60 days in combination with test-and-isolate at maximum test intensity over one year.

The ninth treatise, "Using GIS to Examine the Optimal Location for Long-Term Care Facilities in a Depopulating and Super-aging Society: A case study of Niigata City" is authored by Kazumasa Oguro. This paper shows the following facts. The main purpose of the paper is to analyze and discuss a plan for effective and efficient location of long-term care facilities in a depopulating and super-aging society with the use of GIS (geographical information system) data on the distribution of communal daily long-term care facilities for dementia patients (group homes) and the elderly population in Niigata City, while also taking into consideration future demographics and service lifespan of the facilities. More specifically, the author used data on current and projected future population of the elderly aged 75 and over at the small-area level ("Machi," "Cho," and "Aza"), and compared the current and future needs for group homes by service area and the current supply situation of the said facilities. The analysis clarified that a strong sense of insufficiency of these facilities is already being felt in urban areas, including DIDs (densely inhabited districts), while suburban farming communities are in a rather over-supplied situation. It also showed that, looking to the future, the sense of insufficiency in urban areas is expected to rise increasingly, while the sense of excessive supply is expected to grow further in the suburban farming communities. As this result is based on the current and projected future population data on the elderly aged 75 and over, this finding is considered applicable not only to group homes but also to other residential long-term care facilities. As the need for these types of facilities is expected to grow more than ever against the backdrop of a further future increase in the elderly population, the author believes that the issue of improved efficiency of these facilities by optimizing their geographical locations (through restructuring or relocation) will become increasingly significant. At the same time, promotion of the Care Compact City and urban restructuring will also be required in light of financial constraints.

The tenth treatise, "Empirical Analysis of Yield Determinants in Japan's Municipal Bond Market: Does Credit Risk Premium Exist?" is authored by Takahiro Hattori and Hiroki Miyake. In this study, the authors examine the determinants of the yield spread between issuers in Japan's municipal bond market using panel data and focus on identifying whether credit risk premium exists. The results of the panel data analysis reveal new evidence on the municipal bond market for FY2002-2013. In the first half of the 2000s, the fundamental fiscal statistics, that is, the credit risk indicators, had no impact on the yield spreads, suggesting the absence of credit risk premium. Second, Yūbari City's insolvency in 2006 led to a structural break and since then, investors have begun accounting for local governments' outstanding debt. Third, when important financial events occur, other credit risk indicators also significantly impact the yield spread, suggesting that during such events investors are more aware of credit risk presence. Finally, the findings of this study provide implications for, perhaps, financial institutions, market participants, and regulators.

We would like to express our sincere gratitude to the participants in this research project and many others for their support and efforts in compiling this special issue. We hope that the results of this study will be useful for future research on fiscal and social security reforms and the correction of intergenerational disparities.

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An Analysis of Fiscal Governance: Why Japan's Fiscal Consolidation Fails?

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Abstract

To date, Japan has failed in every attempt to consolidate its public finances, leaving the balance of government debt moving in an upward direction in terms of GDP. Among several reasons, weak budgetary institutions and insufficient fiscal transparency are the most possible candidates for explaining why Japan fails. This can be also applied to other countries, because some countries are successful in maintaining fiscal discipline while others are not, and thus such differences can be explained by budgetary institutions. Budgetary institutions include many things, but those which could strengthen fiscal governance matter; in particular, fiscal rules, a medium-term fiscal framework, and independent fiscal institutions. Thus, the objective of this paper is to analyze Japan's fiscal governance by comparison with other OECD countries. This type of assessment cannot exclude arbitrariness, but the analysis provides the evidence that, among advanced countries, fiscal governance is at a low level in Japan. The problem with Japan's budgetary institutions, in particular, is the lack of a mechanism for the oversight and observance of rules as well as the absence of post hoc evaluation and verification. Reforms of budgetary institutions are urgent to strengthen fiscal governance, but policymakers are always reluctant to implement such reforms. In Japan, efforts have been made for reforms intended to strengthen its political and administrative governance, such as the overhaul of the electoral system and the restructuring of ministries and agencies since the collapse of the bubble economy. It is now possible for a prime minister to exercise political power much more than in the past, but this power is not utilized for strengthening fiscal governance. Ultimately, this is one of Japans greatest political problems.

1. Introduction

Japan's economic and fiscal landscapes have changed radically since the bubble economy burst early in the 1990s. Moreover, the government's already swollen debt has further expanded as it bumped up fiscal spending to battle an economic slump caused by the coronavirus disease (COVID-19) that began to hit Japan in early 2020. These developments are more or less common to major industrial countries. Yet Japan has a singularity among developed countries, particularly in connection with its fiscal soundness. To date, Japan has failed in every attempt to consolidate its public finances, leaving the balance of government debt moving in an upward direction in terms of GDP.

Why has Japan failed to restore balance in public finance? Firstly, the author thinks there are problems in budgetary institutions. Fiscal consolidation has thus far hit a snag halfway because Japan cannot undertake fiscal management in a manner that responds to economic cycles and shocks.

Also problematic are repeated makeshift accounting manipulations that leave the national budget low in transparency. Secondly, the country's macroeconomic environment lacks incentives that encourage fiscal consolidation. International organizations such as the International Monetary Fund (IMF) have issued warnings over Japan's fiscal conditions time and again (including one by the IMF in 2014). Under the current circumstances, however, Japan has not faced a trade-off between economic stability through fiscal stimulus (reflationary measures) and sustainability of continued borrowing[1].

Needless to say, fiscal rehabilitation is not the final goal. The immediate question faced by Japan is how to overcome the issue of rapid birthrate decline and fast population aging. The question concerns the contents of public finances. According to Ministry of Finance (2020), expenditure in the initial General Account budget for FY2020 represents an increase of 36.5 trillion yen (including 24.2 trillion yen in social security expenses and 9.1 trillion yen in national debt-servicing costs) compared with FY1990. The increased spending is covered by 26.9 trillion yen in government bond issues, 5.5 trillion yen in tax revenue, and 4.0 trillion yen in other revenue. Almost all of the increment in the social security budget is financed by borrowing. Is debt-based social security sustainable? Furthermore, Japan's social security budget is over-allocated to pension and healthcare programs. Both programs are based on insurance, but enormous amounts of money are channeled into them from the General Account budget, ending up in a scheme assisting high-income earners, since they are also covered by the insurance programs. On the other hand, the budget for human resource investment, such as education and occupational training, is insufficient. It will be difficult to tide over the issue of fewer children and a graying population if such a distribution of resources is left unattended. In order to resolve the problem of fiscal contents, the budgetary system that creates them and allocates resources is critically important.

It is "fiscal governance," the theme of this paper, which the author thinks is important to overcome this and other problems. In a narrow sense, it is to maintain fiscal discipline, but it is also important that fiscal spending constitutes a means of improving national welfare. At the time of the European debt crisis involving Greece and other countries, heavily indebted nations were required to take stringent measures for fiscal consolidation. But these policies brought about adverse side effects, deterring economic growth and generating socioeconomic confusion. "Fiscal reconstruction considering economic growth as well" was what was necessary. Required today are fiscal policy management that can address various shocks, and greater efficiency in the execution of the details of fiscal programs such as the social security system.

Problems associated with budgetary institutions are not limited to Japan. Foreign countries also face them. Some countries are successful in retaining fiscal discipline while others are not. What makes difference between them? Reforms of budgetary institutions have made progress over the past 30 years. The author will also discuss this on the basis of the latest developments. The objective of this paper is to analyze Japan's public finances in a quantitative manner from the perspective of fiscal governance. The next section overviews the track record of Japan's fiscal management and the reform of budgetary institutions conducted thus far. Section 3 provides the framework of analysis, followed by Section 4, which looks into fiscal governance based on this framework. Finally, Section 5 concludes the analysis and discussions.

2. Developments in Japan's fiscal management

[1] Konzelmann (2019) says "In 2017, for example, Japan's debt-to-GDP ratio was the highest in the world, at around 240 percent. But Japan was in no danger of default because the debt was mostly held by its own citizens; and since Japan has control over its currency, it can both issue debt in that currency and print more to pay it off"(p.49).

(1) From the collapse of the bubble economy to the DPJ government

Japan achieved a long-cherished halt to the flotation of deficit-financing bonds in the settlement of accounts for FY1991 owing to an increase in tax revenue generated by the bubble economy. However, the country's fiscal conditions have since gone from bad to worse[2]. It was the administration of Prime Minister Ryutaro Hashimoto that strove to improve the public finances that were in bad shape. In this connection, FY1997 was positioned as "the first year of fiscal structural reform." In the first place, the Hashimoto administration took a cabinet decision in December 1996 on the targets for restoring fiscal soundness, including one calling for the fiscal deficit of the central and local governments to be held down to not more than 3% in proportion to GDP by FY2005, as well as FY1997 budget compilation guidelines. Secondly, the consumption tax was raised from 3% to 5%, effective April 1997. Thirdly, a fiscal structural reform conference comprising leaders of the government and ruling party was established in January 1997. Based on discussions at the conference, the Fiscal Structural Reform Act[3] was voted into law in November. The law called for the fiscal deficit of the central and local governments to be curtailed to not more than 3% of GDP by FY2003. Among other targets listed by the law was the termination of dependence on deficit-financing bonds.

Efforts for fiscal consolidation were thus kicked off, but the economy entered a recessionary phase in May 1999. Since the autumn of that year, the financial system became unstable amid a spate of failures of financial institutions coupled with the impact of the Asian currency crisis. These developments prompted the government to compile a supplementary budget and a stimulus package to bolster economic activity. At the same time, the government revised the Fiscal Structural Reform Act, putting off the fiscal consolidation target to FY2005.

The law was an ambitious attempt, incorporating specific numerical targets based on experiences in foreign countries, among other things, but became ineffective in only a little more than a year. However, this was not an unfortunate outcome affected by economic downturn but because the law itself had major problems such as no consideration for economic cycles.

It was the administration of Prime Minister Junichiro Koizumi, inaugurated in April 2001, that launched fresh efforts to restore worsened fiscal soundness. The Koizumi administration undertook the privatization of postal services and other reforms on the strength of the Council on Economic and Fiscal Policy[4], newly established as part of the overhaul of central government administration. The Koizumi Cabinet also mapped out the "Basic Policies 2002" stipulating fundamental policies on economic and fiscal management, setting targets for bringing the primary balance of the central and local governments into the surplus in the early 2010s in a renewed attempt at spending cuts. The total expenditure of the General Account (on an account settlement basis) in FY2006 decreased 2.7% from FY2002[5], representing a rare spending drop in fiscal management to date. The budget deficit in the general government sector shrank to 2.8% of GDP in 2007.

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[2] The departure from deficit-financing bonds was not due to "fiscal consolidation without tax hikes" advocated by the government's second ad hoc council for the promotion of administrative reform, or the so-called *Doko* task force (headed by business leader *Toshio Doko*), set up in 1981. Fiscal spending swelled in the bubble economy period as well.

[3] Officially, the law is known as the "Act on Special Measures concerning Promotion of Fiscal Structural Reform."

[4] The Council on Economic and Fiscal Policy is a research and deliberation body based on the Act for Establishment of the Cabinet Office, comprising the prime minister (chairman) and ten members. The members are the Chief Cabinet Secretary and the Minister of State for Special Missions (the Minister of State for Economic and Fiscal Policy) as well as the Minister of Finance; the Minister of Economy, Trade and Industry; Governor of the Bank of Japan, and four private-sector members who are academics and corporate executives.

[5] Some areas of expenditure showed increases in FY2006, including social security-related expenses (up 4.7%), debt-servicing costs (up 15.6%), and general allocation funds to local governments (up 2.0%), but other areas saw decreases, including education and science expenses (down 20.8%), defense spending (down 2.1%), and public works expenditure (down 15.9%).

It was the "Integrated Expenditure and Revenue Reform" that emerged as a program putting the final touches on the Koizumi administration's structural reform policy in order to clear the path of fiscal structural reforms pursued amid economic recovery. In his "Basic Policies 2006," Koizumi included the target of bringing the primary balance of the central and local governments into the surplus in FY2011 and specified the amount of an expenditure cut in each area, such as social security, to achieve that target. The integrated reform committed Liberal Democratic Party (LDP) lawmakers, who had thus far tended to seek increased expenditure and lower taxation, to fiscal consolidation under Prime Minister Koizumi's strong leadership. But the proposed fiscal consolidation soon ended in failure. In the face of the 2007–2008 global financial crisis, the government issued extra national bonds for economic measures, doubling the amount of their flotations from 25.4 trillion yen in FY2007 to 52.0 trillion yen in FY2009 (on an account settlement basis). As for the target of restoring fiscal soundness in the integrated reform drive, the government of Prime Minister *Taro Aso* postponed by ten years the target of bringing the primary balance into the surplus in "Basic Policies 2009."

It is the administration of the Democratic Party of Japan (DPJ), which assumed the reins of government in September 2009, that took over the legacies of an economic slump triggered by the financial crisis (Lehman shock) and subsequent expansion of the budget deficit. What the DPJ government championed was "politician-led policymaking." It sought to implement this in budget compilation as well as in fiscal management, using the newly established National Strategic Bureau as a core. This, however, was a continuation of trial and error, leaving both bad aspects as well as good aspects intact[6].

The budget deficit in the general government sector stood at 9.8% of GDP in 2009, only slightly falling to 9.1% in 2010 and 2011, while the primary balance, after adjustment for economic cycles, worsened from -7.0% in 2009 to -7.9% in 2010, and -7.5% in 2011 based on OECD statistics. The DPJ is not to blame for reduced tax revenue stemming from economic stagnation and the shocking impact of the Great East Japan Earthquake. After all, expenditure swelled as the party sought to meet promises in its election manifesto, such as the payment of child allowances[7].

On the other hand, the DPJ administration performed better than the second cabinet of Prime Minister Shinzo Abe in terms of restoring fiscal discipline. In the first place, it reformed the budgetary institutions, introducing a medium-term fiscal framework and fiscal management strategy (on which a cabinet decision was made in June 2010)[8]. The strategy called for the deficit in the primary balance of the central and local governments to be halved from the FY2010 level by FY2015 and to be reduced to zero by FY2020. It also proposed the formulation of a medium-term fiscal framework covering three years from FY2011. Another favorable factor is the imposition of a special tax levy (income, residential, and corporate taxation) for reconstruction from the Great East Japan Earthquake. The author thinks the DPJ deserves appreciation for the legislation securing financial resources for post-disaster reconstruction realized after revision talks between the ruling and

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[6] As for problems in economic and fiscal policies of the DPJ administration, refer to Tanaka (2013).

[7] The DPJ administration set up a manifesto review committee in 2011 to analyze the reasons for failing to secure sufficient revenue sources and realize policy measures. As such reasons, it cited the following, among others: (1) a revenue decrease (9.2 trillion yen) caused by a sharp economic downturn following the Lehman shock, (2) the National Diet divided, with the upper house controlled by the opposition camp, and (3) the need to change policy priorities due to the devastating earthquake. But (1) is not justifiable at all because the DJP had asserted in its election manifesto that it would realize child allowances and other policy measures by replacing budgetary allocations for other programs. For a detailed analysis, refer to Tanaka (2013).

[8] In order to discuss the budgetary institution reform, the DPJ set up a panel in September 2009 to discuss how to compile the budget in a better manner, and another in January 2010 to look into medium-term fiscal management. The author participated in both panels.

opposition sides. Thirdly, worthy of attention are the integrated reform of social security and taxation, and its main pillar, the consumption tax increase. The DPJ faced rough going in winning Diet approval of a package of bills related to the integrated reform, encountering stiff objection from within the party and the departure of some member lawmakers led by maverick kingmaker Ichiro Ozawa. What was unprecedented, however, was that the ruling and opposition camps came to terms on a tax increase. However, the DPJ had to pay a high price for the successful legislation, losing a general election in December 2012 held on its promise to finalize the law. It cost the party dearly indeed.

(2) Second Abe Cabinet & thereafter

In contrast to the DPJ government management failure, it was the second Abe administration that succeeded thereafter. Testimony to this is the number of days in office as prime minister (both successive and cumulative totals), which was a historical record high. Political stability is worthy of commendation, but more important are the prime minister's government performances in economic, fiscal, and other terms.

Characterizing the Abe administration was emphasis on economic issues such as a breakaway from deflation. The average nominal economic growth (during Abe's seven years in power from 2012 to 2019) was 1.62%, higher than the DPJ administration's 0.37% (in the three years from 2009 to 2012), but the real growth rate of 1.03% was lower than the DPJ government's 1.84%[9]. This was the outcome of the so-called Abenomics, although simple comparison is impossible due to different economic and other conditions at the time of each administration's inauguration. Also, the Abe administration was unable to achieve its goal of emerging out of deflation within two years[10].

As for fiscal management, the Abe administration took over the DPJ government's target of fiscal consolidation. Namely, in its "Medium-term Fiscal Plan" authorized by the cabinet in August 2013, the Abe administration pledged to "halve the deficit in the primary deficit of the central and local governments in proportion to GDP by FY2015 from the FY2010 level and bring the balance into the surplus by FY2020." However, the target of fiscal consolidation was not attained, as in the past. It was postponed in the "Basic Policy on Economic and Fiscal Management and Reform 2018" (approved by a cabinet decision in June 2018), in which the government said it would seek to bring the primary balance into the surplus in FY2025. It will be safe to say that the Abenomics policy of restoring fiscal soundness through economic growth has ended in failure.

In reviewing the target, the Cabinet Office conducted the "interim review on Integrated Economic and Fiscal Reforms" (issued by the Committee for Promoting the Integrated Economic and Fiscal Reforms in March 2018) and explained the reasons for failing to achieve the target. The ratio of the primary balance deficit to GDP in FY2018 was around 1.7% on a trial calculation basis in July 2015, which worsened to around 2.9% in a January 2018 estimate. As reasons for the deterioration, the Cabinet Office assessment cited the following four factors: (1) efforts were exerted to make spending more efficient in line with expenditure guidelines (improving the primary balance 0.7% or 3.9 trillion yen), (2) there were adverse effects of a supplementary budget (a deterioration of 0.4% or 2.5 trillion yen), (3) tax revenue decreased due to slower economic growth (a deterioration of 0.8% or 4.3 trillion yen), and (4) the planned consumption tax hike was postponed (a deterioration of 0.7% or 4.1 trillion yen). After all, the presumed growth rate (3% nominally and

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[9] The figures are based on data by National Accounts of Japan in April–June 2020.

[10] In a joint statement issued in January 2013 by the government (more precisely, the Cabinet Office and the Ministry of Finance) and the Bank of Japan, the bank incorporated the target of price stability in the form of an annual consumer price increase of 2%, among other things.

2% in real terms) was too optimistic[11]. The interim assessment explained that expenditure-cutting efforts were made, but this cannot be said to be a precise description. Estimated expenditure was excessive from the beginning because it was based on higher consumer prices right from the start (in reality, prices did not rise, ending up in less expenditure than estimated), and efforts for spending cuts were made only in a small number of budget programs, resulting in limited progress in such endeavors.

Next, the author will analyze the General Account. On an account settlement basis, expenditure almost leveled off from FY2012 (97.1 trillion yen) to FY2018 (99.0 trillion yen) while the amount of new government bonds issued fell from 47.5 trillion yen to 34.4 trillion yen in the same period as tax revenue increased from 43.9 trillion yen to 60.4 trillion yen. Japan's public finances appear to have improved, but attention is necessary. This is because expenditure snowballed in the wake of the global financial crisis and the Great East Japan Earthquake (reaching 101 trillion yen in FY2009 and 107 trillion yen in FY2011), almost maintaining the same swollen level in the following years[12].

A comparison of the initial budget for FY2019 with FY2012 as a base (Table 1) shows a 20.1 trillion yen rise in tax revenue. With 11.6 trillion yen earmarked for reduction in government bond flotations, the total expenditure increased by 11.1 trillion yen. Although tax revenue expanded, each fiscal year's tax system revision resulted in lower taxation in most cases. It is therefore considered that almost no tax increase efforts were made except for consumption tax hikes. Budget items showing expenditure increases were social security expenses, up 7.7 trillion yen, public works spending, up 2.3 trillion yen, and debt-servicing costs, up 1.6 trillion yen, with expenses for other items remaining the same or being decreased. A look at funding in each fiscal year's initial budget shows that tax revenue gains used to reduce debt-servicing costs were limited, except in FY2015 and FY2016, and that cases of allocating such higher revenue to increased expenditure are conspicuous.

Table 1: Change in the General Account (FY2012-FY2019)

	Change (trillion yen)
Total revenue	11.1
Tax revenue	20.1
Borrowings*	-10.9
Total spending	11.1
Social welfare	7.7
Public works	2.3
Debt service	1.6
Defense	0.5
Education and science	0.2

Source: Author's estimates based on data from MOF Japan.

Note: "Borrowing" includes transfers from special accounts, since it signifies a reduction in reserves.

[11] In the "Economic and Fiscal Projections for Medium to Long Term Analysis" (July 2018), announced after the interim evaluation, nominal GDP growth rates of 2.8%–3.5% (1.5%–2.1% in real terms) were forecast for FY2019-2027 in the case of growth achieved (2.8%–1.6% nominally and 1.5%–1.1% in real terms in the baseline case), representing the usual optimistic forecasts. Setting optimistic preconditions is the globally common reason for failing in fiscal consolidation (Tanaka 2011). Japan is a country that never learns lessons.

[12] A special account for reconstruction from the Great East Japan Earthquake was set up in the national budget in FY2012, and the allocations for expenses related to the disaster that were listed in the General Account in FY2011 have been excluded from the account since FY2012.

Even though bond issues were reduced, often special account reserves were transferred to the General Account and other makeshift funding measures taken, in effect covering portions of expenditure with deficit-financing bonds (as in FY2013, FY2017, and FY2019). The increased portion of tax revenue was used to make childcare services and education free, render national land resilient, and earmarked for supplementary budgetary allocations.

3. Definition and measurement of fiscal governance

In the first place, preceding studies regarding the definition of "fiscal governance" are examined here. Hallerberg et al. (2009) defined fiscal governance as "the package of rules, norms, and institutions that structure the way governments make a budget" (p.199), pointing out that its configuration depends on the political structure existing in the country concerned. The European Commission defines it as "the institutional side of fiscal policy as it comprises the set of rules and procedures that determine how public budgets are prepared, executed and monitored" (European Commission 2008:128). These definitions represent almost the same meaning as a budgetary institution. Based on the fact that the budgetary institution influences fiscal performance, this paper will focus on "a package" that improves fiscal performance. It should be added in this connection that fiscal performance is a concept that includes not only simple restrictions on deficit or debt but also strategic resource distribution, efficient execution, and the like[13].

Next, the author will consider what sort of package is important. According to Hallerberg et al. (2009), indices representing fiscal governance have been developed. Specifically, the indices include fiscal targets, the structure of negotiations, the structure of the parliamentary process, budget execution, information on the budget draft, and the relationship between national and subnational governments. As four aspects of fiscal governance, Giosi et al. (2014) cite numerical fiscal rules, independent fiscal institutions, medium-term budgetary frameworks, budgeting procedures (prudent economic assumptions, transparency, centralization of the budget process, and focus on results). As particularly important elements of fiscal governance, the European Commission cites numerical fiscal rules, independent fiscal institutions, and medium-term fiscal frameworks. Tanaka (2011) cites four points, namely, fiscal rules, a medium-term fiscal framework, transparency, and a decision-making system.

In order to truly strengthen fiscal governance, institutions, procedures and other contents, as well as their quality, are important. This is because numerical rules are not always maintained even if they are stipulated in a constitution or law, as typically shown in the failure of fiscal deficit criteria under the Maastricht Treaty. The author discusses details of important aspects constituting fiscal governance. From the perspective of beefing up fiscal governance, the author will look into the three aspects of numerical rules, a medium-term fiscal framework, and an independent fiscal institution, as exemplified by the European Commission, sort out their contents and quality, and, later on, consider decision-making and transparency.

The first point of the package is fiscal rules. Kopits and Symansky (1998) define fiscal rules as "a macroeconomic context, as a permanent constraint on fiscal policy, typically defined in terms of an indicator of overall fiscal performance" (p.2). The European Commission suggests "a well-defined fiscal rule, namely (1) a permanent character, (2) specification in terms of an overall fiscal performance indicator; and (3) the provision of a numerical ceiling or target" (EC website). In a broader sense, fiscal rules impose restrictions on budget compilation and fiscal policy

[13] As the objective of fiscal governance, the European Commission cites the following (on its website): 1. attaining sound budgetary positions in particular by containing the deficit bias, i.e. tackling the tendency to conduct unsustainable fiscal policies giving rise to high deficits and increasing debt ratios, 2. reducing the cyclicality of fiscal policymaking and 3. improving the efficiency of public spending.

planning/implementation (Tanaka 2011).

What matters is the quality of rules. Tanaka (2011) cites the following as standards for evaluating fiscal rules: (1) clearly defined, (2) permanent, (3) comprehensive coverage, (4) accurately measured, (5) reasonable and proper, (6) procyclical consideration, (7) explicitly stipulated exceptions, (8) status of their observance projected and verified, (9) provisions in place that would address their violation, and (10) status of their actual observance.

Auerbach (2012) cites ten items as preconditions for fiscal rules to function. In particular, the following are important: (1) an understanding that budget rules can have an impact on fiscal policies and the economy, (2) sensible design of fiscal rules requires a clear statement of underlying objectives, (3) an understanding that cyclical flexibility is important because countercyclical stabilization policy can be effective, (4) budget rules should be forward looking, but should discount the future. As details of the fiscal rule strength index, the EU cites the following: Statutory/legal base of the rule, room for setting or revising objectives, nature of the body in charge of rule monitoring and the correction mechanism, correction mechanisms in case of deviation from the rule, resilience to shocks or events outside the control of the government[14]. Similarly, the IMF has come up with its own fiscal rule index comprising such items as legal basis, coverage (central government, general government), enforcement, supporting procedures and institutions (multi-year expenditure ceilings, fiscal responsibility law, independent body), and flexibility (clearly-defined escape clauses, fiscal balance defined in cyclically adjusted terms) (Schaechter et al., 2012).

Fiscal rules are generally of four types: balance, expenditure, revenue, and debt. Among them, the expenditure rule is singled out as the most important[15]. Cordes et al. (2017) state as follows: (1) the compliance rate for expenditure rules is greater than that for budget balance rules, particularly if the expenditure rule is directly under the control of the government and the rule is enshrined in law or in a coalition agreement, (2) the presence of expenditure rules is associated with stronger fiscal performance, that is, a higher primary balance—after taking into account conventional determinants—and countercyclical policies, (3) expenditure rules are associated with lower levels of public investment in emerging market economies, where weaker PFM [Public Financial Management] systems may be less effective at preventing policymakers from deferring high-quality discretionary spending for the sake of complying with the rule (p.317).

The second point of the package is a medium-term fiscal framework. For the "medium-term fiscal framework," wording is expressed in various ways, including a multi-year budget, medium-term fiscal plan, and medium-term estimate[16]. It is a framework for bypassing the legally mandatory single-year budgetary system and allowing budget policy to be planned, discussed and decided over a number of years, and thus shows medium-term estimates or projections of major fiscal policy indicators such as expenditure, revenue, balance and outstanding debt (Tanaka 2011). Using the term "medium-term budget framework (MTBF)," the European Commission says that "a single year perspective provides a poor basis for sound fiscal planning. MTBFs usually cover the preparation, execution, and monitoring of multiannual budget plans and contain both expenditure and revenue projections as well as the resulting budget balances"[17].

The IMF (2007:41) refers to the following as requirements for a good medium-term fiscal framework: (1) fiscal policy objectives and quantitative fiscal targets need to be articulated and

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[14] See European Commission webpage titled "Numerical fiscal rules in EU member countries".

[15] Anderson and Minarik (2006) analyze the benefits and defects of the deficit and expenditure rules.

[16] In English, the term is described as a medium-term fiscal framework, medium-term expenditure framework, etc. The IMF (2007) classifies the medium-term fiscal framework into general government, budget, expenditure, and the like, depending on coverage.

[17] See European Commission webpage titled "Medium-term budgetary frameworks".

defended at the highest level of government; (2) robust revenue forecasts are critical, and the target levels of expenditure must be rigorously related to the macroeconomic prospects over the medium term; (3) budget and forward estimates are better set in nominal terms to ensure that program managers respond to price changes; (4) the framework should be based on clearly defined and fully costed policy proposals; and (5) the medium-term budget framework should be accompanied by strengthened measures to review individual expenditure policies and their institutional delivery mechanisms.

The index constructed by the European Commission captures the quality of the national medium-term budgetary framework through five criteria: (1) coverage of the targets/ceilings included in the national medium-term fiscal plans; (2) connectedness between the targets/ceilings included in the national medium-term fiscal plans and the annual budgets; (3) involvement of national parliament in the preparation of the national medium-term fiscal plans; (4) involvement of independent fiscal institutions in the preparation of the national medium-term fiscal plans; and (5) level of detail included in the national medium-term fiscal plans[18]. Meanwhile, Tanaka (2011) cites the following: (1) legal basis, (2) coverage, (3) restrictiveness, (4) evaluation of preconditions for growth rates, (5) verification of actual results, (6) independent assessment, (7) parliamentary involvement, and (8) coordination with local government finances.

The third point is independent fiscal institutions (IFIs). These are also called independent parliamentary budget offices or fiscal councils[19]. The OECD (2015) defines IFIs as "independent parliamentary budget offices or fiscal councils, independent fiscal institutions (IFIs) [that] are publicly funded, independent bodies with a mandate to provide non-partisan oversight and analysis of, and in some cases advice on, fiscal policy and performance" (p.4). Hagemann (2011) defines a fiscal council as "a publicly-funded entity staffed by non-elected professionals mandated to provide nonpartisan oversight of fiscal performance and/or advice and guidance – from either a positive or normative perspective – on key aspects of fiscal policy" (p.76). The European Commission defines IFIs as "non-partisan public bodies, other than the central bank, government or parliament aimed at promoting sustainable public finances through various functions, including monitoring compliance with fiscal rules, production or endorsement of macroeconomic forecasts for the budget, and/or advising the government on fiscal policy matters"[20].

Even if established, organizations do not always function. Therefore, it becomes important to identify their duties and set up a mechanism for ensuring that they are carried out. Jankovics and Sherwood (2017) say, based on their analysis of the performance of IFIs in Europe, that two points are crucial: official macroeconomic forecasts used for fiscal planning, and their assessment of national compliance with numerical fiscal rules. To improve the role of IFIs, they point out the need to ensure more appropriate safeguards of independence, improve the forecast endorsement process, and conduct more timely and comprehensive monitoring of numerical rules. Beetsma and Debrun (2017), and Beetsma et al. (2018) similarly emphasize the two functions of IFIs.

As indicators that measure the functions of IFIs specifically, the European Commission lists the following six items: (1) monitoring compliance with fiscal rules; (2) macroeconomic forecasting; (3) budgetary forecasting and policy costing; (4) analysis of long-run sustainability of public finances; (5) promotion of fiscal transparency; and (6) normative recommendations on fiscal policy[21].

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[18] See footnote No.17.

[19] Debrun et al. (2009) classify "fiscal agencies" into an "Independent Fiscal Authority" and a "Fiscal Council," sorting out the functions of each. Definitions of independent fiscal institutions are described in detail by Ueno (2015).

[20] See European Commission webpage titled "Independent fiscal institutions". Based on the "Council Directive 2011/85," EU member countries were required to set up IFIs as organizations monitoring the observance of fiscal rules.

[21] This is the Scope Index of Fiscal Institutions (SIFI). See European Commission webpage titled "Independent fiscal institutions".

The IMF has developed a signal enhancement capacity index, which is assessed based on the following issues:
(1) Independence and governance: Legal independence, safeguards on budget, composition, appointment, and term of high-level staff, size of the council, staff commensurate to tasks
(2) Remit of fiscal councils: Forecasts provision/assessment, costing of measures, long-term sustainability analysis, positive analysis, normative analysis or recommendations
(3) Tasks and Channels of Influence: Public reports, high media impact, binding forecasts, formal consultation or hearings, stalling the budget process, compliance or explanation[22].

The fourth point is decision-making regarding fiscal policy and budget compilation. Referring to negotiating forms of the cabinets of European countries, Hallerberg et al. (2009) analyze negotiation in cabinets: General constraint, agenda setting, budget norms, structure of negotiation. Tanaka (2011) compares the degree of centralization of budget-compiling authority among 11 OECD member countries in terms of the finance minister's positioning, the form of budget negotiations, the method of dispute settlement, parliamentary modification, decisions on the budget outline in parliament, etc.

The fifth point is the transparency of a budget and fiscal management. As standards for budgetary transparency, Alt and Lassen (2006) cite the following 11 points: (1)non-financial performance data included in the budget documentation presented to the legislature; (2) special reports on the fiscal outlook prior to an election; (3)a report on the long term (10–40 years) outlook for public finances; (4) report on contingent liabilities; (5) more than one supplementary budget to the legislature in each fiscal year; (6) auditing of in-year financial reports; (7) subjecting economic assumptions to independent review; (8) accrual accounting in its financial statements; (9) a legal requirement that the budget documentation contains a projection of expenditure beyond the next fiscal year; (10) a legal requirement that the budget include an ex post comparison between projected expenditure in future years and the actual expenditures in those years; (11) the impact that variations in the key economic assumptions would have on the budget outturn. Hameed (2005) has developed a set of indices of fiscal transparency using information obtained from the IMF's Fiscal Transparency Code[23]. The indices include independent assessment of forecasts, budget realism, projections guided by a medium-term quantitative framework, and new policy costs. Tanaka (2011) looks into 20 pieces of budgetary information, including fiscal rules, sensitivity analysis, tax expenditure, and financial statements, regarding Japan's budget to see if they are submitted by the government to the National Diet when compared with overseas examples. Focusing on the government's budget analysis ability, Kasperskaya and Xifr (2019) measure budgetary analytical capacity (BAC) based on three dimensions: Reliability of projections, openness to legislative scrutiny, and transparency.

As a system related to transparency, some experts point out the importance of a framework, such as a fiscal responsibility law, under which fiscal targets and rules are introduced, and verification of their observance is laid down. New Zealand introduced such legislation in 1994[24], with many countries later adopting a similar law. The law mandates a new government set up after an election to introduce a medium- to long-term fiscal strategy and fiscal rules/targets, among other things, based on the law's principles. Fiscal responsibility legislation is designed to provide a statutory framework for future governments to be accountable for discretionary changes in policies

[22] For details, see Debrun and Kinda (2014). Referring to the Netherlands' CPB, or Bureau for Economic Policy Analysis, Debrun et al. [2017:418] say, "Although it is difficult to identify a robust causal link between the activities of the CPB and improved fiscal performance in the Netherlands, the CPB's media visibility supports the idea that it actively contributes to the quality of the public debate and reduces information asymmetries between decision makers and the public."
[23] This refers to the IMF's "Code of Good Practices on Fiscal Transparency -- Declaration on Principles".
[24] Through a legal amendment in 2004, the law was absorbed into the Public Finance Act.

(Cangiano 1996:22).

Van Eden et al. (2013) define a fiscal responsibility law as "legal frameworks that embed in law an agreed-on set of policies, processes, or arrangements intended to improve fiscal outcomes, discipline, transparency, and accountability by requiring governments to commit to fiscal objectives and strategies that can be monitored" (p.80). The authors say there are three types, depending on what is given priority: The principle of transparency (e.g. New Zealand), rules regarding procedures, and rules regarding fiscal policy.

As reasons for the fiscal responsibility law having been successful in observing fiscal discipline in New Zealand through different governments despite the lack of legally binding power, Gill (2019) cites the following: (1) first, there is suprapartisan recognition of the importance of fiscal discipline, thus constituting a mechanism of ensuring political commitment; (2) secondly, the Treasury is an independent organization, undertaking various fiscal analyses and drawing up fiscal reports (beforehand/afterward, short- and long-term), thus boosting fiscal transparency.

4. Fiscal governance in Japan

Based on the analyses and discussions thus far, the author will sort out fundamental problems underlying fiscal management in Japan. As six important elements of "sound fiscal policy" advocated by the IMF, Heller (2003) singles out the following: (1) pursuing an appropriate short-term fiscal policy stance; (2) placing fiscal policy in a medium-term framework, and with an eye to the long-term; (3) an emphasis on fiscal sustainability; (4) having the capacity to ensure the successful implementation of a country's fiscal policy objectives; (5) the importance of the structural content of fiscal policies; (6) the importance of high quality, transparent budget process, good governance, and a well-managed expenditure and revenue administration. In light of these, we can classify themes subject to fiscal policy assessment into two groups: Fiscal policy and distribution of resources [(1), (2), (3) & (5)] and the budgetary institutions that plan and execute them [(4) & (6)]. Japan's problems associated with the former group include the following: Few attempts at fiscal reconstruction have succeeded; fiscal policy based on economic cycles is not established; the budget is lopsidedly focused on social security, particularly pension and healthcare, while investment in human resources is insufficient as to childrearing and education. But such issues will not be discussed further here. Among the latter group's specific problems are: a balanced budget rule under the public finance law is not functioning; the expenditure ceiling is applied only to part of the initial General Account budget, lacking in a mechanism to hold down expenditure in the medium term; with supplementary budgets used repeatedly, the budgetary system has become inefficient; accounting manipulations are conducted between general and special accounts; the transparency of budget and fiscal management is low; economic growth rates used for the budget for the new fiscal year and for the medium-term fiscal framework are optimistic; with the finance minister's power weak, decision-making is fragmented[25]; and there is almost no fiscal policy-assessing function in the government and the Diet.

In short, Japan's fiscal governance is extremely weak. To confirm this through international comparison, the author will take up fiscal governance in Japan and other advanced countries, comparing that of both sides in a quantitative manner based on preceding studies concerning measurement of fiscal governance, reviewed in the previous chapter. Subjects covered for analysis are fiscal rules, medium-term fiscal frameworks, independent fiscal institutions, and the budgetary institutions in general including the accounting system, decision-making, etc. as well as fiscal rules.

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[25] This is due to the Liberal Democratic Party's involvement in budget compilation; refer to Campbell (1977), Meyer and Naka (1998), and Wright (2002), among other papers.

As for fiscal rules, the author formulates an index of fiscal rules for each country, using the IMF database on fiscal rules (2015) and its EU version (2018). Regarding the IMF dataset, the author selects OECD countries and develops an overall fiscal rules index which consists of a fiscal rules score (number of domestic rules, monitoring, formal enforcement, coverage, legal basis, clearly-defined escape clauses, fiscal balances defined in cyclically adjusted terms) and a supporting procedures score (multi-year expenditure ceiling, fiscal responsibility law, independent fiscal body)[26]. The subsequent outcome is as shown by Figure 1. Japan is ranked 29th in the score for fiscal rules among 35 countries. As for the EU, the author calculates the total score of each country by evaluation based on such standards as statutory/legal base of the rule, room for setting or revising objectives, nature of the body in charge of rule monitoring and the correction mechanism, correction mechanisms in case of deviation from the rule, clearly defined escape clauses, and targets defined in cyclically-adjusted terms. Since Japan is not included in the EU database, the author assesses the country's items concerned. Not all countries have the three fiscal rules in place. Accordingly, the number of countries covered differs according to the rules. Japan is ranked last for this index (see Figure 2).

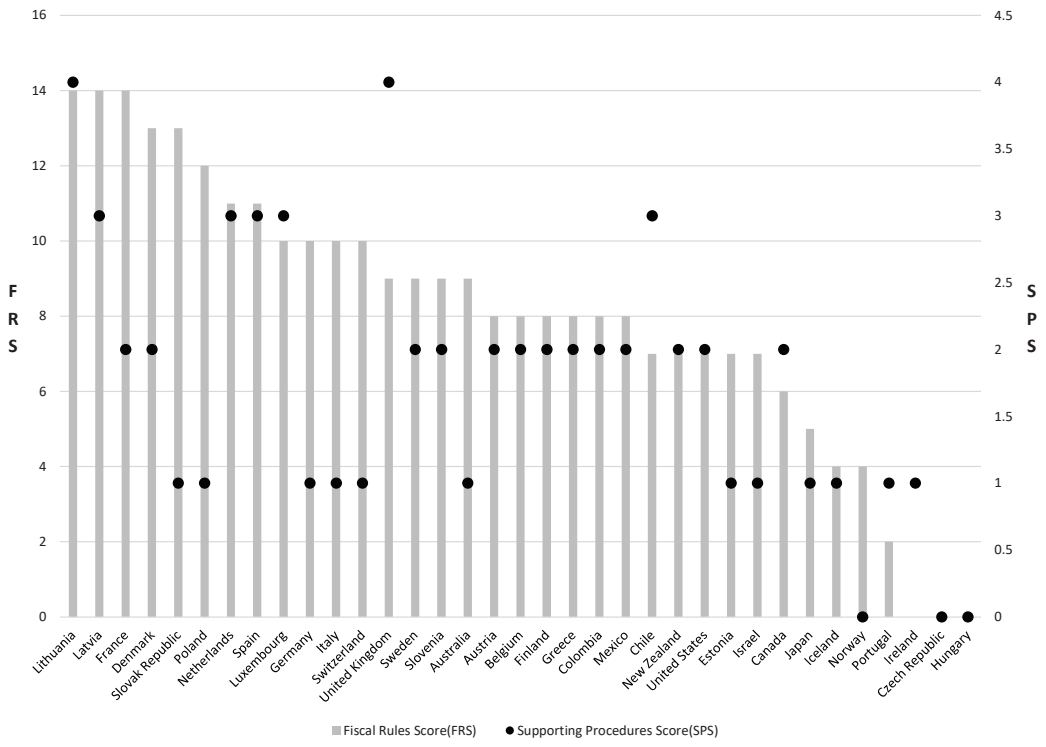


Figure 1: Fiscal Rules Score and Supporting Procedures Score

Source: Author's assessments based on IMF Fiscal Rules Database.

[26] Basically, a country scores one point when it corresponds to a given item and earns no points when it does not. That country's total points are turned into an index (as is the case with other indices). As for standards such as oversight (except for the rule-reinforcing system and stabilization mechanism), countries are assessed according to different types of fiscal rules, including expenditure and fiscal balance.

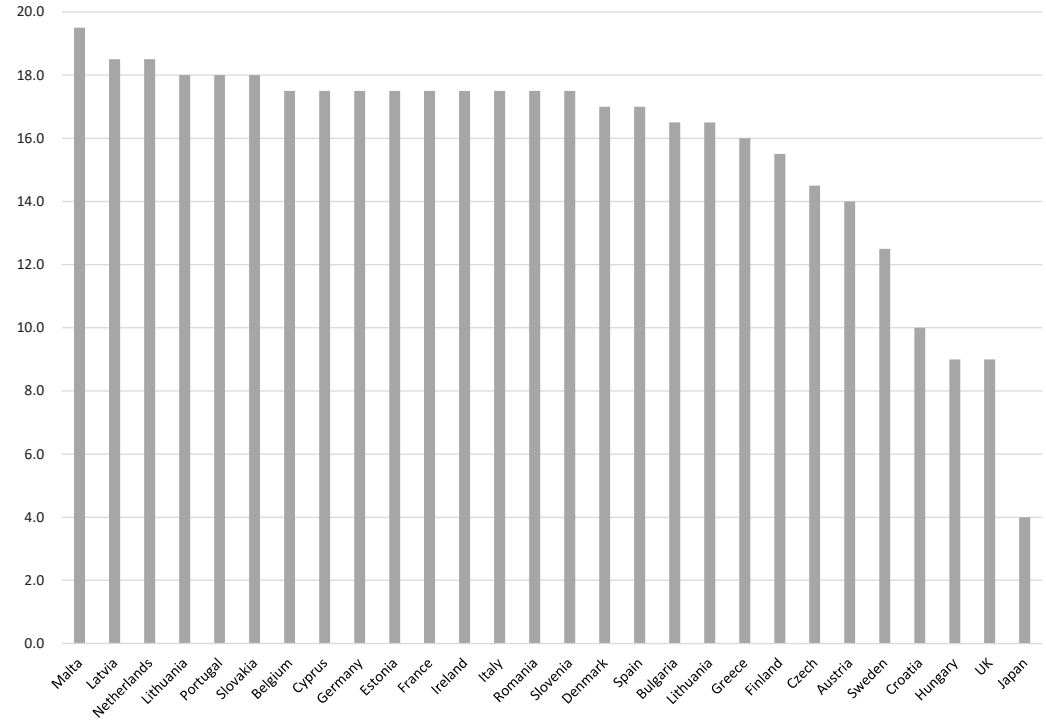


Figure 2: Fiscal Rules Index

Source: Author's asessments based on Fiscal Rules Database of Euroepan Commission.

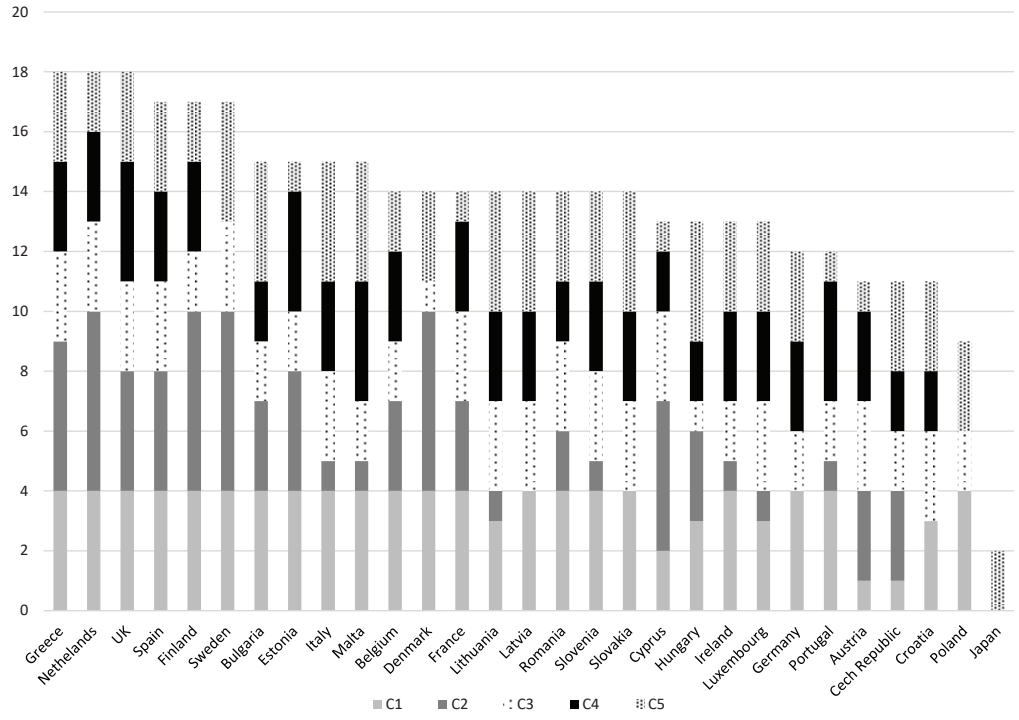
Regarding the medium-term fiscal framework, the EU database (2018) was used (the author's evaluation being used for Japan). A "medium-term fiscal framework score" was calculated on the basis of five standards: Coverage of the targets/ceilings included in the national medium-term fiscal plans (C1), connectedness between the targets/ceilings included in the national medium-term fiscal plans and the annual budgets (C2), involvement of national parliament or use of a coalition agreement in the preparation of the national medium-term fiscal plans (C3), involvement of independent fiscal institutions in the preparation of the national medium-term fiscal plans C4), and level of detail included in the national medium-term fiscal plans (C5). Of the 25 countries covered, Japan's rating was the lowest (Figure 3).

The IMF and EU databases are used for independent fiscal institutions. An independent fiscal institution in the true sense of a general definition does not exist in Japan, but the IMF database (2014) covers as such the Fiscal System Council in the case of Japan, which is under the Ministry of Finance. Each independent fiscal institution is assessed regarding independence, governance, functions, transparency, and information dissemination. Based on these standards, Figure 4 compares the "index of authority of an independent fiscal institution"[27]. As for the EU (2018), Figure

[27] Beetsma and Debrun (2017) made a similar analysis based on IMF data, ranking Japan in 29th place among 30 independent fiscal institutions. At the bottom is Chile, while the top five are the UK, Portugal, Slovenia (IMAD), the Netherlands, and Germany.

5 compares the "index of authority of an independent fiscal institution" based on the following six standards: monitoring compliance with fiscal rules (TK1); macroeconomic forecasting (TK2); budgetary forecasting and policy costing (TK3); analysis of long-run sustainability of public finances (TK4); promotion of fiscal transparency (TK5); normative recommendations on fiscal policy (TK6)[28]. Japan is ranked low in all standards.

The OECD database (2018) includes various budget-related data. The author selected ten areas from the data, standardized them and prepared rankings (see Table 2). The areas covered are budget-related reports; important budget reports; a fiscal framework, including fiscal rules; a medium-term fiscal framework; transparency and openness; participation, inclusiveness and data; comprehensive accounting; effective budget execution; fiscal risk; and audit and independent fiscal institutions. Japan's average rank in the ten areas is 29.1 among the 34 countries involved.



Figuer 3: Index of Medium-term Fiscal Framework

Source: Author's asessments based on MTBF Database of Euroepan Commission.

[28] In case a country has two or more institutions, one given the highest standing is selected.

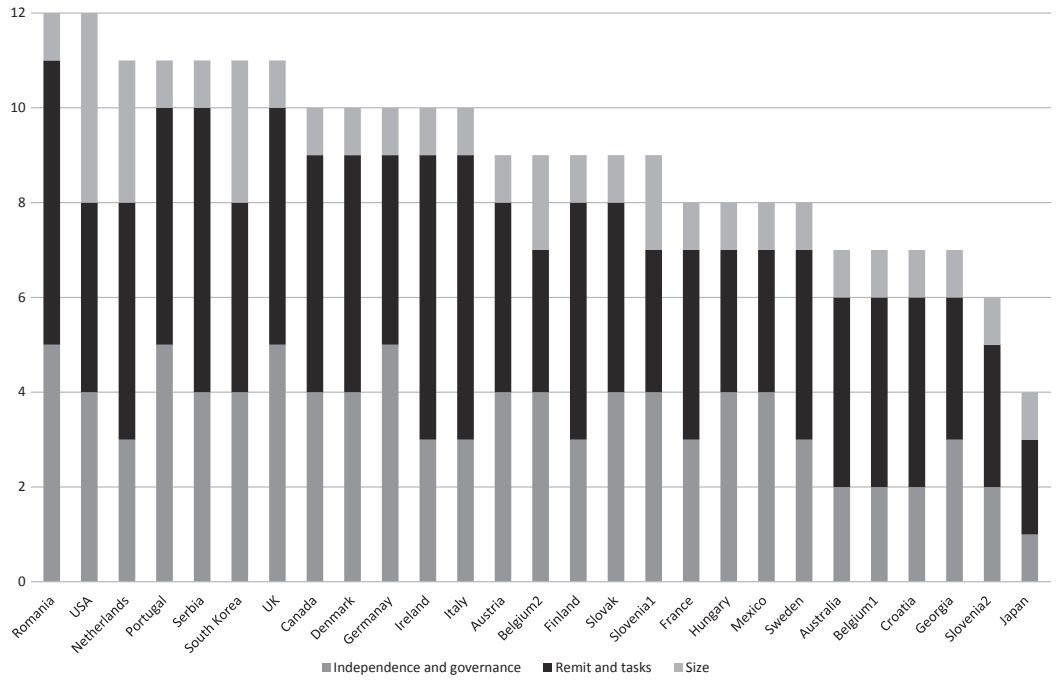
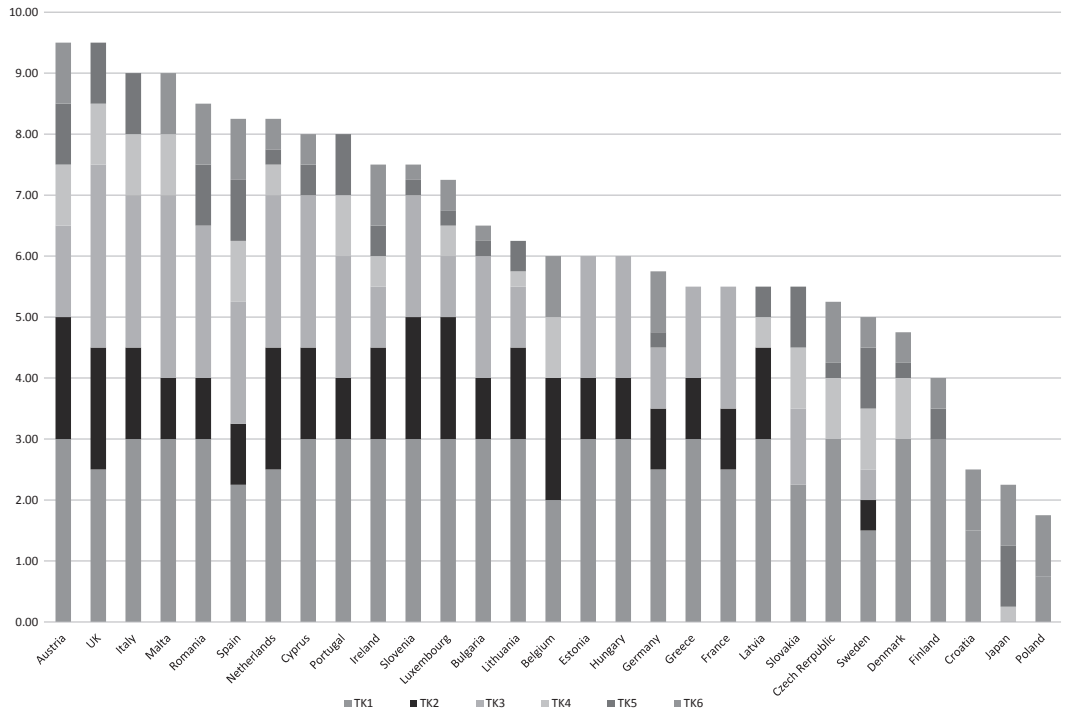


Figure 4: Index of Independent Fiscal Institutions

Source: Author's asessments based on Fiscal Council Database of IMF.



Figuer 5: Index of Independent Fiscal Institutions

Source: Author's asessments based on IFIs Database of Euroepan Commission.

Table 2: Comprehensive Asessment of Budgetary Institutions by Ranking

	Budget reports	Key budget reports	Fiscal framework	Medium-term fiscal framework	Transparency and openness	Participation, Inclusiveness and data	Comprehensive accounting	Effective budget execution	Fiscal risks	Audit and IFIs	Average ranking
Australia	22	11	34	27	22	1	2	1	3	30	15.3
Austria	25	23	24	19	9	21	13	1	28	1	16.4
Belgium	16	16	6	34	26	22	30	29	15	3	19.7
Canada	19	17	26	21	17	3	12	1	17	28	16.1
Chile	17	18	30	22	10	13	27	1	25	24	18.7
Czech Republic	7	7	18	5	16	16	23	16	11	17	13.6
Denmark	31	30	2	13	24	33	19	19	10	29	21.0
Estonia	33	32	17	24	27	31	15	26	30	3	23.8
Finland	1	1	14	3	8	27	7	23	4	16	10.4
France	14	22	8	1	25	7	24	15	34	12	16.2
Germany	23	18	20	15	21	25	31	27	18	11	20.9
Greece	11	23	4	26	32	24	20	1	16	8	16.5
Hungary	8	9	23	18	34	15	5	10	5	15	14.2
Iceland	34	34	25	4	7	9	8	27	21	32	20.1
Ireland	27	28	5	9	6	4	21	10	19	22	15.1
Israel	24	25	27	16	5	30	33	16	31	34	24.1
Italy	2	2	15	28	3	5	22	1	8	6	9.2
Japan	26	29	33	31	14	34	34	31	33	26	29.1
Korea	18	21	29	11	4	2	14	10	32	8	14.9
Latvia	10	10	13	7	19	20	16	19	9	19	14.2
Luxembourg	9	5	11	17	31	10	25	16	29	23	17.6
Mexico	5	7	7	32	1	23	4	21	13	3	11.6
Netherlands	13	11	3	2	13	14	28	33	6	2	12.5
New Zealand	21	14	32	14	30	12	3	10	20	31	18.7
Norway	30	33	31	33	12	19	26	23	23	20	25.0
Poland	20	15	21	25	27	29	32	10	26	24	22.9
Portugal	28	26	12	20	18	8	17	34	26	14	20.3
Slovak Republic	14	13	9	30	23	26	18	21	7	32	19.3
Slovenia	12	18	1	29	29	6	11	1	23	10	14.0
Spain	2	2	9	8	2	17	9	1	14	18	8.2
Sweden	6	6	16	12	11	11	10	23	2	7	10.4
Switzerland	29	27	19	23	15	28	29	29	22	27	24.8
Turkey	4	4	28	10	20	18	1	1	12	13	11.1
United Kingdom	32	31	22	6	33	32	6	32	1	21	21.6

Source: Author's assessments based on OECD International Budget Practices and Procedures Database

5. Conclusion

Fiscal governance, namely a package of budgetary institutions for improving fiscal performance were analyzed in this paper. This sort of assessment cannot exclude arbitrariness, but it is true that, among advanced countries, fiscal governance is at a low level in Japan. The problem with Japan's budgetary institutions, in particular, is the lack of a mechanism for the oversight and observance of rules as well as the absence of post hoc evaluation and verification (Tanaka 2011).

Even if problems lie in Japanese fiscal governance, it is, after all, a question of the political process over scarce resources. Hallerberg et al. (2009) state as follows: "An important insight is that the effectiveness of a given form of fiscal governance depends crucially upon the underlying political system. If parties disagree on basic policy issues about how much should be spent where or how much a given group in society should be taxed, they are unlikely to allow a finance minister to make decisions on the budget for all of them. This discussion suggests that strengthening the formal powers of a finance minister where there are great ideological difference among the policymakers who are needed to approve the budget will have little practical effect, while a similar strengthening of the finance minister should have a large effect where there is little ideological discord in government, so long as the party or parties are running together in the next election" (p. 5).

In Japan, efforts have been made for reforms intended to strengthen political and administrative governance, such as the overhaul of the electoral system and the restructuring of ministries and agencies since the collapse of the bubble economy. Put simply, these are reforms at the initiative of politicians or the cabinet in a departure from a consensus model of the Liberal Democratic Party's 1955 regime.[29] It will be safe to say that they have been established to a certain extent by way of the Junichiro Koizumi administration, the Democratic Party of Japan government, and the Shinzo Abe administration (his second Cabinet and thereafter). However, the policymaking process deteriorated drastically under the second Abe administration, with Abe retiring after becoming Japan's longest serving prime minister. This is because important government policies were shaped in advance by a limited number of officials at the Prime Minister's Office without scientific analysis or in the absence of agreement among the people concerned.[30] Tanaka (2019b) analyzes governance of the policymaking process from the perspective of contestability by comparing and looking into the analysis and verification functions of policies in developed countries, including Japan, which is remarkably weak in such functions. Especially, there are few independent organizations within the government, while the Diet does not have sufficient government-supervising functions.

Leeper (2017) argues the importance of social contracts by saying, "Modern societies are grounded in social contracts between the people and their government. To an extent that is underappreciated, fiscal policies are an essential aspect of social contracts. Social contracts in many countries are under threat. Our societies do face long-run fiscal stresses" (p.61). In the wake of the novel coronavirus pandemic, this stress is expanding globally, and it is particularly remarkable in Japan where birthrate decline and population aging are progressing rapidly. We know what is necessary to improve fiscal governance. The question is how to implement what is necessary. It depends on whether democracy will or will not function in Japan.

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[29] See Iio (2007), Takenaka (2006), etc.

[30] For details, see Tanaka (2019a).

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Borda Count Method for Fiscal Policy - A Political Economic Analysis -

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Abstract

Survey data reveals that government budgets tend to go into the red. Public Choice economists as well as public finance economists have been interested in this phenomenon and have come up with several explanations, such as fiscal illusion. This paper presents a new explanation for this tendency from the political economic point of view; the current voting system might have a tendency to bring about a budget deficit. If policy choices only deal with the current tax rate and do not take into account the intertemporal tax rate, it may be difficult to select a budget-balanced choice. Even if voting choices take into account intertemporal aspects, as there exist so many choices to increase tax rates to reimburse government deficits, votes from people who support a balanced budget are split and therefore it may be difficult to select a budget-balanced choice under the relative majority rule even if a balanced budget is supported by a majority of voters. We further demonstrate that the Borda count method, known to mitigate vote-splitting problems, might overcome this issue.

Keywords**:** relative majority rule, Borda count method, deficit

JEL**: D72; H41; H62**

Remark

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1. Introduction

Macroeconomists almost always assume that the intertemporal government budget is balanced. In other words, the government budget is not necessarily balanced today but is to be balanced in the future. This assumption seems natural because, in our daily life, everyone is required to settle her deficit at some time. However, in reality, is not easy for the government to implement a balanced budget. Buchanan (1987, p.471) asserts that the government budget tends to be in deficit by stating, "*The most elementary prediction from public choice theory is that in the absence of moral or constitutional constraints democracies will finance some share of current public consumption from debt issue rather than from taxation and that, in consequence, spending rates will be higher than would accrue under budget balance.*" An IMF survey[3] also reveals that 139 to 159 countries among 189 countries were in deficit during 2010-2015. Moreover, 112 countries had been in deficit for all six consecutive years during this period.

There are several explanations why government budgets tend to be in deficit. Orthodox tax smoothing (Barro, 1979) cannot explain this tendency. As seen above, Buchanan explains this phenomenon by saying that debt finance is preferred to taxation finance under democracy, which is sometimes called a *fiscal illusion* (Buchanan and Wagner, 1977). Weingast et al. (1981) and Cogan (1993) explain this phenomenon in a microeconomic way, suggesting that a tragedy of the commons brings about government deficits. Alesina and Tabellini (1990) propose a theory that the current government has an incentive to constrain a future government's activity by accumulating public debt.[4]

The purpose of this paper is to propose another explanation. Our explanation, which is based on the study of political economy, is that current voting rules may have a tendency to bring about a non-budget-balanced choice.[5] Firstly, if the policy choices are only for today's tax rate, not only non-budget-balancing people but also budget-balancing people who prefer future tax increases to today's tax increase may opt for no tax increase today. Moreover, even if policy choices take into account an intertemporal tax rate, the relative majority rule might not reflect voter opinion. It is well-known that, although widely implemented, the relative majority rule has several pitfalls. For example, it is vulnerable to vote splitting. If there are several policy choices with similar ideologies, the vote may be split and thus it will turn out to be difficult for these choices to obtain a relative majority. As a result, even though ideology A is supported by the majority, where ideology B is supported by the minority, if there are many policy choices embodying ideology A, a candidate with ideology B may win under the relative majority voting rule. This effect, known as the *spoiler effect*, can be seen in many electoral campaigns, such as in the 2000 U.S. Presidential Elections (The New York Times, 2004). We show that there is a possibility that, even if budget-balancing people are in the majority, they may suffer from the spoiler effect.

There are several voting rules that can be used to overcome the caveats of the relative majority rule. Among these, the Borda count method (Borda, 1784) and Condorcet method (Condorcet, 1785) are well known. We will focus on the Borda count method hereafter.[6] Under the Borda count method,

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[3] IMF Fiscal Monitor

[4] There are other explanations. For example, Oguro et al. (2013) explain it by incorporating the political powers of different generations and intergenerational altruism using an overlapping generations model.

[5] The caveat and possible remedies of the current voting system are analyzed by many studies, including Ishida and Oguro (2018) and Ishida (2015). Among these, Oguro et al. (2018) focus on the proof-of-work system introduced in cryptocurrencies. The mechanism of cryptocurrencies is empirically analyzed in Hattori and Ishida (2020a) and Hattori and Ishida (2020b).

[6] The Condorcet method requires the maximum likelihood method if there are four or more choices (Young, 1988), which is difficult to implement using our model.

if there are n policy choices, each person gives n points, $n-1$ points, $\cdots$, 1 point respectively to each choice. The points for each choice are then summed up. The choice that collects the highest points is elected. This count method is robust for split votes and thus overcomes the spoiler effect. Further, this count method is not an armchair theory, but is used in special legislative seats for ethnic minorities in Slovenia, and a similar method, called the Dowdall method, is implemented in Nauru (Golder, 2005; Fraenkel and Grofman, 2014). We will see that the Borda count method works for our issue as well.

This explanation has some similarities with Alesina and Drazen (1991), where two groups of people play a war of attrition game in order for a group to shift the burden of public debt onto another group. Since a cost must be paid for the postponement of redemption in each period, this war-of-attrition makes social welfare sub-optimal. In this model, people know that non-sustainable debt must be redeemed, but totally rational people act sub-optimally. In our model, the majority of people know that non-sustainable debt must be redeemed, but, due to the current voting system, the social consensus postpones redemption and acts sub-optimally. However, the mechanism is totally different from that in Alesina and Drazen (1991).

Our model is also similar to the agenda-setting model proposed by Romer and Rosenthal (1978) where agenda setters influence the final social consensus. Our model claims that the final social consensus depends on whether the voting agenda is only for today's tax rate or the intertemporal tax rate. However, our model goes further; the final social consensus does depend on what kind of voting system is used.

The remainder of this paper is organized as follows. A simple model is presented in the next section. This simple model is generalized and an individual utility function is specified in the following section. Finally, a conclusion is presented.

2. Simple model

Assume there is an initial government deficit that is normalized to unity. Our interest is people's voting behavior that chooses a policy from several possible plans to reimburse the government deficit in a two-period model ($t = 1,2$). For the sake of simplicity, we assume that there are only three different plans for reimbursing the government deficit. Plan X reimburses the government deficit only at $t = 1$ by tax increases, where plan Y reimburses the government deficit only at $t = 2$ by tax increases. Both plan X and plan Y are budget-balanced plans. However, plan Z is non-budget-balanced; it does not reimburse the government deficit either at $t = 1$ or at $t = 2$. Denoting each plan by (τ_1, τ_2) where τ_i refers to a tax increase at $t = i$, plan X is denoted as $(1,0)$, whereas plan Y is $(0,1)$ and plan Z is $(0,0)$. We assume people's voting behavior depends only on tax profile. Note that, if a policy is chosen, it will definitely be implemented. In other words, the selected policy fully binds not only this period's tax rate but also next period's tax rate.

Let there be $n_a + n_b + n_c$ people. n_a people have preference A, n_b people have preference B, and n_c people have preference C. People with preference A or B prefer balanced-budget plans. Among balanced-budget plans, people with preference A prefer plan X to plan Y (early reimbursement is preferred), where people with preference B prefer plan Y to plan X (late reimbursement is preferred). People with preference C prefer a non-balanced-budget plan and consider that plan Y is at least better than plan X.[7] These preferences are described in Figure 1, where $\mathrm{S} \succ \mathrm{T}$, meaning that S is preferred to T. We assume that budget-balancing people are greater

[7] An identical discussion is possible when people with preference C consider that plan X is at least better than plan Y. Without loss of generality, we assume here that people with preference C consider that plan Y is at least better than plan X.

in number than non-budget-balancing people; i.e. $n_a + n_b > n_c$. We also assume $n_c > n_a$ and $n_c > n_b$. An example of what we are considering is $n_a = n_b = 3$ and $n_c = 4$. Finally, we assume truthful voting hereinafter.

A: $X \succ Y \succ Z$
B: $Y \succ X \succ Z$
C: $Z \succ Y \succ X$

Figure 1: Voting preferences for people A, B and C

As follows, we will see that a balanced-budget plan is not chosen in this framework if policy choices do not take into account the intertemporal aspect or if relative majority rule is implemented.

(1) Let there be two policy choices that do not take into account the intertemporal aspect; tax increase at $t = 1$ and no-tax-increase at $t = 1$. People with preference B as well as preference C will then select the latter choice whichever voting rule is implemented. Therefore, a no-tax-increase is chosen even though budget-balancing people are in the majority.

(2) Let there be three policy choices that take into account the intertemporal aspect; $(\tau_1, \tau_2) = (1,0), (0,1), (0,0)$. People with preference A vote for the first choice, people with preference B the second, and people with preference C the third. Therefore, under the relative majority rule, $(\tau_1, \tau_2) = (0,0)$ is chosen even though budget-balancing people are in the majority.

The reasons for this result are summarized in the following two points. First, if the choices only take into account today's tax rate ($t = 1$), not only non-budget-balancing people (preference C) but also budget-balancing people who prefer late reimbursement (preference B) choose no-tax-increase today. Since $n_b + n_c > n_a$ holds, the choice of no-tax-increase is selected. This result holds whichever voting rule is implemented. Second, even if the choices take into account the future tax rate ($t = 2$), votes from budget-balancing people will be split between plan X and plan Y, which will result in a win for plan Z under the relative majority voting rule because $n_c > n_a$ and $n_c > n_b$ hold. As a result, even if budget-balancing people are the majority, the non-balanced-budget choice is selected.

This issue is overcome by incorporating the intertemporal aspect in policy choices and implementing the Borda count method. Under the Borda count method, each person gives n points, $n-1$ point, ⋯, 1 point respectively to n choices. The points for each choice are summed, the choice collecting the largest number of points being selected. Using the Borda count method for the three policy choices (plan X, Y and Z), people with preference A give 3 points to plan X, 2 points to plan Y, and 1 point to plan Z. People with preference B give 3 points to plan Y, 2 points to plan X, and 1 point to plan Z. People with preference C give 3 points to plan Z, 2 points to plan Y, and 1 point to plan X. This is described in Figure 2.

	X	Y	Z
A	3	2	1
B	2	3	1
C	1	2	3
Total points	$3n_a + 2n_b + n_c$	$2n_a + 3n_b + 2n_c$	$n_a + n_b + 3n_c$

Figure 2: Voting result under the Borda count method

In this case, budget-balanced plan Y is chosen because $2n_a + 3n_b + 2n_c > n_a + n_b + 3n_c$ and $2n_a + 3n_b + 2n_c > 3n_a + 2n_b + n_c$. We will generalize this idea in the following section.

3. General model

As we have seen in the previous section, we show that the Borda count method is efficient in overcoming the aforementioned issue. However, the model presented in the previous section does not specify an individual utility function. Also, it considers only three policy choices; $(\tau_1, \tau_2) = (1,0), (0,1), (0,0)$. In order to generalize the previous model, we specify the voter's utility function and consider many possible policy choices hereafter.

Assume that there are k budget-balancing people and l non-budget-balancing people. If $l < k$, budget-balancing people are in the majority where $l > k$ implies non-budget-balancing people are in the majority.[8] Each person is indexed by $i \in [1, k + l]$. Before period 0, the initial government debt that is to be reimbursed by period 3 is $D > 0$, and the number of budget-balancing and non-budget-balancing people and everyone's future endowments are already common knowledge. The initial government debt might be used to finance public goods provided before period 0. In period 0, the lump-sum tax schedule is determined by voting, the details of which are discussed later. In period 1 and period 2, each person is endowed with $w_i \in (0, n_i)$ and $n_i - w_i \in (0, n_i)$, respectively, and has to pay a lump-sum tax, $\tau_1 \in [0, \min_i w_i)$ and $\tau_2 \in [0, \min_i (n_i - w_i))$, respectively. Note that the size of the lump-sum tax is unaffected by the size of one's endowment. Each person enjoys private consumption, $c_i^1 = w_i - \tau_1$ at period 1 and $c_i^2 = n_i - w_i - \tau_2$ at period 2, respectively, which implies that saving is prohibited by any person.

We will consider a case where tax rates τ_1 and τ_2 are restricted to non-negative integers, and budget-balancing people prefer (τ_1, τ_2) to (τ'_1, τ'_2) and non-budget-balancing people prefer (τ'_1, τ'_2) to (τ_1, τ_2) if $\frac{D}{k+l} \geq \tau_1 + \tau_2 > \tau'_1 + \tau'_2 \geq 0$. If $\tau_1 + \tau_2 = \tau'_1 + \tau'_2$, the preference depends on each person's characteristics independent from whether they are for or against balanced budgets. In order only to demonstrate such preferences, we specify utility functions as follows.

The government reimburses its debt at period 3 from tax revenue during period 1 to period 2; $(k + l)(\tau_1 + \tau_2)$. Since the tax schedule is solely determined by voting, the government has no objective function.

Each person's utility function is

$$U_i = U(c_i^1, c_i^2, \xi, \theta) = \frac{(c_i^1)^{1-\sigma}}{1-\sigma} + \frac{(c_i^2)^{1-\sigma}}{1-\sigma} - \theta v(\xi) \qquad (1)$$

where $\sigma > 0$ measures the degree of relative risk aversion and function $v(\cdot)$ measures the disutility from final government debt per capita.[9] Remaining government debt per capita at period

[8] We are interested in a case where budget-balancing people are in the majority. Supporting evidence of this case is Mochida (2016). Using an Internet-based questionnaire of 1,000 answers randomly sampled from approximately 3.27 million people in Japan, he reports that three quarters of people are budget-balancing people (immediate redemption, 33.1%; gradual redemption, 42.4%) where a quarter of people are non-budget-balancing.

[9] People do not receive utility or disutility directly from government debt. However, it is natural to assume that people may expect future tax increases after period 3, which they themselves or their descendants have to bear. Maybe people expect a future default and take into account its consequence, in which they themselves or their descendants will suffer if there is substantial debt outstanding. Assuming that people take into account their descendants' utility, as appeared in Buchanan (1976), function $v(\cdot)$ is understood to include all these effects. It is worth noting that Alesina and Drazen (1991) also assume that postponing debt redemption is costly because of the distortion of taxation and lobbying costs. Such an effect may also be included in function $v(\cdot)$. The form of the function may be derived by analyzing the probability of default (e.g. Cuadra et

3 is $\xi \equiv \frac{D}{k+l} - (\tau_1 + \tau_2)$. $\theta = 1$ for budget-balancing people where $\theta = 0$ for non-budget-balancing people. We consider neither interest rate nor discount rate. An interpretation of function $v(\cdot)$ is that it measures possible future consequences caused by government debt. Therefore, it is assumed that $v(\xi)$ is a positive, differentiable and strictly increasing function when $\xi > 0$ and a weakly increasing function when $\xi \leq 0$. For technical reasons, we also assume that $v'(\xi) > 1$ when $\xi > 0$ hereafter.[10]

Assume that everyone is given sufficient endowments, i.e. $\frac{D}{k+l} + 1 \leq \min_i w_i$ and $\frac{D}{k+l} + 1 \leq \min_i (n_i - w_i)$ in order to avoid corner solutions.

We also assume that the degree of relative risk aversion σ is small. More specifically, we assume the following condition.

Assumption 1 (sufficiently small relative risk aversion σ): We assume that, for any person i, the following inequality always holds.

$$U(c_i^1, c_i^2, \xi, \theta = 1) > U\left(\widetilde{c_i^1}, \widetilde{c_i^2}, \tilde{\xi}, \theta = 1\right) \quad (2)$$

and

$$U(c_i^1, c_i^2, \xi, \theta = 0) < U\left(\widetilde{c_i^1}, \widetilde{c_i^2}, \tilde{\xi}, \theta = 0\right) \quad (3)$$

Where

$$c_i^1 = w_i - \tau_1 \geq 1 \quad (4)$$

$$c_i^2 = n_i - w_i - \tau_2 \geq 1 \quad (5)$$

$$\frac{D}{k+l} - (\tau_1 + \tau_2) = \xi \quad (6)$$

$$\widetilde{c_i^1} = w_i - \widetilde{\tau_1} \geq 1 \quad (7)$$

$$\widetilde{c_i^2} = n_i - w_i - \widetilde{\tau_2} \geq 1 \quad (8)$$

$$\frac{D}{k+l} - (\widetilde{\tau_1} + \widetilde{\tau_2}) = \tilde{\xi} \quad (9)$$

$$\tilde{\xi} - \xi \geq \frac{1}{k+l} \quad (10)$$

$$\xi, \tilde{\xi} \in \left[0, \frac{D}{k+l}\right]. \quad (11)$$

That is, for both budget-balancing -people and non-budget-balancing people, the total amount of tax (in other words, the remaining amount of government debt at period 3) is of primary importance and its allocation is of secondary importance. In other words, we assume that utility is close to the quasi-linear utility function $U_i = U(c_i^1, c_i^2, \xi, \theta) = c_i^1 + c_i^2 - \theta v(\xi)$ and that deviation from the quasi-linear utility function is only for technical purposes.[11] This condition is satisfied when the degree of relative risk aversion σ is sufficiently small.

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al., 2010), which is not our research focus. Similar methods can be seen in Caselli (1997) and Müller et al. (2016), where a fraction of debt defaults or probability of defaults explicitly appears in the cost function or utility function.

[10] Our discussion can be extended where $v'(\xi) > 1$ holds only for $\xi > \xi_0 > 0$. In such a case, we will define $\overline{D} = D - (k+l)\xi_0$ and consider a situation where debt $\overline{D}$ (excessive debt) is to be reimbursed by period 3.

[11] We assume that people have a slight preference on tax allocation. In other words, some people prefer $(\tau_1, \tau_2) = (3,0)$ to $(\tau_1, \tau_2) = (2,1)$ where other people have the opposite preference. However, this preference is only of secondary importance.

In addition, for the sake of simplicity, we assume integer restriction as follows. As we will consider voting later, a discrete profile is easier to handle than a continuum profile.

Assumption 2 (step size): We assume that w_i and n_i are positive integers and τ_1, τ_2 and $\frac{D}{k+l}$ (initial government debt per capita) are integers. We also assume that $n_i - \frac{D}{k+l}$ is an even number for all i.

Note that the integer step size is arbitrary. Therefore, if a statement requires $\frac{D}{k+l}$ to be sufficiently large, such a statement also holds when the step size is sufficiently small, and vice versa.

Due to Assumption 2, consumptions at period 1 and period 2 are always positive integers. In order to reimburse a government debt whose size is D, possible tax schedules are restricted to

$$(\tau_1, \tau_2) = \left(0, \frac{D}{k+l}\right), \left(1, \frac{D}{k+l} - 1\right), \cdots, \left(\frac{D}{k+l}, 0\right). \quad (12)$$

Following these settings, we propose the tax allocation most preferred by a particular person i.

Proposition 1: If person i is budget-balancing, her first preference would be the following tax schedule.

$$\begin{cases} (\tau_1, \tau_2) = \left(0, \frac{D}{k+l}\right) \ if \ 0 > w_i - \frac{n_i - \frac{D}{k+l}}{2} \\ (\tau_1, \tau_2) = \left(m, \frac{D}{k+l} - m\right) \ if \ m = w_i - \frac{n_i - \frac{D}{k+l}}{2} \in [0, \frac{D}{k+l}] \\ (\tau_1, \tau_2) = \left(\frac{D}{k+l}, 0\right) \ if \ \frac{D}{k+l} < w_i - \frac{n_i - \frac{D}{k+l}}{2} \end{cases}$$

If person i is non-budget-balancing, her best preference would be tax allocation $(\tau_1, \tau_2) = (0,0)$.

Proof of Proposition 1: A non-budget-balancing person is assumed not to take into account the remaining government debt at period 3 in her utility at period 0. Therefore, at period 0, a non-budget-balancing person always prefers a small lump-sum tax, i.e. $(\tau_1, \tau_2) = (0,0)$.
For budget-balancing people, due to Assumption 1, a balanced-budget tax plan, namely $\tau_1 + \tau_2 = \frac{D}{k+l}$, is preferred. Among balanced-budget tax plans, these people would prefer a smoothed consumption because the CRRA utility function is concave. Therefore,

(a) $(\tau_1, \tau_2) = \left(0, \frac{D}{k+l}\right)$ is the first preference if $0 > w_i - \frac{n_i - \frac{D}{k+l}}{2}$ holds, because $c_i^1 = w_i - \tau_1 = w_i$ is still less than $c_i^2 = n_i - w_i - \tau_2 = n_i - w_i - \frac{D}{k+l}$ and $(\tau_1, \tau_2) = \left(0, \frac{D}{k+l}\right)$ is the corner solution.

(b) $(\tau_1, \tau_2) = \left(m, \frac{D}{k+l} - m\right)$ is the first preferene if $m = w_i - \frac{n_i - \frac{D}{k+l}}{2} \in [0, \frac{D}{k+l}]$ holds, because $c_i^1 = w_i - \tau_1 = w_i - m = \frac{n_i - \frac{D}{k+l}}{2}$ is equal to $c_i^2 = n_i - w_i - \tau_2 = n_i - w_i - \frac{D}{k+l} + m = \frac{n_i - \frac{D}{k+l}}{2}$.

(c) $(\tau_1, \tau_2) = \left(\frac{D}{k+l}, 0\right)$ is the first preference if $\frac{D}{k+l} < w_i - \frac{n_i - \frac{D}{k+l}}{2}$ holds, because $c_i^1 = w_i - \tau_1 = w_i - \frac{D}{k+l}$ is still greater than $c_i^2 = n_i - w_i - \tau_2 = n_i - w_i$ and $(\tau_1, \tau_2) = \left(\frac{D}{k+l}, 0\right)$ is the corner solution.

(Q.E.D.)

Still, a budget-balancing person i prefers any tax schedule that satisfies $\tau_1 + \tau_2 = \frac{D}{k+l}$ to any tax schedule that does not satisfy this condition ($\because$ Condition of small σ).

The abovementioned utility function is given only for demonstrating people's preferences where budget-balancing people prefer (τ_1, τ_2) to (τ'_1, τ'_2) and non-budget-balancing people prefer (τ'_1, τ'_2) to (τ_1, τ_2) if $\frac{D}{k+l} \geq \tau_1 + \tau_2 > \tau'_1 + \tau'_2 \geq 0$. Proposition 1 is shown only to demonstrate that people's preferences between (τ_1, τ_2) and (τ'_1, τ'_2) depend on each person's characteristics (independently of whether they are for or against balanced budgets) if $\tau_1 + \tau_2 = \tau'_1 + \tau'_2$. The following discussion does not depend on the specification of the utility function.

Definition 1 (classification of budget-balancing people): Among budget-balancing people, let the number of people whose first preference is $(\tau_1, \tau_2) = \left(m, \frac{D}{k+l} - m\right)$ be k_m. Note that $\sum_{m=0}^{\frac{D}{k+l}} k_m = k$ is satisfied.

We hereafter consider what kind of tax plan will be considered when voting. We assume that the budget surplus tax schedule be eliminated, namely, people only consider tax schedules where total tax revenue is either equal to or smaller than the current government debt.

Definition 2 (government debt per capita): Define $X \equiv \frac{D}{k+l}$.

Assumption 3 (possible tax schedule): We assume $X < \min_i w_i$ and $X < \min_i (n_i - w_i)$ are satisfied. The government provides possible tax schedules (τ_1, τ_2) that satisfy $\tau_1 + \tau_2 \leq X$, $\tau_1 \in \mathbb{N} \cup \{0\}$ and $\tau_2 \in \mathbb{N} \cup \{0\}$ and people choose the tax schedule they prefer by voting, i.e. we exclude the possibility that a (strict) budget surplus tax schedule be adopted.

Finally, we assume people vote truthfully and do not consider strategic voting.

Let us consider several voting schemes to enable us to verify how the Borda count method works.

Proposition 2: Assume that the voting agenda is only about today's tax rate. Then, if $l + k_0 > \max_{m \geq 1} k_m$ is satisfied, the non-budget-balanced solution $\tau_1 = 0$ is chosen under the relative majority voting rule. If $l + k_0 < \max_{m \geq 1} k_m$ is satisfied, $\tau_1 = 0$ is not chosen.

Proof of Proposition 2: Under the relative majority rule, policy choice $\tau_1 = 0$ collects $l + k_0$ votes, where $\tau_1 = m > 0$ collects k_m votes. Therefore, if $l + k_0 > \max_{m \geq 1} k_m$ is satisfied, the non-budget-balanced solution $\tau_1 = 0$ is chosen even if a majority of people are in favor of a balanced budget, i.e. $l < k = \sum_{m=0}^{\frac{D}{k+l}} k_m$. It is easy to see that, if $l + k_0 < \max_{m \geq 1} k_m$, $\tau_1 = \bar{m}$ for $\bar{m} = \text{argmax}_m\, k_m$ is adopted. (Q.E.D.)

It can be easily seen that it is difficult for a budget-balanced tax plan to be adopted if the voting agenda is only for today's tax rate. Therefore, we can consider taking the intertemporal aspect into account in our voting agenda. However, we can see that it is still difficult to adopt the budget-balanced tax plan under the relative majority voting rule.

Proposition 3: Assume that the voting agenda is the intertemporal tax rate. Then, if $l > \max_m k_m$ is satisfied, the non-budget-balanced solution $(\tau_1, \tau_2) = (0,0)$ is chosen under the relative majority voting rule. If $l < \max_m k_m$ is satisfied, $(\tau_1, \tau_2) = (0,0)$ is not chosen.

Proof of Proposition 3: Each person votes for $(\tau_1, \tau_2) \in \{(\tau_1, \tau_2) | \tau_1 + \tau_2 \leq \mathrm{X},\ \tau_1 \in \mathbb{N} \cup \{0\}$ and $\tau_2 \in \mathbb{N} \cup \{0\}\}$. Consequently, $(0,0)$ collects l votes and $(m, \mathrm{X} - m)$ collects k_m votes, respectively. If $l > \max_m k_m$ is satisfied, the non-budget-balanced solution $(0,0)$ is chosen even if budget-balancing people are in the majority ($l < k$), in which case the majority of people prefer $(m, \mathrm{X} - m)$, whatever value m takes, to the non-budget-balanced solution $(0,0)$. It is easy to see that, if $l < \max_m k_m$, $(\tau_1, \tau_2) = (\bar{m}, X - \bar{m})$ for $\bar{m} = \mathrm{argmax}_m\, k_m$ is adopted. (Q.E.D.)

The result of Proposition 3 results from the fact that the budget-balancing people's vote is split into multiple choices, $(\tau_1, \tau_2) = (m, \mathrm{X} - m)$ for $m \in [0, X]$. We can see that the Borda count method is effective in coping with this spoiler effect.

Proposition 4: Under the Borda count method,

(1) *An almost* budget-balanced tax plan is *asymptotically* chosen if budget-balancing people are in the majority $(k > l)$ and the step size of government debt per capita X defined under Assumption 2 is sufficiently small. To be precise, $\forall \varepsilon_1 > 0$, $\forall \varepsilon_2 > 0, \exists X_0$ s.t. $\forall X > X_0$[12]; $\frac{k}{l} > 1 + \varepsilon_1 \Rightarrow$tax plan $(\overline{\tau_1}, \overline{\tau_2})$ is chosen where $\overline{\tau_1} + \overline{\tau_2} > (1 - \varepsilon_2)X$.

(2) *An almost* no-tax plan is *asymptotically* chosen if non-budget-balancing people are in the majority $(k < l)$ and the step size of government debt per capita X defined under Assumption 2 is sufficiently small. To be precise, $\forall \varepsilon_1 > 0$, $\forall \varepsilon_2 > 0, \exists X_0$ s.t. $\forall X > X_0$; $\frac{l}{k} > 1 + \varepsilon_1 \Rightarrow$tax plan $(\overline{\tau_1}, \overline{\tau_2})$ is chosen where $\overline{\tau_1} + \overline{\tau_2} < \varepsilon_2 X$.

(3) If budget-balancing people are a $\frac{3}{4}$ majority or more $(k \geq 3l)$, budget-balanced tax plan $(\overline{\tau_1}, \overline{\tau_2})$ with $\overline{\tau_1} + \overline{\tau_2} = X$ is always chosen whatever value X takes.

(4) If non-budget-balancing people are more than a $\frac{2}{3}$ majority $(2k < l)$, the no-tax plan $(0,0)$ is always chosen whatever value X takes.

Proof of Proposition 4: See Appendix 1

This proposition reveals that the Borda count method assures that the majority's opinion is, at least asymptotically, reflected in tax policy. If budget-balancing people are in the majority and government debt per capita is sufficiently large, a tax plan close to a budget-balanced tax plan is chosen asymptotically. This proposition does not specifically state which tax plan is to be chosen, but says that a tax plan that is approximately budget balanced is to be chosen. If non-budget-balancing people are in the majority and government debt per capita is sufficiently large, a tax plan close to a no-tax plan is chosen asymptotically. Moreover, it is proven that, if budget-balancing people are in a supermajority (75% majority), a budget-balanced tax plan is always chosen and if non- budget-balancing people are in a supermajority (66.7% majority), a no-tax plan is always chosen.

One may complain that, not all possible policy choices are placed on the agendas of political

[12] As noted in Assumption 2, this proposition requires either the step size to be sufficiently small or government debt per capita X to be sufficiently large.

parties during actual political campaigns, and thus Proposition 4, in which all possible tax policies are on the agenda, is unrealistic. Realistically, we can consider a case where some policy choices are selected for the agenda. In such a case, we can show that the majority's opinion will *almost certainly* be reflected in tax policy. To be precise, if the number of policy choices on the agenda is sufficiently small, the majority's opinion will almost certainly be reflected in tax policy (Proposition 5). If the number of policy choices on the agenda is sufficiently large, similar to Proposition 4, the opinion of the supermajority of people (75% or 66.7%) will be reflected in tax policy (Proposition 6). These results reinforce our message provided in Proposition 4.

Proposition 5: Consider a case where, for a sufficiently small N, N tax policies are on the agenda. At least a budget-balanced tax policy and a no-tax policy are included on this agenda. Under the Borda count method,
(1) A budget-balanced tax plan is *almost certainly* chosen if budget-balancing people are in a majority ($k > l$), policy choices are randomly distributed, and the step size of government debt per capita X defined under Assumption 2 is sufficiently small.

To be precise, assume there are $N \geq 3$ policy choices where at least one policy is budget balanced ($\tau'_1 + \tau'_2 = X$), one policy is a no-tax plan ($(\tau_1, \tau_2) = (0,0)$) and other choices are uniformly distributed according to $\{(\tau_1, \tau_2) \in \mathbb{Z}^2 | \tau_1 \geq 0, \tau_2 \geq 0, \tau_1 + \tau_2 \leq \mathrm{X}, (\tau_1, \tau_2) \neq (\tau'_1, \tau'_2), (\tau_1, \tau_2) \neq (0,0)\}$. For a sufficiently small N, $\forall \varepsilon > 0$, $\exists X_0$ s.t. $\forall X > X_0$; the budget-balanced tax plan $(\overline{\tau_1}, \overline{\tau_2})$ with $\overline{\tau_1} + \overline{\tau_2} = X$ is chosen with a probability of $1 - \varepsilon$ or more.
(2) A no-tax plan is *almost certainly* chosen if non-budget-balancing people are in a majority ($k < l$), policy choices are randomly distributed, and the step size of government debt per capita X defined under Assumption 2 is sufficiently small.

To be precise, assume there are $N \geq 3$ policy choices where at least one policy is budget balanced ($\tau'_1 + \tau'_2 = X$), one policy is a no-tax plan ($(\tau_1, \tau_2) = (0,0)$) and other choices are uniformly distributed according to $\{(\tau_1, \tau_2) \in \mathbb{Z}^2 | \tau_1 \geq 0, \tau_2 \geq 0, \tau_1 + \tau_2 \leq \mathrm{X}, (\tau_1, \tau_2) \neq (\tau'_1, \tau'_2), (\tau_1, \tau_2) \neq (0,0)\}$. For a sufficiently small N, $\forall \varepsilon > 0$, $\exists X_0$ s.t. $\forall X > X_0$; the no-tax plan $(0,0)$ is chosen with a probability of $1 - \varepsilon$ or more.

Proof of Proposition 5: See Appendix 2

Proposition 5 holds for a sufficiently small number of policy choices on the agenda. If there is a sufficiently large number of policy choices on the agenda, the following proposition holds.

Proposition 6: Consider a case where, for a sufficiently large N, N tax policies are on the agenda. Assume that policy choices on the agenda include at least one budget-balanced policy ($\tau'_1 + \tau'_2 = X$) and one no-tax policy ($(\tau_1, \tau_2) = (0,0)$), and assume that other choices are uniformly distributed according to $\{(\tau_1, \tau_2) \in \mathbb{Z}^2 | \tau_1 \geq 0, \tau_2 \geq 0, \tau_1 + \tau_2 \leq \mathrm{X}, (\tau_1, \tau_2) \neq (\tau'_1, \tau'_2), (\tau_1, \tau_2) \neq (0,0)\}$. Under the Borda count method,
(1) *An almost* budget-balanced tax plan is *asymptotically* and *almost certainly* chosen if budget-balancing people are in the majority ($k > l$) and the step size of government debt per capita X defined under Assumption 2 is sufficiently small.
(2) *An almost* no-tax plan is *asymptotically* and *almost certainly* chosen if non-budget-balancing people are in the majority ($k < l$) and the step size of government debt per capita X defined under Assumption 2 is sufficiently small.
(3) If budget-balancing people are a $\frac{3}{4}$ majority or more ($k \geq 3l$), the budget-balanced tax plan $(\overline{\tau_1}, \overline{\tau_2})$ with $\overline{\tau_1} + \overline{\tau_2} = X$ is *almost certainly* chosen whatever value and stem size X takes.
(4) If non-budget-balancing people are more than a $\frac{2}{3}$ majority ($2k < l$), the no-tax plan $(0,0)$ is

almost certainly chosen whatever value and stem size X takes.

Proof of Proposition 6: See Appendix 3

Integrating these results, the majority's opinion will be *asymptotically* and *almost certainly* reflected in tax policy under the Borda count method, both when N is sufficiently large and when N is sufficiently small. These results represent the superiority of the Borda count method for representing people's preferences.

4. Conclusion

The current voting system is not one-size-fits-all. If policy choices do not incorporate intertemporal aspects, voters have little opportunity to express their real preferences. Furthermore, in reality, the relative majority rule is, although criticized in many ways, widely implemented. However, this voting rule is vulnerable to vote splitting. If there are many choices in which similar ideologies are upheld, it will be difficult for these choices to be chosen under the relative majority rule. Even if policy choices incorporate intertemporal aspects, the relative majority voting rule might not reflect voter preferences, a situation that could be remedied by the Borda count method.

Our paper does not intend to refute the existing explanations regarding why there is a tendency for budget deficits. Our paper intends to present another explanation for widely-implemented voting systems to have a tendency to bring about budget deficits.

Our paper only considers two types of voters; budget-balancing people and non-budget-balancing people. Further research may consider other types of voters, such as semi-budget-balancing people. A caveat of our paper is that one of our main results is valid if budget-balancing people are in the majority, which is not obvious at all. Another caveat of our paper is that it assumes truthful voting and excludes the possibility of strategic voting. Considering the possibility of strategic voting may polish this paper in a theoretical way.

Appendix 1 (Proof of Proposition 4)

Each person votes for $(\tau_1, \tau_2) \in \{(\tau_1, \tau_2) | \tau_1 + \tau_2 \leq \mathrm{X},\ \tau_1 \in \mathbb{N} \cup \{0\}$ and $\tau_2 \in \mathbb{N} \cup \{0\}\}$ by Borda voting.

(a) First, we calculate how many points the no-tax plan $(0,0)$ collects. Non-budget-balancing people give maximum points $\frac{(X+1)(X+2)}{2}$ to the no-tax plan $(0,0)$. Therefore, it collects $\frac{(X+1)(X+2)}{2} l$ points from non-budget-balancing people. Budget-balancing people give a minimum of 1 point to the no-tax plan $(0,0)$. Therefore, it collects k points from budget-balancing people. In sum, the no-tax plan $(0,0)$ collects $k + \frac{(X+1)(X+2)}{2} l$ points.

(b) Second, we calculate how many points budget-balanced tax plans (τ_1, τ_2) with $\tau_1 + \tau_2 = \mathrm{X}$ collect *on average*. Non-budget-balancing people give 1 point to $X+1$ points, respectively, on budget-balanced tax plans. Therefore, they collect $\frac{(X+1)(X+2)}{2} l$ points in total from non-budget-balancing people. Budget-balancing people give $\frac{(X+1)(X+2)}{2}$ points to $\frac{(X+1)(X+2)}{2} - X$ points, respectively, to budget-balanced tax plans. Therefore, they collect $(X+1)\frac{(X+1)(X+2)-X}{2} k$ points in total from budget-balancing people. In sum, budget-balanced tax plans collect $(X+1)\frac{(X+1)(X+2)-X}{2} k + \frac{(X+1)(X+2)}{2} l$ points in total and

$\frac{(X+1)(X+2)-X}{2}k+\frac{X+2}{2}l=\frac{X^2+2X+2}{2}k+\frac{X+2}{2}l$ points *on average*.

(c) Third, we calculate how many points a tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p\in(0,X)$ can collect *at most*. Non-budget-balancing people strictly prefer any tax plan (τ_1,τ_2) with $\tau_1+\tau_2<p$ to a tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p$. Therefore, a tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p\in(0,X)$ collects *at most* $(X+1)+X+\cdots+(p+1)=\frac{(X+p+2)(X-p+1)}{2}$ points from a non-budget-balancing person. Budget-balancing people strictly prefer any tax plan (τ_1,τ_2) with $\tau_1+\tau_2>p$ to a tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p$. Therefore, a tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p\in(0,X)$ collects *at most* $1+2+\cdots+(p+1)=\frac{(p+1)(p+2)}{2}$ points from a budget-balancing person. In sum, a tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p\in(0,X)$ can collect *at most* $\frac{(p+1)(p+2)}{2}k+\frac{(X+p+2)(X-p+1)}{2}l$ points.

(d) Consider a case where budget-balancing people are in the majority ($k>l$). As $\frac{X^2+2X+2}{2}k+\frac{X+2}{2}l>k+\frac{(X+1)(X+2)}{2}l$ holds, the no-tax plan $(0,0)$ is never chosen. If a balanced tax plan (τ_1,τ_2) with $\tau_1+\tau_2=\mathrm{X}$ is chosen, (1) and (3) are already proven. Therefore, we will focus on the case where tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p\in(0,X)$ is chosen. In such a case, $\frac{(p+1)(p+2)}{2}k+\frac{(X+p+2)(X-p+1)}{2}l>\frac{X^2+2X+2}{2}k+\frac{X+2}{2}l$ is necessary. Equivalently, $\frac{X^2+2X-(p^2+p)}{2}l>\frac{X^2+2X-(p^2+3p)}{2}k\Leftrightarrow\frac{X^2+2X-(p^2+p)}{X^2+2X-(p^2+3p)}>\frac{k}{l}\Leftrightarrow1+\frac{2p}{X^2+2X-(p^2+3p)}>\frac{k}{l}$ is necessary. Note that $\frac{2p}{X^2+2X-(p^2+3p)}=0$ when $p=0$ and $\frac{2p}{X^2+2X-(p^2+3p)}$ is a strictly increasing function with p. Let $\varepsilon_1\equiv\frac{k}{l}-1$ and $\varepsilon_2\equiv1-\frac{p}{X}$. Then, a necessary condition that a tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p\in(0,X)$ is chosen is that $\frac{2(1-\varepsilon_2)}{(2\varepsilon_2-\varepsilon_2^2)X+3\varepsilon_2-1}>\varepsilon_1$ holds. This inequality shows that, whatever value $\varepsilon_1>0$ and $\varepsilon_2>0$ take, a sufficiently large X prevents this inequality from holding. In other words, whatever value $\varepsilon_1>0$ and $\varepsilon_2>0$ take, if X is sufficiently large, $\tau_1+\tau_2$ must be greater than $(1-\varepsilon_2)X$ to be chosen. ε_1 is increasing on the right-hand side of $\frac{2(1-\varepsilon_2)}{(2\varepsilon_2-\varepsilon_2^2)X+3\varepsilon_2-1}>\varepsilon_1$ and ε_2 decreasing on the left-hand side. Thus, (1) is proven and *An almost* balanced-budget tax plan is always *asymptotically* chosen if government debt per capita X is sufficiently large.

(e) Let's continue to consider a case where budget-balancing people are in the majority ($k>l$). (3) is proven because $\max_{p\in(0,X)}\left[1+\frac{2p}{X^2+2X-(p^2+3p)}\right]=\left[1+\frac{2p}{X^2+2X-(p^2+3p)}\right]_{p=X-1}=1+\frac{2(X-1)}{X+2}=\frac{3X}{X+2}<3$ holds. If $\frac{k}{l}\geq3$, the above finding implies that the inequality $1+\frac{2p}{X^2+2X-(p^2+3p)}>\frac{k}{l}$ never holds. Therefore, a balanced tax plan (τ_1,τ_2) with $\tau_1+\tau_2=\mathrm{X}$ must be chosen in this case.

(f) Next, consider a case where non-budget-balancing people are in the majority ($k<l$). If a no-tax plan $(0,0)$ is chosen, (2) is already proven. Therefore, we will focus on a case where tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p\in(0,X]$ is chosen. In such a case, $\frac{(p+1)(p+2)}{2}k+\frac{(X+p+2)(X-p+1)}{2}l>k+\frac{(X+1)(X+2)}{2}l$ is necessary. Equivalently, $\frac{p^2+3p}{2}k>\frac{p^2+p}{2}l\Leftrightarrow\frac{l}{k}<1+\frac{2}{p+1}$ is necessary. Note that $\frac{2}{p+1}$ is a strictly decreasing function with regard to p. Let $\varepsilon_1\equiv\frac{l}{k}-1$ and $\varepsilon_2\equiv\frac{p}{X}$. Then, a necessary condition that a tax plan (τ_1,τ_2) with $\tau_1+\tau_2=p\in(0,X]$ is chosen is that $\varepsilon_1<\frac{2}{\varepsilon_2X+1}$ holds. This inequality shows that, whatever value $\varepsilon_1>0$ and $\varepsilon_2>0$ take, a sufficiently large X prevents this inequality from holding. In other words, whatever value $\varepsilon_1>0$ and $\varepsilon_2>0$ take, if X is sufficiently large, $\tau_1+\tau_2$ must be smaller than ε_2X to be chosen. ε_2 is decreasing on the right-hand side of $\varepsilon_1<$

$\frac{2}{\varepsilon_2 X+1}$ is and ε_1 is increasing on the left-hand side. Thus, (2) is proven and *an almost* no-tax plan is always *asymptotically* chosen if government debt per capita X is sufficiently large.

(g) Let's continue to consider a case where non-budget-balancing people are in the majority ($k < l$). (4) is proven because $\max_{p\in(0,X]}\left[1+\frac{2}{p+1}\right]=\left[1+\frac{2}{p+1}\right]_{p=1}=2$ holds. If $\frac{l}{k}>2$, the above finding implies that the inequality $\frac{l}{k}<1+\frac{2}{p+1}$ never holds. Therefore, a no-tax plan $(0,0)$ must be chosen in this case.

(Q.E.D.)

Appendix 2 (Proof of Proposition 5)

Let p satisfy $p\in\mathbb{N}$ and $0<p\le X$. Let $T\subset\{(\tau_1,\tau_2)\in\mathbb{Z}^2|\tau_1\ge 0,\tau_2\ge 0,\tau_1+\tau_2\le \mathrm{X}\}$ be N tax policies on the agenda and Δ_p be the number of tax policies on the agenda which satisfy $\tau_1+\tau_2=p$. Note that $\sum_{p=1}^{X}\Delta_p=N-1$ holds because there is a tax policy $(0,0)$ which is not included in $\sum_{p=1}^{X}\Delta_p=N-1$. It is easily proven that $\mathrm{Prob}\{\exists p,\Delta_p\ge 2\}\xrightarrow[X\to\infty]{}+0$.[13] Therefore, it is almost certain that either $\Delta_p=0$ or $\Delta_p=1$ holds for all p $(0<p\le X)$.

The budget-balanced tax policy collects N points from budget-balancing people in total and 1 point from non-budget-balancing people in total. Therefore, the budget-balanced tax policy collects $Nk+l$ points.

Consider any tax policy with $\tau_1+\tau_2=p<X$. Since it is almost certain that either $\Delta_p=0$ or $\Delta_p=1$ holds for all p $(0<p<X)$, if this tax policy is the t^{th} preferred by budget-balancing people, it is the $N+1-t^{\text{th}}$ preferred by non-budget-balancing people. Therefore, it collects $(N+1-t)k+tl$ points. It is obvious that $t\ge 2$ holds.

As a special case, no-tax policy collects $k+Nl$ points.

As $Nk+l>(N+1-t)k+tl$ always holds for $k>l$, statement (1) holds. Also, as $Nk+l<k+Nl$ as well as $(N+1-t)k+tl<k+Nl$ hold for $t\le N-1$ when $k<l$, statement (2) holds.

(Q.E.D.)

Appendix 3 (Proof of Proposition 6)

Assume that N is sufficiently large to allow the law of large numbers to be applied. Then, it is *almost certain* that there are *approximately* $\frac{N}{\frac{(X+1)(X+2)}{2}}(Q+1)=\frac{2(Q+1)N}{(X+1)(X+2)}$ policies that satisfy $\tau_1+\tau_2=Q$. As a special case, substituting $Q=X$, we can show that there are approximately $\frac{2N}{X+2}$

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[13] [sketch of proof] Consider a case where a budget-balanced tax policy (τ'_1,τ'_2) and no-tax policy $(0,0)$ are given *a priori* and other $N-2$ policy choices (τ_1^1,τ_2^1), (τ_1^2,τ_2^2), $\cdots$, $(\tau_1^{N-2},\tau_2^{N-2})$ are allocated one by one. There are $E=\frac{(X+1)(X+2)}{2}-2$ choices to be selected. Before allocating these choices, $\forall p\in(0,X)$; $\Delta_p=0$ and $\Delta_X=1$ hold. The first policy does not make any Δ_p greater than one with a probability of $\frac{E-X}{E}$. (Among E choices, only X budget-balanced choices make Δ_p greater than 1.) The second choice does not make any Δ_p greater than one with a probability of $\frac{(E-1)-X-(X-1)}{E-1}$ or more. The third choice does not make any Δ_p greater than one with a probability of $\frac{(E-2)-X-(X-1)-(X-2)}{E-2}$ or more.$\cdots$ N-2th choice does not make any Δ_p greater than one with a probability of $\frac{\{E-(N-3)\}-X-(X-1)-(X-2)-\cdots-\{X-(N-3)\}}{E-(N-3)}$ or more. Therefore, as N is assumed to be sufficiently small, $1-\mathrm{Prob}\{\exists p,\Delta_p\ge 2\}\ge\frac{E-X}{E}\cdot\frac{(E-1)-X-(X-1)}{E-1}\cdot\frac{(E-2)-X-(X-1)-(X-2)}{E-2}\cdots\frac{\{E-(N-3)\}-X-(X-1)-(X-2)-\cdots-\{X-(N-3)\}}{E-(N-3)}\xrightarrow[X\to\infty]{N\ small}1$ and thus $\mathrm{Prob}\{\exists p,\Delta_p\ge 2\}$ is asymptotically zero if X is sufficiently large.

budget- balanced policies.

(a) First, we calculate how many points the no-tax plan $(0,0)$ collects. Non-budget-balancing people give maximum points N to the no-tax plan $(0,0)$. Therefore, it collects Nl points from non-budget-balancing people. Budget-balancing people give a minimum 1 point to the no-tax plan $(0,0)$. Therefore, it collects k points from budget-balancing people. In sum, the no-tax plan $(0,0)$ collects $k + Nl$ points.

(b) Second, we calculate how many points budget-balanced tax plans (τ_1, τ_2) with $\tau_1 + \tau_2 = \mathrm{X}$ collect *on average*. Non-budget-balancing people give 1 point to $\frac{2N}{X+2}$ points, respectively, to budget-balanced tax plans. Therefore, they collect $\frac{\frac{2N}{X+2}\left(\frac{2N}{X+2}+1\right)}{2} l$ points in total from non-budget-balancing people. Budget-balancing people give N points to $\frac{\frac{2N}{X+2}\left(2N-\frac{2N}{X+2}+1\right)}{2}$ points, respectively, to budget balanced tax plans. Therefore, they collect $\frac{\frac{2N}{X+2}\left(2N-\frac{2N}{X+2}+1\right)}{2} k$ points in total from budget-balancing people. In sum, budget-balanced tax plans collect $\frac{N}{X+2}\left\{\left(N - \frac{N}{X+2} + \frac{1}{2}\right)k + \left(\frac{N}{X+2} + \frac{1}{2}\right)l\right\}$ points in total and $\left(N - \frac{N}{X+2} + \frac{1}{2}\right)k + \left(\frac{N}{X+2} + \frac{1}{2}\right)l$ points *on average*.

(c) Third, we calculate how many points a tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = p \in (0, X]$ can collect *at most*. Non-budget-balancing people strictly prefer any tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 < p$ to a tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = p$. Therefore, a tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = p \in (0, X]$ collects *at most* $\sum_{Q'=Q}^{X} \frac{2(Q'+1)N}{(X+1)(X+2)} = \frac{(X+Q+2)(X-Q+1)N}{(X+1)(X+2)}$ points from a non-budget-balancing person. Budget-balancing people strictly prefer any tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 > p$ to a tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = p$. Therefore, a tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = p \in (0, X]$ collects *at most* $\sum_{Q'=0}^{Q} \frac{2(Q'+1)N}{(X+1)(X+2)} = \frac{(Q+1)(Q+2)N}{(X+1)(X+2)}$ points from a budget-balancing person. In sum, a tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = p \in (0, X]$ can collect *at most* $\frac{(Q+1)(Q+2)N}{(X+1)(X+2)} k + \frac{(X+Q+2)(X-Q+1)N}{(X+1)(X+2)} l$ points.

(d) Consider a case where budget-balancing people are in the majority ($k > l$). As $\left(N - \frac{N}{X+2} + \frac{1}{2}\right)k + \left(\frac{N}{X+2} + \frac{1}{2}\right)l > k + Nl$ holds, a no-tax plan $(0,0)$ is never chosen. If a balanced tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = \mathrm{X}$ is chosen, (1) is already proven. Therefore, we will focus on a case where a tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = Q \in (0, X)$ is chosen. In such a case, $\frac{(Q+1)(Q+2)N}{(X+1)(X+2)} k + \frac{(X+Q+2)(X-Q+1)N}{(X+1)(X+2)} l > \left(N - \frac{N}{X+2} + \frac{1}{2}\right)k + \left(\frac{N}{X+2} + \frac{1}{2}\right)l$ is necessary. Equivalently, $\frac{k}{l} < \frac{2N(X+1)(X+2) - (X+1)(X+2) - 2N(X+1) - 2NQ(Q+1)}{2N(X+1)(X+2) + (X+1)(X+2) - 2N(X+1) - 2N(Q+1)(Q+2)}$ is necessary. Let $\varepsilon_1 \equiv \frac{k}{l} - 1$ and $\varepsilon_2 \equiv 1 - \frac{Q}{X}$. Whatever value $\varepsilon_1 > 0$ and $\varepsilon_2 > 0$ take, for a sufficiently large N, a sufficiently large X prevents this inequality from holding.[14] In other words, whatever value $\varepsilon_1 > 0$ and $\varepsilon_2 > 0$ take, for a sufficiently large N, if X is sufficiently large, $\tau_1 + \tau_2$ must be greater than $(1 - \varepsilon_2)X$ to be chosen. Thus, (1) is proven.

(e) Next, consider a case where non-budget-balancing people are in a majority ($k < l$). If a no-tax plan $(0,0)$ is chosen, (2) is already proven. Therefore, we will focus on a case where a tax plan (τ_1, τ_2) with $\tau_1 + \tau_2 = Q \in (0, X]$ is chosen. In such a case, $\frac{(Q+1)(Q+2)N}{(X+1)(X+2)} k + \frac{(X+Q+2)(X-Q+1)N}{(X+1)(X+2)} l > k + Nl$ is necessary. Equivalently, $\frac{k}{l} > \frac{Q(Q+1)N}{(Q+1)(Q+2)N - (X+1)(X+2)}$ is

[14] Suppose N takes its maximum value $\frac{(X+1)(X+2)}{2}$. The inequality is then deduced to be $\frac{k}{l} < \frac{X^2+2X-Q^2-Q}{X^2+2X-Q^2-3Q}$. Since $\varepsilon_2 \equiv 1 - \frac{Q}{X}$, this inequality is equivalent to $\frac{k}{l} < \frac{(2\varepsilon_2 - \varepsilon_2^2)X + 1 + \varepsilon_2}{(2\varepsilon_2 - \varepsilon_2^2)X - 1 + 3\varepsilon_2}$. A sufficiently large X prevents this inequality from holding. An identical discussion holds for a sufficiently large N.

necessary. Let $\varepsilon_1 \equiv \frac{l}{k} - 1$ and $\varepsilon_2 \equiv \frac{Q}{X}$. Whatever value $\varepsilon_1 > 0$ and $\varepsilon_2 > 0$ take, for a sufficiently large N, a sufficiently large X prevents this inequality from holding.[15] In other words, whatever value $\varepsilon_1 > 0$ and $\varepsilon_2 > 0$ take, for a sufficiently large N, if X is sufficiently large, $\tau_1 + \tau_2$ must be smaller than $\varepsilon_2 X$ to be chosen. Thus, (2) is proven.

(f) The sufficient condition that a budget-balanced tax policy is adopted is $\forall Q \in (0, X); \left(N - \frac{N}{X+2} + \frac{1}{2}\right)k + \left(\frac{N}{X+2} + \frac{1}{2}\right)l > \frac{(Q+1)(Q+2)N}{(X+1)(X+2)}k + \frac{(X+Q+2)(X-Q+1)N}{(X+1)(X+2)}l \wedge \left(N - \frac{N}{X+2} + \frac{1}{2}\right)k + \left(\frac{N}{X+2} + \frac{1}{2}\right)l > k + Nl$. By simple calculation, this condition is equivalent to $\forall Q \in (0, X); \frac{k}{l} > \frac{2N(X+1)(X+2) - (X+1)(X+2) - 2N(X+1) - 2NQ(Q+1)}{2N(X+1)(X+2) + (X+1)(X+2) - 2N(X+1) - 2N(Q+1)(Q+2)} \wedge k > l$. For a sufficiently large N, this condition is equivalent to $\frac{k}{l} > \frac{2N(3X+1) - (X+1)(X+2)}{2N(X+1) + (X+1)(X+2)} \wedge k > l$ and thus $\frac{k}{l} \geq 3$ is a sufficient condition that a budget-balanced tax policy is chosen. Therefore, (3) is proven.

(g) The sufficient condition that a no-tax policy is adopted is $\forall Q \in (0, X]; \frac{(Q+1)(Q+2)N}{(X+1)(X+2)}k + \frac{(X+Q+2)(X-Q+1)N}{(X+1)(X+2)}l < k + Nl$. By simple calculation, this condition is equivalent to $\forall Q \in (0, X]; \frac{k}{l} < \frac{Q(Q+1)N}{(Q+1)(Q+2)N - (X+1)(X+2)}$. Since $\min_{Q \geq 1, N, X} \frac{Q(Q+1)N}{(Q+1)(Q+2)N - (X+1)(X+2)} = \frac{1}{2}$ holds, $\frac{k}{l} < \frac{1}{2}$ is a sufficient condition that a no-tax policy is chosen. Therefore, (4) is proven.

(Q.E.D.)

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[15] Suppose N takes its maximum value $\frac{(X+1)(X+2)}{2}$. The inequality is then deduced to be $\frac{k}{l} > \frac{Q+1}{Q+3}$. Since $\varepsilon_2 \equiv \frac{Q}{X}$, this inequality is equivalent to $\frac{k}{l} > \frac{\varepsilon_2 X + 1}{\varepsilon_2 X + 3}$. A sufficiently large X prevents this inequality from holding. An identical discussion holds for a sufficiently large N.

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Why Fiscal Reform Makes no Progress in Japan

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Abstract

We use the Overlapping Generations Model with intergenerational heterogeneity to analyze the preferred form of taxation to achieve the fiscal reform necessary to maintain fiscal sustainability in Japan. We assumed two forms of taxation, *i.e.* the consumption tax increase or the progressive labor income tax increase, and used utility criteria and the existing voting system for our analysis. The results showed that support for a consumption tax increase is limited to the upper income bracket in generations younger than middle-age, rendering implementation of the fiscal reform policy impossible. Thus, we assumed a utilitarian government and confirmed that the consumption tax increase option would be favored in a case in which the sum of utility changes in all the people alive in the year fiscal reform is launched. However, a utilitarian government is equivalent to forcing other income groups to make sacrifices solely for the benefit of the high-income group and calls into doubt whether such a choice is fair.

Keywords: declining birthrate; aging population; fiscal reform; consumption tax; simulation analysis

JEL classification: **H30, C68, H61, E62, B41**

Introduction

(1) Financial trends

The sustainability of Japan's fiscal and social security systems, established on the premise of a growing population and an expanding economy, continues to be placed in jeopardy due to the declining birthrate and aging population. This situation was caused by accumulated government debt rising to more than double the GDP due to the failure to implement drastic institutional reform in spite of the projected inversion of the population pyramid.

Looking back on the circumstances, Japan's finances had deteriorated to such an extent that a declaration of fiscal emergency had to be issued in 1982. However, on the strength of the bounty of the so-called bubble economy, which began in the latter part of the 1980s, the situation was temporarily turned around and the country freed itself from the issuance of deficit-covering government bonds for four consecutive years from FY1990. Nevertheless, the financial condition once again deteriorated as a result of a continued increase in discretionary outlay, including tax cuts and government investment mainly in public projects which were implemented as economy-boosting measures in the post-bubble period.

In 2001, a new administration came into office and implemented reform of the former expansionary fiscal policy by proclaiming government expenditure reductions and structural reform.

In reality, although reduction in public investment progressed, the improvement in the fiscal balance was slow-paced, due partly to a slow recovery from the recession. However, tax revenue increased gradually in an expanding economy led by a steadily expanding global economy and weak yen. The national tax revenue for FY2007 reached 51 trillion yen, surpassing the level recorded for FY2000, when the economy was shored up by information technology.

Unfortunately, however, the situation once again changed drastically due to the Lehman Shock of 2008. The national tax revenue for FY2009 plunged to 38.7 trillion yen, and government expenditure surpassed 101 trillion yen due partly to the impact of economy-boosting measures. Subsequently, although the national revenue remained flat, as government expenditure remained at a high level, the government's dependence on bonds surpassed 50% in FY2009 for the first time since World War II, which allowed the critical conditions to drag on.

The second administration change towards the end of 2012 drastically shifted its policy emphasis to economic recovery. Under the policy package known as Abenomics, the "three arrows" strategy—bold monetary policy, flexible fiscal policy, and a growth strategy that promoted private investment—was issued. As measures for achieving fiscal soundness, the government aimed at increasing income by terminating deflation, thereby increasing tax revenue. In addition to that, partly due to the effect of the consumption tax hike implemented in 2014, FY2017 recorded the highest national tax revenue in 26 years—58.9 trillion yen—which is close to the 59.8 trillion yen recorded for FY1991. The government's dependence on bonds also dropped to 34.5% for FY2018 (based on the initial budget).

Despite increased tax revenue, government expenditures remained at high levels against a backdrop of a sustained increase in social security-related expenses. As a result, the Japanese government's outstanding debt continued to increase. According to an official announcement by the Ministry of Finance, the long-term debt outstanding as a percentage of GDP for FY2018 (on a budget basis) was 196%, tripling in the past 30 years. (The long-term debt outstanding as a percentage of GDP for FY1988 (actual) was 64%, and that for FY2003 (actual) was 134%.)

(2) Sustainability of government debt and tax increase policy

With a critical financial situation as a backdrop, empirical studies on the sustainability of the Japanese government's debt have been actively performed. Studies performed on the basis of the data of the 2000s have increasingly demonstrated that Japan's finances and government debt do not satisfy sustainability conditions.[1] This apprehension is deep-rooted even now. While the consumption tax hike was postponed, the level of consumption tax required to ensure fiscal sustainability has been estimated by OECD at 20% (2015), by Braun and Joines at 30-60% (2016), and at 40-60% by Hansen and Imrohoroglu (2016).

Nevertheless, government bonds have actually been sold in a stable manner, and their rates also continued to decline. As a result, interest payments remained at low levels, and the environment surrounding the government debt has been stable. Despite concerns expressed by many economists, there has, so far, been no sign of financial collapse. However, the trend of aging of the elderly,[2] which is projected to continue throughout this century, will increase social security benefit payments

[1] For instance, refer to Fukuda and Teruyama (1994), Kato (1997, 2004), Doi and Nakazato (1998, 2004), Hatano (1999, 2005), Doi (2000, 2004), Ihori, Nakazato, and Kawade (2002), Ono (2004), and Ihori and Doi (2007).

[2] The trend of aging of the elderly refers to an increasing percentage of the elderly aged 75 or over in the total elderly population. In fact, the elderly aged 75 or over, which accounted for 29.2% of the total elderly population in 1955, increased to 49.7% in 2017, and is projected to reach 66.5% in 2065.

and is expected to become a major contributor to the increase in government expenditure.[3] There is no doubt that avoiding further accumulation of outstanding government debt in anticipation of pressure to increase government expenditure in the future is an urgent issue from the standpoint of securing fiscal flexibility.

For the following reasons, it seems that the fiscal authorities prefer a consumption tax rate hike[4] rather than government expenditure reductions to achieve fiscal soundness: (1) consumption tax, which is widely borne by the entire population and not by any specific generation, is an appropriate revenue source for social security benefits in consideration of the declining number of people in the working-age generation and increasing number in the elderly, retired generations; and (2) consumption tax is less susceptible to economic fluctuations and is stable compared with income and corporate taxes. In fact, under the comprehensive reform of social security and taxation systems reflecting these ideas, the consumption tax rate was scheduled to be increased to 8% in FY2014 and to 10% in October 2015.[5] However, this planned increase to 10% was postponed to April 2017 and again to October 2019 on the grounds of a growing concern about a recession.

(3) Tax increase policy and public opinion

While a drastic tax increase is necessary to ensure sustainability of government debt, the people who bear the burden can be thought to have a "rational" reason for a choice regarding postponement of a consumption tax rate hike.

Let us first consider the interests of the elderly, retired generations. As their remaining life expectancy is shorter than that of the working-age generations, elderly people could be exempted from bearing their share of the burden if there is a delay in improvement in fiscal revenue and expenditure due to a tax increase. According to the "Comprehensive Survey of Living Conditions, 2016" issued by the Ministry of Health, Labour and Welfare, over 80% of elderly households (aged 65 or over) depend on benefits including public pension for over 60% of their income. Therefore, if their social security benefits are significantly reduced, they would inevitably be thrown into poverty, as they have no other source of income. If that should happen, however, they might expect to be eligible to receive public assistance and may not feel the need for an immediate increase in consumption tax rate. A consumption tax hike also places a great sense of burden on elderly, low-income households. The elderly, retired generations whose major income source is a pension on which they live (while also using any savings) would naturally desire that an improvement in fiscal revenue and expenditure should be achieved through income tax, which is exclusively borne by the working-age generations, and not through consumption tax, which they themselves also have to bear.

On the other hand, the optimal strategy for the working-age generations would be to ask the elderly, retired generations to also shoulder their share of the burden in order to avoid bearing the entire burden themselves. It also seems, however, that the actual working-age generations do not think they will be responsible for the financial burden. When the circumstances of the actual working-age generations are observed based on the salary levels of salaried workers in the private sector, the average salary dropped from 4.18 million yen in 1996 to 3.56 million yen in 2016—a decline of 620,000 yen over a period of 20 years.[6] The average salary by age group (among males)

[3] According to the Cabinet Secretariat, Cabinet Office, Ministry of Finance and Ministry of Health, Labour and Welfare (2018), social security benefit payments as a percentage of GDP is projected to increase from 21.5% in FY2018 to around 23-24.0% in FY2040.

[4] See Cabinet Secretariat (2011).

[5] The schedule for a consumption tax rate hike is stipulated under the Fundamental Tax Reform Act. The distribution of the additional revenue is also stipulated under the Social Security System Reform Program Act.

[6] National Tax Agency, "Statistical Survey of Actual Status for Salary in the Private Sector".

for 2016 had decreased by nearly 10% across all age groups compared with two decades ago. In addition, among the generations between the ages of 20 and 59, there are 13.57 million unmarried persons who live with their parents, including as many as 2.17 million so-called *parasite singles* aged between 20 and 54, who depend on their parents for their basic living necessities.[7,8] Quite a few of them have no choice but to rely on their parents' pension and/or income. Even among the working-age generations, the livelihood of some households is projected to be disrupted or both the parents and their children's livelihoods could be at stake if a reduction in social security benefits or a consumption tax hike is implemented. Therefore, it is not surprising that they hope to avoid drastic financial and social security reform; or if it is not avoidable, that they hope that such reform is implemented at the cost of upper income brackets and not through a consumption tax hike.

As seen above, even among the working-age generations, low-income households would prefer an income tax increase rather than a consumption tax increase, considering the scale of their effective tax burden ratio. In fact, according to the "Survey on the Redistribution of Income" issued by the Ministry of Health, Labour and Welfare, although the ex-post income distribution is relatively stable due to the effect of income taxation and social security systems, the initial income gap has widened. The background factors include not only a cyclical downward pressure on wages due to slack in the labor market in macroeconomic terms but also changes in the economic structure, such as a rise in the employment rate of non-regular employees and loss of higher-wage employment opportunities. In addition, Japan has seen not only stagnation in initial income but also changes in the household structure, such as an increase in the unmarried population, who gain small benefits from taxation and social security systems.

To sum up, it is considered that the low income brackets both in the elderly, retired generations and working-age generations tend to prefer a tax increase in income tax on upper income bracket, not a consumption tax hike, and only the upper income bracket of the working-age generations tend to prefer an increase in consumption tax, which is shouldered broadly and thinly by the entire population.

(4) Analysis methods

As discussed above, in considering the feasibility of fiscal reform in Japan, the crucial point is whether the age/income brackets to which individuals with voting rights belong seek an increase in income tax or in consumption tax at the time that the methods and start of fiscal reform are determined. A general equilibrium Overlapping Generations Model with intragenerational heterogeneity is a suitable tool for the following reasons: it can address the issue of intragenerational and intergenerational household attributes and the resultant difference in perceptions of interests, and it enables a quantitative assessment of different effects, which are brought about by different fiscal reform methods, on respective welfare levels in a macroeconomic environment.

Previous studies in which income gap and policy effect in Japan were quantitatively analyzed from a standpoint relatively similar to our awareness of the issue include Miyazato and Kaneko (2001) and Okamoto (2013). Miyazato and Kaneko (2001) introduced four different income groups and bequest in a general equilibrium Overlapping Generations Model, which has its origin in Auerbach and Kotlikoff (1987), and estimated the effect of the 2000 Pension Reform on the intergenerational and intragenerational income gap by taking into account two cases—one in which mobility between different income groups is fixed and the other in which it is fluid. The study

[7] Yamada (1999) defines *parasite singles* as "unmarried people who live with their parents even after graduation and depend on their parents for their basic living necessities."

[8] See Nishi (2017).

clarified that although a progressive reduction in the income replacement ratio corrects the intergenerational income gap, it has the combined effect of narrowing the intragenerational income gap when the mobility between different income groups is fluid and expanding the intragenerational income gap when the mobility between different income groups is fixed.

Okamoto (2013) focused on a pension reform plan in which "the public pension is limited to basic pension alone, and the basic pension benefits are entirely financed by consumption tax," and performed a simulation analysis in order to elucidate the effect of this reform plan on economic welfare and intragenerational and intergenerational income redistribution by using the Auerbach and Kotlikoff (1987)-style general equilibrium simulation model of overlapping generations and by incorporating three different earning ability classes (low, medium, and high income classes) into the representative households. The simulation results suggest that although the said reform plan increases capital accumulation and promotes economic growth from a macro perspective, the attainment of a Pareto improvement is difficult even if money transfer between generations whose economic welfare decreases and those whose economic welfare improves is taken into consideration. On the other hand, however, as this reform plan also substantially improves the welfare of future generations by achieving a significant economic growth in the future, if emphasis is placed on enhancing the welfare of future generations, implementation of this reform plan is therefore desirable.

These previous studies explicitly or tacitly assume a paternalistic government, which makes policy decisions by using as assessment criteria the possibility of a Pareto improvement and the degree of reduction in the burden on the current heavily-burdened generations (many of which are future generations).[9] In actual democratic countries, however, eligible voters who have diverse attributes such as generation, income bracket, and so on, contribute to policy decisions by taking into consideration changes in the utility and economic welfare for themselves. In other words, there is no assurance that the best policy from a long-term perspective beyond the intergenerational and inter-income brackets' conflicts of interest and the synthesized sum of policy desired by diverse eligible voters match—this point is ignored by previous studies. Therefore, this paper aims to clarify by generation and by income bracket pros and cons in the case where eligible voters correctly recognize the benefits and burdens brought to them when a policy is presented.

The remaining part of this paper is organized as follows: Section 2 explains the model we used in our simulation analysis. Section 3 explains the data we used, specifies parameters, and presents the tracking performance of the current Japanese economy. In Section 4 we confirm the future trends of macroeconomic variables and financial and social security variables, and classify the simulation results into three different cases: (1) when the eligible voters consider their own utility and welfare in the short-term, (2) when the eligible voters consider their own utility and welfare in the long-term, and (3) when a utilitarian government makes a policy choice without putting it up for a vote and considers the differences in policies that are chosen by voting and those determined by the utilitarian government. Lastly, in Section 5, we summarize and present policy implications.

1. Simulation model

The details of our simulation model are described in this section, the details of our simulation model. The simulation model is positioned in the stream of the general equilibrium Overlapping Generations Model, which has its origin in Auerbach and Kotlikoff (1987). We also modeled the actual fiscal and social security systems of Japan, as needed, to make them better suited for an

[9] See, for instance, Brunner (1996), Nishiyama and Smetters (2005).

analysis of the Japanese economy. The simulation model consists of the following five sectors: household sector, corporate sector, government sector, pension sector, and other social security sector. For simplification, only one type of goods which can be either consumable or investment, exists, and foreign trade does not exist. At each point in time, a large number of working-age generations and retired generations (65 generations in total), who are expected to live for a finite time period, exist simultaneously.

(1) Households

Households are classified into four income brackets based on different productivity: low income bracket, lower-middle income bracket, upper-middle income bracket, and upper income bracket. The structure of each income bracket is the same; it is identical with what has conventionally been called *setai* ("household" or "family unit"). The utility of each household is determined by its consumption level. Also, there is uncertainty as to lifespan, and property may be unintentionally left behind (presence of inheritance). A household born in year t starts to work at the age of 20, continues to work until the age of 64, retires completely at the age of 65, and dies before reaching 85. As a result of taking an action to maximize expected utility over time, each household decides on a consumption and saving profile under the budget constraints of lifetime income, which consists of labor income, interest income, pension income, and unintended inheritance, given the fiscal and social security system.

If this is formulated, the utility function U_i^g of the i-th generation household in income bracket g, is:

$$U_i^g = \frac{1}{1-\gamma}\sum_{j=0}^{65} sr_{i,j}\left(\frac{1}{1+\rho}\right)^{j-1} c_{i,j}^{g,1-\gamma} \quad (1)$$

where $c_{i,j}^g$ is consumption, γ is the inverse of elasticity of intertemporal substitution, and ρ is the time preference rate. The income brackets $g\ (=l, lm, um, u)$ represent the low income, lower-middle income, upper-middle income, and upper income bracket, respectively. In addition, $sr_{i,j}$ denotes the probability that an i-th generation individual is able to live until the age of j, which is expressed by the sum of multiplying the age-dependent and generation-specific survival rate $q_{j,j-1}^i$.[10]

$$sr_{i,j} = \prod_{m=1}^{j} q_{m,m-1}^i \quad (2)$$

The budget constraint equation for a household in income bracket g, aged j as of year t is:

$$a_{i,j}^g = a_{i,j-1}^g\{1 + r_t(1 - tr_t)\} + pen_{i,j}^g + pm_{i,j}^g + pn_{i,j}^g + beq_{i,j}^g + \tilde{w}_t e_j^g\left(1 - tw_t\tilde{w}_t e_j^g\right) - c_{i,j}^g(1 + tc_t) - b_{i,j}^g - bm_{i,j}^g - bn_{i,j}^g \quad (3)$$

where $a_{i,j}^g$ is the financial asset owned by an i-th generation individual aged j in income bracket g, r_t is the interest rate at year t, $\tilde{w}_t(=(1+\lambda)w_t)$ is the wage rate at year t, which is measured in efficiency units, λ is labor productivity, and e_j^g is the age profile of the wage earning ability of an individual aged j in income bracket g. $pen_{i,j}^g$, $b_{i,j}^g$, $pm_{i,j}^g$, $bm_{i,j}^g$, $pn_{i,j}^g$, $bn_{i,j}^g$ denote public pension benefits, pension premiums, medical care benefits, insurance premiums for medical care, long-term care insurance benefits, and insurance premiums for long-term care of an i-th generation individual aged j in income bracket g, respectively. In addition, $beq_{i,j}^g$ denotes the inheritance received. tr_t, tw_t, tc_t denote capital income tax rate, labor income tax rate, and consumption tax rate, respectively, as of year t. The labor income tax rate is progressively charged

[10] We calculated the survival rate based on the median population estimates from the "Population Projections for Japan (2017 estimates)" released by National Institute of Population and Social Security Research.

on the labor income of each period.

By following in the steps of Auerbach and Kotlikoff (1987) and Okamoto (2013), we assumed the income bracket-specific marginal tax rate as $tw_t = \psi + \pi w_t e_j^g, \pi > 0$. In this instance, the income bracket-specific average tax rate is $\overline{tw}_t = \psi + \frac{\pi}{2} w_t e_j^g$. In addition, according to this formulation, if $\pi = 0$, labor income tax is not a progressive but a proportional tax. By making π larger and making ψ smaller at the same time, the progressive taxation system can be strengthened further, while keeping the total tax revenue constant.

As for the public pension, while pension premiums $b_{i,j}^g$ are collected from working-age generations until they retire at the age of 64, pension $pen_{i,j}^g$ is granted to retired generations aged 65 or over. The public pension system is two-tiered; it consists of a fixed-amount component f_t and an earnings-related component $pr_{i,j}^g$. While the fixed-amount component commonly applies to all income brackets, a certain percentage β of the average labor income per year H_i^g earned by an i-th generation individual in income bracket g during his/her working period is granted as an earnings-related component.

$$b_{i,j}^g = tp_t \widetilde{w}_t e_j^g \quad (4)$$

$$pen_{i,j}^g = f_t + pr_{i,j}^g = f_t + \beta H_i^g \quad (5)$$

$$H_i^g = \frac{1}{44} \sum_{j=1}^{44} \widetilde{w}_t \, e_j^g \quad (6)$$

As the model incorporates uncertainty of lifespan, it is necessary that the assets owned by the household who exited the model before reaching the above-specified lifespan of 85 are retained in the model based on a certain rule. Hence, we treat such assets as unintended inheritance in this paper. More specifically, if a household in a certain income bracket exited the model, his/her assets will be equally distributed to all the surviving households in the same income bracket. In this instance, the inheritance amount $beq_{i,j}^g$ received by an i-th generation individual aged j in income bracket g is:

$$beq_{i,j}^g = \frac{(1-tb)BEQ_t^g}{\sum_{k=0}^{65} N_{t-k+1,k}^g}, \text{ however, } BEQ_t^g = \sum_{j=0}^{65} \left(N_{t-j,j}^g - N_{t-j,j+1}^g \right) a_{t-j,j}^g \quad (7)$$

where tb is inheritance tax, BEQ_t^g is the total amount of inheritances received by income bracket g, and $N_{i,j}^g$ is the population of the i-th generation in income bracket g as of age j.

Therefore, by solving the maximization problem of the utility function in equation (1) with equation (3) as budget constraint, the following flow of consumption is obtained for each household in each income bracket:

$$c_{i,j}^g = \left\{ \frac{1+sr_{i,j}}{1+sr_{i,j-1}} \right\}^{\frac{1}{\gamma}} \left\{ \frac{1+(1-tr_t)r_t}{1+\rho} \right\}^{\frac{1}{\gamma}} \left\{ \frac{1+tc_{t-1}}{1+tc_t} \right\}^{\frac{1}{\gamma}} c_{i,j-1}^g \quad (8)$$

where macro-level total consumption C_t in year t is:

$$C_t = \sum_g \sum_{j=0}^{65} N_{t-j+1,j}^g \, c_{t-j+1,j}^g \quad (9)$$

and, macro-level assets owned by households A_t are:

$$A_t = \sum_g \sum_{j=0}^{65} N_{t-j+1,j}^g \, a_{t-j+1,j}^g \quad (10)$$

In addition, labor supply L_t in year t is determined by the total population of the working-age generation in each income bracket and labor efficiency by age as follows:

$$L_t = \sum_g \sum_{j=0}^{44} N_{t-j+1,j}^g \, e_j^g \quad (11)$$

In addition, labor supply is inelastic, and no labor is supplied after retirement at the age of 64.[11]

(2) Firms

Firms produce products based on the Cobb-Douglas technology, according to given factor prices, in order to maximize their profit. In other words, corporate activity is expressed by the Cobb-Douglas production function with capital K_t, which is supplied by households, and labor power LE_t, measured in efficiency units, as production factors, and outputs goods Y_t, which can be both consumption goods and investment goods. In addition, firms maximize their profits given their capital and cost of labor. Furthermore, technological progress rate λ is Harrod-neutral, and exogenously constant.

$Y_t = AK_t^{\alpha} LE_t^{1-\alpha}$, however, $LE_t = (1+\lambda)^t L_t$ (12)

where α is capital share.

As firms are price takers, their respective marginal productivity must equal their earnings ratio based on their profit maximization conditions. Hence, the following equation holds:

$r_t = \alpha A K_t^{\alpha-1} LE_t^{1-\alpha} - \delta$, $w_t = (1-\alpha) A K_t^{\alpha} LE_t^{-\alpha}$ (13)

where δ is the capital depletion rate.

(3) Government

The major annual government revenues include labor income tax, consumption tax, capital income tax, and gift tax, while its major annual expenditures include outlay G_t other than transfer expenditure and the government's contribution to the pension sector GSP_t. If the tax revenue is insufficient to cover the annual government expenditures, government bonds are issued and coupon payments are made accordingly.

In this instance, the government's budget constraint equation as of year t is:

$D_{t+1} - D_t = r_t D_t + G_t + GSP_t + GSM_t + GSN_t - T_t$ (14)

where D_t is government debt outstanding, T_t is tax revenue, and GSM_t and GSN_t are the government's contribution to the medical insurance sector and to the long-term care insurance sector, respectively.

Note that $G_t = \theta_G Y_t$, $\theta_G > 0$,

$T_t = tc_t C_t + \sum_g \sum_{j=1}^{44} \left\{ \psi w_t e_j^g + \frac{1}{2} \pi \left(w_t e_j^g \right)^2 \right\} + tr_t A_t + tb_t BEQ_t$ (15)

(4) Pensions

The public pension sector is independent of the government and is managed under the pay-as-you-go system with reserve PF_t, similar to the one currently adopted by Japan. It receives pension premiums B_t, which are collected from the working-age generations until they retire at the age of 64, and the government's contribution GSP_t to the fixed-amount component F_t, and provides a pension PEN_t for the retired generations aged 65 or over, the balance being kept as a reserve.

$B_t = tp_t \tilde{w}_t L_t$ (16)

$P_t = \beta \sum_g \sum_{j=45}^{65} N_{t-j+1,j}^g H_{t-j+1}^g$ (17)

[11] It is considered that the assumption in which retired households do not supply labor at all, as in the case with our model, is not extreme, considering the uniformly lower post-retirement wage levels compared with working period and a major reduction in the labor participation rate among the elderly generation compared with the working generation.

$F_t = \sum_{j=45}^{65} N_{t-j+1} f_t$ (18)

$GSP_t = \zeta F_t$ (19)

ζ is the government's share of contributions to the basic pension component,
where the budget constraint equation of the pension sector is:

$PF_{t+1} = \{1 + (1 - tr_t) r_t\} PF_t + GSP_t + B_t - P_t$ (20)

(5) Other social security sector

According to our model, medical insurance and long-term care insurance exist as the other social security sector, independent of the government sector and public pension sector. The sector provides benefits with a revenue source of insurance premiums and the users' out-of-pocket expenses; the gap between the income and expenses is borne by the government, and the sector is managed under the pay-as-you-go system.

First, the medical insurance sector is expressed as follows:

$BM_t = \sum_g \sum_{j=0}^{65} bm_{i,j}^g = \sum_g \sum_{j=0}^{65} tm_t \left(\tilde{w}_t + pen_{i,j}^g\right) N_{t-j+1,j}^g$ (21)

$PM_t = \sum_g \sum_{j=0}^{65} pm_{i,j}^g N_{t-j+1,j}^g$ (22)

where the budget constraint equation of the medical insurance sector is:

$PM_t = BM_t + GSM_t$ (23)

Next, the long-term care insurance sector is expressed as follows:

$BN_t = \sum_g \sum_{j=20}^{65} bn_{i,j}^g = \sum_g \sum_{j=20}^{65} tn_t \left(\tilde{w}_t + pen_{i,j}^g\right) N_{t-j+1,j}^g$ (24)

$PN_t = \sum_g \sum_{j=45}^{65} pm_{i,j}^g N_{t-j+1,j}^g$ (25)

where the budget constraint equation of the long-term care insurance sector is:

$PN_t = BN_t + GSN_t$ (26)

Note that BM_t、BN_t、PM_t、PN_t、GSM_t、GSN_t denote the total revenue from insurance premiums for medical care, total revenue from insurance premiums for long-term care, total amount of medical care benefits, total amount of long-term care insurance benefits, the government's contribution to the medical insurance sector, and the government's contribution to the long-term care insurance sector.

(6) Equilibrium condition

In order to close the model, the following conditions regarding the capital and goods markets are needed.

$K_t + D_t = A_t + PF_t$ (27)

$Y_t = C_t + K_{t+1} - (1 - \delta) K_t + G_t + GSP_t + GSM_t + GSN_t$ (28)

2. Data and parameter values

This section discusses the data and parameter values required for simulation analysis in the following section. As parameter values are difficult to estimate or relevant analyses are not available, we decided to use values which would make the simulation results realistic.

As mentioned earlier, many previous studies performed simulations by calibrating parameter values on the assumption that the economic conditions in the most recent year are stationary. In such a case, however, the economic conditions in the most recent year could influence the simulation results, which can pose a serious problem for the AK model, coupled with limited availability of estimated parameter values that are usable. Hence, in performing the simulation in this paper, we avoided possible impact of the stationarity assumption concerning initial values and of the methods of setting parameter values for the economy in 2018 and beyond, which is the target period of our analysis, by reproducing, as much as possible, the economic conditions of the years for which various actual figures can be obtained by dating back to 1901 and through to the years for which the latest data can be obtained. In short, our simulation is characterized by a reproduction of the economic and financial conditions of Japan without assuming that the present conditions are stationary.[12]

(1) Data

For the population variables, we traced the past actual figures back to 1950 based on the "Population Estimates" of the Statistics Bureau, Ministry of Internal Affairs and Communications. As for the future population in FY2018 and beyond, we used median estimates data up to 2115 from the "Population Projections for Japan (2017 estimates)" released by National Institute of Population and Social Security Research. In addition, as estimates published in the "Population Projections for Japan" covers a period only up to 2115, we set the population growth of persons 20 years of age at zero percent for subsequent years. As for the survival rate of households, we used the Future Life Tables included in the "Population Projections for Japan (2017 estimates)" released by National Institute of Population and Social Security Research.

Next, for the major financial and macroeconomic variables, we used chronological data from the "Annual Report on National Accounts" published by the Economic and Social Research Institute, Cabinet Office. The specifics are explained below.

As for the actual figure of government consumption, we summed the final consumption expenditure of government, public capital formation, and public stock increase. For the actual figures of consumption tax revenue and labor income tax revenue, we used tax imposed on products/imported products and tax imposed on income, respectively, which are specified in Supporting Table 6 "Account classified by the Sub-sectors of General Government" in the "Annual Report on National Accounts" (Flow Accounts). With regard to the capital income tax revenue and inheritance tax revenue, we used self-assessed income tax, withholding income tax, and inheritance tax specified in the "National Tax Agency Annual Statistics Report." Note that consumption tax revenue, labor income tax revenue, capital income tax revenue, and inheritance tax revenue are endogenously determined. As for the actual figure of government debt outstanding, the sum of central and local government bonds including investment-and-loan bonds, which are specified in Supporting Table 6 "Closing Stocks of Financial Assets and Liabilities" in the "Annual Report on National Accounts" (Stock Accounts) were used. For the actual primary balance figure, we used the primary balance figure specified in Supporting Table 6 "Account classified by the Sub-sectors of

[12] See Shimasawa, Nanba, Tsutsumi and Oguro (2018) for the methods and results of simulation and a comparison with actual figures in detail.

General Government" in the "Annual Report on National Accounts" (Flow Accounts). Both variables are endogenously determined based on the government's budget constraint equation.

For the social security-related variables, the total amount of medical care benefits, total amount of long-term care benefits, government's contribution to pension financing, pension reserve balance as a percentage of GDP, and income replacement ratio are exogenously given.

For the actual figure of the total amount of pension benefits and that of the total amount of pension premiums, we used welfare pension, national pension, and seamen's insurance pension benefits, and long-term accounting of respective mutual aid associations specified in Supporting Table 9 "Transfers from General Government to Households" in the "Annual Report on National Accounts" (Flow Accounts); and welfare pension, national pension, seamen's insurance pension provision, and long-term accounting of respective mutual aid associations specified in Supporting Table 10 "Social Security Contributions" in the "Annual Report on National Accounts" (Flow Accounts). As for the government's contribution to pension financing, we used the current transfers within general government in the social security funds, which are specified in Supporting Table 6 "Account classified by the Sub-sectors of General Government" in the "Annual Report on National Accounts" (Flow Accounts).

For the revision schedule of the government's share of contributions to the basic pension component and income replacement ratio, we abide by the Pension Reform enacted in June 2004. The pension premium rate is endogenously determined so as to satisfy the budget constraint equation of the pension sector under the exogenously given income replacement ratio, the government's share of contributions to the public pension, and the pension reserve ratio; and the total revenue from the pension insurance premiums is obtained. In addition, the pension reserve balance is assumed to be consumed by leaving aside, in 2100, an amount equivalent to a year's worth of the total amount of pension benefits after the simulation has been started.[13]

As for the actual figures of the total amount of medical care benefits, total amount of long-term care benefits, total revenue from insurance premiums for medical care, and total revenue from insurance premiums for long-term care, we used relevant items specified in Supporting Table 9 "Transfers from General Government to Households (Social Security Transfers)" in the "Annual Report on National Accounts" (Flow Accounts) and those specified in Supporting Table 10 "Social Security Contributions" also in the "Annual Report on National Accounts" (Flow Accounts), respectively.

For the technological progress rate, a variable which determines a long-term economic growth rate, we computed the Solow residual in the track of Hayashi and Prescott (2002), and averaged figures in the 1980s and beyond. We obtained the capital depletion rate by dividing the fixed capital depletion rate of non-financial corporations and financial corporations specified in "Income and Outlay Accounts classified by Institutional Sectors" in the "Annual Report on National Accounts" (Flow Accounts) by the installation-type capital stock value specified in the "Private Sector Capital Stock Statistics" published by the Economic and Social Research Institute, Cabinet Office.

We assumed that the assumed future values for exogenous variables for respective sectors discussed above are constant at the levels of FY2016 during the simulation period.

(2) Specifying parameters

As for the time preference rate ρ and the inverse of elasticity of intertemporal substitution γ concerning utility function of households, and capital share α, values have been given to these

[13] The 2004 Fiscal Recalculation requires that the targeted reserve level should be set such that a certain level of payment reserve (equivalent to a year's worth of pension benefits) is assured in FY2100.

parameters such that various macroeconomic variables, financial variables, and social security variables are able to reproduce the actual data of Japan in FY2016, while using as reference values used in previous studies performed at home and abroad and estimation results obtained through empirical analyses.[14,15] Households are classified into four income brackets. We used data from the "Basic Survey on Wage Structure" of the Ministry of Health, Labour and Welfare; more specifically, the average wage and the number of workers by educational background—graduates of junior high schools, graduates of senior high schools, graduates of higher professional schools and junior colleges, and graduates of universities or graduate schools—to estimate the age profile of the wage earning ability. By doing so, we segmented the same generation into subgroups.[16,17] As for the age profile of the wage earning ability e_j^g of an individual aged j in income bracket g, we adopted a quadratic form($e_j^g = e^{a_0+a_1 j-a_2 j^2}$, $a_0,\ a_1,\ a_2 > 0$)similar to many of the previous studies including Auerbach and Kotlikoff (1987), Miles (1999) and others. The estimation results of age-specific productivity profile are as follows:

$e^l = e^{0.014475+0.000712j-0.000012j^2}$, $e^{lm} = e^{0.014406+0.000872j-0.000015j^2}$,
$e^{um} = e^{0.014417+0.000948j-0.000015j^2}$, $e^u = e^{0.011067+0.001827j-0.000023j^2}$

Auerbach and Kotlikoff (1987) and Okamoto (2013) segmented income brackets by multiplying average age-specific wage profiles by different constants .[18] In contrast, we estimated the educational attainment-specific and age-specific wage profile directly from the "Basic Survey on Wage Structure" of the Ministry of Health, Labour and Welfare, and deemed educational attainment to represent income brackets before incorporating them into the model as the income bracket-specific and age-specific wage profile. The point is that, according to Auerbach and Kotlikoff (1987) and Okamoto (2013), the age-specific deviation rates for the wages of different income brackets and for progressive labor income tax rate roughly correspond to the constants, which were used to segment income brackets regardless of ages. In our model, on the other hand, the deviation rates for wages of different income brackets and for progressive labor income tax rate fluctuate by age. That is, according to previous studies, the difference in the timing of a tax hike and in the tax rate implemented for the purpose of fiscal reform does not affect the decision-making of households within the same generation differently, as the age-specific profiles of wages and progressive labor income tax rate are identical among different income brackets. In this paper, on the other hand, the contents of and different timing of a newly implemented policy have an impact also on the decision-making of households within the same generation, as their profiles are not identical. This is an essential feature to enable generation-specific and income bracket-specific households to decide on a policy through voting.

The parameters and exogenous variables detailed above are shown in Table 1. A comparison between the results of a simulation performed based on these settings and the actual figures for FY2016 are shown in Table 2.

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14 Referred to in Uemura (2002) and Kawade, Bessho, and Kato (2003).

15 The same parameter values were used for each income bracket concerning utility function of households.

16 In this paper, the population ratio of income brackets in each generation remain fixed during the simulation period. In addition, mobility between different income brackets is not taken into consideration.

17 l, ml, mh, h, denote graduates of junior high schools, graduates of senior high schools, graduates of higher professional schools and junior colleges, and graduates of universities or graduate schools, respectively.

18 Okamoto (2013) set values of constants for low income bracket, middle income bracket, and upper income bracket at 0.7143, 1, and 1.4283 respectively. In other words, Okamoto virtually assumes that the income earning ability of the upper income bracket is twice as high as that of the low income bracket throughout the lifetime. In reality, however, the gap varies by age.

Table 1. Parameter values and exogenous variables

Parameter name / Exogenous variables	Values
Time preference rate (ρ)	-0.0075
Inverse of elasticity of intertemporal substitution (γ)	0.60
Capital share (α)	0.25
Income replacement ratio (β)	0.50
Technological progress rate (λ)	0.01
Progressive labor income tax	$\psi = 0.02$ $\pi = 0.03$
Capital income tax rate	0.20
Inheritance tax rate	0.10
Government's share of contributions to the basic pension component	0.50
capital depletion rate (δ)	0.05
Government consumption expenditures as a percentage of nominal GDP	0.123

Table 2. A comparison between actual figures and simulated figures

Endogenous variables	Actual figures	Simulated figures
Savings rate	0.123	0.134
Consumption tax revenue (% of nominal GDP)	0.084	0.085
Labor income tax revenue (% of nominal GDP)	0.069	0.071
Capital income tax revenue (% of nominal GDP)	0.009	0.009
Inheritance tax revenue (% of nominal GDP)	0.004	0.004
Total amount of pension benefits (% of nominal GDP)	0.073	0.069
Primary balance (% of nominal GDP)	-0.026	-0.024
Government debt outstanding (% of nominal GDP)	1.955	2.023

(3) Simulation cases

Here we describe the outline of the simulation cases. We set the following simulation cases in order to analyze 1) which of the two, an income tax increase or a consumption tax increase is 2) chosen by which income brackets of which generations, and 3) whether or not the choice made by voting coincides with that made under an utilitarian government, in the case that fiscal reform is to be implemented through tax increase.

In case 1, the government debt outstanding as a percentage of nominal GDP is firstly set at 202% in 2018, 150% is attained in 2060, and equivalent levels are exogenously given for subsequent

years. Further, in order to realize this path, the progressive labor income tax rate is endogenously increased. In case 2, the consumption tax rate is endogenously increased in order to realize the path that leads to the achievement of similar levels of government debt outstanding as a percentage of nominal GDP, as explained in Case 1. In addition, a sufficient period of time is ensured in the simulation to achieve stationary conditions after the start of fiscal reform.

3. Simulation results

In this section we perform a simulation based on the data, parameter values, and simulation setting described in the preceding section and analyze the results. First, we look at the trends of macroeconomic and financial variables and clarify which choice the age-specific and income bracket-specific households make regarding the fiscal reform measure: a progressive labor income tax increase (Case 1) or a consumption tax increase (Case 2).

(1) Demographic, macroeconomic, and financial variables

1) Demographic trends
We consider the demographic trends of the model based separately on (i) the trends of total population and (ii) the trends of population aging rate.

(i) Trends in total population
The total population in this model denotes the level of population aged between 20 and 85 years. The total population in this model starts to decline gradually from 2017; it further drops to 37% of the level of 2017 in 2115, and to 20% of the 2017 level over an ultra-long-term period (Figure 1). A comparison between the levels and trends of the total population in the model and the actual levels and trends[19] confirms that largely similar levels and trends are being reproduced.

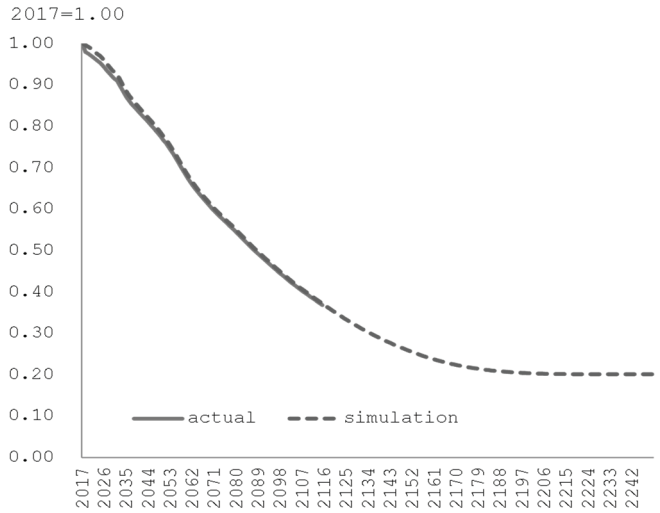


Figure 1. Trends in total population

[19] As for the actual trends, we used the median birth and median death data from the "Population Estimates" of the Statistics Bureau, Ministry of Internal Affairs and Communications for 2017, and those from the "Population Projections for Japan (2017 estimates)" released by National Institute of Population and Social Security Research for 2018 through 2115. The same applies to the trends of population aging rate, which is described below.

(ii) Trends in population aging rate

The population aging rate in this model indicates the percentage of elderly aged 65 or over in the total population aged between 20 and 85 years. The population aging rate continues to increase from nearly 30% in 2017 to a peak in 2051 at 37.6%, and then declines until around 2060 (Figure 2). It then nearly flattens with repeating fluctuations, and gradually declines from around 2140 to reach 28% over an ultra-long-term period. When compared with the actual population aging rate, the levels and trends are largely similar, as is the case with the total population.

Such a drastic shift in demographics has a major impact on macroeconomy, finance, and social security. In the following, we analyze the trends in savings rate, GDP, interest rate, wage rate, average values of consumption tax rates, and marginal labor income tax rates, public pension premium rates, and Gini coefficient.

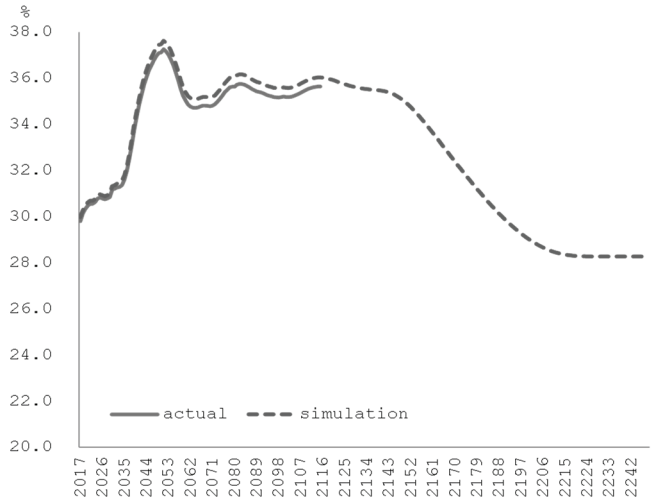


Figure 2. Trends in population aging rate

2) Savings rate

If we assume that consumption behaviors are driven by the life cycle hypothesis, the savings rate will decline, as dissaving by retired generations overwhelms the savings of working-age generations in line with the acceleration of demographic aging. Furthermore, in the case when labor income tax is increased, the tax burden concentrates on the working period, thereby straining disposable income, and, as a result, savings in the working period falls below that in the case of a consumption tax hike, which imposes an average tax burden over a lifetime. Therefore, it is evident that the savings rate in Case 2 (i.e., consumption tax increase) consistently hovers above the level of Case 1 (i.e., labor income tax increase) by about five percentage points (Figure 3).

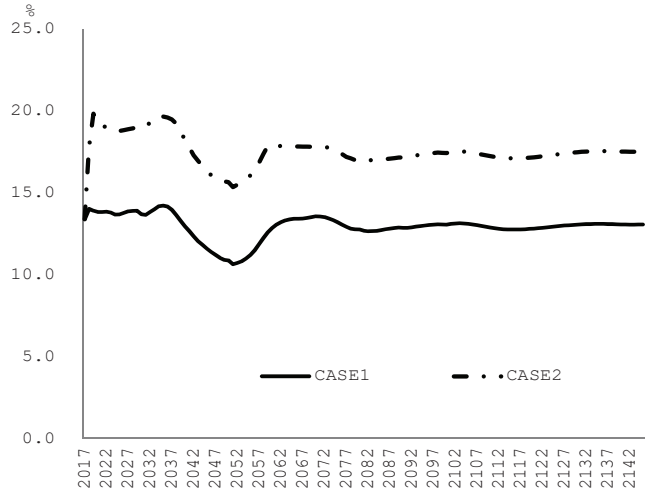


Figure 3. Trends in savings rate

3) GDP

Let us now look at the trends in GDP. According to the neoclassical growth model—designed by Solow (1956) and Swan (1956)—in which the technological progress rate is exogenously determined, and which we have adopted in this paper, although the impact of changes in savings rate on the economic growth rate is temporary, the impact on GDP level is enduring. For instance, when the savings rate increases for some reason, the economic growth rate deviates upward from the conventional growth path for a while. However, after a lapse of sufficient time, it goes back to the original growth path. As a result, the GDP level increases in proportion to the period during which the growth rate exceeded the original path.

In consideration of the above, the simulation results show that although GDP increases until around 2030 in both cases, it decreases after that to 85% and 90% of the 2017 levels in Case 1 and Case 2, respectively, over an ultra-long-term period (Figure 4). The GDP level of Case 2 exceeds that of Case 1, which is because the saving rate of Case 2 exceeds that of Case 1.

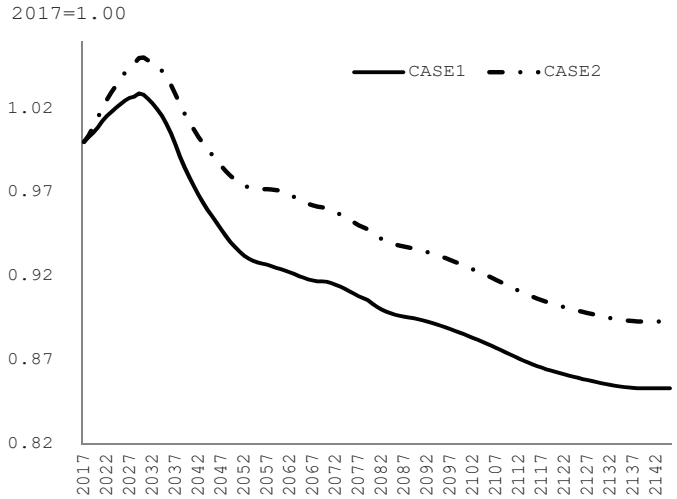


Figure 4. Trends in GDP

4) Interest rate

In this simulation model, interest rate and wage rate are determined by marginal conditions, which are based on profit maximization behavior of firms. In addition, labor supply is exogenously determined, and interest rate is dependent on capital stock level. Furthermore, as capital transfer between countries is also ignored, the capital stock level is solely dependent on the sum of savings built up by working-age generations and spending down of one's savings by the retired generation in the country. Therefore, the interest rate is lower in Case 2, in which the savings rate is relatively higher than Case 1 (Figure 5).

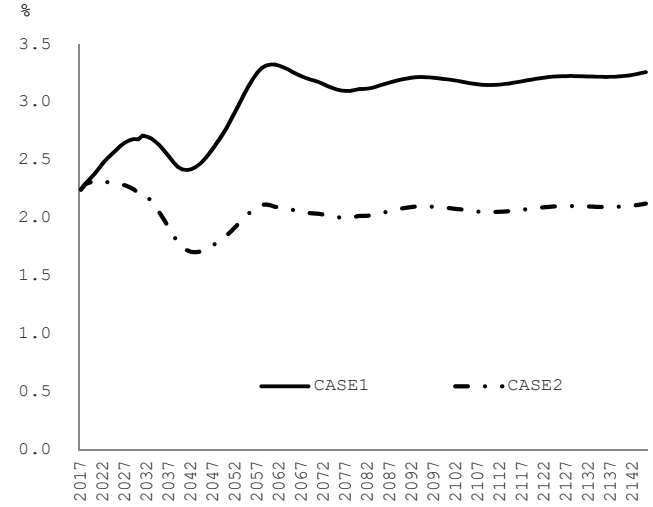


Figure 5. Trends in interest rate

5) Wage rate

In contrast to the interest rate, the wage rate is higher when the savings rate is higher and capital is accumulated. It is also higher as population aging advances further and the labor force population becomes relatively scarce. Therefore, the wage rate in Case 2 is consistently higher than that in Case 1 (Figure 6). In either case, the wage rate hits a peak around 2050 when Japan will see the peak of the aging society, and then it will turn downward.

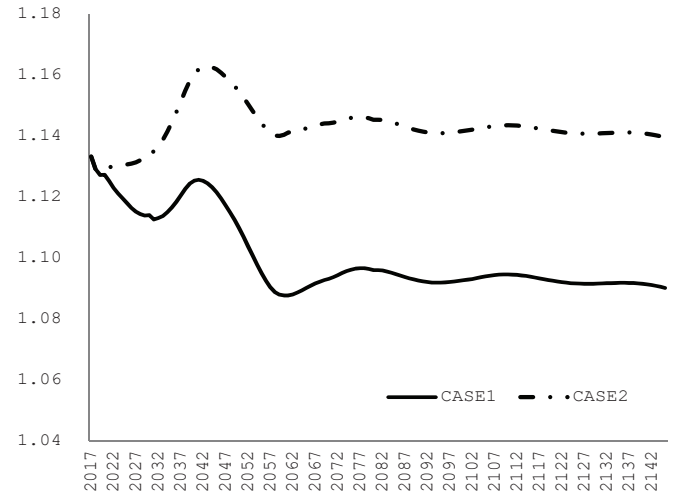
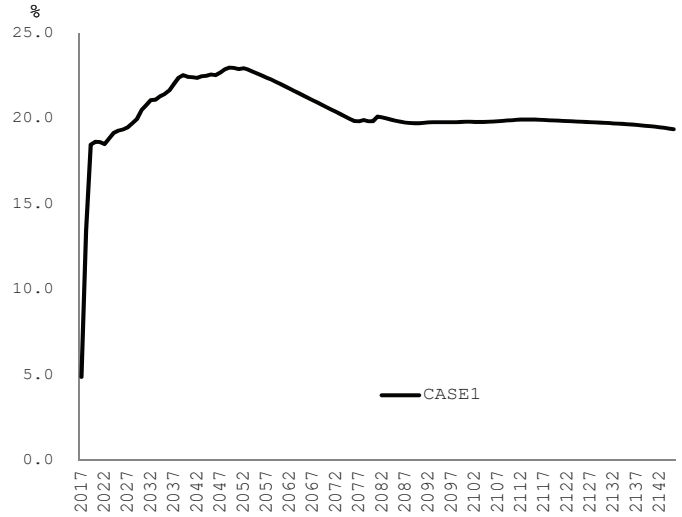


Figure 6. Trends in wage rate

6) Tax rates

In Case 1, the average value of the marginal income tax rate continues to increase even after having shown a sharp increase from 4.9% to 18.5% with the launch of fiscal reform and reaches a peak of 23% in around 2050, similar to the population aging rate. It then slowly declines and becomes nearly flat at under 20% in the late 2070s and beyond (Figure 7). Next, the consumption tax rate remains roughly flat after having shown an increase from 8% to 17% with the launch of fiscal reform. The tax rate levels of the marginal labor income tax rate in Case 1 are higher than those of the consumption tax rate in Case 2, which is attributable to a reduced taxation base caused by a shrinking workforce against the background of an aging society, coupled with higher government interest-payment expenses compared with Case 2 in response to the increased interest rate, thus requiring more tax revenue to achieve a 150% government debt outstanding as a percentage of GDP in the same way as Case 2.

(1) Marginal labor income tax rates



(2) Consumption tax rate

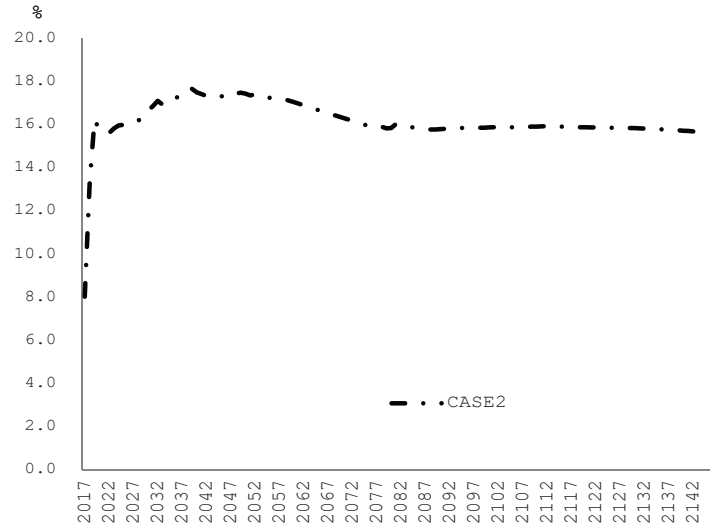


Figure 7. Trends in tax rates

7) Public pension premium rate

The 2004 Pension Reform requires that the public pension premium rate is fixed at 18.3% in September 2018 and beyond, and the pension reserve is used toward 2100. In this model, we endogenously obtain a pension premium rate, which is required for maintaining the 50% income replacement ratio, while using the pension reserve. The simulation results show that, in both cases, the endogenously determined premium rate exceeds the level assumed under the 2004 Pension Reform and shows a trend similar to that of the population aging rate (Figure 8). In other words, the aging of society suggests that the pension premium burden will need to be increased above that assumed under the system reform. In addition, the premium rate is higher in Case 1 than in Case 2, which is because younger generations will inevitably have to pay higher premium rates to cover the cost associated with pension benefits for the elderly generation due to reduced wage rates.

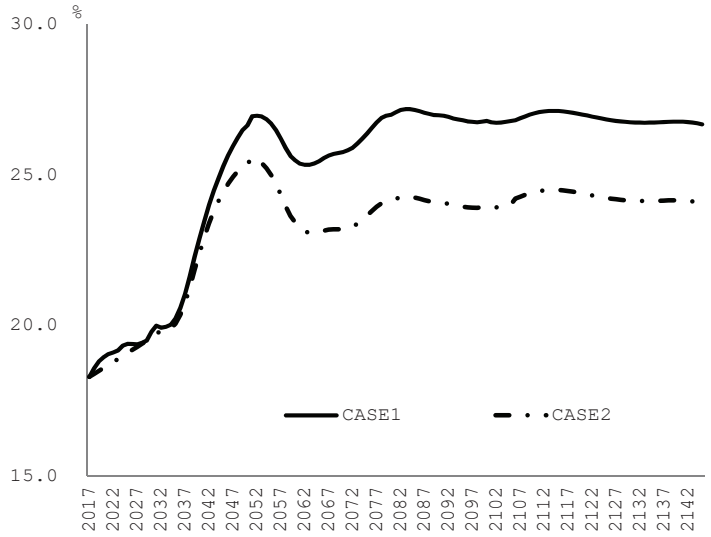


Figure 8. Trends in public pension premium rate

8) Gini coefficient

If we look at the trends in the Gini coefficient, which indicates the degree of inequality of income distribution, by setting the Gini coefficient for 2017 at 1, it deteriorates in Case 2, in which the consumption tax rate increases concurrently with the start of fiscal reform, due to the absence of a mechanism that rectifies the income disparities in the current consumption tax system (Figure 9). In Case 1, on the other hand, in which the progressive labor income tax rate increases, the Gini coefficient improves, as higher labor income earners bear a heavier burden. Therefore, if an assessment is performed based on the Gini coefficient, which indicates income disparities at a specific point in time, income disparities are better rectified in Case 1.

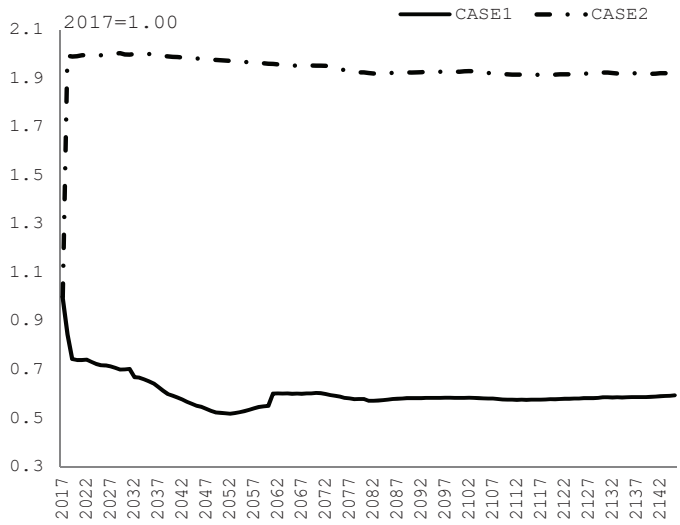


Figure 9. Trends in Gini coefficient

(2) Generation-specific and income bracket-specific lifetime net tax burden rate

We use the lifetime net tax burden rate[20] to broadly analyze the impact of policy changes for fiscal reform on households from the intergenerational and intragenerational perspective.

(a) Intergenerational gap

The conceivable causes of the intergenerational gap include demographic structure, changes in macroeconomic trends, and the inevitable burden placed on later generations due to higher taxes and pay-as-you-go public pension premiums.

Table 3 shows that, in both cases, and in the respective income brackets, the older the generation, the smaller the lifetime net tax burden rate; and the younger the generation, the larger the lifetime net tax burden rate. This is attributable to an inevitable increase in pension premium rate under the pay-as-you-go public pension system along with the aging of society, and a heavier burden placed on later generations in order to maintain the sustainability of government finances, which is encumbered by a huge amount of debt. Next, when the generation-specific lifetime net tax burden rate is compared between Case 1 and Case 2, the intergenerational gap measured between 0-year-olds and 85-year-olds, and between 0-year-olds and future generations, is greater in Case 1 than in Case 2 across all income brackets. This is because compared with Case 2, the tax burden is concentrated on the working period in Case 1, and moreover, because later generations will have to bear higher labor income tax to ensure fiscal sustainability, which results in a greater lifetime net tax burden rate placed on younger generations. On the other hand, the burden on retired elderly generations is greater in Case 2 than in Case 1. This is because in Case 1 the retired generation and close-to-retirement generation do not have to bear the additional burden of a progressive labor income tax increase, while in Case 2 they will have to bear the additional burden of a consumption tax increase even after their retirement. The above discussion clarifies that the intergenerational gap

[20] The lifetime net tax burden rate is derived by deducting social security benefits, etc. received from the government from the lifetime tax and social insurance premium burden paid to the government, which is then divided by lifetime income. In this paper, we estimated lifetime net tax burden rate by generation and by income bracket. As for previous studies in the US, see Auerbach, Gokhale and Kotlikoff (1993), for those in Australia, see Ablett and Tseggai-Bocurezion (2000), and for those in Japan, see Shimasawa and Oguro (2016).

tends to expand if a declining birthrate and aging population advances under tax and public pension systems that place intensive burdens on the working period.

Hence, if there is a need to give consideration to the expansion of the intergenerational gap as well upon the implementation of a tax increase aimed for fiscal reform, it would be desirable to choose a tax system that smoothens out tax burden bumps throughout people's lifecycle instead of one that imposes an intensive tax burden on a specific working period. However, doing so would have the policy implication that it would generate opposition from elderly generations, who would have to bear an increased burden.

(b) Intragenerational income gap

As is clear from the equation system discussed in Section 2, the major source of intragenerational gaps in this model is the difference in wage earning ability.

Table 3 shows that, in both cases, the lower the income bracket, the lower the lifetime net tax burden rate compared with the upper income bracket across all generations; and that upper-middle and upper income brackets bear net tax burdens across all generations. When the two cases are compared, the government's fiscal sustainability is ensured by increasing the progressive labor income tax in Case 1, whereas in Case 2, it is dealt with by increasing the consumption tax. The lifetime net tax burden rate is greater among the upper income bracket in Case 1, which means a reduced intragenerational lifetime income gap. Conversely, in Case 2, the intragenerational lifetime income gap does not shrink so much as in Case 1.

Based on the above discussion, upon the implementation of tax increase aimed at fiscal reform, if a reduction in intragenerational gap is included in the policy objectives, strengthening of progressive labor income tax would be desirable instead of consumption tax, in which case, however, the policy implication is that it would generate opposition from upper income brackets.

Table 3. Generation-specific and income bracket-specific lifetime net tax burden rate

	Case 1 (1)				Case 2 (2)				Difference (3) (= (2) – (1))			
Income bracket	Low	Lower-middle	Upper-middle	Upper	Low	Lower-middle	Upper-middle	Upper	Low	Lower-middle	Upper-middle	Upper
0	17.5	21.2	25.1	51.1	16.0	18.7	21.5	37.8	1.5	2.5	3.6	13.4
5	17.2	20.9	24.8	51.2	15.8	18.6	21.4	37.7	1.4	2.3	3.5	13.5
10	16.8	20.6	24.5	51.3	15.7	18.4	21.2	37.6	1.2	2.2	3.3	13.8
15	16.4	20.2	24.1	51.3	15.5	18.2	21.0	37.4	0.9	1.9	3.1	14.0
20	15.8	19.6	23.6	51.0	15.3	18.0	20.8	37.0	0.5	1.6	2.8	14.0
25	14.7	18.3	22.3	49.5	14.5	17.2	19.9	35.7	0.2	1.2	2.4	13.8
30	13.1	16.6	20.4	46.7	13.4	16.0	18.6	33.9	-0.3	0.6	1.8	12.8
35	11.4	14.7	18.3	43.2	12.3	14.8	17.3	31.9	-0.9	-0.1	1.0	11.2
40	9.6	12.6	15.9	39.0	11.1	13.5	15.9	30.0	-1.5	-0.9	0.0	9.0
45	7.8	10.4	13.5	34.2	9.8	12.1	14.4	27.9	-2.1	-1.6	-0.9	6.3
50	6.0	8.4	11.2	29.3	8.5	10.6	12.8	25.7	-2.4	-2.2	-1.6	3.6
55	4.2	6.3	8.7	24.1	6.8	8.8	10.9	23.2	-2.6	-2.5	-2.2	1.0
60	2.6	4.4	6.3	18.9	5.1	7.0	8.9	20.4	-2.6	-2.6	-2.6	-1.5
65	1.1	2.6	4.2	13.9	3.4	5.1	6.9	17.4	-2.4	-2.5	-2.7	-3.5
70	0.2	1.6	3.1	12.2	1.8	3.3	4.9	14.5	-1.6	-1.7	-1.8	-2.3
75	0.0	1.4	2.9	11.9	1.5	3.0	4.5	14.0	-1.5	-1.6	-1.7	-2.1
80	-1.4	-0.2	1.1	8.8	-0.9	0.3	1.6	9.4	-0.4	-0.5	-0.5	-0.6
85	-1.7	-0.5	0.6	7.8	-1.5	-0.4	0.7	8.0	-0.1	-0.1	-0.1	-0.1
Future generation	17.6	21.3	25.1	50.8	15.8	18.5	21.3	37.4	1.8	2.8	3.8	13.4

(3) Policy decision

Given the macroeconomic and financial environment discussed above, we analyze how households respond, by age and by income bracket, to a consumption tax increase or an income tax increase implemented by the government for the purpose of fiscal reform concerning the following three cases: 1) voters consider their own utility and welfare in the short-term perspective; 2) voters consider their own utility and welfare in the long-term perspective; and 3) a utilitarian government makes a choice without putting it up for a vote.

1) The case in which voters consider their own utility and welfare in the short-term perspective

Assume that eligible voters aged 18 and over behave in a short-sighted manner when they choose either a labor income tax increase or a consumption tax increase. In other words, it is assumed that they vote for an option that is considered to decrease their utility more moderately, whether it be labor income tax or consumption tax, by comparing their own utility changes at a specific point in time of the tax increase.[21] More specifically, they vote for a labor income tax increase if the expected reduction in utility due to a labor income tax increase is smaller than that caused by a consumption tax increase; and they vote for a consumption tax increase if the expected reduction in utility due to a consumption tax increase is smaller than that caused by a labor income tax increase. Which they vote for depends on the size of the consumption tax burden amount, which is imposed on the amount of consumption smoothed out through their lifetime, and that of the labor income tax burden amount, which is imposed on earned labor income smoothed out through their lifetime, at the time of voting. In other words, basically, households whose income exceeds their consumption and have positive savings at the time of voting support a consumption tax increase. On the contrary, households whose income is lower than their consumption and have negative savings at the time of voting support a labor income tax increase. Whether households have positive savings or negative savings at the time of voting differs by generation and by income bracket, and a difference arises from the combination of age and income bracket.[22] If you look at the results with the above in mind, households in the upper income bracket/generations aged 55 or younger, upper-middle income bracket/generations aged 42 or younger, lower-middle income bracket/generations aged 38 or younger, and low income bracket/generations aged 34 or younger prefer a consumption tax increase rather than a labor income tax increase. Therefore, supported by 56% of eligible voters, the consumption tax increase will come into effect (Figures 10, 11, and 12).

[21] Households who are yet to reach age 20 at the time of voting do not appear in the model. As such households have not taken any utility maximization action at the time, they do not actually have any information that they can use to decide on pros and cons regarding a policy change. However, considering that a policy change transforms the subsequent economic and fiscal environment, even if they have yet to appear in the model at the time of voting, once they enter the model, their consumption path would naturally be different before and after the policy change. Therefore, we assume in this paper that even the households who are yet to exist at the time of voting are able to recognize the changes in the level of utility, whether it be temporarily or throughout their lifetime, and decide on pros and cons regarding a policy change by comparing the cases at the time they enter the model.

[22] Note that, however, in case where the population of the retired generation overwhelms that of the working-age generation under the condition that a comparable amount of money is required for fiscal consolidation for both simulation cases, the amount of consumption tax burden per person becomes smaller, and the amount of labor income tax burden per person becomes larger. Therefore, households whose amount of consumption tax burden is larger than the amount of labor income tax burden do exist, even though their savings are positive. On the contrary, households whose amount of labor income tax burden is larger than the amount of consumption tax burden do exist, even though their savings are negative. Hence, there are cases in which positive or negative savings are not correlated with the tax increase option they vote for.

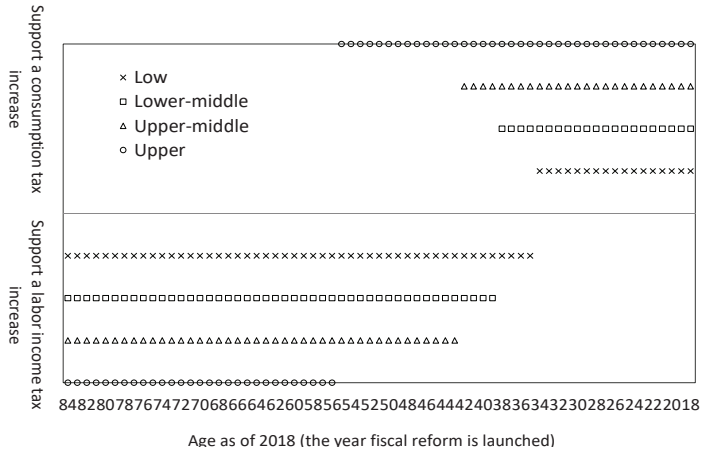


Figure 10. Generation-specific and income bracket-specific tax increase measure voted for (in the case of myopic voters)

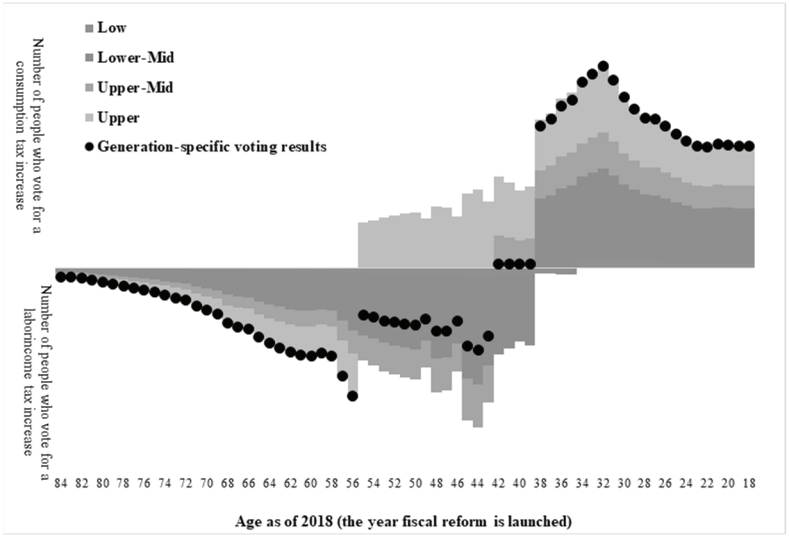


Figure 11. Generation-specific and income bracket-specific voting results(in the case of myopic voters)

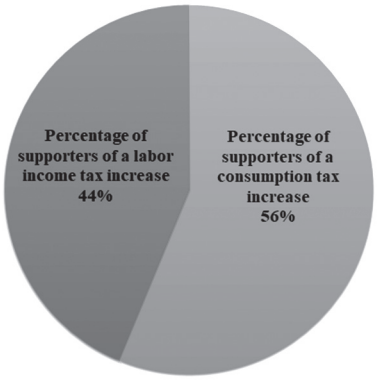


Figure 12. Voting results (in the case of myopic voters)

2) The case in which the voters consider their own utility and welfare in the long-term perspective

Voters who take a long-term perspective compare cumulative changes in their own lifetime utility that start to occur following the start of a tax increase. They vote for a labor income tax increase if the expected reduction in lifetime utility due to the labor income tax increase is smaller than that caused by a consumption tax increase. On the contrary, they vote for a consumption tax increase if the expected reduction in lifetime utility due to the consumption tax increase is smaller than that caused by a labor income tax increase. If you focus on generation (age) first, it would be reasonable for those whose retirement and the timing of a tax increase are close or those in the retired generation—regardless of income bracket—to prefer a labor income tax increase as the consumption tax increase option would extend the taxable period and increase their burden. Next, if you look at the difference by income bracket within the same generation, a labor income tax increase lessens the burden on lower income brackets because of its progressive structure. On the other hand, as the same tax rate is applied under a consumption tax increase to all income brackets and its taxable period is 20 years longer than that of the labor income tax, it would be reasonable for households in lower income brackets to prefer a labor income tax increase (Figures 13, 14, and 15).

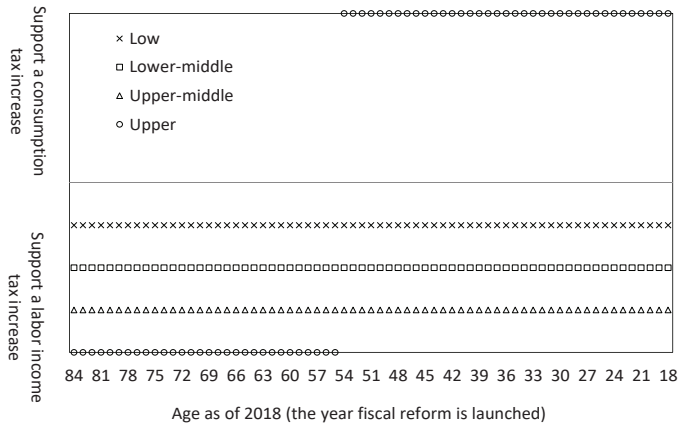


Figure 13. Generation-specific and income bracket-specific tax increase measure voted for (in the case where voters have a long-term perspective)

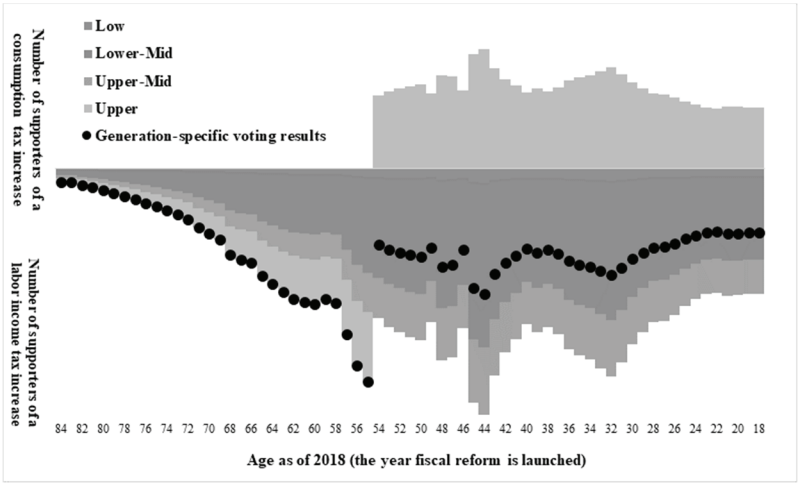


Figure 14. Generation-specific and income bracket-specific voting results (in the case where voters have a long-term perspective)

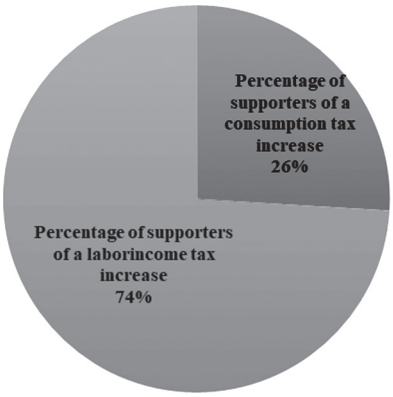


Figure 15. Voting results (in the case where voters have a long-term perspective)

3) Summary

As discussed above, we now know that which of the two taxes—a consumption tax increase or a progressive labor income tax increase—is chosen by voting depends on the range of perspectives taken by the eligible voters. In other words, if utility change at the time of voting is used as the criterion for judgement, a consumption tax increase is chosen; and if lifetime utility change is used as the criterion for judgment, a progressive labor income tax increase is chosen.[23]

These results are based on the assumption that eligible voters at the time of the policy proposal are the target. We also assumed a case in which voters have a long-term perspective, future generations also have voting rights and are able to participate in voting in 2018, and estimated the number of future generations that are required to gain support for a consumption tax increase (Figure 16). The result showed that it is only after taking into account the generation who will be born 173 years after 2018, when the policy proposal is made, that the supporters of a consumption tax increase exceed those of a progressive labor income tax increase.

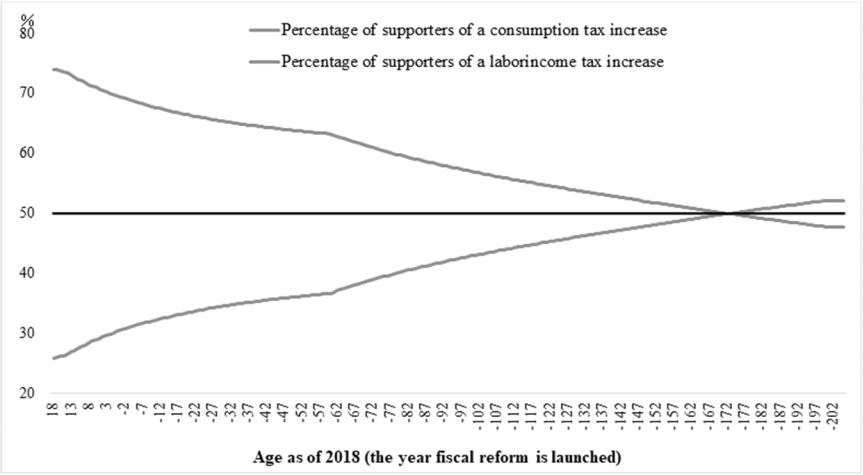


Figure 16. Results obtained from a case in which future generations participate in the voting (in the case where voters have a long-term perspective)

[23] Theoretically, and if a lifelong perspective is taken, even with progressive labor income tax, if tax deductions combined with benefits or lump sum benefits such as Universal Credit, etc., are granted in the correct manner, it would become congruent with consumption tax, and therefore, there is no point in distinguishing between progressive labor income tax and consumption tax. However, we think that there is much point in distinguishing these tax systems as systems are not currently designed that way in Japan.

4) The case in which a utilitarian government makes a choice without putting it up for a vote

The above analyses clarified that a different fiscal reform measure is chosen depending on the range of perspectives taken by voters when they consider their utility. However, if the mechanism restricts participants to eligible voters at the time of the policy proposal, the households of subsequent generations across all income brackets will be totally disregarded. Hence, we assume a government under which the interests of not only eligible voters but also of non-voting generations are taken into consideration, and analyze a world in which a labor income tax increase or a consumption tax increase as a fiscal reform measure is chosen based on the sum of changes in the level of utility on the basis of the welfare function under a utilitarian government SW, as shown below.

$$SW = \sum_g \sum_{k=0}^{84} \left(U_{k,c}^g - U_{k,w}^g \right) N_k^g \qquad (23)$$

where k is the age as of 2018, and $U_{k,c}^g, U_{k,w}^g$ indicate the level of utility of the k-th generation in income bracket g of Case 1 and Case 2, respectively. N_k^g indicates the population of the k-th generation in income bracket g as of 2018.

(a) The case in which an option is chosen based on utility changes at a specific point in time

In the case where a utilitarian government makes a choice based on the sum of changes in the level of utility of all the people at the time they propose a fiscal reform measure, it would choose a consumption tax increase if it focuses on changes at a specific point in time. However, the upper income brackets greatly contribute to utility change due to a consumption tax increase, and it is the generation aged 34 or younger whose utility changes turn positive in all income brackets due to a consumption tax increase (Figure 17).

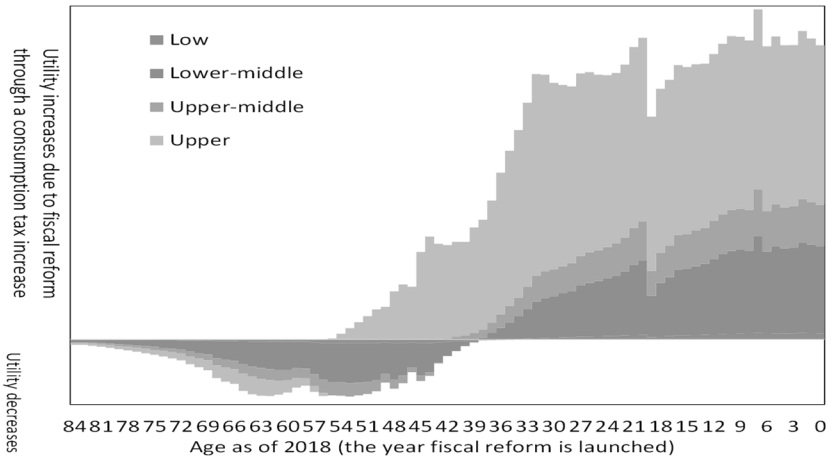


Figure 17. Changes in the level of utility by generation and by income bracket as of the launch of fiscal reform

(b) The case in which an option is chosen based on lifetime utility changes

In the case where a utilitarian government makes a policy choice based on the sum of changes in the level of utility of all the people, it would choose a progressive labor income tax increase if it takes into account the lifetime utility changes in the voting generations alone. On the other hand, if it takes into account the lifetime utility of generations aged 13 or older, who do not have voting rights under the current election system, it would choose a consumption tax increase (Figure 18). In this case, however, the sum of changes in the level of utility of all the people turn positive due to a great

contribution by the upper income bracket. More specifically, the lifetime utility changes in generations aged 54 or younger who belong to the upper income bracket exceed those of other income brackets and other generations (Figure 19).

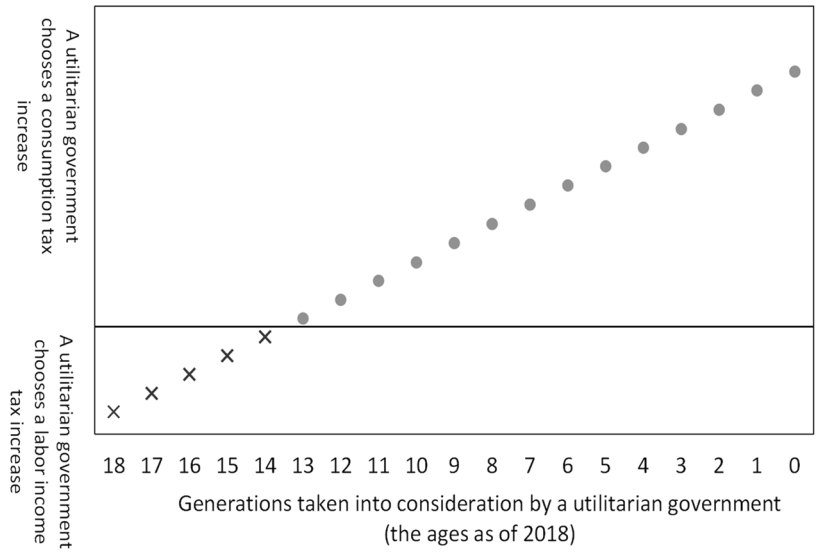


Figure 18. The tax increase measure chosen by a utilitarian government and ages of future generations which are taken into consideration (in the case where changes in the level of lifetime utility is used as the criterion for judgement)

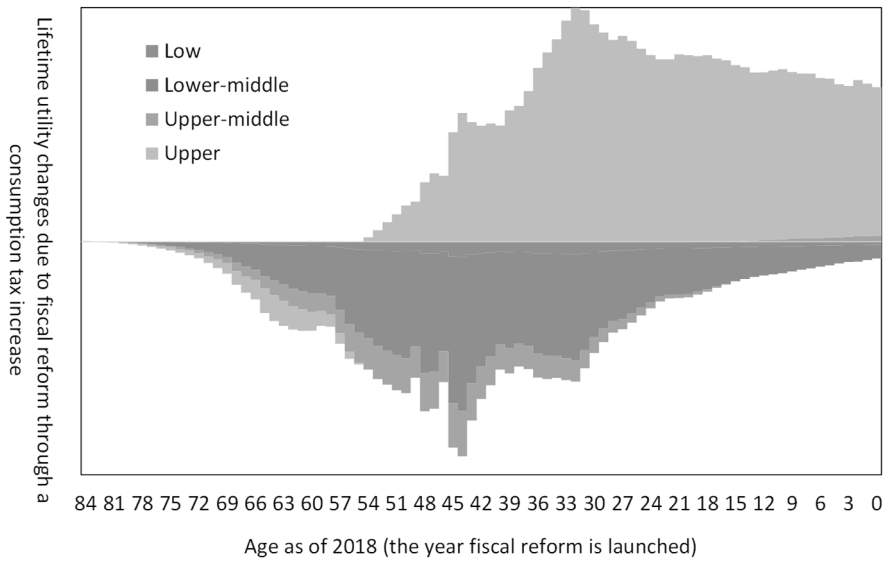


Figure 19. Changes in the level of lifetime utility by generation and by income bracket

4. Conclusion

In this paper, we use the Overlapping Generations Model with intergenerational heterogeneity to analyze the preferred form of taxation to achieve the fiscal reform necessary to maintain fiscal sustainability in Japan. We assumed two forms of taxation, i.e. consumption tax increase or progressive labor income tax increase, and used utility criteria and the existing voting system for our analysis.

The simulation results revealed that different options would be chosen by voters depending on the time span they take into consideration in judging the desirability of the policy based on their utility criteria, and, furthermore, by their birth year and income bracket. More specifically, the voters in elderly, retired generations prefer a labor income tax increase rather than a consumption tax increase, while the working-age generations, particularly those in low income brackets, prefer a labor income tax increase rather than a consumption tax increase. Consequently, supporters of a consumption tax increase are limited to the upper income brackets in generations younger than middle-age, and fiscal reform through an income tax increase intended by the financial authorities is not feasible under the current voting system. In order to make it feasible, a policy needs to be determined based on a method under which the interests of not only those who currently have voting rights but also of future generations, who are yet to have voting rights, can also be taken into consideration and by agents who are able to do so, in a longer-range perspective, based on certain rules under which conflicts of interests between different birth years and income brackets can be overcome.

As an example, we assumed a utilitarian government and were able to confirm that the consumption tax increase option would certainly be chosen in a case where the sum of utility changes for all the people living in the year the fiscal reform is launched is taken into consideration. It must be noted, however, that this result is attributable to a major improvement in utility in the upper income bracket, and that the adoption of a consumption tax increase option by a utilitarian government is equivalent to sacrificing other income brackets solely for the benefit of the upper income bracket. Hence, whether or not such a choice is consistent with fairness among taxpayers is highly questionable.

Finally, we would like to refer to issues that remain unaddressed in this paper.

First, in this paper, by ignoring the question of whether fiscal reform through a tax increase is chosen, we analyzed which of the two—a consumption tax increase or a labor income tax increase—is chosen by voting for the purpose of maintaining the sustainability of Japan's finance. In reality, however, an economic growth-driven fiscal reform measure is desired by the people instead of a drastic tax increase that passes on a financial burden to future generations through the issuance of government bonds. Therefore, the situation does not allow us to venture to choose fiscal reform through a tax increase, whether it be a consumption tax or a labor income tax. If it becomes difficult to obtain financial resources through the issuance of government bonds, such an option might also be considered. However, it will be too late by then. What macroeconomic, financial, and political conditions are required in order to actually put tax increase options such as the ones we analyzed in this paper on the table for consideration will need to be studied separately.

Next, labor supply is inelastic in the simulation model we used in this paper. That is, labor supply is neither reduced, however heavy the burden of tax or social security may be in the working period, nor increased to ease the burden of consumption tax in retirement years. In reality, however, the working-age generation would prefer leisure rather than labor if the burden becomes excessive, and the retired generation could prefer labor rather than leisure. In that case, the level of utility of generation-specific and income bracket-specific households would be impacted, thereby influencing

their policy options, which may lead us to a conclusion different from the one reached in this paper. Hence, in order to analyze the effect of elastic labor supply on policy options, it is necessary to introduce a utility function of leisure, abolish the age retirement system, and enable an endogenous choice of labor supply.

Furthermore, in this paper, the number of eligible voters equals the number of voters regardless of age and income bracket. That is, the voting rate by age and by income bracket is fixed at 100%. In reality, however, it is widely known that the age-specific voting rate shows a bell-shaped curve; it is low among younger voters, increases with age to reach a peak between the ages 60 and around 64, and then declines as age advances further. In addition, the voting rate is higher among higher income brackets. Therefore, if actual age-specific and income bracket-specific voting rate is taken into consideration, the political influence exerted by the elderly generation and upper income bracket through voting may be greater than the results of our simulation in this paper, thereby possibly forming a conclusion different from that of ours. For instance, adding weight to the voting results in some way or introducing a mechanism under which the age-specific and income bracket-specific voting rate is endogenously decided on are considered as significant attempts for the purpose of making the results of a simulation more realistic and enhancing the persuasiveness of political implications.

In this paper, we arbitrarily set the year fiscal reform is launched, the year it is completed, and the targeted government debt outstanding as a percentage of GDP at 2018, 2060, and 150%, respectively. If, for instance, fiscal reform is started at a later year, responses such as pros and cons of the tax increase measure are considered to differ by generation and by income bracket. Therefore, a simulation needs to be performed by changing the year fiscal reform is launched, the year it is completed, and the targeted government debt outstanding as a percentage of GDP.

Finally, in this paper, we focused only on a consumption tax increase and a progressive labor income tax increase as political options for fiscal reform. There are, however, other practical options, such as government expenditure reductions including social security benefits paid at public expense, or an increase in the rates of inheritance tax or gift tax. Regarding these options as well, utility changes and resultant responses such as pros and cons are considered to differ by generation and by income bracket. Therefore, if a similar quantitative assessment is performed, a comparative evaluation of such policy options would be possible.

We would like to address these issues in future research.

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Effects of Fiscal Integration of the Public Pension System in Japan

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Abstract

Japan's public pension system has introduced a "macroeconomic slide," which automatically reduces benefits to maintain pension finances. However, the reduction rate for the basic pension (28.0%) is much higher than that for the earnings-related pension (2.6%). Financial integration of the National Pension Plan and the Employees' Pension Plan is being considered to align these rates, but detailed results have not been released. The fiscal effects of the macroeconomic slide are clarified in this paper and it is estimated that the reduction rate after fiscal integration is 9.0%. Furthermore, it is shown that the financial support from the Employees' Pension Plan to the National Pension Plan through fiscal integration would be 0.4 trillion yen in 2020. The future national subsidy would also increase by 26.4% (2.3 trillion yen in 2063 at FY2019 prices).

Keywords**:** macroeconomic slide, financial integration, basic pension,

JEL classification**: G22, H55**

1. Introduction.

Since the late 1970s, Japan's birthrate has been declining, the population has been aging rapidly, and Japan has the highest population aging rate in the world. In addition, the public pension system has repeatedly raised contributions and reduced benefit levels with each revision of the system. As a result, there have been serious concerns about the system's sustainability, especially among the younger generation. In order to alleviate these concerns, a major revision was conducted in 2004. A mechanism called the "macroeconomic slide" was introduced, which sets a ceiling on the level of contributions and gradually and automatically reduces the level of benefits such that the public pension's income can cover the benefits. On the other hand, even if it is fiscally sustainable, it is necessary to put a specific stop to the decline in the level of benefits so that the original purpose of public pensions, namely, income security in old age, is not significantly impaired. Therefore, a verification is conducted every five years to see if the income replacement rate of the model household[1] at the time of the new ruling is secured at 50% in the future. This verification is called "actuarial valuation," and the most recent results of the 2019 actuarial valuation (Ministry of Health, Labor and Welfare, 2020a) were released on August 27, 2019.

[1] The husband is covered by the EPI from 20 to 59 years and the wife, who is the same age as her husband, has always been dependent on him.

In the 2019 actuarial valuation, it showed the outlook for the income replacement rate for six cases of future economic growth and labor participation: cases I-III, in which economic growth and labor participation will advance; cases IV and V, in which economic growth and labor participation will increase to a certain degree, and case VI, in which economic growth and labor participation will not advance. In cases I-III, where economic growth and labor participation proceed in line with the government's policy goals, the income replacement rate of 50% will be secured. However, in other cases where economic growth and labor participation proceed to a certain extent, or not at all, it will not be easy to ensure 50%.

The reduction in benefits due to the macroeconomic slide differs significantly between the basic pension and earnings-related pension. In Case III, to ensure the sustainability of pension finances, the basic pension would need to be reduced by 28.0%. In comparison, the earnings-related pension would need to be reduced by only 2.6%. This significant difference is due to the poor financial situation of the National Pension Plan. However, the reduction in the basic pension will considerably impact elderly people with low pension amounts. This is because many of those expected to receive low basic pensions are non-regular workers and will not receive the earnings-related pension or will receive only a small earnings-related pension.

To avoid a significant decrease in the basic pension, a method of aligning the reduction rate of the basic pension and that of the earnings-related pension is being considered. The Ministry of Health, Labor, and Welfare (2020b) released its trial calculation in December 2020. According to the results, if the reduction rates are aligned, the new aligned reduction rate will be 9.9%, and will significantly ease the decline in the basic pension. However, to achieve this, the Employees' Pension Plan needs to support the National Pension Plan. There are many specific methods for the support; for example, integration of the two accounts or a fiscal adjustment with equivalent effect is indicated. However, no specific method or detailed results were shown.

In this paper, therefore, the results of the 2019 actuarial valuation, for which data have been released in detail, are analyzed. First, we clarify the fiscal effects of macroeconomic slide by showing the fiscal outlook when the macroeconomic slide is not implemented. Next, we will estimate the aligned reduction rate brought about by fiscal integration or the fiscal adjustment and assess the financial support from the Employees' Pension Plan to the National Pension Plan. Finally, a discussion of desirable measures is provided.

2. Research methods

2.1. The financial structure of the public pension system

The finances of the public pension system are divided into the National Pension Account (NP account) and the Employees' Pension Insurance Account (EPI account), each of which is managed independently. Figure 1 shows the financial structure of the public pension system. The NP account is for Category 1 subscribers, while the EPI account is for Category 2 and 3 subscribers. The Basic Pension Account (BP account) provides the basic pension to all beneficiaries. The BP account is an account established to proportionally divide the contributions for the basic pension benefits between the two accounts and does not need to be considered in particular when considering fiscal issues.

The income of the NP account comprises contributions from Category 1 subscribers, a national subsidy, and investment returns from its reserve fund. Almost all the NP account's expenditures are the transfers to the BP account for the basic pension benefit. There are other small expenditures, but these are omitted from the figure for simplicity.

The income of the EPI account comprises contributions from Category 2 subscribers, a national subsidy, and investment returns from its reserve fund. The EPI account's expenditure includes the

transfers to the BP account and the earnings-related pension benefits[2] for Category 2 subscribers. Again, there are other small expenditures, but these are omitted from the figure for simplicity.

The BP account provides the basic pension to all beneficiaries, and its financial resources are transfers from the NP and EPI accounts. The amounts of the transfers are calculated based on the number of subscribers as follows.

$$\text{Transfer from NP account} = T \times \frac{A}{A+B+C}$$

$$\text{Transfer from EPI account} = T \times \frac{B+C}{A+B+C}$$

where:

T is the total amount of the basic pension.

A is the number of Category 1 subscribers who pay contributions.

B is the number of Category 2 subscribers aged between 20 and 59 years.

C is the number of Category 3 subscribers.

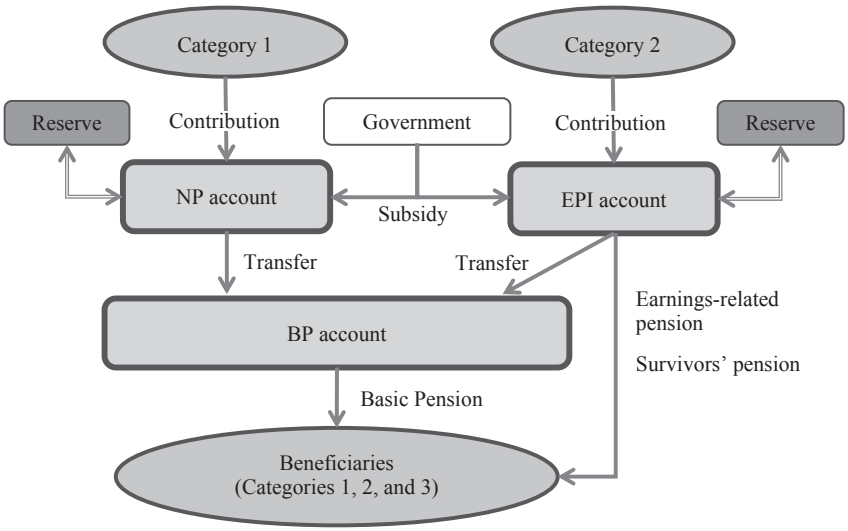

Figure 1: Financial structure of the public pension system

2.2. Calculation of the macroeconomic slide

The macroeconomic slide reduces benefits every year to achieve the fiscal balance of over 100 years in both the NP account and EPI account. This annual reduction rate is calculated considering the rate of decline in the number of active insured persons and the growth in life expectancy. The rate varies from year to year but is expected to be roughly 1% on average. Thus, intuitively, the macroeconomic slide can be thought of as a mechanism that automatically reduces benefits by about 1% every year until fiscal balance is achieved. Therefore, the number of years the macroeconomic slide will need to continue determines the benefits for the elderly in the future. Specifically, the following steps (a) through (e) are taken to calculate the macroeconomic slide.

a) Prepare an income and expenditure forecast for the NP account, assuming no

[2] Including survivors' pension to the dependent spouses of deceased beneficiaries

macroeconomic slide.

b) Determine the year in which the macroeconomic slide for the basic pension will end to balance the NP account.
c) Prepare an income and expenditure forecast for the EPI account, assuming no macroeconomic slide.
d) Develop an income and expenditure forecast for the EPI account if the macroeconomic slide is applied only to the basic pension.
e) Determine the year in which the macroeconomic slide for the earnings-related pension will end to balance the EPI account.

However, the government published only the results of steps (b) and (e). It is necessary to estimate (a), (c), and (d) to analyze the effects of fiscal integration of the public pension plan in Japan.

The annual reduction rates are not disclosed either. However, the annual reduction rate for each year can be easily estimated since it is the income replacement rate for that year divided by the income replacement rate for the previous year. Table 1 shows the annual reduction rate and accumulated reduction rate for each year. As for the basic pension, the reduction should be continued until 2047, with 0.3% reduction in 2020, 0.2% reduction in 2021, and so on, and finally ending with a 28.0% reduction. As for the earnings-related pension, the reduction should be continued until 2025, with 0.2% reduction in 2020, 0.3% reduction in 2021, and so on, and finally ending with a 2.6% reduction.

Table 1: Reduction Rates by Macroeconomic Slide

	Basic pension		Earnings-related pension		Basic pension		
Year	Annual reduction rate	Accumulated reduction rate	Annual reduction rate	Accumulated reduction rate	Year	Annual reduction rate	Accumulated reduction rate
2020	0.3%	0.3%	0.2%	0.2%	2035	1.6%	13.5%
2021	0.2%	0.4%	0.3%	0.4%	2036	1.6%	14.9%
2022	0.4%	0.8%	0.5%	0.9%	2037	1.7%	16.3%
2023	0.6%	1.4%	0.7%	1.7%	2038	1.7%	17.7%
2024	0.8%	2.2%	0.9%	2.5%	2039	1.6%	19.0%
2025	0.8%	3.0%	0.1%	2.6%	2040	1.6%	20.3%
2026	0.9%	3.8%	-	2.6%	2041	1.6%	21.6%
2027	0.9%	4.7%	-	2.6%	2042	1.6%	22.9%
2028	1.0%	5.6%	-	2.6%	2043	1.7%	24.2%
2029	1.0%	6.5%	-	2.6%	2044	1.7%	25.4%
2030	1.0%	7.5%	-	2.6%	2045	1.7%	26.7%
2031	1.1%	8.5%	-	2.6%	2046	1.7%	27.9%
2032	1.3%	9.6%	-	2.6%	2047	0.1%	28.0%
2033	1.3%	10.8%	-	2.6%	2048	-	28.0%
2034	1.4%	12.1%	-	2.6%	2049	-	28.0%

Source: Calculated by the author based on the 2019 actuarial valuation.

The macroeconomic slide for the fiscal integration of the NP account and EPI account can be calculated by the following steps (f) and (g).

f) Prepare an income and expenditure forecast for the integrated account, assuming no macroeconomic slide. This is the sum of (a) and (c).
g) Determine the year in which the macroeconomic slide for the pensions will end to balance the integrated account.

2.3. Reserve without macroeconomic slide (steps (a) and (c))

The income and expenditure forecast in steps (a) and (c) can be calculated backward from the published results of (b) and (e) using Table 1. Let the reserve without macroeconomic slide at the end of fiscal year *t* in the NP account be $F_t^{(1)}$.

$$F_t^{(1)} = F_{t-1}^{(1)} + \left(C_t^{(1)} + S_t^{(1)} + I_t^{(1)}\right) - \left(P_t^{(1)} + B_t^{(1)}\right) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

where:

$C_t^{(1)}$: Contribution from Category 1 subscribers

$S_t^{(1)}$: National subsidy

$I_t^{(1)}$: Investment income

$P_t^{(1)}$: Transfer to the BP account

$B_t^{(1)}$: Other expenditure minus other income.

Let the reserve without macroeconomic slide at the end of fiscal year *t* in the NP account be $\tilde{F}_t^{(1)}$. If $E_t^{(1)}$ is the macroeconomic slide factor ($= 1 -$ accumulated reduction rate), $\tilde{F}_t^{(1)}$ satisfies the following equation.

$$\tilde{F}_t^{(1)} = \tilde{F}_{t-1}^{(1)} + \left(C_t^{(1)} + S_t^{(1)} \times E_t^{(1)} + \tilde{I}_t^{(1)}\right) - \left(P_t^{(1)} \times E_t^{(1)} + B_t^{(1)} \times E_t^{(1)}\right) \cdots\cdots\cdots\cdots \quad (2)$$

Since $S_t^{(1)} \times E_t^{(1)}$, $P_t^{(1)} \times E_t^{(1)}$, $B_t^{(1)} \times E_t^{(1)}$, and $E_t^{(1)}$ in equation (2) are disclosed, $S_t^{(1)}$, $P_t^{(1)}$, and $B_t^{(1)}$ can be obtained. $C_t^{(1)}$ is also disclosed. Using equation (2), $\tilde{F}_t^{(1)}$ can be calculated.

Regarding the EPI account, let the reserve without macroeconomic slide at the end of fiscal year *t* in the EPI account be $F_t^{(2)}$.

$$F_t^{(2)} = F_{t-1}^{(2)} + \left(C_t^{(2)} + S_t^{(2)} + I_t^{(2)}\right) - \left(P_t^{(2)} + B_t^{(2)}\right) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (3)$$

where:

$C_t^{(2)}$: Contribution from Category 2 subscribers

$S_t^{(2)}$: National subsidy

$I_t^{(2)}$: Investment income

$P_t^{(2)}$: Transfer to the BP account

$B_t^{(2)}$: Earnings-related pension and other expenditure minus other income.

Let the reserve without macroeconomic slide at the end of fiscal year *t* in the EPI account be $\tilde{F}_t^{(2)}$. If $E_t^{(2)}$ is the macroeconomic slide factor ($= 1 -$ accumulated reduction rate), $\tilde{F}_t^{(2)}$ satisfies

the following equation.

$$\tilde{F}_t^{(2)} = \tilde{F}_{t-1}^{(2)} + \left(C_t^{(2)} + S_t^{(2)} \times E_t^{(1)} + \tilde{I}_t^{(2)}\right) - \left(P_t^{(2)} \times E_t^{(1)} + B_t^{(2)} \times E_t^{(2)}\right) \cdots\cdots\cdots\cdots \quad (4)$$

Since $S_t^{(2)} \times E_t^{(2)}$, $P_t^{(2)} \times E_t^{(1)}$, $B_t^{(2)} \times E_t^{(2)}$, $E_t^{(1)}$, and $E_t^{(2)}$ in equation (4) are disclosed, $S_t^{(2)}$, $P_t^{(2)}$, and $B_t^{(2)}$ can be obtained. $C_t^{(2)}$ is also disclosed. Using equation (4), $\tilde{F}_t^{(2)}$ can be calculated.

2.4. Macroeconomic slide at the fiscal integration

As for the macroeconomic slide, when fiscal integration of the NP account and EPI account is implemented, we can sum the two accounts and calculate the macroeconomic slide that will result in the finances being balanced.

Let the reserve without macroeconomic slide at the end of fiscal year *t* in the integrated account be F_t.

$$F_t = F_{t-1} + \left(C_t + S_t + I_t\right) - \left(P_t + B_t\right) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (5)$$

where:

C_t : Contributions, $C_t^{(1)} + C_t^{(2)}$

S_t : National subsidy, $S_t^{(1)} + S_t^{(2)}$

I_t : Investment income

P_t : Transfer to the BP account, $P_t^{(1)} + P_t^{(2)}$

B_t : Earnings-related pension and other expenditure minus other income, $B_t^{(1)} + B_t^{(2)}$.

Let the reserve without macroeconomic slide at the end of fiscal year *t* in the integrated account be $\tilde{F}_t$. If E_t is the macroeconomic slide factor $(= 1 - \text{accumulated reduction rate})$ and we assume $E_t = E_t^{(1)}$ $(t \leqq t_0)$, $\tilde{F}_t$ satisfies the following equation.

$$\tilde{F}_t = \tilde{F}_{t-1} + \left(C_t + S_t \times E_t + \tilde{I}_t\right) - \left(P_t \times E_t + B_t \times E_t\right) \cdots\cdots\cdots\cdots \quad (6)$$

where, $E_t = E_{t_0}$ $(t > t_0)$.

Since the condition for financial sustainability is that the final year's reserves can cover one year's worth of expenditures, the cumulative macroeconomic slide E_{2115} satisfies the following equation.

$$\tilde{F}_{2114} = P_{2115} \times E_{2115} + B_t \times E_{2115} \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (7)$$

Solving equation (6) and (7), we can obtain t_0 and E_{2115}.

2.5. Financial support from the Employees' Pension Plan to the National Pension Plan

In order to align the reduction rate of the basic pension and earnings-related pension, the Employees' Pension Plan must support the National Pension Plan, thereby reducing the transfer to the BP account from the NP account. Then, let the reduction factor be r or the new transfer be $r\left(P_t^{(1)} - K_t\right) + K_t$

in equation (2), where K_t is the basic pension for those who were exempt from contributions[3]. In this case, the national subsidy other than K_t is also reduced. The new subsidy will be $r\left(S_t^{(1)} - K_t\right) + K_t$.

Therefore, the new equation will be

$$\tilde{F}_t^{(1)} = \tilde{F}_{t-1}^{(1)} + \left(C_t^{(1)} + \left(r\left(S_t^{(1)} - K_t\right) + K_t\right) \times E_t \ + \tilde{I}_t^{(1)}\right) - \left(r\left(P_t^{(1)} - K_t\right) + K_t + B_t^{(1)} \times E_t^{(1)}\right) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (8)$$

If the reduction rates are the same through the years, r must satisfy the following equation.

$$\tilde{F}_{2114}^{(1)} = r\left(P_{2115}^{(1)} - K_{2115}\right) + K_{2115} + B_{2115}^{(1)} \times E_{2115}^{(1)} \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (9)$$

Solving equation (9), we can obtain r.

The reduction factor reduces the transfer to the BP account from the NP account to $r\left(P_t^{(1)} - K_t\right) + K_t$. Therefore, the financial support from the Employees' Pension Plan to the National Pension Plan is $(1 - r)\left(P_t^{(1)} - K_t\right)$.

3. Results

3.1. NP account under the current system

Figure 2 compares the financial projections of the NP account reserves with and without macroeconomic slide. If the macroeconomic slide is not implemented, the reserve fund will be exhausted by 2050. After that, continuing to calculate mechanically, the amount of the reserve fund in 2063 will be -21.3 trillion yen (-7.9 trillion yen at 2019 prices, likewise below) and -447.9 trillion yen (-51.2 trillion yen) in 2115.

Figure 2 also shows that if the macroeconomic slide is implemented until 2047, the reserve fund will not be depleted, and the NP account can be financially maintained until 2115. In other words, the macroeconomic slide of the basic pension requires a reduction in the basic pension equivalent to 447.9 trillion yen (-51.2 trillion yen), which is the equivalent of the 2115-year reserve of the national pension account. The final reduction rate for the basic pension is 28.0%.

3.2. EPI account under the current system

Figure 3 compares the financial projections of the EPI account reserves without and with macroeconomic slide. If the macroeconomic slide is not implemented, the reserve fund will be exhausted by 2067. After that, continuing to calculate mechanically, the amount of the reserve fund in 2115 will be -5053.8 trillion yen (-578.2 trillion yen).

Figure 3 also shows that if the macroeconomic slide is implemented only for the basic pension, the reserve fund lasts until 2094, and the amount of the reserve fund in 2115 will be -1092.3 trillion yen (-125.0 trillion yen). In addition, if the macroeconomic slide for the earnings-related pension is implemented until 2023, the reserve fund will not be depleted, and the EPI account can be financially maintained until 2115. The final reduction rate for the earnings-related pension is 2.6%.

[3] Since the basic pension for those who were exempt from contributions is 100% covered by the government subsidy, K_t is not subject to the reduction by the fiscal support.

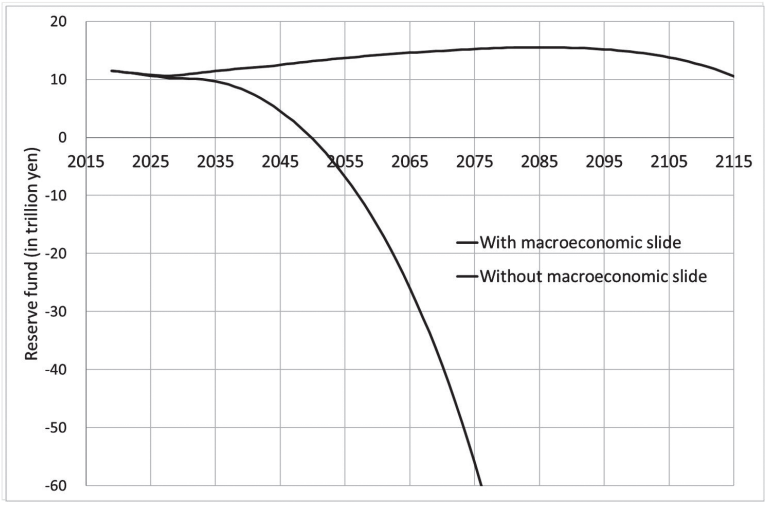

Figure 2: Financial projections of the NP account

Source: Ministry of Health, Labour and Welfare (2020a) for the financial projections with macroeconomic slide; author's calculations for the financial projections without macroeconomic slide.

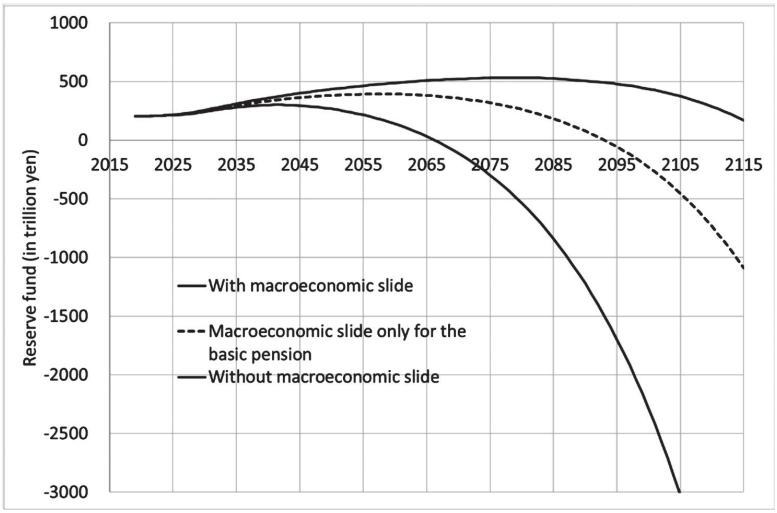

Figure 3: Financial projections of the EPI account

Source: Ministry of Health, Labour and Welfare (2020a) for the financial projections with macroeconomic slide; author's calculations for the financial projections without macroeconomic slide.

3.3. Integrated account

Figure 4 compares the financial projections of the integrated account reserves with and without macroeconomic slide. If the macroeconomic slide is not implemented, the reserve fund will be exhausted by 2066. After that, continuing to calculate mechanically, the amount of the reserve fund will be -5,501.7 trillion yen (-629.4 trillion yen) in 2115.

Solving equation (6) and (7), we can obtain $t_0 = 2032$ and $E_t = 0.91002$ $(t \geqq t_0)$. Figure 4 also shows that if the macroeconomic slide is implemented until 2032, the reserve fund will not be depleted, and the integrated account can be financially maintained until 2115. The final reduction rate for both the earnings-related and basic pension is 9.0% .

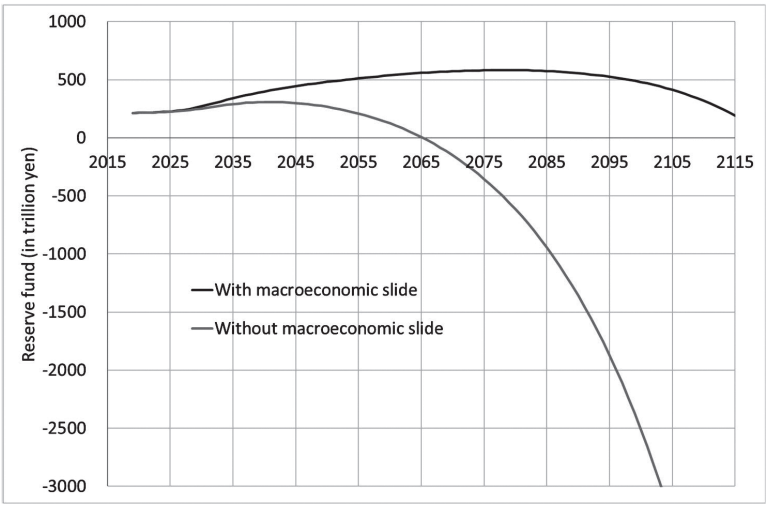

Figure 4: Financial projections of the integrated account

Source: Author's calculations

3.4. Financial support from the Employees' Pension Plan to the National Pension Plan

From equation (9), we obtain $r = 0.872$. Then, the financial support from the Employees' Pension Plan to the National Pension Plan is $0.128\left(P_t^{(1)} - K_t\right)$. In 2020, $P_{2020}^{(1)} = 3.3$ trillion yen and $K_{2020} = 0.4$ trillion yen, then, $0.128P_{2020}^{(1)} = 0.4$ trillion yen. Since the transfer to the BP account from the EPI account is 21.3 trillion yen, the amount of support is not significant (only 1.9% of the transfer) for the EPI account.

4. Conclusion.

In the public pension system, if finances are expected to deteriorate, it is necessary to achieve long-term fiscal balance by either raising contributions or reducing the level of benefits. In Japan, since it is difficult to raise contributions, the macroeconomic slide was introduced to reduce the level of benefits. The 2019 actuarial valuation indicated that it would be necessary to reduce the basic pension by 28.0% and the earnings-related pension by 2.6%.

However, in order to avoid a significant decline in the level of the basic pension, financial support from the Employees' Pension Plan to the National Pension Plan has become an issue for consideration, and the trial calculations for aligning the rate of reduction were presented. It is necessary to integrate the two accounts financially or to make fiscal adjustments with equivalent effects, but the specific method was not presented. Neither have its detailed results been made public.

The fiscal effects of the macroeconomic slide have therefore been clarified in this paper by analyzing the 2019 actuarial valuation. The author then estimated the aligned reduction rate in the case of the accounts' integration. In addition, the amount of financial support from the Employees' Pension Plan to the National Pension Plan was estimated.

As a result, it became clear that the aligned reduction rate would be 9.0%, and the transfer to the BP account from the NP account should be reduced by 12.8% or about 0.4 trillion yen in 2020. However, this is only 1.9% of the transfer from the EPI account, so the amount of support is not significant for the Employees' Pension Plan.

However, there is another problem with fiscal integration. This problem is that the national subsidy will increase significantly. Equations (2) and (4) show that the subsidy is $S_t^{(1)} \times E_t^{(1)} + S_t^{(2)} \times E_t^{(1)} = \left(S_t^{(1)} + S_t^{(2)}\right) \times E_t^{(1)}$. Therefore, the fiscal integration increases the multiplier $E_t^{(1)}$ from 0.72 to 0.91. In other words, the national subsidy will increase by 26.4%.

For example, in 2063, the national subsidy will be 22.9 trillion yen (8.5 trillion yen) under the current system. However, after fiscal integration, it will increase by 6.0 trillion yen (2.3 trillion yen) to 28.9 trillion yen (10.8 trillion yen). Financial support of only about 0.4 trillion yen in 2020[4] from the Employees' Pension Plan to the National Pension Plan will significantly increase the national subsidy. Why would the national subsidy increase through fiscal integration? This is due to a structural problem in the fiscal system, which needs to be re-examined.

Fiscal integration is a conceivable idea, but it would require a significant increase in the national subsidy and the understanding of the employees, the insured of the Employees' Pension Plan. A structural problem in the fiscal system may exist. Therefore, it may be necessary to discuss whether there are other appropriate measures.

Acknowledgement

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Ministry of Health, Labour and Welfare (2020b), Tsuika Shisan (Additional Estimates), https://www.mhlw.go.jp/content/000710902.pdf (accessed November 28, 2021).

[4] The financial support is 12.8% of the transfer to the BP account from the NP account every year. The amount of the financial support was 0.4 trillion yen in 2020.

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FY2019 Financial Verification and Public Pension Finance[1]
Evaluation of the Total Factor Productivity Growth Rate, An Economic Assumption

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Abstract

In this study, after constructing a simple stochastic model using data on the rate of increase in Total Factor Productivity (TFP) over the past 30 years, we use the Monte Carlo simulation method to estimate the probability of realization of the rate of increase in TFP assumed by each case in the FY2019 Financial Verification and examine the economic assumptions and pension finance issues. Until the FY2014 Financial Verification, information on which scenarios were probable and which were not was lacking. However, in the FY2019 Financial Verification, frequency distributions based on historical data for key parameters (e.g., the rate of increase in TFP), which form the core of the data, were included as part of the reference materials, and the assumptions for each scenario were clarified as to where they were positioned in the frequency distribution and what percentage of the frequency distribution they covered. While including frequency distributions is commended, the coverage rate does not match the probability of realization of the TFP increase rate assumed by the Financial Verification. This suggests the importance of using a stochastic model to evaluate the rate of increase in TFP, which is an assumption for Financial Verification.

***Keywords*:** Pension finance, Financial Verification, Total Factor Productivity (TFP) growth rate, frequency distribution, probability model

1. Introduction

The main purpose of this study is to examine the economic assumptions and pension finance issues in Financial Verification of the public pension disclosed by the government. After constructing a stochastic model using data on the rate of increase in Total Factor Productivity (TFP) over the past 30 years, we used a Monte Carlo simulation method to estimate the probability of realizing the rate of increase in TFP assumed in each of the cases of the FY2019 Financial Verification.

As is well known, the soundness of pension finances is assessed by conducting a Financial

[1] The initial draft of this paper was reviewed for comment by Yano Makoto, President; Morikawa Masayuki, Director; and Nakata Daigo, Senior Fellow, Research Institute of Economy, Trade and Industry (RIETI); Inagaki Seiichi, Professor, International University of Health and Welfare, and Hisanaga Takuma, Economist, Asia Pacific Department, IMF. The author is solely responsible for the content of this paper, and all opinions expressed herein are his own and do not represent the official views of the institution to which he belongs.

Verification, which is equivalent to a medical checkup of pension finances, at least once every five years in accordance with the law. The key assumptions for conducting the Financial Verification are: (1) population assumptions, (2) labor force assumptions, and (3) economic assumptions. In this study, (1) population assumptions are based on the "Population Projections for Japan" published by the National Institute of Population and Social Security Research; (2) labor force assumptions are based on the "Labor Supply and Demand Estimates—Policy Simulations Based on the Labor Supply and Demand Model (FY2013)" published by The Japan Institute for Labour Policy and Training; and (3) economic assumptions are based on studies by a special committee established under the Pension Subcommittee of the Social Security Council of the Ministry of Health, Labour and Welfare (MHLW).

Of these, economic assumptions, such as the rate of increase in TFP, the rate of increase in prices, the rate of increase in wages, and investment yield, have the greatest impact on the results of the Financial Verification. However, Financial Verification is conducted by combining assumptions (1), (2), and (3) and by assuming a wide range of multiple scenarios that can be considered reasonable in the long term.

While the method of estimating a wide range of multiple scenarios clearly contributes to the provision of multifaceted information, it also poses the problem of making it difficult to determine which of the multiple scenarios in the results of Financial Verification is most valid.

For example, even within (3), economic assumptions, the FY2009 Financial Verification set three cases: a moderate economy, a strong economy, and a weak economy, based on different assumptions, including the rate of increase in TFP, while the FY2014 Financial Verification set eight cases, and the FY2019 Financial Verification set six cases. In addition, in the FY2019 Financial Verification there are multiple scenarios described in (1) and (2), as well as optional calculations assuming certain systemic changes.

Of course, information on the assumptions used in Financial Verification (e.g., the rate of increase in TFP) and the probability of realization of each scenario will also be necessary to determine the level of validity of the scenarios.

For this reason, "Financial Verification (Peer Review) of the Public Pension System Based on the FY2014 Financial Verification and Actuarial Valuation" by the Actuarial Subcommittee of the Social Security Council (2016), Ministry of Health, Labour and Welfare can be used as reference. Chapter 10, Part 2, "Proposals for Future Financial Verification," also lists four issues: 1) reliable implementation of Financial Verification, 2) analysis of factors causing changes in pension finances, 3) probabilistic outlook, and 4) distributional estimation. The report points out the importance of publishing the probabilistic outlook as an effective means of providing a more detailed picture of the stability of pension finances.[2]

As pointed out by Inagaki (2020), research results from universities and research institutes include Kitamura, Nakajima, and Usuki (2006), Kitamura (2008), and Inagaki and Shimizu (2014). However, at present, the government has not officially released a probabilistic outlook for the future.[3]

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[2] The recommendations in Chapter 10 point out that "if results based on multiple economic assumptions are treated in parallel, as in this case, there is concern that the original purpose of Financial Verification, which is to determine the year in which the benefit level adjustment will end, will not be fulfilled, and a probabilistic outlook may be one measure to deal with this."

[3] While pointing out the importance of the probabilistic outlook, the report also notes the concern that "there are various issues, such as the selection of the target basic rate, setting the distribution of the basic rates, consistency among the basic rates, the number of simulations required, and the method of expressing the results, which require a certain degree of division in the implementation." Chapter 10, 2. Actuarial Subcommittee of the Social Security Council, (2016), The Ministry of Health, Labour and Welfare, "Financial Verification (Peer Review) of the Public Pension System Based on the FY2014 Financial Verification and Fiscal Recalculation."

For this reason, the "Economic Assumptions in Pension Finances (Report of Study Results)" by the 11th Special Committee for Economic Assumptions (SCEA) of the Pension Subcommittee of the Social Security Council (March 13, 2019), Ministry of Health, Labour and Welfare states that "it is important to note that the results of Financial Verification are not forecasts that accurately predict future conditions, including population and the economy, but rather are projections of future pension finances based on certain scenarios from data currently available on population and the economy."

Further, it states that "in conducting Financial Verification, it is necessary to assume a wide range of multiple scenarios that are considered to be reasonable in the long term, set multiple cases of assumptions as the average long-term picture, and interpret the results with a wide range." The implication of this statement is that Financial Verification is calculated based on multiple case assumptions, and projections of pension finances are made, but with no evaluation of the validity of scenarios.

Although there is no information on the assumptions for Financial Verification or the probability of realization of each scenario in the FY2019 Financial Verification, for the key parameters that form the core of Financial Verification (e.g., rate of increase in TFP, rate of increase in prices, rate of increase in wages, and investment yield) frequency distributions (histograms) based on historical data are included in reference materials, as described in Section 2. We clarified where the assumptions for each scenario are positioned in the frequency distribution and what percentage of the frequency distribution they cover.

Frequency distributions were lacking until the FY2014 Financial Verification, and while including them is commended, the coverage rate of the frequency distribution did not necessarily correspond to the realized probability of the rate of increase in TFP, which is an assumption for Financial Verification. To begin with, one of the problems faced in making economic assumptions for the rate of increase in TFP is how to quantitatively evaluate the validity of each assumption based on objective data and indicators. Without some kind of quantitative evaluation, it is difficult to verify the validity of Financial Verification assumptions and the scenarios on which they are based.

In this study, we use data on the rate of increase in TFP over the past 30 years. After constructing a simple stochastic model, a Monte Carlo simulation method is used to estimate the probability of realizing the rate of increase in TFP assumed in each of the FY2019 Financial Verification cases, and to examine the economic assumptions and issues related to pension finances in Financial Verification. This paper is organized as follows. Section 2 outlines the assumptions for the rate of increase in TFP in the FY2019 Financial Verification as well as the frequency distribution and coverage ratio of the rate of increase in TFP included in the materials for Financial Verification. Section 3 provides an overview of the data and the probability model used in the estimation, and then estimates the probability of the rate of increase in TFP. Section 4 provides a discussion of the estimation results. The final Section 5 summarizes and proposes issues for future study.

2. FY2019 Financial Verification and assumption of TFP increase rate

In compliance with the law, the financial health of the pension system is confirmed by conducting a Financial Verification, which is the equivalent of a medical checkup of pension finances, at least once every five years. A previous Financial Verification was conducted in FY2014, and another Financial Verification was conducted five years later, in FY2019.

The FY2014 Financial Verification examined eight cases (Cases A-H) under different conditions, including nominal investment yield and real wage growth, in addition to the rate of increase in TFP, which determines the direction of economic growth. The FY2019 Financial Verification, discussed in this paper, defines six scenarios (Cases I-VI).

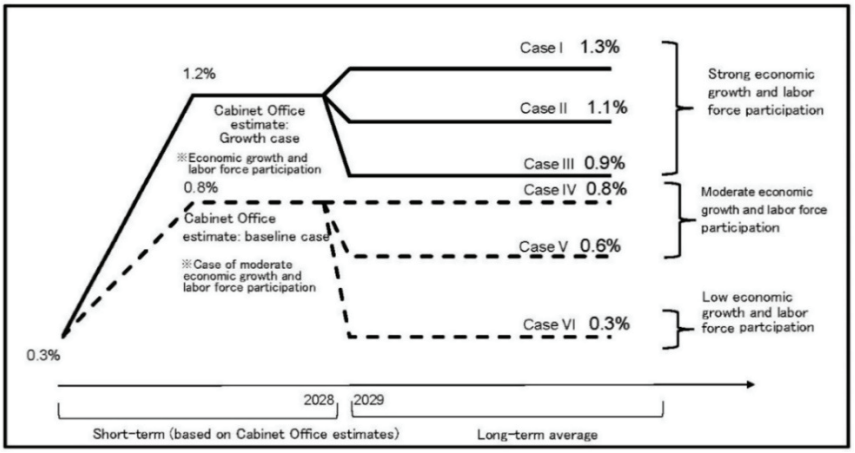

Figure 1: Assumptions for rate of increase in TFP in FY2019 Financial Verification

Source: Excerpt from Document 2-1, "Current Status and Financial Projection of the National Pension and Welfare Finances: Results of FY2019 Financial Verification," 9th Meeting of the Pension Subcommittee of the Social Security Council (August 27, 2019), Ministry of Health, Labour and Welfare.

What is the highlight of the FY2019 Financial Verification report? It is that the frequency distributions (histograms) based on historical data for key parameters that form the core of Financial Verification (e.g., rate of increase in TFP, rate of increase in prices, rate of increase in wages, and investment yield) are included in the reference materials, while clarifying where each scenario falls in the frequency distribution. (Note: See pages 26, 38-40, and 63 of "Economic Assumptions for Pension Finances (Reference Collection)" (hereinafter referred to as "Reference Materials"), Document 2 of "The 10th Expert Committee on Economic Assumptions for Pension Finances" (March 7, 2019), Pension Subcommittee of the Social Security Council, Ministry of Health, Labour and Welfare.)

For the economic assumptions used in the FY2019 Financial Verification, six scenarios were developed for the rate of increase in TFP in FY2029 and beyond: Case I (1.3%), Case II (1.1%), Case III (0.9%), Case IV (0.8%), Case V (0.6%), and Case VI (0.3%), based on past trends in the rate of increase in TFP (Figure 2).

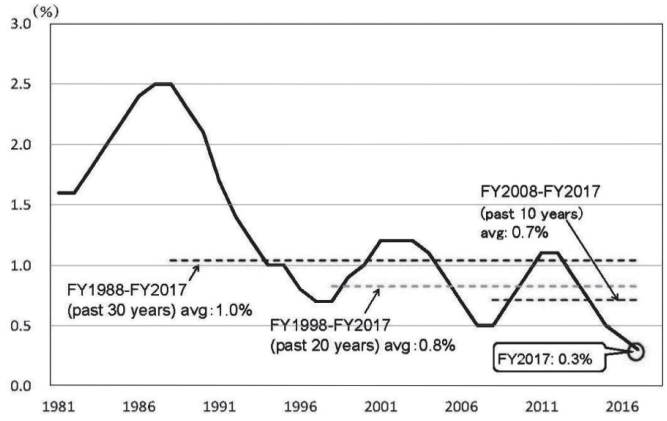

Figure 2: Trends in TFP growth rate (FY1981-FY2017)

Source: Excerpted from Document 2-1, "Current Status and Financial Projection of the National Pension and Welfare Finances: Results of FY2019 Financial Verification," 9th Meeting of the Pension Subcommittee of the Social Security Council (August 27, 2019), Ministry of Health, Labour and Welfare.

The validity of each scenario was explained as follows based on the distribution of past rates of increase in TFP. (Note: See page 6 of Document 1, "Economic Assumptions in Pension Finances (Draft) (Report of Study Results)" (hereafter, "Draft Report") of the 10th Special Committee for Economic Assumptions (SCEA) of the Pension Subcommittee of the Social Security Council, (March 7, 2019) Ministry of Health, Labour and Welfare.)

> The assumption for the long-term rate of increase in Total Factor Productivity (TFP) (from FY2029) is a range of 0.3% to 1.3%. Since the burst of the bubble economy in the latter half of the 1990s, the rate has been in the range of 0.3% to 1.2%. Looking at the distribution of actual results over the past 30 years (FY1988-FY2017), about 20% (17%) exceeds the assumption of 1.3% in Case I, which corresponds to a scenario in which Case I covers about 20% (17%) of the actual results over the past 30 years. Similarly, 1.1% in Case II corresponds to a scenario in which about 40% (40%), 0.9% in Case III corresponds to a scenario in which about 60% (63%), 0.8% in Case IV corresponds to a scenario in which about 70% (67%), 0.6% in Case V corresponds to a scenario in which about 80% (83%), and 0.3% in Case VI corresponds to a scenario in which 100% (100%) is covered.

Supplementary explanation is required for the meaning of the numerical values appearing in the explanation of this draft report. For example, consider Case III with a TFP increase rate of 0.9%.

First of all, the meaning of the statement that "in terms of the distribution of actual results over the past 30 years (FY1988-2017), 0.9% in Case III corresponds to a scenario in which approximately 60% (63%) of the population is covered" can be easily understood by looking at the frequency distribution of past rates of increase in TFP. On page 26 of the reference materials, the frequency distribution of the rate of increase in TFP over the past 30 years (FY1988-2017) is provided in Figure 3, and, of that distribution, the percentage of TFP increase of 0.9% or more is 63%. This is what we mean when we say that 0.9% in Case III corresponds to a scenario where about 60% (63%) is covered.

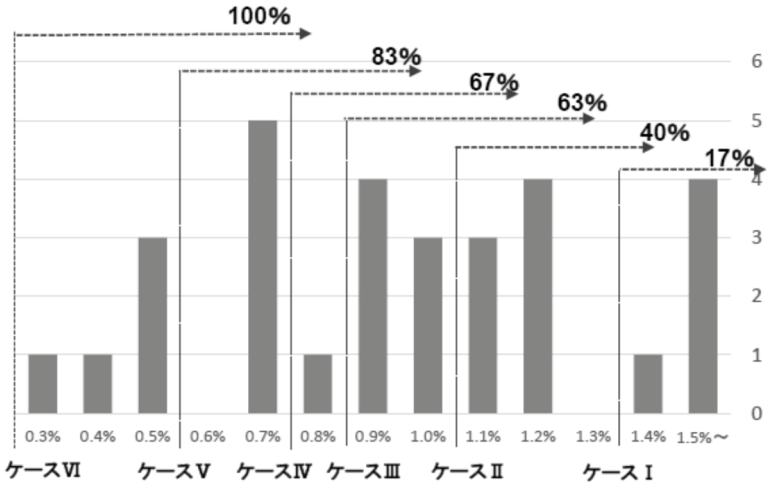

Figure 3: Frequency distribution of TFP increase rate (FY1988-FY2017)

Source: Excerpted from Document 2-1, "Current Status and Financial Projection of the National Pension and Welfare Finances: Results of FY2019 Financial Verification," 9th Meeting of the Pension Subcommittee of the Social Security Council (August 27, 2019.) Ministry of Health, Labour and Welfare.

However, this does not indicate that the Case III scenario will be realized with a 63% probability. Even assuming that the distribution of the rate of increase in TFP in the future will remain unchanged from that of the past, the Case III scenario will not be realized with a 63% probability. The reason for this is simple: Case III assumes that the rate of increase in TFP will always be at least 0.9% for each year after FY2029, and, if the rate of increase in TFP falls below 0.9% even for one year, the assumptions of Case III will not be met.

This is clear in the following simple case. What is the probability that the rate of increase in TFP in the first year is 0.9% or higher, and that the rate of increase in TFP in the second year is also 0.9% or higher? Assuming that the random variable for the rate of increase in TFP in each year is independent, 39.7% (= 0.63 × 0.63) is the correct probability. In other words, the value of 63% indicates the probability that the rate of increase in TFP will be 0.9% or higher in a given year, but it does not indicate the probability that the rate of increase in TFP will always be 0.9% or higher in every year after 2029.

Is it possible to make certain assumptions and conduct an assessment of the assumptions regarding the rate of increase in TFP in each case of the FY2019 Financial Verification? To do this, in the following Section 3, after constructing a simple stochastic model for the rate of increase in TFP, a Monte Carlo simulation method will be used to estimate the probability of realization of the rate of increase in TFP assumed for each of the FY2019 Financial Verification cases.

3. Overview of the data used and the probability model

First of all, the data on the rate of increase in TFP shown on page 9 of Document 2-1, "Current Status and Financial Projection of the National Pension and Welfare Finances—Results of FY2019 Financial Verification," 9th Meeting of the Pension Subcommittee of the Social Security Council (August 27, 2019), Ministry of Health, Labour and Welfare is the data from the Cabinet Office Monthly Economic Report, "Quarterly Estimates of GDP for Oct.-Dec. 2018 (The First Preliminary Estimates)." This paper will use this data as a basis for the rate of increase in TFP.

The value of the rate of increase in TFP in year t is then denoted as $\rho(t)$. The difference between the rate of increase in TFP in year t and the rate of increase in TFP in year (t-1) is denoted by $\Delta\rho(t) = \rho(t) - \rho(t-1)$ and by using $\Delta\rho(t)$ we define $\Delta^2\rho(t) = \Delta\rho(t) - \Delta\rho(t-1)$.

Table 1: Basic statistics including the rate of increase in TFP

	ρ	$\Delta\rho$	$\Delta^2\rho$
Average	1.22	-0.04	0.00
Distribution σ^2	0.40	0.03	0.02
σ	0.63	0.17	0.13
Maximum value	2.50	0.20	0.20
Minimum value	0.30	-0.40	-0.20
Median	1.10	0.00	0.00

Source: Based on the data from "Quarterly Estimates of GDP for Oct.-Dec. 2018 (The First Preliminary Estimates)," the relative frequency distribution of ρ, relative frequency distribution of $\Delta\rho$, and relative frequency distribution of $\Delta^2\rho$ are estimated and graphed in Figure 4, Figure 5, and Figure 6, respectively.

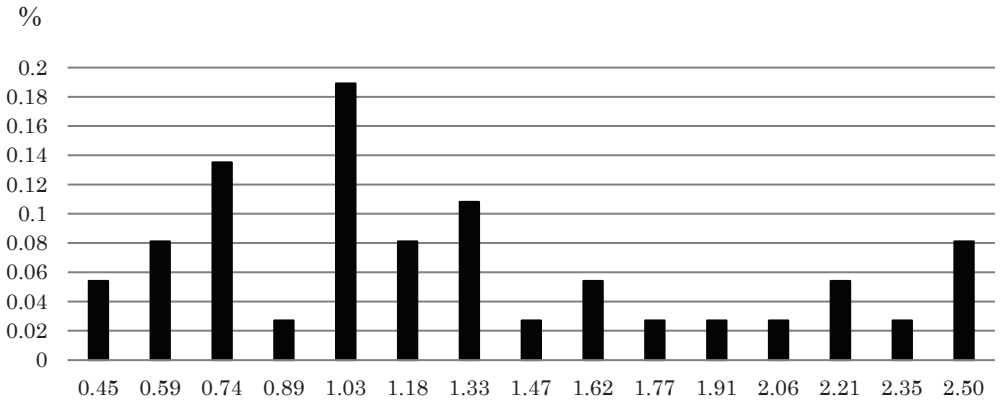

Figure 4: Relative frequency distribution of ρ (Unit of horizontal axis: %)

Source: Compiled by the author from "Quarterly Estimates of GDP for Oct.-Dec. 2018 (The First Preliminary Estimates)" in the Monthly Economic Report, Cabinet Office, Government of Japan.

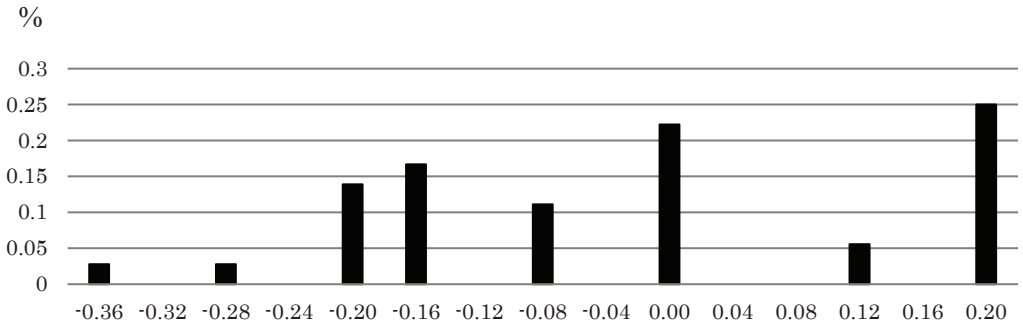

Figure 5: Relative frequency distribution of $\Delta\rho$ (Unit of horizontal axis: percentagepoints)

Source: Compiled by the author from "Quarterly Estimates of GDP for Oct.-Dec. 2018 (The First Preliminary Estimates)" in the Monthly Economic Report, Cabinet Office, Government of Japan.

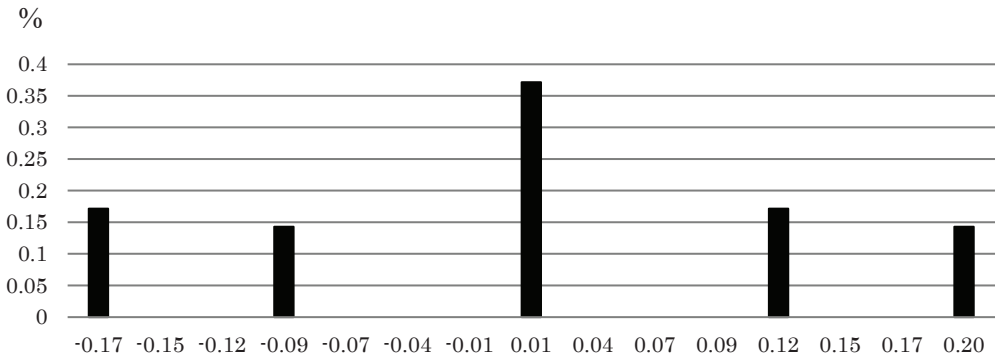

Figure 6: Relative frequency distribution of $\Delta^2\rho$

Source: Compiled by the author from "Quarterly Estimates of GDP for Oct.-Dec. 2018 (The First Preliminary Estimates)" in the Monthly Economic Report, Cabinet Office, Government of Japan.

The relative frequency distribution of variable x is expressed as P_x. When the value of variable x in year t is independent of the value in year (t-1) and probabilistically follows the relative frequency distribution $P(x)$, the probability that the variable in year t is $x(t) = \alpha$ is $P_x(\alpha)$. There are various possible candidates for variable x, but the simplest probabilistic models are the following three.

1) $x = \rho$
2) $x = \Delta\rho$
3) $x = \Delta^2\rho$

Of these, the probability model in 1) is somewhat unreasonable from a practical standpoint. This is because Figure 4 (relative frequency distribution of ρ) shows that, for example, there is a reasonable probability that the rate of increase in TFP in year t will be $\rho(t) = 0.45$ and that it will be $\rho(t+1) = 2.50$ in year (t+1). However, as shown in Figure 2, there is no year in which the rate of increase in TFP has increased by more than 2 percentage points. This can be read from the fact that the maximum value of $\Delta\rho$ is 0.20 percentage points and the variance σ is 0.17 percentage points in Table 1 (Basic Statistics). Based on the above, we will consider 2) and 3) above as the probability models for this paper.

Probability model: $\boldsymbol{x = \Delta\rho}$

First, let's consider a stochastic model of $x = \Delta\rho$. In the FY2019 Financial Verification, calculations were conducted for a period of 97 years, from FY2019 to FY2115. In the calculations for each case, as shown in Figure 1, it was assumed that the rate of increase in TFP would gradually increase from FY2019 to FY2028, and that it would become a constant value over the long term from FY2029 onward. Assuming this constant value is β, and the total rate of increase in TFP from FY2019 to FY2028 is δ, when evaluating the average rate over the 50 years from FY2019, the following conditions will satisfy the assumption of the rate of increase in TFP set by the Financial Verification.

$$\frac{1}{50}\sum_{t=1}^{50}\rho(2018+t) \geq \gamma \equiv \frac{1}{50}(\delta + 40\beta) \qquad (1)$$

The right-hand side of this inequality (γ) represents the average rate of increase in TFP assumed in the FY2019 Financial Verification for 50 years starting in FY2019, and γ for each case is shown in Table 2. (Note: For the assumption of the rate of increase in TFP from FY2019 to FY2028, see page 11 of Document 2-1, "Current Status and Financial Projection of the National Pension and Welfare Finances: Results of FY2019 Financial Verification," 9th Meeting of the Pension Subcommittee of the Social Security Council (August 27, 2019), Ministry of Health, Labour and Welfare.)

Table 2: Average rate of increase in TFP assumed by Financial Verification (FY2019-FY2068)
(Unit: %)

	Case Ⅰ	Case Ⅱ	Case Ⅲ	Case Ⅳ	Case Ⅴ	Case Ⅵ
γ	1.24	1.08	0.92	0.784	0.624	0.384

Source: Compiled by author.

If variable $\Delta\rho$ follows a probabilistic relative frequency distribution $P_{\Delta\rho}$, the lower limit in Figure 5 is $\Delta\rho_{min}$ and the upper limit is $\Delta\rho_{max}$, and its cumulative probability distribution $F(\Delta\rho)$ is as follows:

$$F(\Delta\rho) = \int_{\Delta\rho_{min}}^{\Delta\rho} P_{\Delta\rho}(s)ds \qquad (\text{ただし、} \int_{\Delta\rho_{min}}^{\Delta\rho_{max}} P_{\Delta\rho}(s)ds = 1) \qquad (2)$$

Furthermore, in year t (t=2020, 2021,...,2068), when $\varepsilon(t)$ is the uniformly distributed random number generated in the interval [0, 1], $\Delta\rho(t)$ in year t is defined as follows:[4]

$$\Delta\rho(t) = F^{-1}(\varepsilon(t)) \qquad (3)$$

In the FY2019 Financial Verification, the initial value of the rate of increase in TFP (for FY2019) is $\rho(2019) = 0.4$. Therefore, using this as the initial value, random numbers for 49 years (t=2020,2021,...,2068) were generated using the Monte Carlo simulation method, and (3) was added to the left-hand side of inequality (1) to check whether the condition in (1) is satisfied. We run this operation (Monte Carlo simulation) 5,000 times to determine the value of the variable $K(j)$ in the following way. First, let j=,1,2,3,...,5000, and perform the above operation once at the jth time, and set $K(j) = 1$ if the condition in (1) is satisfied. If the condition in (1) is not satisfied, $K(j) = 0$. Once this operation (Monte Carlo simulation) has been completed 5,000 times, the following equation is used to define the realized probability q of the rate of increase in TFP assumed by each case of FY2019 Financial Verification.

$$q = \frac{1}{5000}\sum_{j=1}^{5000} K(j) \qquad (4)$$

Using the above method, we can create a Matlab program and estimate the realization probability q of (4) in each case of FY2019 Financial Verification, as shown in Table 3.

Table 3: Realization probability of TFP increase rate (probability model: $x = \Delta\rho$)

	Case I	Case II	Case III	Case IV	Case V	Case VI
q	0.38%	0.86%	1.62%	4.78%	12.3%	91.84%

Source: Compiled by author.

To show the accuracy of the estimation in Table 3, Figure 7 shows the probability distribution of $\Delta\rho$ (average of 5,000 times) obtained as the average of 5,000 Monte Carlo simulations added to the relative frequency distribution of $\Delta\rho$ in Figure 5. The probability distribution of $\Delta\rho$ (averaged over 5,000 times) is shown as a white bar graph, and it can be confirmed that it is generally consistent with the relative frequency distribution of $\Delta\rho$, which is shown as a black bar graph (based on data on the rate of increase in TFP from the "Quarterly Estimates of GDP for Jan.-Mar. 2020 (The Second Preliminary Estimates (Revised)").

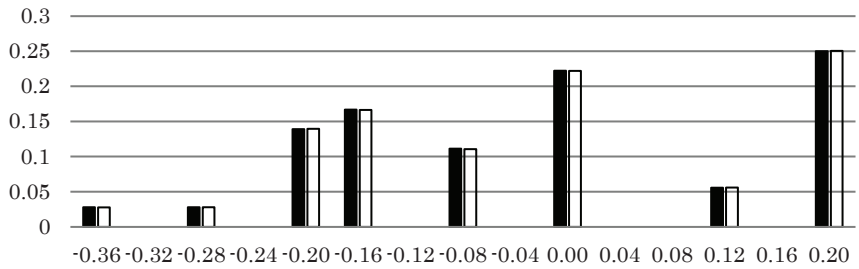

Figure 7: Probability distribution of $\Delta\rho$ (average of 5,000 Monte Carlo simulations)

Source: Compiled by author.

[4] The Black-Scholes equation and other theories of financial engineering assume that stock prices follow a geometric Brownian motion, but in reality the rates of return on various asset prices are not normally distributed in many cases. This is also the case for general economic variables such as the rate of increase in TFP. To solve this problem, Hörmann and Leydold (2003) and Imai and Tan (2006) proposed the inverse function method of generating random variables from uniformly distributed random numbers in the interval [0, 1], and a similar method is employed in the analysis of Financial Verification in this paper.

Probability model: $x = \Delta^2\rho$

Next, we consider a stochastic model with $x = \Delta^2\rho$. The method for estimating the realized probability q of the rate of increase in TFP assumed by each of the FY2019 Financial Verification cases is roughly the same as that for the stochastic model with $x = \Delta\rho$, but modifications to (2) and (3) will be necessary.

First, if the variable $\Delta^2\rho$ follows a probabilistic relative frequency distribution$P_{\Delta^2\rho}$, with the lower limit in Figure 6 being $\Delta^2\rho_{min}$ and the upper limit being $\Delta^2\rho_{max}$, then its cumulative probability distribution $G(\Delta^2\rho)$ is as follows:

$$G(\Delta^2\rho) = \int_{\Delta^2\rho_{min}}^{\Delta^2\rho} P_{\Delta^2\rho}(s)ds \quad （ただし、\int_{\Delta^2\rho_{min}}^{\Delta^2\rho_{max}} P_{\Delta^2\rho}(s)ds = 1） \qquad (5)$$

Using this (5) and the uniform random number $\varepsilon(t)$ in interval [0, 1], the $\Delta^2\rho(t)$ in year t (t=2020, 2021,...,2068) is determined by:

$$\Delta^2\rho(t) = G^{-1}(\varepsilon(t)) \qquad (6)$$

In addition, the initial value of the rate of increase in TFP in FY2019 Financial Verification is $\rho(2019) = 0.4$, so using this as the initial value is no different from the calculation process in (4), but the value of $\Delta\rho(2019)$ is required for the calculation of the left-hand side of inequality (1). Since the data on the rate of increase in TFP in the Cabinet Office document “Quarterly Estimates of GDP for Jan.-Mar. 2020 (The Second Preliminary Estimates (Revised))” shows $\Delta\rho(2019) = 0$, this value was used to calculate the probability of realization q of (4) in each case of FY2019 Financial Verification, using the same method as in the probability model with $x = \Delta\rho$ as shown in Table 4. Figure 8 is similar to Figure 7. In Figure 8, the white bars represent the probability distribution of $\Delta^2\rho$ (average of 5,000 times). This can be confirmed as generally consistent with the black bars in the graph, in Figure 6, Relative frequency distribution of $\Delta^2\rho$.

Table 4: Realization probability of TFP increase rate (probability model: $x = \Delta^2\rho$)

	Case I	Case II	Case III	Case IV	Case V	Case VI
q	21.2%	28.94%	36.12%	44.9%	54.22%	80.78%

Source: Compiled by author.

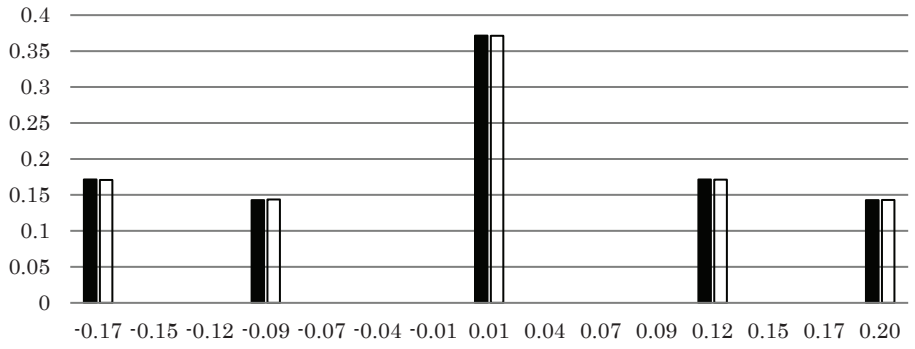

Figure 8: Probability distribution of $\Delta^2\rho$ (average of 5,000 Monte Carlo simulations)

Source: Compiled by author.

4. Discussion of estimation results

What can we read from the results of the calculations in Table 3 and Table 4? The first thing to note is that the coverage ratios for Cases I through VI in Figure 3 are very different from the realization probabilities in Table 3 and Table 4. This means that the coverage ratio in Figure 3 does not match the probability of realization of the rate of increase in TFP assumed in the Financial Verification.

When assuming a stochastic model with $x = \Delta\rho$, Table 3 shows that the probability of achieving the rate of increase in TFP assumed for Cases I through IV is less than 5%, and even for Case V, the probability is a severe 12%. Only Case VI has a realization probability of about 90%.

This is an extremely harsh result. To begin with, in the 2004 pension reform, the government clearly stated in the law that the income replacement rate for pensions should be maintained at 50% or higher in the future, and it also mandated a revision of the system if the rate falls below 50%. In the FY2019 Financial Verification, even in the three cases (Case I, Case II, and Case III) assuming high growth (real GDP growth of 0.4% to 0.9% after FY2029), as shown in Table 5, the income replacement rate of 61.7% at present (FY2019) will decline to 50.8%-51.9%, revealing that the benefit level will be reduced by about 20% in about 30 years.

Further, in the three cases of low growth (real GDP growth rate of -0.2% to -0.5% after FY2029) (Case IV, Case V, and Case VI), the income replacement rate will fall below 50%, and in Case VI, the national pension fund will run out of money in FY2052 and shift to a full pay-as-you-go system. The report also clarifies the possibility that the income replacement rate will be around 36% to 38%.

Table 5: End year of benefit level adjustment and final income replacement rate (FY2019 Financial Verification)

	Case I	Case II	Case III	Case IV	Case V	Case VI
End year of benefit level adjustment	2046	2046	2047	2053	2058	2052 onwards
Final income replacement ratio (Note)	51.9%	51.6%	50.8%	46.5%	44.5%	36－38%

Note: Cases IV through VI represent the income replacement rate when the income replacement rate falls below 50% in FY2043-2044 and the benefit level is mechanically adjusted until fiscal balance is achieved.

Source: Prepared by the author based on Document 2-1, "Current Status and Financial Projection of the National Pension and Welfare Finances: Results of FY2018 Financial Verification," 9th Meeting of the Pension Subcommittee of the Social Security Council (August 27, 2019) Ministry of Health, Labour and Welfare.

Given these FY2019 Financial Verification results, the only probability of realizing the rate of increase in TFP assumed by Case VI, which is approximately 90%, suggests that future pension finances may become truly severe.

However, the above discussion is based on the assumption of a probability model with $x = \Delta\rho$, and the discussion changes if we assume a probability model with $x = \Delta^2\rho$. When assuming a stochastic model with $x = \Delta^2\rho$, Table 4 shows that the probability of achieving the rate of increase in TFP assumed by Case I to Case III increases to approximately 21% - 36%. As in Table 3, the probability of realization of Case VI is the highest at about 80%, but the probability of realization of Case IV and Case V also increases to about 45% - 54%.

Compared to Case VI, in which the final income replacement rate is just under 40%, Cases IV and V can maintain a final income replacement rate of just under 50%, meaning that if the rate of

increase in TFP assumed by Cases IV and VI can be achieved, the income replacement rate will be approximately 1.2 times higher.

It can be seen from Tables 3 and 4 that the probability of realization of the rate of increase in TFP will change depending on what is adopted as the stochastic model when evaluating the assumption of the rate of increase in TFP for the FY2019 Financial Verification. The main reasons for this can be seen in Table 1, Figure 5, and Figure 6. First, the rate of increase in TFP rises and falls in response to the effects of the business cycle, but in the long term it is on a downward trend, with the average value of $\Delta\rho$ slightly negative and the average value of $\Delta^2\rho$ zero. This is because the relative frequency distribution of $\Delta\rho$ (Figure 5) is somewhat skewed to the left, so this probability model can take into account the downward trend in the rate of increase in TFP, but the relative frequency distribution of $\Delta^2\rho$ (Figure 6) has a shape close to a normal distribution, so this probability model does not necessarily reflect a downward trend. As a result, this difference may be reflected in the differences in realization probabilities shown in Tables 3 and 4. Therefore, it is important to interpret the estimation results with a wide range, but we also need to face the reality that the realization probability of Case I and Case II is only less than 30%, even assuming the estimation results shown in Table 4 (probability model with $x = \Delta^2\rho$).[5]

5. Conclusions and future issues

The main purpose of this study was to examine the economic assumptions and pension finance issues in the Financial Verification of the public pension disclosed by the government. After constructing a stochastic model using data on the rate of increase in TFP over the past 30 years, we used a Monte Carlo simulation method to estimate the probability of realizing the rate of increase in TFP assumed in each of the cases of the FY2019 Financial Verification. The results of this study revealed the following three points.

The first point is the importance of using a constant probability model to evaluate assumptions such as the rate of increase in TFP in the Financial Verification. Until the FY2014 Financial Verification, information on which scenarios were probable and which were not was lacking. However, in the FY2019 Financial Verification, frequency distributions based on historical data for key parameters (e.g., the rate of increase in TFP), which form the core of the data, were included as part of the reference materials, and the assumptions for each scenario were clarified as to where they were positioned in the frequency distribution and what percentage of the frequency distribution they covered. While including frequency distributions is commended, as discussed in Section 4, the coverage does not match the probability of realization of the rate of increase in TFP assumed in the Financial Verification. This suggests the importance of using a constant stochastic probability model to evaluate the rate of increase in TFP assumed in Financial Verification.

Second, assuming a stochastic model with $x = \Delta\rho$, the probability that the rate of increase in TFP assumed in Cases I through IV of the FY2019 Financial Verification will be realized is less than 5%, and even in Case V it is about 12%. Only Case VI has a probability of realization of about 90%.

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[5] Detailed explanations will be omitted, but using the same method as in Tables 3 and 4, the estimated probability of realization of the rate of increase in TFP, assuming a stochastic model with $x = \Delta\rho/\rho$, is 0.1% for Case I, 0.4% for Case II, 1.1% for Case III, 1.4% for Case IV, 4.0% for Case V, and 48.2% for Case VI. In order to remove the anomaly of the bubble period, the probability of realization of the rate of increase in TFP was estimated using data on the rate of increase in TFP from FY 1992 to FY 2017, using the same stochastic model as in Tables 3 and 4, as follows. First, Table 3 shows that Case I is 0%, Case II is 0%, Case III is 0.3%, Case IV is 1.6%, Case V is 7.8%, and Case VI is 80.5%. Next, Table 4 shows that Case I is 3.1%, Case II is 18.1%, Case III is 37.3%, Case IV is 58.1%, Case V is 79.2%, and Case VI is 97.1%.

Case VI also reveals the possibility that the national pension fund will run out of money in FY2052 and switch to a full pay-as-you-go system, as well as the possibility that the income replacement ratio will be around 36% to 38%, which suggests that future pension finances may become extremely constricted.

Third, when assuming a stochastic model with $x = \Delta^2\rho$, the probability that the rate of increase in TFP assumed by Cases I to III of the FY2019 Financial Verification will be realized increases to approximately 21% - 36%, while the probability of realization of Cases I and II is less than 30%. This suggests that the TFP increase rates of 1.1% and 1.3% and Case I and Case II may be somewhat optimistic assumptions.

The following three issues should be addressed in the future.

The first is to estimate the probability of realization of the assumptions made in the Financial Verification process by constructing stochastic models for important parameters other than the rate of increase in TFP, which is the core of the Financial Verification process (e.g., the rate of increase in prices, the rate of increase in wages, and investment yield). This paper estimated the probability of realization of the rate of increase in TFP and discussed the assumptions underlying Financial Verification, but it did not estimate the probability of realization of the rate of increase in prices, the rate of increase in wages, or the investment yield, which are issues for the future.

The second is the construction of a multivariate stochastic model. The key parameters that will form the core of Financial Verification include the rate of increase in TFP, the rate of increase in prices, the rate of increase in wages, and investment yield. These variables are not independent and may be correlated with each other. However, this paper estimates the probability of realization of the rate of increase in TFP, which is a prerequisite for Financial Verification, based on the assumption that the stochastic model that determines the behavior of the rate of increase in TFP is independent of variables such as the rate of increase in prices, the rate of increase in wages, and investment yield. Another future task is to extend the estimation to a multivariate stochastic model with correlations among each of the variables in a less complex model form that can be used in actual Financial Verification.

The third is the application to areas other than Financial Verification of pensions. In order to forecast the medium- to long-term macroeconomic and fiscal projections, and to examine the direction of financial reconstruction and other measures, the Cabinet Office publishes “Economic and Fiscal Projections for Medium to Long Term Analysis.” These calculations also make certain assumptions about the rate of increase in TFP, etc., while estimating the outstanding balance of public debt (relative to GDP), the budget deficit (relative to GDP), etc., and it is important to evaluate the validity of these assumptions (e.g., the rate of increase in TFP). The probabilities of realization of Case I and Case II shown in Tables 3 and 4 indicate the possibility that the assumed rates of increase in TFP of 1.1% and 1.3% after the FY2029 Financial Verification are optimistic. Evaluation of the validity of this assumption will be an issue for future study.

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Reconsidering Aging and Financial Markets in East Asia

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Abstract

Amid the concern over detrimental effects of rapid aging in East Asia, estimations of the impacts of the region's demography on macroeconomic variables have been conducted since the early 2000s. A recent example is IMF (2017), which estimated several macroeconomic variables using panel data of demographic variables and a number of newly introduced explanatory variables, such as "financial openness" and expected "aging speed." IMF (2017), however, defines the range of ages in the "working age population" differently from those commonly used. In this chapter, we estimate macroeconomic and financial variables by using explanatory variables similar to those of IMF (2017), but with commonly used demographic definitions, and with an increased number of countries during extended periods. The results of the estimations are different from those of IMF (2017) but similar to those of previous literature. "Youth dependency ratio," "old-age dependency ratio" and "expected aging speed" have significant impacts on interest rates and stock return, the impacts of which, however, can be mitigated by increased "financial openness." Empirically revealed relationships between "aging speed" and savings as well as financial variables is a "conundrum" which is not consistent with the Life Cycle/Permanent Income hypothesis, but can be explained using "behavioral economics." The resulting shortage of savings after retirement can be rectified by introducing "Saving More Tomorrow" type pension plans which incorporate behavioral economics and are widely available in the United States. Similar plans may provide solutions against the expected shortage of savings in East Asia, including Japan.

***JEL Classification number*: E44, E70, O16**

Keywords; demography, aging, East Asia, financial market, savings, interest rates, stock return, financial openness, aging speed, behavioral economics

1. Introduction

Among East Asian countries, including ASEAN (Association of Southeast Asian Nations), 10 countries, Japan, Korea and PRC (People's Republic of China), have become, or are becoming, "aging societies," where the ratio of the elderly (65 years or older) exceeds 7% of the total population. According to the population prospects of the United Nations (2019), "the years to double the elderly ratio" from 7% to 14%, at which level the country enters the "aged society," of East Asian countries are compatible to, or less than those of Japan (24 years), except for the Philippines (35 years), and Myanmar (31 years). The elderly ratios of all East Asian countries are expected to rise (Fig. 1) and the working-age (15 to 64 years of age) population ratios are expected to decline by the year 2050.

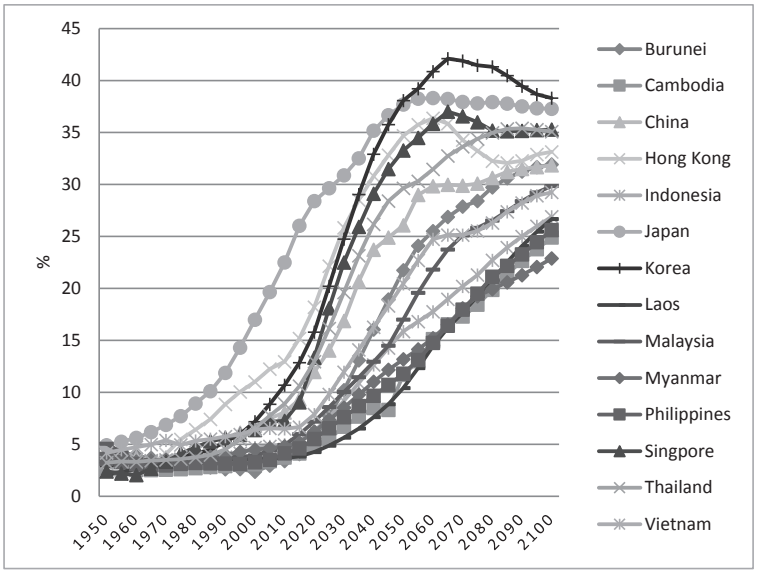

Figure 1: Elderly ratio (%; Pop. age 65 or older / Total pop.) of East Asian Economies
(Source) United Nations (2019) and calculation by author.

Amid the concern over detrimental effects of rapid aging in East Asia, estimations of the impacts of the region's demography on macroeconomic variables have been conducted since the early 2000s. A recent example is IMF (2017), which estimated several macroeconomic variables by using panel data of demographic variables, such as "working age population," and a number of newly introduced explanatory variables, such as "financial openness" and expected "aging speed." IMF (2017), however, defines "working age population" as the population aged 30 to 64, which is different from the usual definition of working age population, covering ages 15 to 64. In this chapter, we estimate macroeconomic variables by using explanatory variables similar to those of IMF (2017), but with a commonly defined working age population, i.e., ages 15 to 64, and with an increased number of countries during extended periods. The results of the estimations are different from those of IMF (2017), but similar to those of previous literature, including studies by the author. "Youth dependency ratio," "old-age dependency ratio" and "expected aging speed" have significant impacts on interest rates and stock return, the impacts of which, however, are mitigated by increased "financial openness."

Section 2 of this chapter reviews preceding literature up to the early 2000s. Section 3 shows the regression results of financial market variables and savings on demography, taking recent literature into "reconsideration." Section 4 deals empirically with the "conundrum" between "expected aging speed" and financial variables including savings, interest rates and stock return, which can be solved by using "behavioral economics." In the United States, retirement savings plans incorporating behavioral economics are already available. We illustrate the outcomes of introducing these plans and provide possible solutions to the ongoing "20 million yen" shortage problem[1] after retirement in Japan. Section 5 summarizes the discussions in this chapter.

[1] Financial Services Agency (2019) mentions that the shortage in retirement income has to be withdrawn from accumulated financial assets, therefore around JPY13 million in 20 years and around JPY20 million in 30 years need to be withdrawn if the income continues to be short of expenditure by JPY50 thousand every month.

2. Literature in the Early 2000s

IMF and other international organizations, as well as many researchers, have estimated the macroeconomic impacts of demographic variables since the early 2000s. Some of this literature is summarized below.

(1) Impact of Aging on Macroeconomic Variables

IMF (2004) demonstrates that GDP per capita growth rates have a positive correlation with working age (aged 15 to 64) population ratios, and a negative correlation with elderly (age 65 or older) population ratios. It also shows that savings rates, investment ratios and current account balances have positive correlations with working age population ratios and negative correlations with elderly population ratios. As such, aging in East Asian countries may cause these countries to lose the "demographic dividend" they have experienced thus far. A decline in the labor force due to retirement in the aging population may reduce potential growth rates, and decreased working age population may reduce savings, investments, capital accumulation, and in turn, reduce growth rates. The volume of reduction in savings is larger than the fall in investment volume, which leads to a deterioration in current account balances. On the fiscal side, population aging induces increases in pension, medical and elderly care expenditure, which has negative impacts on fiscal balances.

Furthermore, different coverages and social security systems may illuminate the geographical, occupational and intergenerational inequalities. On the financial front, aging in East Asia may induce "Asset Market Meltdown" and a fluctuation of demand for, and prices of, financial assets.

(2) Impact of Aging on Economic Growth

Population aging has a negative impact on economic growth. Bloom and Canning (2004) conducted panel estimates of the following modified neo-classical growth model, finding that GDP per capita growth rates (g_y) have positive correlations with labor participation ratio (p), initial working age population ratio (w_0) and its growth rates (g_w).

$$g_y = \lambda (X\beta + p + w_0 - y_0) + g_w$$

(X: other variables (e.g. policy and institutional environment, openness, education, region), β: coefficient vector, λ: convergence speed, y_0: initial income level)

Kihara (2007a, b) uses similar explanatory variables to those of Bloom and Canning (2004), but panel data for different countries in Asia and Sub-Sahara Africa over an extended period (1973 to 2004), to estimate real GDP per capita growth rates. The results are similar to Bloom and Canning (2004); working age population ratio and its growth rate have positive and significant impacts on GDP per capita growth rates.

According to the results of estimations by Kihara (2007a,b), an increase in working age population ratio from 50% to 60% causes GDP per capita to grow by 1.6%, and a 1% increase in the growth rate of working age population ratio (g_w) leads to a 1.6% hike in GDP per capita.

The United Nations has estimated the prospects of working age population ratios in East Asia and finds that the growth rates of their working age population ratios will fall and become negative in coming decades. Reflecting the fall in g_w, demographic contributions to GDP growth rates are expected to decline.

(3) Impact of Aging on Savings

Now, let us turn to the impact of aging on savings. The Life cycle/Permanent income hypothesis suggests that people save while in their middle ages, and dissave in youth and old ages. Bosworth and Chodorow-Reich (2007) estimate the impacts of aging on savings using panel data of 85

countries during the period 1960-2004 (in 5-year periods). The estimated results show that demography has significant effects on savings, and saving rates are lower when the old-age or youth dependency ratio is higher. They also indicate that demographic impacts on saving rates are particularly large in Asia. Thus, rapid aging in Asia may have larger macroeconomic impacts than in other regions. The comparison between age cohorts shows that the saving rates peak at age 40 to 50 years.

Kihara (2007a,b) estimates saving rates by different countries (in Asia and Sub-Sahara Africa) and periods (1970-2004, 4-year periods), but obtains similar results as found in the literature mentioned above. The saving rates are estimated to rise when the population ratio of the "high-saving-generation" (aged 40 to 64) over "working age" (aged 15 to 64) rises. (The domestic gross saving ratio rises by 0.5% when the high-saving-population ratio increases by 1%). On the other hand, the saving rates are estimated to fall when the "old-age dependency" ratio (population of age 65 or older / working age population) rises. (The domestic gross saving ratio falls by 2% when the dependency ratio increases by 1%.) Both relationships are significant and robust.

What are the prospects for the "high-saving-generation" population in East Asia? United Nations (2019) predicts that the population ratios of the high-saving-generation in ASEAN countries will continue to increase for a while. However, in East Asia, they will peak out in Korea and Thailand in the year 2020, China in 2030, Brunei and Vietnam in 2035, Myanmar in 2060, Indonesia in 2065, Lao Republic and Cambodia in 2075, and the Philippines in 2090; all countries will experience a reduction in the population ratio of the high-saving-generation within this century. East Asian economies need to eliminate the vulnerabilities of financial markets during the affluent period of savings, in order to efficiently channel their reduced volumes of savings in aged societies toward sustained investment and growth.

(4) Impact of Aging on Financial and Capital Markets

Since the early 2000s, a substantial volume of literature on theories and empirical studies presents significant impacts of aging on financial markets due to changing saving rates and preferences for different classes of assets. IMF (2004), for example, mentions that empirical analyses show a robust relationship between the population of the high-saving-generation and asset prices (e.g., asset prices rise when baby boomers become 40 to 64 years old). They also show the possibility of lower stock prices when baby boomers become old (e.g., in the United States, baby boomers born in 1946 to 1964 may begin to retire at 65 years of age, that is, from around 2010); i.e., there is a possibility that that the "Asset Market Meltdown Hypothesis" may hold.

Besides IMF, many empirical analyses have been conducted to estimate the impacts of aging on financial asset prices and interest rates, including Davis and Li (2003) and Park and Rhee (2005). Following these studies, Bessho and Kihara (2006) estimate demographic impacts on real stock indices, stock return and real government bond yields by using panel data from 50 countries during the period 1950-2004. The results are mostly consistent with the Asset Market Meltdown Hypothesis of aging, which are, (i) an increase in the high-saving-generation ratio raises financial asset holdings and asset (stock) prices (in turn, a fall in the ratio leads to "Asset Market Meltdown"), (ii) when aging proceeds, the holdings of long-term bonds are reduced, pulling their prices down, which in turn raises government bond yields (interest rates).

What is likely to occur in the ratios of "elderly population over the population of the high-saving-generation" in East Asian economies in the future? It is certainly expected that these ratios will rapidly increase, from 22.4% in 2010 to 53.7% in 2050, even in the "Southeast Asia" region (e.g. ASEAN countries) where the elderly ratio is relatively low.

If, in East Asia, the elderly population, who sell financial assets, grows rapidly, but the

population of the high-saving-generation, who purchase the assets, stagnates or declines, then it would be highly possible that prices of financial assets fall and interest rates rise, as is envisaged by the "Asset Market Meltdown Hypothesis."

3. New Estimates of Financial Variables by Demography

As it becomes clear that East Asian economies, the current growth center of the world, will turn "gray," the interest of researchers in the economic impacts of aging has been renewed. For instance, World Bank (2016) gives a comprehensive review of aging trends and policy responses in Asia and the Pacific. In this section, the IMF (2017) analyses are reviewed, and the empirical results of new analyses which rectify the problems of IMF (2017) are demonstrated.

(1) IMF (2017) Estimates of Interest Rates and Stock Return

IMF (2017) estimates (i) 10-year-government bond interest rates, and (ii) stock return by using demographic variables including (a) "youth" dependency ratios (population of age less than 30 / population aged 30 to 64) , (b) "old" dependency ratios (population of age 65 and older / population aged 30 to 64), and (c) aging speed (the projected change in the old dependency ratio in the coming 20 years; the proxy of change in survival probability), in addition to other explanatory variables such as (d) capital openness (Chinn-Ito financial openness index, ranging from 0 (completely closed) to 1 (completely open)), and (e) world interest rates.

The data used by IMF are panel observations consisting of 42 countries (interest rate estimates) and 14 countries (stock return estimates) annually during the period 1985-2013. The country fixed effects model is used to perform the estimations.

The empirical results of IMF (2017) are as follows;

(i) Both interest rates and stock return rise as the youth dependency ratio rises.
(ii) As the old dependency ratio rises, interest rates fall. However, the impact on stock return is undetermined (the estimate is not statistically significant).
(iii) Increase in aging speed causes interest rates to fall, but stock return to rise.
(iv) On the other hand, the estimated coefficients of interactive terms between demographic variables and "capital openness" have inverse signs to the estimated coefficients of the respective demographic variables, with similar magnitudes. This means that an increase in capital openness mitigates the demographic impacts on financial markets.

Furthermore, F tests cannot reject the null hypothesis that the estimated coefficients of demographic variables are equal (with the opposite sign) to those of the interactive terms between the respective demographic variables and capital openness. Therefore, the new explanatory variable "demographic variables × (1 – capital openness)" can be introduced to perform the estimate. The estimated coefficients of the new interactive terms in the regression of long-term (10-year) real interest rates, for instance, indicates that an increase in youth dependency ratio, a decrease in old dependency ratio and a decrease in aging speed are expected to raise long-term interest rates in the countries with a less open capital market. On the other hand, the impacts of those demographic variables could be nullified by completely opening their capital markets (i.e., capital openness = 1).

(2) New Estimates of Interest Rates, Stock Return and Savings Rates

In this chapter, we regress (i) real government bond interest rates, (ii) real lending interest rates, and (iii) real stock return (the rate of increase in stock prices) on similar explanatory variables to IMF (2017), including youth dependency ratio, old age dependency ratio, aging speed, Chinn-Ito financial openness index and world interest rates, by using panel data of these variables.

However, (i) "working age population" is defined to be those aged 15 to 64, which is commonly used, but different from IMF (2017). (ii) We also use both GDP deflator and CPI (Consumers Price Index) to make the "nominal" variables "real" ones, to check the robustness of the estimated results. (iii) As the "world interest rates," we use the SDR interest rates (before cut-off)[2] which represents the weighted average of the interest rates of major currencies.

Data on interest rates and stock prices used to perform the estimations are panel observations retrieved from IMF/IFS (International Financial Statistics), which consists of all countries retrievable (79-92 countries for interest rate estimates, 75 countries for stock return estimates) during the period 1970-2015, covering the transition period from the "fixed" to the "flexible" exchange rate system. The number of countries is larger and the data period longer than those of IMF (2017).

The regression method consists of panel estimates of the cross-country fixed effects model, as conducted by IMF (2017). However, we regress not only by annual data but also by compiling the data in 5-year averages.

The estimated results are, in some respects, different from those of IMF (2017), but largely consistent with the preceding literature such as Bessho and Kihara (2006). In particular, they indicate that an increase in the old age dependency ratio causes interest rates to rise and stock return (the rate of increase in stock price indices) to fall.

(3) Panel Regression of Real Interest Rates (Fixed Effects Model) (79-92 Countries during the Years 1970-92)

As Table 1 indicates, the regression results in this chapter are different from those of IMF (2017), and this is due partly to the definition of "working age." The estimated coefficient of the interactive term between "youth dependency ratio" and (1 – financial openness) is significantly negative in financially closed economies, whereas IMF (2017) estimates the coefficient to be significantly positive.

The estimated coefficient of the interactive term between "old age dependency ratio" and (1 – financial openness) is significantly positive in financially closed economies. This means that an increase in the old age dependency ratio in financially closed economies is expected to induce withdrawals of financial assets, reduce demand for financial assets, and then reduce the bond prices and raise the interest rates or yields. IMF (2017), however, estimates the coefficient to be significantly negative.

The estimated coefficient of the interactive term between "aging speed" and (1 – financial openness) is, as seen in IMF (2017), significantly negative, which means that the prospect of increase in aging speed in financially closed economies brings bond prices up and interest rates down. IMF (2017) explains this to be a result of increased lifetime savings and increased demand for financial assets. However, as is seen in the empirical results below, when aging speed rises, the savings ratio, in fact, significantly falls. The IMF (2017) explanation is, therefore, not consistent with this empirical outcome.

It is noteworthy that the increase in financial openness mitigates the demographic impacts on interest rates. As financial openness becomes closer to one on the 0-1 scale, the "coefficient × (1 – financial openness)" approaches closer to zero.

The real interest rates of government bonds are considered to link with the interest rates of

[2] The SDR interest rate at the beginning of the year (January 2) is allocated to the rate of the respective year. SDR interest rates are weighted averages of the interest rates, which consist of the German Mark, French Franc, Japanese Yen, British Pound, and US dollar during the period 1969-99, of Euro, Japanese Yen, British Pound, US dollar during 2000-2016, and of Chinese yuan, Euro, Japanese Yen, British Pound, US dollar after 2017, retrieved from IMF HP.

major currencies, i.e., "world interest rates," through interest arbitrage transactions. Therefore, "world interest rates" are included in the controlled variables in the interest rate panel regression. "Real SDR interest rates," retrievable from the IMF database and deflated by price indices, are used as the proxy of "world interest rates." Even after controlling for "world interest rates," the estimated coefficients of the interactive terms between demographic variables and financial openness have the same signs and significance, as those in Table 1 show.

Table 1: Panel regression of real interest rates（Fixed effect model）（1970-2015, 79-92 countries）

Explained variables / Explanatory variables	Annual model (1970－2015)			5-yr. average model (1970-2015)		
	GB Int. rates (GD)	GB Int. rates (CPI)	Lending Int. rates (CPI)	GB Int. rates (GD)	GB Int. rates (CPI)	Lending Int. rates (CPI)
Constant	3.768*** (7.70)	4.155*** (7.77)	10.903*** (12.25)	5.780*** (6.73)	8.048*** (5.79)	10.495*** (5.18)
Youth dependency ratio × (1 - financial openness)	**-0.102*** (-3.77)**	**-0.125*** (-4.34)**	**-0.210*** (-5.74)**	**-0.223*** (-4.94)**	**-0.314*** (-4.34)**	**-0.188** (-2.33)**
Old age dependency ratio × (1 – financial openness)	**0.161* (1.80)**	**0.248** (2.50)**	**0.616*** (2.73)**	**0.404*** (2.61)**	**0.711*** (2.80)**	**0.622 (1.25)**
Aging speed × (1 – financial openness)	**-0.310** (-2.08)**	**-0.555*** (-3.49)**	**-1.005*** (-2.96)**	**-0.547** (-2.27)**	**-1.575*** (-4.15)**	**-0.999 (-1.49)**
Adjusted R^2	0.281	0.284	0.221	0.233	0.175	0.137
Country/Observation	79/1867	79/1841	92/2264	79/463	79/459	92/550

（Note）"GD" indicates deflated by GDP deflator, "CPI" indicates deflated by Consumer Price Index. Figures in parentheses are t values. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.
（Source）Estimation by author.

The estimated coefficient of real SDR interest rate in the regression of real "government bond" interest rates is significantly positive, as expected, which means that SDR interest rates have a positive correlation with the government bond interest rates of each country. The coefficient of SDR interest rate in the regression of real "lending" interest rates is, however, estimated as significant but negative. International transactions of securities may make the interest rates of government bonds arbitrage with world interest rates, whereas monetary policies adopted by each country may cause the impact of world interest rates on lending rates to be counter-cyclical.

Table 2: Panel regression of real interest rates（including SDR real interest rates as a controlled variable）（1970-2015, 79-92 countries）

Explained variables / Explanatory variables	Annual model (1970-2015)			5-yr. average model (1970-2015)		
	GB Int. rates (GD)	GB Int. rates (CPI)	Lending Int. rates (CPI)	GB Int. rates (GD)	GB Int. rates (CPI)	Lending Int. rates (CPI)
Constant	5.329*** (23.74)	5.594*** (23.33)	11.358*** (14.32)	5.232*** (7.14)	5.378*** (6.61)	10.013*** (10.40)
Youth dependency ratio × (1 - financial openness)	-0.098*** (-7.92)	-0.108*** (-8.37)	-0.249*** (-7.43)	-0.126*** (-3.21)	-0.091** (-2.13)	-0.186*** (-4.74)
Old age dependency ratio × (1 – financial openness)	0.366*** (8.96)	0.396*** (8.93)	0.723*** (3.34)	0.395*** (3.00)	0.449*** (3.04)	0.328 (1.32)
Aging speed × (1 – financial openness)	-0.326*** (-4.78)	-0.369*** (-5.18)	-1.125*** (-3.63)	-0.424** (-2.06)	-0.527** (-2.35)	-0.692** (-2.11)
SDR real interest rates	**0.835*** (82.28)**	**0.861*** (83.84)**	**-0.017*** (-28.38)**	**0.540*** (12.09)**	**0.836*** (27.19)**	**-0.044*** (-41.29)**
Adjusted R^2	0.850	0.857	0.439	0.444	0.721	0.823
Country/Observation	79/1867	79/1841	92/2171	79/463	79/459	92/530

（Note）"GD" indicates deflated by GDP deflator, "CPI" indicates deflated by Consumer Price Index. Figures in parentheses are t values. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.
（Source）Estimation by author.

(4) Panel Regression of Real Stock Return (Fixed Effects Model) (75 Countries, 1970-2015)

The estimated results of "real stock return" also differ from those of IMF (2017), as demonstrated in Table 3. Annual fluctuations of stock prices are observed to be so large that demographic impacts on stock return could not be significantly estimated.

However, the estimated results of the "5-year average model," which uses data averaged over 5 years, amply demonstrate that both "youth dependency ratio" and "aging speed" have significantly positive impacts, whereas the "old age dependency ratio" has a significantly negative impact, on "stock return" in financially closed economies. Their impacts on real stock return have opposite signs to those on real interest rates, but they are consistent with the "Life cycle/Permanent income" hypothesis of savings. According to this hypothesis, the hike in "old age dependency ratio" may increase sales of such financial assets as stocks and bonds (i.e., dissaving) and reduce demand for financial assets, thereby inducing a fall in stock return. The reason why a hike in "aging speed" raises the stock return could be explained by the notion that an increase in possibility of survival would require more life-time savings and raise demand for financial assets. Empirical evidence, however, contradicts the "Life cycle/Permanent income" hypothesis of savings; an increase in aging speed significantly reduces the savings rates.

Increasing "financial openness" mitigates the demographic impacts on stock return, as is estimated in the regression of real interest rates.

Table 3: Panel regression of real stock return（fixed effects model）(1970-2015, 75 countries)

Explained variables / Explanatory variables	Annual model (1970-2015)		5-yr. average model (1970-2015)	
	Real stock return（GD）	Real stock return（CPI）	Real stock return (GD)	Real stock return（CPI）
Constant	118.606 (0.83)	108.488 (0.88)	-2.474 (-0.54)	0.546 (0.16)
Youth dependency ratio × (1 - financial openness)	-4.202 (-0.50)	-4.202 (-0.58)	**0.632**** **(2.23)**	**0.370*** **(1.79)**
Old age dependency ratio × (1 – financial openness)	18.471 (0.54)	17.979 (0.59)	**-2.369**** **(-2.20)**	**-1.668**** **(-2.06)**
Aging speed × (1 – financial openness)	-27.591 (-0.47)	-26.151 (-0.51)	**4.603**** **(2.34)**	**3.326**** **(2.33)**
Adjusted R^2	0.032	0.029	0.144	0.129
Country/Observation	75/2208	75/2155	75/399	75/392

（Note）"GD" indicates deflated by GDP deflator, "CPI" indicates deflated by Consumer Price Index. Figures in parentheses are t values. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.
（Source）Estimation by author.

(5) Demographic Impacts on "Savings Ratio"

How could the newly introduced "aging speed" and "financial openness" variables, as well as the explanatory variables used in previous literature, have impacts on the "savings ratio" in the panel regression?

We regress the "gross savings ratio" (% of GDP) on the high-savings generation ratio (population aged 40 to 64 / population aged 15 to 64), old age dependency ratio, aging speed, GDP per capita growth rate (current and with a one-period lag), (natural logarithm of) GNI per capita, and financial openness, by using the panel data and fixed effects model. As in previous literature, including Kihara (2007a,b), most estimated results indicate that an increase in the "high savings

generation ratio" significantly raises savings ratio, whereas an increase in "old dependency ratio" significantly reduces savings.

The coefficients of "aging speed," however, are estimated to be significantly negative in all specifications, which means that, when the aging speed is expected to increase, the savings ratio would not rise but eventually fall. This result contradicts the IMF (2017) estimates.

The estimated coefficients of interactive terms between demographic variables and (1 – financial openness) are not statistically significant. However, when the variable "financial openness" is independently used to estimate savings ratio, the coefficient of the variable is estimated to be significantly negative, which means that the increase in financial openness reduces the gross savings ratio. This may be because foreign savings can substitute for domestic savings required in financially open economies.

Table 4: Panel regression of savings rates on demography and openness

Explained variable: Gross savings/GDP ratio (%) (1970-2015, 99-104countries) (Panel regression by the country fixed effects model)

Explanatory variables	1. Annual model (1970-2015)				2. 5-yr. average model (1970-2015)			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Constant	11.354*** (7.39)	-2.109 (-0.71)	11.031*** (7.19)	-2.481 (-0.83)	10.259*** (3.68)	-5.058 (-0.95)	9.112*** (3.27)	-6.371 (1.20)
High saving gen. / Working age pop. (%)	**0.179*** (3.60)**	**0.531*** (7.04)**	**0.179*** (3.59)**	**0.450*** (5.83)**	**0.175* (1.90)**	**0.543*** (4.05)**	**0.126 (1.40)**	**0.436*** (3.22)**
Old age dependency ratio (%)	**-0.546*** (-6.83)**	**-0.596*** (-7.45)**	**-0.523*** (-6.55)**	**-0.460*** (-5.47)**	**-0.373*** (-2.92)**	**-0.396*** (-3.11)**	**-0.283** (-2.27)**	**-0.225* (-1.72)**
Aging speed		**-0.428*** (-5.52)**		**-0.394*** (-4.90)**		**-0.466*** (-3.48)**		**-0.436*** (-3.16)**
GDP per capita growth rate (%)	0.248*** (8.93)	0.242*** (8.68)	0.187*** (6.45)	0.189*** (6.29)	0.445*** (4.88)	0.430*** (4.72)	0.406*** (4.07)	0.436*** (4.01)
GDP per capita growth rate (%, 1pd lag)			0.183*** (6.71)	0.169*** (5.87)			0.353*** (4.21)	0.312*** (3.64)
Ln(GNI per capita (Current dollar))	1.329*** (5.14)	1.765*** (6.14)	1.299*** (4.98)	2.047*** (6.77)	1.167** (2.50)	1.744*** (3.37)	1.283*** (2.65)	2.145*** (3.79)
Financial openness				**-1.919*** (-3.32)**				**-2.003* (-1.66)**
Adjusted R^2	0.602	0.601	0.607	0.614	0.629	0.629	0.674	0.679
Country/Observation	104/3274	103/3229	104/3263	99/3033	104/768	103/755	104/727	99/681

（Notes）Figures in parentheses are t values. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.

（Source）Estimation by author.

(6) Demographic Simulations of Interest Rates, Stock Returns and Savings Ratios

Figure 2 shows the simulated results of "real government bonds interest rates" in East Asian economies during the period 1950-2080, using the estimated coefficients of the "5-year average model" (deflated by CPI) and the respective data for demographic variables (retrieved from United Nations (2019)), Chinn-Ito financial openness index and IMF SDR interest rates. Future data for financial openness and SDR interest rates are calculated by assuming that the financial openness of each economy and SDR interest rates in 2015 would continue. As a result, real government interest rates in financially closed economies are expected to rise sharply from their recent very low levels, due to the rises in their old age dependency ratios. On the other hand, the real interest rates of financially open economies, such as Japan and Singapore, hover near the level of world interest rates.

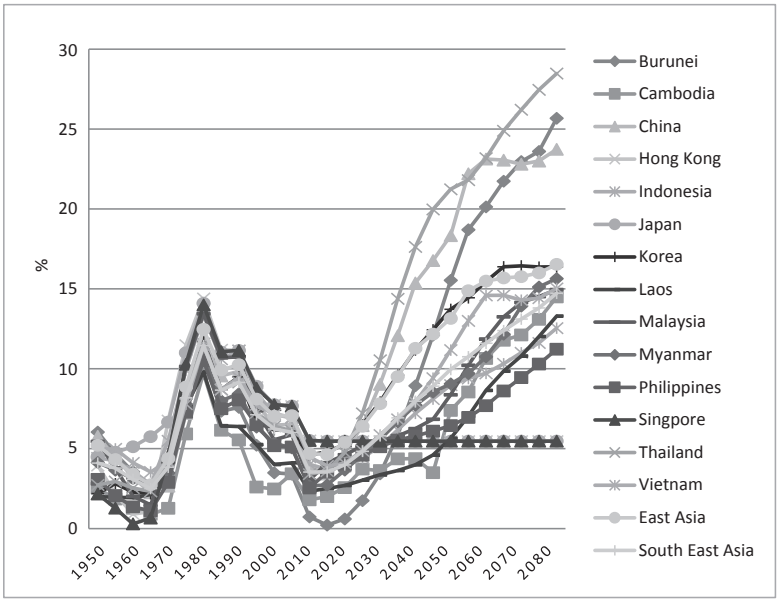

Figure 2: Real Government Bond Interest rates（simulated by estimated results）

(Note) Calculated using the following formula;

Real government bond interest rates ==5.378-0.091{youth dependency ratio × (1 – financial openness)}
+0.449{old age dependency ratio × (1 – financial openness)} - 0.527{aging speed × (1 – financial openness)
+0.836 × SDR real interest rates

(Source) Calculation performed by author using United Nations (2019) and other data.

Figure 3 shows the simulated results of "real stock return" in East Asian economies during the period 1950-2080, by using the estimated coefficients of the "5-year average model" (deflated by GDP deflator) and the respective data for demographic variables (retrieved from United Nations (2019)) and the Chinn-Ito financial openness index. As a result, the real stock returns of financially closed economies are expected to fall sharply in the future, reflecting substantial rises in old age dependency ratios. The decline in real stock returns of financially open economies, such as Japan and Singapore, are restricted.

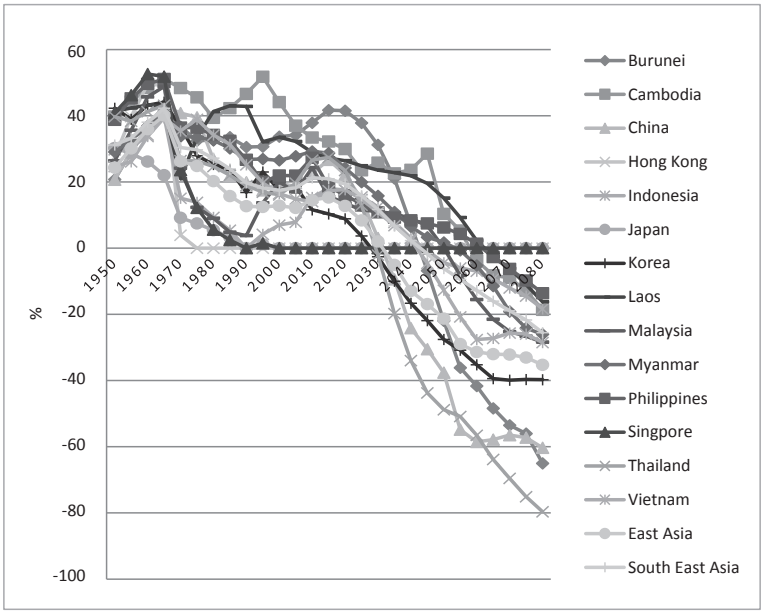

Figure 3: Real Stock Returns (Simulated by estimated results)

(Note) Calculated using the following formula;

Real stock return = 0.632{youth dependency ratio × (1 – financial openness)} - 1.668{old age dependency ratio × (1 – financial openness) + 3.326{aging speed × (1 – financial openness)}

(Source) Calculation performed by author using United Nations (2019) and other data.

Figure 4 shows the simulated results of "gross savings/GDP" ratios in East Asian economies during the period 1960-2080 using the estimated coefficients of specification (4) of the "5-year average model" in Table 4 and the respective data for demographic variables (medium variants of United Nations (2019)), GDP per capita growth rates, GNI per capita and the Chinn-Ito financial openness index. GDP per capita growth rates are forecast by assuming that the growth rates in 2015 would continue. The forecasts of GNI per capita also assume growth at the same rates as GDP per capita growth. Except for Japan, Korea and Thailand, many economies will experience rises in savings ratios, as shown in Figure 4. This is, however, due to the relatively large increase in projected growth rates of GDP and GNI per capita, which contributes to a rise in the savings ratio.

In fact, when savings ratios are simulated by the same functional forms, but excluding the terms GDP per capita growth rates and GNI per capita, all economies would reach the peaks of their savings ratios around 2060, after which the ratios would begin to decline due to the demographic "dissaving" effects, as is shown in Figure 5.

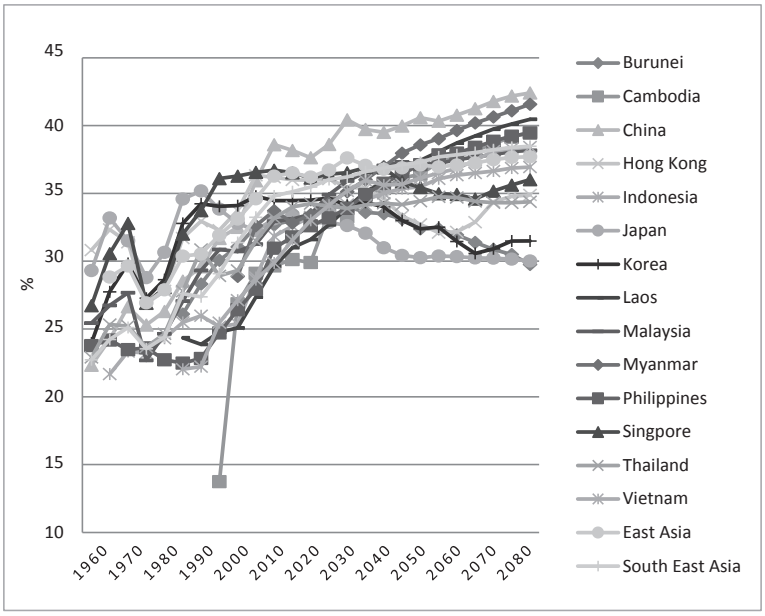

Figure 4: Gross Savings/ GDP (Simulated by estimated results)

(Note) Calculated using the following formula;

Gross savings/GDP (%) = 0.436 × high-saving generation / working age population - 0.225 × old age dependency ratio - 0.436 × aging speed + 0.436 × GDP per capita growth rate + 0.312 × GDP per capita growth rate (one period lag) + 2.145 × Ln (GNI per capita) - 2.003 × financial openness

(Source) Calculation performed by author using United Nations (2019) and other data

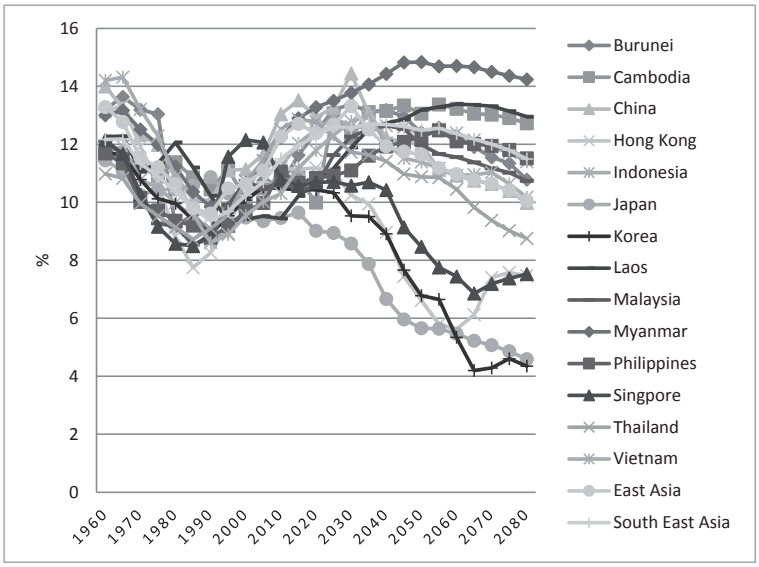

Figure 5: gross savings/ GDP (%) (Effects of demography and financial openness)

(Note) Calculated using the following formula;

Gross savings / GDP (%) = 0.436 × high saving generation / working age population – 0.225 × old age dependency ratio - 0.436 × aging speed - 2.003 × financial openness

(Source) Calculation performed by author using United Nations (2019) and other data.

(7) Policy Implications for Financial Markets

The policies proposed by IMF (2017) to prepare for aging societies are quite similar to those proposed thus far by IMF (2004) and Kihara (2015). For instance, the following reforms in the retirement system are proposed;

(i) The introduction of new financial products to mitigate the saving burden after retirement (e.g., reverse mortgages) and to ensure that longevity risk (e.g., annuities) will reduce precautionary savings.

(ii) As Asia has diverse demographic natures, there are ample opportunities for cross-border risk sharing and financial integration (e.g., savings in aging or aged countries seeking a higher return could be used to finance the large infrastructure gap in pre-aging countries)

(iii) Increasing the availability of "safe assets" (e.g., long-term government bonds or inflation linked securities) can be especially attractive for pension funds and insurance companies.

IMF (2017), and the regression results presented here have clarified that an increase in "financial openness" measured by the Chinn-Ito index mitigates demographic impacts on financial markets, which means that "increasing financial openness" is one countermeasure that can be employed against the adverse impacts of aging.

(8) Financial Markets in Aging East Asia

Aging could have a significant influence on volumes, prices and trading agents in financial markets. Aging reduces savings and financial asset holders sell their assets, thereby causing stock and bond prices to fall and large trading agents such as pension funds to emerge. Are financial markets in East Asia ready for (i) a substantial shift in the demand for assets, (ii) channeling current affluent savings to investment, and (iii) making efficient use of expectedly-reduced-savings to invest?

Cihak, Demirguc-Kunt, Feyen and Levine (2012), utilizing the Global Financial Development Database (GFDD) in 205 countries/economies, creates "indices" to characterize the financial systems of these countries/economies; i.e., "depth" (sizes of financial institutions and markets), "access" (utilization of financial services), "efficiency" (efficiency of promotion of financial intermediation and transactions) and "stability" (stabilities in financial institutions and markets). Based on recent GFDD data, World Bank (2020) ranks each characteristic and overall financial market of a specific country and economy by "quartiles" (from "1" for the lowest 25% to "4" for the top 25%). The results indicate that the financial markets of ASEAN countries, except for Singapore, Malaysia and Thailand, are ranked up to 3 or "not available," which means that some financial challenges remain, whereas almost all characteristics are ranked 4 (top 25%) in Japan.

Since the East Asian financial crisis in 1997, ASEAN countries have made efforts to strengthen financial markets to prevent "double mismatches" in maturity and currency of their assets and liabilities. In particular, on local currency denominated bond markets, such initiatives as ABMI (Asian Bond Market Initiative) and ABF (Asian Bond Fund) have greatly advanced.

The volumes of bond markets in ASEAN countries have grown rapidly. ADB (2020) reviews the situation in local currency denominated bond markets in emerging East Asia, and finds that the outstanding amount of the markets reached more than USD16 trillion at the end of 2019, which represents 83.3% of the GDP of the region and 30 times more than the amount at the end of 1996 (USD0.53 trillion).

Although the volumes of bond markets in East Asia have expanded enormously, the markets still face many qualitative challenges. ADB (2019) quotes a "2019 bond market liquidity survey" which presents structural issues in government and corporate bond markets. The most important structural issues in emerging East Asia as a whole are the lack of derivatives to operate a "hedging mechanism" and "low diversity in investor profiles" caused by a concentration of bond holdings by banks and other financial institutions.

4. Rising Prospect for Aging Speed and Behavioral Economics

(1) The Impacts of Aging Speed on Demand for Financial Assets

It is expected that a rise in "aging speed" (i.e., increased life expectancy) requires an increased amount of life-time expenditure and savings to finance it[3]. The empirical results, however, indicate that an increase in aging speed substantially reduces savings, but induces a reduction in interest rates and an increase in the stock return. This "conundrum" can be understood by thinking that an increase in aging speed causes a substantial shift in the demand for assets from physical resources to financial ones, and thereby rises in the prices of financial assets and falls in their yields (interest rates).

We empirically check whether a rise in "aging speed" eventually increases the demand for financial assets. Table 5 shows the results of panel regressions of outstanding assets of pension funds, deposits, bonds and stocks per GDP (in natural logarithms) on "aging speed"[4]. Table 5 indicates that all estimated coefficients of "aging speed" (reflecting financial openness) are significantly positive, which means that an increase in aging speed raises all financial assets per GDP ratios. Therefore, the increased prospect for a rising aging speed can be considered to raise demand for financial assets, thereby inducing hikes in the prices of financial assets and drops in their yields (interest rates).

Table 5: Demand for Financial Assets and Aging Speed

Explained variables Explanatory variable	Ln (Pension fund / GDP)	Ln (Pension fund / GDP)	Ln (Fin. Inst. Deposit / GDP	Ln (Debt / GDP)	Ln (Stock / GDP)
Constant	1.225*** (8.34)	2.093*** (13.24)	3.187*** (120.06)	0.892*** (5.98)	-0.296* (-1.72)
Aging speed × (1-financial openness)	**0.090***** **(8.46)**	**0.039***** **(3.28)**	**0.061***** **(30.63)**	**0.079***** **(5.85)**	**0.134***** **(8.87)**
AR (1) (First order autoregressive)		0.682*** (9.79)			
Adjusted R^2	0.833	0.963	0.748	0.884	0.872
Country/Obs. (Sample period)	75/966 (1990-2015)	71/879 (1991-2015)	102/3851 (1970-2016)	89/1270 (1999-2015)	89/1267 (1999-2015)

(Notes) Figures in parentheses are t values. *,** and *** indicate significance at t 10%, 5% and 1% significance level, respectively.
(Source) Estimation by author.

(2) The Impacts of Aging Speed on Physical Investment and Assets

Is it true to say that the increase in aging speed reduces the demand for physical assets and investment? We conduct panel estimates of physical investment (gross fixed capital formation /

[3] World Bank (2016) suggests that the effects on household savings depend on the relative strength of two offsetting effects: (a) "the compositional effect" from a higher share of older people in the population and (b) "the behavioral effect" as people save more to finance a longer expected period of retirement. Predictions on which of these effects will dominate in East Asia and the Pacific are mixed, but, according to World Bank (2016), on balance they suggest that concerns about the effects of aging on savings and capital formation in the region may be overstated for three reasons: (i) Household and corporate savings rates are higher in the region than in others. (ii) Survey evidence points to flatter savings and age profiles in the region than in others, and to an increase in savings rates at all ages in the region in recent decades. (iii) Significant inefficiencies in financial markets in the region's developing countries suggest that scope exists for more efficient mediation of savings into capital formation and increased productivity.

Although rising "aging speed" predicts the "behavioral effect" mentioned above, empirical results suggest the opposite. (iii) above provides a reason why developing financial markets in East Asia is a critical task.

[4] Wo-Hausman tests reject cross-section random effects. Therefore, the fixed effects model with white heteroscedastic correction is used to perform the estimations.

GDP) by using the explanatory variables, including financial-openness- adjusted "aging speed"[5]. The results are shown in Table 6, in which the coefficients of financial-openness-adjusted "aging speed" are estimated to be significant at the 1% level and are robustly estimated at around -0.1 to -0.15, regardless of the changes in controlled variables (GDP per capita growth rate and real interest rates; both coefficients are estimated to be significant with the expected signs). Thus, the demand for physical assets declines when aging speed rises.

Table 6: Demand for Physical Assets and Aging Speed
Explained variables: Gross Fixed Capital Formation /GDP (%)

Explanatory vari.	Spec.1	Spec.2	Spec.3	Spec.4	Spec.5
Constant	24.371*** (84.17)	23.471*** (71.24)	24.305*** (86.44)	23.328*** (86.48)	16.713*** (30.23)
Aging speed × (1-financial openness)	**-0.157*** (-4.81)**	**-0.107*** (-3.18)**	**-0.140*** (-4.53)**	**-0.094*** (-3.28)**	**-0.096*** (-3.31)**
GDP per capita growth rate (%)		0.319*** (6.87)	0.303*** (6.99)	0.212*** (5.62)	0.101** (2.46)
GDP per capita growth rate (%, 1pd lag)				0.369*** (6.10)	0.311*** (4.40)
Real GB int. rates (CPI)			-0.042** (-2.46)	-0.037** (-2.54)	-0.030** (-2.22)
Gross Savings / GDP (%)					0.311*** (10.83)
Adjusted R^2	0.416	0.450	0.553	0.587	0.579
Country/Obs. (Sample period)	100/3717 (1970-2016)	100/3650 (1970-2016)	75/1724 (1970-2015)	75/1704 (1971-2015)	74/1477 (1971-2015)

(Notes) Figures in parentheses are t values. *,** and *** indicate significance at the 10%, 5% and 1% significance level, respectively.
（Source）Estimation by author.

It would appear to be a rationale choice to increase current savings when increases in aging speed and future old dependency ratio (i.e., increased prospects for survival) are expected. The empirical evidence shows, however, that an increase in aging speed induces a reduction in savings, but an increase in demand for financial assets. This "conundrum" can be explained by "behavioral economics" as the phenomena of "delaying savings" due to "time-inconsistency." According behavioral economics, when making decisions ordinary people do not discount future utilities at a constant discount rate, as *Homo economicus* would do (i.e., "exponential discounting"), but at a larger discount rate for the near future and a smaller discount rate for the distant future (i.e., quasi "hyperbolic discounting"). Thus, economic agents who intend to save immediately before retirement tend to greatly discount the utilities of consumption after retirement at the time immediately before retirement. The optimal decision for them is to consume more without saving before retirement (from the Euler equation of hyperbolic discounting model). A "sophisticated economic agent" may make "commitments" to bind their future behavior at the time of decision-making to avoid time-inconsistency. One of the "commitment devices" to prevent "delaying savings" is to invest in "illiquid assets" which include a "pension contract." "Naïve economic agents" may not make a commitment, but tend to hold "liquid assets," including deposits and other financial assets, which

[5] Wo-Hausman tests reject cross-section random effects. Therefore, the fixed effects model with white heteroscedastic correction is used to perform the estimations.

are easy to cash[6]. The empirical results, showing that an increase in aging speed reduces savings and physical investment, but raises demand for financial assets, raising their prices (causing falls in their yields), are consistent with "delaying savings" phenomena based on time-inconsistency.

(3) Promotion of Retirement Savings and Behavioral Economics

The shortage of savings at the time of retirement has been recognized by many countries, and some measures have been introduced to increase enrollment in, and contribution to, pension systems. OECD (2019) identifies the measures to promote retirement savings by two types of financial incentives; i.e., "tax incentives" and "non-tax incentives." Many countries have adopted tax incentives for retirement savings by exempting taxes at the time of contribution and investment, and only taxing the benefits of pensions ("EET" tax system). Non-tax incentives have also been introduced in some countries by making matched contributions by government and employers, or by government subsidizing.

In recent years, retirement savings plans utilizing the knowledge of "behavioral economics" have been introduced by many pension systems in the United States and other countries.

According to Benartzi and Thaler (2013), in the United States, the proportion of workers at risk of having inadequate funds to maintain their lifestyle through retirement is estimated to have increased from 31% in 1983 to 53% in 2010, and roughly half of US employees (78 million) have no access to retirement plans at their workplace. One of the reasons for this "savings crisis" is the ongoing shift in the private, public and local sectors from defined benefit (DB) pension plans to defined contribution (DC) plans. These problems are not faced only by the United States but also by the United Kingdom and New Zealand.

Under these circumstances, "comprehensive pension plans" to facilitate adequate saving for retirement are advocated with following four ingredients; (i) "Availability" for every worker to access, but with the ability to "opt-out," (ii) "Automatic enrollment" where employees are automatically signed up unless they opt out, (iii) "Automatic investment" in which there has to be a "default" investment option once employees are automatically enrolled, and (iv) "Automatic escalation" of the saving rate.

Incorporating the four characteristics above, Benartzi and Thaler devised the "Saving More Tomorrow" (SMT) pension program in generic terms, based on behavioral economics.

According to Benartzi and Thaler (2013), the SMT originally included the following three components;

(i) Employees are invited to "commit now to increase their saving rate later." According to behavioral economics, "self-control" is easy to accept if delayed rather than immediate due to (quasi) hyperbolic discounting.

(ii) Planned increases in the saving rate are linked to pay raises. Because the increase in the savings rate is "a portion" of the pay raises, employees do not see their pay fall. This would diminish the effect of "loss aversion," i.e., the tendency to assign larger weights to losses than gains.

(iii) Once employees sign up for the plan, they remain in it until they reach a preset limit or choose to "opt out." This uses "inertia" to keep people in the system.

In the company that originally introduced SMT, employees who elected to join (and 78% of those offered the plan did) ended up almost quadrupling their savings rate from 3.5% to 13.6% in less than four years. This evidence of success stimulated many companies in the United States to adopt the SMT plan. Take-up then increased considerably, helped by the passage of the Pension

[6] Refer to Ogaki and Tanaka (2014) Chapter.6, pp.111-139.

Protection Act of 2006, which encouraged firms to adopt a combination of "automatic enrollment" and "automatic escalation." Benartzi and Thaler (2013) indicates that by 2011 56% of employers who offer 401(k) plans "automatically enrolled" employees, and 51% offered "automatic escalation," as is seen in Figure 6.

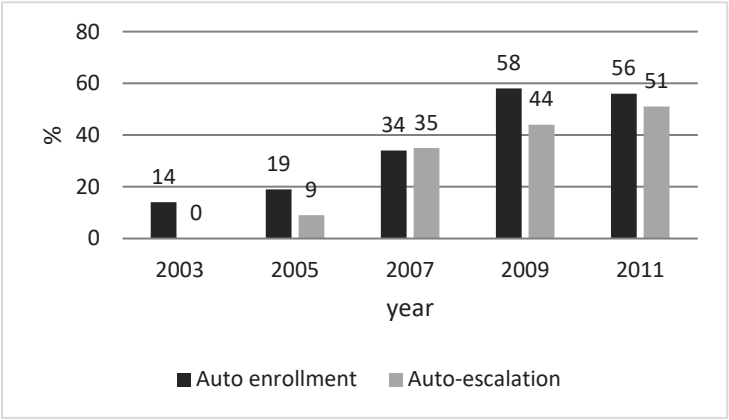

Figure 6: Percentage of us employers who offer 401(k) plans that atutomatically enroll employees and escalate savings rates

(Source) Benartzi and Thaler (2013) and calculation by author]

Does inducing a large contribution to retirement saving actually "increase" total saving, or does it "shift" saving from one place to another? According to Benartzi and Thaler (2013), Danish data that include measures of household wealth suggest that when employees are automatically enrolled into a retirement savings plan, 85% of that saving is new, rather than shifted.

(4) Decision-making, Bottlenecks and Nudges of Retirement Savings

According to Otake (2019), following "nudges" are needed to cope with decision-making and bottlenecks on retirement savings, as indicated in Table 7. The "20-million-yen shortage at retirement" under the current pension system in Japan, which is suggested by a report from the Financial Council, can be the "guideline" to necessitate more retirement savings from the viewpoint of behavioral economics.

Table 7: Decision-making, bottle necks and nudges on retirement savings

Necessary decision	Recognition of importance in retirement savings	How much to allocate to retirement savings?	Enrollment inthe plan	Choosing financial products	Purchas-ing financial products	Checking returns of assets (balancing portfolios)
Bottlenecks	Retirement in distant future	Calculation todecide the amount to save is complicated	Burden to join	Complicated products	Delaying purchase	Burden to check
Nudges	**Loss aversion** (informed about low level of life)	**Guideline onhow much to save,** Application for calculation	Simple procedure, **Obligatory/ automatic enrollment**	**Default investment**	**Automatic purchase**	Automatic information system, **Automatic rebalancing**

（Source） Compiled by author from Otake (2019), pp.66-67

(5) Solutions to the Shortage of Savings

Not only developed countries but aging East Asian economies will have a high possibility of turning into "short-of-savings" economies, where financial resources after retirement are insufficient. Concerns over a shortage of retirement savings are not limited to Japan, where the Financial Council raised the issue of the "20-million-yen shortage" after retirement in 2019, but are also found in such countries such as Malaysia and Singapore, where defined contribution (provident fund type) pension systems prevail. Improvements in "financial systems" to mitigate and solve problems of savings shortages are required, as the problems will have adverse impacts not only on the financial resources of the retired, but on macroeconomies such as growth rates or returns in financial markets.

A shortage in savings is caused by behavioral economic factors such as "loss aversion" based on (quasi) "hyperbolic discounting," "time inconsistency" and limited rationalities. As aging proceeds in East Asian economies, behavioral-economics-based financial and pension systems should be established, and nudge-utilizing financial products should be developed. For instance, when a DC (defined contribution) type pension is introduced to supplement a DB (defined benefit) type pension, which is widely adopted by East Asian countries including Japan, their pension systems and products should embody the following characteristics, as with SMT:

(i) Produce a "Guideline" to show necessary amounts of retirement savings
(ii) "Automatic enrollment" (Employees are enrolled automatically unless they opt-out)
(iii) "Automatic Escalation" (Members commit to rising saving rates. "Loss aversion" is alleviated by linking it with salary rises)
(iv) "Automatic Investment" (Premiums are allocated by "default" and automatically withdrawn)
(v) "Automatic Rebalancing" (Portfolio is automatically rebalanced according to fluctuation of prices of assets such as stock, and adjusted by age)

5. Concluding Remarks

In the midst of concerns over rapid aging in East Asian economies and its adverse effects on their financial markets, macroeconomic impacts due to demography have been estimated since the early 2000s. One recent example is IMF (2017), in which macroeconomic variables are regressed on demography, financial openness, future aging prospects (aging speed) and other explanatory variables using global panel data. The IMF (2017) estimates, however, define "working age population" as those people aged 30 to 64, which is unusual and differs from previous literature.

This chapter overviews aging in East Asia in the first section, and reviews previous literature in the second section. The third section conducts panel estimates by using similar explanatory variables to IMF (2017), but with different demographic definitions (a working age population aged 15 to 64), with an expanded number of sample countries and lengthened estimation period. The estimated results indicate that an increase in old age dependency ratio substantially raises interest rates and reduces stock return, which differs from IMF (2017), but is consistent with the results of previous literature. The regression results also indicate that an increase in future "aging speed" prospects reduces interest rates and raises stock return. These demographic impacts are, however, restricted to those in financially closed economies. In financially open economies, demographic effects on interest rates and stock return are mitigated, and savings ratio is reduced as foreign savings can substitute for domestic ones. Therefore, policies to increase financial openness can contribute not only to capital market developments, but also to the prevention of the adverse effects of aging. The simulated developments and forecasts of interest rates, stock return and savings rates are shown up to the year 2080 by using estimated coefficients of variables, demographic prospects and other data.

The fourth section considers the relations between future aging speed, on the one hand, and savings, interest rates and stock return, on the other, from the viewpoints of behavioral economics. When prospects for an increase in aging speed are expected, it seems to be a rational choice to increase savings during working age, because an increase in consumption after retirement is naturally anticipated. The empirical results, however, indicate that "prospects for an increase in aging speed" significantly reduce savings, but pull interest rates down and raise stock return. This "conundrum" can be understood by considering that the increased aging prospects induce a large shift in resource holdings from physical assets to financial ones, which drives the prices of financial assets up and their yields down. The estimated results of panel regression demonstrate the robust relationship between an increase in aging speed on the one hand, and an increase in demand for financial assets and a decline in physical investment, on the other.

These empirical findings can be explained by the phenomena of "delaying savings" based on "time-inconsistent" behavior. The number of employees whose savings are not sufficient to cover their expenditures after retirement is increasing in the United States and Europe. Recent studies such as Benartzi and Thaler (2013) advocate savings-promoting pension systems (for example, "Save More Tomorrow") based on "behavioral economics," and these have shown large increases in enrollment and continuation ratios as well as contribution rates. The same type of shortages in savings could be emerging in aging East Asia, as was crystallized by the "20-million-yen shortage after retirement" report by the Japanese Financial System Council. The establishment of financial and pension systems that have embedded "nudges" based on behavioral economics is also required in our region.

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Effects of Fiscal Rules on the Fiscal Policy Reaction to Government Indebtedness

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Abstract

It is well known that fiscal policy is prone to react to public debt in order to ensure fiscal sustainability. This paper examines whether and how fiscal rules would exert an influence on this relationship. Our dataset consists of 28 OECD member countries over the period from 1985 to 2015. Our empirical evidence suggests that the reaction of fiscal policy to public debt is likely to become weak or even disappear when strong fiscal rules are in place. At the same time, fiscal rules exert significant disciplinary effects unless public debt exceeds a certain level. Governments need to lower public debt to a certain level in order to ensure the disciplinary effects of the fiscal rules and public debt itself.

***JEL*: E62, H61, H62, H63**

Keywords: Fiscal rules, public debt, fiscal policy

1. Introduction

Since the outbreak of the COVID-19 pandemic, governments around the world have taken decisive actions to support their economies and people's lives. Most governments have been employing large fiscal support packages for households, workers, and businesses. The discretionary fiscal policies were unprecedented in size. With substantial falls in GDP, governments are running large fiscal deficits, and public debt ratios reached a record high in 2020. These are expected to climb further in some countries in 2021[1]. Despite the deterioration of fiscal positions and a severe collapse in the economies, financial markets have held up well thanks mainly to liquidity injections by major central banks around the world. The supportive financial conditions have enabled governments to concentrate on fighting against the pandemic. On the other hand, once the covid-19 pandemic fades, market pressure demanding fiscal sustainability might resurface in the future. Policymakers should be vigilant about fiscal risk and may need to start paying attention to medium-term strategies to restore fiscal soundness.

A government emphasizing disciplinary fiscal policy would be expected to secure sufficient

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[1] The IMF projects the public debt of advanced countries to reach 122.5 percent of GDP at end-2021 (IMF, July 2021).

fiscal space either with measures to increase revenues or slush expenditures in the future to pay for current government liabilities. In such a fiscal regime, primary balances are likely to react to public debt and ensure long-term fiscal sustainability. The existing literature confirms the positive relationship between the primary balance and public debt (Me'litz, 1997; Favero, 2002; Afonso, 2008). On the other hand, the political economic theories argue that budgets are the result of a political process of budgeting that appears to be suffering from deficit bias[2]. A strand of literature reports the importance of budgetary institutions in mitigating deficit bias[3]. Indeed, to address deficit bias and pursue sustainable government finance, governments across the world have tried to invent or adopt frameworks to strengthen budgetary institutions, including fiscal rules. Fiscal rules are an institutional framework to impose a permanent quantitative constraint on fiscal policy. First adopted in advanced countries, they have also gained popularity among governments in emerging economies. Empirical literature generally confirms that institutionary strong fiscal rules tend to facilitate fiscal discipline and counter-cyclical fiscal policy (e.g., Debrun et al., 2008; Nerlich and Reute, 2013; Bergman et al., 2016).

Although disciplinary effects of fiscal rules and public debt are well established, the existing literature examines the response of fiscal policy to those two determinants independently. However, well-designed fiscal rules may allow governments to decide their fiscal policy independently from the level of public debt. In other words, the primary balance may not respond to public debt, but to the fiscal rules. As long as the fiscal rules work effectively, fiscal authorities could pursue a policy to reduce primary deficit. Therefore, lower responsiveness of primary balance to public debt would not undermine long-term fiscal sustainability. Furthermore, as high public debt is likely to cause fiscal policy to shift toward the pro-cyclical (Combes et al, 2017), reducing the influence of public debt in formulating budgets would be consistent with the argument that fiscal policy should be counter-cyclical.

With this consideration, in contrast to previous studies, we investigate how public debt and fiscal rules jointly influence fiscal policy measured by the cyclically adjusted primary balance. More precisely, we test the hypothesis that a stricter fiscal rule would abate the positive response of fiscal policy to public debt. For this evaluation, we employ a dynamic panel model for 28 member countries of the Organization of Economic Cooperation and Development (OECD) over the period from 1985 to 2015. The dataset covering pre- and post-Lehman periods allows us to incorporate the effect of fiscal governance reform in the EU into the analysis. Our source of underlying data on fiscal rules is the IMF Fiscal Rules Dataset 1985-2015. The dataset includes descriptions of the design of fiscal rules and information about the types and characteristics of rules.

Our empirical evidence suggests that a cyclically adjusted primary balance tends to respond to public debt positively, while cyclically adjusted primary expenditures do negatively. Those relationships would exist as long as fiscal rules are not in place or are not institutionally strong. With strong fiscal rules, the positive relationship between public debt and fiscal policy is likely to become weaker or even disappear. At the same time, fiscal rules exert significant disciplinary effects. On the other hand, fiscal rules do seem not to function effectively when the level of public debt is high, while higher public debt is less likely to contribute to improving fiscal positions even under stricter fiscal rules. Thus, adopting better budgetary institutions represented by fiscal rules is necessary but

[2] A prevailing argument on the cause of deficit bias is the so-called common pool problem. Individual politicians or political parties have an incentive to increase specific spending to dispense favors to constituencies and win elections. As financing sources of this spending will be revenues raised through taxation, their constituencies bear only a fraction of the total costs. The mismatch between public service beneficiaries and bearers of the expense results in deficit bias (Velasco 2000, Weingast et al. 1981).

[3] Budgetary institutions are defined as the formal and informal rules governing the budgetary process (Hallerberg et al., 2009).

not sufficient for fiscal sustainability. Governments need to lower public debt to a certain level in order to ensure the disciplinary effects of the fiscal rules and public debt itself.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. In section 3, we present our empirical approach. Section 4 describes details of the data. Section 5 looks through and discusses the estimation results. In section 6, we conclude our findings with a possible direction for future work.

2. Literature review

Our study is related to research that focuses on the fiscal policy response to public debt. The pioneering research by Bohn (1998) confirms for the U.S. that the primary surplus is an increasing function of the public debt-to-GDP ratio in the U.S. This finding is also confirmed for France, Germany, Italy, and Spain by Favero (2002), who employs structural models to examine the effects of monetary and fiscal policies on macroeconomic variables. Additional supportive evidence is reported by Mulas-Grandos (2003) for the EU member countries and Tujula and Wolswijk (2007) for the OECD countries. Afonso (2008) also shows for the EU member countries that the positive response of the primary balance to public debt or the existence of Ricardian fiscal regimes hold for pre- and post-Maastricht, and pre- and post-Stabilty and Growth Pact period.

Our research is also related to studies that analyze the effects of fiscal rules on fiscal policy. A fiscal rule is defined as a permanent constraint on fiscal policy, typically setting a numerical target referring to an indicator of overall fiscal performance (Kopits & Symanski, 1998). The main aim is, in general, to control deficit bias existing in the decision-making process to formulate a government budget. According to Shaechter et al. (2012), there are four types of rules—budget balance rules, expenditure rules, debt rules, and revenue rules, and each type of rule has its strong and weak points.

Budget balance rules, which typically specify a target on budget balance as a share of GDP, provide clear guidance and support fiscal authorities in ensuring debt sustainability. However, the rules defined as overall balance or not cyclically adjusted variables do not stabilize economies' cyclical movements but are likely to make fiscal policy pro-cyclical. Expenditure rules, which are typically set in absolute terms, a share of GDP, or growth rates, prove clear operational guidance for fiscal policy. They can also contribute to controlling fiscal balance or public debt when accompanied by budget balance or debt rules. Furthermore, expenditure rules foster counter-cyclical fiscal policy by excluding certain cyclical-sensitive expenditure items such as unemployment support. Debt rules, in general, set a ceiling for public debt as a share of GDP. While the rules have an advantage in being relatively easy to communicate and monitor, their weak point is that the response of debt-to-GDP ratio to fiscal policy is slow. Furthermore, when debt is well below its ceiling, the rule would not provide any binding guidance. Revenue rules, in general, aim at enhancing tax revenues or preventing an excessive tax burden. Unless rules restrict the use of windfall revenue for additional spending, they do not contribute to ensuring fiscal sustainability.

An early empirical study by Poterba (1994) indicates a positive correlation between restrictive fiscal rules and rapid adjustments to unexpected deficits for state governments in the United States. Also, for the United States, Inman (1996) points out that an effective balanced budget rule must be stipulated in the constitution, enforced by a politically independent council, and costly to amend. Among studies focusing on the Economic and Monetary Union (EMU), fiscal rules covering broader government sectors are likely to improve primary fiscal balance (Debrun et al., 2008). Afonso and Hauptmier (2009) is interesting in the context of our article. Like us, they interact public debt with a fiscal rule index to examine their effects on the primary balance, although they focus only on the effects of the public debt-to-GDP ratio on the relationships between fiscal rules and primary balance.

Moreover, their studies relate to EU member countries, not OECD member countries. Bergman et al. (2016) point out that the effectiveness of fiscal rules in reducing the pro-cyclicality of fiscal policy depends on government effectiveness.

Among fiscal rules, balanced budget rules and debt rules are the most effective. The independent fiscal councils and medium-term fiscal frameworks may help strengthen the function of fiscal rules (Nerlich and Reute, 2013). On the other hand, there is empirical evidence that expenditure rules can limit expenditure bias to some extent, especially when there are revenue shortfalls (Wierts, 2008). In the context of the business cycle and fiscal policy, fiscal rules tend to reduce fiscal pro-cyclicality in both advanced and emerging economies (Manasse, 2006; Ayuso-i-casals et al., 2009). Expenditure policy tends to be subject to a pro-cyclical bias, and strictly enforced expenditure rules may mitigate this tendency (Holm-Hadulla et al., 2012). On the other hand, the use of cyclically adjusted targets, well-defined escape clauses, and strict legal and enforcement arrangements may be essential to mitigate the pro-cyclicality of policy, especially in developing countries (Bova et al., 2014; Guergiul et al., 2017).

3. Empirical Approach

To analyze whether and how fiscal rules affect the relationship between fiscal policy and public debt, we consider the following dynamic panel model:

$$Fiscal_{it} = \beta_0 + \beta_1 Fiscal_{it-1} + \beta_2 Public\ Debt_{it-1} + \beta_3 Fiscal\ rule_{it} + X_{it}^{'}\theta + \alpha_i + \varepsilon_{it} \quad (1)$$

where F is our fiscal policy variable for country i and year t[4]. The cyclically adjusted fiscal variables capture the discretionary fiscal policy or the fiscal stance. α_i measures the unobserved country effects and $\varepsilon_{it}$is the error term[5]. The model includes a lagged dependent variable F_{it-1} to account for the possible autocorrelation of fiscal policy that results from a gradual adjustment to a fiscal target or just from the serial correlation in the exogenous shocks. $Public\ debt_{it-1}$ is the public debt-to-GDP ratio of the previous year. The coefficient β_2 indicates a discretionary fiscal policy response to the previous year's public debt. If β_2 is significantly positive, fiscal authorities try to reduce the primary deficit or increase the primary surplus in order to stabilize the public debt-to-GDP ratio. $Fiscal\ rule_{it}$ is the numerical fiscal rule index. X_{it} is a vector of control variables. We discuss details of dependent and independent variables in the next section.

To examine the interaction effect of fiscal rules, we estimate the following model, which includes the interaction term between public debt and fiscal rule index:

$$F_{it} = \beta_0 + \beta_1 F_{it} + \beta_2 Public\ debt_{it-1} + \beta_3 Fical\ rule_{it} + \beta_4 (Public\ debt_{it-1} \times Fiscal\ rule_{it}) + X_{it}^{'}\theta + \alpha_i + \varepsilon_{it} \quad (2)$$

$Public\ debt_{it-1} \times Fiscal\ rule_{it}$ is the interaction term. $\beta_2 + \beta_4 Fiscal\ rule_{it}$ is the marginal effect of public debt on fiscal policy for any given level of fiscal rule index.

The presence of a lagged dependent variable implies that the within estimator with fixed effect OLS creates biased and inconsistent estimates due to the correlation between the regressor and the

[4] Holm-Hadulla et al. (2012) and Bergman et al. (2016), for example, estimate similar regression equations.

[5] In terms of model specification, a Hausman test suggests that regressors correlate with error terms. Therefore, the equation needs to be estimated with a fixed effect model instead of a random effect model.

centered lagged error term. Furthermore, as Celasun and Kang (2006) and Golineli and Momigliano (2009) suggest, we need to consider and instrument the likely endogeneity issue of some regressors such as the output gap. Following their arguments, we use Blundell and Bond (1998) system GMM. The system GMM estimator uses a subset of the internal instruments to handle the bias caused by dynamic panel specification. Assuming in our model that the lagged dependent variable and the cyclical variable are endogenous, and the lagged debt is weakly exogenous, we include these variables as a GMM-style instrument.

Another statistical issue related to performing the system GMM methods is that the number of instruments is quadratic in T. A large number of instruments may overfit endogenous variables and weaken the Hansen test of the instrument's joint validity (Roodman, 2009a). Roodman (2009b) recommends restricting the lag length used in generating these instrument sets or collapsing them by having different moments for each lag instead of each lag and time period. We use the Stata command xtabond2 written by Roodman (2009b) and apply both methods in estimating our equation.

4. Data

4.1. Dependent variables

We use a yearly unbalanced panel data set of 28 OECD countries covering a maximum period of 1985 to 2015[6]. The dependent variables are the cyclically adjusted primary balance, cyclically adjusted primary expenditures, and cyclically adjusted primary revenues (hereinafter, the primary balance, primary expenditures, and primary revenues, respectively). All three variables are measured as a percentage of GDP. The cyclically adjusted variables indicate the fiscal stance in a given year. All variables are taken from the OECD Public Finance Dataset, which provides a detailed breakdown of public expenditure and revenues for OECD member countries[7].

4.2 Fiscal rules

The primary explanatory variable in this study is the fiscal rule index. The fiscal rule data are collected from the Fiscal Rules Dataset 1985-2015 provided by the IMF Fiscal Affairs Department. The dataset covers four types of rules—budget balance rules, expenditure rules, debt rules, and revenue rules. It also provides details on characteristics of rules, including their legal basis, coverage of government sectors, and enforcement procedures, taking stock of key supporting features that are in place, such as multi-year expenditure ceilings, fiscal responsibility law, as well as independent bodies responsible for setting budget assumptions and monitoring budget implementation. Following the procedure proposed by Schaechter et al. (2012), we add up the scores of those characteristics and supporting features, normalizing the resulting fiscal rule index to have theoretical lower and upper limits of 0 and 5. The higher the index, the stronger the fiscal rule is. In order to examine the effects of each fiscal rule, we also construct the balanced budget rule index, the expenditure rule index, and the debt rule index using a similar methodology to that applied in constructing the fiscal rule index.

[6] Countries in the sample are Australia, Austria, Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, United Kingdom, and the United States.

[7] The dataset is available at https://www.oecd.org/economy/public-finance/oecd-public-finance-dataset.htm. Bloch et al. (2016) elaborate technical details concerning the construction of the dataset.

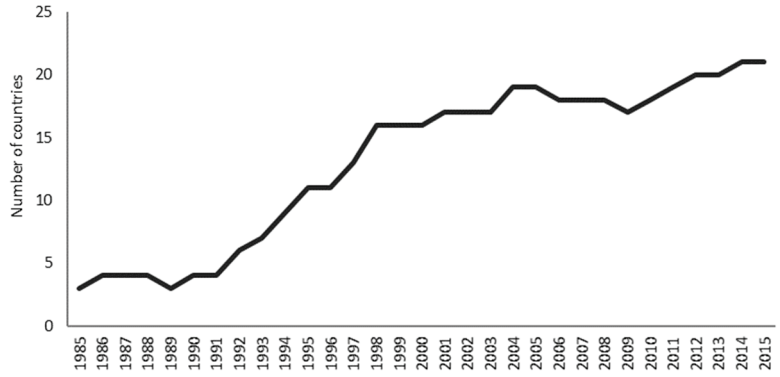


Figure 1 Number of countries adopting fiscal rules

Figure 1 shows the time series trends of the number of countries adopting the fiscal rule. While only three countries, Australia, Germany, and Japan, had some types of fiscal rules in 1985, the number reached 21 in 2015. Figure 2 presents a breakdown of the fiscal rule index for respective countries as of 2015. The index is zero for Canada, Hungary, and Iceland, as those countries did not implement fiscal rules in 2015. The value of the index reaches a maximum for the Netherlands, followed by Spain and Denmark. Most of the countries implement several types of fiscal rules. The type of rule most widely used in the sample countries is the balanced budget rule. As seen in section 2, budget balance rules are likely to lead to pro-cyclical fiscal policy when aiming at headline budget balance. To overcome this problem, some countries employ a cyclically adjusted budget balance or structural fiscal balance as a fiscal policy target[8].

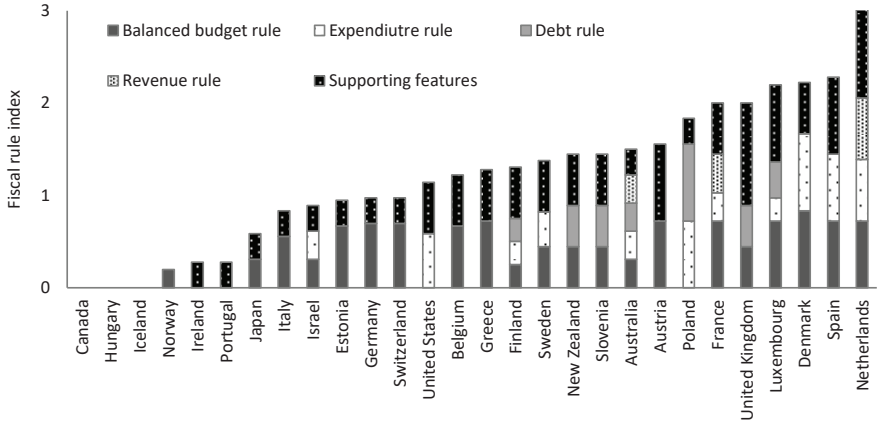


Figure 2 Types of fiscal rules adopted as of 2015

4.3 Public debts and other control variables

Following the literature on determinants of fiscal deficit, we employ control variables concerning i) fiscal and economic situations, ii) politics, and iii) others. Among the fiscal and economic variables, the first variable is the government indebtedness measured by public debt as a percentage of GDP

[8] Australia, Denmark, Finland, Germany, Norway, Spain, Sweden, Switzerland, and the U.K. adopted structural fiscal balance as a fiscal policy target in the 1990s or 2000s. In the EU, the treaty on Stability, Coordination and Governance in the Economic and Monetary Union (TSCG), which entered into force on 1 January 2013, provides the requirement that the euro area countries have a structural budget balance rule in domestic legal orders. The enforcement of the TSCG accelerated adoption of a structural balance target across the euro area countries.

(hereinafter, public debt). The variable is in the estimation to account for the considerations of fiscal authorities to ensure fiscal stability and sustainability. High public debt is expected to increase the primary balance. The lagged variable is in the estimation, as policymakers would refer to the public debt figure in the previous year to formulate a budget. The second variable is the output gap to capture the business cycle, measured as the difference between real GDP and potential GDP. The coefficient indicates the cyclical behavior of fiscal policy, which is found to be counter-cyclical if the coefficient is statistically significant and has a negative sign, pro-cyclical if it is positively significant, and a-cyclical otherwise. The third variable is the rate of consumer price inflation. The variable is in the model to capture its influence on fiscal balance via several channels. High inflation exerts upward pressure on government receipts and expenditures through nominal progression in tax rates and tax brackets and via price-indexation. Higher inflation can also affect government fiscal policy through possible impacts on economic growth via erosion of cost competitiveness (Tujula & Wolswijk, 2004). We also include the natural logarithm of the population as there might be economies of scale in public services. The old age dependency ratio, the percentage of population aged above 64 to the total population, is also in the model to capture the effects of aging on government expenditures or revenues. All economic and fiscal variables are collected from the OECD Economic Outlook 2020.

The political variables are in the model to control for impacts of political characteristics on fiscal policy and outcomes in each sample country. We use the fragmentation of government measured as the sum of the squared seat shares of all parties in the government. Various studies report evidence that political fragmentation within governments may lead to fiscal deficits. To account for election cycles in government expenditures, revenues, or budget deficits, we use the number of years remaining in the current term and an election year dummy variable equal to one for the year of the parliamentary election. These variables are taken from the World Bank Database of Political Institutions.

We also include two additional dummy variables. One is the euro dummy, which equals one if a country is a member of the EMU and zero if not. The countries in the EMU are strictly subject to the EU-wide fiscal governance framework, and thus their fiscal policy is less flexible than the non-member countries. Another dummy variable is the crisis dummy, which is equal to one if a country faces a financial crisis[9] . The descriptive statistics of all variables are presented in Table 1.

Table 1 Descriptive statistics

	Mean	Obs.	Max	Min	Std. Div.
Cyclically adjusted primary balance	0.0	760	7.4	-27.7	3.2
Cyclically adjusted primary expenditures	41.9	759	63.8	26.6	6.7
Cyclically adjusted primary revenues	41.9	728	58.4	25.4	7.1
Public debt-to-GDP	69.9	736	217.9	6.7	36.5
Fiscal rule index	0.6	839	3.2	0.0	0.6
Output gap	-0.6	771	12.6	-16.5	3.3
Log population	16.3	839	19.6	12.4	1.6
Change of old age dependecy ratio	0.3	811	2.0	-0.7	0.3
Inflation	3.8	839	48.0	-4.5	5.2
Government fragmentation	0.7	839	1.0	0.2	0.3
Years left in current term	1.7	839	4.0	0.0	1.2
Election year	0.3	839	1.0	0.0	0.5
Crisis	0.1	839	1.0	0.0	0.3
Euro area	0.3	839	1.0	0.0	0.4

Source: Compiled by author from public sources.

[9] We follow crisis episode data compiled by Laeven and Valencia (2018).

4.4 Unit root tests

In this section, we present the unit root test results of our variables to examine whether the series is stationary or not. Given that the panel data is unbalanced, the ADF panel unit root test proposed by Im et al. (2003), namely the IPS, and Fisher-type test suggested by Maddala and Wu (1999) and Choi (2001) are applied. The test results are shown in Table 2. The results reveal that, except for the old age dependency ratio, the null unit root hypothesis can be rejected at the 10 percent level for all or most cases. Therefore, we consider those dependent and explanatory variables as stationary. Based on the test result, the old age dependency ratio is in the model with first differences.

Table 2 Unit root tests (p values)

Variable	IPS		Fisher, ADF		Fisher, PP	
	No trend	Trend	No trend	Trend	No trend	Trend
Cyclically adjusted primary balance	0.000	0.001	0.013	0.074	0.000	0.004
Cyclically adjusted primary expenditures	0.005	0.002	0.105	0.038	0.000	0.001
Cyclically adjusted primary revenues	0.016	0.001	0.009	0.078	0.004	0.001
Public debt	0.754	0.055	0.080	0.035	1.000	0.999
Output gap	0.000	0.000	0.000	0.000	0.091	0.969
Inflation	0.000	0.000	0.000	0.001	0.000	0.000
Log of population	0.016	0.000	0.010	0.000	0.001	0.000
Old age dependency ratio	0.960	0.623	0.034	0.208	0.710	1.000
Government fragmentation	0.000	0.116	0.036	0.454	0.000	0.011
Years left in current term	0.000	0.000	0.000	0.000	0.000	0.000
Fiscal rule index	Not tested					
Election dummy	Not tested					
Euro area dummy	Not tested					
Crisis dummy	Not tested					

Note: The null hypothesis is that all panels have unit roots. The test results were obtained by using the xtunitroot command of Stata. All the tests subtract the mean of the series across panels to mitigate the impact of cross-sectional dependence.
Source: Estimations by author.

5 Empirical results

5.1. Baseline

Table 3 reports fixed effects system GMM estimates for the primary balance. The consistency of the system GMM estimator depends on the validity of the instruments. We conduct two specification tests. The first is a Hansen J-test of over-identifying restrictions, which tests the joint validity of the instruments. The test results indicate that we cannot reject the null hypothesis that instrumental variables are exogenous for all estimate results. The second test examines the serial correlation in the error term. The Arellano-Bond test for AR(1) confirms the presence of the first-order autocorrelation in the differenced residuals. In contrast, the Arellano-Bond test for AR(2) indicates no second-order serial correlation in the differenced error terms. These test results confirm the appropriateness of the estimator.

Columns 1 of Table 3 are the regression results of Equation 1, suggesting that the primary balance positively responds to public debt and fiscal rule index. The coefficients are statistically significant at the 1 percent levels, respectively. The coefficient of public debt suggests that a 10-percentage point increase in government indebtedness drives up the primary balance by about 0.4 percentage points of GDP. A move from the lowest level debt burden to the highest level would

reduce the size of discretionary fiscal policy by about 8 percentage points of GDP. Furthermore, a one standard deviation increase in public debt leads to an additional 1 percentage point of GDP change on the primary balance. On the other hand, the positive coefficient of the fiscal rule index confirms that fiscal rules also have a disciplinary effect on fiscal policy. A one-point increase in the index drives up the balance by about 0.6 percentage points of GDP. The regression result predicts that a move from the lowest index level, which is zero, to the highest results in an additional improvement of the primary balance by about 2 percentage points of GDP. A one standard deviation change in the index predicts that the primary balance will increase by about 0.4 percentage points of GDP.

Regarding the control variables in column 1, all the economic variables have signs of coefficients, as we expected. The output gap is negatively related to the primary balance but insignificant. An increase in the output gap associated with a decline in the primary balance implies that fiscal policy tends to be pro-cyclical. A large population and a rise in dependency ratio are likely to worsen the primary balance. Higher inflation has a positive but insignificant effect on the primary balance. In the meantime, none of the political variables is statistically significant. The primary balance tends to improve with a larger number of years remaining in the current term. These results are consistent with a political business cycle theory that expects governments to carry out expansionary fiscal policy close to elections. Against our expectation from the common pool theory, the estimation results suggest that the more a government is fragmented, the more the primary balance tends to improve. The crisis dummy variable is negatively significant at the 1 percent level, implying that the primary surplus shrinks or the deficit widens during crisis periods. Finally, the negative coefficient of the euro area dummy indicates that a country in the EMU is likely to pursue an expansionary fiscal policy.

To capture the interaction effect between public debt and fiscal rule index, we estimate Equation 2, which includes an interaction term of those variables (column 2). The interaction term (lagged public debt $\times$ fiscal rule index) is statistically significant at the 1 percent level. A negative sign of the coefficient associated with the interaction term suggests that a strengthening of fiscal rules is likely to reduce the positive response of the primary balance to public debt. The marginal effect of public debt on the primary balance conditional on the fiscal rule index is represented by $0.060 - 0.035 \times$ Fiscal Rule Index. The coefficient of public debt, 0.060, shows the marginal effect when the value of the fiscal rule index is equal to zero. It is almost 1.5 times larger than that without the interaction term, indicating that the impact of public debt on fiscal policy is pronounced for governments with no fiscal rule.

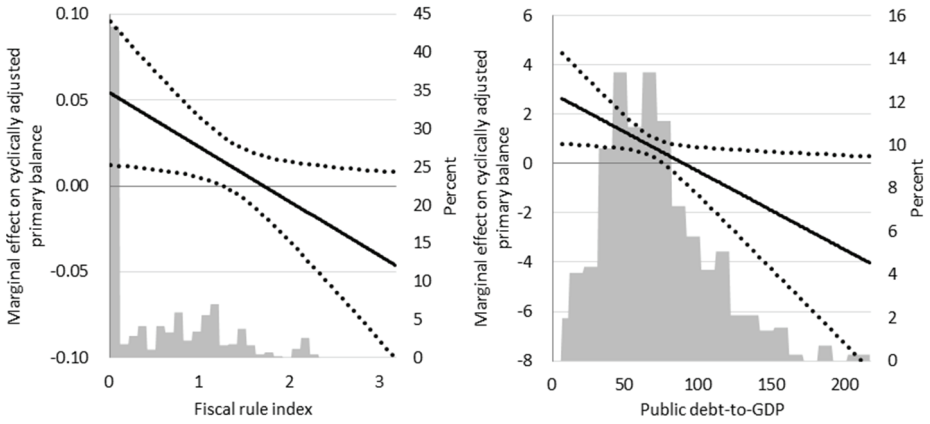
This study is interested in interaction effects varying according to a range of condition variables, i.e., the fiscal rule index. Therefore, we try to identify this relationship by drawing marginal effects and confidence bounds of the estimation results following the procedure proposed by Brambor et al. (2006). Sub-figure (a) in Figure 3 reports the marginal effect corresponding to the minimum and maximum values of the fiscal rule index. The negative slope suggests that a more outstanding public debt-to-GDP improves the cyclically adjusted primary balance. At the same time, the effect tends to weaken as the fiscal index becomes stricter. The confidence bounds indicate that the marginal effect of public debt is statistically significant at the 5 percent level if the fiscal rule index is no higher than 1.5. Once the index is above this threshold, the marginal effect turns to be negative and statistically insignificant. Sub-figure (a) also presents a histogram describing the distribution of the fiscal rule index in our sample. It shows that there are fewer observations at higher levels of the fiscal rule index. Indeed, most countries fall somewhere between 0 and 2.0.

Table 3 Regression for the cyclically adjusted primary balance

	(1)	(2)
Dependent variable	Cyclically adjusted primary balance	
Public debt (t-1)	0.036***	0.060***
	(0.013)	(0.016)
Fiscal rule index	0.595***	3.119***
	(0.188)	(0.742)
Public debt (t-1) * Fiscal rule index		-0.035***
		(0.011)
Dependent variable (t-1)	0.629***	0.640***
	(0.063)	(0.064)
Output gap	-0.060	-0.089*
	(0.061)	(0.052)
Log population	-0.396***	-0.370***
	(0.121)	(0.102)
Change of old age dependecy ratio	-1.318**	-1.526***
	(0.578)	(0.497)
Inflation	0.107	0.138*
	(0.081)	(0.079)
Government fragmentation	0.192	0.053
	(0.591)	(0.668)
Years left in current term	0.011	-0.028
	(0.078)	(0.085)
Election year	-0.113	-0.231
	(0.200)	(0.213)
Crisis	-1.263***	-1.371***
	(0.366)	(0.386)
Euro area	-0.447	-0.486
	(0.328)	(0.342)
Constant	3.873**	1.850
	(1.563)	(1.524)
Observations	687	687
Number of countries	28	28
AR(1)	0.004	0.003
AR(2)	0.365	0.252
Number of instruments	22	23
Hansen's J	0.371	0.253

Note: The dependent variable is a cyclically adjusted primary balance. AR(1) and AR(2) are tests of autocorrelation of the first and second order. Hansen's J is a test for over-identifications. Tests for autocorrelation and over-identification report p-values. Figures in parentheses are robust standard errors. *** indicates p<0.01, ** p<0.05, * p<0.1.
Source: Estimations by author.

The interaction term in Equation (2) also allows us to evaluate the marginal effect of fiscal rules at different values of public debt-to-GDP. Sub-figure (b) confirms our expectations that the fiscal rule index exerts a significantly positive effect. However, the negative slope indicates that the effect declines along with an increase in public debt and becomes insignificant when public debt is above 75%, which is slightly higher than the sample mean. Fiscal rules positively impact the primary balance for more than half of the public debt values in our sample. The insignificant marginal effects of the fiscal rule index at high values of public debt align with the view that a combination of strong fiscal rules and lower debt ratios would be a good strategy for pursuing a sound fiscal policy, as suggested by Afonso and Hauptmeire (2009).



(a) Marginal effects of public debt (b) Marginal effects of fiscal rules

Figure 3 Marginal effects on the cyclically adjusted primacy balance

5.2. Primary expenditures and revenues

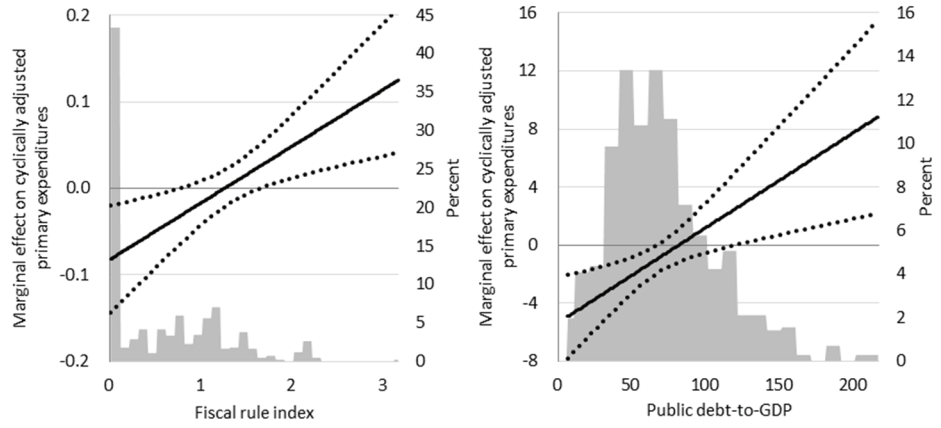
This section uses alternative dependent variables—cyclically adjusted primary expenditures and cyclically adjusted primary revenues. Column 1 in Table 4 confirms that public debt and fiscal rule index negatively affect primary expenditures. The negative coefficients indicate that increasing public debt or strengthening fiscal rules tend to reduce the primary expenditures. However, they fail to reject the null hypothesis at the 10 percent level. The t-statistics of about 1.6 for public debt and 1.5 for the fiscal rule index imply milder effects on the primary expenditures. On the other hand, column 2, with the primary revenues, reveals that public debt and fiscal rule index also have negative coefficients, although neither are statistically significant.

The estimate with an interaction term for the primary expenditures (column 3) shows that public debt and fiscal rule index are now significant. The higher coefficient of public debt with rather than without the interaction term suggests that the effects of public debt in reducing primary expenditures are strong when governments have no fiscal rules to control fiscal policy. With the positively significant coefficient of the interaction term, the effects of public debt become small with strong fiscal rules. Sub-figure (a) of Figure 4 on the marginal effects confirms the above findings. The insignificance of public debt with a fiscal rule index higher than 0.55 implies that the government could control expenditure policy through fiscal rules when well-designed and strict fiscal rules are in place. The marginal effects of fiscal rules at different public debt values also confirm that the fiscal rules are effective as long as public debt is below a certain level, which, in our sample, is 66 percent of GDP. On the other hand, the estimation for the primary revenues does not show a meaningful result. Figure 5 also confirms these results.

Table 4 Regressions for the cyclically adjusted primary expenditures and cyclically adjusted primary revenues

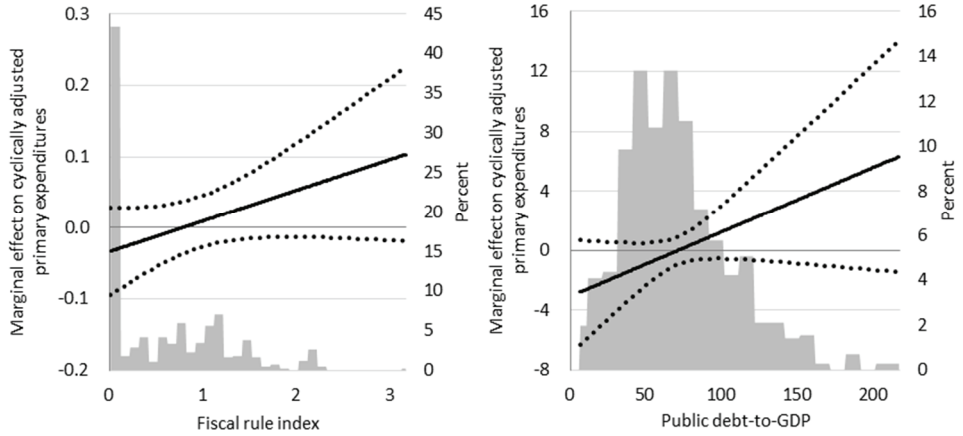
Dependent variables	(1) Cyclically adjusted primary expenditures	(2) Cyclically adjusted primary expenditures	(3) Cyclically adjusted primary revenues	(4) Cyclically adjusted primary revenues
Public debt (t-1)	-0.046	-0.082**	-0.002	-0.007
	(0.028)	(0.032)	(0.017)	(0.021)
Fiscal rule index	-0.680	-5.328***	-0.111	-0.925
	(0.441)	(1.597)	(0.199)	(1.214)
Public debt (t-1) * Fiscal rule index		0.066***		0.012
		(0.023)		(0.017)
Dependent variable (t-1)	0.524***	0.548***	0.796***	0.798***
	(0.109)	(0.098)	(0.129)	(0.135)
Output gap	-0.234**	-0.156*	-0.144***	-0.129**
	(0.104)	(0.088)	(0.051)	(0.054)
Log population	0.090	-0.012	-0.242	-0.278
	(0.427)	(0.314)	(0.333)	(0.278)
Change of old age dependecy ratio	1.279	1.467	0.079	0.084
	(1.136)	(0.995)	(0.696)	(0.624)
Inflation	-0.097	-0.148	-0.006	-0.013
	(0.099)	(0.105)	(0.070)	(0.073)
Government fragmentation	-2.641	-2.177	-0.844	-0.750
	(1.795)	(1.741)	(0.877)	(0.846)
Years left in current term	0.005	0.072	0.064	0.078
	(0.091)	(0.098)	(0.087)	(0.084)
Election year	-0.148	0.068	-0.151	-0.107
	(0.296)	(0.290)	(0.228)	(0.217)
Crisis	1.526**	1.769***	0.678*	0.732*
	(0.593)	(0.555)	(0.367)	(0.398)
Euro area	1.867**	1.752*	0.468	0.430
	(0.899)	(0.910)	(0.444)	(0.519)
Constant	22.948***	25.942***	13.063	13.887
	(7.156)	(6.041)	(9.210)	(9.639)
Observations	687	687	670	670
Number of countries	28	28	27	27
AR(1)	0.002	0.003	0.000	0.000
AR(2)	0.193	0.143	0.013	0.013
Number of instruments	24	25	22	23
Hansen's J	0.154	0.148	0.215	0.195

Note: AR(1) and AR(2) are tests of autocorrelation of the first and second order. Hansen's J is a test for over-identifications. Tests for autocorrelation and over-identification report p-values. Figures in parentheses are robust standard errors. *** indicates p<0.01, ** p<0.05, * p<0.1.
Source: Estimations by author.



(a) Marginal effects of public debt (b) Marginal effects of fiscal rules

Figure 4 Marginal effects on the cyclically adjusted primary expenditures



(a) Marginal effects of public debt (b) Marginal effects of fiscal rules

Figure 5 Marginal effects on the cyclically adjusted primary revenues

5.3. Extensions

5.3.1 Non-linear effects of public debt

The first set of extensions deals with a possible heterogeneous relationship between fiscal policy and public debt. The effect of public debt on the primary balance or primary expenditures and interaction effects of fiscal rules may not be linear. The effect may differ along with the level of public debt[10]. To examine these arguments, we introduce the squared public debt into the estimation model to capture possible non-linear effects of government indebtedness on fiscal policy. The estimation results are reported in Table 5. Column 1 confirms the non-linear effects for the primary balance. The negatively significant effects of the squared public debt imply that higher public debt

[10] Our analysis in the following section focuses on the cyclically adjusted primary balance and primary expenditures, as the fiscal rules do not significantly affect the cyclically adjusted primary revenues.

tends to worsen the primary balance. The coefficient of the squared public debt means that the marginal effect of public debt turns negative only when the level exceeds 238 percent of GDP. A similar result is also confirmed for the primary expenditures (column 3). In both estimations, the response of the fiscal rule index is equivalent to the baseline.

Columns 2 and 4 show the estimation results when introducing the interaction term between public debt and fiscal rule and between the squared public debt and fiscal rule index. Both interaction terms are statistically significant and have opposite signs. The marginal effect of public debt depends on the fiscal rule index and public debt itself[11]. Therefore, we illustrate how the response of primary balance varies according to the fiscal rule index for three levels of public debt—the average of the quintile with low indebtedness (public debt=34% of GDP), the average of the quintile with medium indebtedness (public debt=65% of GDP), and the average of the quintile with high indebtedness (public debt=110% of GDP). Figure 6 shows the marginal effects on the primary balance. The graphs again indicate that increasing the strength of fiscal rules tends to reduce the response of the primary balance to public debt. However, for countries with higher government debt in Sub-figure (c), strict fiscal rules are likely to strengthen the positive marginal effects, although the confidence bands suggest the effects are mostly insignificant. Figure 7 shows that the marginal effect on the primary expenditures also has a similar function to the fiscal rules[12]. The estimation result in this section implies that even if the government adopts institutionally strong fiscal rules, disciplinary fiscal policy may not be warranted as long as public debt remains at a high level. Fiscal authorities need to keep public debt in check in order to ensure a disciplinary fiscal policy.

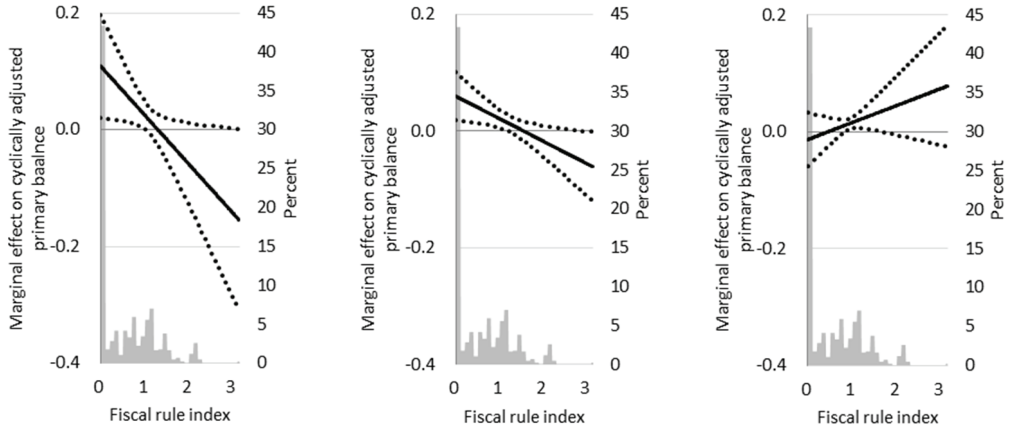
Table 5 Regressions with the squared public debt

Dependent variables	(1)	(2)	(3)	(4)
	Cyclically adjusted primary balance		Cyclically adjusted primary expenditures	
Public debt (t-1)	0.108***	0.164**	-0.125**	-0.334**
	(0.037)	(0.073)	(0.054)	(0.131)
Public debt^2 (t-1)	-0.000**	-0.001*	0.000**	0.002**
	(0.000)	(0.000)	(0.000)	(0.001)
Fiscal rule index	0.591**	5.580**	-0.768	-15.307***
	(0.223)	(2.382)	(0.517)	(5.382)
Public debt (t-1) * Fiscal rule index		-0.135*		0.352**
		(0.066)		(0.141)
Public debt^2 (t-1) * Fiscal rule index		0.001*		-0.002**
		(0.000)		(0.001)
Observations	687	687	687	687
Number of countries	28	28	28	28
AR(1)	0.004	0.005	0.003	0.009
AR(2)	0.401	0.271	0.214	0.149
Number of instruments	26	28	28	30
Hansen's J	0.412	0.149	0.0843	0.101

Note: All explanatory variables and a constant term are included but not shown here for brevity. AR(1) and AR(2) are tests of autocorrelation of the first and second order. Hansen's J is a test for over-identifications. Tests for autocorrelation and over-identification report p-values. Figures in parentheses are robust standard errors. *** indicates p<0.01, ** p<0.05, * p<0.1.
Source: Estimations by author.

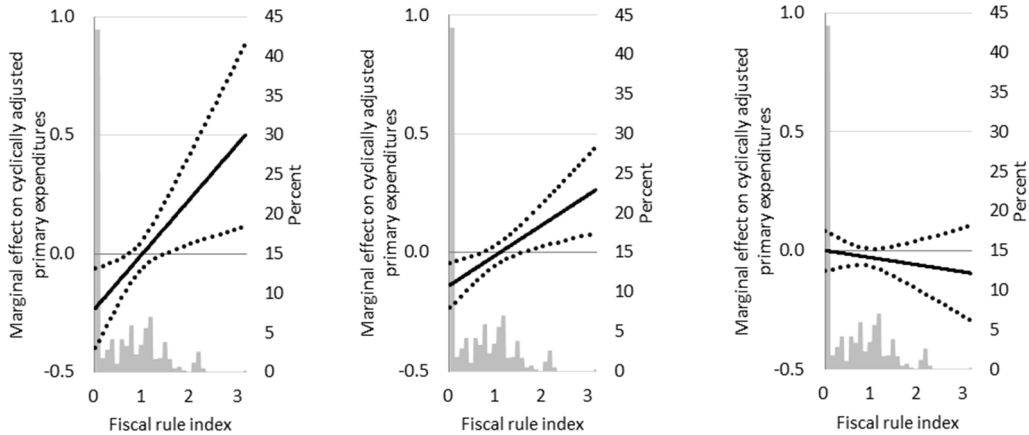
[11] The marginal effect is represented by $\beta_1 + \beta_3 Pulcib\ deb_{it-1} + \beta_4 Fiscal\ rules_{it} + \beta_5 Pulcib\ deb_{it-1} \times Fiscal\ rules_{it}$.

[12] Although we do not present graphs of the marginal effects of fiscal rules conditional upon public debt, these also support our findings in the baseline estimation.



(a) Low public debt (b) Medium public debt (c) High public debt

Figure 6 Marginal effects on the cyclically adjusted primary balance for different levels of public debt



(a) Low public debt (b) Medium public debt (c) High public debt

Figure 7 Marginal effects on the cyclically adjusted primary expenditures for different levels of public debt

5.3.2 Breakdown of the fiscal rule index

The second set of extensions is to break down the fiscal rule index into each type of rule. To understand what type of rules influences the link between the fiscal policy variables and public debt, we replace the fiscal rule index, which is an aggregate index, with three types of rule indices—the balanced budget rule index, expenditure rule index, debt rule index[13].

Table 6 indicates the regression results of Equation 2 with the three indices, respectively. While the signs of public debt, each type of fiscal rules, and their interaction terms are the same as those

[13] We do not estimate using the revenue rule index as the revenue rules are not always designed to contribute to maintaining fiscal sustainability.

in the baseline estimation, the effects of each rule type differ. Balanced budget rules are the most effective tool in improving the primary balance, the coefficients being significantly positive at the 5 percent level for the primary balance and at the 1 percent level for the primary expenditures (columns 1 and 4). Debt rules are also significant at the 10 percent level for both dependent variables (columns 3 and 6), while the coefficient of expenditure rules does not show a statistically significant effect (columns 2 and 5). The interaction terms of the balanced budget rule index and debt rule index are significant for the primary balance and primary expenditures[14]. Debrun et al. (2008) points out that the balanced budget rules and debt rule exert effective impacts on fiscal policy, while expenditure rules are marginal. Their arguments are supported by other studies (e.g. Nerlich et al., 2013; Bergman et al. 2016). Our results are mostly in line with those suggested by the related literature.

Table 6 Regressions for different types of fiscal rules

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Cyclically adjusted primary balance			Cyclically adjusted primary expenditures		
Type of fiscal rules	Balanced budget rule	Expenditure rule	Debt rule	Balanced budget rule	Expenditure rule	Debt rule
Public debt (t-1)	0.054**	0.034**	0.035**	-0.073***	-0.052*	-0.039
	(0.022)	(0.015)	(0.016)	(0.026)	(0.030)	(0.024)
Fiscal rule index	1.958**	0.762	1.136*	-2.922***	-1.664	-2.032*
	(0.840)	(0.479)	(0.562)	(0.892)	(1.218)	(1.087)
Public debt (t-1)	-0.022*	-0.008	-0.013*	0.034**	0.021	0.023*
* Fiscal rule index	(0.012)	(0.006)	(0.007)	(0.014)	(0.014)	(0.013)
Observations	687	687	687	687	687	687
Number of countries	28	28	28	28	28	28
AR(1)	0.004	0.003	0.004	0.00274	0.00165	0.000537
AR(2)	0.458	0.480	0.442	0.154	0.198	0.408
Number of instruments	23	23	23	25	25	25
Hansen's J	0.135	0.497	0.505	0.172	0.107	0.265

Note: All explanatory variables and a constant term are included but not shown here for brevity. AR(1) and AR(2) are tests of autocorrelation of the first and second order. Hansen's J is a test for over-identifications. Tests for autocorrelation and over-identification report p-values. Figures in parentheses are robust standard errors. *** indicates $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Estimations by author.

5.4. Robustness analysis

This study estimates the baseline model using the system GMM estimator that is widely used in previous literature in similar fields and is well suited to dynamic panels with small T and large N. However, it may be worth examining alternative estimation methodologies to verify the robustness of our results. The first and second methodologies applied are the pooled OLS and the fixed effect estimations. The third is the feasible generalized least squares (FGLS), which is most efficient for panels with large T and small N as well as cross-sectional correlation and group-wise heteroscedasticity in the error term. The final technique is the bias-corrected least-squares dummy variable (LSDV) proposed by Bruno (2005), which is suitable for the autoregressive panel mode.

Table 7 presents robustness test results. All estimations except the pooled OLS include country fixed effects. Although the pooled OLS, fixed effect, and FGLS estimation cannot deal with the bias caused by a lagged dependent variable, we include it for comparison purposes. All estimations mostly support our arguments. Although the interaction terms are insignificant in some estimations, the signs of the coefficients are the same as the baseline model.

[14] Although we do not present the graphs of marginal effects, they also support the estimation results.

Table 7 Robustness tests

Depedent variable	(1) Cyclically adjusted primary balance	(2) Cyclically adjusted primary expenditures	(3) Cyclically adjusted primary balance	(4) Cyclically adjusted primary expenditures	(5) Cyclically adjusted primary balance	(6) Cyclically adjusted primary expenditures	(7) Cyclically adjusted primary balance	(8) Cyclically adjusted primary expenditures
Estimators	Pooled	Pooled	Fixed effect	Fixed effect	FGLS	FGLS	LSDV	LSDV
Public debt (t-1)	0.016***	-0.013***	0.022*	-0.026	0.020***	-0.040***	0.019***	-0.031***
	(0.004)	(0.004)	(0.012)	(0.016)	(0.005)	(0.005)	(0.007)	(0.007)
Fiscal rule index	0.953***	-0.713**	1.073**	-1.554**	0.628**	-1.644***	0.966**	-1.557***
	(0.280)	(0.307)	(0.393)	(0.574)	(0.305)	(0.267)	(0.398)	(0.428)
Public debt (t-1)	-0.008**	0.005	-0.008	0.014**	-0.003	0.015***	-0.007	0.015***
* Fiscal rule index	(0.004)	(0.004)	(0.005)	(0.006)	(0.003)	(0.003)	(0.005)	(0.005)
Dependent variable (t-1)	0.710***	0.936***	0.651***	0.684***	0.645***	0.645***	0.726***	0.779***
	(0.068)	(0.017)	(0.041)	(0.039)	(0.028)	(0.023)	(0.032)	(0.027)
Observations	687	687	687	687	687	687	687	687
Number of countries	28	28	28	28	28	28	28	28
R-squared	0.632	0.899	0.539	0.655				

Note: All explanatory variables and a constant term are included but not shown here for brevity. AR(1) and AR(2) are tests of autocorrelation of the first and second order. Hansen's J is a test for over-identifications. Tests for autocorrelation and over-identification report p-values. Figures in parentheses are robust standard errors. *** indicates p<0.01, ** p<0.05, * p<0.1.

Source: Estimations by author.

6. Conclusions

The current health crisis has led to public debt rising to unprecedented levels across the world. Expansionary fiscal policies are critical to protect people and support firms under the Covid-19 pandemic. While it is still too early to wind down sizable spending and revenue measures, governments may need to start preparing to shift from crisis-mode policy to fiscal restoration in the medium-term with mounting debt burdens. With this consideration, this paper has examined the interaction effect of fiscal rules on the relationship between public debt and fiscal policy—the cyclically adjusted primary balance, cyclically adjusted primary expenditures, and cyclically adjusted primary revenues.

The empirical evidence suggests that, as previous studies reported, the cyclically adjusted primary balance tends to respond to public debt positively, while the cyclically adjusted primary expenditures react negatively. The cyclically adjusted primary revenues do not show a significant response. However, our empirical study finds that those relationships are likely to weaken or disappear when stricter fiscal rules are in place. At the same time, fiscal rules exert significant disciplinary effects. These results indicate that well-designed fiscal rules will be dominant in the budgeting process and will reduce the influence of public debt requiring the government to adjust fiscal policy to ensure fiscal sustainability. However, fiscal rules do seem not to function effectively when the level of public debt is high. With the result that higher public debt makes it less likely that fiscal positions can be improved even under stricter fiscal rules, we may conclude that adopting better budgetary institutions represented by fiscal rules is a necessary but not sufficient condition for fiscal sustainability. Governments need to lower public debt to a certain level in order to ensure the disciplinary effects of the fiscal rules and public debt itself. Finally, balanced budget rules show the most significant influence, followed by the debt rule. Our estimation fails to show significance with regard to the expenditure rule.

There remains work to be conducted to understand the nature of the relationship among public debt, fiscal rules, and fiscal policy. The fiscal rule index we employ is based on the IMF Fiscal Rules Dataset 1985-2015. While containing details of institutional characteristics, the dataset does not provide information on whether each rule works effectively or not. We need to incorporate a track record of whether and how much fiscal policy has complied with rules. Furthermore, we did not perform a profound examination of why the fiscal rules do not show an effective influence under a high public debt. High public debt may result from fiscal policy that has less emphasis on long-term fiscal stability or ineffectiveness of the government to contain deficit bias. Answering this question might also contribute to the literature focusing on debt sustainability issues.

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A Comparison of Behavior-Restriction and Test-and-Isolate Policies Using an Epidemiological Model

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Abstract

In this study, we analyze the effects of behavior-restriction and test-and-isolate policies on disease spread and the macro economy using a model that combines an epidemiological model (the Susceptible-Infected-Recovered [SIR] model) and an economic growth model (the Solow model). First, we compare the change in the spread of disease using three types of behavior-restriction policy and policy durations: 80% contact reduction over 30 days, 70% contact reduction over 60 days, and 60% contact reduction over 360 days. In each of these cases, policy adoption quickly suppresses the spread of the disease, but the disease spread resumes sometime after the policy lapses. To significantly reduce the total number of deaths in the 1,000 days following the beginning of the outbreak, behavioral restrictions would have to remain in place for considerable periods, such as a full year, and the economic losses from such a duration would be very high. Second, we show that shortening behavioral restrictions and introducing a test-and-isolate policy can reduce the spread of disease while reducing economic losses. We specifically derive an optimal policy for minimizing economic losses, excluding the cost of testing, with an upper limit on the total number of deaths associated with the disease: In the baseline analysis, we find the optimal scenario to be behavioral restrictions producing an 80% reduction in contact (equivalent to an approximate 55% reduction in excursions) implemented over about 60 days in combination with test-and-isolate at maximum test intensity over one year.

Keywords: COVID-19; SIR model; Behavioral-restriction policy; Test-and-isolate policy

JEL codes: E00; E69

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1 Introduction

The novel coronavirus infection (COVID-19), which first appeared at the end of 2019, has spread worldwide with the global movement of people. To prevent the spread of the disease, many countries have placed cities on lockdown, and Japan has adopted a policy aiming to reduce contact by 80%. Behavioral-restriction policies such as lockdowns and 80% reduction in contact have been shown to be effective in preventing the spread of COVID-19; however, the economic cost is extremely high. For this reason, many economists are now studying COVID-19.[1]

While economists have adopted various approaches to their analysis of COVID-19, the analysis using a mathematical epidemiological model known as the Susceptible-Infected-Recovered (SIR) model that has drawn attention from macroeconomists. The simplest SIR model presents a model comprising a system of difference equations (or differential equations)-considering the change in three types of state over time: (1) Susceptible: those who can be infected, (2) Infectious, and (3) Recovered (including deaths). Since the SIR model is compatible with dynamic macroeconomic models, many macroeconomists have used the SIR model in their analyses since the pioneering work of Atkeson (2020).

In this study, we use the SIR model to analyze how behavioral-restriction policy and test-and-isolate policy affect disease spread and economic activity. As in Holtemoeller (2020), the model used in this study is a SIR model connected to the Solow model, a standard model in economic growth theory, making it possible to simultaneously describe not only the spread of infection but also the economic activity. The simple SIR model is further extended to consider incubation periods and patients with asymptomatic infections. Additionally, the testing costs and the possibility of case fatality rates increasing with the number of hospitalized patients (treatment limits) are considered by the model.

The main features of this study are as follows: First, we compare how the spread of the infection changed under three types of behavioral-restriction policy and policy duration: 80% contact reduction (an approximate 55% reduction in excursions) for 30 days; a 70% contact reduction (an approximate 45% reduction in excursions) for 60 days, and a 60% contact reduction (an approximate 37% reduction in excursions) for 360 days. In each case, the introduction of a policy can quickly suppress the spread of infection; however, its spread resumes after a period following the policy's end. To significantly reduce the total number of deaths

[1]For example, the National Bureau of Economic Research's (NBER) working papers concerning COVID-19 can be found at: `https://www.nber.org/nber-studies-related-covid-19-pandemic-topic-area`.

in the 1,000 days following the beginning of the outbreak, behavioral restrictions would have to remain in place for considerable periods, such as a full year, and the economic losses from such a duration would be very high.

Second, we show that rather than long-term behavioral restrictions, the introduction of a test-and-isolate policy can suppress the spread of disease while also reducing economic losses. Specifically, we derive an optimal policy for minimizing economic losses, excluding the cost of testing, with an upper limit on the total number of deaths associated with the disease: In the baseline analysis, we find the optimal scenario to be behavioral restrictions producing an 80% reduction in contact (equivalent to an approximate 55% reduction in excursions) implemented over about 60 days in combination with test-and-isolate at maximum test intensity over one year.

The main characteristic of the analysis offered in this study is that we set an upper limit on the total number of deaths and searched for the optimal policy minimizing economic loss under the condition that the upper limit on deaths is not exceeded. Holtemoeller (2020) finds that the optimal policy in the sense of maximizing economic welfare will be a mix of behavioral restrictions and test-and-isolate, but that the total number of deaths under the optimal policy will increase.

Additionally, we assume a consumer utility function to consider economic welfare, which is not necessarily consistent with the model. Moreover, the optimal policy in the sense of minimizing economic losses shows that it is not desirable to rely entirely on behavioral restrictions. Instead, this study finds that by considering an upper limit on total deaths as a constraint, even in the absence of consideration for economic welfare, the optimal policy in the sense of minimizing economic loss is a mix of behavioral restrictions and test-and-isolate. We also show that the results are robust (1) where there are restrictions to the upper limit on testing intensity, (2) where the testing costs are high, (3) where the reinfections can occur, and (4) where the exposed persons affect new infections.

Atkeson (2020) carried out pioneering research bringing SIR model analysis to the field of economics. With the subsequent spread of COVID-19, many economists have conducted analyses using the SIR model. In Holtemoeller (2020), on which the model used in this study is based, economic activity can be analyzed by connecting the SIR model with the Solow model. Moreover, Holtemoeller (2020) introduced not only the behavioral-restriction policies analyzed by Atkeson (2020), but also test-and-isolate policies, and found that a mix of behavioral-restriction and test-and-isolate policy to be desirable in maximizing economic welfare.

There is no explicit consideration given to the optimization behaviors of economic agents in the models used by Holtemoeller (2020) and in this study, since they are based on the Solow model. Then again, Eichenbaum, Rebelo and Trabandt (2020a, 2020b, 2020c) connect the SIR model to a dynamic general equilibrium model, a standard model in contemporary macroeconomics, and there are therefore analyses that simultaneously consider the optimization behaviors of economic agents.[2] In particular, Eichenbaum, Rebelo and Trabandt (2020b) analyze the role of test-and-isolate policies, relating closely to this study. However, Eichenbaum Rebelo and Trabandt (2020b) do not consider testing costs, and this is a major point of difference from this study.

The remainder of this paper is organized as follows. First, we introduce the model in Section 2. In Section 3, we compare the effects of behavioral-restriction policy through numerical experiments using the model. We also derive the optimal policy that minimizes economic losses, setting an upper limit on the total number of deaths, and confirm the robustness of the results by changing the upper limit on testing intensity and testing costs. Lastly, we conclude in Section 4.

2 Models

2.1 Baseline SIR Model

The classic epidemiological model (SIR model) considers three types of state: (1) Susceptible: those who can be infected, (2) Infectious, and (3) Recovered (including deaths). In this study, based on the model used by Holtemoeller (2020), we consider the following expanded SIR model. First, the initial population is set to 100, and this population is separated into seven categories: (1) Susceptible: those who can be infected S_t, (2) Exposed, E_t, (3) Symptomatic Infectious, I_t, (4) Asymptomatic Infectious, X_t, (5) Hospitalized, H_t, (6) Recovered: those who have recovered and acquired immunity, R_t, and (7) Dead, D_t. The first period of the model is assumed to be 1 day. Assuming that the number of newly infected individuals is proportional to the product of Susceptible persons, S_{t-1}, and Infectious persons (The sum of I_{t-1} and X_{t-1}) in the previous

[2] When using a dynamic general equilibrium model, it is necessary to consider aspects of imperfect information, such as whether economic agents know whether they are infected, whether they can understand the spread of infection within in the macro economy, and the negative externalities of their own behavior on the infection rate in the economy as a whole, which are difficult to analyze. The topic of externalities has been addressed by Eichenbaum, Rebelo and Trabandt (2020a), and information imperfections by Eichenbaum, Rebelo and Trabandt (2020b) and Hamano, Katayama and Kubota (2020), among others.

period, the transition equation for Susceptible persons S_t is given by:

$$\text{Susceptible:} \qquad S_t = S_{t-1} - \bar{\beta}\,\frac{S_{t-1}(I_{t-1} + \phi_t X_{t-1})}{Pop_0}. \tag{1}$$

Here, $\bar{\beta}$ is a parameter for new infections; for the purposes of standardization, we divide the total by the initial population. ϕ_t is a parameter expressing the relative infectivity of Asymptomatic Infectious persons, X_t, against I_t.

Assuming that a certain fraction, σ_I, of Exposed persons, E_t, transition to Symptomatic Infectious I_t and Asymptomatic Infectious X_t, the transition equation is given by:

$$\text{Exposed:} \qquad E_t = E_{t-1} + \bar{\beta}\,\frac{S_{t-1}(I_{t-1} + \phi_t X_{t-1})}{Pop_0} - \sigma_I E_{t-1}. \tag{2}$$

Let the proportion of infected individuals ξ become Symptomatic, I_t, and the remainder,$1-\xi$, become Asymptomatic, X_t. Moreover, both in Symptomatic and Asymptomatic cases, it is assumed that proportion γ_I will recover, while a proportion of Symptomatic persons, γ_H, will become seriously ill, becoming Hospitalized persons, H_t. The transition equation of infected persons is given as follows:

$$\text{Symptomatic infected:} \qquad I_t = I_{t-1} + \xi\sigma_I E_{t-1} - \gamma_I I_{t-1} - \gamma_H I_{t-1}, \tag{3}$$

$$\text{Asymptomatic infected:} \qquad X_t = X_{t-1} + (1-\xi)\sigma_I E_{t-1} - \gamma_I X_{t-1}. \tag{4}$$

While proportion δ_H of Hospitalized persons recover, proportion μ_t will unfortunately die. The transition equation for Hospitalized persons H_t, Recovered persons R_t, and Deaths, D_t, is given as follows:

$$\text{Hospitalized persons:} \qquad H_t = H_{t-1} + \gamma_H I_{t-1} - \delta_H H_{t-1} - \mu_t H_{t-1}, \tag{5}$$

$$\text{Recovered persons:} \qquad R_t = R_{t-1} + \gamma_I(I_{t-1} + X_{t-1}) + \delta_H H_{t-1}, \tag{6}$$

$$\text{Deaths:} \qquad D_t = D_{t-1} + \mu_t H_{t-1}. \tag{7}$$

To take medical limitations into account, in this study we assume that the case fatality rate, μ_t, is a function of the increase in the number of hospitalized persons relative to the population, given by the following equation:

$$\mu_t = \bar{\mu} + b_\mu \left(\frac{H_{t-1}}{Pop_{t-1}}\right)^2. \tag{8}$$

Last, the total population, Pop_t, is defined as follows:

$$Pop_t = Pop_0 - D_t = S_t + E_t + I_t + X_t + H_t + R_t. \tag{9}$$

2.2 SIR-Solow model

The baseline model described above is a system of difference equations that capture the dynamics of infection numbers, to which the Solow model is docked so that economic activity can be considered.[3] The aggregate production function is a Cobb-Douglas function, given by the following equation:

$$Y_t = A_t K_t^{\alpha} N_t^{1-\alpha}. \tag{10}$$

Note that A_t is total factor productivity, K_t is capital input, N_t is labor input, and α is the cost share of capital. If total factor productivity grows uniformly at an annual growth rate of γ_A, the transition equation is given by[4]

$$A_t = A_{t-1}(1+\gamma_A)^{1/360} \tag{11}$$

Let labor input N_t be the population Pop_t that is not hospitalized, and let λ be the fraction of the labor force such that:

$$N_t = \lambda(Pop_t - H_t). \tag{12}$$

Assuming a constant savings rate, γ_K, consumption C_t is given by:

$$C_t = (1-\gamma_K)Y_t. \tag{13}$$

Moreover, taking the annual capital consumption rate to be δ, the transition equation for capital stock, K_t becomes:

$$K_t = (1-\delta)^{1/360} K_{t-1} + \gamma_K Y_{t-1}. \tag{14}$$

2.3 Introducing behavioral-restriction and test-and-isolate policies

Here we introduce behavioral-restriction policy (contact reduction policy) and test-and-isolate policy into the model introduced above. First, we define behavioral-restriction policy to be "policy that uniformly

[3] Although it is possible to model changes in labor supply and other factors based on the optimization behavior of economic agents, as shown in Eichenbaum, Rebelo, and Trabandt (2020a, 2020b, 2020c), we use a Solow model to keep the analysis as simple as possible.

[4] Here we follow Holtemoeller (2020) in setting 1 year = 360 days.

restricts the behaviors of susceptible, exposed, symptomatic, and asymptomatic persons at rate ν_t." Since at this point the behaviors of both susceptible persons, S_t, and infected persons (I_t and X_t) are reduced by share ν_t, contact between the two groups is reduced, and new infections are halted at $(1-\nu_t)^2$ where there are no behavioral-restriction policies. This means, for example, for an 80% contact restriction, $(1-\nu_t)^2 = 0.2$, and so $\nu_t = 0.5528$, which corresponds to a reduction in excursions of about 55%. Based on the above, the transition equation for Susceptible persons, S_t, and exposed persons, E_t, is given as follows

$$\text{Susceptible persons:} \qquad S_t = S_{t-1} - \bar{\beta}(1-\nu_t)^2 \frac{S_{t-1}(I_{t-1} + \phi_t X_{t-1})}{Pop_0}, \tag{15}$$

$$\text{Exposed persons:} \qquad E_t = E_{t-1} + \bar{\beta}(1-\nu_t)^2 \frac{S_{t-1}(I_{t-1} + \phi_t X_{t-1})}{Pop_0} - \sigma_I E_{t-1}. \tag{16}$$

The test-and-isolate policy is defined as the "policy of testing a θ_t proportion of the population, excluding hospitalized and recovered patients and isolating detected positive individuals from socioeconomic activities by having them isolate in ordinary and appropriate places." We therefore divide infected persons not by the symptomatic and asymptomatic statuses used in the model, but by whether or not they test positive. I_t is untested symptomatic infected persons, $\tilde{I}_t$ is tested, symptomatic infected persons, X_t is untested asymptomatic infected persons, and $\tilde{X}_t$ is tested asymptomatic infected persons. Tested infected persons $\tilde{I}_t + \tilde{X}_t$ are isolated, and the number of such persons is taken to be U_t. Proportion δ_U of tested infected persons U_t will recover. The transition equation of infected persons is given thus:

$$\text{Untested symptomatic infected persons:} \qquad I_t = I_{t-1} + \xi\sigma_I E_{t-1} - \gamma_I I_{t-1} - \gamma_H I_{t-1} - \theta_t I_{t-1}, \tag{17}$$

$$\text{Tested symptomatic infected persons:} \qquad \tilde{I}_t = \tilde{I}_{t-1} + \theta_t I_{t-1} - \gamma_H \tilde{I}_{t-1} - \delta_U \tilde{I}_{t-1}, \tag{18}$$

$$\text{Untested asymptomatic infected persons:} \qquad X_t = X_{t-1} + (1-\xi)\sigma_I E_{t-1} - \gamma_I X_{t-1} - \theta_t X_{t-1}, \tag{19}$$

$$\text{Tested symptomatic infected persons:} \qquad \tilde{X}_t = \tilde{X}_{t-1} + \theta_t X_{t-1} - \delta_U \tilde{X}_{t-1}. \tag{20}$$

The following equations express Hospitalized persons, Recovered persons, and the total population:

$$\text{Hospitalized persons:} \qquad H_t = H_{t-1} + \gamma_H(I_{t-1} + \tilde{I}_{t-1}) - \delta_H H_{t-1} - \mu_t H_{t-1}, \tag{21}$$

$$\text{Recovered persons:} \qquad R_t = R_{t-1} + \gamma_I(I_{t-1} + X_{t-1}) + \delta_U(\tilde{I}_{t-1} + \tilde{X}_{t-1}) + \delta_H H_{t-1}, \tag{22}$$

$$\text{Total population:} \qquad Pop_t = Pop_0 - D_t = S_t + E_t + I_t + X_t + \tilde{I}_t + \tilde{X}_t + H_t + R_t. \tag{23}$$

Since persons subject to behavior restrictions and isolated infected persons are unable to participate in

economic activity, labor input, N_t under those policies is given by the following:

$$N_t = (1 - \nu_t)\lambda(Pop_t - H_t - U_t). \tag{24}$$

Lastly, let the cost of testing be Φ per test, such that the total cost of testing, T_t is given by:

$$T_t = \theta_t(S_t + E_t + I_t + X_t)\Phi. \tag{25}$$

3 Main Results

3.1 Parameter values

Many of the parameter values in the model are similar to those in Holtemoeller (2020). According to Wang et al. (2020), the duration of COVID-19 infection is 2.3 days and the incubation period is 5.2 days; therefore, $\gamma_I = 1/2.3$ and $\sigma_I = 1/5.2$. According to the World Health Organization (2020), 80% of infections in China were mild cases with a hospital stay of about 14 days, while severe cases were hospitalized for between three to six weeks.

We therefore take the weighted average of $0.8 \times 14 + 0.2 \times 31.5 = 17.5$ as the duration of hospitalization. We thus set $\delta_H = 1/17.5$. Since Li et al. (2020) estimated that 86% of the total infected population in China would not have been tested, we set $\xi = 1/8$. $\bar{\beta}$ is set such that the basic reproduction number is $R^o = \bar{\beta}/\gamma_I = 2.3$. The relative infectivity of an asymptomatic infected person is $\phi_t = 1$.

Following Holtemoeller (2020), we set $\gamma_H = 1/7$, with initial values of exposed persons, symptomatic and asymptomatic infected persons as $E_1 = 0.1393$, $I_1 = 0.0087$ and $X_1 = 0.0610$, respectively.

The form of the case fatality rate function differs from that in Holtemoeller (2020), but it is a quadratic function of hospitalized patients to account for medical treatment limitations. Here, taking $\bar{\mu} = 0.02$, b_μ is set such that $\mu_t = 0.1$ when $H_t/Pop_t = 0.001$.

Following Holtemoeller (2020), we set the parameters of the Solow model as follows: cost share of capital $\alpha = 0.36$, saving rate (ratio of investment to GDP) $\gamma_K = 0.21$, annual growth rate of total factor productivity $\gamma_A = 0.005$, capital depletion rate $\delta = 0.035$, and labor force participation rate $\lambda = 0.545$. The initial value of total factor productivity, A_1, is set such that initial production, $Y_1 = 100$ and that the Solow model steady-state is achieved before the initial period.

The cost of testing is assumed to take a baseline of $\Phi = 0.1$. Holtemoeller (2020) selects an extremely small value, $\Phi = 3.3 \cdot 10^5$; however, in our analysis, we assume that the cost of testing the entire population is 10% of GDP, and set $\Phi = 0.1$.[5] We also consider a case where $\Phi = 0.3$ in the robustness check presented in Section 3.5.

3.2 Comparison of the effects of behavioral-restriction policies and policy durations

First, we compare behavioral-restriction policies and their effects over their duration. Specifically, we compare the effects of (1) the 80% contact reduction policy for 30 days, (2) the 70% contact reduction policy for 60 days, and (3) the 60% contact reduction policy for 360 days. In each case, the policy begins on the 30th day. Here, an 80% contact reduction means that $(1 - \nu_t)^2 = 1 - 0.8$), as we have seen in Equation (15), and, for example, in Policy (1), we set $\nu_t = 0.5528$ for the 30 days from the 30th day, and $\nu_t = 0$ otherwise. Note that we do not consider testing in this experiment and so set $\theta_t = 0$.

Figures 1 and 2 plot the number of infections, total deaths, and GDP by the 60th and 720th day, respectively. The number of infections, so-called Active Cases, is defined as $I_t + X_t + H_t$. Total deaths are given by D_t, while GDP is expressed using Y_t. As shown in Figure 1, while contact reduction policies are in place, their efficacy in preventing infection depends on their intensity. However, as the change in infections in Figure 2 shows, once the policy ends, the spread of infection will resume, albeit with a certain time lag. In the case with an 80% reduction in contact over 30 days, the spread of infection resumes promptly after the policy lapses, with the peak of the case explosion occurring on the 112th day (52 days after the policy). In the case with a 70% reduction in contact over 60 days too, the spread of infection reappears soon after the policy, with the peak of the case explosion occurring on day 159 (69 days after the policy lapses). In the case with a 60% contact reduction over 360 days, although no re-emergence of the infection's spread is observed for a fairly long period, the spread of infection increases around day 600, with the peak of the case explosion on the 683rd day (293 days after the policy lapses). Concerning total deaths as of the 1,000th day,

[5] By transforming equation (25),

$$\frac{T_t}{Y_t} = \theta_t \frac{S_t + E_t + I_t + X_t}{Y_t} \Phi$$

we now assume that initially $Y_1 = 100$ and that the total population is $Pop_1 = S_1 + E_1 + I_1 + X_1 = 100$. Since $\theta_1 = 1$ implies that the entire population is tested, Φ can be interpreted as the ratio of the cost of testing the entire population to GDP in the initial period.

2.1% of the population would die without policy intervention, compared with 1.7% in the case with 80% contact reduction for 30 days, 1.6% in the case with 70% contact reduction for 60 days, and 0.6% in the case with 60% contact reduction for 360 days.

These results show that one month or two months of behavioral-restriction does not make a significant difference in the number of deaths and that the spread of infection returns following a time lag after the policy lapse. This means that behavioral-restriction policies are merely a way to stall until a vaccine or effective treatment can be developed. Conversely, a year of contact reduction would (at least up to the 1,000th day), significantly reduce the number of deaths, but a year of sustained behavioral restrictions would risk significant damage to the macroeconomy.

Figure 1: The effects of behavioral-restriction policies (1): Up to day 60

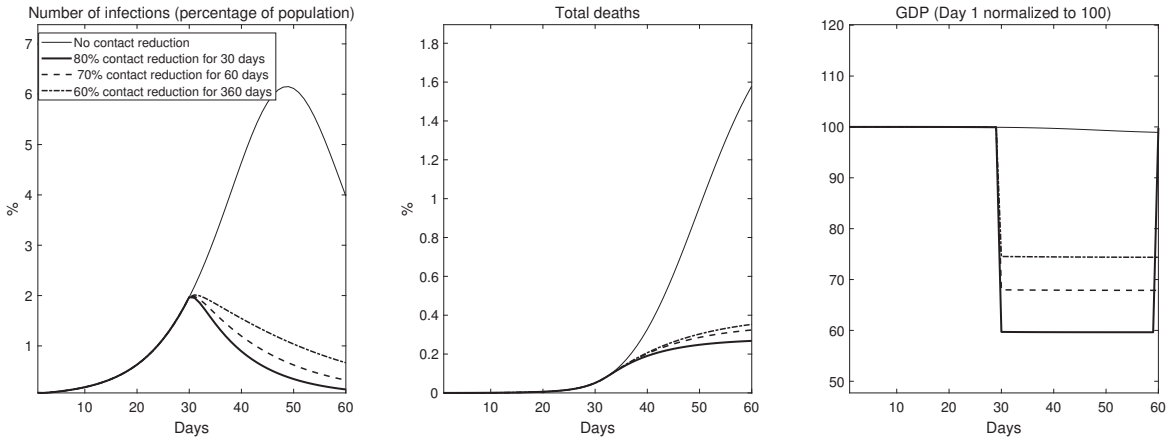
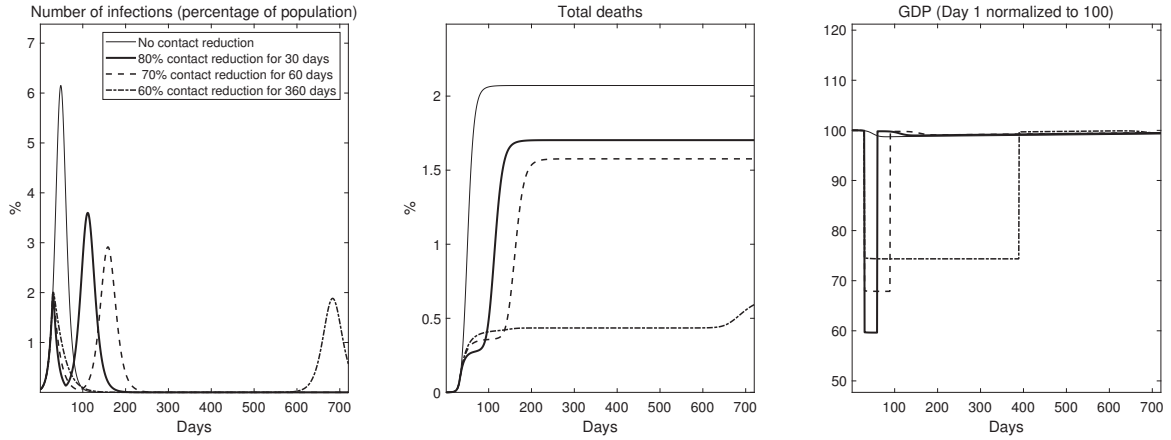


Figure 2: The effects of behavioral-restriction policies (2): Up to day 720



3.3 Test-and-isolate policies as alternatives to behavioral-restriction policies

We have seen the effects of behavioral-restriction policies, but prevention of the spread of infection using behavioral-restriction policy alone requires such policies to be implemented for long periods, and are highly damaging to the economy. A test-and-isolate policy could therefore be implemented in lieu of behavioral restrictions.

As shown in Equation (28), the number of new cases is determined by:

$$\bar{\beta}(1-\nu_t)^2 \frac{S_{t-1}(I_{t-1}+\phi_t X_{t-1})}{Pop_0}$$

However, if testing intensity in the previous period, θ_{t-1}, is set appropriately, the number of new cases can be kept as ν_t because I_{t-1} and X_{t-1} are reduced through Equations (17) and(19). Here, since ν_t can finish at a lower value, labor supply, as defined by Equation (24), increases, which may also reduce the loss of economic activity.

3.4 An optimal policy package combining behavioral-restriction and test-and-isolate

The total number of fatalities is 0.2829% where 80% contact reduction ($(1-\nu)^2 = 1-0.8$) starts on the 30th day and continues for 360 days. Here we consider a policy package with the lowest economic loss (a behavioral-restriction and test-and-isolate combination), under the condition that the total number of deaths does not exceed this number. The economic loss when continuing 80% contact reduction for 360 days is 20.69% compared to when no infection occurs at all; and by combining test-and-isolate, we examine to what extent economic damage can be suppressed.

In this experiment, the contact reduction parameter ν_t is varied in increments of 0.05 from 0 to 0.55; the contact reduction period is varied in increments of 30 days from 0 to 360 days; the testing intensity θ is varied in increments of 0.1 from 0 to 1; the testing intensification period is varied in 30-day increments, from 0 to 360 days: We simulate and analyze the economic losses and a total number of fatalities during these periods. As before, we begin the policies at 30 days, and simulate for 720 days before calculating economic loss. To account for the cost of testing, economic loss is calculated as the percentage deviation from GDP (less the cost of testing) had there been no infection at all.

Table 1 shows the results for the optimal policy package. According to this table, to minimize economic loss, contact reduction should be limited to $\nu_t = 0.3$ (since $(1-0.3)^2 = 0.49$, this is an approximate 50%

reduction in contact) for 90 days, while testing should be increased to a maximum $\theta = 1$ and continued for one year. Economic loss, here, is 7.25%–much lower than the 20.69% economic loss incurred when 80% contact reduction is continued for 360 days.

Table 1: Optimal policy package (1)

Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
90	0.3	360	1	7.25%	0.2732%

3.5 Robustness

It was shown in the previous subsection that a combination of behavioral restrictions and test-and-isolate can reduce the total number of fatalities to less than when 80% contact reduction is maintained for 360 days, while reducing economic losses. Here we confirm the robustness of this result by modifying the previous settings.

(1) A scenario where the upper limit of testing intensity, θ, is low The upper limit for θ was set to 1 in the experiment in the previous section. $\theta_t = 1$ implies testing the entire population that is not known to be infected, but this is not always easy to do in practice. Thus, here we confirm the results when the upper limit of θ is set to lower values (0.25 and 0.1). In numerical experiments, the grid of θ is set to 0.01 increments, while all other settings remain the same as in the previous subsection.

Table 2 shows the results of experiments to find the optimal policy package when constraints are imposed on the upper limit of θ. Where the upper limit on θ is 0.25, and bounded by the condition that total deaths cannot exceed the scenario with 80% contact reduction continued for 360 days, the policy minimizing economic losses should be $\nu = 0.45$ continued for 330 days, together with testing intensity $\theta = 0.25$ continued for 330 days. In this scenario, economic losses amount to 16.07%. Moreover, where the upper limit is set to 0.1, and bounded by the condition that total deaths cannot exceed the scenario with 80% contact reduction continued for 360 days, the policy minimizing economic losses should be $\nu = 0.55$ continued for 330 days, together with testing intensity $\theta = 0.08$ continued for 120 days. In this scenario, economic losses amount to 19.00%.

Although factors for minimizing economic losses such as the number of days' duration of a policy varies depending on the upper limit of θ, in all cases we find that both behavioral restrictions and test-and-isolate are effective in reducing economic loss.

Table 2: Optimal policy package (2): Where there is an upper limit on θ

where $\theta \leq 0.25$					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
330	0.45	330	0.25	16.07%	0.2823%
where $\theta \leq 0.1$					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
330	0.55	120	0.08	19.00%	0.2820%

(2) A scenario where the cost of testing, Φ, is high The cost of testing was assumed to be $\Phi = 0.1$ in the experiment in the previous subsection. We set $\Phi = 0.3$, which is three times the baseline cost of testing, to confirm the robustness of the results. The parameter values and experiment methods are the same as before.

Table 3 shows the results of experiments to find the optimal policy package where testing costs are $\Phi = 0.3$. For an upper bound on θ of 1 (where there is no constraint on the upper bound), and bounded by the condition that total deaths cannot exceed the scenario with 80% contact reduction continued for 360 days, the policy minimizing economic losses should be $\nu = 0.3$ continued for 180 days, together with testing intensity $\theta = 0.8$ continued for 360 days. In this scenario, economic losses amount to 15.87%. Moreover, where the upper limit on θ is 0.25, and bounded by the condition that total deaths cannot exceed the scenario with 80% contact reduction continued for 360 days, the policy minimizing economic losses should be $\nu = 0.5$ continued for 300 days, together with testing intensity $\theta = 0.18$ continued for 360 days. In this scenario, economic losses amount to 17.76%. Finally, for an upper bound on θ of 0.1, and bounded by the condition that total deaths cannot exceed the scenario with 80% contact reduction continued for 360 days, the policy minimizing economic losses should be $\nu = 0.55$ continued for 330 days, together with testing intensity $\theta = 0.04$ continued for 240 days. In this scenario, economic losses amount to 19.23%.

Table 3: Optimal policy package (3): Where the cost of testing is high

Baseline (no constraint on θ)					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
180	0.3	360	0.8	15.87%	0.2732%
Where $\theta \leq 0.25$					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
300	0.5	360	0.18	17.76%	0.2801%
Where $\theta \leq 0.1$					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
330	0.55	240	0.04	19.23%	0.2822%

The above results are not significantly different from those for $\Phi = 0.1$, suggesting that besides behavior-restriction policies, test-and-isolate is also effective in reducing economic losses.

(3) Case with reinfections According to BNO News (2020)[6], reinfections of COVID-19 are confirmed. Then, we modify our model as follows. Recovered persons lose their antibodies to COVID-19 at a probability γ_{RS} and become Susceptible.

$$\text{Susceptible persons:} \quad S_t = S_{t-1} - \bar{\beta}(1-\nu_t)^2 \frac{S_{t-1}(I_{t-1} + \phi_t X_{t-1})}{Pop_0} + \gamma_{RS} R_{t-1}, \tag{26}$$

$$\text{Recovered persons:} \quad R_t = R_{t-1} + \gamma_I (I_{t-1} + X_{t-1}) + \delta_H H_{t-1} - \gamma_{RS} R_{t-1}. \tag{27}$$

We set $\gamma_{RS} = 1/180$, that is consitent with the finding of UK Biobank (2021):the COVID-19 antibodies remain for at least 6 months.

In this setting, the total number of fatalities is 2.3927% where 80% contact reduction starts on the 30th day and continues for 360 days. Table 4 shows the results of experiments to find the optimal policy package with reinfections. It tells us that besides behavior-restriction policies, the test-and-isolate policy is still effective in reducing economic losses.

Table 4: Optimal policy package (4): Case with reinfections

Baseline (no constraint on θ)					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
240	0.2	360	1.0	9.62%	2.3577%
Where $\theta \leq 0.25$					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
360	0.45	300	0.25	17.45%	2.3103%
Where $\theta \leq 0.1$					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
360	0.5	330	0.1	18.95%	2.3811%

(4) Case where Exposed persons affect new infections In the case of COVID-19, there is possibility where Exposed persons affect the number of new infections. Then we modify the model as follows.

$$\text{Susceptible persons:} \qquad S_t = S_{t-1} - \bar{\beta}(1-\nu_t)^2 \frac{S_{t-1}(E_{t-1} + I_{t-1} + \phi_t X_{t-1})}{Pop_0}, \tag{28}$$

$$\text{Exposed persons:} \qquad E_t = E_{t-1} + \bar{\beta}(1-\nu_t)^2 \frac{S_{t-1}(E_{t-1} + I_{t-1} + \phi_t X_{t-1})}{Pop_0} - \sigma_I E_{t-1}. \tag{29}$$

We assume that the test cannot idenfity Exposed persons.

In this setting, the number of infections rapidly increases, and the peak of the case explosion occurrs on the 14th day. There is no difference between behavioral-restriction policies if the policies begin on the 30th day. Then, we consider the situation where the policies begin on the 10th day.

The total number of fatalities is 2.0090% where 80% contact reduction starts on the 10th day and continues for 360 days. Table 5 shows the results of experiments to find the optimal policy package.

[6] https://bnonews.com/index.php/2020/08/covid-19-reinfection-tracker/.

Table 5: Optimal policy package (5): Case where Exposed affects new infections

Baseline (no constraint on θ)					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
330	0.5	240	1.0	18.79%	2.0047%
Where $\theta \leq 0.25$					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
330	0.55	30	0.03	19.80%	2.0038%
Where $\theta \leq 0.1$					
Contact reduction		Increased testing		Policy effect	
Period	ν	Period	θ	Economic loss	Total deaths
330	0.55	30	0.03	19.80%	2.0038%

The table suggests that besides behavior-restriction policies, the test-and-isolate policy is still effective in reducing economic losses.

4 Conclusion

In this study, we analyzed the effects of behavior-restriction and test-and-isolate policies on disease spread and the macro economy using a model that combines an epidemiological model (the SIR model) and an economic growth model (the Solow model). First, we compared the effects of three types of behavioral-restriction policies, and the duration of those policies, on the spread of infection: 80% contact reduction for 30 days, 70% contact reduction for 60 days, and 60% contact reduction for 360 days. In each case, introducing policy can quickly suppress the spread of infection; however, its spread resumes sometime after the policy lapses. To significantly reduce the total number of deaths in the 1,000 days following the beginning of the outbreak, behavioral restrictions would have to remain in place for considerable periods, such as a full year, and the economic losses from such a duration would be very high. Second, we showed that rather than long-term behavioral restrictions, introducing a test-and-isolate policy can suppress the spread of dis-

ease while also reducing economic losses. We particularly derived optimal policy for minimizing economic loss, excluding the cost of testing, with an upper limit on the total number of deaths associated with the disease. The baseline analysis showed that behavioral restrictions yielding an 80% contact reduction should be continued for 60 days, and that test-and-isolate should be continued for one year at maximum testing intensity.

This study analysis also raises several issues. One of these is parameter values: Although many parameters in the model are chosen in line with previous studies, they have not been calibrated to the Japanese data; herefore we may need to be cautious about directly adapting their quantitative implications to the Japanese economy. Another is an issue that concerns the model itself. To simplify the analysis, in this study we combined a very simple Solow model with the SIR model. At the same time, there are some studies, such as Eichenbaum, Rebelo and Trabandt (2020a, 2020b, 2020c), that join a dynamic general equilibrium model, in which economic agents perform optimizing behaviors, with the SIR model. As shown in the Lucas critique, it is desirable to use a dynamic general equilibrium model to forecast policy effects that capture changes in the optimization behavior of economic agents accompanying policy changes. It is therefore a topic for the future to analyze whether the conclusions of this study remain robust when using a dynamic general equilibrium model.

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Using GIS to Examine the Optimal Location for Long-Term Care Facilities in a Depopulating and Super-aging Society: A case study of Niigata City

Kazumasa Oguro

Abstract

The main purpose of this paper is to analyze and discuss a plan for effective and efficient location of long-term care facilities in a depopulating and super-aging society with the use of GIS (geographical information system) data on distribution of communal daily long-term care facilities for dementia patients (group homes) and elderly population in Niigata City, while also taking into consideration future demographics and service lifespan of the facilities. More specifically, we used data on current and projected future population of the elderly aged 75 and over at the small-area level ("Machi," "Cho," and "Aza"), and compared the current and future needs for group homes by service area and the current supply situation of the said facilities.

Our analysis elucidated that a strong sense of insufficiency of these facilities is already being felt in urban areas, including DIDs (densely inhabited districts), while suburban farming communities are relatively over-supplied. It also clarified that, looking to the future, the sense of insufficiency in urban areas is expected to rise increasingly, while the sense of excessive supply is expected to grow further in the suburban farming communities. As this result is based on the current and projected future population data on the elderly aged 75 and over, this finding is considered applicable not only to group homes but also to other residential long-term care facilities.

As the need for these types of facilities is expected to grow more than ever against the backdrop of a further increase in the elderly population in future, we believe that the issue of improved efficiency of these facilities by optimizing their geographical locations (through restructuring or relocation) will become increasingly significant. At the same time, promotion of Care Compact City and urban restructuring will also be required in light of financial constraints.

Keywords: Community-based Comprehensive Care, Compact City, Depopulation, GIS, Voronoi tessellation, Building life span, Finance

***JEL Classification*: H55, H75, I13, J10, R12**

I. Introduction

The main purpose of this paper is to analyze and discuss a plan for efficiently locating long-term care facilities in a depopulating and super-aging society with the use of GIS (geographical information system) data on distribution of communal daily long-term care facilities for dementia

patients (group homes) and the elderly population in Niigata City, while also taking into consideration future demographics and service lifespan of the facilities.

As is well known, with an aim to address the issue of a super-aging society and improve the sustainable medical and long-term care service system, the government enacted the "Amendatory Law to the Related Acts for Securing Comprehensive Medical and Long-term Care in the Community" during the ordinary Diet session in 2014. Based on this law, the government has been promoting a "Community-based Comprehensive Care System" (Article 5 of the said Law) centered mainly on the Long-Term Care Insurance System.

The "Community-based Comprehensive Care System" aims to build by 2025, when the baby boomer generation reaches the age of 75 and over, a framework for providing housing, medical care, long-term care, disease prevention, and livelihood support as an integrated service to enable the elderly and others to continue to live their lives in the way in which they are accustomed in familiar surroundings of homes and communities until the end of their lives, even if they should come to have serious needs for long-term care.

However, three major problems exist in promoting the "Community-based Comprehensive Care System." First is the issue of finance. The graying of society has expanded social security costs, thereby increasing Japan's fiscal deficit. Social welfare benefits, which were about 90 trillion yen in FY2007, rose to about 116 trillion yen in FY2016, accounting for about 20% of GDP. That is, although the social welfare benefits have continued to expand at an annual average of about 2.6 trillion yen over the past decade, it is very likely that the pressure to boost social security costs, including mainly medical care and long-term care costs, will grow even further towards 2025 when all members of the baby boomer generation reach the age of 75 and over. As a matter of fact, according to the "Revision of Cost Projections Related to Social Security (March 2012)" of the Ministry of Health, Labour and Welfare, pension payments are likely to increase marginally from about 56 trillion yen in FY2015 to 60 trillion yen in FY2025 due to application of the macroeconomic slide system, while medical care and long-term care payments are projected to increase sharply from about 50 trillion yen to about 75 trillion yen during the same period.

The second issue concerns measures for a sharply increasing elderly population and depopulation. The elderly in the latter stage of life (people aged 75 and over) tend to have higher demands for medical and long-term care service compared with the early-stage elderly (people aged 65 to 74). According to the population projection (based on median birth rate, median death rate) by the National Institute of Population and Social Security Research, however, the elderly in the latter stage of life (people aged 75 and over), which numbered about 9 million in 2000, is projected to reach about 20 million in 2025.

In addition, compared to the population of elderly in the latter stage of life in 2010, the number will grow by about 1.3 times in 2020, by about 1.6 times in 2030, and by about 1.7 times in 2050, which will inevitably lead to a ballooning of the medical and long-term care needs. In urban areas, in particular, the number of people on waiting lists for admission to special nursing homes for the elderly will increase sharply, thus exacerbating the issue of the lack of long-term care facilities.

The third issue is measures for local communities at a risk of vanishing. The "Grand Design of National Spatial Development towards 2050: Creation of a Country Generating Diverse Synergies among Regions" published by the Ministry of Land, Infrastructure, Transport and Tourism in July 2014 clarified that the grid squares (the entire land is divided into a "grid consisting of squares of 1km^2 each") in which the population in 2050 will fall to below half that of 2010 will account for over 60% of the currently inhabited areas (= 44% + 19%). The plan also anticipates the possibility that about 20% of those grid squares, accounting for over 60% of the currently inhabited areas, might become uninhabited. When this is observed by "population size of municipalities," smaller

communities will face a greater population decline rate, and the population of municipalities with a current population of under 10,000 will drop by about half. While the current population of Japan (as of 2010) will decrease by half in 2083, about 70 years later, the above finding suggests that the speed of population decline in regions where the population is projected to drop by more than half in about 40 years (between 2010 and 2050) is twice the speed of the population decline of the national average or even greater. As a result, municipalities with smaller populations are more likely to face a financial crisis.

Measures to clear up the above three problems simultaneously are limited. One of the conceivable effective measures is, as pointed out in Oguro (2015), the promotion of the "Care Compact City," which combines the "Community-based Comprehensive Care System" and "Compact City," which seeks population consolidation. The "Care Compact City" is an initiative aimed at efficiently and effectively providing medical and long-term care services in a consolidated, high-quality residential and community space, known as a "Compact City."

Pushing forward the above-mentioned initiatives is one effective measure to simultaneously solve the three problems mentioned above. However, it is also extremely significant to analyze in which area long-term care-related facilities should be appropriately located, while determining the distribution status and projection of the demographics.

Such analysis is closely related to the issue of optimal geographical location of facilities. Rapid progress in GIS in recent years has enabled us to visualize understanding and analysis of the situation. Although analysis leveraging GIS on long-term care-related issues is still limited to date, Bojo, Yamada, and Ueno (2005), for instance, analyzes the relationship between the geographical location of facilities and demand for them by performing simulation analysis on commuting care facilities for the elderly (day service centers) in Kanazawa City, while also taking into consideration distribution of the elderly population and other factors such as frequency of visits at and capacity of facilities. Their analysis revealed the following findings: 1) the elderly living in the center of the city are basically adequately served by commuting care service, while those living in mountainous areas are not appropriately served by the service due to lack of nearby facilities, and 2) the percentage of elderly population unable to use facilities even at a maximum commuting distance of 2.5 km is less than 2%.

In addition, Takahashi, Odagiri, and Uchida (2006) performed a Voronoi tessellation for Kofu City, Yamanashi Prefecture by regarding each location of commuting care facilities for the elderly as a kernel, and estimated "the number of elderly with care needs" (the number of persons requiring long-term care in a Voronoi sphere, which was estimated according to the proportional distribution method based on facility floor area). Their analyses revealed the following findings: 1) "the number of elderly with care needs" are concentrated in the center and northwestern part of the city, which supports the idea of preferentially locating facilities in those areas, and 2) the areas of Voronoi spheres in these two regions greatly differ, and in addition to greater demand for long-term care service, the assumed coverage area of each facility is also more extensive in the northwestern part of the city. More recently, Furukawa and Naito (2015) analyzed the locational issue of "senior salons" or gathering places for the elderly by using Voronoi tessellation with the case example of Komatsushima City, Tokushima Prefecture. The results of the analysis elucidated the importance of grasping beforehand the distribution of facility users (the elderly), and drawing up of a geographical location policy in response to the situation upon deciding on where to locate a facility for the elderly.

Although the use of GIS has proven to be effective in studying a facility location policy as discussed above, no research has taken into consideration future population demographics such as in 2030 or in 2050 or the building lifespan of facilities.

Therefore, in this paper, we analyze and discuss a vision for efficiently locating long-term care

facilities in a depopulating and super-aging society with the use of GIS data on distribution of communal daily long-term care facilities for dementia patients (group homes) and the elderly population in Niigata City, while also taking into consideration future demographics and service lifespan of facilities.

This paper is organized as follows. Section 2 gives an overview of long-term care facilities in Niigata City, the target of the analysis in this paper. Section 3 then confirms the present status and projection of the residential long-term care facilities, population, and aging in Niigata City, leveraging GIS. Section 4 performs an analysis on optimal geographical location of facilities by leveraging Voronoi tessellation. Finally, Section 5 gives a summary and discusses the future agenda.

II. Overview of the long-term care facilities in Niigata City

Let us start with an overview of the long-term care facilities in Niigata City. Long-term care facilities are classified broadly into commuting care facilities including day service and day care facilities, and residential facilities including special nursing homes for the elderly, group homes, health care facilities for the elderly requiring long-term care, and sanatorium-type medical care facilities for the elderly requiring care. According to the investigation we carried out on long-term care facilities in Niigata City by leveraging the "long-term care service information disclosure system" of the Ministry of Health, Labour and Welfare, we found a total of 347 commuting long-term care facilities in Niigata City and a total of 187 residential long-term care facilities (See Table 1).

While the average total floor space of day service centers is 536 m^2, that of nursing homes for the elderly, a typical residential facility, is 4,101 m^2, which implies that the latter facilities, with a larger total floor space on average, require a higher spatial cost, such as for building management. For this reason, our analysis and consideration of data in this paper is entirely focused on residential long-term care facilities.

Table 1: Long-term care facilities located in Niigata City

Long-term care facilities	Number of facilities
Commuting care facilities	328
Residential facilities	187

Source: Prepared based on the "long-term care service information disclosure system" of the Ministry of Health, Labour and Welfare. (The investigation was carried out in December 2014.)

The residential long-term care facilities (187) are classified into seven types. The number of facilities of each type in Niigata City is shown in Table 2. With regard to these 187 residential long-term care facilities, we gathered data on their addresses, number of employees, capacity, number of current residents/inpatients and the number of people on the waiting list, etc. as location information, as well as data on type of structure, total floor area, year of construction, etc. as building information, and prepared a partial overview of the findings, which is shown in Table 3.

Table 2: Residential long-term care facilities located in Niigata City

Type	Number of facilities
Welfare facilities for the elderly requiring long-term care	57
Health care facilities for the elderly requiring long-term care	38
Sanatorium-type medical care facilities for the elderly requiring care	6
Daily life care for residents of specified facilities Fee-based homes for the elderly, etc.	14
Communal daily long-term care for dementia patients	48
Community-based daily life care for residents of welfare facilities for the elderly requiring long-term care	23
Community-based daily life care for residents of specified facilities Fee-based homes for the elderly	1
Total	187

Source: Prepared based on the "long-term care service information disclosure system" of the Ministry of Health, Labour and Welfare.
(The investigation was carried out in December 2014.)

Table 3: Overview of employees, users, and buildings of residential long-term care facilities in Niigata City

	Item		Total	Per facility
Employees	Number of employees		7,551 persons	40.4 persons
Users	Capacity		10,135 persons	54.2 persons
	Number of residents/inpatients		9,847 persons	52.7 persons
	Occupancy ratio		97.2 %	
	Average age of residents		82.9 years old	
	Male to female ratio of residents	Male	19.6 %	
		Female	80.4 %	
	Number of residents/inpatients according to the level of care needed	Support level 1	35 persons	(0.4 %)
		Support level 2	32 persons	(0.3 %)
		Care level 1	532 persons	(5.4 %)
		Care level 2	1,436 persons	(14.5 %)
		Care level 3	2,313 persons	(23.4 %)
		Care level 4	2,584 persons	(26.2 %)
		Care level 5	2,951 persons	(29.9 %)
	Average length of stay		864 days	
	Number of people on the waiting list		23,236 persons	124.3 persons
Buildings	Total floor area (of 149 facilities)		581,449 m^2	3,902 m^2

Source: Prepared based on the "long-term care service information disclosure system" of the Ministry of Health, Labour and Welfare. (The investigation was carried out in December 2014.) We used the "Registry Information Service" provided by General Incorporated Foundation of Civil Legal Affairs as reference for the total floor area. It should be noted, however, that the hospital area and day service area are often housed in one building under single real-estate registration, in which case the total floor area comprises that of the entire building, including service areas other than those used for residential long-term care.

This table shows that, as of today, the occupancy ratio at residential long-term care facilities in Niigata City is close to 100%, reflecting the sharply increasing number of elderly and the comparatively limited capacity of facilities. Also, there is a strong sense of insufficiency from the fact that about 23,000 people are on the waiting list for the capacity of about 10,000 persons. The table also shows that about 80% (79.5% to be precise) of the residents/inpatients require care level 3 or over. Now, let us look at the yearly trends of the accumulated number of residential long-term care facilities in Niigata City and accumulated floor area of those facilities.

As shown by Figures 1 and 2, a large supply of health care facilities for the elderly requiring long-term care (called “Roken facilities”) started in the latter part of 1980s, and yet another major increase was observed in the middle of the 1990s. This increase is considered to indicate that many of them were supplied as sanatorium-type medical care facilities for the elderly requiring care (so-called “recuperation beds” or “elderly hospitals”). It also should be noted that following the Long-Term Care Insurance Act enacted in 2000, the “recuperation beds” were actively converted into “Roken facilities” as part of the government measures taken, and as a result, health care facilities for the elderly requiring long-term care grew in number.

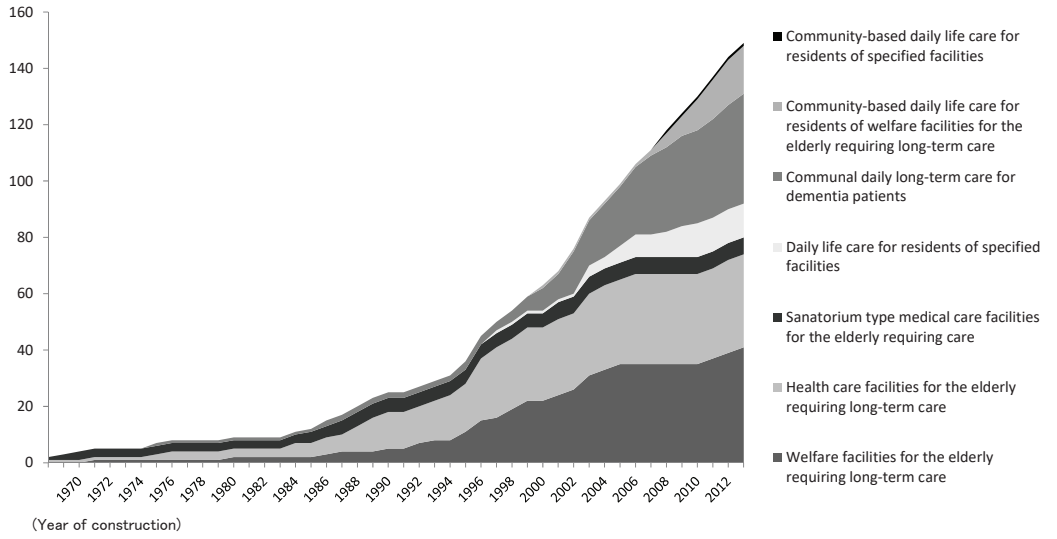
However, in and after the latter part of the 2000s, when such conversion support measures were terminated, the number of health care facilities for the elderly requiring long-term care has almost flattened. In addition, the welfare facilities for the elderly requiring long-term care (called “special nursing homes for the elderly”), which had shown a dramatic increase in number in the 1990s, has also shown a minor increase in the 2000s due to downsizing of generous support measures for the opening of such facilities. However, a slightly increasing trend has been observed in recent years.

Although daily life care for residents of specified facilities (called “fee-based homes for the elderly”) started to increase in the 2000s, it has almost flattened in recent years, which is considered to have been an impact of quantitative control.

On the other hand, the types of facilities which have shown a steady increase are those that provide communal daily long-term care for dementia patients (called “group homes”) and those that provide community-based daily life care for residents of welfare facilities for the elderly requiring long-term care (called “community-based, fee-based homes for the elderly”). These types of facilities are considered to be increasing in line with government policy. However, as the capacity and floor area of these facilities are small in scale, the accumulated floor area of these facilities remains at a relatively low level.

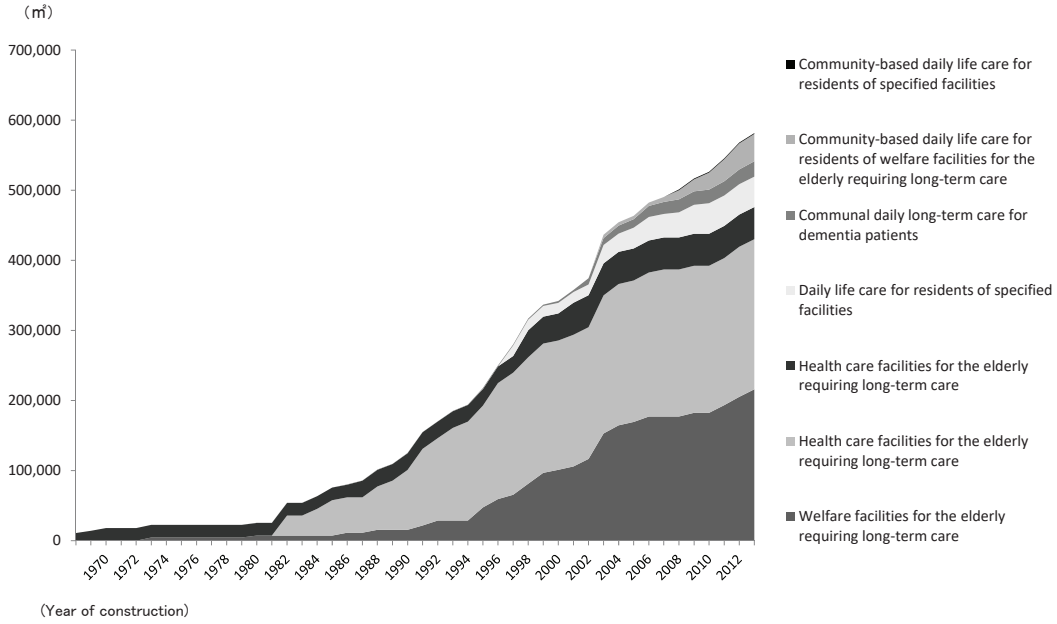
Although residential long-term care facilities have largely increased both in number and area, as shown by the figures above, the overall scale of this type of facility will not increase in the way it has to date due to a shift that has occurred in supportive measures from large-scale facilities to community-based small-scale facilities.

Figure 1: Yearly trends of the accumulated number of residential long-term care facilities in Niigata City



Source: Prepared based on the "long-term care service information disclosure system" of the Ministry of Health, Labour and Welfare. (The investigation was carried out in December 2014.)

Figure 2: Yearly trends of the accumulated floor area of residential long-term care facilities in Niigata City



Source: Prepared based on the "long-term care service information disclosure system" of the Ministry of Health, Labour and Welfare. (The investigation was carried out in December 2014.)

The reason is that the elderly population is also highly likely to enter a phase of decline around 2030. For instance, the population trends (including projections) of those 75 years old and over in Niigata City and the trends of accumulated floor area of residential long-term care facilities up to the present can be illustrated by Figure 3 below. It is considered that the challenge ahead for us will be how we should respond to the needs for these facilities in response to an increasing elderly population in the future, and how we should consider and act on community-based facilities and their services.

Specifically, it is considered unwise to greatly expand the overall scale of residential long-term care facilities as has been done previously in terms of area, as the population of the elderly in the latter stage of life (aged 75 and over) is highly likely to decline from around 2030. However, until that time, the number of the elderly in the latter stage of life is projected to continue to increase. Hence, how effectively existing facilities can be used on a continuous basis will become an increasingly significant perspective.

For this reason, we made an estimate on what percentage of existing facilities is likely to be considered questionable as of 2030 and 2050 due to building lifespan by making a certain assumption regarding the useful lifespan of buildings. We considered the useful lifespan of buildings as follows.

First, although the useful lifespan of buildings in terms of tax code (i.e. 24 years for wooden buildings, 50 years for RC or reinforced-concrete structured buildings, and 38 years for steel-framed buildings) is used in some cases, in this paper, we consider a useful lifespan of buildings that is focused on the actual and physical aspect of the building life span. In doing so, we could set the useful lifespan of buildings (building lifespan) at “50 years for a wooden building,” “60 years for an RC structured building,” and “50 years for a steel-framed building” on the basis of the building structure skeleton and survey-based estimates on building lifespan (Komatsu, 2008 and 2011).

For instance, in 2050, wooden and steel-framed buildings that were built before 2000 and RC structured buildings that were built before 1990 will be considered questionable. However, as many of the buildings that have been built under the old earthquake-resistance standards (based on the Building Standards Act prior to 1981) pose a problem in terms of aseismic performance in the first place, these were included in our study as questionable buildings.

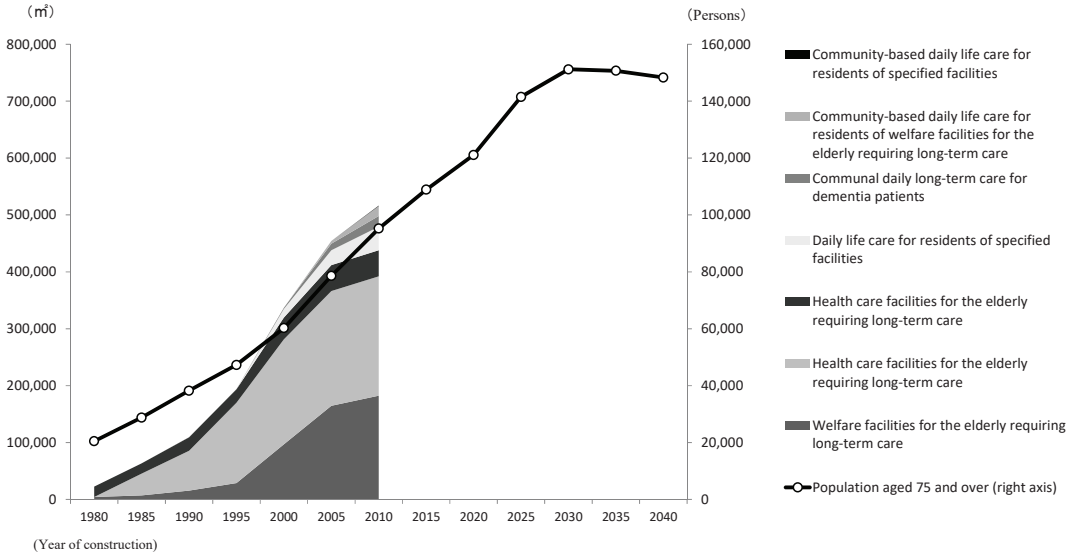
Talking about the notion of useful lifespan of buildings as the building lifespan, we can find a number of cases in which use of a building itself is hindered as a result of evasion or negligence regarding renewal or maintenance/management of required equipment towards the end of the building’s lifespan.

If we also take this issue into account, many of the buildings in their last 10 years of useful lifespan, as mentioned above, will be considered “potentially” questionable” as they are approaching the end of the building lifespan. In other words, it would be appropriate to set the “useful lifespan of buildings that are considered questionable (including “potentially” questionable buildings that are approaching the building lifespan)” at “40 years for a wooden building,” “50 years for a RC-structured building,” and “40 years for a steel-framed building.”

In this instance, in 2050, wooden and steel-framed buildings that were built before 2010 and RC structured buildings that were built before 2000 will become questionable or “potentially” questionable buildings. It is needless to say that, at the minimum, measures including proper maintenance, necessary repair work, and renewal of equipment must be properly taken, as buildings increasingly deteriorate or become obsolete without such upkeep.

Based on the above prerequisites, the percentage of facilities that are likely to be considered questionable in terms of building lifespan in 2030 and 2050 are shown in Table 4. As is clear from the table, it is projected that problems will surface in many of the buildings by around 2050, and how facility renewal should be conducted by that time is likely to become a significant issue.

Figure 3: Trends of accumulated floor area of residential long-term care facilities and population trends (including projections) of 75 years old and over in Niigata City



Source: Prepared based on the "long-term care service information disclosure system" of the Ministry of Health, Labour and Welfare
(the investigation was carried out in December 2014), "Population Projection for Japan" by National Institute of Population and Social Security Research, and "National Census" by the Ministry of Internal Affairs and Communications.

Table 4: Projection of the building lifespans of residential long-term care facilities in Niigata City

Questionable as of present	Questionable in 2030 (including "potentially" questionable buildings)		Building considered problem-free in 2030
Building built before 1981	Wooden or steel-framed building built before 1990*	RC-structured building built before 1980*	
6	1	0	
		Total 7	142
		(percentage) 5%	(percentage) 95%

Questionable as of present	Questionable in 2050 (including "potentially" questionable buildings)		Building considered problem-free (including potentially problem-free building) in 2050
Building built before 1981	Wooden or steel-framed building built before 2010*	RC-structured building built before 2000*	
6	62	38	
		Total 106	43
		(percentage) 71%	(percentage) 29%

* "Buildings built before 1981" are excluded.
Source: Prepared by the author.

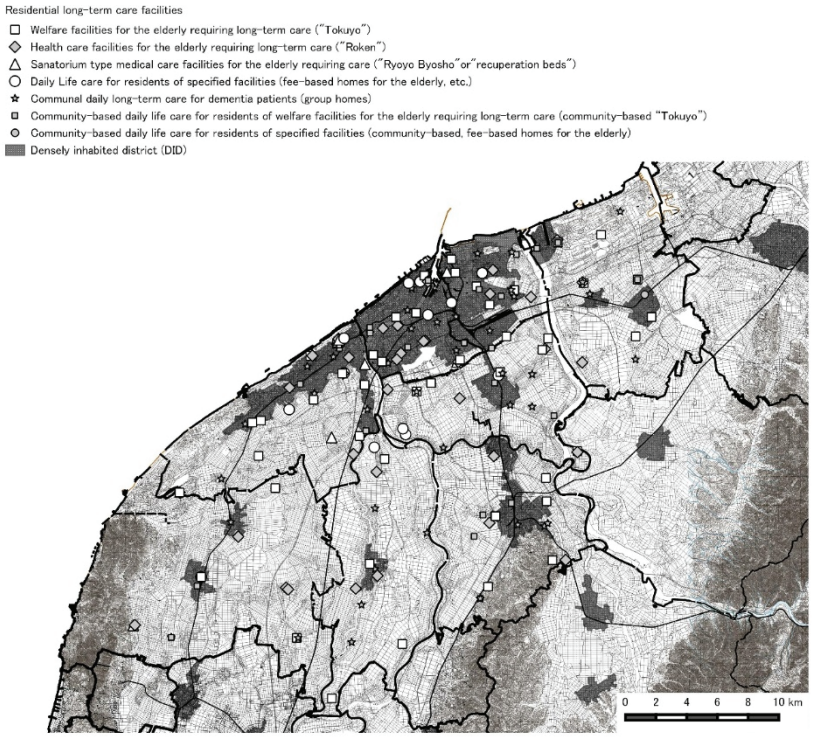
III. Current status and projection of GIS-leveraged residential long-term care facilities and population/aging

With regard to the residential long-term care facilities in Niigata City, let us first present how "long-term care service," "total floor area of building," and "number of residents/inpatients" are distributed according to geospatial information (Figures 4 to 6). As reference, information on railroads, roads, rivers, urban area (buildings), densely inhabited districts (DIDs[1]) is also included.

Please note that the types of long-term care services reflect those that are currently available. Some facilities have previously been classified into a different long-term care service category. For instance, some of the formerly sanatorium-type medical care facilities for the elderly requiring care (elderly hospitals) have been converted into health care facilities for the elderly requiring long-term care ("Roken" facilities).

If you look at the relationship between the scale of facilities (number of residents/inpatients) and their distribution status, many of the large-scale facilities are located in the outlying areas of the urban areas (DIDs).

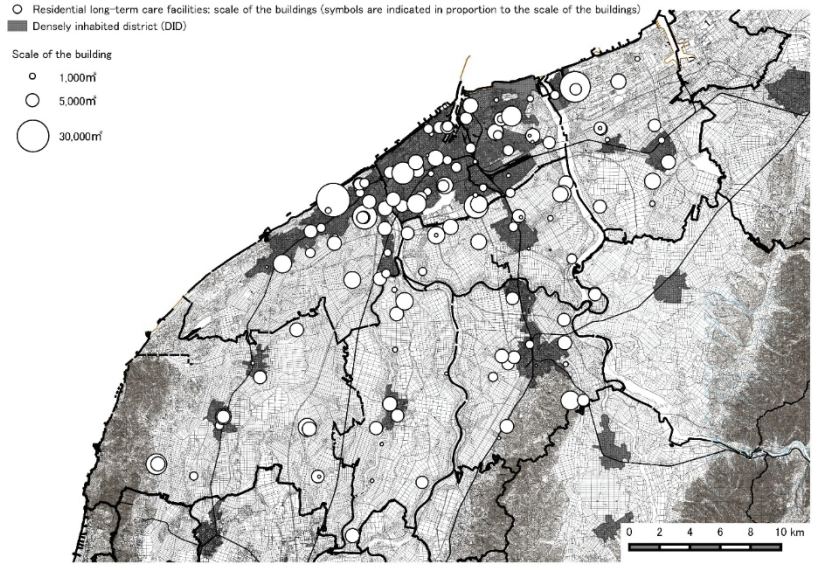
Figure 4: Distribution status of residential long-term care facilities by category in Niigata City



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan.)

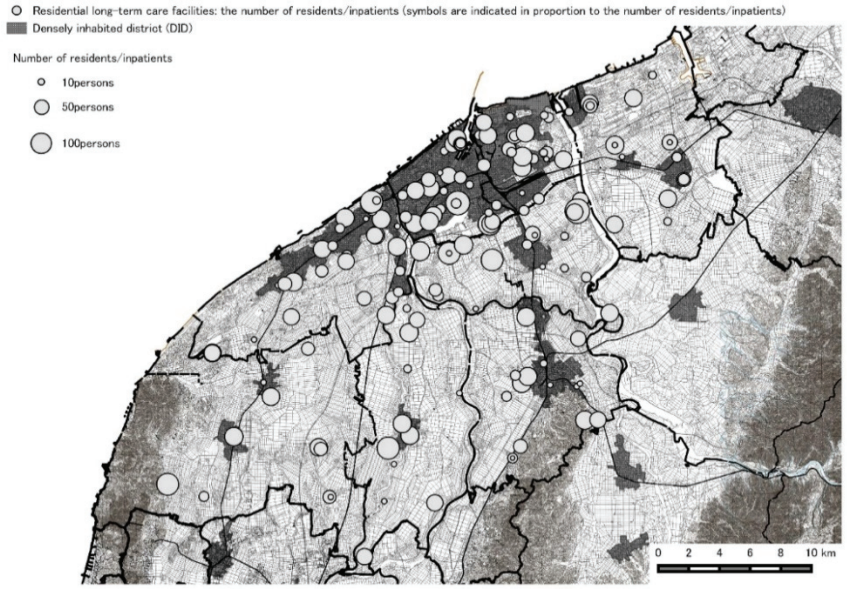
[1] A densely inhabited district is abbreviated as "DID." If two or more districts whose population density is 4,000 or more people per square kilometer lie next to each other on the municipality border, and make up a population of 5,000 and over at the time of National Census, the district is referred to as a DID.

Figure 5: Distribution of residential long-term care facilities in Niigata City by scale of building



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Figure 6: Distribution of residential long-term care facilities in Niigata City by number of residents/inpatients



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Although the population projection performed by the National Institute of Population and Social Security Research is considered the most well-known of all projections, the smallest geographical unit in their projection is municipality (village, town, city), and the projection covers the period up to 2040. As demographics is considered to vary greatly by region, even within the same administrative district, the projections do not offer a clue to project small area-based demographics in the future.

With regard to the small area-based population projection, the projection itself has not been performed to date due to difficulty of obtaining, in general, vital statistics (statics on births and deaths) by small area. In 2015, however, Prof. Takashi Inoue, Faculty of Economics, Aoyama Gakuin University unveiled a projection of the whole nation by small area for the period up to 2060 ("System of Small Area Population Projection for Nationwide Japan" https://goo.gl/lSoL6O). The population projection was performed based on the conventional cohort-change rate method by importing the concept of population potential, which asserts that geographically close areas also present similar population statistics. In this paper, we visualized and analyzed the said projection data in geographical space. The population projection for Niigata City performed by the National Institute of Population and Social Security Research and the total of small area-based population projections for Niigata City performed by Prof. Takashi Inoue, Faculty of Economics, Aoyama Gakuin University are shown in comparison below (Table 5 and 6).

Table 5: Population projection for Niigata City performed by the National Institute of Population and Social Security Research

Population	2010	2020	2030	2040
0 to 14 years old	103,398	88,644	72,519	63,220
15 to 64 years old	519,787	459,236	418,861	355,904
65 to 74 years old	93,475	114,068	89,718	100,899
75 years old and over	95,241	121,101	151,200	148,322
Total	811,901	783,049	732,298	668,345

Source: "National Census" (2010 data) by the Ministry of Internal Affairs and Communications and "Regional Population Projections for Japan" by National Institute of Population and Social Security Research

Table 6: Total of small area-based population projections for Niigata City performed by Prof. Takashi Inoue, Aoyama Gakuin University

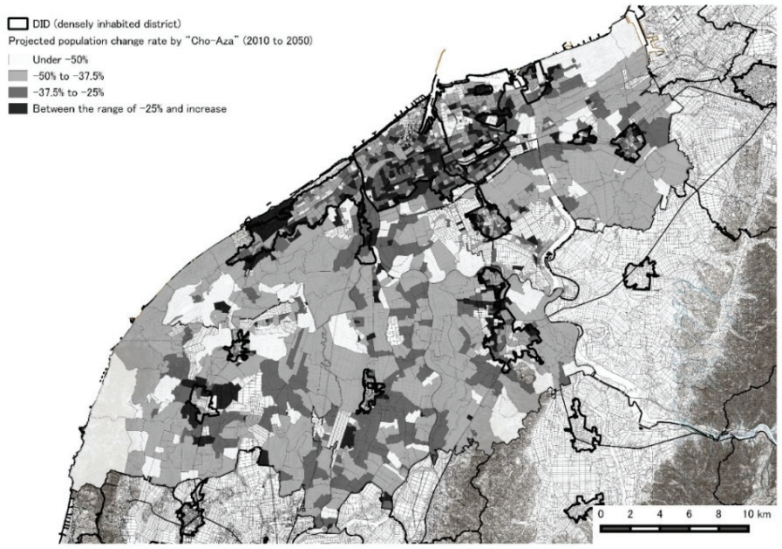
Population	2010	2020	2030	2040	2050
0 to 14 years old	103,398	91,075	72,636	60,155	51,167
15 to 64 years old	519,787	451,140	401,016	329,169	265,609
65 to 74 years old	93,475	115,194	91,613	102,794	88,147
75 years and over	95,241	114,197	137,750	128,480	133,655
Total	811,901	771,606	703,015	620,598	538,578

Source: "National Census" (2010 data) by the Ministry of Internal Affairs and Communications and "System of Small Area Population Projection for the Whole Japan" by Prof. Inoue of Department of Economics, Aoyama Gakuin University

The projected population change rate in Niigata City at the small area level ("Cho and Aza") between 2010 and 2050 is shown in Figure 7 below. ("Cho" and "Aza" are subdivisions of a municipality.) Most of the area is projected to face a population decline of 25% or more with the exception of some areas including the outer edge of the urban areas. By comparison, the population decline rate for the country between 2010 and 2050 is 24.2% according to the National Institute of Population and Social Security Research, and that for the city of Niigata is 33.7% according to the projection performed

by Prof. Takashi Inoue of Aoyama Gakuin University. In addition, although the population decline rate is not so high in the currently densely populated urban areas including DIDs, the reduction in terms of the population number will be greater, because the population base is large to start with.

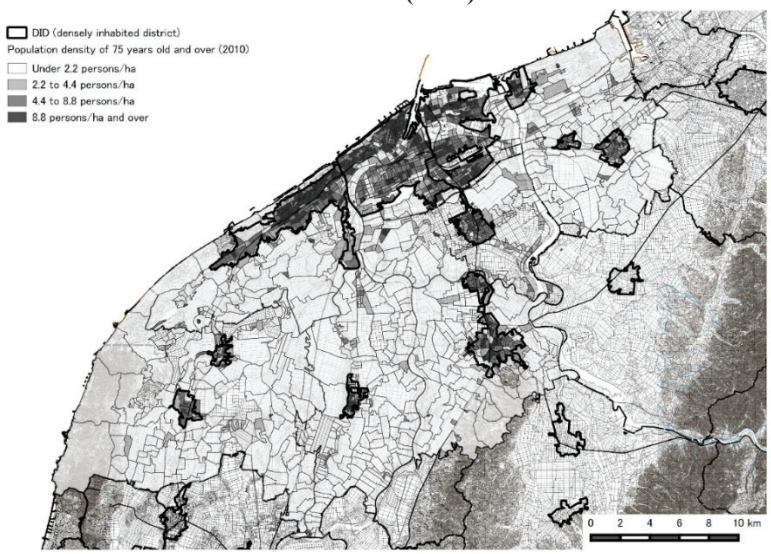
Figure 7: Projected population change rate in Niigata City between 2010 and 2050



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

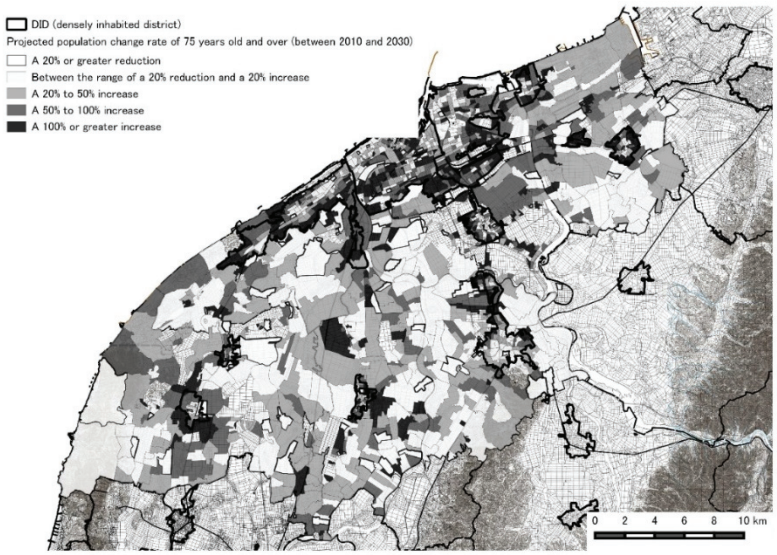
Next, with regard to the population aged 75 and over, population density at "Cho-Aza" area level in 2010 is shown in Figure 8, and then, the projected population change rates between 2010 and 2030 as well as between 2030 and 2050 are shown in Figure 9 and Figure 10, respectively.

Figure 8: Population density of persons 75 years old and over in Niigata City at "Cho-Aza" area level (2010)



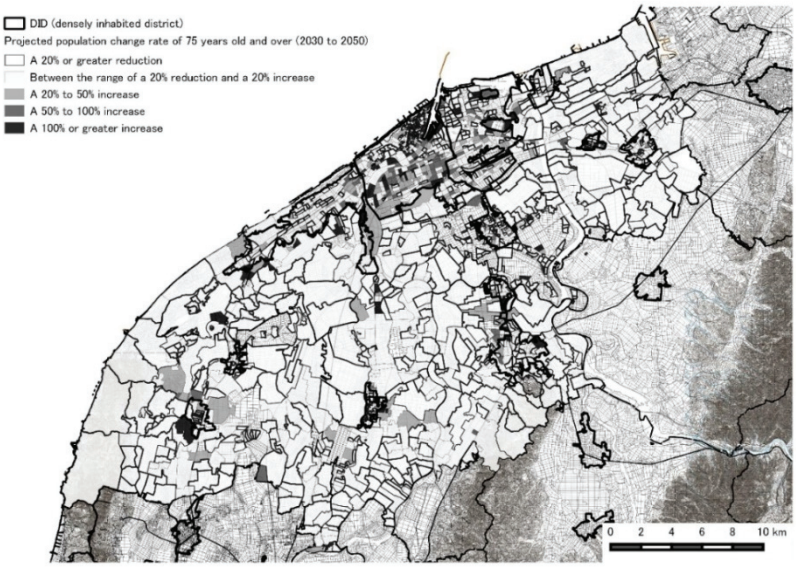
Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Figure 9: Projected population change rate of persons 75 years old and over in Niigata City between 2010 and 2030



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Figure 10: Projected population change rate of persons 75 years old and over in Niigata City between 2030 and 2050



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

The population of persons 75 years old and over is projected to increase in many districts of Niigata City between 2010 and 2030, mainly in urban areas (DIDs). In particular, a very large number of outlying areas of DIDs show a 100% or greater increase. A relatively large number of suburban farming communities also indicate an increase, and areas that indicate a 20% or greater reduction are limited.

On the other hand, between 2030 and 2050, the population of persons 75 years old and over is projected to decline by over 20% in many of the districts. The projection also indicates that an increase will be observed in the outlying areas of DIDs and the center of Niigata City. As the total population of persons 75 years old and over is projected to decrease slightly, it is considered that the decline in numbers in the suburbs and increase in the DIDs are at a comparable level.

Based on the year of construction, the distribution of residential long-term care facilities that are projected to be considered questionable or become potentially questionable in 2030 or 2050 is shown in Figures 11 and 12 below.

Although there is a small number of facilities that are likely to be questionable in 2030, over 70% of the existing facilities are considered to have problems in 2050 due to building lifespan. The projection also indicates that many of those problematic facilities are located in the outlying areas of DIDs and suburban farming communities. This result reflects the fact that this area contains a large number of relatively old buildings.

As discussed above, although it is considered that problems such as aging facilities and renewal of facilities will occur only rarely before 2030 due to building lifespan, a large number of problems is anticipated in the period 2030 to 2050, such as demolition or rebuilding of facilities, mainly among those located in the outlying areas of DIDs and suburban farming communities.

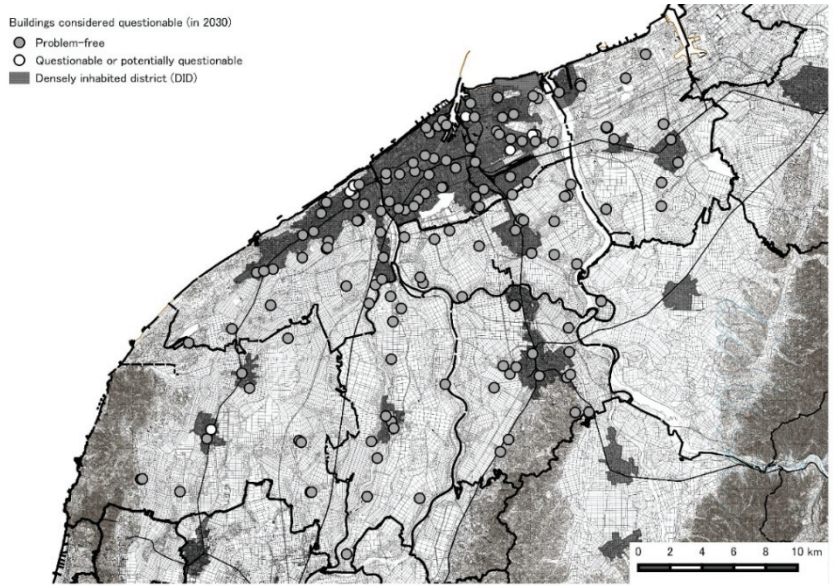
The residential long-term care facilities that have recently been built have shifted their focus to community-based facilities. It is considered desirable that such facilities be located to match the distribution of their core users, i.e., the population of persons 75 years old and over, coupled with promotion of the “Community-based Comprehensive Care System.”

However, as discussed above, many of the residential long-term care facilities in Niigata City are located in the outlying areas of urban areas (DIDs) or their suburban farming communities, while users of such facilities who are 75 years old and over are concentrated in urban areas. This finding apparently shows that there is currently a major gap between facilities and their users in terms of their locational relationship.

The gap between the supply of and demand for facilities is anticipated to expand even further for the following reasons. Although the population of persons 75 years old and over shows an increasing trend for the period up to 2030, including suburban farming communities, the said population is projected to decline by over 20% in most districts of such farming communities for the period 2030 to 2050, while that in urban areas (DIDs), mainly in their outer edge, is projected to greatly increase during the same period. Furthermore, another problem is that while only a few existing facilities are anticipated to become questionable before 2030 in terms of their building lifespan, many facilities located mainly in the outlying areas of DIDs and suburban farming communities will become questionable during the period 2030 to 2050.

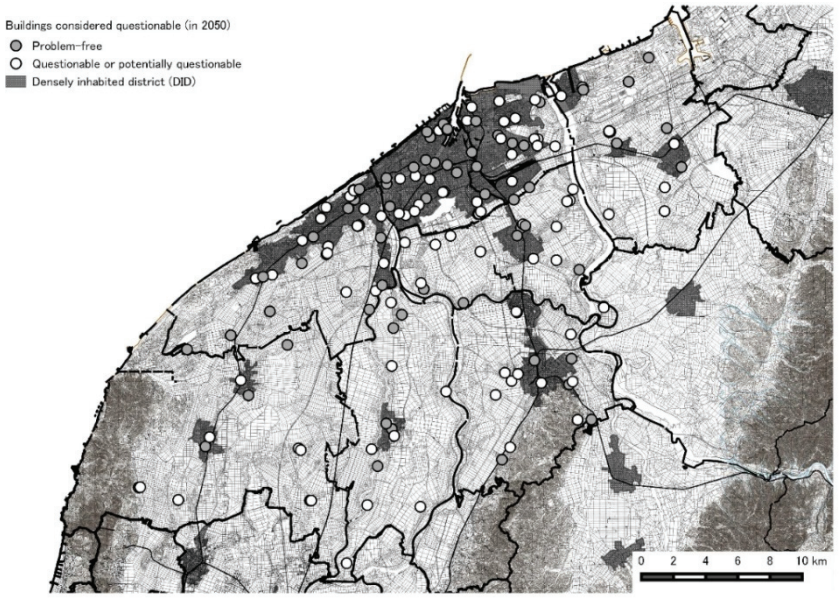
As discussed above, it can be said that we should study the optimal geographical location of residential long-term care facilities in Niigata City based on the present status of disproportionately located facilities, while also taking into account the projection of population changes by small area, etc. and the projection based on the standpoint of facility aging.

Figure 11: Questionable or potentially questionable residential long-term care facility buildings in 2030



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Figure 12: Questionable or potentially questionable residential long-term care facility buildings in 2050



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

IV. Analysis concerning optimal geographical location of facilities leveraging Voronoi tessellation

The concern over the lack of residential long-term care facilities will grow along with an increase in the elderly, particularly those aged 75 and over. As discussed above, however, it is important that we examine the way we think about proper geographical location of facilities in the future by taking into consideration the issue of disproportionately distributed/located facilities in Niigata City, a real difference in increase or decrease of the population of persons 75 years old and over for the period up to 2050, as well as future relocation needs due to aging of residential long-term care facilities.

Therefore, in this section, we focus on group homes as one kind of residential long-term care facility, and study the status of their excess or deficiency based on the projected population data on persons 75 years old and over at the "Cho-Aza" area level. With regard to the index concerning lack of facilities for dementia patients per capita aged 75 and over, we assumed the following indices in estimating the level of deficiency.

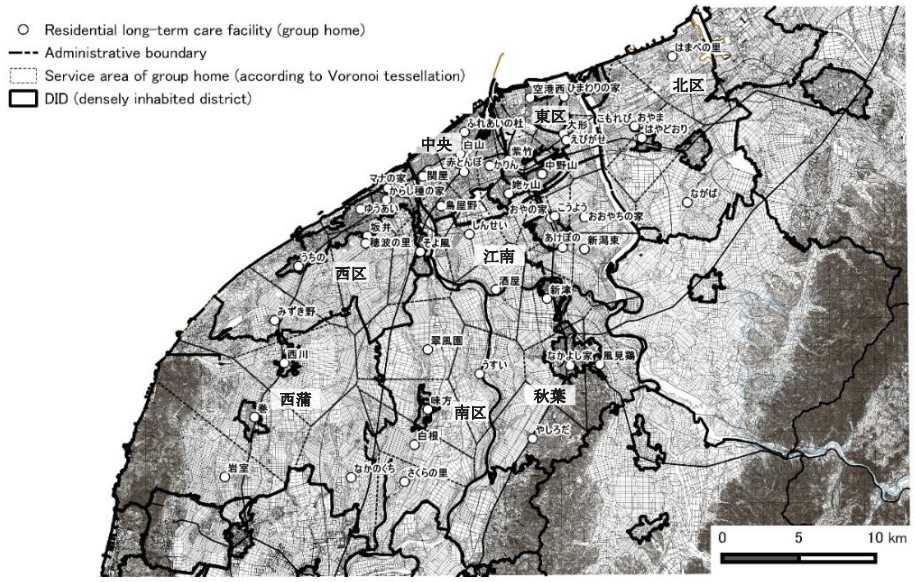
The "probability that the elderly aged 75 and over develop dementia" is calculated to be 17.74% according to the age group-specific data on "elderly people with dementia whose daily life independence level is rated II or higher," which is part of the "Data on Certification of Eligibility for Long-term Care Insurance (2010)" of the Ministry of Health, Labour and Welfare.

On the other hand, however, if we look at "communal daily long-term care facilities for dementia patients" (group homes) as "facilities for dementia patients," there are actually many elderly dementia patients who receive long-term care at home or reside in facilities, including "Tokuyo," "Roken," or sanatoriums. This led us to look for useful data on what percentage of the elderly whose daily life independence level is rated II or higher enter a group home. We found a "breakdown of the residence of elderly dementia patients" in the "Latest Information on the Long-Term Care Insurance System (September 2012)" issued by the Ministry of Health, Labour and Welfare. According to the information, out of the total of 2.8 million elderly dementia patients, 140,000 reside in group homes, which accounts for 5% of the total.

Therefore, when estimating a "shortage of capacity of facilities for dementia patients per capita aged 75 and over," it is considered appropriate to calculate a "probability that the elderly aged 75 and over develop dementia and enter a group home (on national average)" according to the following equation: 17.74% × 5% = 0.89%. As there were 95,241 elderly aged 75 and over in Niigata City in 2010, the capacity of required facilities for dementia patients can be estimated as follows: 95,241 persons × 0.89% = 847 persons. Now, as there are currently 48 group homes with total capacity of 639 persons in Niigata City, there is a 208-persons shortage of capacity. In addition, by using the value 0.89%, the appropriate number of the elderly population aged 75 and over per group home resident within its service area is estimated as follows: 1 ÷ 0.0089 = 112 (persons).

For the purpose of estimating an excess or deficiency status of group home facilities, we performed a Voronoi tessellation by regarding each location of the group homes in Niigata City as a kernel, and set the service area for each group home based on distance. We superimposed this service area map on the "Cho-Aza"-based area map (fractions were reallocated in proportion to the area), and estimated the projected elderly population aged 75 years old and over by service area in 2010, 2030, and 2050, thereby calculating the over- or under-populated status of the elderly aged 75 and over per service area of each group home. In doing so, we used the population of 112 persons per group home resident as the index concerned with excess or deficiency status of facilities, as earlier mentioned. The results are shown in Table 7 and Figures 14 through 16. Figure 13 shows how wards are distributed in Niigata City, the geographical location of group homes and their names (abbreviated).

Figure 13: Service area of group homes in Niigata City (according to Voronoi tessellation)



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Considering that the total capacity of the group homes located in Niigata City in 2010 is 639 persons, and that the national average of the population of persons 75 years old and over per group home resident is 112 persons, the size of the population of 75 years old and over for whom the existing facilities is considered to be capable of providing service is calculated as follows: 639 persons × 112 persons = 71,568 persons. On the basis of the population of persons 75 years old and over in Niigata City in 2010, 95,241 persons, the populational coverage level is 75% (= 71,568 persons ÷ 95,241 persons). Therefore, under the present situation, an insufficiency of facilities is being observed in Niigata City as a whole.

When observed by service area of group homes (Figure 14), the population of persons 75 years old and over per group home resident in some of the urban areas, including DIDs, is 448 persons, which is four times greater than that of the national average, and indicates a seriously deficient situation. On the other hand, the population of persons 75 years old and over per group home resident in many of the suburban farming communities that are not DIDs is less than 112 persons, which indicates that facilities are provided in relative excess of the service required. Nevertheless, as every group home is fully occupied, it is considered that the facilities with excess capacity are filled by people from neighboring service areas. Considering the fact that the populational coverage level of facilities in Niigata City as a whole is 75%, the remaining 25%, or unmet demand, is considered to elucidate a situation in which elderly people are obliged to enter other types of residential long-term care facilities such as fee-based homes for the elderly, or be forced to receive long-term care at their homes.

Table 7: Population of persons 75 years old and over in the service areas of group homes, and population of persons 75 years old and over per group home resident

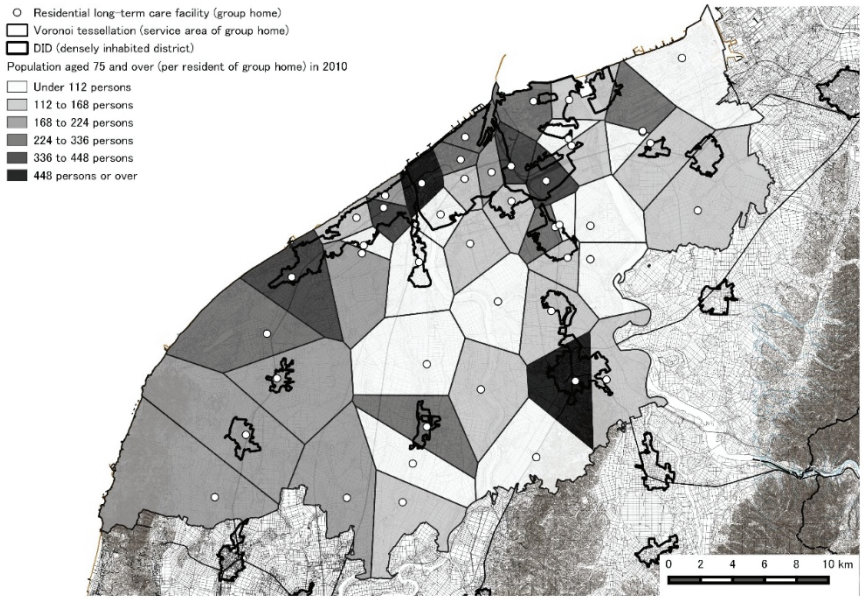
Ward	Group home name (abbr.) (English/Japanese)		Capacity	Population of 75 years old and over in the service area			Population of 75 years old and over per resident of group home			Increase-decrease rate	
				2010	2030 projection	2050 projection	2010	2030 projection	2050 projection	2030/2010	2050/2030
Kita	Komorebi	こもれび	18	511	1,131	1,063	28.4	62.8	59.1	121%	-6%
	Hayado-ori	はやどおり	9	1,397	3,006	2,929	155.2	334.0	325.4	115%	-3%
	Nakaba	ながば	18	2,644	4,124	3,514	146.9	229.1	195.2	56%	-15%
	Hamabe-no-sato	はまべの里	18	1,156	1,541	1,080	64.2	85.6	60.0	33%	-30%
	Oyama	おやま	9	1,191	2,040	1,755	132.3	226.6	195.0	71%	-14%
Higashi	Himawari-no-ie	ひまわりの家	18	2,377	3,782	3,382	132.1	210.1	187.9	59%	-11%
	Oogata	大形	18	1,208	2,318	2,707	67.1	128.8	150.4	92%	17%
	Ku-ko-nishi	空港西	18	4,877	6,917	6,499	271.0	384.3	361.1	42%	-6%
	Ebigase	えびがせ	9	1,044	2,158	2,011	116.0	239.8	223.5	107%	-7%
	Nakano-yama	中野山	9	3,050	5,698	5,822	338.9	633.1	646.8	87%	2%
Chuo	Ubagayama	姥ヶ山	18	2,280	3,964	3,973	126.7	220.2	220.7	74%	0%
	Sekiya	関屋	9	3,948	5,363	5,896	438.7	595.9	655.2	36%	10%
	Fureai-no-yashiro	ふれあいの杜	18	4,257	5,176	4,346	236.5	287.5	241.4	22%	-16%
	Shichiku	紫竹	9	3,708	5,194	5,491	412.0	577.1	610.1	40%	6%
	Hakusan	白山	9	2,552	3,329	3,405	283.5	369.9	378.4	30%	2%
	Toyano	鳥屋野	27	1,913	3,265	4,365	70.8	120.9	161.7	71%	34%
	Karin	かりん	18	3,071	4,652	6,009	170.6	258.5	333.8	51%	29%
	Akatonbo	赤とんぼ	18	2,922	4,378	5,969	162.3	243.2	331.6	50%	36%
Konan	Ooyachi-no-ie	おおやちの家	18	1,124	1,265	1,146	62.5	70.3	63.7	12%	-9%
	Niigata Higashi	新潟東	18	909	1,372	1,382	50.5	76.2	76.8	51%	1%
	Oya-no-ie	おやの家	9	2,001	3,377	3,329	222.3	375.2	369.9	69%	-1%
	Koyo	こうよう	9	550	743	629	61.1	82.6	69.8	35%	-15%
	Sakaya	酒屋	9	923	1,086	808	102.5	120.6	89.8	18%	-26%
	Akebono	あけぼの	9	1,059	1,872	1,989	117.7	208.0	221.0	77%	6%
	Shinsei	しんせい	9	1,229	1,810	1,487	136.5	201.1	165.3	47%	-18%
Akiba	Niitsu	新津	18	2,046	3,390	3,560	113.7	188.4	197.8	66%	5%
	Nakayoshi-ya	なかよし家	9	4,535	5,493	4,540	503.9	610.3	504.4	21%	-17%
	Kazamidori Takiya	風見鶏・たきや	18	2,048	2,429	2,040	113.8	135.0	113.3	19%	-16%
	Yashiroda	やしろだ	18	1,395	1,840	1,607	77.5	102.2	89.3	32%	-13%
Minami	Ajikata	味方	9	2,034	2,767	2,520	226.0	307.4	280.1	36%	-9%
	Sakura-no-sato	さくらの里	9	1,201	1,382	1,118	133.4	153.6	124.2	15%	-19%
	Usui	うすい	9	1,264	1,550	1,263	140.5	172.2	140.3	23%	-19%
	Shirone	白根	9	748	869	716	83.1	96.6	79.5	16%	-18%
	Sui-fu-en	翠風園	18	1,493	1,747	1,779	83.0	97.1	98.8	17%	2%
Nishi	Mizukino	みずき野	9	1,205	1,672	1,425	133.9	185.8	158.4	39%	-15%
	Uchino	うちの	9	2,775	4,522	3,945	308.4	502.5	438.3	63%	-13%
	Sakai	坂井	27	1,236	2,199	2,118	45.8	81.5	78.5	78%	-4%
	Karashi-dane-no-ie	からし種の家	9	3,041	4,486	4,353	337.9	498.5	483.7	48%	-3%
	Yu-ai	ゆうあい	27	3,470	4,855	4,102	128.5	179.8	151.9	40%	-15%
	Honami-no-sato	穂波の里	9	1,504	2,067	2,248	167.2	229.7	249.7	37%	9%
	Mana-no-ie	マナの家	9	2,001	2,156	2,328	222.3	239.5	258.7	8%	8%
	Soyokaze	そよ風	27	2,500	4,577	4,462	92.6	169.5	165.3	83%	-3%
Nishikan	Maki	巻	18	3,061	4,237	3,695	170.1	235.4	205.3	38%	-13%
	Iwamuro	岩室	9	1,710	2,089	1,571	190.0	232.1	174.6	22%	-25%
	Nishikawa	西川	9	1,782	2,213	1,895	198.1	245.9	210.5	24%	-14%
	Nakanokuchi	なかのくち	9	1,422	1,649	1,386	158.0	183.2	154.0	16%	-16%

Population of 75 years old and over per resident of group home: 224 persons or over (double the number of national average)

Population of 75 years old and over per resident of group home: under 112 persons (the national average)

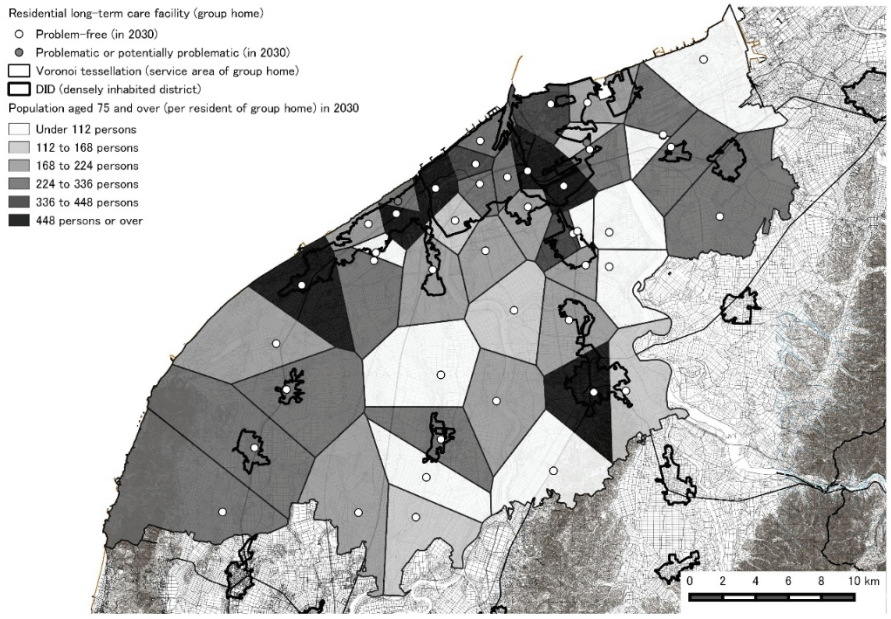
Source: Prepared by the authors.

Figure 14: Population of persons 75 years old and over per group home resident in Niigata City in 2010



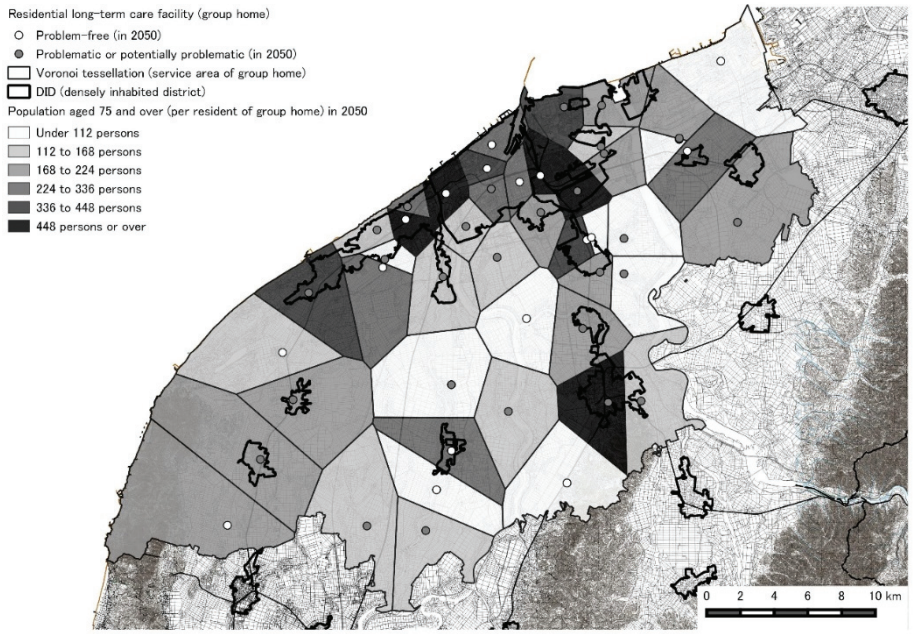
Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Figure 15: Projected population of persons 75 years old and over per group home resident in Niigata City in 2030



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Figure 16: Projected population of persons 75 years old and over per group home resident in Niigata City in 2050



Source: Prepared by the author. (The map is based on the "Fundamental Geospatial Data" of Geospatial Information Authority of Japan. Data are partially based on the "Digital National Land Information" of the Ministry of Land, Infrastructure, Transport and Tourism.)

Next, based on the population projection for 2030, let us look at changes in the populational coverage level of facilities, provided that the geographical locations and capacities of group homes remain unchanged from the present status (Figure 15). The populational coverage level of facilities in Niigata City as a whole in 2030 is 52% (= 71,568 persons ÷ 137,750 persons), indicating a trend that the population of persons 75 years old and over per group home resident will increase in all service areas. In many of the urban areas including DIDs, in particular, the population of 75 years old and over per group home resident is projected to be over 448 persons (fourfold the national average), and similarly, an increase is projected in many of the suburban farming areas. Therefore, if the present situation of the group home facilities remains unchanged, a sense of insufficiency will grow even stronger in urban areas, and a sense of insufficiency will also intensify in many of the farming communities where demand is mostly satisfied under the present situation.

Similarly, if we compare the population projection for 2050 with the current geographical locations and capacities of group homes (Figure 16), a sense of insufficiency comparable to that of 2030 is continuously observed in urban areas including DIDs. On the other hand, a sense of insufficiency that has been felt in farming communities is alleviated due to a decline in the population aged 75 years old and over in many parts of those communities. Incidentally, the populational coverage level of facilities in 2050 is 54% (= 71,568 persons ÷ 133,655 persons). It is also projected that about two-thirds of the existing group home facilities will become questionable in 2050 due to building lifespan. These questionable facilities include many of those located in suburban farming communities, in which needs are anticipated to remain limited into the future.

As discussed above, Niigata City as a whole is short of group homes under the present situation, and regional imbalances are also being observed. It is therefore recommended that both the number of facilities and their capacities be increased in future mainly in areas where there is a strong sense of insufficiency. In order to ensure adequate supply of facilities into the future, the following factors will need to be taken into consideration: 1) disproportionately located facilities, thereby creating an excess or deficiency status, 2) gap in demand projection between that for the period from now to 2030 and that from 2030 to 2050, and 3) a real difference in demand projection, etc.

It is considered that between 2030 and 2050, many of the existing facilities will have to be demolished or rebuilt due to building lifespan. It is therefore considered necessary to also conduct facility renewal based on the idea of where facilities should be properly located, including rebuilding of facilities at their present sites or at relocated sites, or facility consolidation, etc., by taking into account the issue of the aging of facilities mentioned above.

V. Summary and future agenda

The major purpose of this paper was to analyze and study how long-term care facilities should effectively and efficiently be located in a depopulating and super-aging society with the use of GIS data on distribution of residential long-term care facilities and elderly population in Niigata City, while also taking into consideration future demographics and lifespan of facilities.

With an awareness of these issues, we specifically focused on communal daily long-term care facilities for dementia patients (group homes) as part of the residential long-term care facilities. We used data on current and projected future population of the elderly aged 75 and over at “Cho-Aza” area level, and compared the current and future needs for group homes by service area and the current supply situation of the said facilities.

Our analysis showed that a strong sense of insufficiency of these facilities is already being felt in urban areas, including DIDs, while suburban farming communities are relatively over-supplied. It also clarified that looking to the future, the sense of insufficiency in urban areas is expected to rise increasingly, while the sense of excessive supply is expected to grow further in the suburban farming communities. As this result is based on the current and projected future population data on the elderly aged 75 and over, this finding is considered applicable not only to group homes but also to other residential long-term care facilities.

As the need for these types of facilities is expected to grow more than ever against the backdrop of a further increase in the elderly population in future, we believe that the issue of improved efficiency of facilities by optimizing their geographical locations will become increasingly significant. At the same time, promotion of the Care Compact City will also be required in light of financial constraints. Furthermore, as an increasing number of existing facilities is also expected to face the issue of aging, screening for optimization, including reorganization or relocation of facilities, as well as introduction of private-sector initiatives will become extremely significant.

These initiatives will also require in-depth study on reorganization of urban structure, not to mention facility-specific study. It is therefore considered extremely important that they be integrated into and contribute to study on the reorganization of infrastructure in urban and local areas, including roads, bridges, sewage system, schools, and other educational facilities.

In our recent analysis on optimal geographical location of facilities by leveraging Voronoi tessellation, we captured, assessed, and performed analysis on data concerning facilities on the supply side, the population of persons 75 years old and over as the index on the demand side, and their positional relationship in terms of distance by defining the service areas of facilities through the use of GIS. While our analysis covered a total of 48 group home facilities in Niigata City, the

small area-based population data covered as many as about 2,200 small areas, which means that each facility provides service, on average, to nearly 50 small areas. It is therefore also possible to perform an even more finely grained analysis on positional relationship between facility and population in terms of distance. For instance, calculation of the current and projected population of persons 75 years old and over in a 500m radius, 500 to 1,000m radius, 1,000m radius or over from each facility is also possible.

With regard to long-term care facilities and their service, accessibility for users is important for commuting care facilities. For home-visit service, as well, accessibility to users helps increase efficiency of service providers. As for residential facilities, it is most desirable for family members if they are located closer to their homes as it enables them to visit residents more frequently. If an environment that enables the elderly to enjoy support service focused on continued living at home, including medical and long-term care service and retail shopping, is created within walking distance, it will encourage the elderly to go out more actively, improve their quality of life, and prevent long-term care needs. At the same time, this is expected to reduce costs concerned with medical and long-term care.

With this in mind, and also for the purpose of promoting the "Care Compact City," an initiative aimed at efficiently and effectively providing medical and long-term care services in a consolidated, high-quality residential/regional space, we believe that we will be able to perform a detailed assessment on the effects of optimal facility locations by calculating the current and projected population in each radius from the assumedly appropriate hub facility or place in a consolidated environment, while taking into account the relationship between long-term care facilities/public facilities and users in terms of distance.

Furthermore, in addition to the above, studying proactive relocation of housing, for instance, proactive moving to urban areas by leveraging vacant houses or open space, which are expected to increase further, after carrying out renovation required for people in their senior years or rebuilding existing houses geared for the elderly, will lead to the formulation of effective measures and assessment methods. This would be aimed at promoting a more effective "Community-based Comprehensive Care System" and "Compact City" and at building a "Care Compact City," the integration of the two, from the aspect of positional relationship in terms of distance, including not only the supply side (facilities) but also the demand side (housing).

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Empirical Analysis of Yield Determinants in Japan's Municipal Bond Market: Does Credit Risk Premium Exist?

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Abstract

In this study, we examine the determinants of the yield spread between issuers in Japan's municipal bond market using panel data and focus on identifying whether credit risk premium exists. The results of the panel data analysis reveal new evidence on the municipal bond market for FY2002-2013. In the first half of the 2000s, the fundamental fiscal statistics, that is, the credit risk indicators, had no impact on the yield spreads, suggesting the absence of credit risk premium. Second, Yūbari City's insolvency in 2006 led to a structural break, and since that time investors have begun accounting for local governments' outstanding debt. Third, when important financial events occur, other credit risk indicators also significantly impact the yield spread, suggesting that investors are more aware of credit risk presence during such events. Finally, the findings of this study may provide implications for financial institutions, market participants and regulators.

Keywords: Yield spread, municipal bond market, credit risk, Japan

***JEL classification*: E43; G12; G14; H74**

1. Introduction

1.1. Japan, the largest municipal bond market among unitary states

Factors determining the yield level of public bonds are an issue that has thrust its way into the public consciousness of the global financial market. The 2010 public financial collapse in Greece led to the European sovereign debt crisis, which not only triggered unrest concerning the default probability of Greece's public bonds but also impacted other countries such as Spain, Portugal, and Italy. In the United States, the 2008 global financial crisis severely damaged state and local public finances and led to numerous financial problems, such as the Detroit bankruptcy and the insolvency of Illinois state pension funds. In fact, the recent news that the Puerto Rican government missed its municipal bond payments has taken many investors in the global financial market by surprise.

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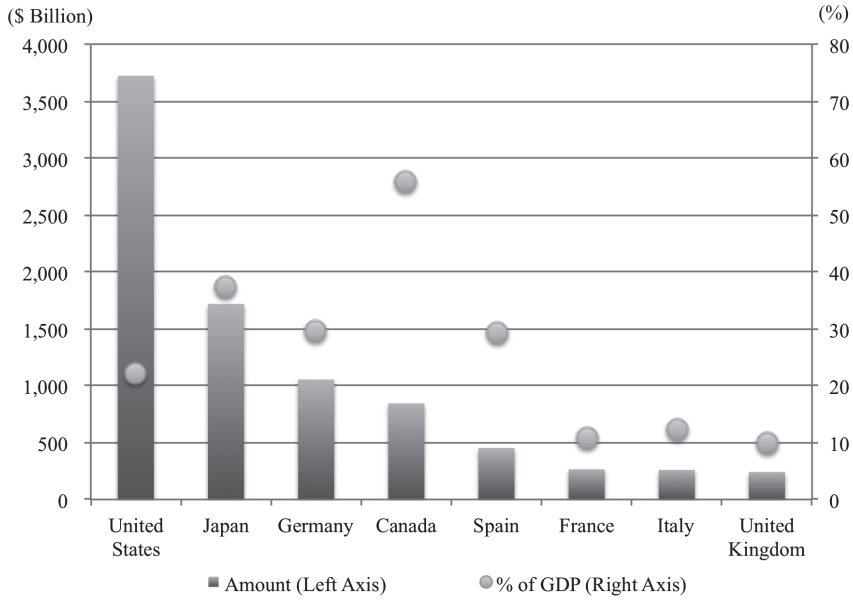
In this study, we examine the yield determinants of sub-sovereign bonds. In particular, we attempt to answer the following questions. Do investors believe that sub-sovereign bonds are subject to credit risk? Does their evaluation reflect the sub-sovereign bond yield as credit risk premium? Thereby, does the yield spread between the issuers reflect their fiscal soundness or credit risk? In other words, is the so-called "market discipline" present in the sub-sovereign market?

Several preliminary analyses share the aims of this study. The distinguishing characteristic of our analysis, however, is that we focus on Japan's municipal bond market[1]. Today, few scholars discuss the bond market primarily because of language barriers and difficulties in accessing statistical data, thus leading to an important sector in Japan with meaningful insight being largely overlooked.

In fact, the scale of Japan's municipal bond market is large among the advanced countries. It is widely known that Japan's outstanding public debt as a percentage of GDP is now more than 200% and dominates that of other advanced countries. Japanese local governments are not isolated from this situation. As of 2013, the outstanding municipal debt, comprising debt loans and bonds, owned by Japanese local governments is $1.7 trillion (Figure 1), which is the second highest among advanced countries, following the United States.

Figure 1: Outstanding Municipal Debt in Advanced Countries



Note: Data as of 2013.

Source: OECD.Stat.

Undoubtedly, Japan's municipal bond market, excluding debt loans, is significantly smaller. This is because about 60% of municipal debt consists of loans issued by private commercial banks through the Fiscal Investment and Loan Program (FLIP), which is managed by the central government. However, in terms of the scale of municipal bond market, the United States and Canada, where the state and local governments borrow money mainly by issuing bonds, rank higher than Japan, followed by Germany, where about 60% of municipal debts are in the form of bonds.

[1] See Igata and Miyake (2007) and Miyake (2008) for a detailed discussion of the Japanese municipal debt market and relevant local public finance institutions.

1.2. Credit risk of municipal bonds in unitary states

It is noteworthy that all countries with a municipal bond market exceeding $500 billion (e.g., the United States, Germany, and Canada) adopt a federal system, except Japan. In a federal state, state governments have the sovereign power, and the role and discretion of the state government in public finance management are relatively large. This also holds true when issuing municipal debt, and thus it seems natural that the scale of the municipal bond market in a federal state is correspondingly large. Most of the extant literature focuses on the yield determinants of municipal bonds in federal states, mainly those in the United States (Bayoumi, Goldstein, and Woglom, 1995; Brune and Liu, 2011), Canada (Booth, Georgopoulos, and Hejazi, 2007; Landon and Smith, 2000), and Germany (Heppeke-Falk and Wolff, 2008).

In contrast to these three countries, Japan adopts a unitary system. In a unitary state, the central government decides the fundamental characteristics and role of the local government in public finance. The discretion of the local government, including that concerning the issuance of municipal debt, is relatively small. In addition, the local government receives substantial funds from the central government through special grants and fiscal equalization systems and its revenue is dependent on these funding systems. Thus, the relationship between the central and local governments in a unitary state is generally closer than that in a federal state.

This close relationship also involves the so-called "implicit government guarantee," which possibly effects the yield of municipal bonds, and, especially, the existence of credit risk premium. Similar to the federal state, the primary responsibility to pay debt service in the unitary state is held by the local government as an issuer. In general, the central government does not share this responsibility or explicitly guarantee the debt service of municipal bonds. However, when a local government faces deteriorating fiscal conditions and finds it difficult to repay its own debt, the central government may sometimes provide an extraordinary grant as an ex-post bailout, which is known as the implicit government guarantee. If the expectation of such a guarantee exists in the market, it will reflect on the yield level of municipal bonds. More concretely, the credit risk premium of municipal bonds would disappear and their yield level would almost equal that of government bonds. The difference in the yield level of municipal bonds by local government would also disappear or be determined by the degree of bailout possibility, not fiscal conditions (Jenkner and Lu, 2014; Landon and Smith, 2000).

Therefore, in terms of yield determinants and existence of credit risk premium (or implicit government guarantee), the characteristics of the municipal bond market in a unitary state differ from those in a federal state. This is particularly the case in the United States, where Chapter 9 of the Bankruptcy Act for Local Governments exists and cases of municipal bond default are not rare. To empirically examine such a possibility in a unitary state in the context of a public bond market is an interesting research topic. Thus, we focus on Japan, the largest among advanced unitary states, to provide meaningful insight into the bond market.

The remainder of this paper is organized as follows. Section 2 briefly reviews the preliminary literature on the yield determinants in municipal bond markets. Section 3 presents the estimation equation and the sample data used in our estimations. Sections 4 and 5 report the results and implications of our empirical analyses. Section 6 concludes the paper.

2. Literature review

The literature mainly comprises studies on municipal bond markets in federal states, such as those in the United States. Many studies on credit risk premiums highlight the significance of local governments' fiscal soundness as a determinant of the municipal bond yield in both primary and

secondary markets. For example, Capeci (1994) finds that the current decision making of a local government about issuing municipal bonds affects their yield. Bayoumi, Goldstein, and Woglom (1995) reveal a nonlinear relationship between the states' outstanding debt and municipal bond yields, that is, the higher a state government's debt accumulates, the more rapidly municipal bond yield rises. Capeci (1991), Liu and Thakor (1984), and Stover (1991), among others, focus on the effects of credit ratings as a credit risk indicator on municipal bonds. Their studies are based on the fact that state and local governments in the United States generally purchase credit ratings, in contrast to those in Japan and advanced European countries.

Some studies examine the effects of financial events on the municipal bond market, such as New York City's fiscal emergency in the 1970s (Kidwell and Trzcinka, 1982; Kidwell and Trzcinka, 1983), and the default of municipal bonds (Halstead, Hegde, and Klein, 2004; Peavy III and Hempel, 1987). Peng, Kriz, and Wang (2014) find that the 2007-2009 Great Recession had some impact on the municipal bond market and that the effects differ between high- and low-rated municipal bonds.

Analyses have also been conducted on the municipal bond market in the United States and various factors affecting bond yield, such as fiscal institutions, debt management policies, public accounting, financial disclosure practices, issuers' financial sophistication, and sales type. Some recent studies examine liquidity risk premium or trading costs in the municipal bond market (Downing and Zhang, 2004; Harris and Piwowar, 2006; Wang, Wu, and Zhang, 2008).

By contrast, studies on Japan's municipal bond market are limited to Nakazato (2011) and Tanaka (2013). While Nakazato (2011) asserts the existence of credit risk premium in Japan, Tanaka (2013) shows that not all fiscal statistics affect yield spreads. Hattori (2018) uses CDS data to decompose the credit and liquidity factors of Japan's municipal bond market.[2]

Similarly, this study examines whether investors believe in the default possibility of a municipal bond and account for a local government's fiscal soundness. However, we drastically improve the estimation in the following manner. First, we use simpler and fundamental fiscal data as credit risk indicators. Nakazato (2011) and Tanaka (2013) exclude variables such as simple fiscal surplus and primary balance, which are often used in practices in Japan's local public finance and adopted as independent variables in previous studies on the public bond market. Instead, they use secondary variables, such as current surplus ratio, which neglects capital revenue and expenditure[3].

Second, we estimate a fixed effects model using the strength of the panel data. While Tanaka (2013) includes individual effects in the model, Nakazato (2011) does not. Accounting for individual effect allows us to capture each local government's time-consistent characteristics, in addition to time-varying fiscal data, that affect municipal bond yield.

Third, we focus on the possibility of a spurious regression by conducting unit root tests. By contrast, Nakazato (2011) does not conduct such a test and Tanaka (2013) performs only an LLC test (Levin, Lin and Chu, 2002). However, as will be explained later, we suspect that the yield spread of Japan's municipal bond relative to government bonds, which the two studies adopt as a dependent variable, can follow a unit root. Thus, their estimation results can be derived from a spurious regression.

Finally, we extend the sample term from FY2002 to FY2013 to include the 2007-2009 Great Recession, whereas Nakazato (2011) and Tanaka (2013) focus on FY2003-2006 and FY2003-2008.

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[2] Hattori (2019a, 2021) computes the liquidity premium in the JGB market. Hattori (2019b) discusses the liquidity enhancement auction provided by the Ministry of Finance, Japan.

[3] We conducted separate estimations using such variables in Equations (1) and (2) and found that the results remain unchanged.

3. Estimation equation and data

3.1. Specifying the estimation equation

In this paper, we conduct an empirical study of the yield determinants in Japan's municipal bond market. In particular, we focus on the yield difference between local governments. To do so, we follow Bernoth, von Hagen, and Schuknecht (2012) and estimate the equation for fiscal year *t*:

$$Spread_{i\,t} = \beta_0 + \beta_1\, maturity_{i\,t} + \beta_2\, L_{i\,t} + \boldsymbol{\beta_3}'\, \mathbf{z_{i\,(t-1)}}$$

$$+ Dummy\ YS\left(\gamma_1\, maturity_{i\,t} + \gamma_2\, L_{i\,t} + \boldsymbol{\gamma_3}'\, \mathbf{z_{i\,(t-1)}}\right)$$

$$+ Dummy\ LS\left(\delta_1\, maturity_{i\,t} + \delta_2\, L_{i\,t} + \boldsymbol{\delta_3}'\, \mathbf{z_{i\,(t-1)}}\right) + \lambda_t + \mu_i + \varepsilon_{i\,t}, \quad \cdots \quad (1)$$

where $Spread_{i\,t}$ is the yield spread of the municipal bond issued by local government *i*, $maturity_{i\,t}$ is the term to maturity, and $L_{i\,t}$ is the measure of liquidity. $\mathbf{z_{i\,(t-1)}}$ contains the independent variables related to credit risk. $Dummy\ YS$ and $Dummy\ LS$ are financial event dummies. μ_i denotes the unobservable individual effect and λ_t is the unobservable time effect, which allows us to estimate the fixed effects model using dummy variables[4]. $\varepsilon_{i\,t}$ is an error term.

The equation highlights the following two points. First, the dependent variable $Spread_{i\,t}$ is defined as a deviation from the municipal bond market index, instead of the government bond yield. The literature on bond yield determinants generally uses a spread relative to government bonds. However, in the case of Japan's municipal bond market, the spread relative to government bonds can also follow the unit root process (Table 1). By contrast, the spread relative to the municipal bond index does not follow the unit root process. We are mainly interested in whether credit risk exists and if the fiscal soundness of each local government affects the municipal bond yield. Thus, we focus on the yield difference between local governments and find no difference between yield spreads relative to government bonds and municipal bond market indexes (Benson and Rogowski, 1978; Goldstein and Woglom, 1991). As a result, we adopt the latter as a dependent variable to eliminate the possibility of a spurious regression.

Second, we carefully consider the timing of data announcements related to local public finance. We set the independent variables related to fiscal data ($\mathbf{z_{i\,(t-1)}}$) lagged by one year and use the sample data of the yield spread for December 31 and March 31 for each fiscal year. To ensure that we use complete balanced panel data, we adopt one dataset for each local government per year, including the yield spread[5]. Thus, when deriving the sample data for the yield spread, we chose one business day in each year. It is natural to assume that the spread would react immediately after new fiscal data announcements if such information had an impact. In the case of local public finance institutions in Japan, there are two instances in which investors receive data on the fiscal year ($t-1$): December 31 or March 31 in the following fiscal year t[6]. Thus, we selected two days in each fiscal year and lagged the timing of the fiscal data in $\mathbf{z_{i\,(t-1)}}$. We also conduct two types of estimations, which contribute to checking the robustness of our analysis.

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[4] We conducted an F-test and Hausman test to determine the model (i.e., pooled-OLS, random effects model, or fixed effects model) using the entire sample. The null hypotheses for both tests were rejected.

[5] The yield (spread) of municipal bonds is available on a daily basis, whereas fiscal data on Japan's local government are released annually.

[6] The schedule of data announcements for local public finance is as follows: The fiscal year spans the period from April 1 to March 31. Data on local public finance are uniformly arranged by the Ministry of Internal Affairs and Communications (MIC). Investors can access this information through, for example, MIC's website. For example, investors can access brief data for FY2006 (April 2006-March 2007) by December 2007 and detailed data by March 2008.

Table 1: Unit Root Test Results

Variables	Yield Spread Relative to Central Government Bond				Yield Spread Relative to Municipal Bond Index			
Date of Sample Yield Spread	December 31		March 31		December 31		March 31	
Sample Term	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13
IPS Test	1.4055	2.7899	0.6443	1.9309	-12.1318	-5.6796	-1.7317	-4.3097
	(0.9201)	(0.9974)	(0.7403)	(0.9733)	(0.0000)	(0.0000)	(0.0417)	(0.0000)
LLC Test	1.6198	-0.8335	-1.5201	-3.2015	-15.2106	-13.2562	-4.0866	-10.3979
	(0.9474)	(0.2023)	(0.0642)	(0.0007)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ADF Test	22.6903	13.1836	28.3057	18.5674	211.0370	141.6490	60.2388	117.3000
	(0.9993)	(1.0000)	(0.9895)	(1.0000)	(0.0000)	(0.0000)	(0.1106)	(0.0000)

Variables	Maturity				Issue Amount			
Date of Sample Yield Spread	December 31		March 31		December 31		March 31	
Sample Term	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13
IPS Test	-33.6606	-14.9584	-6.8579	-70.7861	-4.3588	-1.3427	-3.2037	-2.3E+14
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0897)	(0.0007)	(0.0000)
LLC Test	-124.8230	-65.5595	-18.1135	-459.4220	-7.7154	-3.5372	-6.3864	-3.5485
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0002)
ADF Test	165.7240	134.0690	115.9010	163.6670	92.4254	38.2278	79.3323	47.2395
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0577)	(0.0016)	(0.0651)

Variables	Real Surplus Ratio		Primary Balance Ratio		MDO Ratio		Debt Service Ratio	
Sample Term	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13
IPS Test	-3.7902	-5.1564	-2.6410	-1.4630	-5.6061	-2.8750	-2.2063	-10.5020
	(0.0001)	(0.0000)	(0.0041)	(0.0717)	(0.0000)	(0.0020)	(0.0137)	(0.0000)
LLC Test	-7.2041	-15.8195	-4.6877	-9.9785	-7.5754	-7.4611	-4.9082	-37.8493
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ADF Test	88.2492	125.2280	69.0644	69.7351	121.4690	91.0002	68.1809	129.2910
	(0.0004)	(0.0000)	(0.0248)	(0.0339)	(0.0000)	(0.0004)	(0.0292)	(0.0000)

Notes: 1. p-values are shown in parentheses.

2. We conduct three tests: an IPS (Im, Pesaran, and Shin, 2003), an LLC (Levin, Lin, and Chu, 2002), and an augmented Dickey–Fuller (ADF; Maddala and Wu, 1999) test.

3. Information criteria (BIC) are applied to select lag length.

4. As for yield spreads, maturity, and issue amount, we conduct two unit root tests on the sample data collected since they differ between December 31 and March 31.

3.2. Sample data and data resources

Next, we describe the dataset. Detailed definitions and data sources of each variable are presented in Table 2.

To compute $Spread_{i\,t}$, we estimated the difference between the yield of publicly-offered municipal bonds and NOMURA-BPI Municipals. Here, we use the yield determined in the secondary market; we assume that yields based on the secondary market reflect investors' views more accurately than those based on issue[9]. We adopt data for publicly-offered municipal bonds in Japan on the basis of data availability and those more actively traded than other municipal bonds[10]. The latter indicates that the yield of publicly-offered municipal bonds reflects risk evaluation by investors more precisely.

An issuer generally trades two or more issues in the publicly-offered municipal bond market every business day. We select data on the basis of such issuers as follows for December 31 and March 31 in each fiscal year as follows. First, to conduct a balance panel data analysis, we limit the scope of issuers to local governments that have regularly issued bonds (annually) throughout the estimation period. Second, from these, we chose a local government with issues whose current maturity is closest to 10 years, which is the typical maturity period in Japan's municipal bond primary market.

Next, we describe the independent variables included in Equation (1). We used term to maturity ($maturity_{i\,t}$) as the characteristic variable of each bond issue[11] and issue amount as a liquidity risk indicator ($L_{i\,t}$). We used several fiscal statistics for credit risk indicators ($\mathbf{z_{i\,(t-1)}}$)[12]. The real surplus or primary balance ratios are included as flow-based indicators. Both indicate the surplus or deficit of local governments in each fiscal year. The municipal debt outstanding (MDO) ratio and debt service ratio are variables that allow us to gauge the scale of debt owned by each local government. These four variables are ratios relative to financial resources, which are general measures representing the fiscal size of each local government in Japan. Using the ratio variables, instead of absolute data, allows us to capture local governments' fiscal difficulty within its own scale.

Finally, we use data from FY2002, the year from which yield sample data became available, to FY2013, the latest year in which fiscal data for the previous fiscal year are presented.

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[9] One reason underlying this assumption is that, in Japan, all municipal bonds were issued with the same yields every month up to August 2006. Until then, MIC, a representative of municipal bond issuers, negotiated issue conditions with financial institutions for all bonds issued in the same month.

[10] As mentioned, Japanese local governments borrow money through bonds (municipal bonds) or loans. However, we exclude the following bonds from our analysis: private-placement bonds issued mainly to banks; joint local government bonds, which are cooperatively issued by two or more local governments; and mini bonds, offered to local people and enterprises.

[11] Almost all publicly-offered municipal bonds, including issues in our estimations, are irredeemable and fixed rate bonds. Similar to advanced countries in Europe, a revenue bond has not yet been issued to date in Japan's municipal bond market. Thus, the main characteristic that differs between issues is maturity.

[12] Note that we do not use credit rating as a credit risk indicator. Undoubtedly, credit ratings are widely used in empirical analyses on credit risk in municipal and corporate bonds. However, few local governments in Japan have been rated by international rating agencies such as Standard & Poor's Ratings Services or Moody's Investors Service. In addition, the credit rating in the municipal bond market rarely fluctuates; thus, the data are not suitable for a panel data analysis.

Table 2: Details and Data Resources of Dependent and Independent Variables

Variables	Definition	Data Sources
Dependent Variables (*Spread*)		
▪ Yield Spread of Municipal Bonds	Yield of publicly offered municipal bonds in the secondary market − Municipal bond market yield benchmark index * "Municipal bond market yield benchmark index" is NOMURA-BPI Municipals (municipal bond market yield index)	Japan Securities Dealers Association (JSDA), Reference Statistical Prices (Yields) for OTC Bond Transactions, Nomura Securities Co., Ltd., NOMURA-BPI Municipals (municipal bond market yield index)
Independent Variables		
1) Maturity (*Maturity*)	Year to maturity	JSDA, Reference Statistical Prices (Yields) for OTC Bond Transactions
2) Liquidity Risk Index (*L*)	Issue amount	JSDA, Reference Statistical Prices (Yields) for OTC Bond Transactions
3) Credit Risk Index (**z** or **x**)		
▪ Real Surplus Ratio	Actual surplus / general financial resource * Actual surplus = revenue - expenditure * General financial resource is defined as the general current revenue and each local government decides its use. MIC calculates statistics and uses them to understand the fiscal scale of each local government.	Ministry of Internal Affairs and Communications (MIC), Statistical Yearbook on Local Public Finance (*Chiho-Zaisei Tokei Nenpo*)
▪ Primary Balance Ratio	Primary balance / general financial resource * Primary balance = (revenue - debt finance funds) − (expenditure - debt service)	MIC, Statistical Yearbook on Local Public Finance (*Chiho-Zaisei Tokei Nenpo*)
▪ Municipal Debt Outstanding (MDO) Ratio	Municipal debt outstanding / general financial resource ※"Municipal debt" includes not only publicly offered municipal bonds but also loan debts through FILP, bank loans, and the private placement bond.	Japan Local Government Bond (JLGB) Association, Statistical Yearbook on Municipal Debt (*Chihosai Tokei Nenpo*), MIC, Statistical Yearbook on Local Public Finance (*Chiho-Zaisei Tokei Nenpo*)
▪ Debt Service Ratio	Debt service / general financial resource	MIC, Statistical Yearbook on Local Public Finance (*Chiho-Zaisei Tokei Nenpo*).
▪ Real Deficit Ratio (*)	Actual deficit (expenditure - revenue) / general financial resource ※ If the fiscal balance of a local government is in surplus, this ratio is not calculated. Thus, when we use this ratio in the estimation, we convert it into dummy variables, that is, 1 if this ratio has a value, and 0 if it is not calculated (fiscal balance is surplus).	MIC, MIC website (http://www.soumu.go.jp/iken/zaisei/kenzenka/index.html)
▪ Consolidated Real Deficit Ratio (*)	Sum of actual deficit (expenditure - revenue) of the ordinary, special, and public enterprise accounts / general financial resource ※ Similar to the real deficit ratio, we convert this ratio to dummy variables.	MIC, MIC website (http://www.soumu.go.jp/iken/zaisei/kenzenka/index.html)
▪ Real Debt Service Ratio (*)	Debt service (which the issuer is responsible for) / general financial resource ※ This has been calculated by MIC since FY 2006 and differs from debt service ratio. Debt service in the calculation of the real debt service ratio excludes debt service funded by the central government or other local governments through the fiscal equalization system and special grants.	MIC, MIC website (http://www.soumu.go.jp/iken/zaisei/kenzenka/index.html)
▪ Future Burden Ratio (*)	Consolidated debt service / local government's financial revenue resource (based on general financial resource)	MIC, MIC website (http://www.soumu.go.jp/iken/zaisei/kenzenka/index.html)

Notes: * denotes variables included in x_(i (t-1)) in Equation (2).

3.3. Events affecting municipal bond yield

We account for two financial events by adding event dummies: the Yūbari shock and Great Recession or Lehman Shock.

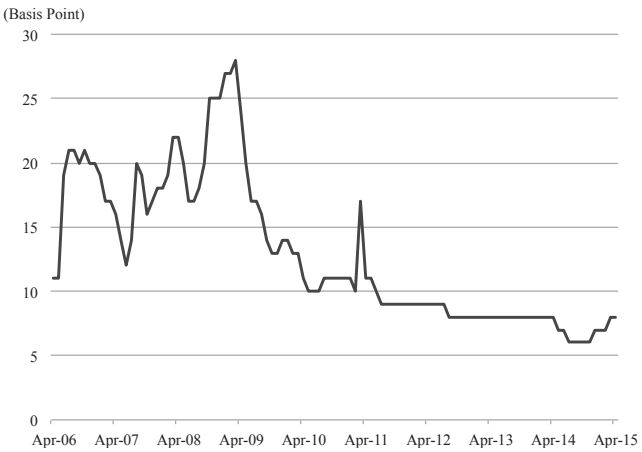
In 2006, Yūbari City in Hokkaido Prefecture became insolvent and declared a public finance emergency, an event widely known as the Yūbari shock. Since then, the city has initiated a fiscal reconstruction process under the central government's administration. The city has a small local government and remains inexperienced in issuing publicly-offered bonds. However, we consider the Yūbari case as an unprecedented event in Japan's municipal bond market for three reasons. First, it is rare for local governments to be part of a reconstruction process. Second, the event raised concerns about the fiscal condition of local governments among not only investors but also the general public. Finally, as a result of the event, the central government considered introducing a bankruptcy act that would be available to local governments wanting to restructure their debt burden.

The Yūbari shock could have had two possible effects on the municipal bond market. The first of these is a temporary effect. In June 2007, the central government passed the Law Relating to the Financial Soundness of Local Governments[17], which aimed at understanding the fiscal condition of each local government more precisely and in a timely manner and providing mechanisms for local governments facing fiscal difficulties. As for bankruptcy, the central government did not add a clause that that allows local governments to carry out debt adjustment, which could have relieved investors' concern about default risks in municipal bonds. To check if such a temporary shock existed, we include the dummy variable $Dummy\ YS$ and its intersection with other independent variables in Equation (1). We set $Dummy\ YS$ to 1 from June 2006 to June 2007.

Second, the shock possibly led to structural changes in Japan's municipal bond market; for example, the event changed yield (spread) determinants, such as credit risk premiums. To check for this possibility, we conduct the estimation by dividing the sample data between May and June 2006.

The Lehman Shock refers to a global financial market crisis or the Great Recession caused by the Lehman Brothers' filing of bankruptcy. We set August 2007, when the BNP Paribas shock occurred and the subprime loan market in the United States collapsed, as the start time for $Dummy\ LS$, which takes the value of 1. The end of this event is set to December 2009, when the spread between the NOMURA-BPI Municipals and government bond yield converged to the level reported before the BNP Paribas shock (Figure 2).

Figure 2: Nomura BPI Municipal T-Spread Index Trend



Source: Nomura

[17] For a detailed discussion of this law, see Miyake (2008).

4. Estimation results

Equation (1) is estimated using OLS and robust standard errors. Table 3 shows the results for two estimations according to the date of the sample yield spread (i.e., December 31 and March 31), three estimations as per the sample term (FY2002-2013, FY2002-2005, and FY2006-2013), and two estimations for each sample term that are based on flow-base fiscal statistics used as an independent variable (estimation types A and B).

We are mainly interested in the credit risk premiums of the municipal bond yield. In other words, we focus on the significance of credit risk indicators. The results are as follows.

First, before the Yūbari shock, that is, FY2002-2005, none of the credit risk indicators were statistically significant at the 5% level, suggesting that the credit risk premium did not exist in Japan's municipal bond market until FY2005. However, the Kyoto City dummy negatively affects the yield spread of municipal bonds. Kyoto is famous as the traditional capital of Japan and for having debt levels higher than those in other Japanese cities. This suggests that specific time-consistent information is important as a yield spread determinant in this term [18].

Second, after the Yūbari shock, that is, FY2006-2013, the MDO ratio had a consistent impact on the yield spread, including the term after the Lehman Shock. In all four estimations, the MDO ratio, not multiplied by $Dummy\ YS$ or $Dummy\ LS$, is statistically significant at the 5% level. This suggests that investors became concerned about the credit risk of municipal bonds in FY2006. In other words, the Yūbari shock led to a structural break in the market.

Third, the Yūbari and Lehman Shocks had a temporary impact on the yield spread. Three out of the four estimations show that either the intersection of the debt service ratio with $Dummy\ YS$ or $Dummy\ L$, or both, significantly impacted the spread. In addition, three out of the four estimations show that one or both of the intersections of the flow-based credit indicator with these events are statistically significant. These results suggest that investors pay attention to not only the MDO ratio but also other credit risk indicators during a financial event. In other words, both financial events made investors more conscious about the fiscal soundness of local governments.

[18] Here, some participants pointed out that the popularity or brand image of each local government affects, to a certain extent, the yield spread. Although the estimation results perhaps support this hypothesis, the factors determining this individual effect remain beyond the scope of this study.

Table 3(i): Estimation Results for Equation (1)

Date of Sample Yield Spread	December-31					
Sample Term	FY2002 - FY2013		FY2002 - FY2005		FY2006 - FY2013	
Estimation Type	A	B	A	B	A	B
Maturity	0.1808	0.2649	0.6853	0.6467	0.2004	0.2141
	(0.3715)	(0.3883)	(0.3315)	(0.3328)	(1.4853)	(1.2794)
Issue Amount	-0.0004	0.0018	0.0005	-0.0005	0.0013	0.0000
	(0.0017)	(0.0020)	(0.0016)	(0.0016)	(0.0035)	(0.0037)
Real Surplus Ratio	0.4888		-0.4286		0.2933	
	(0.2053)		(0.3449)		(0.3956)	
Primary Balance Ratio		0.0347		-0.0079		0.1220
		(0.0304)		(0.0121)		(0.0367)
MDO Ratio	0.2851	0.5207	0.1602	0.1233	2.0445	2.6289
	(0.3386)	(0.3481)	(0.5569)	(0.7859)	(0.8134)	(0.8503)
Debt Service Ratio	0.3835	-6.2308	-7.7300	-6.4604	-6.9135	-15.1658
	(3.4495)	(4.8297)	(5.7029)	(5.1802)	(7.5084)	(8.3629)
Dummy YS * Maturity	5.1064	4.6627			4.8414	4.1549
	(2.8233)	(2.6069)			(2.7868)	(2.4206)
Dummy YS * Issue Amount	-0.0024	-0.0015			-0.0017	0.0004
	(0.0054)	(0.0047)			(0.0028)	(0.0033)
Dummy YS * Real Surplus Ratio	-0.5504				-0.7596	
	(0.5367)				(0.3145)	
Dummy YS * Primary Balance Ratio		-0.0918				-0.1951
		(0.0839)				(0.0683)
Dummy YS * MDO Ratio	0.0117	-0.0344			-0.5238	-0.2240
	(0.4229)	(0.4180)			(0.3489)	(0.3359)
Dummy YS * Debt Service Ratio	7.0316	19.2823			13.5431	29.1775
	(3.1828)	(9.3502)			(7.0455)	(8.6414)
Dummy LS * Maturity	-5.0425	-4.5344			-5.0957	-5.2692
	(2.9697)	(2.9310)			(3.4451)	(3.2255)
Dummy LS * Issue Amount	0.0163	0.0071			0.0100	0.0091
	(0.0061)	(0.0043)			(0.0045)	(0.0040)
Dummy LS * Real Surplus Ratio	-1.4344				-0.8432	
	(0.5021)				(0.3290)	
Dummy LS * Primary Balance Ratio		-0.0148				-0.0949
		(0.0432)				(0.0405)
Dummy LS * MDO Ratio	0.0853	-0.0289			-0.4510	-0.2059
	(0.3452)	(0.3542)			(0.3183)	(0.3001)
Dummy LS * Debt Service Ratio	15.7011	17.0095			13.8128	19.5566
	(9.5643)	(10.0730)			(9.2270)	(9.6582)
N	288	288	96	96	216	216
R-squared	0.8660	0.8582	0.9523	0.9512	0.8787	0.8785

Notes: * denotes variables included in x_(i (t-1)) in Equation (2).

Table 3(ii): Estimation Results for Equation (1) (Continued)

Date of Sample Yield Spread	March-31					
Sample Term	FY2002 - FY2013		FY2002 - FY2005		FY2006 - FY2013	
Estimation Type	A	B	A	B	A	B
Maturity	0.3023	0.6540	1.4354	1.4219	0.1410	0.8896
	(0.5155)	(0.4875)	(0.1614)	(0.1650)	(1.8604)	(1.7559)
Issue Amount	-0.0039	0.0002	0.0002	-0.0000	-0.0047	-0.0004
	(0.0018)	(0.0017)	(0.0010)	(0.0012)	(0.0042)	(0.0033)
Real Surplus Ratio	0.6358		-0.1067		-0.0980	
	(0.2429)		(0.2507)		(0.5748)	
Primary Balance Ratio		0.0388		-0.0062		0.1283
		(0.0322)		(0.0121)		(0.0496)
MDO Ratio	0.2278	0.5606	0.0545	-0.0777	2.0525	2.4335
	(0.3694)	(0.3698)	(0.5784)	(0.7524)	(0.8218)	(0.8701)
Debt Service Ratio	0.7269	-8.1014	-4.6006	-4.0819	-4.0696	-17.5856
	(3.8345)	(5.5754)	(4.4428)	(4.0586)	(7.6362)	(9.8056)
Dummy YS * Maturity	-2.5593	-2.1160			-3.2184	-3.3107
	(1.3412)	(0.9926)			(2.0738)	(1.7760)
Dummy YS * Issue Amount	0.0062	0.0046			0.0016	0.0014
	(0.0037)	(0.0022)			(0.0031)	(0.0030)
Dummy YS * Real Surplus Ratio	-0.8857				-0.4204	
	(0.3862)				(0.3010)	
Dummy YS * Primary Balance Ratio		-0.0642				-0.1228
		(0.0313)				(0.0524)
Dummy YS * MDO Ratio	0.4221	0.3208			-0.2655	-0.0356
	(0.2189)	(0.2143)			(0.2895)	(0.2987)
Dummy YS * Debt Service Ratio	1.6035	12.7724			5.4724	18.1972
	(3.2811)	(4.2573)			(7.1102)	(7.0813)
Dummy LS * Maturity	-4.2734	-4.5644			-5.3388	-5.4806
	(4.5744)	(4.3551)			(3.7241)	(3.7348)
Dummy LS * Issue Amount	-0.0020	-0.0103			-0.0042	-0.0085
	(0.0069)	(0.0061)			(0.0054)	(0.0052)
Dummy LS * Real Surplus Ratio	-1.6120				-1.0050	
	(0.5597)				(0.4072)	
Dummy LS * Primary Balance Ratio		0.0636				-0.0131
		(0.0539)				(0.0513)
Dummy LS * MDO Ratio	-0.3218	-0.4772			-0.9492	-0.7198
	(0.5855)	(0.6466)			(0.5073)	(0.4931)
Dummy LS * Debt Service Ratio	35.8820	34.7996			37.4037	42.0427
	(15.6443)	(14.9429)			(13.4963)	(13.0307)
N	288	288	96	96	216	216
R-squared	0.8715	0.8651	0.9803	0.9803	0.8293	0.8271

Notes: 1. Robust standard errors are shown in parentheses.

2. Local governments used as samples are Aichi, Chiba, Fukuoka, Gunma (FY2006-2013), Hiroshima, Hokkaido, Hyogo, Kumamoto (FY2006-2013), Kyoto, Niigata, Osaka, Saitama, and Shizuoka prefectures, Tokyo Metropolitan, Chiba, Fukuoka, Hiroshima, Kanagawa, Kawasaki, Kitakyushu, Kobe, Kyoto, Nagoya, Osaka, Saitama (FY2006-2013), Sapporo, and Yokohama cities.

5. Impact of new fiscal indices: Additional estimation and results

We performed additional regressions to derive robust results for whether the credit risk indicators significantly impact Japan's municipal bonds' yield (spread). This estimation is based on the fact that since September 2008, MIC released four fiscal indices related to the fiscal condition of local governments: real deficit ratio, consolidated real deficit ratio, real debt service ratio[20], and future burden ratio. Because investors generally use these four indices to evaluate the credit risk of municipal bonds, we add them as independent variables to Equation (1).

$$Spread_{i\,t} = \beta_0 + \beta_1\, maturity_{i\,t} + \beta_2\, L_{i\,t} + \boldsymbol{\beta_3}'\,\mathbf{z_{i\,(t-1)}} + \boldsymbol{\beta_4}'\,\mathbf{x_{i\,(t-1)}} + Dummy\ LS\left(\delta_1\, maturity_{i\,t} + \delta_2\, L_{i\,t} + \boldsymbol{\delta_3}'\,\mathbf{z_{i\,(t-1)}} + \boldsymbol{\delta_4}'\,\mathbf{x_{i\,(t-1)}}\right) + \lambda_t + \mu_i + \varepsilon_{i\,t} \ldots. \quad (2)$$

$\mathbf{x_{i\,(t-1)}}$ contains four fiscal indices. It is lagged one year for the same reason as $\mathbf{z_{i\,(t-1)}}$. Other variables are almost the same as those in Equation (1). The only exception is that the debt service ratio is excluded from $\mathbf{z_{i\,(t-1)}}$ because $\mathbf{x_{i\,(t-1)}}$ includes it instead. Similar to the estimation of Equation (1), we chose December 31 and March 31 to derive sample data for the yield spread. This is because the revised values of the four fiscal indices are announced in December and the timing of the announcement of the other fiscal indices included in $\mathbf{z_{i\,(t-1)}}$ remain unchanged[21]. In addition, the sample size of the issuers is extended to include data on local governments that began issuing publicly-offered municipal bonds up to FY2008.

Table 4 shows the regression results for Equation (2). Estimation types A and B differ in the flow-base fiscal variable included in the estimation. For types C and D, which individually correspond to types A and B, we exclude future burden ratio, which is highly correlated with the real debt service ratio (the correlation is greater than 0.7). The estimation results suggest the same implication as those in Equation (1). That is, among the credit risk indicators, the MDO ratio is the only credit risk indicator that consistently affects yield spread[22]. Besides, a financial event, such as the Lehman Shock, is bound to increase investor concern about credit risk.

To elaborate on the latter result, for all estimations, the intersections of the real deficit ratio and consolidated real deficit ratio with $Dummy\ LS$ are statistically significant when using the spread for March 31. Those of real debt service ratio are significant when the future burden ratio is excluded from the estimation. On the other hand, when the spread is for December 31, we derive results similar to those for the real deficit and real debt service ratios. As for variables included in $\mathbf{z_{i\,(t-1)}}$, three of the four results show that real surplus ratio is statistically significant at the 5% level in the case of a financial event, but not during a normal term.

6. Conclusion

In this study, we empirically analyze yield determinants, particularly of the yield spread between local governments in Japan's municipal bond market. Our estimation results differ from those in Nakazato (2011) and Tanaka (2013) and the implications contrast those provided by earlier studies, many of which analyze the United States.

First, during stable market periods, investors in Japan's municipal bond market generally pay

[20] See Table 2 for differences in using the debt service ratio to estimate Equation (1). The real debt service ratio had already been used to estimate local public finance in September 2008, but was calculated up to FY2006. To ensure continuity, all of our estimations with Equation (1) use the debt service ratio.

[21] The preliminary results for the four fiscal indices are released around September 30. To check for robustness, we estimate Equation (2) using the spread for September 30. The result remains the same as that for December 31 (Table 4).

[22] Some results show that the consolidated real deficit ratio is sufficiently consistent. However, theoretically, it seems strange that only one of the four fiscal variables in $\mathbf{x_{i\,(t-1)}}$ is significant. Thus, we do not emphasize this result.

little or no attention to the soundness of local governments. This was supported by the finding that, in the first half of the 2000s, none of the fundamental statistics were statistically significant as an independent variable in the municipal bond yield. Then, in 2006, the Yūbari shock caused a structural change. More specifically, the MDO ratio significantly impacted the yield spread. However, among the fundamental fiscal statistics, only this ratio was shown to have an impact. This suggests that investors tend to believe that credit risk can be evaluated without accounting for various fiscal statistics, such as fiscal surplus or debt service in each fiscal year. In other words, investors decide without fully analyzing the fiscal condition of the local government.

Our results clearly differ from those of many previous studies on the U.S. municipal bond market, where numerous indicators, including the fundamental fiscal statistics, significantly impact bond yield. This suggests that there exists, or existed until FY2005, an expectation of an implicit government guarantee in Japan's municipal bond market.

The second implication corresponds to the reaction of Japan's municipal bond market to financial events. For instance, the fiscal emergency in Yūbari City and the 2007-2009 Great Recession clearly affected the market, especially credit risk premium. Although the conditions appear to be the same as those in the United States, these financial events affected Japan's municipal bond market differently.

More specifically, in the case of an important event, investors in Japan's municipal bond market changed their view of credit risk. They began to recognize that credit risks differ according to the local government and to analyze the fiscal condition of each local government multi-directionally. This is supported by our estimation result that many fiscal statistics are statistically significant only when they are multiplied by an event dummy.

Table 4: Estimation Results for Equation (2)

Date of Sample Yield Spread	March-31				December-31			
Estimation Type	A	B	C	D	A	B	C	D
Maturity	0.9829	0.9062	1.3793	1.3833	-0.3505	-0.7352	-0.2194	-0.6685
	(2.1134)	(1.9518)	(2.1599)	(2.1053)	(0.8147)	(0.7742)	(0.7210)	(0.6903)
Issue Amount	-0.0035	-0.0015	-0.0028	-0.0014	-0.0029	-0.0024	-0.0027	-0.0033
	(0.0043)	(0.0041)	(0.0044)	(0.0043)	(0.0039)	(0.0039)	(0.0038)	(0.0040)
Real Surplus Ratio	0.4700		0.3792		-0.1182		-0.1222	
	(0.4461)		(0.4545)		(0.3367)		(0.3429)	
Primary Balance Ratio		-0.0124		0.0165		0.0262		0.0474
		(0.0419)		(0.0346)		(0.0373)		(0.0283)
MDO Ratio	2.1870	2.4150	2.9651	2.8891	2.2173	2.3908	2.6351	2.6150
	(1.3604)	(1.4934)	(0.8949)	(0.9098)	(1.3493)	(1.4249)	(0.9105)	(0.9395)
Real Deficit Ratio	-1.0032	-0.6463	-0.9528	-0.7754	-0.8126	-0.3444	-0.7482	-0.5923
	(1.2339)	(1.0114)	(1.2411)	(1.0484)	(0.9601)	(0.7234)	(0.9556)	(0.7637)
Consolidated Real Deficit Ratio	2.2823	1.7038	2.0122	1.6853	2.4298	1.7746	2.3190	1.8144
	(1.2874)	(0.9815)	(1.1801)	(0.9769)	(0.9783)	(0.8947)	(0.9279)	(0.8706)
Real Debt Service Ratio	0.1048	0.0987	-0.0052	-0.0912	-0.0041	0.0154	-0.0064	-0.1136
	(0.1654)	(0.1733)	(0.1327)	(0.1324)	(0.1522)	(0.1650)	(0.0987)	(0.1138)
Future Burden Ratio	0.0136	0.0015			0.0093	0.0007		
	(0.0240)	(0.0248)			(0.0226)	(0.0236)		
Dummy LS * Maturity	-16.9294	-15.6340	-14.6387	-12.8083	-4.9462	-2.7043	-4.9023	-2.6658
	(4.1741)	(4.3776)	(3.8091)	(4.5129)	(3.3323)	(3.7401)	(3.2597)	(3.7141)
Dummy LS * Issue Amount	0.0039	-0.0012	0.0048	0.0005	0.0089	0.0043	0.0089	0.0078
	(0.0076)	(0.0059)	(0.0066)	(0.0060)	(0.0050)	(0.0052)	(0.0040)	(0.0042)
Dummy LS * Real Surplus Ratio	-0.7458		-1.0847		-0.8136		-0.8091	
	(0.7266)		(0.5773)		(0.3395)		(0.2844)	
Dummy LS * Primary Balance Ratio		0.1090		0.0312		0.0700		0.0188
		(0.0777)		(0.0658)		(0.0504)		(0.0360)
Dummy LS * MDO Ratio	-1.7154	-1.6377	-1.6279	-1.3562	-0.5871	-0.5670	-0.5926	-0.3892
	(0.8076)	(0.8105)	(0.8588)	(0.8747)	(0.2940)	(0.3072)	(0.2908)	(0.3150)
Dummy LS * Real Deficit Ratio	11.0623	10.5584	11.2003	11.1387	4.5617	4.2372	4.5850	4.4776
	(2.5228)	(2.3309)	(2.3686)	(2.3273)	(2.3070)	(2.6230)	(2.3359)	(2.5855)
Dummy LS * Consolidated Real Deficit Ratio	4.9393	4.7814	4.7162	4.5584	-0.1033	0.2990	-0.0783	0.1781
	(2.1124)	(2.1808)	(2.0517)	(2.1216)	(1.4505)	(1.4111)	(1.4557)	(1.4803)
Dummy LS * Real Debt Service Ratio	0.3440	0.2302	0.5933	0.6398	0.2439	0.1516	0.2611	0.3406
	(0.4224)	(0.4052)	(0.2987)	(0.3164)	(0.2061)	(0.2136)	(0.1184)	(0.1303)
Dummy LS * Future Burden Ratio	0.0227	0.0337			0.0011	0.0142		
	(0.0194)	(0.0178)			(0.0105)	(0.0108)		
N	204	204	204	204	204	204	204	204
R-squared	0.8673	0.8667	0.8625	0.8562	0.8888	0.8866	0.8885	0.8840

Notes: 1. Robust standard errors are shown in parentheses.

2. Local governments used as samples are those described in the Notes appended to Table 3 as well as Gifu, Oita, Okayama, and Yamanashi prefectures and the cities of Hamamatsu Niigata, and Sakai.

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