Japan & The World Economy 66 (2023) 101178

Contents lists available at ScienceDirect

Japan & The World Economy

journal homepage: www.elsevier.com/locate/jwe

Chronological changes of government sectors' fiscal policies and fiscal sustainability in Japan☆

Motonori Yoshida [1]

Graduate School of Economics, Osaka Metropolitan University, Japan

A R T I C L E I N F O

JEL classification:
Numbers: E61
E62
H11
H61
H62
H63
H72
H74
H77

Keywords:
Fiscal sustainability
Fiscal reaction function
Least squares with breakpoints
State-space model
Kalman filter

A B S T R A C T

Since the end of the 1990 s, the sluggish growth of Japan's gross domestic product (GDP) and the mired fiscal state of its public sector have provoked consternation about its public sector's fiscal sustainability. Therefore, I estimated the fiscal reaction functions (stemming from Bohn, 1998a, 2008) with time-varying parameters for all Japan's government sectors (for 1976Q2–2020Q1), i.e., the general government (GG), the central government (CG), the whole of the local governments (WLG), and the whole of the social security funds (WSSF), to chronologically assess their fiscal sustainability using four different models, including a least-squares with breakpoints model and a state-space model with the Kalman filter. My results demonstrate that (1) the least-squares with breakpoints model outperformed the others, and (2) although CG, WLG, and WSSF often sustainably managed their finances during the analysis term, GG has failed to implement a sustainable fiscal policy from the mid-1990 s (3) CG and WSSF adjusted their fiscal postures according to Japan's economic state. Fiscal severity caused WLG to change its fiscal posture.

1. Introduction

For decades Japan's economy has simultaneously shown quite different aspects regarding its economic and public-sector fiscal states. First, Japan's economic vitality has slumped. (1) Its year-on-year gross domestic product (GDP) growth rate has been relatively lower than most other G7 countries since 2001 and the worst since 2015.[2] (2) Japan's general government's (GG's)[3] deficit/GDP ratio (%) averaged − 5.52 from 2010 to 2019, contrasted with − 0.91, which is the mean among all the Organization for Economic Co-operation and Development (OECD) countries. Japan's GG net debt/GDP ratio (%) has also been the worst since 2008 among the G7 countries. [4] Fortunately, Japan's economy overall presently enjoys the world's best financial status: (1) it has maintained its current account surplus for the last 40 years (as of 2019); (2) it has the highest external financial asset balance (3340.6 billion U.S. dollars) in the world, as of 2019Q4 (Q denotes quarter).[5] Taking all the above facts into account, Japan can efficiently extract itself from its dire public fiscal situation using the fertile financial capacity enjoyed by its economy. Fig. 1.

However, note that the fiscal state largely differs among public subsectors in Japan. The central government (CG) has a large primary deficit, unlike the whole of the local governments (WLG) and the whole

☆ I am grateful for financial support from the Japan Society for the Promotion of Science, Grant-in Aid for Science Research (C), 19K01720, and the anonymous reviewers and the editor. This final version omits some detailed explanations due to space limitations. Please contact me for more detailed information about my paper.

E-mail address: myoshida-az@omu.ac.jp.

[1] Professor of Graduate School of Economics, Osaka Metropolitan University, 1–1 Gakuen-cho, Naka-ku, Sakai-city, Osaka, 599–8231, Japan

[2] Japan's average year-on-year GDP growth rate was 0.807% over 1999–2019 and that of the advanced countries (except the G7 countries) was 3.358%. I calculated these figures using the World Economic Outlook Database, April 2021 (International Monetary Fund: IMF).

[3] The general government consists of a central government, local governments, and social security funds.

[4] These figures were reported by (1) OECD: https://data.oecd.org/gga/general-government-deficit.htm, accessed in November 2021 and (2) World Economic Outlook Database, April 2021 (IMF): https://www.imf.org/en/Publications/WEO/weo-database/2021/April, accessed in October 2021.

[5] These figures were reported by (1) FY2019's National Accounts (Cabinet Office, Japan) and (2) Principal Global Indicators (IMF): https://www.principalglobalindicators.org /?sk=e30faade-77d0–4f8e-953c-c48dd9d14735&sId= 1390023474041, accessed in October 2021.

https://doi.org/10.1016/j.japwor.2023.101178
Received 30 March 2022; Received in revised form 20 February 2023; Accepted 1 March 2023
Available online 5 March 2023

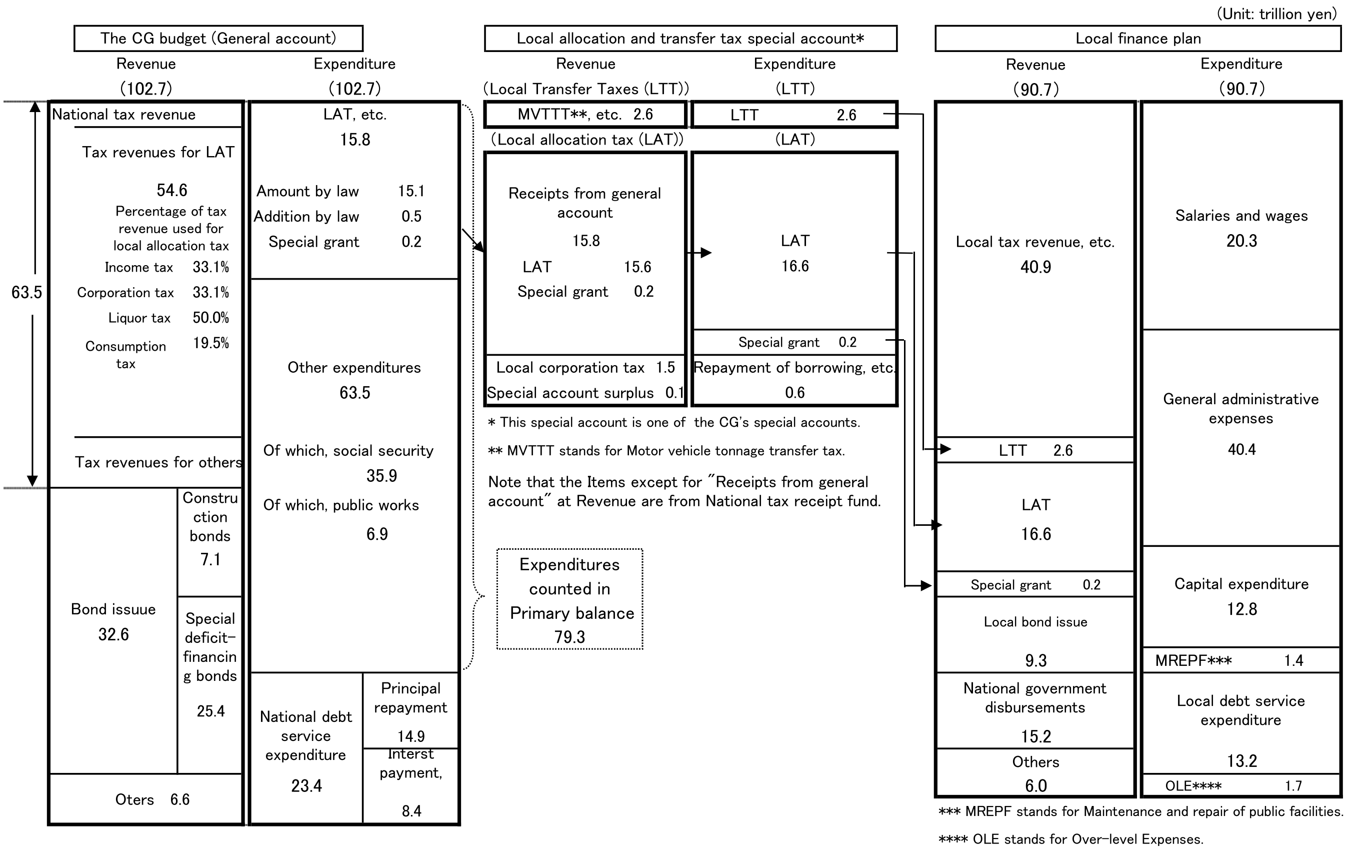

Fig. 1. Fiscal relationship between CG and WLG: ordinary balance and initial budget for FY2020,
Source: By author using *Relationship of the national budget and local finance plan* (ordinary balance; initial budget for FY2020) (Ministry of Internal Affairs and Communications).

of the social security funds (WSSF) (Fig. 2).[6] Moreover, GG is comprised of CG, WLG, and WSSF, and its finances merely reflect the total outcome produced by each public subsector's actions. Based on the expenditure/GDP ratios of all four government sectors, the total weight of WLG and WSSF in GG has remained basically identical to CG since 1991. Therefore, scrutiny of each public subsector's behavior is critical for comprehensively understanding Japan's public sector's posture on its fiscal policy.

Based on the above context and situation, some studies assessed the fiscal sustainability of Japan's government with Bohn's (1998a, 2008) fiscal reaction function (FRF), i.e., examining the reaction of the primary surplus/GDP ratio (primary surplus = government revenue minus expenditure exclusive of interest payments on debt) to the increase of the government debt/GDP ratio. Ihori et al. (2001) did not verify Japan's CG's fiscal sustainability during FY1965–1998 (FY: fiscal year). Doi et al. (2011) also rejected GG's fiscal sustainability for 1980Q1–2010Q1, allowing for the possibility of regime changes. On the contrary, Fujii (2010) supported CG's fiscal sustainability over 1992Q2–2007Q1, and Mochida (2015) defended WLG's fiscal sustainability during 1980Q1–2011Q4. Yoshida (2019) scrutinized the fiscal sustainability of GG, CG, WLG, and WSSF by a state-space model with the Kalman filter (SSMWKF) over FY1970–2017 and suggested that both GG and CG have failed to sustainably manage their finances since the late 1990 s

Unfortunately, previous research works suffer from the following shortcomings: (1) Based on the changes in the primary surplus/GDP ratio and the government debt/GDP ratio in each government sector, each government sector seems to change its fiscal posture as the surrounding conditions shift and move (Figs. 2 and 3). Doi et al. (2011) estimated in two regimes FRFs with a Markov-switching model (MSM). Fujii (2010) separated the analysis period into initial and subsequent parts with a recursive Chow test. However, due to the small sample-size problem with annual data, existing research (except Doi et al., Fujii, and Yoshida, 2019) did not elucidate the chronological changes of the governments' fiscal policies. (2) Although comprehensive research (including all the government sectors) helps analyzers minutely assess whether Japan's public finance has been sustainably functioning, only Yoshida (2019) has simultaneously scrutinized every public subsector. (3) The research results are dependent on the dataset. (4) Even the studies listed above in Item (1) did not scrutinize the factor that caused the structural changes regarding government-finance posture. (5) Except Nguyen et al. (2016), which compared the performance between an ordinary least-squares (OLS) model and an SSMWKF, most studies did not shed light on performance comparisons among estimation models (methods). (6) Only Yoshida (2019) developed time-varying parameter models with effective control variables[7] using an SSMWKF, as in Burger et al. (2012), Nguyen et al. (2016), and Paniagua et al. (2017). (7)

[6] In this paper, public sector denotes GG and public subsector denotes each subsector from which GG is comprised: CG, WLG, and WSSF. I use government sector(s) to explain some issues with all four government sectors (GG, CG, WLG, and WSSF) as argument targets. The setting of GG and the categorization of CG, WLG, and WSSF in GG follow the guidelines in the standard national accounts adopted worldwide.

[7] In this paper, a model (function) with only non-time-varying parameters is called a non-time-varying parameter model and one with only time-varying parameters or both non- and time-varying parameters is a time-varying parameter model.

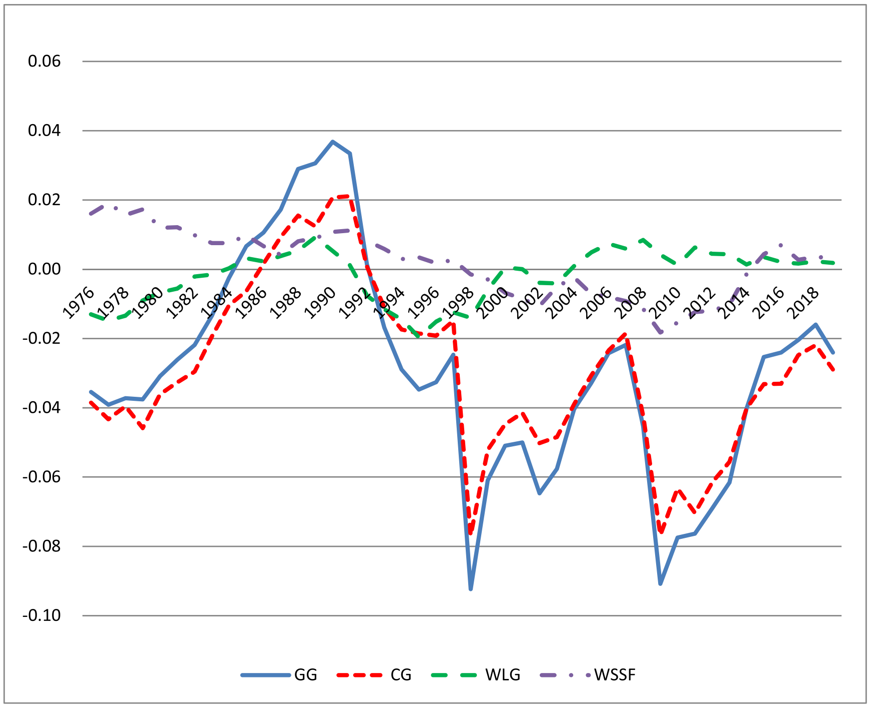

Fig. 2. Primary balance/GDP by government sector,
Source: By author using data from NAs of FY1998, FY2009, and FY2019.

Despite using time-series data, most research (except Yoshida, 2020) did not thoroughly investigate whether the estimated FRFs are ordinary regressions or cointegration relationships. (8) Most research (except Yoshida, 2020) did not consider the effects of fiscal transfers among public subsectors (see Sections 2 and 4.1.). Moreover, (9) although Mahdavi (2014) and Ghosh et al. (2013) considered the relationship between government-finance posture and political and socio-economic conditions, most research did not.

Therefore, I tackled the above shortcomings in the following steps. First, I estimated the quarterly figures of the variables used in this study for 1976Q2–2020Q1 with data from such resources as National Accounts (NAs) (Cabinet Office, Government of Japan) and White Paper on Local Public Finance (WPLPF) (Ministry of Internal Affairs and Communications, Government of Japan) and prepared a dataset whose sample size is sufficient to appropriately scrutinize fiscal-policy changes.[8] Second, I confirmed the properties of the regression models through unit root tests on each variable and cointegration tests on each combination of variables, allowing for structural change(s), as in the following previous works: Perron (1989), Zivot and Andrews (1992), Lee and Strazicich (2003), and Gregory and Hansen (1996). Third, I elucidated the chronological changes of the governments' fiscal policies with four different estimation models: (1) a first-order autoregressive (AR(1)) error (AR1E) model, i.e., a regression model with first-order autoregressive errors, or an OLS model, (2) an MSM, (3) a least-squares with breakpoints (LSWB) model, and (4) an SSMWKF. I eventually compared the estimation performance among the models and obtained robust results. I considered the effects of fiscal transfers among public subsectors and political and socio-economic conditions and investigated the factor that convinced each government to change its fiscal policy using a discrete threshold regression model (TRM) developed by Hansen (1999) with a threshold variable, which explains the state of the economy and the government sectors' finances.

The following are the main findings of this study: (1) The estimation of the LSWB model outperformed the others. (2) CG engaged in sustainable fiscal policy from the late 1970 s through the 2000 s. These findings are consistent with GDP changes and the implementation of fiscal consolidation measures by CG. WLG sustainably managed its finances around the 1990 s. WSSF has basically failed to manage its finances sustainably since the beginning of the 2010 s. GG has been in an unfavorable state for fiscal sustainability since the mid-1990 s (3) The results of the LSWB models and the discrete TRMs demonstrate that CG and WSSF were compelled by Japan's economic state to adjust their fiscal postures, and fiscal severity caused WLG to change its posture for the analysis term.

The rest of this paper is organized as follows. Section 2 introduces related literature and describes the fiscal relationships in GG. Section 3 reviews the theoretical backbone of Bohn's method, and Section 4 explains my empirical models and data. Section 5 describes and scrutinizes my analysis results. Section 6 concludes the paper.

2. Related literature[9] and fiscal relationship of Japan's public subsectors

Since anxiety about public deficits and debt is growing in both developed[10] and developing countries, many studies have investigated

[8] Doi et al. (2011) also created quarterly data for 1980Q1–2010Q1 on the fiscal variables of GG and the sum of CG and WLG with NAs and WPLPF, etc. However, their calculation mainly differs from mine in the following three points: (1) I created the quarterly data of WLG with the quarterly data of WPLPF, following Mochida (2015); (2) I created CG's data with the estimated quarterly data of GG, WSSF, and WLG; (3) they used data from the Bank of Japan's Flow of Funds to match the seasonal patterns of the outstanding government-debt series that were estimated quarterly; I directly estimated the quarterly outstanding government-debt series using estimated net lending/net borrowing figures.

[9] This section explains the lineage of research on government fiscal sustainability before Bohn's method, Bohn's method and its extension, and the remaining important literature.

[10] The U.S. has faced both current balance and public deficits, and the European Union member countries are subject to two restrictions: keeping their public debt/GDP ratio below 60% and their public deficit/GDP ratio below 3%.

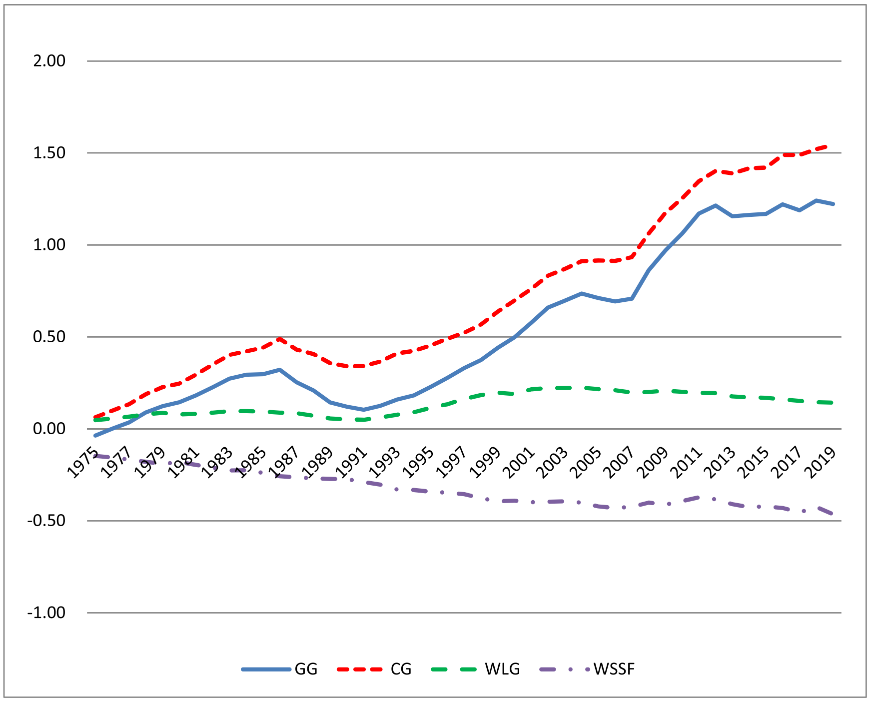

Fig. 3. Net debt/GDP by government sector, Note: Net debt denotes amount of government financial liabilities minus its financial assets.
Source: By author using data from NAs of FY1998, FY2009, and FY2019.

whether a government satisfies its intertemporal budget constraint (IBC) based on its past finance management posture.[11] Hamilton and Flavin (1986), Wilcox (1989), and Kremers (1989) tested the above question by examining the stationarity of outstanding debt or the deficit inclusive of interest payments (or each variable's ratio to GDP) using unit root tests. Trehan and Walsh (1988) and Quintos (1995) examined the cointegration between government expenditures and revenues. However, their results depend on assumed interest-rate properties and face a low power problem with a dataset whose sample size is insufficiently large. To avoid these drawbacks, Bohn (1998a, b, 2008) argued for a sufficient condition to satisfy the IBC, i.e., the primary surplus positively reacts to debt accumulation, and supported the sustainability of the U.S. federal government's finances for 1916–84 and 1792–2003.[12] Using his method, Mendoza and Ostry (2008) examined with panel data the GG-finance sustainability of 34 developing countries from 1990 to 2005 and 22 industrially developed countries from 1970 to 2005. Mahdavi (2014) supported the fiscal sustainability of American state governments with 1962–2008 data.

Although Bohn used constant parameter FRF models, time-varying parameter models have recently been proposed. First, a two-regime MSM estimated regime-specific parameters. For example, Cassou et al. (2017) described the fiscal sustainability of the U.S. federal government during good economic times from 1955Q1–2013Q3. Second, Burger et al. (2012), Nguyen et al. (2016), and Paniagua et al. (2017) respectively elucidated with SSMWKFs the fiscal sustainability of the South African government since the end of the 1980 s, the fiscal unsustainability of the U.S. federal government since 2005, and the failures to sustainably manage government finances in Finland, the Netherlands, and France for 1970–2014.

Next, I review the remaining pertinent literature. First, Yoshida (2020) argued that adequate fiscal transfers from CG would improve prefecture-government finances by a panel data analysis for 1973–2016. Second, Sakuragawa and Sakuragawa (2020) also addressed the small sample-size problem and constructed Japan's FRF with the data of 23 OECD countries (1985–2014), assuming similarity among the citizens' attitudes on fiscal policies in advanced countries. Third, although studies are quite scarce that examine the cause that shifts the government's fiscal posture, Legrenzi and Milas (2013) estimated the FRFs of Greece, Ireland, Portugal, and Spain for 1960–2012, revealing that the debt size or the economic cycle compelled governments to shift their fiscal postures by a logistic smooth TRM.[13] Fournier and Fall (2017), who scrutinized "fiscal fatigue"[14] and the debt limits of 31 OECD countries with panel data for 1985–2013, utilized the debt/GDP ratio as a threshold variable in a discrete TRM. Fukuda and Yamada (2011) clarified that the Japanese government's implicit stock-price targeting explains well the fiscal expenditure increase after the speculative bubble's burst with data for the 1990 s and 2000 s

Subsequently, I outline the fiscal relationships among Japan's public subsectors to clarify my discussion in Section 5. CG greatly supports the finances of WLG and WSSF. First, the relationship between CG and WLG, which is comprised of all prefecture governments and municipality governments (cities, towns, and villages) (Fig. 1), clearly indicates the following: (1) WLG relies on such fiscal transfers from CG for its fiscal operation as *Local allocation tax* (LAT: general grant) and *National government disbursements* (NGDs: specific subsidies and grants). (2) Since the Ministry of Finance and the Ministry of Internal Affairs and Communications decide the total expenditure level of CG and WLG using the levels

[11] There are two main research fields regarding government fiscal sustainability. One examines government-fiscal posture in the past by econometrics techniques, and the other elucidates future fiscal states by computable simulation techniques. Due to space limitations, I focus on a review of the former. Regarding the latter, see the appendix of Yoshida (2018).

[12] Bohn (2007) proved the following: (1) the IBC is satisfied even if the debt series is integrated at an arbitrarily high order or the government expenditure series inclusive of interest payments and revenue series have the same property as the above debt series; (2) revenues and expenditures do not have to be cointegrated for the IBC; (3) unit-root and cointegration tests eventually become incapable of rejecting fiscal sustainability.

[13] See Dijk et al. (2002) for details of smooth TRMs.

[14] This is a phenomenon where the primary balance may still be an increasing function of outstanding debt but at a decreasing rate.

Table 1
Data sources.

Panel A: Main variables	
Source	Note
A: Annual data	
National Accounts (Cabinet office)	Issues for FY1998, FY2009, and FY2019
B: Data to Calculate Quarterly Figures	
GG	
National Accounts (Cabinet office)	Issues for FY1998, FY2009, and FY2019
WSSF	
National Accounts (Cabinet office)	Issues for FY1998, FY2009, and FY2019
WLG	
National Accounts (Cabinet office)	Issues for FY1998, FY2009, and FY2019
White Paper on Local Public Finance (WPLPF) (Ministry of Internal Affairs and Communications)	Issues for FY1970–2019
CG	
National Accounts (Cabinet office)	Issues for FY1998, FY2009, and FY2019
GDP, GDP deflator	
National Accounts (Cabinet office)	Issues for FY1998, FY2009, and FY2019

Panel B: Control and threshold variables		
Item	Source	Notes
Number of members of House of Representatives by party		
	Appendix of precedent collection of House of Representatives (Office of House of Representatives)	Issue in 2017
	Movement of House of Representatives (Office of House of Representatives)	Issues since 2016
Number of members of House of Councilors by party		
	Homepage of House of Councilors by party	URL: https://www.sangiin.go.jp/japanese/san60/s60_shiryou/giinsuu_kaiha.htm (Accessed on July 13, 2022)
Number of applications of public assistance		
	Survey of public assistance recipients (Ministry of Health, Labour and Welfare)	Summary of Results in 2020
Total population		
Population aged 65 and over		
	Population estimates (Statistics Bureau)	"Time-series data" until 2015, "Annual data" since 2016
Projected total population and projected population aged 65 and over		
	Population projections (National Institute of Population and Social Security Research (NIPSSR)) (Institute of Populaton Problems: NIPSSR's predecessor)	Issues in 1975, 1976, 1981, 1986, 1992, 1997, 2002, 2006, 2012, and 2017
Export of Rest of the World		
Receivable property Income of Rest of the World		
	National Accounts (Cabinet office)	Issues for FY1998, FY2009, and FY2019
Composite leading index		
	Indexes of Business Conditons (Cabinet office)	13th revised Indexes
	# Data before 1980	Annual Report on Business CycleIndicators (Economic Planning Agency)

of LAT and local bond issues as adjusting valves, CG eventually finances revenue shortages in the CG and WLG total by issuing special deficit-financing national bonds. CG's primary deficit can be largely attributed to this function. Next, CG provides many subsidies to WSSF, which is comprised of special accounts related to the social security of the national and local governments[15] and other public organizations responsible for medical insurance, pension insurance, long-term care insurance business, etc. In fact, (1) of the 95.3 trillion yen (initial budget for FY2020, likewise for Items (2)-(4)) in the total revenue in the *National pensions special account* that manages public pension and medical insurance benefits in Japan, 14.6 trillion was transferred from CG. (2) Of the 24.2 trillion yen in total revenue in the *National health insurance account* in each region, 3.4 trillion was NGD from CG. (3) Of the 16.5 trillion yen in total revenue in the *Medical care account* for latter-stage elderly in each region, 5.4 trillion was NGD from CG. (4) Of the 11.6 trillion yen in total revenue in the *Elderly care insurance account* in each region, 2.6 trillion was NGD from CG.

3. Theoretical backbone of Bohn's (1998a, 2008) method[16]

Bohn (1998b) identified the sufficient conditions for government fiscal sustainability under a GDP (aggregate income) stream with a finite present value:

$$s_t = \beta d_{t-1} + \mu_t, \tag{1}$$

$$s_t = f(d_{t-1}) + \mu_t, \tag{2}$$

where $\beta(>0)$, s_t, d_{t-1}, and μ_t respectively denote the primary surplus/GDP ratio, the government debt/GDP ratio at the end of the previous period, and an error term following a bounded stochastic process. Subscript t indexes the periods. If d^* exists and satisfies $f'(d_{t-1}) \geq \beta > 0$, $\forall d \geq d^*$, then Eq. (2), which is non-linear, can also be a sufficient condition.

Assuming a government finances a stochastic path of its spending G_t by tax revenue T_t and borrowing from financial markets, Bohn (1995) set the following government budget constraint in period t:

$$D_t + G_t - T_t = \sum_{s_{t+1} \in S_{t+1}} p(s_{t+1}|h_t) D(s_{t+1}|h_t) \tag{3}$$

where D_t, s_t, $h_t = (s_t, s_{t-1}, \ldots, s_0)$, and $p(s_{t+1}|h_t)$ respectively denote the government debt at the start of period t, an element of set S_t, which is the state of society at each period t, an element in set H_t, which is the economy's history up to period t, and the price of securities at period t. Assuming that all individuals are equal, Bohn (1995) also derived the following transversality condition (TVC) and the IBC based on Eq. (3):

$$\text{TVC} : \lim_{N\to\infty} E_t[u_{t,N} D_{t+N}] = 0, \tag{4}$$

$$\text{IBC} : D_t = \sum_{n=1}^{\infty} E_t\left[u_{t,n}(T_{t+n} - G_{t+n})\right] \tag{5}$$

where $u_{t,N}$, $D_{t+N} = d_{t+N}GDP_{t+N}$, T_t, and G_t respectively denote the marginal substitution rate between periods t and $t+N$, the government debt after N periods from t, the government tax revenue, and the government expenditure exclusive of interest payments on debt. d_{t+N} is the government debt/GDP ratio after N periods from t. Then Bohn (1998b) proved that Eqs. (1) or (2) satisfy Eq. (4) and (5) using the property of $\lim_{n\to\infty}(1-\beta)^n d_t = 0$ for $n > N$ (if $1 > \beta > 0$).[17]

[15] CG and WLG do not include these special accounts.
[16] For details, see Bohn (1995, 1998a, b, and 2008).
[17] Since the $(1-\beta)^n$ for $1 > \beta > 0$ factor reduces the government debt more than in a Ponzi scheme, government debt does not diverge. Even if $|\beta|$ is quite trivial, the debt after infinite periods converges to zero and the IBC is held.

4. Empirical model and data

4.1. Unique regressors of this study

To inspect such fiscal-transfer effects as Mahdavi (2014) and Yoshida (2020), I created an original variable that explains fiscal-transfer intensity by extending Yoshida's method:

$$rd_t \equiv grrate\ of\ net\ grant_t - grrate\ of\ GDP_t, \tag{6}$$

$$grrate\ of\ net\ grant_t \equiv \left(net\ grant_t - average\ net\ grant_{1976Q2-1977Q1}\right) / average\ net\ grant_{1976Q2-1977Q1},$$

$$grrate\ of\ GDP_t \equiv \left(GDP_t - average\ GDP_{1976Q2-1977Q1}\right) / average\ GDP_{1976Q2-1977Q1},$$

where *net grant* is the amount calculated by subtracting the total amount of the general and specific payable grants and subsidies from the receivable ones and t indexes the quarterly periods. A positive figure of this variable of WLG and WSSF means that the net financial transfer from CG to them exceeds Japan's economic state. Simultaneously, a positive CG figure means that the financial transfer from it to WLG and WSSF is richer since its net fiscal-transfer amount is negative at every period. Assuming that *net grant* supports the public subsectors, except CG, this variable should negatively influence CG's primary surplus and positively influence those of the other public subsectors. However, note that *net grant* might consume more of the WLG and WSSF budgets if the burden owed by them accompanying fiscal transfers from CG is sufficient large.

Next, I created the growth rates from the previous period regarding the following five variables as control variables to examine the influences of political and socio-economic conditions on the government's fiscal posture: (1) liberal-representative ratio to the total in the House of Representatives (in the Diet); (2) liberal-councilor ratio to the total in the House of Councilors; (3) ratio of public-assistant applications to the total population; (4) ratio of exports of *Rest of the World* to Japan to its GDP; (5) ratio of property-income receipts of *Rest of the World* to Japan's GDP. I also prepared as the sixth control variable, (6) the first-order difference of differences of the actual ratios of seniors 65 and over to the total population minus the projected ratios.[18] I refer to these variables by the following names in this order: *gr_liberatiorep*, *gr_liberaratioco*, *gr_paratio*, *gr_exratio*, *gr_proinratio*, and *d_unexagratio*. The first two control variables detect the liberal party's negative influences on fiscal sustainability based on the linkage of partisan changes to the policy consequences (Hibbs, 1977). Simultaneously, the liberal parties, e.g., the Democratic Party of Japan (DPJ) that briefly held power from 2009 to 2012, started to consider fiscal discipline after the fiscal sustainability issue emerged in developed countries. Therefore, these variables might have positively affected fiscal sustainability since the mid-2000 s. The third variable's effect is supposedly negative since growing public assistance is assumed to consume more government resources. However, excessively burgeoning public assistance might cause governments to tighten their finances. The fourth and fifth variables sometimes show positive effects since both are expected to reveal the openness of Japan's market and pressure from abroad on its public sector. Contrarily, they might negatively affect government finances if the amount of the value-added outflow overseas is too large. The last variable is expected to detect any negative impact of an unexpected deepening of an aging society, which also likely consumes government resources. However, this deepening might induce a positive effect like excessive bourgeoning of public assistance.

Table 2
Variable list.

Panel A: Annual data

Variable	Utilized Original Data	Derivation
Primary Balance	a. Primary balance b. Financial surplus and deficit c. Interest payments d. Interest receipts	
Net Debt Outstanding	a. Financial assets b Financial liabilities	b - a
Government Expenditure (exclusive of net interest payments)	a. Government expenditures b. Interest payments c. Interest receipts	a - (b - c)
Net Grant	a. Intergovernmental fiscal transfers, receivable b. Intergovernmental fiscal transfers, payable	a - b
GDP	a. GDP	
GDP Deflator	a. GDP deflator	

Panel B: Variables to calculate quarterly figures

GG	WSSF
Gross fixed capital formation	Property income, receivable
Consumption of fixed capital	Property income, payable
Changes in inventories	Social contributions, receivable
Purchases of land, net	Other current transfers, receivable
Saving, net	Social benefits other than social transfers in kind, payable
Capital transfers, receivable	Other current transfers, payable
Capital transfers, payable	Final consumption expenditure
Interest, payable	Capital transfers, receivable
Interest, receivable	Capital transfers, payable
Current transfers within general government, payable	Gross fixed capital formation
Current transfers within general government, receivable	Consumption of fixed capital
WLG	Changes in inventories
Debt service (*)	Purchases of land, net
Reserves (*)	Interest, payable
Local government loans (*)	Interest, receivable
Transfers from other accounts (*)	Current transfers within general government, payable
Total expenditure (*)	Current transfers within general government, receivable
Interest, payable	**CG**
Interest, receivable	Using the above governments' figures
Current transfers within general government, payable	**GDP related**
Current transfers within general government, receivable	GDP & GDP deflator

Notes: 1. Government expenditure includes net land-purchase costs.
2. Variables with (*) are from WPLPF. 3. All others are from NAs.

4.2. Empirical models

I first estimated the FRFs with non-time-varying parameters from 1976Q2–2020Q1 using the following AR1E model[19] or the OLS model; the latter was adopted when no autoregressive process of the error term

[18] I adopted the ratio of one previous "Population projections" (by NIPSSR: see Table 1-Panel B) of the latest version for each period during the analysis term. This is because an analyzer ought to suppose that each public subsector cannot flexibly change its fiscal posture in a relatively short run, paying attention to the facts that (1) CG implements an actuarial review of Japan's public-pension finance every five years and (2) NIPSSR also projects the future population in Japan every five years.

[19] This model was estimated by the maximum likelihood (ML) method.

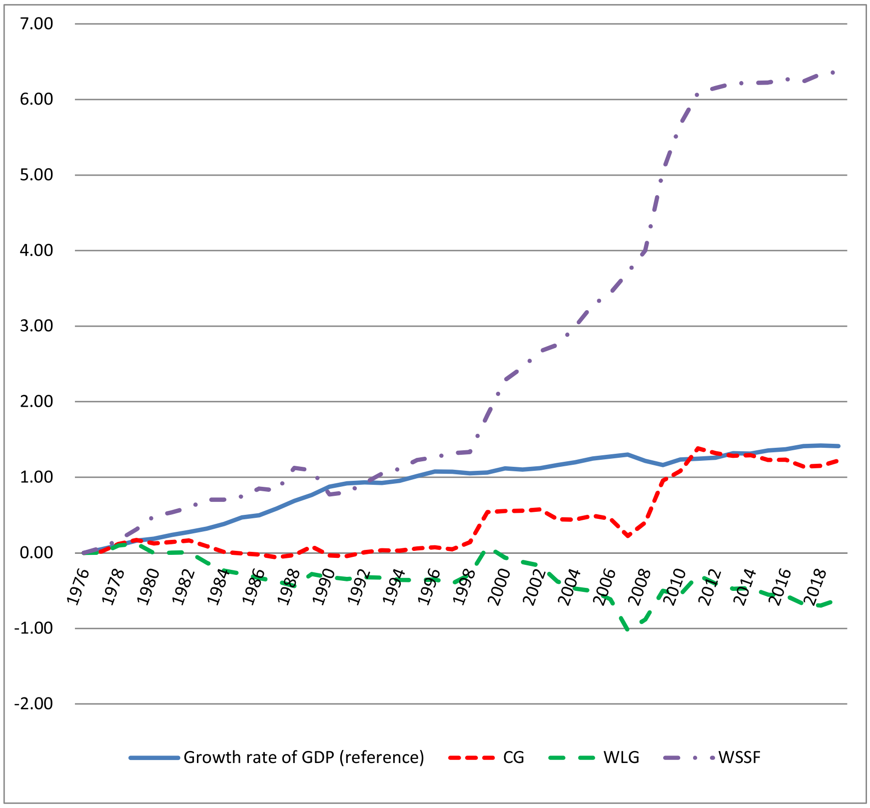

Fig. 4. *rd* by public subsector and growth rate of GDP,
Source: By author using data from NAs of FY1998, FY2009, and FY2019.

Table 3
Gregory and Hansen cointegration test with a break.

Object	s, d, dsq					s, s (−1), d, dsq					s, s (−1), d, dsq (except WSSF), rd				
Government	Statistic		Level	Critical value	Break point	Statistic		Level	Critical value	Break point	Statistic		Level	Critical value	Break point
GG	Zα	-62.65	0.01	-57.01	1992Q4	Zα	-242.51	0.01	-63.64	2009Q4	Zα	-232.87	0.01	-70.18	1991Q4
	Zt	-6.34	0.01	-5.44	1992Q4	Zt	-18.98	0.01	-5.77	2007Q3	Zt	-17.76	0.01	-6.05	1991Q4
CG	Zα	-173.02	0.01	-57.01	1983Q2	Zα	-209.48	0.01	-63.64	2010Q4	Zα	-181.78	0.01	-70.18	2003Q3
	Zt	-13.03	0.01	-5.44	1983Q2	Zt	-15.25	0.01	-5.77	2007Q2	Zt	-13.71	0.01	-6.05	2003Q3
WLG	Zα	-78.24	0.01	-57.01	2005Q1	Zα	-193.55	0.01	-63.64	1989Q1	Zα	-190.98	0.01	-70.18	1989Q1
	Zt	-7.17	0.01	-5.44	2005Q1	Zt	-14.61	0.01	-5.77	1989Q1	Zt	-14.40	0.01	-6.05	1989Q1
WSSF	Zα	-277.56	0.01	-57.01	2013Q2	Zα	-177.77	0.01	-63.64	2013Q2	Zα	-188.04	0.01	-63.64	2013Q2
	Zt	-25.54	0.01	-5.44	2013Q2	Zt	-13.39	0.01	-5.77	2013Q2	Zt	-14.21	0.01	-5.77	2013Q2

Note: s (−1) denotes s_{t-1}.

(Eq. (8)) was confirmed.[20]

AR1E or OLS model

$$s_t = \alpha_c + \alpha_s s_{t-1} + \alpha_d d_{t-1} + \alpha_{dsq} dsq_{t-1} + \alpha_{gvar} GVAR_t + \alpha_{yvar} YVAR_t + \alpha_{rd} rd_t + \boldsymbol{Z}_t' \boldsymbol{\alpha}_{co} + \varepsilon_t, \tag{7}$$

$$dsq_{t-1} \equiv (d_{t-1} - \overline{d})^2,$$

$$GVAR_t \equiv (G_t - G_t^*)/GDP_t,$$

$$YVAR_t \equiv (1 - GDP_t/GDP_t^*)(G_t^*/GDP_t),$$

$$\varepsilon_t = \rho \varepsilon_{t-1} + \nu_t, \tag{8}$$

$$E(\nu_t) = 0,\ E(\nu_t^2) = \sigma_\nu^2,\ E(\nu_t \nu_s) = 0 \text{ for } t \neq s.$$

Here d_{t-1}, $\overline{d}$, G_t^*, and GDP_t^* respectively denote the net government debt[21]/GDP ratio at the end of the previous quarter, the average d_{t-1} during the analysis term, and the trends of G_t and GDP_t.[22] $GVAR_t$ and $YVAR_t$ indicate the level of temporary government spending and the output gap; these definitions are identical as those in Barro (1986) and Bohn (1998a). $GVAR_t$ is expected to worsen s_t, and $YVAR_t$ is also expected to worsen (improve) the s_t of a government engaging in a

[20] I prepared AR1E or OLS models and SSMWKFs, adding s_{t-1} and unique control variables to Yoshida's (2019, 2020) models.

[21] This net debt equals the amount of the government's financial liabilities minus its financial assets.

[22] dsq_{t-1} observes whether a higher d_{t-1} convinces a government to improve s_t more.

countercyclical (procyclical) fiscal policy. $\boldsymbol{Z}_t$ and $\boldsymbol{\alpha}_{co}$ are vectors of the control variables and their coefficients. Error term ε_t might follow an autoregressive process of order one (AR (1)) (Eq. (8)). Error term ν_t is independent and identically distributed (i.i.d.) normal. I also added s_{t-1} as a regressor like Burger et al. (2012) to allow for inertia in the government posture.

Note that each government sector is expected to react to d_{t-1}. This setting reflects that both CG and each local government ordinarily make multiple budgets (including initial and supplementary budgets, and a provisional budget if necessary) in a fiscal year. Therefore, it is valid to use the quarter data and adopt d_{t-1} and dsq_{t-1} as the main regressors, like Doi et al. (2011) and Fujii (2010).[23]

Subsequently, I adopted a two-regime MSM, an LSWB model, and an SSMWKF to assess the chronological changes of each government sector's fiscal policies:

Two-regime MSM

$$s_t = \alpha_c(st_t) + \alpha_s(st_t)s_{t-1} + \alpha_d(st_t)d_{t-1} + \alpha_{dsq}(st_t)dsq_{t-1} + \alpha_{gvar}(st_t)GVAR_t + \alpha_{yvar}(st_t)YVAR_t + \alpha_{rd}(st_t)rd_t + \boldsymbol{Z}_t'\boldsymbol{\alpha_{co}}(st_t) + \sigma(st_t)\varepsilon_t, \tag{9}$$

where st_t denotes a fiscal-policy regime that follows a first-order, two-regime Markov process with a transition matrix:

$$P = \begin{pmatrix} p_{11} & 1-p_{22} \\ 1-p_{11} & p_{22} \end{pmatrix},$$

where the (i,j) element of P denotes transition probability p_{ij} that the policy regime moves from regimes i to j. In my context, regime is interpreted as each fiscal-policy posture in the concerned period. ε_t is i.i.d. standard normal.

LSWB model

$$s_t = \boldsymbol{X}_t'\boldsymbol{\beta}_j + \varepsilon_t, j = 0, \ldots, m. \tag{10}$$

Here j indexes the $m+1$ regimes whose number is endogenously determined. The regressors of Eq. (7) belong to $\boldsymbol{X}_t$. ε_t is i.i.d. with mean zero and finite variance.

SSMWKF.[24]

$$\begin{aligned} s_t &= \alpha_c + \alpha_s s_{t-1} + \alpha_{d,t}d_{t-1} + \alpha_{dsq}dsq_{t-1} + \alpha_{gvar}GVAR_t + \alpha_{yvar}YVAR_t + \alpha_{rd}rd_t + \varepsilon_t, \\ &\varepsilon_t \sim N(0,\sigma_\varepsilon^2), \sigma_\varepsilon^2 = \exp(\theta_1). \end{aligned} \tag{11}$$

$$\alpha_{d,t} = \alpha_{d,t-1} + \eta_t, \eta_t \sim N(0,\sigma_\eta^2), \sigma_\eta^2 = \exp(\theta_2). \tag{12}$$

Eqs. (11) and (12) reveal the signal (observation) and state equations. Coefficient $\alpha_{d,t}$ of regressor d_{t-1} is a time-varying state variable, specified as a random walk (Nguyen et al., 2016).[25]

4.3. *Data*[26]

Tables 1 and 2 show the data sources and the annual and quarterly variables by which the necessary quarterly figures are calculated. The analysis term is 1976Q2–2020Q1. The following is the basic idea for making the quarterly figures of the main variables, except the control variables: (1) the annual figures of the necessary variables are collected and made with the annual data of NAs; (2) the ratios to proportionately divide Item (1)'s annual figures into quarterly ones are estimated with the quarterly data of NAs and WPLPF; (3) the quarterly figures of the necessary variables are estimated with the figures of Items (1) and (2). Next, I introduce some focal points for estimating the quarterly figures. The annual and quarterly figures were retroactively revised by focusing on the figures of the overlapping years and quarters among different issues of NAs. I standardized the amount of data with a quarterly GDP deflator (2015 calendar year = 100) and computed the trend levels of the government expenditures and GDP using the Hodrick-Prescott (HP) filter.[27] Finally, all the quarterly figures of the variables were seasonally adjusted using X12-ARIMA.

Subsequently, let me explain two aspects for creating the figures of the control variables. First, I selected the Social Democratic Party of Japan, the Japanese Communist Party, the DPJ, the Reiwa Shinsengumi, and other parties related to them (except the Democratic Party for the People) through the analysis term as liberal parties for creating *gr_liberatiorep* and *gr_liberatiorco*. Second, since no quarterly data exist for creating *gr_paratio* and *d_unexagratio*, I prepared quarterly figures of these two variables by cubic spline interpolation of the annual data.

Next, note the following aspect of the threshold variable, the *Composite leading index* (*cilead*) (2015 calendar year = 100),[28] utilized in a discrete TRM (Section 5.4.).[29] (1) This index's figures before January in 1985 were retroactively revised by focusing on the January 1985 figures of both the old and new series. (2) Since this index is monthly, I adopted the figure of the first month of each quarter as the concerned quarter's figure.

The descriptive statistics of the data are shown in Table A1.

Following Yoshida (2019), I chronologically graphed the primary balance/GDP ratio, the net government debt/GDP ratio, and the *rd* by

[23] Note that since Ostry et al. (2010), some research used a cubic term of d_{t-1} as a regressor of an FRF to argue for a debt limit above which the concerned outstanding debt theoretically diverges to infinity (Ghosh et al., 2013; Sakuragawa and Sakuragawa, 2020). Figs. 2 and 3 in this paper and Fig. 7 in Sakuragawa and Sakuragawa (2020), however, do not show the necessity of using a cubic term regarding Japan's government sectors. To err on the side of caution, I initially estimated the above model with cubic and quartic terms of d_{t-1}. As a result, none of those terms was significantly estimated, as expected, and these variables were considerably above 10 on the variance inflation factor (VIF) index in all the government sectors; these results were identical in cases with only a cubic term. Eventually, I decided not to adopt the cubic and quartic terms of d_{t-1} to avoid any efficiency loss of estimation, the overfitting problem, and multicollinearity, heeding a warning from Bohn (1998a).

[24] See the appendix in Nguyen et al. (2016) for the Kalman filter technique.

[25] I initially estimated the SSMWKFs with control variables. However, no control variable was significantly estimated. Therefore, I eventually adopted them without control variables.

[26] Although I created quarterly data to overcome the small sample-size problem of annual data, the calculation techniques include a wide range of measures and are quite complicated. Therefore, due to space limitations, I just outline them here.

[27] I set the penalty parameter of the HP filter to 1600.

[28] This index was compiled from such indexes as inventory ratio index of final goods, money stock, and stock-price index, etc. that fluctuate more than three months ahead of actual economic movements.

[29] I also estimated this model with the *Diffusion index of the financial position of large manufacturing enterprises* (the Bank of Japan's Tankan) as a threshold variable. Regarding this index, the value one month prior to the beginning of each quarter period was adopted as the concerned period's value. However, since the results were dull, I omitted to mention this threshold variable.

Table 4
Results of FRF estimation with LSWB models.

Term	1st		2nd		3rd		4th		5th	
Panel A: GG										
	1976Q2-1988Q1		1988Q2-1994Q3		1994Q4-2001Q1		2001Q2-2010Q1		2010Q2-2020Q1	
α_c	-0.329	***	-2.722	***	0.009		-0.041	*	0.023	
	(0.113)		(1.004)		(0.054)		(0.021)		(0.087)	
$\alpha_{s(-1)}$	0.214		-0.137		0.361	**	0.704	***	0.866	***
	(0.205)		(0.100)		(0.169)		(0.085)		(0.047)	
α_d	0.233	***	1.868	***	-0.017		0.012		-0.003	
	(0.081)		(0.678)		(0.030)		(0.008)		(0.027)	
α_{dsq}	0.067	***	0.681	***	-0.006		-0.005		-0.001	
	(0.024)		(0.252)		(0.018)		(0.004)		(0.006)	
α_{gvar}	0.573	***	-1.131	***	-0.368	**	0.019		-0.052	
	(0.155)		(0.360)		(0.158)		(0.288)		(0.101)	
α_{yvar}	-0.518		0.233		-1.772	***	-0.346	*	0.001	
	(0.353)		(1.681)		(0.596)		(0.190)		(0.098)	
α_{co1}	-0.041		0.114	***	0.034		0.001		-0.006	***
	(0.036)		(0.038)		(0.025)		(0.003)		(0.002)	
α_{co2}	-0.035		0.034	***	0.025		0.005		-0.012	***
	(0.034)		(0.009)		(0.024)		(0.016)		(0.002)	
α_{co3}	0.041		-0.469		-1.038	***	-0.226	***	0.448	***
	(0.225)		(0.373)		(0.229)		(0.035)		(0.085)	
α_{co4}	-0.060		-0.575	**	0.084		-0.061	**	0.043	**
	(0.044)		(0.279)		(0.083)		(0.029)		(0.018)	
α_{co5}	0.033		0.235	**	-0.002		-0.034	***	-0.010	
	(0.025)		(0.092)		(0.017)		(0.012)		(0.014)	
α_{co6}	4.613		6.057		6.729		-1.807		0.322	
	(4.436)		(13.804)		(6.400)		(2.148)		(0.952)	
Obs.	48		26		26		36		40	
Adj. R^2 0.920, AIC − 6.293, S.E. 0.009, Q-stat 5.246										
Panel B: CG										
Term	1st		2nd		3rd		4th		5th	
	1976Q2-1987Q4		1988Q1-1994Q2		1994Q3-2003Q4		2004Q1-2010Q2		2010Q3-2020Q1	
α_c	-0.521	***	-8.452	**	-0.172	**	-2.185	***	0.712	
	(0.134)		(4.037)		(0.085)		(0.623)		(0.591)	
$\alpha_{s(-1)}$	-0.099		-0.029		-0.459		-0.595	***	0.004	
	(0.205)		(0.167)		(0.727)		(0.077)		(0.259)	
α_d	0.253	***	3.779	**	0.041	**	0.619	***	-0.181	
	(0.066)		(1.809)		(0.019)		(0.181)		(0.139)	
α_{dsq}	0.061	***	1.401	**	0.066	*	-0.245	***	0.037	
	(0.017)		(0.664)		(0.038)		(0.071)		(0.025)	
α_{gvar}	0.696	**	-1.696		-0.659		-0.787		0.372	
	(0.293)		(1.134)		(0.663)		(0.911)		(0.410)	
α_{yvar}	-3.279	**	-1.155		-8.518	*	-1.470		-1.415	
	(1.272)		(5.728)		(4.634)		(1.758)		(1.772)	
α_{co1}	-0.046		0.141		0.076		-0.005		0.000	
	(0.032)		(0.089)		(0.052)		(0.013)		(0.013)	
α_{co2}	0.015		0.052		-0.079		0.072	***	-0.019	
	(0.048)		(0.035)		(0.104)		(0.026)		(0.014)	
α_{co3}	0.290		0.486		-0.820		-0.823	***	1.427	**
	(0.225)		(0.489)		(0.508)		(0.287)		(0.568)	
α_{co4}	-0.016		-0.381	**	0.096		-0.039		0.008	
	(0.049)		(0.174)		(0.104)		(0.064)		(0.072)	
α_{co5}	0.003		0.178	**	0.000		-0.069		0.089	
	(0.025)		(0.083)		(0.028)		(0.045)		(0.060)	
α_{co6}	4.801		15.115		2.154		-1.350		0.089	
	(4.709)		(14.871)		(13.679)		(9.642)		(4.877)	
Obs.	47		26		38		26		39	
Adj. R^2 0.688, AIC − 4.928, S.E. 0.018, Q-stat 1.673										
Panel C: WLG										
Term	1st		2nd		3rd		4th		5th	
	1976Q2-1982Q3		1982Q4-1990Q2		1990Q3-2002Q1		2002Q2-2010Q2		2010Q3-2020Q1	
α_c	-0.095		-0.022		-0.027		-0.806		-0.047	
	(0.101)		(0.097)		(0.007)		(0.867)		(0.048)	
$\alpha_{s(-1)}$	-0.147		0.215	**	-0.216		0.466	**	0.089	*
	(0.167)		(0.085)		(0.130)		(0.201)		(0.049)	
α_d	0.248		0.029		0.020	**	1.052		0.038	
	(0.250)		(0.221)		(0.008)		(1.257)		(0.074)	
α_{dsq}	0.246		0.318		0.206	***	-1.115		0.033	
	(0.441)		(0.493)		(0.030)		(2.094)		(0.247)	
α_{gvar}	-0.657		-1.616	***	-0.792	***	-0.275		0.267	

(*continued on next page*)

Table 4 (*continued*)

Panel C: WLG

Term	1st 1976Q2-1982Q3		2nd 1982Q4-1990Q2		3rd 1990Q3-2002Q1		4th 2002Q2-2010Q2		5th 2010Q3-2020Q1	
	(0.448)		(0.233)		(0.233)		(0.551)		(0.400)	
α_{yvar}	-0.268		0.793		-0.814	***	-3.109	**	0.406	
	(0.998)		(0.552)		(0.260)		(1.480)		(1.132)	
α_{rd}	-0.051		-0.004		0.009		-0.022	***	-0.038	***
	(0.045)		(0.011)		(0.008)		(0.007)		(0.011)	
α_{co1}	-0.004		-0.026	**	0.003		-0.004		0.006	**
	(0.022)		(0.010)		(0.005)		(0.004)		(0.003)	
α_{co2}	-0.005		-0.023	***	0.018	*	0.026		-0.001	
	(0.032)		(0.004)		(0.010)		(0.026)		(0.004)	
α_{co3}	-0.276		0.131		-0.098		0.416	**	-0.281	*
	(0.189)		(0.138)		(0.076)		(0.168)		(0.165)	
α_{co4}	-0.009		-0.039		0.009		0.000		0.021	
	(0.024)		(0.038)		(0.019)		(0.021)		(0.027)	
α_{co5}	0.007		-0.006		0.002		0.034		-0.019	
	(0.013)		(0.017)		(0.009)		(0.023)		(0.020)	
α_{co6}	-23.020	**	4.778	***	-1.391		-4.985		-2.382	
	(9.602)		(1.651)		(1.275)		(4.807)		(2.924)	
Obs.	26		31		47		33		39	

Adj. R^2 0.712, AIC − 7.316, S.E. 0.005, Q-stat 5.118

Panel D: WSSF

Term	1st 1976Q2-1982Q4		2nd 1983Q1-1990Q1		3rd 1990Q2-1997Q3		4th 1997Q4-2004Q1		5th 2004Q2-2010Q4		6th 2011Q1-2020Q1	
α_c	-0.012		0.013		0.035	***	-0.294		-0.026		-0.219	
	(0.024)		(0.004)		(0.013)		(0.240)		(0.103)		(0.142)	
$\alpha_{s(-1)}$	-0.356	*	0.214		0.056		-1.173	***	-0.031		-0.293	***
	(0.209)		(0.134)		(0.355)		(0.098)		(0.146)		(0.107)	
α_d	-0.061		0.015	***	0.025	*	-0.250		-0.010		-0.041	**
	(0.042)		(0.005)		(0.014)		(0.158)		(0.058)		(0.020)	
α_{gvar}	-0.808		-0.523	*	-0.412		7.224	**	-3.830		-2.451	***
	(1.551)		(0.271)		(0.468)		(2.884)		(3.498)		(0.815)	
α_{yvar}	0.959		-0.290		-0.310		0.109		0.317		-1.612	**
	(0.788)		(0.231)		(0.210)		(1.183)		(1.149)		(0.754)	
α_{rd}	-0.036	***	0.009	***	0.001		-0.051	***	-0.002		0.024	**
	(0.013)		(0.003)		(0.008)		(0.009)		(0.003)		(0.026)	
α_{co1}	0.001		-0.001		0.001		-0.031		-0.005		-0.009	
	(0.024)		(0.001)		(0.002)		(0.031)		(0.005)		(0.011)	
α_{co2}	-0.032	*	0.001	*	-0.004		0.186		-0.090	***	0.003	
	(0.018)		(0.001)		(0.006)		(0.154)		(0.033)		(0.012)	
α_{co3}	-0.016		0.023		0.017		0.096		-0.023		-0.232	
	(0.144)		(0.036)		(0.026)		(0.294)		(0.186)		(0.243)	
α_{co4}	0.010		0.002		-0.001		-0.011		0.066		-0.022	
	(0.013)		(0.010)		(0.007)		(0.092)		(0.063)		(0.045)	
α_{co5}	0.010		-0.005		0.000		0.055		0.094	*	-0.103	***
	(0.007)		(0.003)		(0.002)		(0.060)		(0.054)		(0.035)	
α_{co6}	- 7.207		-0.291		0.191		9.482		5.990		4.156	**
	(6.785)		(0.647)		(0.523)		(11.052)		(6.138)		(1.919)	
Obs.	27		29		30		26		27		37	

Adj. R^2 0.796, AIC − 6.227, S.E. 0.009, Q-stat 11.975

Notes: (Panel A) (1) co1 denotes gr_liberatiorep, co2 is gr_liberatioco, co3 is gr_paratio, co4 is gr_exratio, and co5 is gr_proinratio. (2) Q stat denotes Ljung-Box Q-statistic. (3) Newey-West HAC standard errors are in parentheses. (4) "***," "**," and "*" denote 1, 5, and 10 significance levels.
(Panel B) (1) co6 is d_unexagratio. (2) Others are identical as Panel A.
(Panel C; Panel D) Identical as Panel B.

public subsector in Fig. 2–4 with annual data and highlight the following: (1) The primary balance/GDP ratios of GG and CG have been unfavorable since the 1990 s (2) The net government debt/GDP ratios of GG and CG continued to grow over the observation term. (3) The unsoundness of GG's finances can be largely attributed to CG's finances. However, the unsoundness of CG's finances might be attributed to its function that finances the total revenue shortage of every public subsector (Section 2). (4) Fiscal transfers to WSSF intensively grew through the observation term.

5. Results

5.1. Properties of regression models[30]

I investigated the integration order of all the variables using the Augmented Dickey-Fuller (ADF) test and another test with a structural break (Perron, 1989; Zivot and Andrews, 1992). Although I omit the

[30] Nguyen et al. (2016) argued that a study with Bohn's method with time-series data should reveal whether the model is a cointegration relationship or a standard regression.

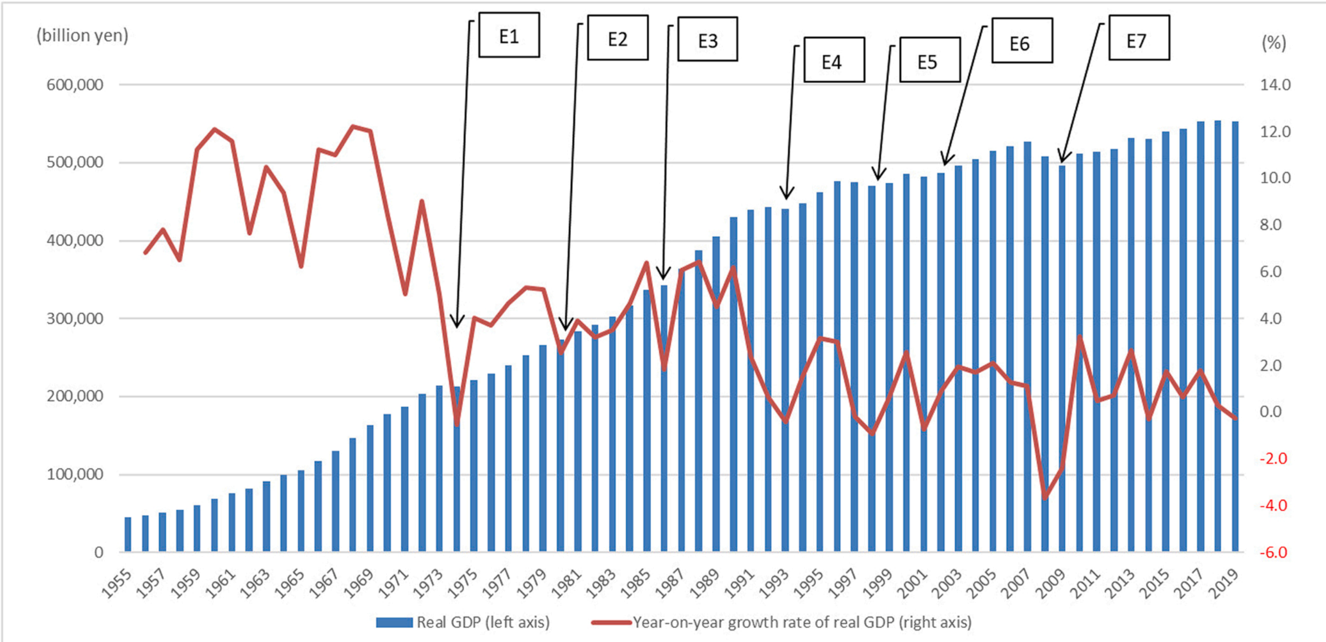

Fig. 5. Changes of level and year-on-year growth rate of real GDP in Japan, Legends: E1: First oil crisis; E2: Second oil crisis; E3: Depression caused by strong yen after Plaza Accord; E4: First Heisei-era depression; E5: Second Heisei-era depression; E6: Depression caused by collapse of information technology bubble; E7: Global financial crisis. Note: Figures of real GDP are standardized with GDP deflator (2015 calendar year = 100).
Source: By author using data from NAs of FY1998, FY2009, and FY2019.

Table 5
Results of FRF estimation with SSMWKF: non-time-varying parameters.

Government	GG		CG		WLG		WSSF	
α_c	-0.002		0.007		0.012			
	(0.036)		(0.060)		(0.017)			
$\alpha_{s(-1)}$			-0.461	***	-0.044			
			(0.052)		(0.068)			
α_{dsq}	-0.006		-0.008		-0.045			
	(0.008)		(0.008)		(0.073)			
α_{gvar}	-0.038		-0.019		-0.827	***	-0.876	
	(0.132)		(0.302)		(0.151)		(1.572)	
α_{yvar}	-1.368	***	-3.519	**	-0.078		-0.748	
	(0.269)		(1.550)		(0.390)		(1.759)	
α_{rd}					-0.002		-0.003	
					(0.005)		(0.005)	
θ_1	-8.912	***	-8.057	***	-10.940	***	-7.958	***
	(0.079)		(0.142)		(0.249)		(0.024)	
θ_2	-10.985	***	-11.285	***	-9.405	***	-13.735	***
	(0.215)		(0.330)		(0.172)		(1.134)	
LL	468.634		406.636		615.007		440.664	
AIC	-5.257		-4.541		-6.898		-4.951	
Obs.	176		176		176		176	

Notes: (1) Standard errors are in parentheses. (2) '***,' '**,' and '*' denote 1, 5, and 10 significance levels.

result details due to space limitations, the latter test results[31] clarified the following: (1)s_t, $GVAR_t$, and $YVAR_t$ are I(0) through every government sector[32]; (2) the other main variables are I(1)[33]; (3) every other control variable is also I(0). Next I examined the cointegration relationships on the concerned variable combinations at a level using the Gregory and Hansen (1996) test with a structural break. The results clarified that each regression model (Section 5.2.) was recognized not as a standard one but as a model nesting some cointegration relationships among the adopted variables (Table 3).[34] I implemented cointegration tests not to examine fiscal sustainability, as in Trehan and Walsh (1988) and Quintos (1995), but to confirm whether an appropriate pair of I (1)

[31] If the structural break is ignored, then the test result is biased toward the null that a unit root exists (Perron, 1989).
[32] Using the ADF test and the test with a structural break, the stationarity of s_t of GG, CG, and WSSF was not recognized. However, using the Lee and Strazicich (2003) test with two breakpoints or the data from 1970Q2–2020Q1, its stationarity was accepted.
[33] These results are consistent with those of Bohn (1998a, 2008).

[34] I also obtained identical results using the Johansen cointegration test with trace.

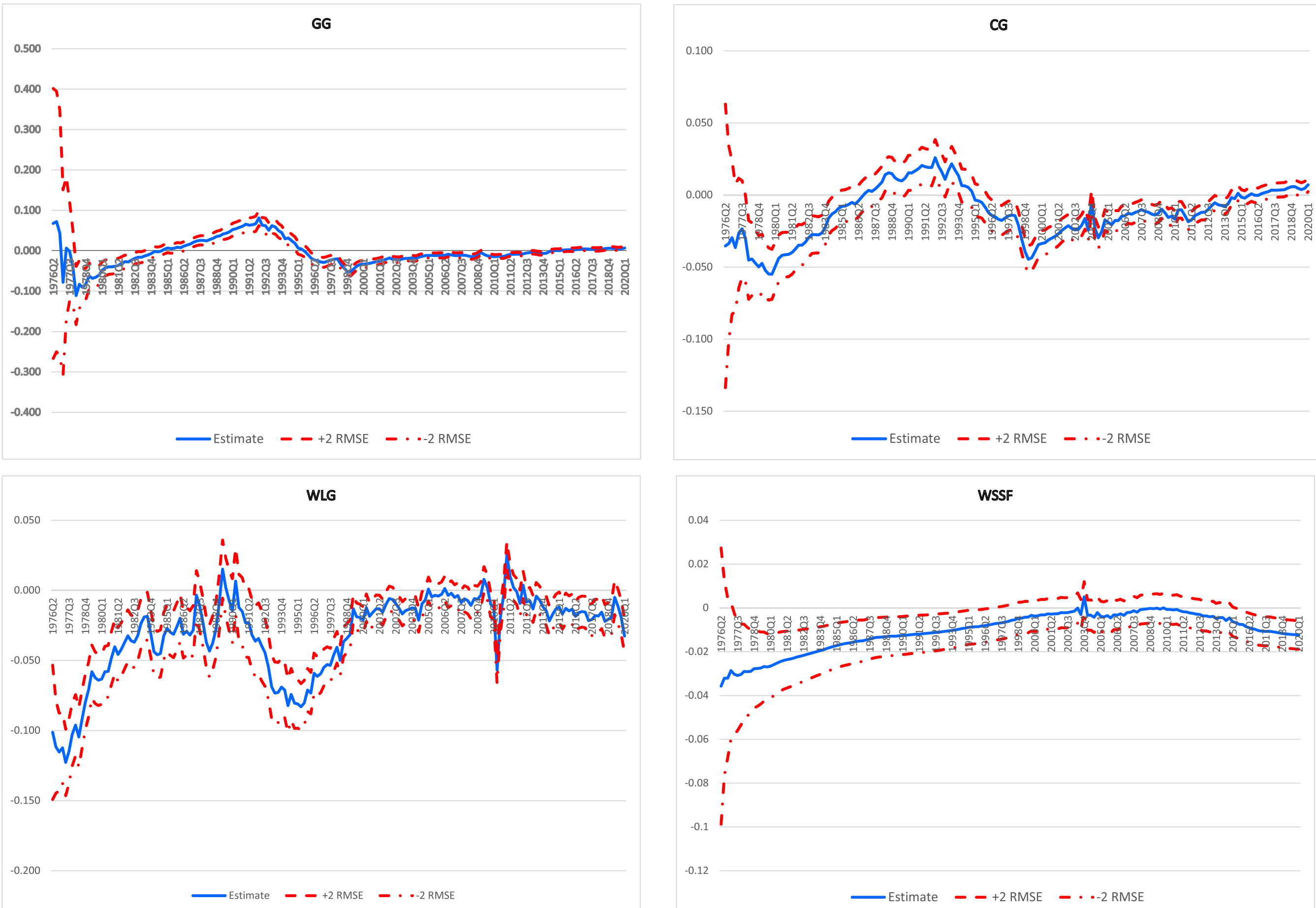

Fig. 6. Time-varying parameter $\alpha_{d,t}$ estimates.

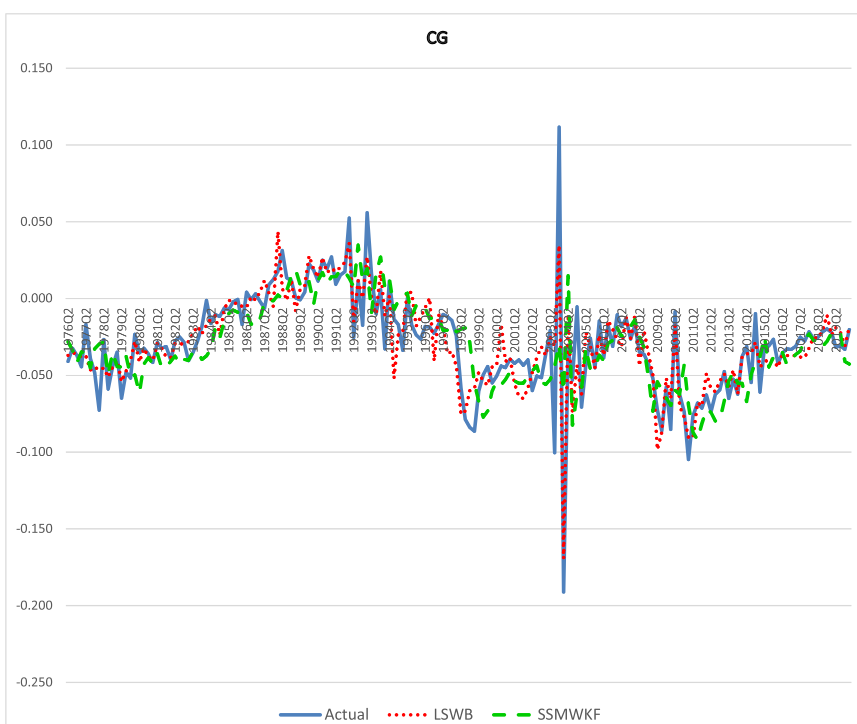

Fig. 7. Comparison of primary surplus/GDP: actual values vs. estimates (CG).

Table 6
Comparison of RMSE of each model.

	AR1E/OLS	MSM	LSWB	SSMWKF
GG	0.0120	0.0138	0.0074	0.0143
CG	0.0234	0.0250	0.0146	0.0237
WLG	0.0072	0.0072	0.0043	0.0078
WSSF	0.0156	0.0165	0.0071	0.0195

recognized through all the government sectors in estimating the LSWB models. Hence, the LSWB models are logically more suitable to estimate FRFs than these two models. Therefore, I just report the gist of the estimation results of the AR1E or OLS models and the two-regime MSMs. I implemented the most appropriate regression model of each government sector by considering the adjustment R-squared (Adj. R^2), the log likelihood (LL), the Akaike Information Criterion (AIC), and the overall

Table 7
Results of discrete TRMs and comparison between results of discrete TRMs and LSWB models.

Panel A: CG (threshold variable: *cilead*)

TR Regime	1st	2nd	3rd	4th	5th
	cilead < 75.600	75.600 < = cilead < 90.600	90.600 < = cilead < 95.600	95.600 < = cilead < 100.600	100.600 < = cilead
α_d	0.478***	0.009	-0.049***	-0.054	-0.094**
	(0.129)	(0.006)	(0.004)	(0.066)	(0.036)
α_{dsq}	0.116***	0.013**	0.020***	0.017	0.024**
	(0.031)	(0.005)	(0.002)	(0.016)	(0.010)
Obs.	42	53	26	28	27
Adj. R^2 0.642, AIC − 4.790, S.E. 0.019, Q-stat 0.357					
LSWB term	1st (P)	2nd (P)	3rd (P)	4th	5th
Average ± SD	56.732–75.016	70.846–90.885	84.179–92.821	90.522–107.639	95.438–102.465

Panel B: WLG (threshold variable: d_{t-1})

TR Regime	1st	2nd	3rd	4th	5th
	d_{t-1} < 0.296	0.296 < = d_{t-1} < 0.382	0.382 < = d_{t-1} < 0.742	0.742 < = d_{t-1} < 0.825	0.825 < = d_{t-1}
α_d	0.325	0.517	0.056***	-1.119	-0.024
	(0.624)	(0.758)	(0.018)	(0.760)	(2.163)
α_{dsq}	0.696	1.384	-0.081	2.109	0.419
	(1.039)	(1.816)	(0.124)	(1.655)	(3.255)
Obs.	33	43	43	28	29
Adj. R^2 0.656, AIC − 7.136, S.E. 0.006, Q-stat 0.000					
LSWB term	1st	2nd	3rd (P)	4th	5th
Average ± SD	0.234–0.329	0.282–0.379	0.256–0.715	0.816–0.886	0.607–0.768

Panel C: WSSF (threshold variable: *cilead*)

TR Regime	1st	2nd	3rd	4th	5th	
	cilead < 66.837	66.837 < = cilead < 88.200	88.200 < = cilead < 91.900	91.900 < = cilead < 97.600	97.600 < = cilead	
α_d	-0.064	0.005*	0.042***	0.063	-0.041*	
	(0.048)	(0.003)	(0.010)	(0.074)	(0.024)	
Obs.	28	51	26	26	45	
Adj. R^2 0.640, AIC − 5.686, S.E. 0.012, Q-stat 8.571						
LSWB term	1st	2nd (P)	3rd (P)	4th	5th	6th (N)
Average ± SD	54.557–64.411	70.591–88.155	78.140–91.214	83.771–93.291	90.620–107.417	95.445–102.625

Notes: (Panel A) (1) "< =" stands for "≤." (2) (P) in LSWB term row indicates that government's fiscal sustainability is supported in the concerned term based on LSWB-estimation results (Table 4). (3) SD stands for standard deviation. (4) "***," "**," and "*" denote 1, 5, and 10 significance levels.
(Panel B) Identical as Panel A.
(Panel C) (1) (N) in LSWB term raw indicates that government's fiscal unsustainability is strongly supported in the concerned term based on LSWB-estimation results (Table 4). (2) Others are identical as Panel A.

variables of the regression model becomes stationary for revealing the model's validity using time-series data.[35]

5.2. FRF

5.2.1. AR1E or OLS model and two-regime MSM

As Section 5.2.2. shows, several breakpoints were eventually goodness of estimating the significant coefficients of the regressors (this manner is also adopted after Section 5.2.2.).

First, based on the estimation results of the AR1E or OLS models,[36] WSSF has adequately managed its finances; GG, CG, and WLG have not. Since rd_t had over 10 values on the variance inflation factor (VIF) index in the estimation of both GG and CG, I ultimately did not adopt this variable as a regressor for GG and CG to avoid the multicollinearity problem. Next, I review the estimation results of the two-regime MSMs.[37] Based on the estimation results of α_d and α_{dsq}, I refer to a regime when

[35] Bohn (1998a, 2008), which is the original research by Bohn's method, also investigated whether every part of the regression model is stationary and examined the cointegration relationship on his model. Bohn (2008) basically confirmed the stationarity of the combination of "d_{t-1}, $GVAR_t$, $YVAR_t$" by the ADF test. Although I also confirmed the cointegration relationship among d_{t-1}, $GVAR_t$, and $YVAR_t$, I omitted its description due to space limitations.

[36] The OLS model was adopted only in the WLG case.

[37] This model was estimated by the ML method. To ensure robust estimation results, I implemented 10,000 random draws of the initial regime probabilities for the estimation algorithm.

Table A1
Descriptive statistics of variables.

	Variable	Mean	Std. Dev.	Max.	Min.	Obs.	Term
GG	s	-0.0290	0.0323	0.0673	-0.0985	176	1976Q2–2020Q1
	d	2.1348	1.6319	4.9587	-0.0590	176	1976Q1–2019Q4
	dsq	2.6481	2.3651	7.9743	0.0002	176	1976Q1–2019Q4
	GVAR	0.0000	0.0079	0.0326	-0.0257	176	1976Q2–2020Q1
	YVAR	0.0001	0.0059	0.0292	-0.0142	176	1976Q2–2020Q1
	rd(*)	0.4278	0.4968	1.4606	-0.1798	176	1976Q2–2020Q1
CG	s	-0.0289	0.0323	0.1116	-0.1912	176	1976Q2–2020Q1
	d	2.9076	1.7690	6.1851	0.3578	176	1976Q1–2019Q4
	dsq	3.1116	2.9446	10.7416	0.0002	176	1976Q1–2019Q4
	GVAR	0.0000	0.0066	0.0334	-0.0264	176	1976Q2–2020Q1
	YVAR	0.0000	0.0018	0.0090	-0.0044	176	1976Q2–2020Q1
	rd	0.4278	0.4968	1.4606	-0.1798	176	1976Q2–2020Q1
WLG	s	-0.0018	0.0101	0.0353	-0.0487	176	1976Q2–2020Q1
	d	0.5414	0.2404	0.8945	0.1754	176	1976Q1–2019Q4
	dsq	0.0575	0.0370	0.1340	0.0001	176	1976Q1–2019Q4
	GVAR	0.0000	0.0032	0.0111	-0.0102	176	1976Q2–2020Q1
	YVAR	0.0000	0.0021	0.0092	-0.0045	176	1976Q2–2020Q1
	rd	-0.3525	0.2628	0.1538	-1.1519	176	1976Q2–2020Q1
WSSF	s	0.0017	0.0206	0.1374	-0.1656	176	1976Q2–2020Q1
	d	-1.3142	0.3747	-0.5902	-1.8637	176	1976Q1–2019Q4
	dsq	0.1396	0.1242	0.5242	0.0000	176	1976Q1–2019Q4
	GVAR	0.0000	0.0016	0.0033	-0.0058	176	1976Q2–2020Q1
	YVAR	0.0001	0.0021	0.0110	-0.0053	176	1976Q2–2020Q1
	rd	2.6202	2.2628	6.4614	-0.0329	176	1976Q2–2020Q1
Control variables & Treshold variable							
	gr_liberatiorep	0.0107	0.1597	1.5426	-0.7645	176	1976Q2–2020Q1
	gr_liberatioco	0.0031	0.0872	0.6610	-0.3529	176	1976Q2–2020Q1
	gr_paratio	-0.0006	0.0243	0.1146	-0.0379	176	1976Q2–2020Q1
	gr_exratio	0.0024	0.0443	0.1001	-0.2473	176	1976Q2–2020Q1
	gr_proinratio	0.0108	0.0944	0.3245	-0.5320	176	1976Q2–2020Q1
	d_unexagratio	0.0000	0.0004	0.0007	-0.0017	176	1976Q2–2020Q1
	cilead (2015 calendar year =100)	85.726	14.778	107.800	51.589	176	1976Q2–2020Q1

Note: rd of GG is CG's rd.

the government implements a relatively weak sustainable fiscal policy as a "worse" regime and the other regime as a "better" one. GG, CG, and WSSF probably struggled to engage in a sustainable fiscal policy in a worse regime.

5.2.2. LSWB model[38]

Table 4 shows the estimation results. Hereafter, I focus on three public subsectors (CG, WLG, and WSSF) and explain their remarkable results because the GG results are simply a combination of these fundamental sectors' results. See Fig. 5 to verify the statements regarding the economic situations.

The following are the CG results: (1) CG adopted a sustainable fiscal policy from the first through the fourth term. (2) CG's dsq_{t-1} result in the second term indicates that it improved its fiscal state when its debt level was relatively low (Fig. 3), and Japan's economy was ascendant.[39] (3) CG adopted a countercyclical policy in the first and third terms. These results can be attributed to the fact that during them, CG took multiple economic stimulus measures in response to the second oil crisis, the yen's sharp appreciation, the bursting of the bubble economy, and the Asian currency crisis. (4) The growth of the liberal parties improved CG's fiscal condition in the fourth term, probably caused by DPJ's administrative reforms, e.g., budget screening and cuts of public works. (5) The expansion of public assistance negatively impacted CG's finances, as expected in the fourth term. However, it positively impacted them in the fifth term. The latter result indicates that CG worried that the recent excessive enlargement of public assistance would worsen its finances. (6) The deepening openness of Japan's markets overseas had negative and positive effects in the second term. Since this term closely matched the first Heisei-era depression, import increases negatively affected CG's finances, and an increase of value-added outflow overseas tightened its fiscal behavior.

The following are the WLG results: (1) WLG adopted a sustainable fiscal policy in the third term. When the bubble economy burst, Japan's economy became devastatingly mired, and local governments were urged to tighten their finances. Moreover, CG supported WLG by enlarging the *Local finance plan*. (2) Intense outlays in the second and third terms negatively affected WLG's finances, as expected; these outlays were probably due to the multiple economic stimulus measures by CG (see Item (3) of CG) because they also included local government projects. (3) WLG adopted a countercyclical policy in the third term when the first and second Heisei-era depressions occurred. (4) The rd_t results suggest that WLG's burden accompanying the fiscal transfer from CG has negatively affected WLG's finances since the end of 1990 s. (5) The growth of the liberal parties negatively affected WLG's finances in the second term.[40] (6) The effects of the expansion of public assistance were contrary to those for CG in the fourth and fifth terms (see Item (5) of CG). This situation is attributed to the fiscal system of public assistance under which CG is responsible for three-fourths of the service cost. (7) The unexpected deepening of Japan's aging society negatively

[38] The breakpoints were determined using the Bai and Perron (1998) test, which sequentially examines the L+ 1 vs. L breaks.

[39] In the second term, CG committed itself to expenditure cuts to stop issuing deficit-financing government bonds. Actually, the bond dependency ratio of the budget dropped to 9.2% in FY1990 (compared to 32.6% in FY1980 and 24.2% in FY1995). During the fifth term, CG implemented revenue reforms to achieve a primary surplus in the CG and WLG totals in FY2020; the consumption-tax rate was raised twice from 5% to 8% in FY 2014 and from 8% to 10% in FY2019. However, despite these efforts, CG finally relinquished the above goal of a primary surplus in FY2019.

[40] At this time, CG established a system of health welfare facilities for seniors and a ten-year strategy for promoting their health and welfare (the *Gold plan*) and spread home-based care for the challenged. Hence, the public services provided by local governments rapidly increased. The liberal parties contributed to this movement.

affected WLG's finances in the first term and positively affected them in the second.[41]

The following are the WSSF results: (1) Although WSSF adopted a sustainable fiscal policy in the second and third terms, it failed to sustainably manage its finances in the sixth term. (2) Intense outlays in the second and sixth terms negatively affected WSSF's finances, as expected. It adopted a countercyclical policy in the six terms. Based on these results, WSSF seemed to respond to the depression after the Plaza Accord, the bursting of the bubble economy, and the quagmire situation of labor demand and labor share of the value added after the global financial crisis during the period. (3) The rd_t results suggest that WSSF's fiscal burden accompanying the fiscal transfer from CG negatively impacted its finances in the first and fourth terms. (4) The growth of the liberal parties negatively affected WSSF's finances in the fifth term.[42] (5) The increase of the value-added outflow overseas positively influenced WSSF's finances in the fifth term and negatively in the sixth term. The sixth term result indicates that the value-added outflow overseas in recent years has devastated social security funds in Japan. (6) The unexpected deepening of the aging society positively affected WSSF's finances in the sixth period. WSSF has recently engaged in a careful fiscal policy by increasing health insurance and public pension premiums and co-payments of medical expenses.

Finally, although GG sustainably managed its finances in the first and second terms as a result of the behavior of CG, WLG, and WSSF, it has failed to do so from the third term.

5.2.3. SSMWKF

Table 5 and Fig. 6 present the estimation results. I estimated time-varying parameter $\alpha_{d,t}$, not by smoothing up to the last period but by filtering up to concerned period t since each government is assumed to rationally decide its fiscal policy at every period with the available information up to it.[43]

Table 5 indicates the following: (1) The estimated coefficients of $GVAR_t$ for WLG and of $YVAR_t$ for CG are also significantly negative, as expected. (2) The absolute value of the estimated coefficient of $YVAR_t$ for CG explains its heavy responsibility for economic stabilization. Fig. 6, where RMSE denotes the root mean squared error and the two dashed lines signify the 95% confidence interval of the estimated value, shows the following facts: (1) The estimates of state variable $\alpha_{d,t}$ vary across the negative and positive areas as time proceeds (except WSSF). (2) Item (1) suggests that judgment of the fiscal sustainability should be based on the estimated FRF with a time-varying parameter and explains why the existing research, which did not use time-varying parameter techniques, reached different fiscal sustainability results depending on the data period. (3) CG struggled to sustainably manage its finances during its entire term, except from the late 1980 s through the mid-1990 s. (4) WLG did not meet Bohn's sufficient condition for fiscal sustainability through the entire analysis term based on a probabilistic viewpoint. However, it did manage its finances better around the late 1980 s and since the mid-2000 s, except around 2010. (5) WSSF has failed to sustainably manage its finances since the mid-2010 s. In addition, the contents of Items (3) and (4) are generally consistent with the economic changes in Fig. 5. (6) Based on considerations of CG and GG, Japan's public sector has failed to sustainably manage its finances since the late 1990 s.[44]

5.3. Comparison of estimation accuracy

First, I graphically compared the actual values of the primary surplus/GDP ratio and the estimates by LSWB models and SSMWKFs to investigate the estimation accuracy of both methods. However, due to space limitations, I present only CG's graph (Fig. 7). Through this trial, I obtained the following: (1) The LSWB model basically outperformed SSMWKF for all government sectors. (2) For WLG, both models worked well through the entire analysis term, except the SSMWKF's estimates for the 1990 s. (3) For WSSF, SSMWKF's estimates failed to follow the variations of the actual series since the end of the 1990 s.

Next Table 6 reinforces the certainty of the above explanation through comparing RMSE between the actual values and the estimates by each model on the primary balance/GDP ratio by government sector and eventually explains that the LSWB model is the best estimation method in this study. [45]

5.4. Factor causing structural changes of government's fiscal posture

Through the discussion so far, obviously, the LSWB model most precisely explains the chronological changes of each government's fiscal policy. Unfortunately, it cannot provide a researcher with a cause for regime-shifting regarding government's fiscal posture. Hence, I estimated the FRFs by the following discrete TRM as an auxiliary estimation of the LSWB model to investigate the cause of fiscal regime changes:

Discrete TRM

$$s_t = \sum_{j=0}^{m} 1_j(q_t, \boldsymbol{\gamma})\boldsymbol{X}_t^{'}\boldsymbol{\beta}_j + \varepsilon_t, j = 0, \ldots, m. \quad (13)$$

Here j indexes the $m+1$ regimes. Indicator function $1_j(q_t, \boldsymbol{\gamma})$ is defined as $1\left(\gamma_j \le q_t < \gamma_{j+1}\right)$ and takes one if the expression in parentheses is true and zero otherwise. q_t is a threshold variable, and $\boldsymbol{\gamma}$ is the vector of the endogenously estimated threshold values: $\gamma_1 < \gamma_2 < \cdots < \gamma_m$. $\boldsymbol{X}_t$ and ε_t are identical as those in Eq. (10).

I adopted the following variables as the threshold ones: (1) *cilead*, which is an indicator explaining Japan's quantitative economic scale and economic state three months or more later; (2) d_{t-1}, which is an indicator explaining the severity degree of the concerned government's fiscal state. Note that the choice of these threshold variables is based on the idea that the government's fiscal behavior can be affected by economic and government's fiscal states (Fukuda and Yamada (2011), Legrenzi and Milas (2013), and Fournier and Fall (2017)).

Table 7 shows the most appropriate estimation results between the estimations employing both threshold variables. Note that (1) since GG's fiscal state is passively decided as the result of CG, WLG, and WSSF's behavior, I focused on the discrete TRM estimations of public subsectors. (2) The employed regression model of each subsector was identical as the LSWB model estimation. (3) Due to space limitations, Table 7 reports only the results of d_{t-1} and dsq_{t-1}. (4) The "Average ± SD" row of each table shows the figure of the threshold variable in the concerned term of the LSWB model.

Table 7 indicates the following: (1) The structural changes of the LSWB models can be generally explained by the discrete TRM results. That is, CG and WSSF probably shifted their fiscal postures based on the

[41] This situation is probably related to the free medical care system for seniors (part of its cost was paid by local governments) implemented from 1973 to 1983 and the increase of LAT that accompanied greater welfare outlays in the 1980 s

[42] This result was probably caused by the following DPJ policies: expanded coverage by employment insurance and recovery of 50,000 lost public pension records, including pension premium payments, records never stored as electronic data, etc.

[43] This model was estimated by the ML method. I also set zero and 0.1 as the initial given values of $\alpha_{d,0}$ and its variance.

[44] This finding is basically consistent with that of Yoshida (2019) who utilized annual data to estimate SSMWKFs.

[45] Consequently, this study's results suggest that if a researcher can prepare large sample-size data, then the LSWB method might become a powerful estimation tool, even though its theory and technique are simple for estimating time-series data. This method could also be useful for estimating data whose variations are large, as in this study.

perspective of the economic condition of the near future. WLG apparently adjusted its fiscal policy based on its fiscal severity. (2) When Japan's quantitative economic scale was relatively small (large) and its economy state was relatively stagnant (vigorous), CG tried (failed) to implement a sustainable fiscal policy. This tendency also basically applies to WSSF's behavior. (3) WLG sustainably managed its finances, when its fiscal state's severity was relatively moderate around the early 1990 s, and it rapidly worsened (rapidly accumulated debt) around the late 1990 s, i.e., obviously trying to converge such rapid debt accumulation.

6. Concluding remarks

I chronologically estimated the FRFs of every Japan's government sector and identified the following: (1) The LSWB model estimated all the governments' postures most accurately among all four models. (2) Based on the results of the LSWB models, CG engaged in a sustainable fiscal policy from the late 1970 s through the end of the 2000 s. These findings are consistent with the GDP changes and the implementation of fiscal consolidation measures by CG. WLG sustainably managed its finances around the 1990 s. WSSF has seemingly failed to sustainably manage its finances since the beginning of the 2010 s. GG has found itself in an unfavorable state of fiscal sustainability since the mid-1990 s (3) The results of the LSWB models and the discrete TRMs demonstrate that CG and WSSF adjusted their fiscal postures based on Japan's economic state and fiscal severity caused WLG to change its posture for the analysis term.

Although this study illuminates GG's sluggish posture as the total of all public subsectors for fiscal sustainability since the mid-1990 s, Section 1 argues that Japan still possesses affluent value-added flows and stocks. Therefore, its public sector should immediately change its fiscal policy direction and embrace a sustainable path so that Japan can avoid economic and government financial collapse due to its rapidly aging society and the interest burden on its huge public debt.[46]

Appendix

See appenidix.
Table A1.

References

Bai, J., Perron, P., 1998. Estimating and testing linear models with multiple structural changes. Econometrica 66, 47–78.
Barro, R.J., 1986. U.S. Deficits since World War 1. Scand. J. Econ. 88, 195–222.
Bohn, H., 1995. The sustainability of budget deficits in a stochastic economy. J. Money, Credit Bank. 27, 257–271.
Bohn, H., 1998a. The behavior of U.S. Public Debt and Deficits. Q. J. Econ. 113, 949–963.
Bohn, H., 1998b. Technical Appendix to: The Behavior of U.S. Public Debt and Deficits (unpublished appendix). A1-A8. ⟨http://www.econ.ucsb.edu/~bohn/papers/qje98app.pdf⟩ (Accessed in September 2019.).
Bohn, H., 2007. Are stationarity and cointegration restrictions really necessary for the intertemporal budget constraint? J. Monet. Econ. 54, 1837–1847.
Bohn, H., 2008. The Sustainability of Fiscal Policy in the United States. In: Neck, R., Sturm, J. (Eds.), Sustainability of Public Debt. MIT Press, Cambridge, MA, pp. 15–49.
Burger, P., Stuart, I., Jooste, C., Cuevas, A., 2012. Fiscal sustainability and the fiscal reaction function For South Africa: Assessment of the past and future policy applications. South Afr. J. Econ. 80, 209–227.
Cassou, S.P., Shadmani, H., Vázquez, J., 2017. Fiscal policy asymmetries and the sustainability of US Government Debt Revisited. Empir. Econ. 53, 1193–1215.
Dijk, D.V., Teräsvirta, T., Franses, P.H., 2002. Smooth transition autoregressive models – a survey of recent developments. Econom. Rev. 21, 1–47.
Doi, T., Hoshi, T., Okimoto, T., 2011. Japanese Government debt and sustainability of fiscal policy. J. Jpn. Int. Econ. 25, 414–433.
Fujii, T., 2010. Sustainability of Japanese Government Finance: reexamination by Bohn's method. Public Financ. Stud. 6, 97–117.
Fournier, J., Fall, F., 2017. Limits to government debt sustainability in OECD countries. Econ. Model. 66, 30–41.
Fukuda, S., Yamada, J., 2011. Stock price targeting and fiscal deficit in Japan: why did the fiscal deficit increase during Japan's lost decades? J. Jpn. Int. Econ. 25, 447–464.
Futagami, K., Konishi, K., 2018. Dynamic analysis of budget policy rules in Japan. J. Jpn. Int. Econ. 50, 72–88.
Gregory, A.W., Hansen, B.E., 1996. Residual-based tests for cointegration in models with regime shifts. J. Econ. 70, 99–126.
Ghosh, A.R., Kim, J.I., Mendoza, E.G., Ostry, J.D., Qureshi, M.S., 2013. Fiscal fatigue, fiscal space and debt sustainability in advanced economies. Econ. J. 123, F4–F30.
Hamilton, J.D., Flavin, M.A., 1986. On the limitations of government borrowing: a framework for empirical testing. Am. Econ. Rev. 76, 808–819.
Hansen, B.E., 1999. Threshold effects in non-dynamic panels: estimation, testing, and inference. J. Econ. 93, 345–368.
Hibbs, D.A., 1977. Political parties and Macroeconomic policy. Am. Political Sci. Rev. 71, 1467–1487.
Ihori, T., Doi, T., Kondo, H., 2001. Japanese fiscal reform: fiscal reconstruction and fiscal policy. Jpn. World Econ. 13, 351–370.
Kremers, J.J.M., 1989. U.S. Federal indebtedness and the conduct of fiscal policy. J. Monet. Econ. 23, 219–238.
Lee, J., Strazicich, M.C., 2003. Minimum lagrange multiplier unit root test with two structural breaks. Rev. Econ. Stat. 85, 1082–1089.
Legrenzi, G., Milas, C., 2013. Modeling the fiscal reaction functions of the GIPS based on state-varying thresholds. Econ. Lett. 121, 384–389.
Mahdavi, A., 2014. Bohn's test of fiscal sustainability of the American State Governments. South. Econ. J. 80, 1028–1054.
Matsuoka, H., 2015. Fiscal limits and sovereign default risk in Japan. J. Jpn. Int. Econ. 38, 13–30.
Mendoza, E.G., Ostry, J.D., 2008. International evidence on fiscal solvency: is fiscal policy 'Responsible'? J. Monet. Econ. 55, 1081–1093.
Mochida, N., 2015. Sustainability of local Government Debt. Public Financ. Stud. 11, 141–165.
Nakajima, T., Takahashi, S., 2017. The optimum quantity of debt for Japan. J. Jpn. Int. Econ. 46, 17–26.
Nguyen, T.D., Suardi, S., Chua, C.L., 2016. The Behavior of U. S. Public Debt and Deficits during the Global Financial Crisis. Contemp. Econ. Policy 35, 201–215.
Ostry, J.D., Ghosh, A.R., Kim, J.I., Qureshi, M.S., 2010. Fisc. Space, IMF Staff Position Notes Vol. 2010 (Issue 011).
Paniagua, J., Sapena, J., Tamarit, C., 2017. Fiscal sustainability in EMU countries: a continued fiscal commitment? International Financial Markets. Inst. Money 50, 85–97.
Perron, P., 1989. The great crash, the oil price shock, and the unit root hypothesis. Econometrica 57, 1361–1401.
Quintos, C.E., 1995. Sustainability of the deficit process with structural shifts. J. Bus. Econ. Stat. 13, 409–417.
Sakuragawa, M., Sakuragawa, Y., 2020. Government fiscal projection and debt sustainability. Jpn. World Econ. 54 (101010), 1–9.
Trehan, B., Walsh, C.E., 1988. Common trends, the government budget constraint, and revenue smoothing. J. Econ. Dyn. Control 12, 425–444.
Wilcox, D.W., 1989. The sustainability of government deficits: implications of the present-value borrowing constraint. J. Money, Credit Bank. 21, 291–306.
Yoshida, M. , 2018. Is Japanese Local-Government Fiscal Management Sustainable? Discussion Paper New Series (Osaka Prefecture University), No. 2018–2. file:///C:/Users/owner/Downloads/2018000207–2.pdf (Accessed in December 2022.).
Yoshida, M., 2019. Is Japanese Public-Sector Finance Sustainable? Discussion Paper New Series (Osaka Prefecture University), No. 2019–3. http://doi.org/10.24729/00016629 (Accessed in December 2021.).
Yoshida, M., 2020. Fiscal sustainability of Local Governments in Japan. Asian Econ. J. 34, 127–162.
Zivot, E., Andrews, D.W.K., 1992. Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. J. Bus. Econ. Stat. 20, 25–44.

[46] Futagami and Konishi (2018) and Nakajima and Takahashi (2017) respectively simulated how Japanese households can benefit from a fiscal consolidation policy (i.e., lowering the government debt/GDP ratio or the government deficit/GDP ratio) by dynamic computable general equilibrium (CGE) and static CGE models. Matsuoka (2015) simulated that the default probability of GG debt will exceed 10% around 2030 using a closed economy model with defaultable government debt if GG's debt/GDP ratio continues to increase exponentially due to the increase in the sovereign risk premium induced by debt accumulation, among other factors. These studies' results support my idea's validity.