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Motonori Yoshida

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Osaka Prefecture University

Sakai, Osaka 599-8531, Japan

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Motonori Yoshida

Graduate School of Economics, Osaka Prefecture University**

Abstract

The total expenditure of Japanese local governments (LGs) exceeds that of the Japanese central government (CG). Japan's LGs as well as its CG are responsible for the worst general government's debt condition among all of the G7 countries. Therefore, I elucidate the fiscal reactions of Japan's prefecture governments (PGs) based on Bohn's (1998a, 2005) method with a panel dataset (47PGs, FY1974-2014), considering nonstationary and endogeneity issues. In my model, a positive reaction of the primary-surplus/gross-regional-product (GRP) ratio to the PG-debt/GRP ratio (*d*) constitutes a sufficient condition for sustainability. This study's results demonstrate the following: 1) PGs in better fiscal conditions manage their finances more steadily; 2) the Fiscal Consolidation law (since FY2008) forces PGs to implement stricter fiscal management; 3) more abundant grants from the CG would ease PGs' fiscal conditions; 4) although the main regressor *d* is I (1), it can become stationary by cointegration with other regressors.

Keywords: Fiscal sustainability, Prefecture governments, Bohn, Panel unit root, Panel cointegration, Endogeneity.

JEL Classification Numbers: E61, E62, H11, H72, H77.

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**Professor of Graduate School of Economics, Osaka Prefecture University, 1-1 Gakuen-cho, Naka-ku, Sakai-city, Osaka, 599-8531, Japan. E-mail address: myoshida@eco.osakafu-u.ac.jp.

1. Introduction

Japan is a global top-class economic power. Its economy has maintained its current account surplus for the last 37 years, and as of 2014, its external financial asset balance is the highest in the world. However, Japan's public sector, one of the subsectors of its economy, has been mired in a relatively dire fiscal condition for decades. The ratio of Japanese general government[1] debt to gross domestic product (GDP) was 235.6% in 2016: this figure is the worst among all of the G7 countries.[2] Since the 1940s, the total expenditure of Japanese local governments (LGs) has exceeded that of the Japanese central (national) government (CG), and the former's ratio to the total sum has generally hovered around 60%; the latter's is around 40%. Although the CG is suffering a quite poor fiscal condition, the LG's finance as a whole is enjoying a relatively stable condition compared to the CG's finance. Yet by scrutinizing the fiscal condition of the tiers of Japanese LGs, the following facts can be focused on. Japanese prefecture governments (PGs), which are in a higher tier of the Japanese LG system, are at capacity simply when they implement ordinary affairs and have a relatively high ratio of outstanding deficit-covering local government bonds (LGBs) to total outstanding LGBs. Moreover, aggregated PGs occupy around half of all local government expenditures. Although the state of Japanese local public finance (LPF) may seem to be more stable than the central finance, neither the CG nor the LGs enjoys any financial margin. (See Section 2 for details.)

Many studies have examined the sustainability of government finance based on previous finance management postures. These studies can be classified into the following three categories: 1) those that follow Hamilton and Flavin (1986) and examine whether public

[1]The general government consists of a central government, local governments, and social security funds in the concerned country.

[2]Italy had the second worst figure: 132.0%. These figures are from the data of Ministry of Finance: URL: https://www.mof.go.jp/tax_policy/summary/condition/a02.htm#a06. (Accessed in March 2018.)

finance satisfies its intertemporal budget condition (IBC); 2) those that inspect the cointegration relationship among government expenditures, tax revenues, and so on, originating in Trehan and Walsh (1988); 3) those that examine the reaction of the primary-surplus/GDP ratio to the government-debt/GDP ratio by Bohn's (1998a, 2005) method. The first category is complicated by adopting appropriate discount rates and the second faces weak power if the samples are not abundant. As a result, since the third category has superior properties for practical applications, many prior researches utilize this method. However, to the best of my knowledge, the researches using Bohn's (1998a, 2005) method suffer from the following weaknesses: 1) the objects of the existing researches are weighted to the general government or to the CG in their objective countries;[3] 2) most existing researches do not completely test and examine the nonstationarity and cointegration relationships on variables despite using time-series data; 3) the existing researches, except Fujii (2010), fail to deal with the endogeneity problem of variables; 4) no existing researches, except Mahdavi (2014), consider the effect of financial transfers from a CG to LGs; and 5) research examining Japanese LG financial managements is quite scant, and primary researches are limited to Mochida (2015) and Yoshida (2016, 2017).

Considering the current state of the Japanese public finance and academic field, as explained above, I scrutinize the fiscal sustainability of Japanese PGs using Bohn's (1998a, 2005) method to determine the general fiscal-management tendencies in Japanese LPF. Also I focus on improving the above points. The following are the main findings of this study: 1) the better a PG's financial condition is, the more sustainably the PG implements its financial management; 2) the "Law on the Fiscal Consolidation of Local Governments" (Law on FCLGs) urges PGs to pursue a more sustainable financial management; 3) the larger the financial transfers become from the CG to a PG, the more sustainably the PG

[3]Claeys, Ramos, and Suriñach (2008) and Mahdavi (2014) studied American and German state governments (see Section 3 for details).

implements its financial management.

The rest of this paper is organized as follows. Section 2 reviews the state of the Japanese economy and the finances of its public sectors. Section 3 introduces related literature and explains the position and aim of this study. As primary steps to verify the fiscal management postures of PGs, Section 4 inspects whether the *Recardian equivalence proposition* and *dynamic efficiency* are established and presents the backbone of Bohn's (1998a, 2005) method. Section 5 explains my empirical model and data. Section 6 offers analysis results and Section 7 concludes the paper.

2. Economic and Public Financial States in Japan

As Table 1 and Figure 1 show, the Japanese economy holistically continues to maintain its current account surplus and its external financial asset balance is also the world's highest. Thus, the Japanese economy retains its status as a global economic power. However, Japan's public sector, one of the subsectors of Japanese economy, remains mired in a poor fiscal condition. The ratio of the Japanese general government debt to GDP was 235.6% in 2016, which is the worst figure among the G7 countries. As described by Tables 2 and 3, the CG is in an especially miserable state. On the other hand, as a total, LG finance finds itself in a relatively good position. Moreover, a thorough investigation of the financial situations by the LG categories in Tables 4 and 5 emphasizes the following facts: 1) the fiscal power of PGs is generally lower than that of municipality governments (MGs); 2) PGs have relatively higher figures than MGs for the ratio of outstanding deficit-covering LGBs to total outstanding LGBs and the debt burden service ratio; 3) PGs have relatively higher ordinary balance ratios, meaning that they are at capacity when they are simply implementing their ordinary affairs. Moreover, the total amount of PG expenditures

occupies almost half of all LG expenditures: its ratio was 47.3% in fiscal year (FY) 2016.

Thus, on the whole, although Japan's LPF enjoys a sounder condition than CG finance, PG finance, which occupies quite a large portion of LPF, cannot be assumed to be in a stable condition. Therefore, I analyze the exact contribution of the finance management posture of PGs to predict how Japan's public sector's finances will proceed and how they affect the Japanese economy.

Subsequently, I classified all 47 PGs into the following three groups to elucidate the influences on the financial management postures brought by the different financial situations: 1) Group 1 consists of 12 prefectures that have a relatively high *future burden ratio*:[4] they are in a quite poor financial condition; 2) Group 2 consists of 23 prefectures that have a middle-level ratio: they are in an average financial condition; and 3) Group 3 consists of 12 prefectures that have a relatively low ratio: they are in a quite good financial condition. Figure 2 shows the changes of the averages of the primary-balance and public-debt/gross-regional-product (GRP) ratios by group and indicates that the former averages are descending in the order of group numbers and the latter are ascending. These situations are consistent with my expectations.

[Table 1 about here]

[Figure 1 about here]

[Table 2 about here]

[Table 3 about here]

[Table 4 about here]

[Table 5 about here]

[4]The future burden ratio is calculated as the ratio of substantial debts that the general account, etc. of the concerned local government will bear in the future, including debts by local public corporations or other corporations, etc. in which it has invested and for which it has promised compensation for losses, to the total of the standard financial scale. The *standard financial scale* equals the sum of the standard tax revenue and the ordinary local allocation tax (Japanese general grant from the CG).

[Figure 2 about here]

3. Related Literature and Aim of This Study

Many studies have examined the sustainability of government finance based on its past finance management posture. Such studies can be classified into the following three categories: 1) those following Hamilton and Flavin (1986), 2) those using a cointegration analysis, and 3) those using Bohn's (1998a, 2005) method.[5]

First, I review the original study in the first category. Hamilton and Flavin (1986) concentrated on the theoretical fact that government finance is sustainable if the discount present value of the indefinitely rolled-over government debt converges to zero: the establishment of a *no-Ponzi game condition*. They examined the significance of the bubble term[6] by an empirical model based on Flood and Garber (1980) and argued that the U.S. federal government's finance is sustainable. However, their method has a problem: their result depends on what the researcher adopts as the discount rate. Next, let me review the original study in the second category. Trehan and Walsh (1988) described the stationarity of the U.S. federal government's deficit (government finance sustainability) by identifying the cointegration relationship between government expenditures, including interest payments, tax revenues, and seigniorage.[7] However, both the unit root test as the preliminary step of a cointegration test and the cointegration test based on a unit root test face the weak power problem if the samples are not abundant. Fukuda and Teruyama (1994) examined Japanese CG's sustainability by the above two methods and rejected its sustainability in the pre-

[5]See the appendix for studies that simulate future states.
[6]The following is the bubble term's content: the product of the expected discount present value at an indefinitely later period of government debt, the rolled-over amount of every period, at some period, and the power term of one plus the discount rate.
[7]After Trehan and Walsh (1988), the following works adopted the cointegration analysis method: Hakkio and Rush (1991), Haug (1991), Ahemd and Rogers (1995) etc.

WW2 (World War 2) term, but they supported it since 1965. Next I explain Bohn (1998a, 2005) and related studies. Although I review the details of this method in Section 4, here I introduce some analysis examples for clarity. Bohn (1998a, 2005) demonstrated that the U.S. federal government's finance is sustainable with datasets from 1916-84 and 1792-2003. Since Bohn's (1998a, 2005) method overcame the drawbacks of Hamilton and Flavin (1986) and cointegration analysis, many empirical studies have utilized it. For example, Mendoza and Ostry (2008) researched 34 developing and 22 industrially developed countries with panel data and reported that the sustainability of general governments is basically supported. Claeys, Ramos, and Suriñach (2008) examined the state government behaviors of the U.S. and Germany. Their results support the fiscal sustainability of America's state governments and reject that of the German state governments. Mahdavi (2014) also investigated the fiscal sustainability of America's state governments.[8]

Next, I introduce the following researches that examined Japanese CG and LGs by Bohn's (1995a, 2005) method. Ihori et al. (2001) rejected Japanese CG's fiscal sustainability. On the other hand, Fujii (2010) supported it with a later dataset.[9] Mochida (2015) supported Japanese LPF's sustainability as a whole. However, analysis of the fiscal management postures of Japanese LGs is quite scant. To the best of my knowledge, the main researches in this field are limited to Akamatsu and Hiraga (2011), Mochida (2015), and Yoshida (2016, 2017). The former two studies researched Japanese PGs and described the fiscal sustainability of Japanese PGs on average with panel data. On the other hand, based on the scrutiny of each PG or each cluster that consists of prefectures with similar figures on some

[8]Bohn (1995a, 2005) used constant parameter models on the fiscal reaction function. However, the time-varying parameter models by the state-space model and the Kalman filter have recently appeared: e.g., Burger et al. (2012) examined South Africa's government, Nguyen, Suardi, and Chua (2016) investigated the U.S. situation, and Paniagua, Sapena, and Tamarit (2017) studied some European countries with this method.
[9]In comparison to Ihori et al. (2001), Fujii (2010) has the following features: 1) he used a quarterly dataset, 2) he divided the analysis term into two parts based on the result of a structural change test, and 3) he considered the regressor's endogeneity.

fiscal indicators, they also demonstrated that the fiscal sustainability of some metropolitan prefectures and those with relatively high fiscal power is not supported. Yoshida (2016, 2017) examined the fiscal sustainability of ordinance-designated city governments and core city governments and supported the former's fiscal sustainability and rejected the latter. However, these researches suffer from the following shortcomings: 1) unlike Mahdavi (2014), existing researches do not fully analyze stationarity and cointegration relationships on variables despite using time-series data; 2) unlike Mahdavi (2014), they do not examine the effects of financial transfers from the CG to LGs; 3) unlike Fujii (2010), they do not consider the endogeneity problem of regressors.

Based on the above survey, the position and aim of my study are summed up as follows: 1) it examines the fiscal management postures of Japanese PGs by Bohn's (1995a, 2005) method, which is more beneficial than the other approaches, to identify the general fiscal-management tendency of Japanese LGs; 2) it inspects the stationarity and cointegration relationships of the variables in detail; and 3) it tests the effects of financial transfers and considers the endogeneity problem of regressors.

4. Confirmation of Premises and Theoretical Backbone

4.1 Confirmation of premises

As a preliminary stage to verify a government's fiscal sustainability, researchers must consider whether the following have been established in an economy: (1) the *Recardian equivalence proposition* of the concerned government and (2) *dynamic efficiency* of the economy, where the government is located. Obviously, if both are established, fiscal sustainability will be automatically satisfied. Therefore, I explain the assumptions of these two issues as a prerequisite for the analysis in Section 5 based on Yoshida (2016).

Recardian equivalence proposition

This proposition insists that the means of financing government resources, whether by taxation or loan by public debt, does not affect the overall macro-economy under the assumption that private economic agents can make reasonable decisions through all periods via precisely incorporating future burdens for public bond redemption (forming the necessary savings for it). If this proposition is established, government finance will be sustainable. However, to establish it, Bernheim (1987) and Seater (1993) argue that the following preconditions are necessary: 1) each generation is connected through bequests based on altruistic motivations; 2) households are not faced with a liquidity constraint and the capital market is complete; 3) a deferral of levying tax does not redistribute resources among generations; 4) the government has adopted a distortion-free (neutral) tax system; 5) a budget deficit does not create value through a bubble; and 6) economic agents are rational and have an infinite time perspective.

When considering Japan's current national and local fiscal system, it is very difficult to assume that all of the above preconditions have been established. Ihori et al. (2001) empirically examined the formation of this proposition for government bonds from the 1970s through the 1990s and concluded that it was not fully established. Holistically considering the above issues, I assume that this proposition has not been established on this study's targets.

Dynamic inefficiency of an economy

In an economy without uncertainty, if the real interest rate falls below the population growth rate, the economy becomes dynamically inefficient. Under this condition, a primary deficit can be continued as long as the public debt per capita remains constant. Kato (2008)

concluded that the Japanese economy has always been dynamically efficient except during its bubble-economy period (1988-1990). Taking uncertainty into account, Abel et al. (1989) examined the dynamic efficiencies of developed countries and described the dynamic efficiency of the Japanese economy.[10] Based on the results of these researches, I assume that the Japanese economy and each of its regional economies satisfy the dynamic efficiency condition during the observation years of this study. Finally, based on the above considerations, I believe that examining the fiscal sustainability of Japanese PGs by Bohn's (1998a, 2005) method is appropriate.

4.2 Bohn (1998a, 1998b, 2005) Model

Bohn (1998b) provided a sufficient condition for government-finance sustainability under the case of the GDP_t stream (aggregate income) with a finite present value. The condition is described as

$$s_t = \beta d_t + \mu_t \ , \tag{1}$$

where $\beta > 0$, s_t denotes the primary-surplus to the GDP ratio, d_t is the government debt to the GDP ratio (at the end of the $t-1$ period), and μ_t is a bounded stochastic process. Subscript t indexes the periods. In the case of Equation (1), the government finance satisfies the following *transversality condition* and IBC:

$$\lim_{N\to\infty} E_t[u_{t,N} D_{t+N}] = 0, \tag{2}$$

where $u_{t,N}$ denotes the marginal substitution rate between periods t and $t+N$ and $D_{t+N} =$

[10]Abel et al. (1989) provided a sufficient condition for dynamic efficiency under uncertainty where the total amount of capital income exceeds investment in all periods and situations.

$d_{t+N}GDP_{t+N}$ is the level of government debt after N periods from t. This sufficient condition is proved by recursively substituting Equation (1) for the primary surplus in the government's budget constraint in every period. The following equation works as a key in the proof of this condition:

$$\lim_{n\to\infty}(1-\beta)^n d_t = 0 \quad \text{for } n > N. \tag{3}$$

The following is the meaning of Equation (3). If $1 > \beta > 0$ in Equation (1), then the government debt does not diverge because its growth is reduced by the $(1-\beta)^n$ factor more than in a Ponzi scheme. Even if $|\beta|$ is quite trivial, the government debt after infinite periods converges to zero, and the government IBC is satisfied. Bohn (1998b) also argues that Equation (1) can be replaced by Equation (4), which is non-linear, if d^* that satisfies $f'(d_t) \geq \beta > 0, \forall\, d \geq d^*$ exists:

$$s_t = f(d_t) + \mu_t. \tag{4}$$

Following the above theoretical backbone, Bohn (1998a, 2005) studied the fiscal sustainability of the U.S. federal government using the regression model below. The regressor of $\left(d_t - \bar{d}\right)^2$ is used to observe whether a higher d_t causes a government to improve s_t more:

$$s_t = \alpha_0 + \beta d_t + \beta_2\left(d_t - \bar{d}\right)^2 + \alpha_G GVAR_t + \alpha_Y YVAR_t + \varepsilon_t\ , \tag{5}$$

where $\bar{d}$ denotes the average of d_t during the analysis periods.[11] In Equation (5), $GVAR$ and

[11]Bohn (1998a) also used a model that adopts the regressor of $\max(0, d_t - \bar{d})$ when adding the squared term of d_t to select periods with debt above d^*.

$YVAR$ are also added and respectively indicate the government expenditure levels and the business cycle states. These two regressors, which are based on Barro's (1986b) analysis model of government budget deficits for controlling systematic fluctuations in μ_t, are also theoretically supposed to negatively affect s_t.[12] Note that the period of d_t is the end of the previous FY of FY t and that of each other variable is FY t.

5. Empirical Model and Data

5.1 Empirical model

This section explains the empirical model used in this study, which basically follows Bohn's (1998a, 2005) model and integrates some original features. The following are its detailed contributions.

1) Object of analysis

Existing studies are quite scant that implement Bohn's (1998a, 2005) test with data of Japanese LGs. Japanese LGs are classified into two major categories. PGs in the first category preside over 47 prefectural regions including municipalities, and in the second category, MGs manage 1718 (as of June 2018) municipality regions, which are more receptive to the needs of the local residents. However, the aggregated PG expenditures occupy almost half of the total Japanese LPF expenditures (47.3%, in FY2016). Therefore, it is quite beneficial to adopt 47 PGs as analysis targets to grasp the predominant stream of Japanese LPF. Hence, this study inspects Japanese PGs, as did Akamatsu and Hiraga (2011) and Mochida (2015).

[12]Barro's (1986b) scheme is based on the tax-smoothing model. See Barro (1979, 1986a, 1986b) for details.

2) Testing stationarity and cointegration relationship of variables

Many researches have utilized Bohn's (1998a, 2005) method. However, despite using time-series variables, most such previous works 1) failed to examine the integration properties of the variables and 2) did not address the validity of the estimation of a fiscal reaction function using time-series variables. This study tackles both these issues with panel data.[13]

3) Method

This study implements a panel data analysis like Claeys, Ramos, and Suriñach (2008), Akamatsu and Hiraga (2011), Mahdavi (2014), and Mochida (2015).

4) Effects of Law on FCLGs

Following the fiscal collapse of Yubari city government in Hokkaido prefecture, the Japanese public began to focus more on the soundness of the fiscal management of LGs.[14] In response to this trend, the Law on FCLGs was enacted by the CG in FY2008, and a method for evaluating the financial management of LGs was reconsidered to holistically understand the financial situations of LGs and their related bodies to identify potential risks. I examined how this reform changed the behavior of LGs (especially, the existence of a structural change). Note that Mochida (2015) also made a similar attempt. However, when using a regression model based on Mochida (2015), a researcher should consider the multicollinearity problem[15] because Mochida's (2015) model used fiscal indicators among

[13]To some extent, Mahdavi (2014) tried these issues.

[14]The Yubari-city government became insolvent due to a decline of the coal industry in the 1980s. Although its government had concealed its actual fiscal deficit using a temporary-borrowing-and-lending method between its general accounts and some special accounts up to FY 2006, about 350 billion yen of the deficit was finally discovered and the net balance ratio of this city achieved -730 in FY2007: this figure is extremely bad (see Table 5 for the definition and the average of this indicator). The Japanese CG announced the collapse of the Yubari-city government in March 2007.

[15]Mochida (2015) ignores this problem.

which high correlations may exist.[16] Therefore, I established a model to avoid this problem and did not use redundant explanatory variables (See Section 6 for details.)

5) Effects of financial transfers from the CG to PGs

To the best of my knowledge, no study has examined the effects of financial transfers from a CB to LGs with Bohn's (1998a, 2005) test using Japanese datasets. Therefore, this study inspects the effects like Mahdavi did (2014). I prepared an original variable that well reflects Japan's intergovernmental fiscal system, as described below. If this variable's value is positive (negative), the financial transfer from the CG to the PG is richer (poorer) than the Japanese economic state in the period. Taking the close relation between Japanese CB and LGs in the country's public finance into account, I expect this variable to positively influence the primary balance (to develop it in the surplus direction):

$$rd_{it} \equiv grrate\ of\ grant_{it} - grrate\ of\ GDP_t \tag{6}$$
$$grrate\ of\ grant_{it} \equiv (grant_{it} - grant_{i1973})/grant_{i1973}$$
$$grrate\ of\ GDP_t \equiv (GDP_t - GDP_{1973})/GDP_{1973}.$$

In Equation (6), $grant$ denotes the total amount of general and specific grants and subsidies.

6) Treatment of endogeneity problem

The fiscal activity of the concerned PG substantially influences the size and state of the regional economy. Hence, the endogeneity problem very likely occurs regarding the

[16]Mochida (2015) used the ordinary balance ratio, the net balance ratio, the debt service burden ratio, the interaction terms of these fiscal indicators and a dummy variable, which identifies the ex-ante and ex-post of the enforcement of the Law on FCLGs. However, e.g., the correlation coefficient between the first and third indicators was 0.530 when using a prefectural dataset (1984-2014).

explanatory variable $YVAR$. Following this idea, I adopted the instrumental variable (IV) method in my estimation. Yet, to the best of my knowledge, no research except Fuji (2010) implemented Bohn's (1998a, 2005) test and simultaneously considered this problem. Therefore, this study is the first that addresses this problem with panel data.

7) Investigation of the gaps in fiscal reactions resulting from fiscal-state differences

From Figure 2, since fiscal reactions apparently depend on fiscal states, I classified all 47 PGs into three groups based on the level of the future burden ratio and analyzed PG's fiscal sustainability by group as well as by all 47 PGs.

I explain the empirical model below:

$$s_{it} = \alpha_0 + \beta_1 d_{it} + \beta_2 dsq_{it} + \alpha_G GVAR_{it} + \alpha_Y YVAR_{it} + \alpha_r rd_{it} \quad (7)$$
$$+\gamma_1 D_t d_{i,t} + \gamma_2 D_t dsq_{it} + \mu_i + \varepsilon_{i,t}$$
$$dsq_{it} \equiv \left(d_{i,t} - \bar{d}\right)^2$$
$$GVAR_{it} \equiv (G_{it} - G_{it}^*)/GRP_{it}$$
$$YVAR_{i,t} \equiv (1 - GRP_{i,t}/GRP_{i,t}^*)(G_{i,t}^*/GRP_{i,t})$$
$$D_t = \begin{cases} 0, & t < 2007 \\ 1, & t \geq 2008 \end{cases}.$$

Here s_{it} is the ratio of the primary balance to the GRP of the region where the PG is located, d_{it} is the PG debt to the GRP ratio at the end of the previous FY, and $\bar{d}$ represents the average value of d_{it} during the estimation periods. G_{it} stands for the PG's expenditure level, excluding debt payments and savings in reserve funds. G_{it}^* is the trend of G_{it} and GRP_{it}^* is the trend of GRP_{it}. In this model, the $GVAR$ and $YVAR$ definitions follow those of Barro (1986b) cited by Bohn (1998a). D_t is a dummy variable that identifies the ex-ante

and ex-post of the enforcement of the Law on FCLGs. $D_t d_{i,t}$ is the interaction term of D_t and d_{it}, and $D_t dsq_{it}$ is the interaction term of D_t and dsq_{it}. In other words, the presence or absence of a structural change is measured based on the significance of these interaction terms. μ_i represents the effect unique to each PG, and $\varepsilon_{i,t}$ represents the error term. Subscripts i and t respectively index the prefectures and periods (in addition, the period unit is FY). However, for the notation of FY, d_{it} is measured at the beginning of the FY (the end of the previous FY), and the other variables represent its end.

Finally, I explain the possibility of overfitting and multicollinearity owing to the existence of the squared term of d_{it} in Equation (7). Although Bohn (1998a) identified these problems, to the best of my knowledge, no research has addressed them except Yoshida (2016, 2017). Hence, to carry out regression analysis, I inspected the redundancy of the squared term of d_{it} as well as the interaction term of D_t and built a model that is closer to the actual reality of the situation (Section 6).

5.2 Data

I implemented a panel data analysis with the finances of 47 PGs in Japan as the analysis targets. The following are the details of the dataset. First, the analysis term is FY1974-2014. Second, I adopted the gross prefecture product as GRP.[17] Third, I followed Mochida (2015) and Yoshida (2016, 2017) concerning the primary balance and government debt. I obtained the primary balance by subtracting the *local bonds* and the *money transferred* in the revenue items from the sum of the *public debt payments* and the *savings in the reserve funds* in the expenditure items. Government debt was obtained by subtracting the *reserve-fund balance* from the PG debt. The amount of PG expenditure was calculated by

[17]I prepared the GRP, GDP, and GDP deflator data from the 93SNA and 68SNA series data. Connecting these two series of data was implemented in the following steps: 1) I calculated the ratio of the figures of 68SNA at the 68SNA's last FY to those of 93SNA; 2) using item 1's ratio, I adjusted the 68SNA data.

subtracting the *public debt payments* and the *savings in the reserve funds* in the expenditure items from the total expenditure amount. Fourth, I prepared the trend level of the PG expenditures and the GRP by the Hodrick–Prescott Filter (HP filter).[18]Fifth, for deriving rd_{it}, this study adopted the amount of local allocation tax as general grants, and the amount of national government disbursements as specific grants. Note that the amount of data used in this study is all standardized using a GDP deflator (2005 calendar year = 100). Finally, the data sources are shown in Table 6 and the data's descriptive statistics in Table 7. In addition, Figure 3 chronologically graphs the rd_{it} averages by group and explains the following facts: 1) the lower the group's financial state was, the higher the average value of rd_{it} was in the long run, and 2) the average value of the rd_{it} of Group 1 with the worst financial state started to exceed that of Group 2 with a middle-level financial state after the Great East Japan Earthquake in March 2011.[19]

[Table 6 about here]

[Table 7 about here]

[Figure 3 about here]

6. Results

6.1 Stationarity and cointegration tests

Bohn (2007) argues that even a debt series with any finite order of integration can satisfy the IBC. However, since the analysis by Bohn's (1998a, 2005) model used time-series data, as Nguyen, Suardi, and Chua (2016) point out, the analyzer must confirm its analysis's

[18]See Hodrick and Prescott (1997) for details. This study also set the penalty parameter at 100.

[19]The second fact shows that Japan's CG transferred relatively larger grants to Group 1. On the other hand, Group 2 was affected most negatively by the following two issues: 1) the budget constraint of Japan's total public finance worsened based on the fiscal support to the prefectures damaged by the Great East Japan Earthquake, and 2) the recent public finance system reforms.

validity in the following steps: 1) it must examine the sustainability of all the variables in the model, i.e., their integration properties, and 2) it must investigate whether the model is viewed as a cointegration relationship or a standard regression.

First, I implemented panel unit root tests on all variables by the LLC test (Levin, Lin, and Chu, 2002), the IPS test (Im, Pesaran, and Shin, 2003), the Fisher ADF test, and the Fisher PP test. The results in Table 8 indicate that the three variables of d_{it}, dsq_{it}, and rd_{it} are I (1). All the other variables are I (0). Like in Bohn (1998a, 2005), I obtained a result where both the stationarity of d_{it} and that of its related variable dsq_{it} are rejected. Note that these results may be attributed to the following two facts: 1) even if d_{it} is I (0), it has high autocorrelation, and 2) when testing unit roots, $GVAR_{it}$ and $YVAR_{it}$ (the important systematic components in Equations (5) and (7)) are ignored, as Bohn (1998a, 2005) pointed out.

Subsequently, following the above unit root tests, I examined whether the linear combinations of the level nonstationary variables become stationary. Hence, I carried out panel cointegration tests using the Kao (1999) and Fisher tests. The results are shown in Table 9. I examined the following variable combinations (d_{it}, dsq_{it}, rd_{it}), (d_{it}, $GVAR_{it}$, $YVAR_{it}$) as well as modified versions of the second combination, which was prepared to verify Bohn's (1998a, 2005) above claim. This table indicates the following: 1) stationarity is accepted on both combinations, and 2) the result of the second combination is consistent with Bohn's (1998a, 2005) claim. [20]

According to the procedures so far, I assume that the fiscal reaction functions appearing below are viewed not as cointegration relationships but as standard regressions, which nest the cointegration relationships among some explanatory variables.

[20]Yet stationarity is not generally accepted in such cases except for the case by the panel ν test statistics with a trend in the Pedroni test (1999, 2004). Therefore, the results here may not be very robust. Addressing this issue is a future task.

[Table 8 about here]

[Table 9 about here]

6.2 Fiscal reaction function

Estimation method

When the models based on Equation (7) were estimated using a panel least squares method, a first-order serial correlation was found in the error term of each model. Thus, to eliminate this, I assumed the following relationship in the error term:

$$\varepsilon_{i,t} = \rho_i \varepsilon_{i,t-1} + \nu_{i,t} \ , \qquad (8)$$
$$E(\nu_{i,t}) = 0, E(\nu_{i,t}^2) = \sigma_{\nu_i}^2, E(\nu_{i,t}\nu_{i,s}) = 0 \text{ for } t \neq s \ .$$

Next I estimated the models represented by Equations (7) and (8) by the panel nonlinear least squares method. To test the significance of each explanatory variable, I adopted a coefficient covariance matrix based on White standard errors that are robust to cross-equation (contemporaneous) correlation and heteroscedasticity.

Estimation results

Tables 10 and 11 show the results where all 47 PGs are the targets, and Table 12 shows the results with the PGs in each group classified by the future burden ratio as targets. Further, note that I examined the fiscal reaction functions based on the following steps:

Step 1: First, I set the regression models from a combination of two factors, which are linear or nonlinear (dsq and $Ddsq$ terms are used) and with/without the rd term.

Step 2: Next I estimated the above models with cross-section fixed effects. When they were rejected, I estimated the above models as pooled ones.

Step 3: Subsequently, based on the adjusted R^2 and the significance state of the regressors in Step 2, I chose the most appropriate model.

Step 4: Again I estimated the model chosen in Step 3 by the IV method to deal with the endogeneity problem of $YVAR$.

Step 5: Finally, from the results in Steps 3 and 4, I scrutinized the fiscal reaction functions.

First, I explain the results in the case of all 47 PGS. From the results of the 4IV model in Table 10, the following are acknowledged. 1) Because the estimated coefficient of dsq is significantly positive, the higher d becomes, the more efforts the PGs make to improve their primary balances: that is, PGs conduct sustainable fiscal management. 2) The estimated coefficient of $GVAR$ is significantly negative, as I anticipated, but not that of $YVAR$. 3) Since the significances of Dd and $Ddsq$ are rejected, I assume that the Law on FCLGs does not influence PGs' behaviors very much. 4) Since the estimated coefficient of rd is significantly positive, the ample fiscal transfer from the CG to each PG improves the state of the PG finance, as I expected.

Next, the Group 1 results are explained. From the results of the 4IV model in Table 12, the following facts are perceived. 1) The estimated coefficients of d and dsq are not significant. On the contrary, the estimated coefficient of Dd is significantly negative, and that of $Ddsq$ is significantly positive. These results mean that the PGs in this group, whose fiscal state is the worst, started to improve their fiscal conditions when d > the threshold value after the enforcement of the Law on FCLGs. 2) The $GVAR$ and $YVAR$ results are the same as those in the case of all 47 PGs. 3) The rd effect is the same as that of the case of all 47 PGs.

Subsequently, the results of Group 2 are explained on the basis of the results of the 2IV model in Table 12 as follows. 1) The estimated coefficients of d are not significant. On the contrary, the estimated coefficient of Dd is significantly positive. These results means that the PGs in this group, whose fiscal state is at the middle-level, started to improve their fiscal condition after the enforcement of the Law on FCLGs. 2) The estimated coefficients of $GVAR$ and $YVAR$ are significantly negative, as I hypothesized. 3) The rd effect is the same as that in the case of all 47 PGs.

Finally, based on the 4IV model in Table 12, the Group 3 results are considered as follows. 1) The estimated coefficients of d are significantly positive at a 10% level, which is rather sluggish. This result means that the PGs in this group tended to improve their fiscal conditions if d increases. That is, they are assumed to conduct sustainable fiscal management. On the other hand, since the estimated coefficients of Dd are not significant, these PGs are also assumed not to change their postures on fiscal management before and after the enforcement of the Law on FCLGs. 2) The $GVAR$ and $YVAR$ results are the same as those in the case of all 47 PGs. 3) The rd effect is identical as that in the case of all 47 PGs. From this, financial transfers are beneficial for the fiscal management of the PGs in this group as well as in Groups 1 and 2.

Here, I summarize the results so far as follows. First, the results of Groups 1-3 generally describe actual situations more closely than those of all 47 PGs. Second, the firmer the PG's fiscal condition is, the more likely it will conduct a sustainable fiscal management. Third, $GVAR$ and $YVAR$, which control the systematic fluctuation of s, behave in a way that most closely matches the anticipated theory in PGs in the middle-level fiscal condition. Fourth, the Law on FCLGs probably forces even PGs with poor fiscal conditions to conduct sustainable fiscal management. Fifth, the larger fiscal transfers from the CG to PGs help PG finances become even sounder. Last, the adjusted R^2 values increase more in the IV

estimations than in the ordinary ones.

[Table 10 about here]

[Table 11 about here]

[Table 12 about here]

7. Concluding Remarks

In Japan since the 1940s, the total sum of local government (LG) expenditures has exceeded the sum of central government (CG) expenditures in a ratio of around six to four. LGs have a relatively sound fiscal state especially recently, but the CG has suffered quite severe fiscal conditions since FY1993 when the primary balance of the CG became negative. Yet different situations are found among the LPF subsectors. Actually, PGs, whose aggregated expenditures occupy almost half of the total amount of LG expenditures, generally do not experience a financial margin: e.g., most are at capacity when they are simply implementing ordinary affairs. PGs also have a relatively high ratio of outstanding deficit-covering LGBs to the total outstanding LGBs (Section 2.)

This study examined the fiscal sustainability of PGs in Japan using a panel dataset (47 PGs, FY1974-2014) to identify the general fiscal-management tendencies in Japanese LPF. This study has the following advantages: 1) it considered the influences caused by fiscal-condition gaps, classified the 47 PGs into three groups by their level of fiscal soundness, and implemented analysis by group as well as by all 47 PGs; 2) it tested whether the enforcement of the Law on FCLGs in FY2008 urged the PGs to improve their fiscal conditions; 3) it investigated whether the fiscal transfers from the CG to PGs helped the PGs conduct sustainable fiscal management; and 4) it dealt with the nonstationary and endogeneity problems of regressors that existing researches failed to treat fully.

This study presents the following findings. First, the more stable a PG's fiscal condition is, the more likely it will conduct a sustainable fiscal management. Second, $GVAR$ and $YVAR$, which control the systematic fluctuation of s, behave in a way that most matches the anticipated theory in PGs with a middle-level fiscal condition. Third, the Law on FCLGs probably urges even PGs with poor fiscal conditions to conduct a sustainable fiscal management. Fourth, larger fiscal transfers from the CG to PGs help their finances become even sounder. Last, the adjusted R^2 values increase more in the IV estimations than in the ordinary ones.

Further, the Japanese both public and private sectors should deeply pay attention to the third and fourth knowledge above. In the expenditure items of Japan's CG, *local allocation tax*, which is a general grant, occupies the second largest ratio to the total expenditure amount next to *social security* among primary expenses. Although the primary balance of the CG among the subsectors in Japanese general governments is very poor, this situation is attributed to the fact that the CG has the final responsibility for conducting Japanese public-sector's finance and financing revenue shortages as a whole by issuing national government bonds. When discussing fiscal consolidation based on the view that concentrates on only the public sector, Japanese society cannot avoid the trade-off problem between the fiscal soundness of the CG and LGs. Therefore, to ameliorate this severe problem and make the distribution of the value added holistically efficient in the Japanese economy,[21] Japanese society has to identify appropriate ways of taxation and sharing costs to manage itself.

Appendix: Related Literature Continued

This appendix describes the existing studies that simulated future states to judge the fiscal

[21] As a whole, the Japanese economy has retained its top-class sound condition in the world for decades. (See Section 2 for details.)

sustainability of the public sector. First, this field's studies can be classified into the following two categories: 1) a simulation that exogenously assigns all socioeconomic variables to the IBC or the transition equations of stock variables, and 2) a simulation that endogenously derives as many socioeconomic variables as possible using dynamic computable general equilibrium (DCGE) models.

First, I review Broda and Weinstein (2005) and Hoshi and Ito (2014) as critical examples of the above first simulation. Broda and Weinstein (2005) derived the requested ratio of government revenue/GDP that helps the Japanese general government meet its IBC condition by a simulation (2000-2100).[22] Hoshi and Ito (2014) simulated the dynamics of Japan's public debt and its private sector's financial assets. Second, I review the existing studies that belong to the above second simulation. The first type of study suffers from a huge drawback: it cannot grasp how the government's fiscal policies and socioeconomic variables endogenously influence each other. Hence, to deal with this problem, some researches utilized the DCGE model that can describe dynamic general equilibrium based on each agent's optimization behavior (e.g., Ihori et al. 2006, Yoshida 2015).[23] Doi et al. (2011), who updated Broda and Weinstein (2005), Hoshi and Ito (2014), and Ihori et al. (2006), argued that Japan's general government has to raise the ratio of its government revenue/GDP to around 40-50% to attain fiscal sustainability. On the other hand, Yoshida (2015) clarified that the monetization policy by the central bank has the potential to make Japan's general government's finance and economy sustainable.

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[22]The values of the following variables are given: 1) the growth rate of the monetary stock, 2) financial transfers to the aged, 3) government expenditures except item 2 and interest payments on public debt, 4) population structure, 5) interest rate of public bonds, 6) the growth rate of GDP, and 7) the amount of public debt at the initial time.

[23]Sugawara and Hosono (2011) reported a 0.2% required primary surplus to make Japanese general government finance sustainable by the dynamic stochastic general equilibrium (DSGE) model.

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Tables and Figures

Table 1 Net Lending (+)/Net Borrowing (-) of Japanese Economy

FY Sector	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1. Households	7.5	3.6	3.7	4.1	2.6	1.4	4.5	2.6	6.5	3.2	1.9	4.4
2. Financial corporations	0.4	2.0	1.0	2.5	-1.3	1.5	3.8	1.2	1.9	0.8	1.1	-0.3
3. Non-financial corporations	-1.6	2.0	2.7	0.4	5.6	4.4	4.2	8.0	1.8	4.5	4.0	2.9
Subtotal	6.3	7.6	7.4	7.0	6.9	7.3	12.5	11.8	10.2	8.5	7.0	7.0
4. General government	-4.4	-5.1	-3.8	-3.0	-2.5	-5.2	-9.2	-8.2	-8.5	-7.7	-6.6	-5.3
5. Rest of world	-1.8	-2.4	-3.6	-4.0	-4.5	-2.0	-3.3	-3.6	-1.7	-0.8	-0.4	-1.6

Notes: Households includes private non-profit institutions serving households.

Source: By author using FY2016's SNA (Cabinet Office).

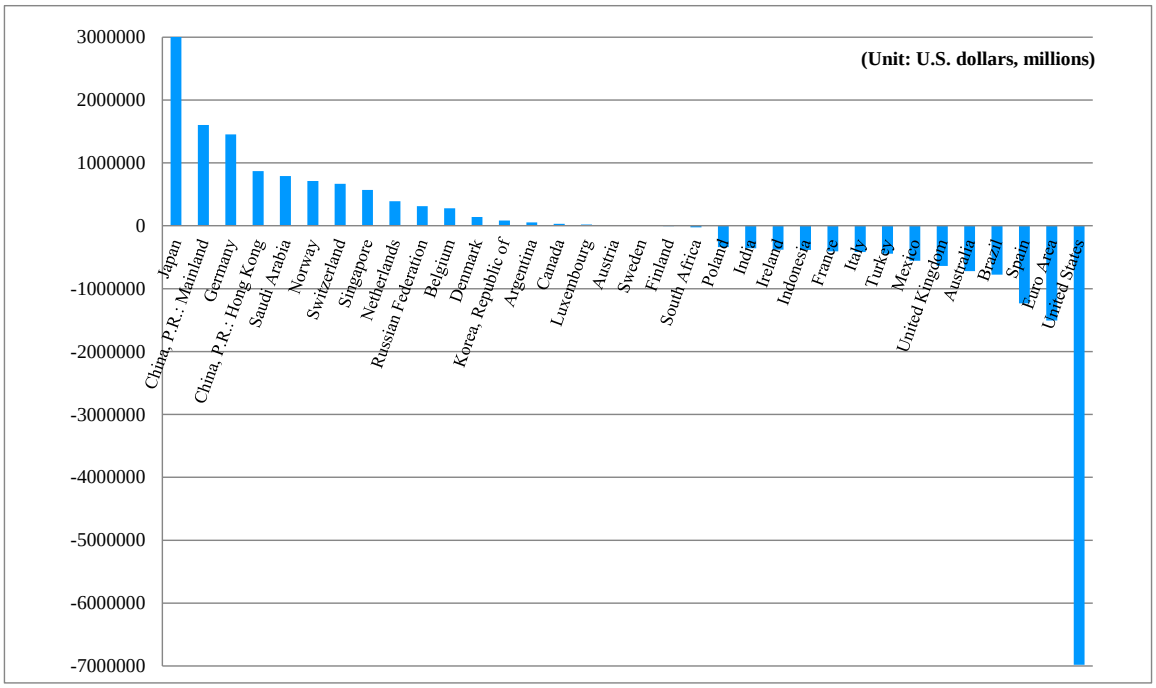

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Figure 1 International Investment Position (2014)

Table 2 Primary-balance by Government Sector in Japan

(Ratio to GDP, %)

	Category/ FY	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total		-3.4	-2.5	-2.3	-4.7	-9.3	-8.0	-7.8	-7.1	-6.3	-4.2
1	Central government	-3.1	-2.4	-1.8	-4.3	-7.7	-6.4	-7.1	-6.2	-5.6	-4.0
2	Local governments	0.5	0.7	0.6	0.9	0.4	0.1	0.6	0.5	0.4	0.2
3	Social security funds	-0.8	-0.9	-1.0	-1.3	-1.9	-1.7	-1.4	-1.3	-1.2	-0.3

Source: By author using FY2016's SNA (Cabinet Office).

Table 3 Long-term Debt Outstanding of Central and Local Government in Japan

(Unit: trillion yen)

FY	1994	2002	2009	2014
Central government	269	536	621	800
Local governments	106	193	198	201
Total	375	729	819	1,001
% of GDP	76%	147%	173%	204%

Source: By author using "Understanding Japanese Budget" (Ministry of Finance), "Explanation of Japanese Public Finance with Charts" (Toyokeizaishinposya Inc.)

Table 4 Details of Outstanding Local Government Bond

(Unit: billion yen)

Category			Prefectures	Municipalities		
	FY	Total B		Subtotal	Cf. Ordinance-designated cities	Core cities
Total A (1)	2013	145,917	89,730	56,187	18,224	6,487
	2008	137,366	80,222	57,143	17,034	6,379
	2003	138,948	77,389	61,558	16,357	6,157
Deficit-covering local bonds (2)	2013	69,303	46,054	23,249	6,921	2,795
	2008	52,892	34,051	18,841	4,947	2,181
	2003	43,257	28,491	14,766	3,477	1,558
Ratio = (2)/(1)	2013	0.475	0.513	0.414	0.380	0.431
	2008	0.385	0.424	0.330	0.290	0.342
	2003	0.311	0.368	0.240	0.213	0.253

Notes: (1) "Total A" indicates total through all bond types, "Total B" indicates total through all categories, "Subtotal" indicates total through all municipality categories. (2) Public enterprise bonds outstanding are not included. (3) The deficit-covering local bonds outstanding in Table are as follows: revenue supplementary bonds, fiscal countermeasure bonds, financial resources countermeasure bonds, temporary fiscal special bonds, temporary special purpose bonds such as public works projects, tax supplementary bonds, temporary tax collection supplementary bonds, and extraordinary fiscal countermeasure bonds. (4) The range of deficit-covering local bonds follows Yoshida (2017).
Source: By author using each year's "Annual Statistics on Local Public Finance" (Ministry of Internal Affairs and Communications).

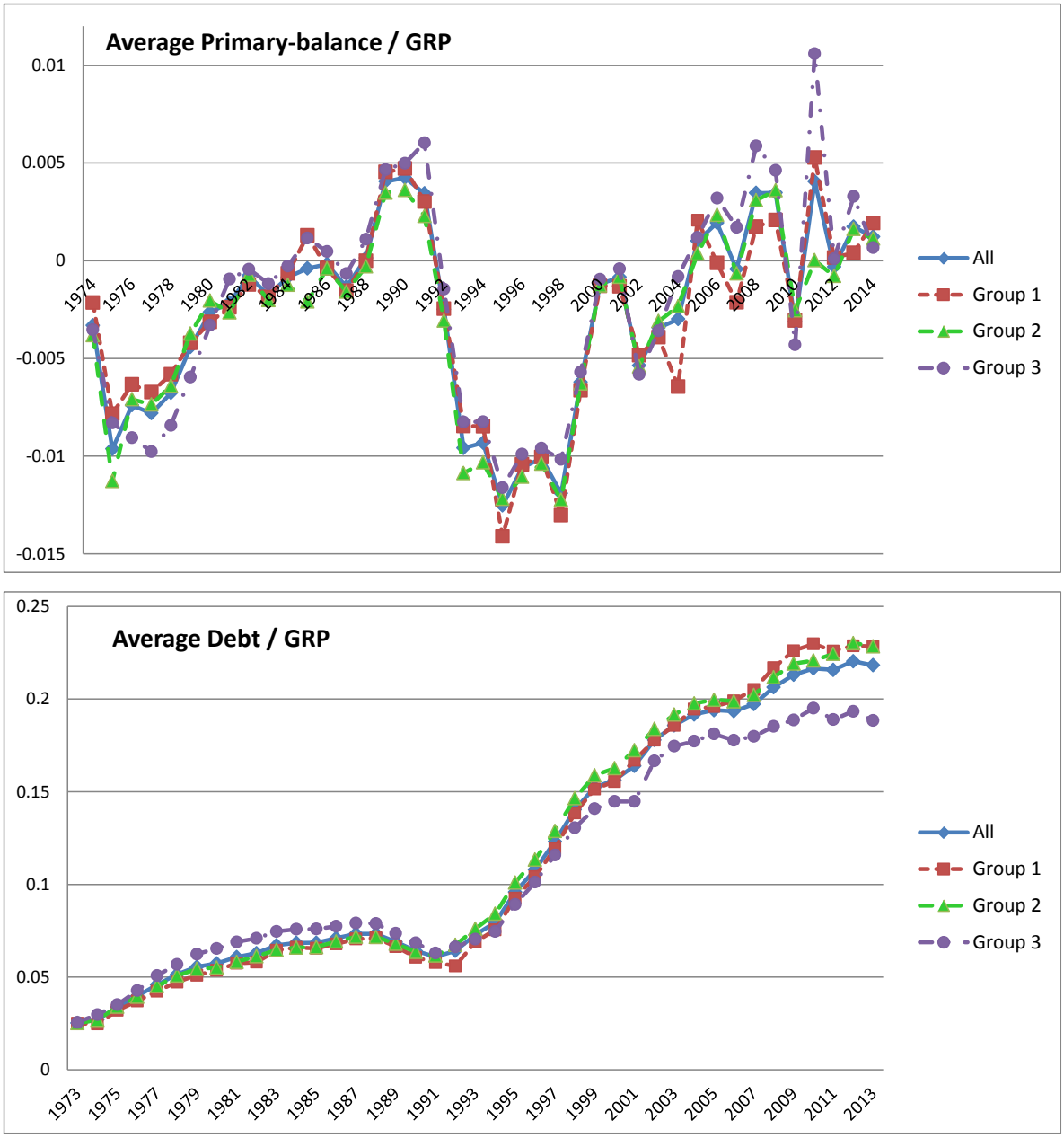
Table 5 Local Public Finance Indicators by Group

(%)

Category	Fiscal indicators / FY	First half of 1970s	2005	2010	2014
Prefectures	1. Ordinary balance ratio	70.2	92.6	91.9	93.0
	2. Net balance ratio	0.6	0.9	1.3	1.5
	3. Debt service burden ratio	4.2	19.3	18.9	19.5
	4. Financial capability indicator	0.52	0.43	0.49	0.47
Municipalities	1. Ordinary balance ratio	73.1	90.2	89.2	91.3
	2. Net balance ratio	4.2	3.5	4.1	4.3
	3. Debt service burden ratio	6.6	17.4	16.5	15.3
	4. Financial capability indicator	0.33	0.52	0.53	0.49
Cf.					
Ordinance-designated cities	1. Ordinary balance ratio	71.0	94.3	95.4	96.6
	2. Net balance ratio	0.1	0.6	1.0	1.2
	3. Debt service burden ratio	7.2	20.9	20.1	19.8
	4. Financial capability indicator	0.78	0.83	0.87	0.85
Core cities	1. Ordinary balance ratio	—	87.0	89.5	90.4
	2. Net balance ratio	—	3.4	3.4	3.3
	3. Debt service burden ratio	—	16.6	16.8	15.8
	4. Financial capability indicator	—	0.78	0.80	0.76

Notes: (1) All figures are percentages. (2) Fourth indicator is an arithmetic average. Others are weighted averages. (3) First indicator = general revenue sources appropriated for ordinary expenditures/ordinary general revenue sources, second indicator = net balance/standard financial scale, third indicator = debt service/general revenue sources, and fourth indicator = past three-year average of "basic financial revenues/basic financial needs." These numerators and denominators are derived by calculating local allocation tax (general grant in Japan).

Source: By author using "White Paper on Local Public Finance, 2017" (Ministry of Internal Affairs and Communications).



Source: By author using statistics shown in Table 6.

Figure 2 Averages of Primary-balance/GRP and Debt/GRP by Group

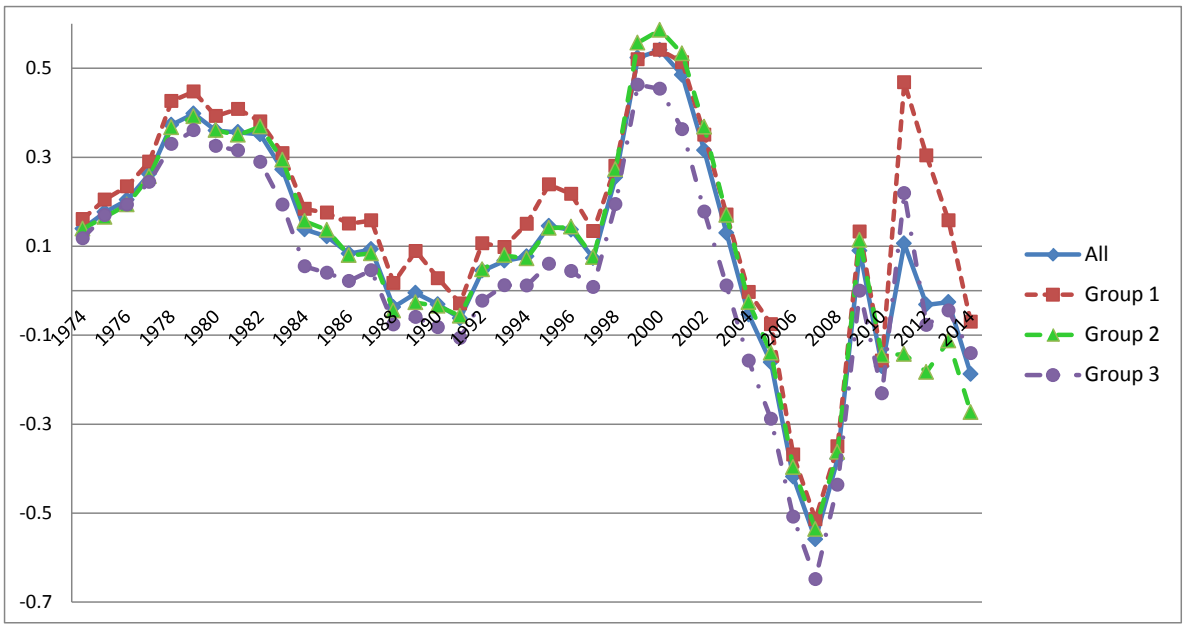
Table 6 Data Sources

No.	Data	Sources
1	Total expenditure, Debt service expenditure, Reserve-fund expenditure, local-bond revenue, money transferred	"Annual Statistics of Local Public Finance," Institute of Local Finance
2	Local debt, Fund balance	"Survey of Prefecture Finance Settlement Situation," Ministry of Internal Affairs and Comunications
3	Local allocation tax, National treasury disbursements	"Annual Statistics of Local Public Finance," Institute of Local Finance
4	GRP	"Prefectural Accounts," Cabinet Office
5	GDP, GDP deflator	"National Accounts," Cabinet Office

Table 7 Descriptive Statistics

(Unit: millions yen)

	Expenditure / Revenue	Mean	Std. Dev.	Max.	Min.	Obs.	Term in FY
Total expenditure	Expenditure	877,861	871,729	7,161,931	169,816	1927	1974-2014
Debt-service expenditure	Expenditure	90,688	96,951	974,605	2,627	1927	1974-2014
Reserve-fund expenditure	Expenditure	19,970	47,365	1,067,404	0	1927	1974-2014
Local-bond revenue	Revenue	107,949	100,889	1,092,564	5,526	1927	1974-2014
Money transferred	Revenue	19,024	40,931	812,014	0	1927	1974-2014
GRP (1)		9,205,161	13,010,699	106,000,000	990,427	1927	1974-2014
Local debt		955,065	1,123,407	7,488,192	27,778	1927	1973-2013
Fund balance		86,464	137,832	1,837,605	2	1927	1973-2013
GRP (2)		9,039,756	12,810,567	106,000,000	978,064	1927	1973-2013



Source: By author using statistics shown in Table 6.

Figure 3 Average rd by Group

Table 8 Panel Unit Root Test Result

Level

With intercept and no trend

Method	LLC		IPS		Fisher ADF		Fisher PP	
	Statistic	P value	Statistic	P value	Statistic	P value	Statistic	P value
s	-7.214 ***	0.000	-10.915 ***	0.000	306.008 ***	0.000	301.652 ***	0.000
d	1.407	0.920	8.432	1.000	23.724	1.000	16.539	1.000
dsq	7.025	1.000	6.875	1.000	51.714	1.000	43.935	1.000
GVAR	-8.904 ***	0.000	-14.749 ***	0.000	403.585 ***	0.000	408.518 ***	0.000
YVAR	-20.285 ***	0.000	-22.224 ***	0.000	643.370 ***	0.000	630.046 ***	0.000
rd	2.258	0.988	0.225	0.589	91.578	0.552	86.666	0.692

Notes: "***," "**," and "*" denote 1, 5, 1and 10 significance levels, respectively.

First Difference

With intercept and no trend

Method	LLC		IPS		Fisher ADF		Fisher PP	
	Statistic	P value	Statistic	P value	Statistic	P value	Statistic	P value
d	-12.765 ***	0.000	-16.187 ***	0.000	451.016 ***	0.000	480.919 ***	0.000
dsq	-18.058 ***	0.000	-18.256 ***	0.000	470.600 ***	0.000	532.614 ***	0.000
rd	-36.034 ***	0.000	-31.764 ***	0.000	960.821 ***	0.000	966.647 ***	0.000

Notes: "***," "**," and "*" denote 1, 5, 1and 10 significance levels, respectively.

Table 9 Panel Cointegration Test

Object	(d, dsq, rd)		(d, GVAR, YVAR)		(d, GVAR)		(d, YVAR)	
Method	Statistic	P value	Statistic	P value	Statistic	P value	Statistic	P value
Kao: with intercept and no trend								
H_0: No Cointegration								
t-statics	-7.488	0.000	1.906	0.028	1.769	0.039	1.894	0.029
Fisher: with intercept and no trend								
H_0: No cointegration vector exists.								
trace test	321.4	0.000	455.200	0.000	242.600	0.000	392.600	0.000
max-eigen test	284.400	0.000	344.000	0.000	252.200	0.000	411.300	0.000
H_0: At most one cointegration vector exists.								
trace test	124.800	0.019	210.100	0.000	85.780	0.715	84.030	0.760
max-eigen test	130.700	0.007	217.700	0.000	85.780	0.715	84.030	0.760
H0: At most two cointegration vectors exist.								
trace test	78.240	0.879	84.340	0.752				
max-eigen test	78.240	0.879	84.340	0.752				

Table 10 Results 1: All 47 PGs

	Linear		Nonlinear				Instrumental variables: Linear	Instrumental variables: Nonlinear
	Fixed	Pooled	Fixed	Fixed	Pooled	Fixed	Fixed	Fixed
Regression model	1-1	1-2	2	3-1	3-2	4	2IV	4IV
Constant	-0.005 ***	-0.004 ***	-0.009 ***	-0.005 ***	-0.004 ***	-0.009 ***	-0.009 ***	-0.008 ***
	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)	(0.003)	(0.003)	(0.003)
	[-3.297]	[-3.177]	[-3.232]	[-2.878]	[-2.876]	[-3.256]	[-2.698]	[-2.965]
d	0.016	0.005	0.039 *	0.015	0.006	0.033 *	0.041	0.014
	(0.012)	(0.010)	(0.022)	(0.013)	(0.012)	(0.020)	(0.029)	(0.020)
	[1.335]	[0.496]	[1.815]	1.149	[0.546]	[1.669]	[1.427]	[0.705]
dsq				0.030	-0.156	0.219		0.644 **
				(0.242)	(0.187)	(0.257)		(0.270)
				[0.123]	[-0.834]	[0.851]		[2.385]
GVAR	-0.234	-0.233	-0.425 ***	-0.233	-0.243	-0.427 ***	-0.489 ***	-0.485 ***
	(0.206)	(0.212)	(0.087)	(0.209)	(0.213)	(0.082)	(0.096)	(0.095)
	[-1.137]	[-1.100]	[-4.906]	[-1.114]	[-1.141]	[-5.218]	[-5.089]	[-5.127]
YVAR	0.176	0.161	-0.135	0.186	0.167	-0.130	-0.455	-0.359
	(0.317)	(0.314)	(0.135)	(0.321)	(0.317)	(0.133)	(0.365)	(0.398)
	[0.556]	[0.512]	[-1.001]	[0.579]	[0.525]	[-0.978]	[-1.247]	[-0.901]
rd			0.012 **			0.012 **	0.015 ***	0.015 ***
			(0.005)			(0.005)	(0.005)	(0.005)
			[2.328]			[2.451]	[3.088]	[3.032]
Dd	0.017 **	0.021 ***	0.018 ***	-0.006	0.001	-0.009	0.023 *	-0.008
	(0.007)	(0.007)	(0.008)	(0.010)	(0.010)	(0.018)	(0.014)	(0.020)
	[2.373]	[3.002]	[2.148]	[-0.613]	[0.063]	[-0.478]	[1.713]	[-0.370]
Ddsq				0.404 **	0.450 ***	0.382		0.243
				(0.187)	(0.186)	(0.280)		(0.300)
				[2.157]	[2.414]	[1.365]		[0.812]
ρ	0.326 ***	0.352 ***	0.516 ***	0.331 ***	0.349 ***	0.528 ***	0.658 ***	0.613 ***
	(0.097)	(0.095)	(0.126)	(0.096)	(0.096)	(0.117)	(0.106)	(0.107)
	[3.361]	[3.689]	[4.108]	[3.449]	[3.634]	[4.528]	[6.222]	[5.729]
Adj. R^2	0.269	0.269	0.361	0.274	0.273	0.369	0.415	0.442
S.E.	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.005
DW ratio	1.948	1.969	2.016	1.947	1.962	2.023	2.209	2.1925
Prob. (J-statistic)							0.000	0.000
Obs.	1880	1880	1880	1880	1880	1880	1739	1739

Notes: 1) "dsq" stands for square of (d - average of d), "rd" is the ratio-difference and "D" is the dummy variable on "Law on FCLGs." 2) DW means Durbin-Watson. White robust standard errors are in parentheses. 3) T-statistics are in brackets. "***," "**," and "*" denote 1, 5, and 10 significance levels, respectively. 4) Model 2IV uses following variables as instruments: cross-section constants, *d* , *GVAR* , *GVAR(-1)* , *YVAR(-1)*, *YVAR(-2)* , *YVAR(-3)* , *YVAR(-4)* , *rd* , *rd(-1)* , *Dd* , and *s(-1)* . Model 4IV uses *dsq* and *Ddsq* in addition to Model 2IV's instruments.

Table 11 Fixed Effects and Redundant Variables Tests: All 47 Prefecture Governments

	Linear		Nonlinear					
	Fixed		Fixed		Fixed		Fixed	
Regression model	1-1		2		3-1		4	
Cross-section F statistic (1)	0.995	[0.483]	2.627	[0.000]	1.041	[0.398]	2.878	[0.000]
Redundant variable F statistic (2)								
YVAR			4.500	[0.034]				
dsq, YVAR, Dd, & Ddsq							12.544	[0.000]

Notes: (1)'s statistic examines the null where cross-section effects are redundant, (2)'s statistic examines the null where concerned variables are redundant. P values (i.e., Type 1 error probabilities) are in brackets .

Table 12 Results 2: by Group

Group 1								Instrumental variables	
	Linear				Nonlinear			Linear	Nonlinear
	Fixed	Pooled	Fixed	Pooled	Fixed	Pooled	Fixed	Pooled	Fixed
Regression model	1-1	1-2	2-1	2-2	3-1	3-2	4	2IV	4IV
Constant	-0.005 ***	-0.005 ***	-0.013 ***	-0.015 ***	-0.005 **	-0.003 **	-0.010 ***	-0.014 ***	-0.009 **
	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)
	[-2.884]	[-2.947]	[-3.932]	[-3.659]	[-2.276]	[-2.207]	[-3.432]	[-3.350]	[-2.299]
d	0.015	0.007	0.060 ***	0.075 ***	0.009	0.002	0.031	0.064 ***	0.019
	(0.015)	(0.013)	(0.022)	(0.023)	(0.016)	(0.014)	(0.021)	(0.022)	(0.031)
	[1.005]	[0.589]	[2.701]	[3.241]	[0.599]	[0.147]	[1.440]	[2.884]	[0.613]
dsq					0.043	-0.106	0.166		0.553
					(0.239)	(0.201)	(0.206)		(0.420)
					[0.179]	[-0.531]	[0.803]		[1.315]
GVAR	-0.095	-0.098	-0.455 **	-0.448 **	-0.104	-0.108	-0.478	-0.465 **	-0.536 ***
	(0.289)	(0.290)	(0.187)	(0.180)	(0.278)	(0.286)	(0.162)	(0.185)	(0.151)
	[-0.330]	[-0.337]	[-2.439]	[-2.496]	[-0.374]	[-0.379]	[-2.948]	[-2.521]	[-3.548]
YVAR	0.254	0.247	-0.239	-0.243	0.229	0.215	-0.237	-0.526	-0.451
	(0.255)	(0.249)	(0.188)	(0.185)	(0.249)	(0.241)	(0.166)	(0.520)	(0.376)
	[0.995]	[0.993]	[-1.268]	[-1.314]	[0.919]	[0.892]	[-1.432]	[-1.012]	[-1.199]
rd			0.014 ***	0.014 ***			0.014 ***	0.015 ***	0.015 ***
			(0.002)	(0.002)			(0.002)	(0.002)	(0.002)
			[6.024]	[6.330]			[6.101]	[6.203]	[6.890]
Dd	0.018 *	0.021 **	0.008	0.006	-0.051 *	-0.045 *	-0.072	0.017	-0.109 *
	(0.010)	(0.010)	(0.008)	(0.007)	(0.027)	(0.025)	(0.046)	(0.019)	(0.059)
	[1.720]	[2.121]	[0.907]	[0.790]	[-1.913]	[-1.830]	[-1.571]	[0.855]	[-1.824]
Ddsq					1.099 **	1.136 **	1.336 *		1.601 *
					(0.469)	(0.459)	(0.734)		(0.960)
					[2.343]	[2.474]	[1.820]		[1.668]
ρ	0.448 ***	0.456 ***	0.745 ***	0.823 ***	0.478 ***	0.492 ***	0.710 ***	0.837 ***	0.768 ***
	(0.094)	(0.091)	(0.085)	(0.067)	(0.087)	(0.082)	(0.082)	(0.060)	(0.084)
	[4.774]	[5.021]	[8.776]	[12.337]	[5.462]	[6.032]	[8.658]	[14.057]	[9.168]
Adj. R^2	0.315	0.323	0.453	0.447	0.357	0.357	0.509	0.421	0.475
S.E.	0.006	0.006	0.005	0.005	0.006	0.006	0.005	0.005	0.005
DW ratio	2.046	2.050	2.103	2.169	2.024	2.038	1.978	2.188	2.061
Prob. (J-statistic)								0.000	0.000
Obs.	480	480	480	480	480	480	480	444	444

Notes: Items 1) - 3) are same as those of Table 10 (This also applies to Groups 2 and 3). 4) Model 2IV uses following variables as instruments: constants, *d* , *d(-1)* , *GVAR* , *GVAR(-1)* , *YVAR(-1)*, *YVAR(-2)* , *YVAR(-3)* , *YVAR(-4)* , *rd* , *rd(-1)* , *Dd* , and *s(-1)* . Model 4IV uses cross-section constants, *dsq*, and *Ddsq* in addition to Model 2IV's instruments.

Group 1	Linear				Nonlinear					
	Fixed		Fixed		Pooled	Fixed		Fixed		
Regression model	1-1		2-1		2-2	3-1		4		5
Cross-section F statistic (1)	0.485	[0.913]	1.512	[0.124]		0.961	[0.481]	1.885	[0.039]	2.885	[0.040]
Redundant variable F statistic (2)										
YVAR & Dd					2.387	[0.093]				
d, dsq, GVAR, YVAR, & Dd								24.970	[0.000]	25.970	[0.001]

Notes: Notes for this table are identical as those of Table 11, as are those of the tables of Groups 2 and 3.

Group 2									Instrumental variables	
	Linear		Nonlinear						Linear	Nonlinear
	Fixed	Pooled	Fixed	Pooled	Fixed	Pooled	Fixed	Pooled	Pooled	Pooled
Regression model	1-1	1-2	2-1	2-2	3-1	3-2	4-1	4-2	2IV	4IV
Constant	-0.005 ***	-0.004 ***	-0.006 ***	-0.005 ***	-0.005 ***	-0.004 ***	-0.006 ***	-0.005 ***	-0.003 **	-0.003 ***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
	[-3.337]	[-3.120]	[-3.540]	[-3.171]	[-3.271]	[-2.796]	[-3.408]	[-3.015]	[-2.548]	[-2.624]
d	0.011	0.003	0.014	0.007	0.011	0.005	0.013	0.008	-0.003	-0.012
	(0.011)	(0.010)	(0.012)	(0.011)	(0.013)	(0.012)	(0.013)	(0.013)	(0.011)	(0.013)
	[1.020]	[0.295]	[1.217]	[0.601]	[0.842]	[0.410]	[1.010]	[0.601]	[-0.264]	[-0.905]
dsq					0.018	-0.121	0.049	-0.090		0.272
					(0.216)	(0.178)	(0.225)	(0.179)		(0.185)
					[0.082]	[-0.679]	[0.217]	[-0.501]		[1.471]
GVAR	-0.446 ***	-0.447 ***	-0.481 ***	-0.472 ***	-0.446 ***	-0.458 ***	-0.478 ***	-0.478 ***	-0.602 ***	-0.603 ***
	(0.086)	(0.083)	(0.087)	(0.083)	(0.084)	(0.083)	(0.085)	(0.084)	(0.105)	(0.102)
	[-5.168]	[-5.415]	[-5.506]	[-5.689]	[-5.294]	[-5.505]	[-5.649]	[-5.728]	[-5.744]	[-5.905]
YVAR	-0.174	-0.194	-0.227	-0.231	-0.164	-0.187	-0.217	-0.222	-0.848 **	-0.896 **
	(0.149)	(0.143)	(0.147)	(0.141)	(0.151)	(0.143)	(0.150)	(0.142)	(0.423)	(0.441)
	[-1.173]	[-1.360]	[-1.544]	[-1.633]	[-1.088]	[-1.305]	[-1.451]	[-1.567]	[-2.005]	[-2.029]
rd			0.002 *	0.002 **			0.002 *	0.002 *	0.003 ***	0.003 ***
			(0.001)	(0.001)			(0.001)	(0.001)	(0.001)	(0.001)
			[1.905]	[2.154]			[1.772]	[1.959]	[2.719]	[2.894]
Dd	0.019 ***	0.022 ***	0.021 ***	0.023 ***	0.002	0.011	0.006	0.014	0.029 ***	0.036 **
	(0.007)	(0.007)	(0.007)	(0.007)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.015)
	[2.689]	[3.183]	[2.978]	[3.341]	[0.264]	[1.239]	[0.684]	[1.551]	[2.984]	[2.427]
Ddsq					0.289 *	0.253	0.237	0.203		-0.217
					(0.175)	(0.179)	(0.186)	(0.184)		(0.225)
					[1.648]	[1.412]	[1.276]	[1.107]		[-0.965]
ρ	0.330 ***	0.354 ***	0.338 ***	0.359 ***	0.324 ***	0.347 ***	0.335 ***	0.353 ***	0.459 ***	0.448 ***
	(0.118)	(0.116)	(0.123)	(0.120)	(0.116)	(0.118)	(0.121)	(0.123)	(0.128)	(0.122)
	[2.798]	[3.047]	[2.763]	[2.977]	[2.799]	[2.928]	[2.774]	[2.877]	[3.582]	[3.686]
Adj. R^2	0.323	0.327	0.327	0.331	0.324	0.327	0.328	0.330	0.438	0.435
S.E.	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.005	0.005
DW ratio	1.738	1.764	1.746	1.768	1.731	1.753	1.741	1.759	2.103	2.096
Prob. (J-statistic)									0.000	0.000
Obs.	920	920	920	920	920	920	920	920	851	851

Notes: 4) Model 2IV uses following variables as instruments: constants, *d* , *d(-1)* , *GVAR* , *GVAR(-1)* , *YVAR(-1), YVAR(-2)* , *YVAR(-3)* , *YVAR(-4)* , *rd* , *rd(-1)* , *Dd* , and *s(-1)* . Model 4IV uses *dsq* and *Ddsq* in addition to Model 2IV's instruments.

Group 2	Linear		Nonlinear			
	Fixed	Fixed	Pooled	Fixed	Fixed	Pooled
Regression model	1-1	2-1	2-2	3-1	4-1	4-2
Cross-section F statistic (1)	0.773 [0.762]	0.772 [0.762]		0.813 [0.712]	0.842 [0.674]	
Redundant variable F statistic (2)						
d & YVAR			4.648 [0.010]			
d, dsq, YVAR, Dd, & Ddsq						12.694 [0.000]

Group 3								Instrumental variables	
	Linear			Nonlinear				Linear	Nonlinear
	Fixed	Pooled	Fixed	Fixed	Pooled	Fixed	Pooled	Fixed	Fixed
Regression model	1-1	1-2	2	3-1	3-2	4-1	4-2	2IV	4IV
Constant	-0.006 ***	-0.003 **	-0.020 **	-0.006 **	-0.003 **	-0.020 **	-0.030	-0.018 *	-0.017 **
	(0.002)	(0.001)	(0.009)	(0.002)	(0.001)	(0.010)	0.028	(0.010)	(0.009)
	[-2.745]	[-2.494]	[-2.209]	[-2.245]	[-2.386]	[-2.100]	-1.066	[-1.817]	[-1.983]
d	0.030	0.007	0.138 **	0.031	0.013	0.121 **	0.152 *	0.126 *	0.110 *
	(0.019)	(0.012)	(0.063)	(0.019)	(0.014)	(0.059)	0.085	(0.067)	(0.065)
	[1.582]	[0.565]	[2.177]	[1.617]	[0.967]	[2.059]	1.779	[1.871]	[1.710]
dsq				-0.125	-0.368	0.795 **	1.017 **		0.709
				(0.341)	(0.260)	(0.325)	0.485		(0.710)
				[-0.368]	[-1.413]	[2.448]	2.098		[0.999]
GVAR	-0.118	-0.126	-0.501 ***	-0.128	-0.150	-0.488 ***	-0.469 ***	-0.534 ***	-0.520 ***
	(0.312)	(0.321)	(0.108)	(0.319)	(0.317)	(0.106)	0.107	(0.116)	(0.113)
	[-0.379]	[-0.392]	[-4.629]	[-0.401]	[-0.474]	[-4.610]	-4.401	[-4.613]	[-4.615]
YVAR	0.640	0.642	-0.178 *	0.634	0.627	-0.166	-0.181 *	-0.405	-0.287
	(0.704)	(0.712)	(0.101)	(0.711)	(0.718)	(0.103)	0.109	(0.266)	(0.276)
	[0.910]	[0.903]	[-1.758]	[0.892]	[0.873]	[-1.616]	-1.667	[-1.522]	[-1.039]
rd			0.024 ***			0.024 ***	0.024 ***	0.025 ***	0.025 ***
			(0.005)			(0.005)	0.005	(0.005)	(0.005)
			[4.814]			[5.070]	5.317	[4.826]	[4.893]
Dd	0.013	0.021 **	0.006	0.015	0.017	-0.006	0.002	0.018	0.007
	(0.009)	(0.009)	(0.009)	(0.018)	(0.019)	(0.012)	0.026	(0.019)	(0.041)
	[1.413]	[2.390]	[0.689]	[0.814]	[0.894]	[-0.456]	0.079	[0.941]	[0.174]
Ddsq				0.055	0.279	0.067	-0.036		-0.224
				(0.427)	(0.374)	(0.325)	0.573		(0.903)
				[0.129]	[0.746]	[0.205]	-0.063		[-0.248]
ρ	0.269	0.295 *	0.830 ***	0.260	0.266	0.852 ***	0.957 ***	0.838 ***	0.830 ***
	(0.178)	(0.177)	(0.072)	(0.177)	(0.171)	(0.073)	0.043	(0.073)	(0.072)
	[1.512]	[1.671]	[11.611]	[1.469]	[1.553]	[11.704]	22.496	[11.458]	[11.490]
Adj. R^2	0.230	0.218	0.579	0.227	0.221	0.589	0.582	0.554	0.567
S.E.	0.008	0.008	0.006	0.008	0.221	0.006	0.006	0.006	0.006
DW ratio	2.110	2.129	1.931	2.105	2.107	1.914	1.956	1.940	1.928
Prob. (J-statistic)								0.000	0.000
Obs.	480	480	480	480	480	480	480	444	444

Notes: 4) Model 2IV uses following variables as instruments: cross-section constants, *d* , *d(-1)* , *GVAR* , *GVAR(-1)* , *YVAR(-1), YVAR(-2)* , *YVAR(-3)* , *YVAR(-4)* , *rd* , *rd(-1)* , *Dd* , and *s(-1)* . Model 4IV uses *dsq* and *Ddsq* in addition to Model 2IV's instruments.

Group 3	Linear		Nonlinear					
	Fixed		Fixed		Fixed		Fixed	
Regression model	1-1		2		3-1		4-1	
Cross-section F statistic (1)	1.674	[0.076]	2.161	[0.016]	1.311	[0.215]	1.697	[0.071]
Redundant variable F statistic (2)								
Dd			0.536	[0.465]				
YVAR, Dd, & Ddsq							1.083	[0.356]