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Empirical Analysis of Yield Determinants in Japan's Municipal Bond Market: Does Credit Risk Premium Exist?

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Abstract

In this study, we examine the determinants of the yield spread between issuers in Japan's municipal bond market using panel data and focus on identifying whether credit risk premium exists. The results of the panel data analysis reveal new evidence on the municipal bond market for FY2002-2013. In the first half of the 2000s, the fundamental fiscal statistics, that is, the credit risk indicators, had no impact on the yield spreads, suggesting the absence of credit risk premium. Second, Yūbari City's insolvency in 2006 led to a structural break, and since that time investors have begun accounting for local governments' outstanding debt. Third, when important financial events occur, other credit risk indicators also significantly impact the yield spread, suggesting that investors are more aware of credit risk presence during such events. Finally, the findings of this study may provide implications for financial institutions, market participants and regulators.

Keywords: Yield spread, municipal bond market, credit risk, Japan

***JEL classification*: E43; G12; G14; H74**

1. Introduction

1.1. Japan, the largest municipal bond market among unitary states

Factors determining the yield level of public bonds are an issue that has thrust its way into the public consciousness of the global financial market. The 2010 public financial collapse in Greece led to the European sovereign debt crisis, which not only triggered unrest concerning the default probability of Greece's public bonds but also impacted other countries such as Spain, Portugal, and Italy. In the United States, the 2008 global financial crisis severely damaged state and local public finances and led to numerous financial problems, such as the Detroit bankruptcy and the insolvency of Illinois state pension funds. In fact, the recent news that the Puerto Rican government missed its municipal bond payments has taken many investors in the global financial market by surprise.

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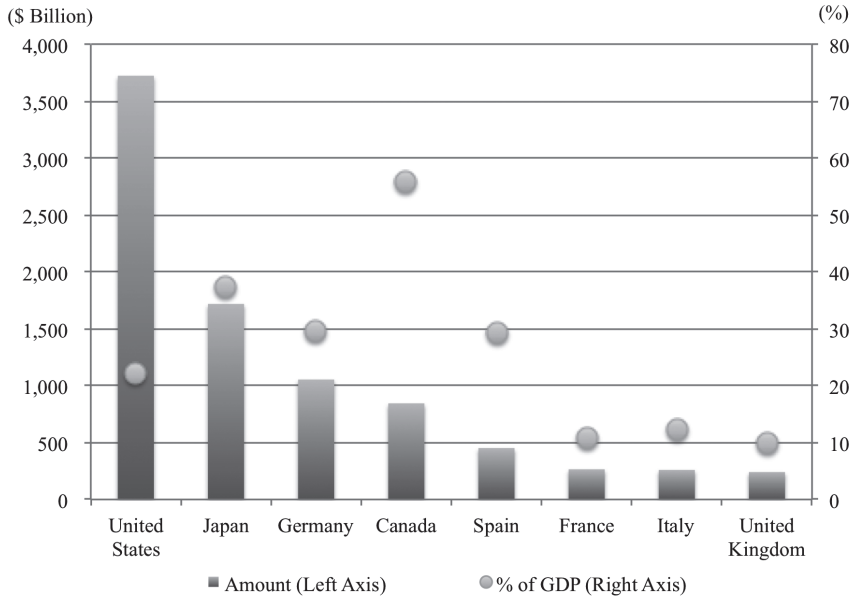
In this study, we examine the yield determinants of sub-sovereign bonds. In particular, we attempt to answer the following questions. Do investors believe that sub-sovereign bonds are subject to credit risk? Does their evaluation reflect the sub-sovereign bond yield as credit risk premium? Thereby, does the yield spread between the issuers reflect their fiscal soundness or credit risk? In other words, is the so-called "market discipline" present in the sub-sovereign market?

Several preliminary analyses share the aims of this study. The distinguishing characteristic of our analysis, however, is that we focus on Japan's municipal bond market[1]. Today, few scholars discuss the bond market primarily because of language barriers and difficulties in accessing statistical data, thus leading to an important sector in Japan with meaningful insight being largely overlooked.

In fact, the scale of Japan's municipal bond market is large among the advanced countries. It is widely known that Japan's outstanding public debt as a percentage of GDP is now more than 200% and dominates that of other advanced countries. Japanese local governments are not isolated from this situation. As of 2013, the outstanding municipal debt, comprising debt loans and bonds, owned by Japanese local governments is $1.7 trillion (Figure 1), which is the second highest among advanced countries, following the United States.

Figure 1: Outstanding Municipal Debt in Advanced Countries



Note: Data as of 2013.

Source: OECD.Stat.

Undoubtedly, Japan's municipal bond market, excluding debt loans, is significantly smaller. This is because about 60% of municipal debt consists of loans issued by private commercial banks through the Fiscal Investment and Loan Program (FLIP), which is managed by the central government. However, in terms of the scale of municipal bond market, the United States and Canada, where the state and local governments borrow money mainly by issuing bonds, rank higher than Japan, followed by Germany, where about 60% of municipal debts are in the form of bonds.

[1] See Igata and Miyake (2007) and Miyake (2008) for a detailed discussion of the Japanese municipal debt market and relevant local public finance institutions.

1.2. Credit risk of municipal bonds in unitary states

It is noteworthy that all countries with a municipal bond market exceeding $500 billion (e.g., the United States, Germany, and Canada) adopt a federal system, except Japan. In a federal state, state governments have the sovereign power, and the role and discretion of the state government in public finance management are relatively large. This also holds true when issuing municipal debt, and thus it seems natural that the scale of the municipal bond market in a federal state is correspondingly large. Most of the extant literature focuses on the yield determinants of municipal bonds in federal states, mainly those in the United States (Bayoumi, Goldstein, and Woglom, 1995; Brune and Liu, 2011), Canada (Booth, Georgopoulos, and Hejazi, 2007; Landon and Smith, 2000), and Germany (Heppeke-Falk and Wolff, 2008).

In contrast to these three countries, Japan adopts a unitary system. In a unitary state, the central government decides the fundamental characteristics and role of the local government in public finance. The discretion of the local government, including that concerning the issuance of municipal debt, is relatively small. In addition, the local government receives substantial funds from the central government through special grants and fiscal equalization systems and its revenue is dependent on these funding systems. Thus, the relationship between the central and local governments in a unitary state is generally closer than that in a federal state.

This close relationship also involves the so-called "implicit government guarantee," which possibly effects the yield of municipal bonds, and, especially, the existence of credit risk premium. Similar to the federal state, the primary responsibility to pay debt service in the unitary state is held by the local government as an issuer. In general, the central government does not share this responsibility or explicitly guarantee the debt service of municipal bonds. However, when a local government faces deteriorating fiscal conditions and finds it difficult to repay its own debt, the central government may sometimes provide an extraordinary grant as an ex-post bailout, which is known as the implicit government guarantee. If the expectation of such a guarantee exists in the market, it will reflect on the yield level of municipal bonds. More concretely, the credit risk premium of municipal bonds would disappear and their yield level would almost equal that of government bonds. The difference in the yield level of municipal bonds by local government would also disappear or be determined by the degree of bailout possibility, not fiscal conditions (Jenkner and Lu, 2014; Landon and Smith, 2000).

Therefore, in terms of yield determinants and existence of credit risk premium (or implicit government guarantee), the characteristics of the municipal bond market in a unitary state differ from those in a federal state. This is particularly the case in the United States, where Chapter 9 of the Bankruptcy Act for Local Governments exists and cases of municipal bond default are not rare. To empirically examine such a possibility in a unitary state in the context of a public bond market is an interesting research topic. Thus, we focus on Japan, the largest among advanced unitary states, to provide meaningful insight into the bond market.

The remainder of this paper is organized as follows. Section 2 briefly reviews the preliminary literature on the yield determinants in municipal bond markets. Section 3 presents the estimation equation and the sample data used in our estimations. Sections 4 and 5 report the results and implications of our empirical analyses. Section 6 concludes the paper.

2. Literature review

The literature mainly comprises studies on municipal bond markets in federal states, such as those in the United States. Many studies on credit risk premiums highlight the significance of local governments' fiscal soundness as a determinant of the municipal bond yield in both primary and

secondary markets. For example, Capeci (1994) finds that the current decision making of a local government about issuing municipal bonds affects their yield. Bayoumi, Goldstein, and Woglom (1995) reveal a nonlinear relationship between the states' outstanding debt and municipal bond yields, that is, the higher a state government's debt accumulates, the more rapidly municipal bond yield rises. Capeci (1991), Liu and Thakor (1984), and Stover (1991), among others, focus on the effects of credit ratings as a credit risk indicator on municipal bonds. Their studies are based on the fact that state and local governments in the United States generally purchase credit ratings, in contrast to those in Japan and advanced European countries.

Some studies examine the effects of financial events on the municipal bond market, such as New York City's fiscal emergency in the 1970s (Kidwell and Trzcinka, 1982; Kidwell and Trzcinka, 1983), and the default of municipal bonds (Halstead, Hegde, and Klein, 2004; Peavy III and Hempel, 1987). Peng, Kriz, and Wang (2014) find that the 2007-2009 Great Recession had some impact on the municipal bond market and that the effects differ between high- and low-rated municipal bonds.

Analyses have also been conducted on the municipal bond market in the United States and various factors affecting bond yield, such as fiscal institutions, debt management policies, public accounting, financial disclosure practices, issuers' financial sophistication, and sales type. Some recent studies examine liquidity risk premium or trading costs in the municipal bond market (Downing and Zhang, 2004; Harris and Piwowar, 2006; Wang, Wu, and Zhang, 2008).

By contrast, studies on Japan's municipal bond market are limited to Nakazato (2011) and Tanaka (2013). While Nakazato (2011) asserts the existence of credit risk premium in Japan, Tanaka (2013) shows that not all fiscal statistics affect yield spreads. Hattori (2018) uses CDS data to decompose the credit and liquidity factors of Japan's municipal bond market.[2]

Similarly, this study examines whether investors believe in the default possibility of a municipal bond and account for a local government's fiscal soundness. However, we drastically improve the estimation in the following manner. First, we use simpler and fundamental fiscal data as credit risk indicators. Nakazato (2011) and Tanaka (2013) exclude variables such as simple fiscal surplus and primary balance, which are often used in practices in Japan's local public finance and adopted as independent variables in previous studies on the public bond market. Instead, they use secondary variables, such as current surplus ratio, which neglects capital revenue and expenditure[3].

Second, we estimate a fixed effects model using the strength of the panel data. While Tanaka (2013) includes individual effects in the model, Nakazato (2011) does not. Accounting for individual effect allows us to capture each local government's time-consistent characteristics, in addition to time-varying fiscal data, that affect municipal bond yield.

Third, we focus on the possibility of a spurious regression by conducting unit root tests. By contrast, Nakazato (2011) does not conduct such a test and Tanaka (2013) performs only an LLC test (Levin, Lin and Chu, 2002). However, as will be explained later, we suspect that the yield spread of Japan's municipal bond relative to government bonds, which the two studies adopt as a dependent variable, can follow a unit root. Thus, their estimation results can be derived from a spurious regression.

Finally, we extend the sample term from FY2002 to FY2013 to include the 2007-2009 Great Recession, whereas Nakazato (2011) and Tanaka (2013) focus on FY2003-2006 and FY2003-2008.

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[2] Hattori (2019a, 2021) computes the liquidity premium in the JGB market. Hattori (2019b) discusses the liquidity enhancement auction provided by the Ministry of Finance, Japan.

[3] We conducted separate estimations using such variables in Equations (1) and (2) and found that the results remain unchanged.

3. Estimation equation and data

3.1. Specifying the estimation equation

In this paper, we conduct an empirical study of the yield determinants in Japan's municipal bond market. In particular, we focus on the yield difference between local governments. To do so, we follow Bernoth, von Hagen, and Schuknecht (2012) and estimate the equation for fiscal year *t*:

$$Spread_{i\,t} = \beta_0 + \beta_1\, maturity_{i\,t} + \beta_2\, L_{i\,t} + \boldsymbol{\beta_3}'\, \mathbf{z_{i\,(t-1)}}$$

$$+ Dummy\ YS\left(\gamma_1\, maturity_{i\,t} + \gamma_2\, L_{i\,t} + \boldsymbol{\gamma_3}'\, \mathbf{z_{i\,(t-1)}}\right)$$

$$+ Dummy\ LS\left(\delta_1\, maturity_{i\,t} + \delta_2\, L_{i\,t} + \boldsymbol{\delta_3}'\, \mathbf{z_{i\,(t-1)}}\right) + \lambda_t + \mu_i + \varepsilon_{i\,t}, \quad \cdots \quad (1)$$

where $Spread_{i\,t}$ is the yield spread of the municipal bond issued by local government *i*, $maturity_{i\,t}$ is the term to maturity, and $L_{i\,t}$ is the measure of liquidity. $\mathbf{z_{i\,(t-1)}}$ contains the independent variables related to credit risk. $Dummy\ YS$ and $Dummy\ LS$ are financial event dummies. μ_i denotes the unobservable individual effect and λ_t is the unobservable time effect, which allows us to estimate the fixed effects model using dummy variables[4]. $\varepsilon_{i\,t}$ is an error term.

The equation highlights the following two points. First, the dependent variable $Spread_{i\,t}$ is defined as a deviation from the municipal bond market index, instead of the government bond yield. The literature on bond yield determinants generally uses a spread relative to government bonds. However, in the case of Japan's municipal bond market, the spread relative to government bonds can also follow the unit root process (Table 1). By contrast, the spread relative to the municipal bond index does not follow the unit root process. We are mainly interested in whether credit risk exists and if the fiscal soundness of each local government affects the municipal bond yield. Thus, we focus on the yield difference between local governments and find no difference between yield spreads relative to government bonds and municipal bond market indexes (Benson and Rogowski, 1978; Goldstein and Woglom, 1991). As a result, we adopt the latter as a dependent variable to eliminate the possibility of a spurious regression.

Second, we carefully consider the timing of data announcements related to local public finance. We set the independent variables related to fiscal data ($\mathbf{z_{i\,(t-1)}}$) lagged by one year and use the sample data of the yield spread for December 31 and March 31 for each fiscal year. To ensure that we use complete balanced panel data, we adopt one dataset for each local government per year, including the yield spread[5]. Thus, when deriving the sample data for the yield spread, we chose one business day in each year. It is natural to assume that the spread would react immediately after new fiscal data announcements if such information had an impact. In the case of local public finance institutions in Japan, there are two instances in which investors receive data on the fiscal year ($t-1$): December 31 or March 31 in the following fiscal year t[6]. Thus, we selected two days in each fiscal year and lagged the timing of the fiscal data in $\mathbf{z_{i\,(t-1)}}$. We also conduct two types of estimations, which contribute to checking the robustness of our analysis.

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[4] We conducted an F-test and Hausman test to determine the model (i.e., pooled-OLS, random effects model, or fixed effects model) using the entire sample. The null hypotheses for both tests were rejected.

[5] The yield (spread) of municipal bonds is available on a daily basis, whereas fiscal data on Japan's local government are released annually.

[6] The schedule of data announcements for local public finance is as follows: The fiscal year spans the period from April 1 to March 31. Data on local public finance are uniformly arranged by the Ministry of Internal Affairs and Communications (MIC). Investors can access this information through, for example, MIC's website. For example, investors can access brief data for FY2006 (April 2006-March 2007) by December 2007 and detailed data by March 2008.

Table 1: Unit Root Test Results

Variables	Yield Spread Relative to Central Government Bond				Yield Spread Relative to Municipal Bond Index			
Date of Sample Yield Spread	December 31		March 31		December 31		March 31	
Sample Term	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13
IPS Test	1.4055	2.7899	0.6443	1.9309	-12.1318	-5.6796	-1.7317	-4.3097
	(0.9201)	(0.9974)	(0.7403)	(0.9733)	(0.0000)	(0.0000)	(0.0417)	(0.0000)
LLC Test	1.6198	-0.8335	-1.5201	-3.2015	-15.2106	-13.2562	-4.0866	-10.3979
	(0.9474)	(0.2023)	(0.0642)	(0.0007)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ADF Test	22.6903	13.1836	28.3057	18.5674	211.0370	141.6490	60.2388	117.3000
	(0.9993)	(1.0000)	(0.9895)	(1.0000)	(0.0000)	(0.0000)	(0.1106)	(0.0000)

Variables	Maturity				Issue Amount			
Date of Sample Yield Spread	December 31		March 31		December 31		March 31	
Sample Term	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13
IPS Test	-33.6606	-14.9584	-6.8579	-70.7861	-4.3588	-1.3427	-3.2037	-2.3E+14
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0897)	(0.0007)	(0.0000)
LLC Test	-124.8230	-65.5595	-18.1135	-459.4220	-7.7154	-3.5372	-6.3864	-3.5485
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0002)
ADF Test	165.7240	134.0690	115.9010	163.6670	92.4254	38.2278	79.3323	47.2395
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0577)	(0.0016)	(0.0651)

Variables	Real Surplus Ratio		Primary Balance Ratio		MDO Ratio		Debt Service Ratio	
Sample Term	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13	FY2002 - 13	FY2006 - 13
IPS Test	-3.7902	-5.1564	-2.6410	-1.4630	-5.6061	-2.8750	-2.2063	-10.5020
	(0.0001)	(0.0000)	(0.0041)	(0.0717)	(0.0000)	(0.0020)	(0.0137)	(0.0000)
LLC Test	-7.2041	-15.8195	-4.6877	-9.9785	-7.5754	-7.4611	-4.9082	-37.8493
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ADF Test	88.2492	125.2280	69.0644	69.7351	121.4690	91.0002	68.1809	129.2910
	(0.0004)	(0.0000)	(0.0248)	(0.0339)	(0.0000)	(0.0004)	(0.0292)	(0.0000)

Notes: 1. p-values are shown in parentheses.

2. We conduct three tests: an IPS (Im, Pesaran, and Shin, 2003), an LLC (Levin, Lin, and Chu, 2002), and an augmented Dickey–Fuller (ADF; Maddala and Wu, 1999) test.

3. Information criteria (BIC) are applied to select lag length.

4. As for yield spreads, maturity, and issue amount, we conduct two unit root tests on the sample data collected since they differ between December 31 and March 31.

3.2. Sample data and data resources

Next, we describe the dataset. Detailed definitions and data sources of each variable are presented in Table 2.

To compute $Spread_{i\,t}$, we estimated the difference between the yield of publicly-offered municipal bonds and NOMURA-BPI Municipals. Here, we use the yield determined in the secondary market; we assume that yields based on the secondary market reflect investors' views more accurately than those based on issue[9]. We adopt data for publicly-offered municipal bonds in Japan on the basis of data availability and those more actively traded than other municipal bonds[10]. The latter indicates that the yield of publicly-offered municipal bonds reflects risk evaluation by investors more precisely.

An issuer generally trades two or more issues in the publicly-offered municipal bond market every business day. We select data on the basis of such issuers as follows for December 31 and March 31 in each fiscal year as follows. First, to conduct a balance panel data analysis, we limit the scope of issuers to local governments that have regularly issued bonds (annually) throughout the estimation period. Second, from these, we chose a local government with issues whose current maturity is closest to 10 years, which is the typical maturity period in Japan's municipal bond primary market.

Next, we describe the independent variables included in Equation (1). We used term to maturity ($maturity_{i\,t}$) as the characteristic variable of each bond issue[11] and issue amount as a liquidity risk indicator ($L_{i\,t}$). We used several fiscal statistics for credit risk indicators ($\mathbf{z_{i\,(t-1)}}$)[12]. The real surplus or primary balance ratios are included as flow-based indicators. Both indicate the surplus or deficit of local governments in each fiscal year. The municipal debt outstanding (MDO) ratio and debt service ratio are variables that allow us to gauge the scale of debt owned by each local government. These four variables are ratios relative to financial resources, which are general measures representing the fiscal size of each local government in Japan. Using the ratio variables, instead of absolute data, allows us to capture local governments' fiscal difficulty within its own scale.

Finally, we use data from FY2002, the year from which yield sample data became available, to FY2013, the latest year in which fiscal data for the previous fiscal year are presented.

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[9] One reason underlying this assumption is that, in Japan, all municipal bonds were issued with the same yields every month up to August 2006. Until then, MIC, a representative of municipal bond issuers, negotiated issue conditions with financial institutions for all bonds issued in the same month.

[10] As mentioned, Japanese local governments borrow money through bonds (municipal bonds) or loans. However, we exclude the following bonds from our analysis: private-placement bonds issued mainly to banks; joint local government bonds, which are cooperatively issued by two or more local governments; and mini bonds, offered to local people and enterprises.

[11] Almost all publicly-offered municipal bonds, including issues in our estimations, are irredeemable and fixed rate bonds. Similar to advanced countries in Europe, a revenue bond has not yet been issued to date in Japan's municipal bond market. Thus, the main characteristic that differs between issues is maturity.

[12] Note that we do not use credit rating as a credit risk indicator. Undoubtedly, credit ratings are widely used in empirical analyses on credit risk in municipal and corporate bonds. However, few local governments in Japan have been rated by international rating agencies such as Standard & Poor's Ratings Services or Moody's Investors Service. In addition, the credit rating in the municipal bond market rarely fluctuates; thus, the data are not suitable for a panel data analysis.

Table 2: Details and Data Resources of Dependent and Independent Variables

Variables	Definition	Data Sources
Dependent Variables (*Spread*)		
▪ Yield Spread of Municipal Bonds	Yield of publicly offered municipal bonds in the secondary market − Municipal bond market yield benchmark index * "Municipal bond market yield benchmark index" is NOMURA-BPI Municipals (municipal bond market yield index)	Japan Securities Dealers Association (JSDA), Reference Statistical Prices (Yields) for OTC Bond Transactions, Nomura Securities Co., Ltd., NOMURA-BPI Municipals (municipal bond market yield index)
Independent Variables		
1) Maturity (*Maturity*)	Year to maturity	JSDA, Reference Statistical Prices (Yields) for OTC Bond Transactions
2) Liquidity Risk Index (*L*)	Issue amount	JSDA, Reference Statistical Prices (Yields) for OTC Bond Transactions
3) Credit Risk Index (**z** or **x**)		
▪ Real Surplus Ratio	Actual surplus / general financial resource * Actual surplus = revenue - expenditure * General financial resource is defined as the general current revenue and each local government decides its use. MIC calculates statistics and uses them to understand the fiscal scale of each local government.	Ministry of Internal Affairs and Communications (MIC), Statistical Yearbook on Local Public Finance (*Chiho-Zaisei Tokei Nenpo*)
▪ Primary Balance Ratio	Primary balance / general financial resource * Primary balance = (revenue - debt finance funds) − (expenditure - debt service)	MIC, Statistical Yearbook on Local Public Finance (*Chiho-Zaisei Tokei Nenpo*)
▪ Municipal Debt Outstanding (MDO) Ratio	Municipal debt outstanding / general financial resource ※"Municipal debt" includes not only publicly offered municipal bonds but also loan debts through FILP, bank loans, and the private placement bond.	Japan Local Government Bond (JLGB) Association, Statistical Yearbook on Municipal Debt (*Chihosai Tokei Nenpo*), MIC, Statistical Yearbook on Local Public Finance (*Chiho-Zaisei Tokei Nenpo*)
▪ Debt Service Ratio	Debt service / general financial resource	MIC, Statistical Yearbook on Local Public Finance (*Chiho-Zaisei Tokei Nenpo*).
▪ Real Deficit Ratio (*)	Actual deficit (expenditure - revenue) / general financial resource ※ If the fiscal balance of a local government is in surplus, this ratio is not calculated. Thus, when we use this ratio in the estimation, we convert it into dummy variables, that is, 1 if this ratio has a value, and 0 if it is not calculated (fiscal balance is surplus).	MIC, MIC website (http://www.soumu.go.jp/iken/zaisei/kenzenka/index.html)
▪ Consolidated Real Deficit Ratio (*)	Sum of actual deficit (expenditure - revenue) of the ordinary, special, and public enterprise accounts / general financial resource ※ Similar to the real deficit ratio, we convert this ratio to dummy variables.	MIC, MIC website (http://www.soumu.go.jp/iken/zaisei/kenzenka/index.html)
▪ Real Debt Service Ratio (*)	Debt service (which the issuer is responsible for) / general financial resource ※ This has been calculated by MIC since FY 2006 and differs from debt service ratio. Debt service in the calculation of the real debt service ratio excludes debt service funded by the central government or other local governments through the fiscal equalization system and special grants.	MIC, MIC website (http://www.soumu.go.jp/iken/zaisei/kenzenka/index.html)
▪ Future Burden Ratio (*)	Consolidated debt service / local government's financial revenue resource (based on general financial resource)	MIC, MIC website (http://www.soumu.go.jp/iken/zaisei/kenzenka/index.html)

Notes: * denotes variables included in x_(i (t-1)) in Equation (2).

3.3. Events affecting municipal bond yield

We account for two financial events by adding event dummies: the Yūbari shock and Great Recession or Lehman Shock.

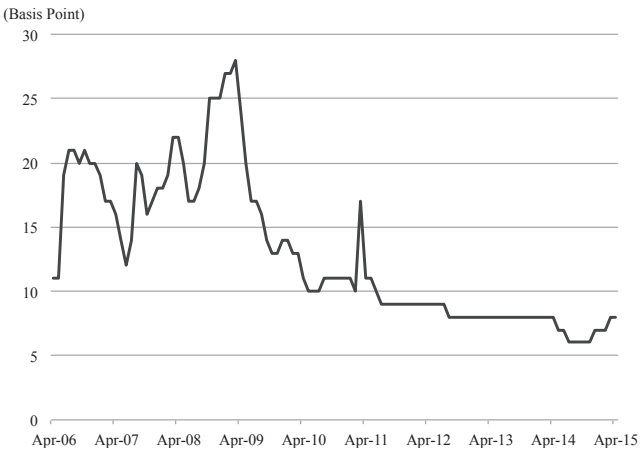
In 2006, Yūbari City in Hokkaido Prefecture became insolvent and declared a public finance emergency, an event widely known as the Yūbari shock. Since then, the city has initiated a fiscal reconstruction process under the central government's administration. The city has a small local government and remains inexperienced in issuing publicly-offered bonds. However, we consider the Yūbari case as an unprecedented event in Japan's municipal bond market for three reasons. First, it is rare for local governments to be part of a reconstruction process. Second, the event raised concerns about the fiscal condition of local governments among not only investors but also the general public. Finally, as a result of the event, the central government considered introducing a bankruptcy act that would be available to local governments wanting to restructure their debt burden.

The Yūbari shock could have had two possible effects on the municipal bond market. The first of these is a temporary effect. In June 2007, the central government passed the Law Relating to the Financial Soundness of Local Governments[17], which aimed at understanding the fiscal condition of each local government more precisely and in a timely manner and providing mechanisms for local governments facing fiscal difficulties. As for bankruptcy, the central government did not add a clause that that allows local governments to carry out debt adjustment, which could have relieved investors' concern about default risks in municipal bonds. To check if such a temporary shock existed, we include the dummy variable $Dummy\ YS$ and its intersection with other independent variables in Equation (1). We set $Dummy\ YS$ to 1 from June 2006 to June 2007.

Second, the shock possibly led to structural changes in Japan's municipal bond market; for example, the event changed yield (spread) determinants, such as credit risk premiums. To check for this possibility, we conduct the estimation by dividing the sample data between May and June 2006.

The Lehman Shock refers to a global financial market crisis or the Great Recession caused by the Lehman Brothers' filing of bankruptcy. We set August 2007, when the BNP Paribas shock occurred and the subprime loan market in the United States collapsed, as the start time for $Dummy\ LS$, which takes the value of 1. The end of this event is set to December 2009, when the spread between the NOMURA-BPI Municipals and government bond yield converged to the level reported before the BNP Paribas shock (Figure 2).

Figure 2: Nomura BPI Municipal T-Spread Index Trend



Source: Nomura

[17] For a detailed discussion of this law, see Miyake (2008).

4. Estimation results

Equation (1) is estimated using OLS and robust standard errors. Table 3 shows the results for two estimations according to the date of the sample yield spread (i.e., December 31 and March 31), three estimations as per the sample term (FY2002-2013, FY2002-2005, and FY2006-2013), and two estimations for each sample term that are based on flow-base fiscal statistics used as an independent variable (estimation types A and B).

We are mainly interested in the credit risk premiums of the municipal bond yield. In other words, we focus on the significance of credit risk indicators. The results are as follows.

First, before the Yūbari shock, that is, FY2002-2005, none of the credit risk indicators were statistically significant at the 5% level, suggesting that the credit risk premium did not exist in Japan's municipal bond market until FY2005. However, the Kyoto City dummy negatively affects the yield spread of municipal bonds. Kyoto is famous as the traditional capital of Japan and for having debt levels higher than those in other Japanese cities. This suggests that specific time-consistent information is important as a yield spread determinant in this term [18].

Second, after the Yūbari shock, that is, FY2006-2013, the MDO ratio had a consistent impact on the yield spread, including the term after the Lehman Shock. In all four estimations, the MDO ratio, not multiplied by $Dummy\ YS$ or $Dummy\ LS$, is statistically significant at the 5% level. This suggests that investors became concerned about the credit risk of municipal bonds in FY2006. In other words, the Yūbari shock led to a structural break in the market.

Third, the Yūbari and Lehman Shocks had a temporary impact on the yield spread. Three out of the four estimations show that either the intersection of the debt service ratio with $Dummy\ YS$ or $Dummy\ L$, or both, significantly impacted the spread. In addition, three out of the four estimations show that one or both of the intersections of the flow-based credit indicator with these events are statistically significant. These results suggest that investors pay attention to not only the MDO ratio but also other credit risk indicators during a financial event. In other words, both financial events made investors more conscious about the fiscal soundness of local governments.

[18] Here, some participants pointed out that the popularity or brand image of each local government affects, to a certain extent, the yield spread. Although the estimation results perhaps support this hypothesis, the factors determining this individual effect remain beyond the scope of this study.

Table 3(i): Estimation Results for Equation (1)

Date of Sample Yield Spread	December-31					
Sample Term	FY2002 - FY2013		FY2002 - FY2005		FY2006 - FY2013	
Estimation Type	A	B	A	B	A	B
Maturity	0.1808	0.2649	0.6853	0.6467	0.2004	0.2141
	(0.3715)	(0.3883)	(0.3315)	(0.3328)	(1.4853)	(1.2794)
Issue Amount	-0.0004	0.0018	0.0005	-0.0005	0.0013	0.0000
	(0.0017)	(0.0020)	(0.0016)	(0.0016)	(0.0035)	(0.0037)
Real Surplus Ratio	0.4888		-0.4286		0.2933	
	(0.2053)		(0.3449)		(0.3956)	
Primary Balance Ratio		0.0347		-0.0079		0.1220
		(0.0304)		(0.0121)		(0.0367)
MDO Ratio	0.2851	0.5207	0.1602	0.1233	2.0445	2.6289
	(0.3386)	(0.3481)	(0.5569)	(0.7859)	(0.8134)	(0.8503)
Debt Service Ratio	0.3835	-6.2308	-7.7300	-6.4604	-6.9135	-15.1658
	(3.4495)	(4.8297)	(5.7029)	(5.1802)	(7.5084)	(8.3629)
Dummy YS * Maturity	5.1064	4.6627			4.8414	4.1549
	(2.8233)	(2.6069)			(2.7868)	(2.4206)
Dummy YS * Issue Amount	-0.0024	-0.0015			-0.0017	0.0004
	(0.0054)	(0.0047)			(0.0028)	(0.0033)
Dummy YS * Real Surplus Ratio	-0.5504				-0.7596	
	(0.5367)				(0.3145)	
Dummy YS * Primary Balance Ratio		-0.0918				-0.1951
		(0.0839)				(0.0683)
Dummy YS * MDO Ratio	0.0117	-0.0344			-0.5238	-0.2240
	(0.4229)	(0.4180)			(0.3489)	(0.3359)
Dummy YS * Debt Service Ratio	7.0316	19.2823			13.5431	29.1775
	(3.1828)	(9.3502)			(7.0455)	(8.6414)
Dummy LS * Maturity	-5.0425	-4.5344			-5.0957	-5.2692
	(2.9697)	(2.9310)			(3.4451)	(3.2255)
Dummy LS * Issue Amount	0.0163	0.0071			0.0100	0.0091
	(0.0061)	(0.0043)			(0.0045)	(0.0040)
Dummy LS * Real Surplus Ratio	-1.4344				-0.8432	
	(0.5021)				(0.3290)	
Dummy LS * Primary Balance Ratio		-0.0148				-0.0949
		(0.0432)				(0.0405)
Dummy LS * MDO Ratio	0.0853	-0.0289			-0.4510	-0.2059
	(0.3452)	(0.3542)			(0.3183)	(0.3001)
Dummy LS * Debt Service Ratio	15.7011	17.0095			13.8128	19.5566
	(9.5643)	(10.0730)			(9.2270)	(9.6582)
N	288	288	96	96	216	216
R-squared	0.8660	0.8582	0.9523	0.9512	0.8787	0.8785

Notes: * denotes variables included in x_(i (t-1)) in Equation (2).

Table 3(ii): Estimation Results for Equation (1) (Continued)

Date of Sample Yield Spread	March-31					
Sample Term	FY2002 - FY2013		FY2002 - FY2005		FY2006 - FY2013	
Estimation Type	A	B	A	B	A	B
Maturity	0.3023	0.6540	1.4354	1.4219	0.1410	0.8896
	(0.5155)	(0.4875)	(0.1614)	(0.1650)	(1.8604)	(1.7559)
Issue Amount	-0.0039	0.0002	0.0002	-0.0000	-0.0047	-0.0004
	(0.0018)	(0.0017)	(0.0010)	(0.0012)	(0.0042)	(0.0033)
Real Surplus Ratio	0.6358		-0.1067		-0.0980	
	(0.2429)		(0.2507)		(0.5748)	
Primary Balance Ratio		0.0388		-0.0062		0.1283
		(0.0322)		(0.0121)		(0.0496)
MDO Ratio	0.2278	0.5606	0.0545	-0.0777	2.0525	2.4335
	(0.3694)	(0.3698)	(0.5784)	(0.7524)	(0.8218)	(0.8701)
Debt Service Ratio	0.7269	-8.1014	-4.6006	-4.0819	-4.0696	-17.5856
	(3.8345)	(5.5754)	(4.4428)	(4.0586)	(7.6362)	(9.8056)
Dummy YS * Maturity	-2.5593	-2.1160			-3.2184	-3.3107
	(1.3412)	(0.9926)			(2.0738)	(1.7760)
Dummy YS * Issue Amount	0.0062	0.0046			0.0016	0.0014
	(0.0037)	(0.0022)			(0.0031)	(0.0030)
Dummy YS * Real Surplus Ratio	-0.8857				-0.4204	
	(0.3862)				(0.3010)	
Dummy YS * Primary Balance Ratio		-0.0642				-0.1228
		(0.0313)				(0.0524)
Dummy YS * MDO Ratio	0.4221	0.3208			-0.2655	-0.0356
	(0.2189)	(0.2143)			(0.2895)	(0.2987)
Dummy YS * Debt Service Ratio	1.6035	12.7724			5.4724	18.1972
	(3.2811)	(4.2573)			(7.1102)	(7.0813)
Dummy LS * Maturity	-4.2734	-4.5644			-5.3388	-5.4806
	(4.5744)	(4.3551)			(3.7241)	(3.7348)
Dummy LS * Issue Amount	-0.0020	-0.0103			-0.0042	-0.0085
	(0.0069)	(0.0061)			(0.0054)	(0.0052)
Dummy LS * Real Surplus Ratio	-1.6120				-1.0050	
	(0.5597)				(0.4072)	
Dummy LS * Primary Balance Ratio		0.0636				-0.0131
		(0.0539)				(0.0513)
Dummy LS * MDO Ratio	-0.3218	-0.4772			-0.9492	-0.7198
	(0.5855)	(0.6466)			(0.5073)	(0.4931)
Dummy LS * Debt Service Ratio	35.8820	34.7996			37.4037	42.0427
	(15.6443)	(14.9429)			(13.4963)	(13.0307)
N	288	288	96	96	216	216
R-squared	0.8715	0.8651	0.9803	0.9803	0.8293	0.8271

Notes: 1. Robust standard errors are shown in parentheses.

2. Local governments used as samples are Aichi, Chiba, Fukuoka, Gunma (FY2006-2013), Hiroshima, Hokkaido, Hyogo, Kumamoto (FY2006-2013), Kyoto, Niigata, Osaka, Saitama, and Shizuoka prefectures, Tokyo Metropolitan, Chiba, Fukuoka, Hiroshima, Kanagawa, Kawasaki, Kitakyushu, Kobe, Kyoto, Nagoya, Osaka, Saitama (FY2006-2013), Sapporo, and Yokohama cities.

5. Impact of new fiscal indices: Additional estimation and results

We performed additional regressions to derive robust results for whether the credit risk indicators significantly impact Japan's municipal bonds' yield (spread). This estimation is based on the fact that since September 2008, MIC released four fiscal indices related to the fiscal condition of local governments: real deficit ratio, consolidated real deficit ratio, real debt service ratio[20], and future burden ratio. Because investors generally use these four indices to evaluate the credit risk of municipal bonds, we add them as independent variables to Equation (1).

$$Spread_{i\,t} = \beta_0 + \beta_1\, maturity_{i\,t} + \beta_2\, L_{i\,t} + \boldsymbol{\beta_3}'\,\mathbf{z_{i\,(t-1)}} + \boldsymbol{\beta_4}'\,\mathbf{x_{i\,(t-1)}} + Dummy\ LS\left(\delta_1\, maturity_{i\,t} + \delta_2\, L_{i\,t} + \boldsymbol{\delta_3}'\,\mathbf{z_{i\,(t-1)}} + \boldsymbol{\delta_4}'\,\mathbf{x_{i\,(t-1)}}\right) + \lambda_t + \mu_i + \varepsilon_{i\,t} \ldots. \quad (2)$$

$\mathbf{x_{i\,(t-1)}}$ contains four fiscal indices. It is lagged one year for the same reason as $\mathbf{z_{i\,(t-1)}}$. Other variables are almost the same as those in Equation (1). The only exception is that the debt service ratio is excluded from $\mathbf{z_{i\,(t-1)}}$ because $\mathbf{x_{i\,(t-1)}}$ includes it instead. Similar to the estimation of Equation (1), we chose December 31 and March 31 to derive sample data for the yield spread. This is because the revised values of the four fiscal indices are announced in December and the timing of the announcement of the other fiscal indices included in $\mathbf{z_{i\,(t-1)}}$ remain unchanged[21]. In addition, the sample size of the issuers is extended to include data on local governments that began issuing publicly-offered municipal bonds up to FY2008.

Table 4 shows the regression results for Equation (2). Estimation types A and B differ in the flow-base fiscal variable included in the estimation. For types C and D, which individually correspond to types A and B, we exclude future burden ratio, which is highly correlated with the real debt service ratio (the correlation is greater than 0.7). The estimation results suggest the same implication as those in Equation (1). That is, among the credit risk indicators, the MDO ratio is the only credit risk indicator that consistently affects yield spread[22]. Besides, a financial event, such as the Lehman Shock, is bound to increase investor concern about credit risk.

To elaborate on the latter result, for all estimations, the intersections of the real deficit ratio and consolidated real deficit ratio with $Dummy\ LS$ are statistically significant when using the spread for March 31. Those of real debt service ratio are significant when the future burden ratio is excluded from the estimation. On the other hand, when the spread is for December 31, we derive results similar to those for the real deficit and real debt service ratios. As for variables included in $\mathbf{z_{i\,(t-1)}}$, three of the four results show that real surplus ratio is statistically significant at the 5% level in the case of a financial event, but not during a normal term.

6. Conclusion

In this study, we empirically analyze yield determinants, particularly of the yield spread between local governments in Japan's municipal bond market. Our estimation results differ from those in Nakazato (2011) and Tanaka (2013) and the implications contrast those provided by earlier studies, many of which analyze the United States.

First, during stable market periods, investors in Japan's municipal bond market generally pay

[20] See Table 2 for differences in using the debt service ratio to estimate Equation (1). The real debt service ratio had already been used to estimate local public finance in September 2008, but was calculated up to FY2006. To ensure continuity, all of our estimations with Equation (1) use the debt service ratio.

[21] The preliminary results for the four fiscal indices are released around September 30. To check for robustness, we estimate Equation (2) using the spread for September 30. The result remains the same as that for December 31 (Table 4).

[22] Some results show that the consolidated real deficit ratio is sufficiently consistent. However, theoretically, it seems strange that only one of the four fiscal variables in $\mathbf{x_{i\,(t-1)}}$ is significant. Thus, we do not emphasize this result.

little or no attention to the soundness of local governments. This was supported by the finding that, in the first half of the 2000s, none of the fundamental statistics were statistically significant as an independent variable in the municipal bond yield. Then, in 2006, the Yūbari shock caused a structural change. More specifically, the MDO ratio significantly impacted the yield spread. However, among the fundamental fiscal statistics, only this ratio was shown to have an impact. This suggests that investors tend to believe that credit risk can be evaluated without accounting for various fiscal statistics, such as fiscal surplus or debt service in each fiscal year. In other words, investors decide without fully analyzing the fiscal condition of the local government.

Our results clearly differ from those of many previous studies on the U.S. municipal bond market, where numerous indicators, including the fundamental fiscal statistics, significantly impact bond yield. This suggests that there exists, or existed until FY2005, an expectation of an implicit government guarantee in Japan's municipal bond market.

The second implication corresponds to the reaction of Japan's municipal bond market to financial events. For instance, the fiscal emergency in Yūbari City and the 2007-2009 Great Recession clearly affected the market, especially credit risk premium. Although the conditions appear to be the same as those in the United States, these financial events affected Japan's municipal bond market differently.

More specifically, in the case of an important event, investors in Japan's municipal bond market changed their view of credit risk. They began to recognize that credit risks differ according to the local government and to analyze the fiscal condition of each local government multi-directionally. This is supported by our estimation result that many fiscal statistics are statistically significant only when they are multiplied by an event dummy.

Table 4: Estimation Results for Equation (2)

Date of Sample Yield Spread	March-31				December-31			
Estimation Type	A	B	C	D	A	B	C	D
Maturity	0.9829	0.9062	1.3793	1.3833	-0.3505	-0.7352	-0.2194	-0.6685
	(2.1134)	(1.9518)	(2.1599)	(2.1053)	(0.8147)	(0.7742)	(0.7210)	(0.6903)
Issue Amount	-0.0035	-0.0015	-0.0028	-0.0014	-0.0029	-0.0024	-0.0027	-0.0033
	(0.0043)	(0.0041)	(0.0044)	(0.0043)	(0.0039)	(0.0039)	(0.0038)	(0.0040)
Real Surplus Ratio	0.4700		0.3792		-0.1182		-0.1222	
	(0.4461)		(0.4545)		(0.3367)		(0.3429)	
Primary Balance Ratio		-0.0124		0.0165		0.0262		0.0474
		(0.0419)		(0.0346)		(0.0373)		(0.0283)
MDO Ratio	2.1870	2.4150	2.9651	2.8891	2.2173	2.3908	2.6351	2.6150
	(1.3604)	(1.4934)	(0.8949)	(0.9098)	(1.3493)	(1.4249)	(0.9105)	(0.9395)
Real Deficit Ratio	-1.0032	-0.6463	-0.9528	-0.7754	-0.8126	-0.3444	-0.7482	-0.5923
	(1.2339)	(1.0114)	(1.2411)	(1.0484)	(0.9601)	(0.7234)	(0.9556)	(0.7637)
Consolidated Real Deficit Ratio	2.2823	1.7038	2.0122	1.6853	2.4298	1.7746	2.3190	1.8144
	(1.2874)	(0.9815)	(1.1801)	(0.9769)	(0.9783)	(0.8947)	(0.9279)	(0.8706)
Real Debt Service Ratio	0.1048	0.0987	-0.0052	-0.0912	-0.0041	0.0154	-0.0064	-0.1136
	(0.1654)	(0.1733)	(0.1327)	(0.1324)	(0.1522)	(0.1650)	(0.0987)	(0.1138)
Future Burden Ratio	0.0136	0.0015			0.0093	0.0007		
	(0.0240)	(0.0248)			(0.0226)	(0.0236)		
Dummy LS * Maturity	-16.9294	-15.6340	-14.6387	-12.8083	-4.9462	-2.7043	-4.9023	-2.6658
	(4.1741)	(4.3776)	(3.8091)	(4.5129)	(3.3323)	(3.7401)	(3.2597)	(3.7141)
Dummy LS * Issue Amount	0.0039	-0.0012	0.0048	0.0005	0.0089	0.0043	0.0089	0.0078
	(0.0076)	(0.0059)	(0.0066)	(0.0060)	(0.0050)	(0.0052)	(0.0040)	(0.0042)
Dummy LS * Real Surplus Ratio	-0.7458		-1.0847		-0.8136		-0.8091	
	(0.7266)		(0.5773)		(0.3395)		(0.2844)	
Dummy LS * Primary Balance Ratio		0.1090		0.0312		0.0700		0.0188
		(0.0777)		(0.0658)		(0.0504)		(0.0360)
Dummy LS * MDO Ratio	-1.7154	-1.6377	-1.6279	-1.3562	-0.5871	-0.5670	-0.5926	-0.3892
	(0.8076)	(0.8105)	(0.8588)	(0.8747)	(0.2940)	(0.3072)	(0.2908)	(0.3150)
Dummy LS * Real Deficit Ratio	11.0623	10.5584	11.2003	11.1387	4.5617	4.2372	4.5850	4.4776
	(2.5228)	(2.3309)	(2.3686)	(2.3273)	(2.3070)	(2.6230)	(2.3359)	(2.5855)
Dummy LS * Consolidated Real Deficit Ratio	4.9393	4.7814	4.7162	4.5584	-0.1033	0.2990	-0.0783	0.1781
	(2.1124)	(2.1808)	(2.0517)	(2.1216)	(1.4505)	(1.4111)	(1.4557)	(1.4803)
Dummy LS * Real Debt Service Ratio	0.3440	0.2302	0.5933	0.6398	0.2439	0.1516	0.2611	0.3406
	(0.4224)	(0.4052)	(0.2987)	(0.3164)	(0.2061)	(0.2136)	(0.1184)	(0.1303)
Dummy LS * Future Burden Ratio	0.0227	0.0337			0.0011	0.0142		
	(0.0194)	(0.0178)			(0.0105)	(0.0108)		
N	204	204	204	204	204	204	204	204
R-squared	0.8673	0.8667	0.8625	0.8562	0.8888	0.8866	0.8885	0.8840

Notes: 1. Robust standard errors are shown in parentheses.

2. Local governments used as samples are those described in the Notes appended to Table 3 as well as Gifu, Oita, Okayama, and Yamanashi prefectures and the cities of Hamamatsu Niigata, and Sakai.

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