Fiscal Conditions and Long-term Interest Rates

Koji Nakamura and Tomoyuki Yagi

We conduct a quantitative analysis of the effects of fiscal conditions and other factors on nominal long-term interest rates based on panel data of 23 member states of the Organisation for Economic Co-operation and Development (OECD) for the period from 1980 to 2013. In addition to labor productivity, the demographic factor, and inflation rates, our analysis shows that the fiscal balance, national burden ratio, and current account balance (= domestic savings) influence nominal long-term interest rates. The elasticity of nominal long-term interest rates to the fiscal balance vary, depending on the levels of government debt outstanding, which are thought to affect perceptions of fiscal sustainability in the future. This implies that the elasticity of nominal long-term interest rates to the fiscal balance is non-linear depending on the levels of government debt outstanding. We also find that a low national burden ratio nurtures future expectations of fiscal consolidation and thus keeps long-term interest rates at low levels. Furthermore, non-traditional monetary policy measures and the preference for safe assets in recent years are found to keep nominal long-term interest rates at low levels.

Keywords: Long-term interest rate, Fiscal balance, Debt outstanding, Current account, National burden ratio, Fiscal reconstruction, Monetary policy
JEL Classification: E43, E52, H62, H63

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I. Introduction

Yields on government bonds (hereafter referred to as "nominal long-term interest rates") serve as the basis for lending interest rates and for pricing various financial products. As such, their fluctuations greatly affect financial and economic activities. Theoretically, nominal long-term interest rates can be explained by the term structure model of interest rates (Equation (1) below) and the Fisher equation (Equation (2) below). According to these formulae, nominal long-term interest rates are explained by real long-term interest rates, long-term inflation expectations, and risk premiums (Equation (3) below).[1]

Term structure model of interest rates: $i_h^L = \frac{1}{T}\sum_{t=0}^{T-1} i_{h+t}^S + RP_h\,,$ (1)

Fisher equation: $i_{h+t}^S = r_{h+t}^S + \pi_{h+t}^S\,,$ (2)

Nominal long-term interest rate:

$$i_h^L = \frac{1}{T}\sum_{t=0}^{T-1} r_{h+t}^S + \frac{1}{T}\sum_{t=0}^{T-1} \pi_{h+t}^S + RP_h = r_h^L + \pi_h^L + RP_h\,. \quad (3)$$

i_h^L: Nominal long-term interest rate

i_h^S: Nominal short-term interest rate

RP_h: Risk premium

r_h^S: Real short-term interest rate

π_h^S: Expected short-term inflation rate

r_h^L: Real long-term interest rate

π_h^L: Expected long-term inflation rate

Risk premiums are seen to comprise, among others, the term premium stemming from uncertainties about the future term structure and the sovereign risk premium stemming from the creditworthiness of the issuer-state.

Past empirical studies on the impact of fiscal conditions on nominal long-term interest rates show varying results from case to case. By conducting an empirical analysis of U.S. data through 2004, Gale and Orszag (2004) report that fiscal deficits and government debt outstanding indeed influence long-term interest rates differently from case to case (Table 1). Meanwhile, Gale and Orszag (2004) conclude that it is the expectation for future fiscal deficits rather than the current fiscal deficits that influence long-term interest rates. Based on international panel data, Alesina *et al.* (1992) state that there is a strong relationship between government debt outstanding and long-term interest rates. More recently, some empirical studies have found that the relationship between fiscal conditions and long-term interest rates is not linear and that the deterioration in fiscal conditions beyond a certain extent results in a non-linear increase in long-term interest rates while past empirical studies found that the relationship was linear and

1. In equations (1), (2), and (3), L, S, h, and T mean long-term, short-term, point of time, and maturity, respectively.

Table 1 Empirical Studies: Effects of Fiscal Conditions on Long-term Interest Rates

Predominately positive significant effect	Mixed effect	Predominately insignificant effect
Current deficit or debt		
1. Feldstein and Eckstein (1970) 2. Kudlow (1981) 3. Carlson (1983) 4. Hutchison and Pyle (1984) 5. Muller and Price (1984) 6. Barth, Iden, and Russek (1985) 7. de Leew and Hollaway (1985) 8. Hoelscher (1986) 9. Cebula (1987) 10. Cebula (1988) 11. Cebula and Koch (1989) 12. Cebula and Koch (1994) 13. Miller and Russek (1996) 14. Kitchen (2002) 15. Kiley (2003) 16. Cebula (2000)	1. Echols and Elliott (1976) 2. Dewald (1983) 3. Tanzi (1985) 4. Zahid (1988) 5. Coorey (1992)	1. Feldstein and Chamberlain (1973) 2. Canto and Rapp (1982) 3. Frankel (1983) 4. Hoelscher (1983) 5. Makin (1983) 6. Mascaro and Meltzer (1983) 7. Motley (1983) 8. Tatom (1984) 9. U.S. Treasury (1984) 10. Giannaros and Kolluri (1985) 11. Kolluri and Giannaros (1987) 12. Swamy *et al.* (1988) 13. Calomiris, Engen, Hassett, and Hubbard (2004)
Expected or unanticipated deficit		
1. Makin and Tanzi (1984) 2. Feldstein (1986) 3. Wachtel and Young (1987) 4. Bovenberg (1988) 5. Thomas and Abderrezak (1988a) 6. Thomas and Abderrezak (1988b) 7. Barth and Bradley (1989) 8. Thorbecke (1993) 9. Elmendorf (1993) 10. Elmendorf (1996) 11. Kitchen (1996) 12. Canzoneri, Cumby, and Diba (2002) 13. Laubach (2003)	1. Sinai and Rathjens (1983) 2. Kim and Lombra (1989) 3. Cohen and Garnier (1991) 4. Quigley and Porter-Hudak (1994) 5. Engen and Hubbard (2004)	1. Bradley (1986)
Vector Auto Regression-based dynamics		
1. Miller and Russek (1991) 2. Tavares and Valkanov (2001) 3. Dai and Phillipon (2004)	1. Mountford and Uhlig (2000) 2. Perotti (2002) 3. Engen and Hubbard (2004)	1. Plosser (1982) 2. Evans (1985) 3. Evans (1987a) 4. Evans (1987b) 5. Plosser (1987) 6. Evans (1989)

Note: Survey results by Gale and Orszag (2004). See Gale and Orszag (2004) for individual paper titles.

an expansion of fiscal deficits resulted in a proportionate increase in long-term interest rates. Based on panel data from advanced economies, Ardagna, Caselli, and Lane (2007) show that high levels of government debt outstanding result in a non-linear relationship between primary balances and long-term interest rates. They point out that when comparing a country with a large government debt outstanding to that with a smaller one, the increase in long-term interest rates is greater in the former even when the levels of primary deficits of these countries are the same. Égert (2010) also states that a government debt outstanding beyond a certain level results in higher long-term interest rates. Baldacci and Kumar (2010) demonstrate that fiscal deficits act to place upward pressure on long-term interest rates as fiscal deterioration unfolds. In addition, Gros (2011) shows that there is a non-linear relationship between the amount of the current account balance and long-term interest rates.

Many of these findings show that a deterioration in fiscal conditions results in higher interest rates, though in varying degrees. In today's Japan, however, nominal long-term interest rates remain low despite the country's record high gross and net government debt levels. On this point, Krugman (2011) notes the fact that Japan's government debt outstanding does not lead to higher interest rates "seems to be an important puzzle to resolve." Also, Caporale and Williams (2002) state that Japan is the only country in which government debt outstanding does not seem to affect interest rates. According to Krugman (2011), this peculiarity of Japan's long-term interest rates is attributable to the country's current account surplus, which keeps long-term interest rates from rising. Hoshi and Ito (2012) attribute Japan's peculiar status to its domestic savings, a home bias, economic stagnation, and the expectation for future fiscal consolidation. Ichiue and Shimizu (2015) cite the increase in demand for safety assets as Japan's population rapidly ages and the country's external assets as factors curbing increases in long-term interest rates. Ichiue and Shimizu (2015) empirically conclude that fiscal factors (i.e., government debt outstanding) have linear effects on long-term interest rates. Tokuoka (2010) documents that "Japan's sizeable pool of household savings, presence of large and stable institutional investors, and strong home bias" to be the factors that are preventing Japanese long-term interest rates from increasing.

We attempt to empirically identify the determinants of government bond yields (i.e., nominal long-term interest rates) based on panel data from advanced economies. Specifically, by performing an empirical analysis, we aim at finding how fiscal variables (e.g., government debt outstanding and fiscal balance) influence nominal long-term interest rates and the reason why Japan's long-term interest rates remain low despite the nation's severe fiscal conditions. For details on the data used in this study, see the attached Appendix.

This paper is organized as follows: Section II examines the relationship between fiscal conditions and long-term interest rates based on the data; Section III describes the outline of the empirical analysis; Section IV presents the results of the empirical analysis; and Section V presents conclusions.

II. Relationship between Fiscal Conditions and Long-term Interest Rates

This section shows stylized facts regarding the relationship between long-term interest rates and fiscal conditions such as government debt outstanding as well as fiscal and primary balances based on data from 23 member states of the Organisation for Economic Co-operation and Development (OECD) for the period from 1980 to 2013.

First, there is almost no correlation between gross government debt outstanding (as a ratio to nominal GDP) and nominal long-term interest rates (Chart 1).[2] Added to this, there is almost no correlation between net government debt outstanding (i.e., gross

2. The relationship between government debt outstanding on both gross and net bases and real long-term interest rates is also examined. It was found that there was almost no correlation with real long-term interest rates on either base, as was the case with nominal long-term interest rates.

Chart 1 Gross Government Debt Outstanding and Nominal Long-term Interest Rates

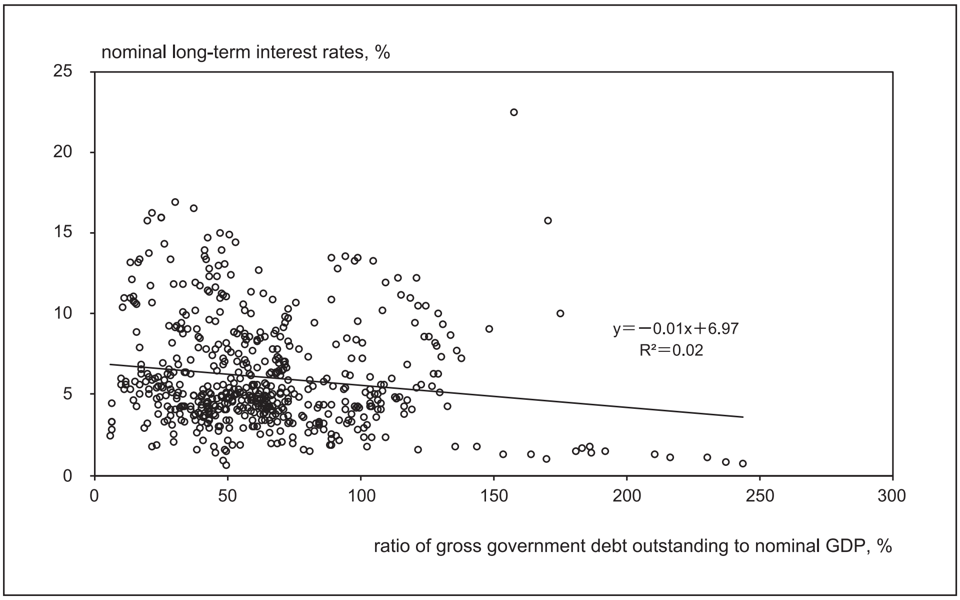
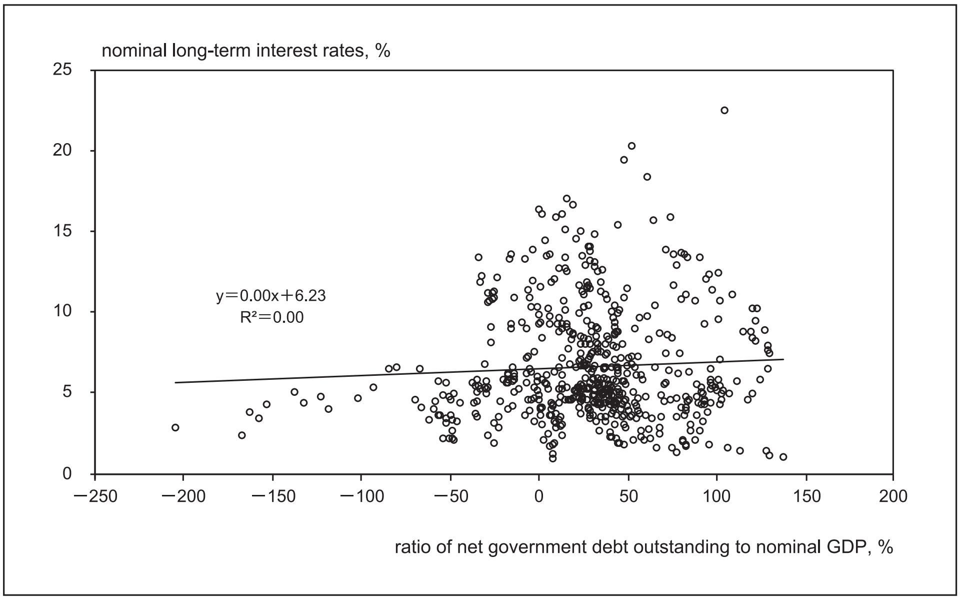


Chart 2 Net Government Debt Outstanding and Nominal Long-term Interest Rates



government debt minus the amount of financial assets held by the government, and as a ratio to nominal GDP) and nominal long-term interest rates (Chart 2). Therefore, the statistical tests based on the two simple variables do not reveal any relationship between government debt outstanding and nominal long-term interest rates.

Next, the relationship between the fiscal balance on a flow basis and nominal long-term interest rates is examined. The correlation is found to be low between the fiscal

Chart 3 Fiscal Balance and Nominal Long-term Interest Rates

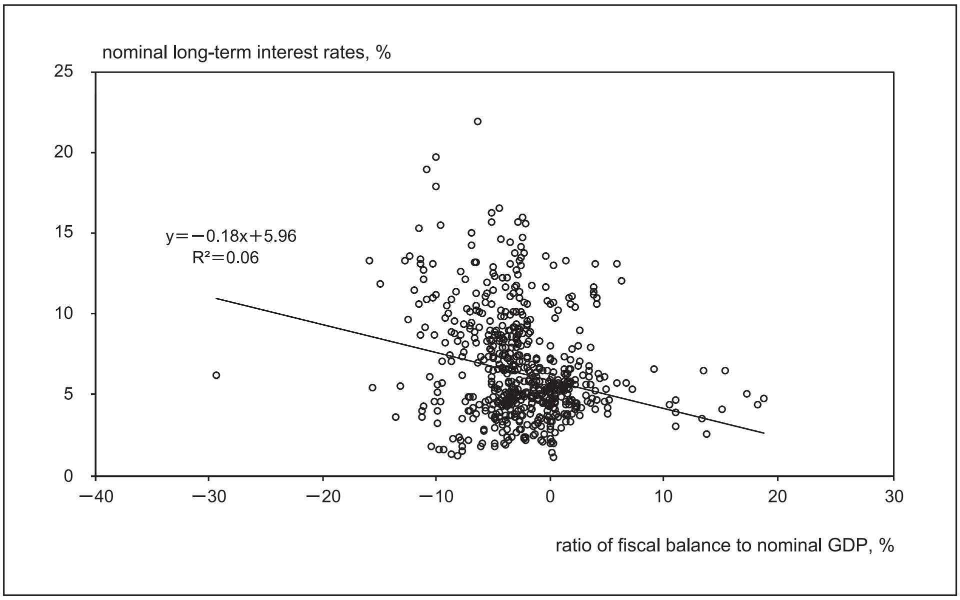
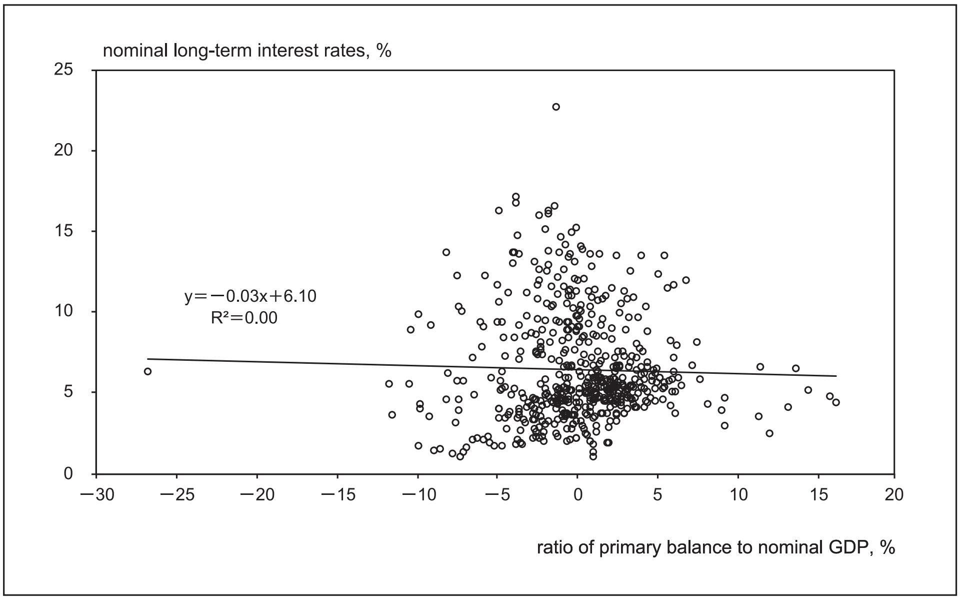


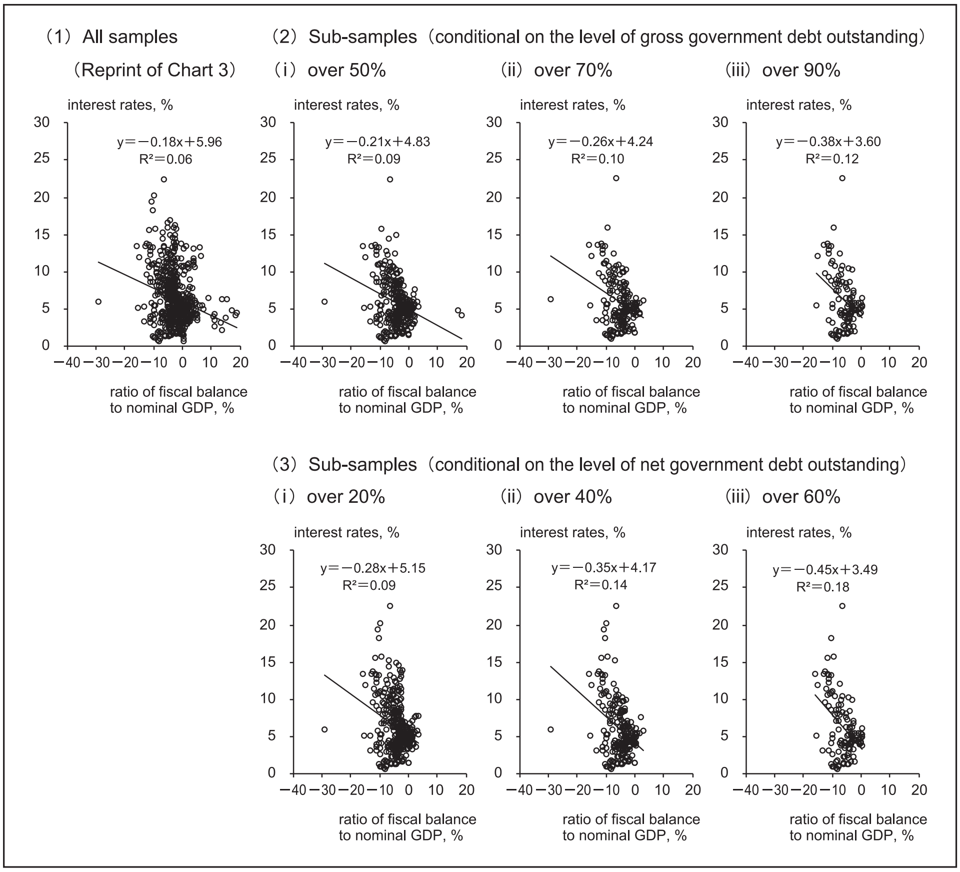
Chart 4 Primary Balance and Nominal Long-term Interest Rates



balance including interest payments (as a ratio to nominal GDP) and nominal long-term interest rates (Chart 3). The primary balance (i.e., fiscal balance excluding interest payments, and as a ratio to nominal GDP) is also found to have a tenuous correlation with nominal long-term interest rates (Chart 4).

Then, samples, in which the amounts of government debt outstanding are above a certain value, are selected to see the relationship between the fiscal balance and nominal

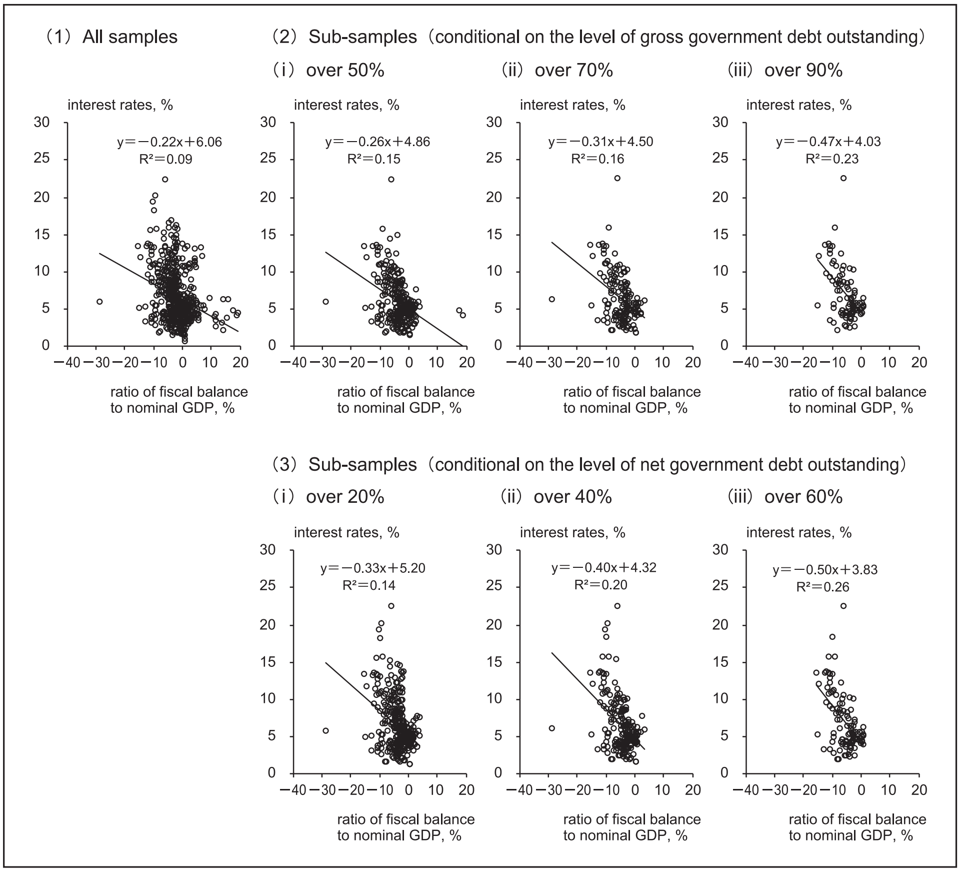
Chart 5 Fiscal Balance and Nominal Long-term Interest Rates Conditional on the Level of Government Debt Outstanding (All Samples)



long-term interest rates. First, samples, in which the ratio of gross government debt outstanding to GDP is 50 percent or more, are selected to show the relationship between the fiscal balance and nominal long-term interest rates (Chart 5). The chart indicates that the correlation for these samples is somewhat greater than that for all samples, and that the elasticity of nominal long-term interest rates to the fiscal balance for these samples is higher as well. Furthermore, for those samples in which the ratios of gross government debt outstanding to GDP are 70 percent or more, the correlation between the two proves to be stronger and the elasticity higher. The same trend is observed for the samples in which the ratio of debt outstanding to GDP is 90 percent or more. The findings are the same when the relationship between the fiscal balance and nominal long-term interest rates is examined based on net debt outstanding. The correlation is also found to be stronger and the elasticity greater when the analysis is based on net debt outstanding than when it is based on gross debt outstanding.

Next, we use the data samples excluding those of Japan (Chart 6). For both gross and net debts outstanding, the correlation between the fiscal balance and nominal long-term interest rates becomes stronger and the elasticity higher. These tendencies are more pronounced when we use data excluding those of Japan. When only the samples

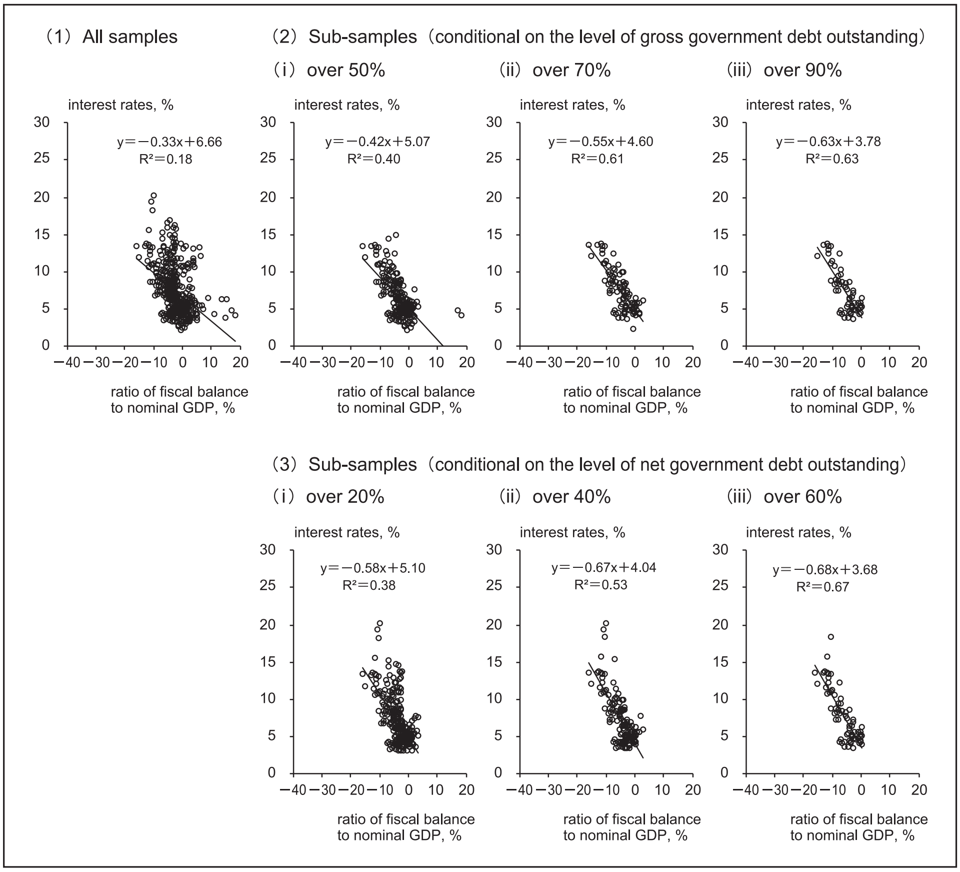
Chart 6 Fiscal Balance and Nominal Long-term Interest Rates Conditional on the Level of Government Debt Outstanding (Samples Exclude Japan)



predating the financial crisis in 2008 are selected and when data from Japan are excluded, the correlation between the fiscal balance and nominal long-term interest rates clearly becomes even stronger and the elasticity higher as the levels of government debt outstanding rise (Chart 7).

In prior studies, the results are divided as to whether it is the current fiscal variables or future fiscal variables that affect long-term interest rates. Given the findings presented above, one interpretation would be: (1) the present fiscal balance influences nominal long-term interest rates, but to a small degree, and that (2) a large fiscal deficit, combined with a high government debt outstanding, increases concerns about the sustainability of future fiscal conditions, thus increasing the impact on nominal long-term interest rates. In the latter case, information on the fiscal balance combined with that on government debt outstanding can be interpreted as a proxy variable representing the "expectation" for the sustainability of future fiscal conditions.

Chart 7 Fiscal Balance and Nominal Long-term Interest Rates Conditional on the Level of Government Debt Outstanding (Samples before the Financial Crisis and Exclude Japan)



Note: Samples before the financial crisis use data from 1980 to 2007.

III. Outline of the Empirical Analysis

Based on the findings in Section II, we examine the various factors that can influence nominal long-term interest rates. Here, we use yields on 10-year government bonds (spot rates), which are dependent variables, as nominal long-term interest rates.[3]

A. Variables Related to the Real Economy

As seen in Section I, nominal long-term interest rates can be broken down into real long-term interest rates, long-term inflation expectations, and risk premiums. Labor productivity and the demographic factor are to be examined here as factors influencing

3. Ichiue and Shimizu (2015) use forward rates of 10 countries from 1990 as long-term interest rates. Here in this paper, we use spot rates as long-term interest rates in order to include more countries (23 countries) and longer time series data from 1980. As for Germany, Japan, the U.K., and the U.S., the correlation coefficient between spot rates (10 years) and forward rates (five-year by five-year) of government bonds is around 0.9, respectively, and we find that they move almost synchronously.

real long-term interest rates.

B. Inflation Rates

The long-term inflation expectation is an essential independent variable for nominal long-term interest rates. In many countries, however, data on long-term inflation expectation are not always available for an extended period. Therefore, we use actual inflation rates in order to include as many countries as possible. As for inflation rates, this study uses the headline rate of increase in consumer prices.

C. Nominal Short-term Interest Rates

Based on a term-structure model of interest rates, nominal short-term interest rates may possibly be counted as one independent variable. Indeed, taking the Taylor rule into account, these rates move, to some extent, in harmony with real economic variables and inflation rate trends. However, assuming that monetary policy reacts to short-term economic fluctuations in a forward-looking manner, changes in nominal short-term interest rates reflect not only the current levels of labor productivity, the demographic factor, and inflation rates, but also their future expectations. Therefore, we use nominal short-term interest rates as explanatory variables.

D. Fiscal Balance and Government Debt Outstanding

It is thought that there is a correlation between fiscal or primary balances and nominal long-term interest rates. In addition, there is a strong correlation between "the fiscal balance conditional on the levels of government debt outstanding," which could reflect the expectation of future fiscal sustainability, and nominal long-term interest rates, as shown in Section II. Therefore, this panel estimation takes into account, along with the fiscal balance itself, the fact that the impact of the fiscal balance conditional on the levels of government debt outstanding on nominal long-term interest rates increases in a non-linear fashion when the levels of government debt outstanding exceed certain levels. We use the ratios of fiscal variables to nominal GDP, as in Section II.

We use the net government debt outstanding and the fiscal balance including interest payments as explanatory variables for the following panel estimations. This is because net government debt outstanding (which is obtained after offsetting the debt with the government's financial asset holdings) would be a more appropriate indicator of the government's ability to pay. Previous studies demonstrated that net government debt outstanding had a significant impact compared with gross government debt outstanding.[4] As to the choice between fiscal balance and primary balance, in order to assess the government's ability to pay, we think it appropriate to include interest payments, and therefore use the fiscal balance as an explanatory variable. Later in this paper, we examine the robustness of this analysis using different variables such as gross government debt outstanding and primary balance.

4. For example, Ichiue and Shimizu (2015) state that "if the financial assets held by the government can be used to repay debts, it is appropriate to consider that the effect of default risk is determined by net debt, which is calculated by offsetting those financial assets."

E. Expectations for Fiscal Consolidation

Even if the current fiscal conditions are severe, a high expectation for future fiscal consolidation would keep the government's ability to pay from being questioned and therefore would not raise the fiscal risk premium, an element of nominal long-term interest rates. One of the factors which keep Japan's nominal long-term interest rates from rising is said to be the expectation for fiscal consolidation (Hoshi and Ito [2012]). We use the national burden ratio (as a ratio to nominal GDP), that is the sum of tax payments and social security fees, as a variable representing the expectation for fiscal consolidation. In the actual estimation exercise, we use the deviations from the all-sample averages as explanatory variables. Despite a severe current fiscal condition, a low national burden ratio would lead to the expectation that future increases in tax payments or social security fees would contribute to a fiscal consolidation, which, in turn, may keep long-term interest rates from rising. In contrast, a high government debt outstanding and a large fiscal deficit, despite an already high national burden ratio, would put to question the sustainability of fiscal health, leading to higher levels of nominal long-term interest rates. In fact, Japan's national burden ratio is below those of other countries in this analysis. Japan's low national burden ratio may have affected expectations for future fiscal consolidation.

F. Current Account Balance

The current account balance is also said to affect nominal long-term interest rates (Krugman [2011], and Hoshi and Ito [2012]). A current account surplus equivalent to excess domestic savings would facilitate the domestic absorption of government bonds and is thought to keep long-term interest rates from rising. By contrast, a current account deficit equivalent to a domestic savings shortfall makes it difficult to absorb government bonds domestically, making it necessary to raise funds from overseas. Assuming that there is a home bias, raising funds overseas is likely to result in higher interest rates. We use the ratio of the current account balance to nominal GDP as an explanatory variable.

G. Non-traditional Monetary Policy Measures

Faced with low growth rates and low inflation following the global financial crisis, central banks of advanced economies have faced the zero lower bound of nominal short-term interest rates and have attempted to stimulate the economy by using non-traditional monetary policy measures. Although non-traditional monetary policy measures may take different forms, many of them are characterized by techniques designed to reduce the term premium through large purchases of long-term government bonds. We adopt the monetary base (as a ratio to nominal GDP) as a proxy variable of the non-traditional monetary policy measure applicable on a cross-country basis.[5]

5. A government bond-purchasing dummy in which the period after the introduction of large-scale government bond purchase programs by central banks as their policy measures is represented by 1 and other periods by 0. The value of the dummy multiplied by that for the monetary base is used as a proxy variable for the degree of monetary easing. Specifically, the dummy is 1 for Japan from 2001 and onward, from 2009 and onward for the U.K. and the U.S., and 2010 and onward for the euro area. We show the results of analyses in which the monetary base *per se*, rather than the dummy variables, are used to verify the robustness of the estimation, although the sample size becomes smaller.

H. Impact of the European Sovereign Debt Crisis

The analysis here includes countries in which nominal long-term interest rates surged due to the European sovereign debt crisis. These countries immediately suffered sharp increases in their long-term interest rates due to the above-mentioned factors plus an intensive "fire sale" of their sovereign bonds by investors who were hit by concerns over the possibility of defaults. Such short-term investors' behavior cannot be captured by the above-mentioned explanatory variables. Therefore, for these countries, dummy variables are used as explanatory variables for the periods in which they received support from the International Monetary Fund (IMF) or other organizations.

I. Preference for Safe Assets

Growing risks in the international financial capital markets (e.g., the Asian financial crisis and the global financial crisis) have apparently pushed up demand for government bonds, which are considered as safe assets, with this leading to a decrease in long-term interest rates of these countries. This phenomenon, widely known as "flight to quality" or "flight to safety," has been observed in government bonds of Japan, the U.S., the U.K., and Germany. In addition, financial institutions have increased their incentives to hold government bonds with lower risks in response to a call for tighter financial regulations following the global financial crisis. These factors are held responsible for increasing investors' demand for lower risk government bonds. In this paper, we use dummy variables to explain the demand-side factors, that is "preference for safe assets," of Japan, the U.S., the U.K., and Germany for the two periods: the Asian financial crisis (1997–1998) and the post-global financial crisis (2008–2013).

IV. Results of the Empirical Analysis

This section presents the results of the empirical analysis. The analysis covers 23 member countries of the OECD, whose panel data are used for the sample period which runs from 1980 through 2013. Following the procedures taken by numerous earlier studies, we include the fixed effect attached to each country in order to control country-specific factors.[6]

A. Method of Setting the Government Debt Level as a Condition

In Section III, we used the fiscal balance as an explanatory variable conditional on the level of government debt outstanding. Specifically, estimations are made by applying two methodologies.

The first method assumes the dummy variable to be 1 when the level of government debt outstanding exceeds a certain threshold. We estimate the parameters for cases with different levels of debt outstanding. Hereafter, this dummy is to be referred to as the "simple dummy variable." The specification of the function is presented in Equation (4). For the samples, if the ratio of net government debt outstanding to GDP is at a certain threshold, $\rho\%$, or above, the dummy for the debt outstanding would be 1,

6. The merits of estimation using panel data are to control differences of economic entities and to use many samples with high degree of freedom. See Baltagi (1995) and Hsiao (1986).

otherwise 0. In order to measure the impacts of the different levels of net government debt outstanding, we estimate the coefficients of fiscal balance with different debt levels as we change the threshold ρ , when the dummy variable takes 1.

$$\text{a} * \text{fiscal balance } + \alpha * \text{debt outstanding dummy} * \text{fiscal balance}. \tag{4}$$

The second methodology is to make an estimation using the debt outstanding dummy which is obtained by making a logit transformation of government debt outstanding in such a way that the impact of the fiscal balance increases continuously, along with the rise in the level of government debt outstanding. Hereafter, this dummy is to be referred to as the "logit transformation dummy variable." It means that the government debts outstanding are lined up in ascending order of their ratios to nominal GDP (i.e., the dummy is zero when the ratio is low) so that the dummy variable would keep growing as the debt outstanding-to-GDP ratio rises, increasing the fiscal balance's impact until the variable converges to 1.

B. Estimation Results (Relating to Fiscal Conditions)

1. Results when the simple dummy variable is used

Specification 1 of Table 2 shows the estimation results without the dummy variable of government debt outstanding. Specifications 2–4 of Table 2 show the estimation results with dummy variables when the ratios of the government debt outstanding-to-GDP are above certain levels. The threshold levels ρ, at which the dummy variables take 1, are set at 50 percent for Specification 2, 70 percent for Specification 3, and 90 percent for Specification 4. They show that the signs of the parameters match those assumed in Section III. That is, the parameters for the fiscal balance are negative and significant. This implies that the higher the fiscal deficits, the higher the nominal long-term interest rates. When the levels of government debt outstanding are above certain thresholds, the parameters of dummy variables are also negative and significant as shown in Specifications 3 and 4. These results indicate that fiscal balance with higher levels of government debt would put additional upward pressure on nominal long-term interest rates. Comparing Specifications 3 and 4, we find that the absolute value of the parameter on the dummy variable of Specification 4 with the debt threshold of 90 percent is larger than that of Specification 3. This indicates that the impact of fiscal deficits with higher levels of government debt on long-term interest rates becomes larger.

Chart 8 shows the estimation results with different thresholds for dummy variables of government debt outstanding as we change ρ by one percentage point. The parameters of fiscal balance, which measures the direct impacts of fiscal balance on nominal long-term interest rates, are more or less constant regardless of the levels of government debt outstanding. On the other hand, the absolute levels of parameters of dummy variables, which are assumed to be additional impacts of fiscal deficits on nominal long-term interest rates, become larger as the threshold levels of government debt outstanding become larger. These results show that the impacts of fiscal deficits on nominal long-term interest rates become larger as the levels of government debt outstanding increase.

Table 2 Results of Panel Regressions

Dependent variable: Nominal long-term interest rates (10-year bonds)

Variables	Coeff.	1	2	3	4	5
Fiscal balance	a	−0.12***	−0.12***	−0.10***	−0.10***	−0.10***
		(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Debt outstanding dummy (D_D)	α		−0.01	−0.14***	−0.16**	−0.16**
×Fiscal balance			(0.04)	(0.04)	(0.07)	(0.07)
National burden ratio	b	0.10**	0.11***	0.12***	0.09**	0.10***
(deviation from all-sample average)		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Current account	c	−0.06*	−0.06*	−0.06*	−0.07**	−0.07**
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Labor productivity	d	0.11***	0.10**	0.09**	0.10***	0.10***
		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Demographic factor	e	0.71***	0.84***	0.81***	1.02***	0.97***
		(0.19)	(0.24)	(0.24)	(0.27)	(0.25)
Inflation rates	f	0.23***	0.25***	0.30***	0.27***	0.28***
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Short-term interest rates	g	0.55***	0.54***	0.51***	0.52***	0.51***
		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Government bond-purchasing dummy	h	−0.02	−0.02	−0.03**	−0.02	−0.02*
×Monetary base		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant		1.96***	1.93***	1.93***	1.96***	1.96***
		(0.12)	(0.13)	(0.13)	(0.13)	(0.13)
European sovereign		6.28***	6.24***	6.14***	6.08***	6.19***
debt crisis dummy		(1.19)	(1.17)	(1.12)	(1.09)	(1.13)
Safe asset dummy		−0.86***	−0.85***	−0.95***	−0.98***	−0.99***
		(0.21)	(0.22)	(0.22)	(0.23)	(0.23)
Adjusted R-squared		0.834	0.839	0.844	0.844	0.843
AIC		3.354	3.365	3.337	3.336	3.342
S.E. of regression		1.256	1.260	1.243	1.243	1.246
Durbin–Watson stat		1.273	1.295	1.296	1.310	1.302
Number of countries		23	23	23	23	23
Number of samples		539	512	512	512	512
Simple dummy threshold D_D = 1: Net government debt outstanding (ρ)		—	$\rho \geqq 50\%$	$\rho \geqq 70\%$	$\rho \geqq 90\%$	—

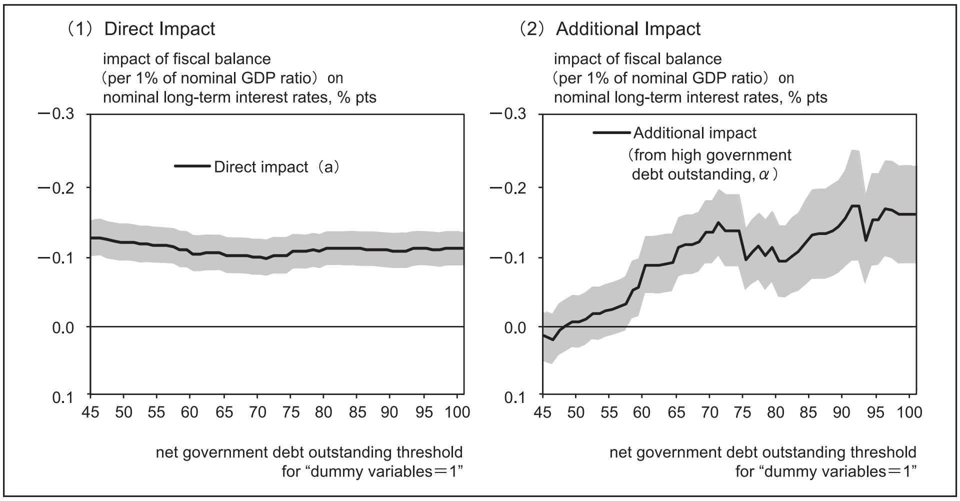
Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.
2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).
3. Specification 5 is estimated by using the logit transformation dummy variable.

Next, we look at the impact of the national burden ratio on nominal long-term interest rates. We use the deviations of the actual levels from the all-sample average as explanatory variables. The results show that a high national burden-to-GDP ratio leads to a high level of nominal long-term interest rates, while a low national burden-to-GDP ratio leads to low long-term interest rates. These results are what we assumed in Section III. When the national burden-to-GDP ratios are low, it is expected that there is room for future fiscal consolidation, and the impact of budget deficits on nominal long-term interest rates is offset even when the government debt level is high.

2. Results when the logit transformation dummy variable is used

We construct the logit transformation dummy variables, which are the conditions of government debt outstanding, taking into account the results of simple dummy vari-

Chart 8 Impact of Fiscal Balance on Nominal Long-term Interest Rates (Estimated Using Simple Dummy Variables)



Note: The rolling threshold of net government debt outstanding is used here for estimation. For the samples, if the ratio of net government debt outstanding to nominal GDP is at a certain threshold of ρ%, or above, the debt outstanding dummy takes 1, otherwise 0. Shaded areas indicate ±1S.E.

ables (Chart 9).[7] Estimated results using these dummy variables are shown in Specification 5 of Table 2. They are almost the same as those derived from the application of simple dummy variables. The coefficient of the fiscal balance is negative and significant and a greater fiscal deficit contributes to higher nominal long-term interest rates. Our estimated result shows that a 1-percentage point decline in the fiscal balance allows the long-term interest rate to rise by 10 basis points. In addition, a high government debt level boosts the impact of fiscal balance on nominal long-term interest rates. This is illustrated more clearly in Chart 10, which points to an increase in the parameter at different government debt levels. It shows that the greater the government debt outstanding, the greater the uncertainty over fiscal sustainability, which results in a non-linear increase in the impact of fiscal deficits on long-term interest rates. Our result demonstrate that the deterioration in the fiscal balance by a 1-percentage point pushes the long-term interest rate by 26 basis points in association with higher debt outstanding (in that case, 16 basis points are added to the above-mentioned 10 basis points). On the other hand, such an impact is offset if the national burden ratio is low.

The estimation results in Table 2 are compared from the viewpoint of the adjusted coefficient of determinants and Akaike Information Criterion (AIC). The values for the former are greater for Specifications 2–5 which assume that the fiscal balance's impact on the long-term interest rates is non-linear than that for Specification 1 which does not. As to the AIC, the values for Specifications 3–5 are smaller than those for Specification 1. In addition, standard errors of Specifications 3–5 are smaller. Based on these results,

7. Specifically, the following formulae are used to make logit transformation.

$$\text{Debt outstanding dummy} = \exp[\gamma(\text{Net debt outstanding} - \theta)]/\{1 + \exp[\gamma(\text{Net debt outstanding} - \theta)]\}$$

Based on all-sample data, θ denotes average net debt outstanding×3, γ denotes the standard deviation of net debt outstanding/300.

Chart 9 Logit Transformation Dummy Variables (Government Debt Outstanding)

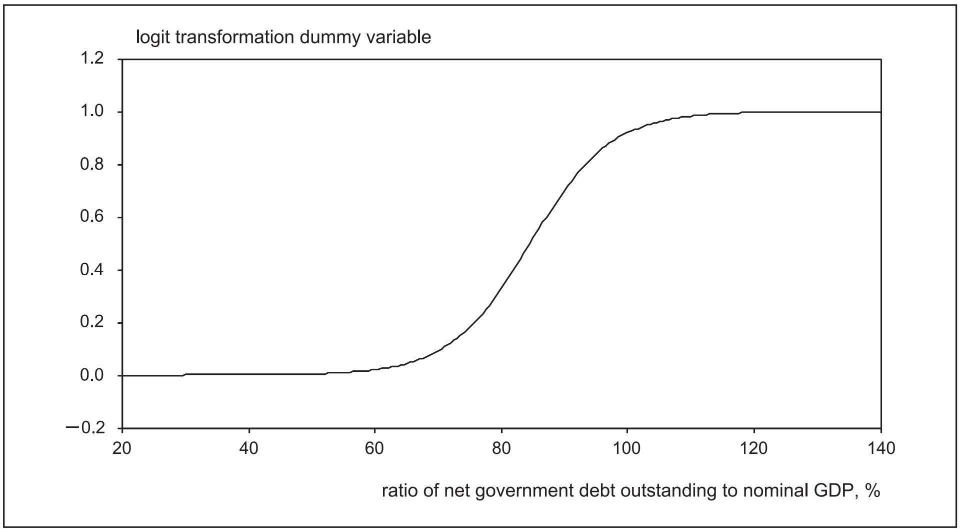
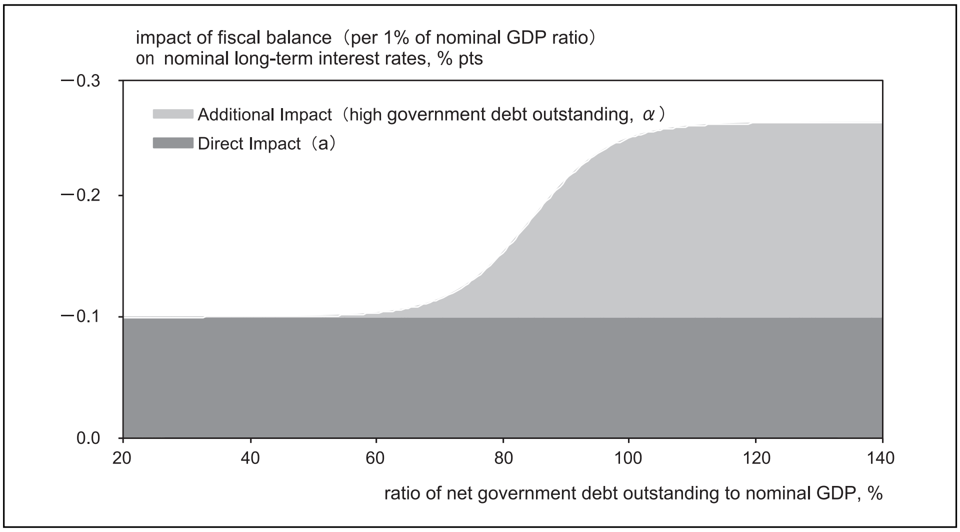


Chart 10 Impact of Fiscal Balance on Nominal Long-term Interest Rates (Estimated Using Logit Transformation Dummy Variables)



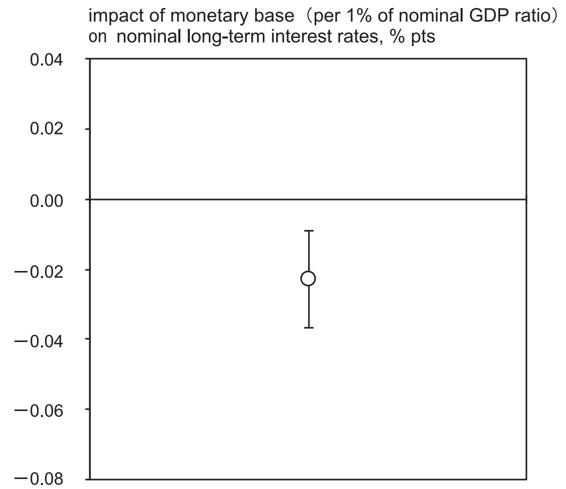
Note: This chart shows the degree of contribution when the estimation is based on logit transformation dummy variables (Specification 5 of Table 2).

we conclude that the assumption on non-linear impacts of fiscal deficits on long-term interest rates conditional on the levels of government debt outstanding is appropriate.

C. Estimation Results (Other Variables)

The results are about the same for each specification for the other variables. First, the coefficient of non-traditional monetary policy measures is a negative value. This is consistent with the fact that low long-term interest rates in recent years were at-

Chart 11 Impact of Non-traditional Monetary Policy on Nominal Long-term Interest Rates



Note: This chart shows the degree of contribution when the estimation is based on logit transformation dummy variables (Specification 5 of Table 2). The vertical line indicates ±1S.E.

tributable to the non-traditional monetary policy measures, which has compressed the term-premium (Chart 11). The standard error, however, is somewhat larger than our estimated coefficient. For this reason, we consider that non-traditional monetary policy measures were implemented at times when demand for safe assets increased, especially for the period following the global financial crisis, this has possibly caused multicollinearity between the safe asset dummy and the government bond-purchasing dummy.

The impact of non-traditional monetary policy measures on long-term interest rates in our finding shows a slightly smaller value than those of previous studies. The Bank of Japan's Monetary Affairs Department (2015) shows that the increase in the Bank's purchases of long-term government bonds from March 2013 to December 2014, which is about 110 trillion yen, reduced long-term interest rates by 0.8 percentage point. Based on Specification 5 of Table 2 in this paper, we estimate that the reduction in long-term interest rates for the same period is 0.5 percentage point. Fukunaga, Kato, and Koeda (2015) estimates that the combination of purchasing long-term government bonds and extending the duration of bond holdings from April 2013 to September 2014 contribute to a reduction in long-term interest rates by 0.6 percentage point. Based on Specification 5 of Table 2 in this paper, we estimate that the increase in the Bank's purchases of long-term government bonds contribute to a reduction in long-term interest rates by 0.4 percentage point.

The parameters for the current account balance are negative: a greater current account deficit boosts nominal long-term interest rates, while a greater current account surplus depresses long-term interest rates. Our estimation in Specification 5 of Table 2 shows that a 1-percent shift in the current account balance leads to 7 basis points change in the long-term interest rate. The parameters for other factors, such as labor productivity, the demographic factor, inflation rates, and short-term interest rates are positive: any increase in these factors leads to higher long-term interest rates.

We find that the European sovereign debt crisis dummy exerts significant upward pressure on the government bond rates of crisis-hit countries. The safe asset dummy also places downward pressure on the government bond rates of specific countries when demand for these bonds increases in correspondence with the confusion in the international financial capital markets and tighter financial regulations. However, the elasticity of the dummy depends on the amount of stress placed on international financial capital markets and/or the degree of preference for safe assets, among other factors. Therefore, rather than measuring the impact using dummy variables shown in this paper, if we perform a quantitative analysis with the possible use of quantified time-series data of investors' preferences for safe assets and add these quantified data as explanatory variables, our analysis will become even more sophisticated.[8]

D. Robustness Check of Estimation

Here, we examine the robustness of our estimation results.

We use gross government debt outstanding instead of net, which reduces government debt outstanding by the amount of its financial asset holdings. Table 3 shows that the statistical significances of several parameters are lower compared to the regressions which use net government debt outstanding.

Next, we use primary balance as an explanatory variable instead of fiscal balance, which includes interest payments. Table 4 shows that some of the coefficients estimated by using primary balance are less significant and the fitness of some specifications are lower than those of fiscal balance.

In Section III, we examined the impacts of non-traditional monetary policy measures by using the dummy variable. Here, we use monetary base as a proxy of non-traditional monetary policy measures without dummy variables not only for the period of the non-traditional monetary policy regime, but also for the period of the traditional monetary policy regime. Table 5 shows the results. While the signs of the monetary base are correct, the fitness of the equations is lower than those of the previous specification.

In order to control common movements across countries, we examine the results of the estimation with time dummy variables. Table 6 shows that while the fitness improves, the signs of coefficients are incorrect and their significance are low.[9]

We examine the case where we use not only fiscal balance, but also net government debt outstanding as explanatory variables. In Section II, we showed that simple scattered diagrams did not reveal a clear relationship between the levels of government debt outstanding and long-term interest rates. Table 7 shows the estimation results using government debt outstanding with other explanatory variables. The significance of the parameter of government debt outstanding is low and the sign of the parameter is opposite. Based on the result, we conclude that there is no clear relationship between the levels of government debt outstanding and long-term interest rates. Note that the

8. Arslanalp and Tsuda (2012) make an attempt to quantify information on capital inflows and outflows at the time of the global financial crisis.
9. Multicollinearity is possibly at play among the time dummy variable and other variables.

Table 3 Results of Panel Regressions (Robustness Check): Gross Government Debt Outstanding

Dependent variable: Nominal long-term interest rates (10-year bonds)

Variables	Coeff.	6	7	8	9
Fiscal balance	a	-0.12^{***}	-0.12^{***}	-0.12^{***}	-0.12^{***}
		(0.03)	(0.03)	(0.03)	(0.02)
Debt outstanding dummy (D_D) ×Fiscal balance	α'	−0.06	−0.10	-0.18^{**}	-0.27^{***}
		(0.05)	(0.06)	(0.08)	(0.10)
National burden ratio (deviation from all-sample average)	b	0.07	0.06	0.07	0.07
		(0.05)	(0.05)	(0.05)	(0.05)
Current account	c	-0.05^{*}	-0.06^{*}	-0.07^{**}	-0.08^{**}
		(0.03)	(0.03)	(0.03)	(0.03)
Labor productivity	d	0.08^{**}	0.09^{**}	0.09^{***}	0.10^{***}
		(0.04)	(0.04)	(0.04)	(0.03)
Demographic factor	e	1.18^{***}	1.25^{***}	1.35^{***}	1.54^{***}
		(0.25)	(0.26)	(0.27)	(0.28)
Inflation rates	f	0.27^{***}	0.27^{***}	0.29^{***}	0.32^{***}
		(0.06)	(0.06)	(0.06)	(0.06)
Short-term interest rates	g	0.53^{***}	0.53^{***}	0.51^{***}	0.49^{***}
		(0.03)	(0.03)	(0.03)	(0.03)
Government bond-purchasing dummy ×Monetary base	h	−0.02	−0.02	-0.03^{*}	-0.03^{**}
		(0.01)	(0.01)	(0.01)	(0.01)
Constant		1.91^{***}	1.91^{***}	1.94^{***}	1.95^{***}
		(0.12)	(0.12)	(0.12)	(0.12)
European sovereign debt crisis dummy		6.08^{***}	6.06^{***}	5.91^{***}	5.88^{***}
		(1.14)	(1.11)	(1.03)	(0.97)
Safe asset dummy		-0.87^{***}	-0.86^{***}	-0.81^{***}	-0.80^{***}
		(0.21)	(0.21)	(0.22)	(0.23)
Adjusted R-squared		0.830	0.831	0.837	0.842
AIC		3.293	3.285	3.254	3.217
S.E. of regression		1.214	1.209	1.191	1.169
Durbin–Watson stat		1.292	1.300	1.314	1.321
Number of countries		23	23	23	23
Number of samples		486	486	486	486
Simple dummy threshold D_D = 1: Gross government debt outstanding (ρ')		$\rho' \geqq 90\%$	$\rho' \geqq 100\%$	$\rho' \geqq 110\%$	$\rho' \geqq 120\%$

Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.

2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).

coefficients of fiscal balance conditional on the debt level and national burden ratio are both significant and that the signs of the coefficients are correct.

The national burden ratio was used for earlier estimations as a variable that represents fiscal reconstruction expectations. Here, by considering fiscal deficit as a national burden in the form of future tax hikes, and then by adding the fiscal deficit to the national burden ratio as the "potential national burden ratio," we can use fiscal reconstruction expectations as a proxy variable. Although the fiscal balance is already added as explanatory variables here in our estimation, we check its robustness by first computing the potential national burden ratio (ratio to nominal GDP) and then redo calculations using the value of divergence derived from the all-sample average as explanatory variables. The results in Table 8 show that the impacts of the potential national burden

Table 4 Results of Panel Regressions (Robustness Check): Primary Balance

Dependent variable: Nominal long-term interest rates (10-year bonds)

Variables	Coeff.	10	11
Primary balance	a′	−0.09***	−0.08**
		(0.03)	(0.04)
Debt outstanding dummy (D_D) ×Primary Balance	α''		−0.11
			(0.08)
National burden ratio (deviation from all-sample average)	b	0.05	0.07
		(0.05)	(0.05)
Current account	c	−0.09***	−0.08**
		(0.03)	(0.03)
Labor productivity	d	0.10**	0.09**
		(0.04)	(0.04)
Demographic factor	e	1.31***	1.21***
		(0.26)	(0.27)
Inflation rates	f	0.24***	0.25***
		(0.05)	(0.05)
Short-term interest rates	g	0.56***	0.55***
		(0.03)	(0.03)
Government bond-purchasing dummy×Monetary base	h	−0.00	−0.01
		(0.01)	(0.01)
Constant		2.13***	2.15***
		(0.14)	(0.15)
European sovereign debt crisis dummy		6.55***	6.52***
		(1.17)	(1.14)
Safe asset dummy		−0.49**	−0.65***
		(0.22)	(0.23)
Adjusted R-squared		0.825	0.826
AIC		3.390	3.400
S.E. of regression		1.275	1.279
Durbin–Watson stat		1.318	1.346
Number of countries		23	23
Number of samples		486	464

Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.
2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).
3. Specification 11 is estimated by using the logit transformation dummy variable.

ratio on long-term interest rates are statistically significant. In these cases, however, the coefficients of the fiscal balance are no longer significant.

The current account, which is added to the explanatory variable in this paper, indicates the amount that domestic funds are capable of absorbing in terms of the flow. On the other hand, the difference between the private financial asset outstanding and the government debt outstanding is regarded as to be a measurement for the margin of domestic funds in terms of the stock. Table 9 shows the estimated results obtained by adding the ratio of nominal GDP to this explanatory variable. We confirm in this table that long-term interest rates remain at low levels when the balance of private financial asset is larger than the outstanding of government debt. In these cases shown in Table 9, however, the degrees of freedom-adjusted coefficients become smaller than that in Table 2, with some coefficients losing significance. Stock information is indeed im-

Table 5 Results of Panel Regressions (Robustness Check): Monetary Base

Dependent variable: Nominal long-term interest rates (10-year bonds)

Variables	Coeff.	12	13
Fiscal balance	a	−0.12***	−0.11***
		(0.03)	(0.03)
Debt outstanding dummy (D_D) ×Fiscal balance	α		−0.29**
			(0.12)
National burden ratio (deviation from all-sample average)	b	0.17***	0.15**
		(0.06)	(0.06)
Current account	c	−0.06	−0.05
		(0.04)	(0.04)
Labor productivity	d	0.04	0.05
		(0.05)	(0.04)
Demographic factor	e	1.04***	1.32***
		(0.29)	(0.33)
Inflation rates	f	0.33***	0.36***
		(0.09)	(0.09)
Short-term interest rates	g	0.49***	0.48***
		(0.04)	(0.04)
Monetary base	h′	−0.03**	−0.04***
		(0.01)	(0.01)
Constant		2.31***	2.22***
		(0.23)	(0.24)
European sovereign debt crisis dummy		6.09***	5.80***
		(1.14)	(1.03)
Safe asset dummy		−0.96***	−1.41***
		(0.22)	(0.31)
Adjusted R-squared		0.773	0.782
AIC		3.340	3.305
S.E. of regression		1.233	1.210
Durbin–Watson stat		1.302	1.357
Number of countries		21	21
Number of samples		355	354

Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.
2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).
3. Specification 13 is estimated by using the logit transformation dummy variable.

portant for measuring the margin of domestic funds, but long-term interest rates seem to respond to movements in the current account that correspond to short-term flows.

Finally, we consider the effect of non-traditional monetary policy measures. Its impact, shown in Table 2, is somewhat smaller than other empirical studies. As discussed earlier on, since the preference for safe assets increased coincidently in the same period, the effect of non-traditional monetary policy measures might be somewhat underestimated with the inclusion of the two factors into the explanatory variables. We confirm this by performing an estimation that does not contain the safe asset dummy for the period after 2010. The results in Table 10 reveal that the parameters of non-traditional monetary policy measures are statistically significant and larger in size than those in Table 2. A more detailed explanatory variable, representing the preference for safe assets, will probably provide us with parameters of non-traditional monetary

Table 6 Results of Panel Regressions (Robustness Check): Time Dummy Variables

Dependent variable: Nominal long-term interest rates (10-year bonds)

Variables	Coeff.	14	15
Fiscal balance	a	−0.02	0.01
		(0.02)	(0.02)
Debt outstanding dummy (D_D) ×Fiscal balance	α		-0.14^{***}
			(0.05)
National burden ratio (deviation from all-sample average)	b	0.02	−0.03
		(0.02)	(0.03)
Current account	c	−0.03	-0.05^{**}
		(0.02)	(0.02)
Labor productivity	d	−0.04	−0.08
		(0.07)	(0.08)
Demographic factor	e	0.35^{*}	0.82^{***}
		(0.19)	(0.22)
Inflation rates	f	0.29^{***}	0.25^{***}
		(0.05)	(0.05)
Short-term interest rates	g	0.29^{***}	0.22^{***}
		(0.03)	(0.04)
Government bond-purchasing dummy ×Monetary base	h	0.04^{***}	0.05^{***}
		(0.01)	(0.01)
Constant		3.46^{***}	3.90^{***}
		(0.20)	(0.26)
European sovereign debt crisis dummy		5.95^{***}	5.71^{***}
		(0.94)	(0.88)
Safe asset dummy		−0.18	-0.29^{*}
		(0.15)	(0.17)
Adjusted R-squared		0.903	0.908
AIC		2.869	2.858
S.E. of regression		0.961	0.953
Durbin–Watson stat		1.195	1.232
Number of countries		23	23
Number of samples		539	512

Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.
2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).
3. Specification 15 is estimated by using the logit transformation dummy variable.

policy measures that are closer to the results in Table 10.

E. Decomposition of Nominal Long-term Interest Rates in Various Nations

The following are the results of factor decomposition of estimated nominal long-term interest rates in various nations based on the parameters obtained thus far. Chart 12 shows the factors of these interest rates in various countries which are decomposed based on the averages for 2012 and 2013.[10] For the peripheral countries in Europe, which experienced a debt crisis during this period, the impact of the European crisis dummy, which reflects the rush to "fire sale" and other behaviors due to market panic,

10. Chart 12 shows the decomposition of the degree of contribution when the estimation is based on logit transformation dummy variables (Specification 5 of Table 2). The estimation based on simple dummy variables generally produces the same results.

Table 7 Results of Panel Regressions (Robustness Check): Level of Net Government Debt Outstanding

Dependent variable: Nominal long-term interest rates (10-year bonds)

Variables	Coeff.	16	17
Fiscal balance	a	−0.12***	−0.11***
		(0.02)	(0.02)
Net government debt outstanding	a″	−0.00	−0.01
		(0.01)	(0.01)
Debt outstanding dummy (D_D) ×Fiscal balance	α		−0.18**
			(0.08)
National burden ratio (deviation from all-sample average)	b	0.11***	0.11***
		(0.04)	(0.04)
Current account	c	−0.06*	−0.07**
		(0.03)	(0.03)
Labor productivity	d	0.10***	0.10***
		(0.03)	(0.03)
Demographic factor	e	0.85***	0.93***
		(0.24)	(0.25)
Inflation rates	f	0.25***	0.26***
		(0.05)	(0.05)
Short-term interest rates	g	0.54***	0.52***
		(0.03)	(0.03)
Government bond-purchasing dummy ×Monetary base	h	−0.01	−0.02
		(0.02)	(0.02)
Constant		1.98***	2.08***
		(0.17)	(0.19)
European sovereign debt crisis dummy		6.26***	6.18***
		(1.18)	(1.12)
Safe asset dummy		−0.77***	−0.94***
		(0.21)	(0.22)
Adjusted R-squared		0.839	0.843
AIC		3.361	3.342
S.E. of regression		1.258	1.245
Durbin–Watson stat		1.285	1.295
Number of countries		23	23
Number of samples		517	512

Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.
2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).
3. Specification 17 is estimated by using the logit transformation dummy variable.

is significant. The fiscal balance factors also helped boost interest rates. On the other hand, we see that the preference for safe assets is the factor that is pushing down long-term interest rates in Japan, the U.S., the U.K., and Germany in a uniform manner. Added to this, in the U.S. and Japan, the upward pressure on interest rates from their fiscal balance factors was offset by the expectation for fiscal consolidation, which was represented by national burden ratios. As for Japan, in addition to the depressing effects of the declining share of working age population, its non-traditional monetary policy measures and current account surplus helped depress long-term interest rates.

The differences between the actual and estimated levels of interest rates are more or less negligible for the U.S., the U.K., and Germany. By contrast, in Japan, the actual rates are lower than the estimated rates. This implies that additional downward pres-

Table 8 Results of Panel Regressions (Robustness Check): Potential National Burden Ratio

Variables	Coeff.	18	19
		Dependent variable: Nominal long-term interest rates (10-year bonds)	
Fiscal balance	a	−0.02	0.00
		(0.04)	(0.04)
Debt outstanding dummy (D_D) ×Fiscal balance	α		−0.16**
			(0.07)
Potential national burden ratio (deviation from all-sample average)	b′	0.10**	0.10***
		(0.04)	(0.04)
Current account	c	−0.06*	−0.07**
		(0.03)	(0.03)
Labor productivity	d	0.11***	0.10***
		(0.04)	(0.04)
Demographic factor	e	0.71***	0.97***
		(0.19)	(0.25)
Inflation rates	f	0.23***	0.28***
		(0.05)	(0.05)
Short-term interest rates	g	0.55***	0.51***
		(0.03)	(0.03)
Government bond-purchasing dummy ×Monetary base	h	−0.02	−0.02*
		(0.01)	(0.01)
Constant		5.71***	5.98***
		(1.43)	(1.47)
European sovereign debt crisis dummy		6.28***	6.19***
		(1.19)	(1.13)
Safe asset dummy		−0.86***	−0.99***
		(0.21)	(0.23)
Adjusted R-squared		0.834	0.843
AIC		3.354	3.342
S.E. of regression		1.256	1.246
Durbin–Watson stat		1.273	1.302
Number of countries		23	23
Number of samples		539	512

Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.
2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).
3. Specification 19 is estimated by using the logit transformation dummy variable.

sure is placed on long-term interest rates for Japan due to other explanatory factors, which are not included in the current equation. The reasons for this may be that (i) the government bond market is responding to the notion that Japan's monetary easing measure may continue for an extended period relative to other countries, with the inflation rate being below the central bank's target and (ii) its home bias is possibly higher than other countries.

An examination of the contribution from the overall fiscal factors, including fiscal balance, the national burden ratio level, and the factors of the debt crisis, reveals that the level of such contribution in the European peripheral countries is higher than those in Japan or the United States (Chart 13). This may be attributed to the fact that the national burden ratios in Europe are already high, making it difficult for these countries to raise their national burden ratios further to increase fiscal sustainability.

Table 9 Results of Panel Regressions (Robustness Check): Level of Net Domestic Financial Asset Outstanding

Dependent variable: Nominal long-term interest rates (10-year bonds)

Variables	Coeff.	20	21
Fiscal balance	a	−0.11***	0.10***
		(0.03)	(0.03)
Debt outstanding dummy (D_D) ×Fiscal balance	α		−0.26**
			(0.12)
National burden ratio (deviation from all-sample average)	b	0.8	0.08
		(0.06)	(0.06)
Net private financial asset outstanding —Net government debt outstanding	c′	−0.01*	−0.01**
		(0.00)	(0.00)
Labor productivity	d	0.06	0.06
		(0.04)	(0.04)
Demographic factor	e	1.27***	1.44***
		(0.27)	(0.29)
Inflation rates	f	0.36***	0.39***
		(0.09)	(0.09)
Short-term interest rates	g	0.49***	0.47***
		(0.04)	(0.04)
Government bond-purchasing dummy ×Monetary base	h	−0.00	−0.02
		(0.01)	(0.01)
Constant		1.89***	1.86***
		(0.14)	(0.14)
European sovereign debt crisis dummy		6.53***	6.32***
		(1.30)	(1.22)
Safe asset dummy		−0.85***	−1.07***
		(0.22)	(0.25)
Adjusted R-squared		0.814	0.820
AIC		3.223	3.193
S.E. of regression		1.165	1.146
Durbin–Watson stat		1.471	1.508
Number of countries		21	21
Number of samples		367	367

Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.
2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).
3. Specification 21 is estimated by using the logit transformation dummy variable.

V. Conclusion

We conduct a quantitative analysis of the effects of fiscal conditions and other factors on nominal long-term interest rates based on panel data of 23 member states of the OECD for the period from 1980 to 2013. In addition to labor productivity, the demographic factor, and inflation rates, our analysis shows that the fiscal balance, national burden ratio, and current account balance (= domestic savings) influence nominal long-term interest rates. The elasticity of nominal long-term interest rates to the fiscal balance vary, depending on the levels of government debt outstanding, which are thought to affect perceptions of fiscal sustainability in the future. This implies that the elasticity of nominal long-term interest rates to the fiscal balance is non-linear depending on the levels of government debt outstanding. We also find that a low national burden ratio nurtures future expectations of fiscal consolidation and thus keeps long-term interest

Table 10 Results of Panel Regressions (Robustness Check): Non-traditional Monetary Policy Measures

Dependent variable: Nominal long-term interest rates (10-year bonds)

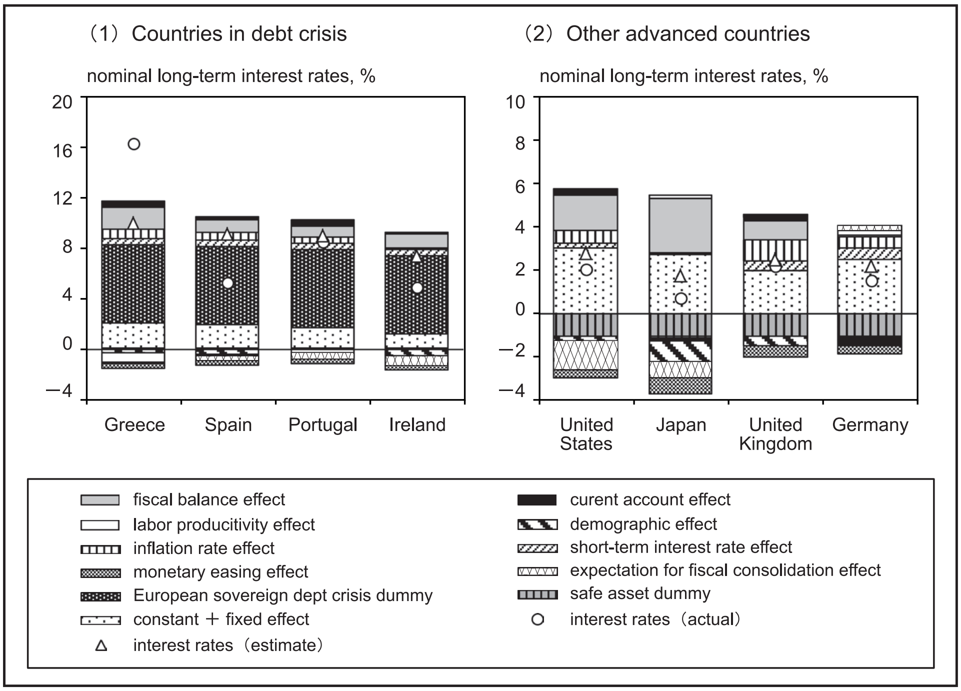
Variables	Coeff.	22	23
Fiscal balance	a	−0.11***	−0.10***
		(0.02)	(0.02)
Debt outstanding dummy (D_D) ×Fiscal balance	α		−0.14**
			(0.07)
National burden ratio (deviation from all-sample average)	b	0.09**	0.10**
		(0.04)	(0.04)
Current account	c	−0.06**	−0.08**
		(0.03)	(0.03)
Labor productivity	d	0.10***	0.10**
		(0.04)	(0.04)
Demographic factor	e	0.70***	0.92***
		(0.19)	(0.25)
Inflation rates	f	0.23***	0.27***
		(0.05)	(0.05)
Short-term interest rates	g	0.55***	0.52***
		(0.03)	(0.03)
Government bond-purchasing dummy ×Monetary base	h	−0.04***	−0.04***
		(0.01)	(0.01)
Constant		1.98***	1.97***
		(0.12)	(0.13)
European sovereign debt crisis dummy		6.55***	6.50***
		(1.19)	(1.15)
Safe asset dummy (through 2009)		−0.71***	−0.63**
		(0.26)	(0.26)
Adjusted R-squared		0.833	0.841
AIC		3.362	3.357
S.E. of regression		1.262	1.256
Durbin–Watson stat		1.273	1.296
Number of countries		23	23
Number of samples		539	512

Notes: 1. Standard errors are given in parentheses. * denotes significance at 10%; ** at 5%; *** at 1%. In order to correct for the bias brought on by the contemporaneous correlation of the error terms, we use panel-corrected standard errors.
2. Independent variables are lagged by one year, variables of monetary base, European sovereign debt crisis dummy, and safe asset dummy have no time lags, and those of current account, inflation rates, and debt outstanding dummy have almon lags (three years).
3. Specification 23 is estimated by using the logit transformation dummy variable.

rates at low levels. In addition, non-traditional monetary policy measures and the preference for safe assets in recent years are found to keep nominal long-term interest rates at low levels.

Based on these findings, we point out five reasons why nominal long-term interest rates in Japan is so low despite the fact that its government debt level is high and fiscal deficits continue to be large. First, the national burden ratio in Japan is below those of other advanced economies and therefore leaves room for future raises. This sustains the expectation for future fiscal consolidation. Second, Japan's fiscal deficits are being funded domestically thanks to the continuing presence of domestic excess savings (= the current account surplus). Third, the non-traditional monetary policy measure is depressing the term premium. Fourth, the declining share of working age population is reducing real interest rates. Fifth, under increased stress in the international financial

Chart 12 Decomposition of Nominal Long-term Interest Rates (CY2012–2013 Average)



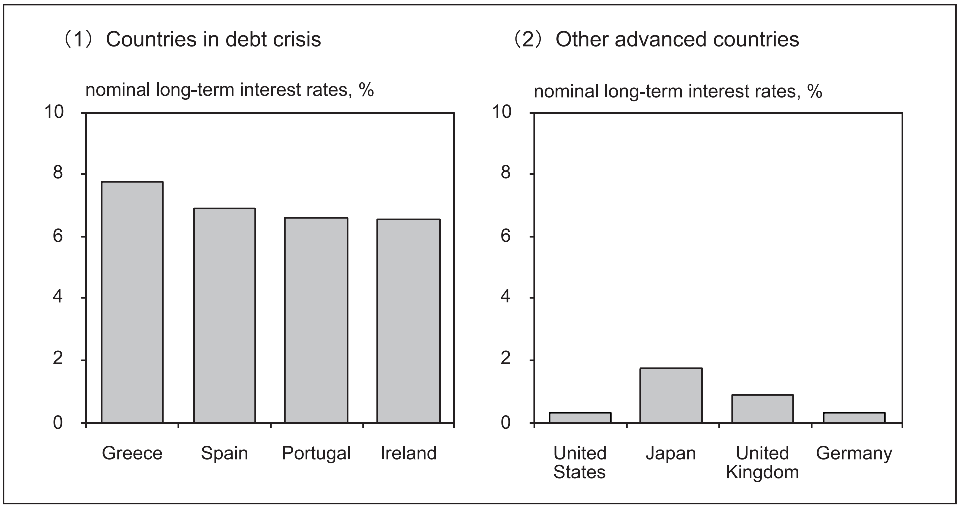
Notes: 1. This chart shows the degree of contribution when the estimation is based on logit transformation dummy variables (Specification 5 of Table 2).
2. The fiscal balance effect, expectation for fiscal consolidation effect, and monetary easing effect are explained by the terms "fiscal balance" and "debt outstanding dummy × fiscal balance," "national burden ratio," and "government bond-purchasing dummy × monetary base" respectively in Table 2.

capital markets, demand for Japanese government bonds will rise due to the preference for safe assets.

Before concluding this report, attention should be paid to the following points concerning the analysis presented above.

First, caution must be paid in handling the variables representing expectations for the future. The variables comprising nominal long-term interest rates are all those referring to future expectations, such as future real interest rates, inflation expectations, and risk premiums. For future variables, the empirical analysis here uses dummy variables conditional on the levels of government debt outstanding and the national burden ratio to indicate future fiscal sustainability, in addition to the actual values of various indicators. Added to the methods used here, there may be room for improvement regarding the variables for expressing expected future fiscal conditions. In fact, indicators directly measuring expectations or forecasts, including questionnaire surveys and financial market indicators (such as the forward rate and implied volatility indicator), have recently become available. Time-series data are becoming increasingly accessible. We attempt to secure the robustness of the analysis by including as many countries as possible and by expanding the coverage of the time-series data as much as possible

Chart 13 Impact of Overall Fiscal Factors on Nominal Long-term Interest Rates (CY2012–2013 Average)



Note: This chart shows the sum total of the fiscal balance effect, expectation for fiscal consolidation effect, and the European sovereign debt crisis dummy in Chart 12.

in this paper. This is why we do not make use of questionnaire surveys relating to expectations or financial market indicators which have become available only recently. However, in the future, if variables for future expectations can be used appropriately by adopting these indicators, it would be possible to verify the robustness of this analysis.

Second, an analysis could be expanded to use high frequency data. This study is based on annual data, because its focus is to examine the impact of fiscal conditions on nominal long-term interest rates. If the focus is also on short-term fluctuations of nominal long-term interest rates, analyses based on data which are available at greater frequency, such as quarterly, monthly, and daily data, would be necessary. In that case, even though the analyses would be based on the specifications used in this paper, along with additional explanatory variables needed to capture short-term fluctuations, more dynamic specifications of the functions would be needed.

Third, a comparison with structural models would be needed. It should be examined whether the dynamics of each variable verified in this study are consistent with the general equilibrium model explicitly incorporating expectations.

Fourth, we could analyze the causes of the decline in global long-term interest rates in recent years in more depth. Analyses on factors common to all countries, namely "global factors," are also much needed in order to capture economic movements in each country under the open economy. The Bank of Japan (2013) argues that the recent downtrend in the long-term interest rates observed in Japan, the U.S., the U.K., and Germany is affected by a common global factor. This paper demonstrates that the shifting trends in labor productivity and the demographic factor have begun to be mirrored in the decline in interest rates commonly seen among developed countries in recent years. These arguments corroborate the evidence that both the potential growth rate and natural interest rate are decreasing simultaneously in developed countries. It may also be that interest rates in Japan, the U.S., the U.K., and Germany have been falling synchronously due to the preference for safe assets under increased pressure on the international financial capital market. Thus, further analyses on these global common factors are deemed valuable.

APPENDIX: DATA SOURCES[11]

- Countries covered: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, South Korea, Luxemburg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
- Nominal long-term interest rates (10-year), short-term interest rates, current account balance (as a ratio to nominal GDP), national burden ratio (as a ratio to nominal GDP), government debt outstanding (as a ratio to nominal GDP), fiscal balance (as a ratio to nominal GDP), primary balance (as a ratio to nominal GDP), private financial asset outstanding (as a ratio to nominal GDP), inflation rates (CPI), real growth rates: the OECD's *Economic Outlook* and the IMF's *World Economic Outlook* (WEO).
- Population: The United Nations' *World Population Prospects*.
- Monetary base: (as a ratio to nominal GDP):[12] HAVER and central banks.
- Labor productivity is obtained by subtracting the rate of change in working age population from the real economic growth rate. The demographic factor is the change in the share of working age population to total population. This is obtained by subtracting the rate of change in total population from the rate of change in working age population.

11. Due to constraints in data availability, sample periods are shorter than others, and/or the latest values are used to fill in data of unavailable periods for some countries.
12. For monetary base data of some countries in the euro zone, the all-euro zone value is used instead.

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