Convenience yield on government bonds and unconventional monetary policy in Japanese corporate bond spreads

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Abstract

This paper examines the factors that contribute to credit spreads in the primary market for Japanese corporate bonds, especially when the Bank of Japan implemented unconventional monetary policy measures. The models of credit spreads based on the Treasury convenience yield hypothesis are estimated using an issue-level dataset. The results indicate that the factors to explain credit spreads changed under the unconventional monetary policy regime. Investors became less sensitive to the risk of default for issuers with different credit quality due to the unprecedented degree of monetary easing. The Japanese government's debt-to-GDP ratio, which is a measure of the convenience yield on government bonds, is an important driver of credit spreads throughout the sample period.

JEL classification numbers: E50, G12, G30

Keywords: Convenience yield, Corporate bonds, Credit spreads, Japanese government bonds, Unconventional monetary policy.

1 Introduction

Over the past two decades, the Japanese corporate bond market experienced many changes and events. Among them, the major and most unexpected event was the Fukushima Daiichi nuclear disaster at Tokyo Electric Power Co. (TEPCO)'s Fukushima Daiichi Nuclear Power Plant on March 11, 2011. It had a severe impact in Japan and rendered TEPCO, Japan's largest corporate bond issuer, unable to raise funds from the public bond market.[1] The amount of outstanding TEPCO corporate bonds was about 5 trillion yen ($ 60.9 billion) when the Great East Japan Earthquake hit Japan (The Nikkei, April 21, 2011). It is striking that the largest issuer suddenly dropped out of the primary corporate bond market in Japan. In addition, the other electric power companies, the principal issuers in Japanese corporate bond market, were downgraded due to the high uncertainty over their future costs. The Great East Japan Earthquake affected the corporate bond market in Japan not only through principal issuers dropping out, but also through (unconventional) monetary policy. In the wake of this disaster, the Bank of Japan (BOJ) had a significant task: to revive the damaged economy. The BOJ rushed to bolster markets and implemented many unconventional monetary policy measures after March 2011. The Japanese corporate bond market then experienced an unprecedented degree of monetary easing, which resulted in yields at record lows.

This study investigates the factors that contribute to the credit spread, which is the difference in yields between defaultable debt instruments and risk-free government securities of comparable maturity, in the Japanese corporate bond market. This study focuses on the period after the Great East Japan Earthquake, when the BOJ implemented unconventional monetary policy measures. There is a large body of literature explaining corporate bond spreads. For example, Puri (1996), Gande et al. (1997), Gande et al. (1999), and Puri (1999) describe the factors that determine the spreads for corporate bonds in the primary market. Moreover, papers such as Longstaff et al. (2005), Wu and Zhang (2008), Gilchrist and Zakrajšek (2012), and Faust et al. (2013) provide evidence that the underlying economic factors and individual default risk are important determinants of credit spreads in the secondary market. To account for the shock of the nuclear disaster on electric power companies, this study focuses on credit spreads for corporate bonds in the primary market.

In theory, credit spreads after the Great East Japan Earthquake should be higher due to the increasing uncertainty about future economic fundamentals and damage to domestic production.

[1] After the Fukushima nuclear disaster, it took about 6 and a half years for TEPCO to resume public corporate bond issuance on March 3, 2017, through its subsidiary TEPCO Power Grid Inc.

In fact, Kumano et al. (2014) observe negative spillover effects due to disruptions of supply chain networks and the declines in domestic production in some sectors in the period following the Great East Japan earthquake. However, this study finds that the credit spreads after this earthquake are lower on average when the credit spread model was estimated using data on individual corporate bonds issued in these 20 years.

Behind this puzzling response, the Great East Japan earthquake and unconventional monetary policy on the credit spreads had two opposing effects. First, the disruption in supply chain networks and decline in domestic production increased credit spreads, and not only in the corresponding sector. The increasing uncertainty about future economic fundamentals had a negative impact on credit risk. This effect could increase the credit spreads. On the other hand, soon after this earthquake, the BOJ expanded its asset buying scheme and maintained a massive stimulus program to support the damaged economy. This monetary stimulus lowered not only the interest for Japanese government bonds (JGB), but also the credit spreads. During the sample period after this earthquake, the BOJ employed many unconventional monetary policy measures, which were influential and had affected the corporate bond market (see Kuroda (2016) for a detailed description of the policy measures).

Using an issue-level dataset, this study undertakes a detailed analysis to explain the credit spread in the Japanese corporate bond market. In explaining the credit spread, Krishnamurthy and Vissing-Jorgensen (2012) provide interesting theoretical implications and show empirical evidence that an increase in the Treasury supply lowers credit spreads using U.S. annual data, referring to the value that investors assign to the liquidity and safety attributes of Treasuries as the Treasury convenience yield. However, prior studies largely ignore this Treasury convenience yield as a factor of credit spreads in firm- or issue-level analyses. In this study, the issue-level dataset allows us to integrate the convenience yield on government bonds, which is an aggregate factor with issue-level characteristics, by controlling for the financial health of the issuer, issue characteristics, and bookrunner characteristics, which explain the remaining variations in credit spreads that aggregate data cannot potentially explain. Following Krishnamurthy and Vissing-Jorgensen (2012), we assume that three factors determine credit spreads: expected default on the corporate bond, a risk premium associated with the covariance between default and the pricing kernel, and the convenience yield on government bonds. Although prior studies document a relationship between Treasury supply and interest rate spreads; for example, swap spreads in Cortes (2003) and spread

between Refcorp bonds and Treasury bonds in Longstaff (2004). However, this study is the first to document the significant and important relationship wherein the increase in the stock of government bonds lowers credit spreads in an issue-level analysis. In addition, the results suggest that the BOJ's unconventional monetary policy significantly lowered credit spreads for all rating classes, and investors became less sensitive to individual issuers' credit risk.

We illustrate the robustness of the findings by considering the truncated nature in our sample. The OLS estimations are likely to be biased due to the truncated nature of the sample because we observe only those firms that actually issued corporate bonds and lack information on firms that wanted raise funds, but had to give up, such as electric companies, even those with investment-grade credit ratings. We account for this problem and estimate a sample selection model as a robustness check. The results are qualitatively similar to the main results. This paper proceeds as follows. Section 2 briefly discusses the background of Japan's corporate bond market. Section 3 describes the data used to estimate the models. Section 4 details the variables and estimation methodology, and Section 5 presents estimation results. We present concluding remarks in Section 6.

2 Background

At $ 11 trillion, the Japanese bond market is the second largest in the world behind the United States at $ 37 trillion as of Q4 2015, according to the Bank for International Settlements (BIS). The bond market was largely dominated by government bonds due to its size and liquidity. All bonds issued in the Japanese corporate bond market are investment-grade,[2] and defaults on corporate bonds are rare. Thus, the Japanese corporate bond market is considered non-volatile and provides issuers with long-term funding.

In the past 20 years, the 2008 global financial crisis and the 2011 Great East Japan earthquake were major economic events striking both the Japanese corporate bonds market and Japan's economy. In 2008, the Japanese straight corporate bond market experienced its first straight corporate bond default in seven years during this period of credit market turmoil. During 2008-2010, eleven cases of straight corporate bond defaults caused a sharp increase in credit spreads in the secondary

[2]Although there are speculative grade (below investment-grade) corporate bonds in the secondary market, they were originally issued with ratings in the investment-grade category, but the credit rating was downgraded and the possibility of default increased markedly.

market. Then, the BOJ's efforts to support market liquidity and its policy-based financing to facilitate corporate financing calmed the market turmoil.

The recent financial crisis also influenced the primary market for Japanese corporate bonds, where the amount issued during 2008 decreased by about 4% to about 8.8 trillion yen, and the number of issues decreased by 26.9%, according to the Japan Securities Dealers Association. However, the financial crisis was triggered not by an endogenous shock but by an exogenous shock stemming from the collapse of the housing and securitization markets in the U.S. The amounts issued in 2009 increased to 11.4 trillion yen, which was even higher than before the financial crisis.

The events following the Fukushima Daiichi nuclear disaster at Tokyo Electric Power Co.'s (TEPCO) Fukushima Daiichi Nuclear Power Plant on March 11, 2011 had a severe impact on the Japanese economy. In the aftermath of this tragic event, authorities decided to conduct policies for economic and financial stability from dimensional channels, including an international intervention in exchange rate markets (see Neely (2011)). This event had a dramatic impact on the Japanese corporate bond market because TEPCO was Japan's largest corporate bond issuer, with about 5 trillion yen ($ 60.9 billion) of outstanding corporate bonds when the disaster occurred (The Nikkei, April 21, 2011). The credit spreads for outstanding TEPCO corporate bonds jumped to about 400-500 basis points after the earthquake and tsunami, from just 8 basis points before the disaster.[3] Due to this disaster, TEPCO was unable to raise funds from the public offered bond market for about six and a half years. Moreover, rating institutions downgraded other Japanese electric power companies as well, which were principal issuers in the corporate bond market due to greater regulatory uncertainty and lower profitability and cash flows. The first corporate bond issued by an electric power company after the nuclear disaster was in June 2011 by Okinawa Electric Power Company, the only one of the ten electric power companies with no nuclear power plant, and this issue was relatively small. It took more than a year for other electric power companies to issue a corporate bond after the nuclear disaster event due to the greater uncertainty relating to nuclear power plants.

In contrast with movements in the credit spreads in the secondary market, credit spreads in the primary market were back to its level before the nuclear disaster event within a few months, as the business environment, particularly supply chains, was recovering. Moreover, the BOJ faced a task of outstanding significance in reviving the damaged economy. It rushed to bolster markets in the

[3]Uranaka, T. (2011, May 2, Japan says no limits to Tepco liability from nuclear disaster *Reuters*)

wake of this disaster.

[Figure 1 around here]

As Figure 1 shows, the BOJ's JGB holdings dramatically increased after the Great East Japan earthquake, reaching 30% of JGB outstanding amounts. This caused a decline in interest rates across the yield curve of JGBs, and their yields dropped to record lows. This implies that the BOJ's massive purchases of JGBs could affect the corporate bond spreads in the primary market through a parallel shift down in the yield curve, which appears to help firms raise funds by decreasing the cost of funding; however, investors do not find that the record low credit spreads compensate for their credit risk compared to some risk-free interest rates, such as banks' reserves at the central bank, which have a positive 0.1 % rate as of November 2015.

One characteristic of the JGB market is its rather low interest rate, although Japan has a very high debt to GDP ratio. Large budget deficits and outstanding JGBs since the 2008 global financial crisis were followed by the 2011 Great East Japan earthquake downgrade of Japan's credit rating. Outstanding government bonds and borrowings increased to 1,049.4 trillion yen by the end of March 2016. Considering the size of the country's deficit and borrowing level, JGB interest rate levels seems puzzling. One possible explanation for this relationship is that JGBs are held mostly by citizens of Japan (about 90%). While the puzzling relationship between the low JGB yield and high debt to GDP ratio is interesting, this study focuses on the relationship with the stock of JGBs and corporate bond spreads, which we examine empirically in the following sections.

3 Data

This study focuses on exploring the convenience yield on government bonds as well as other factors contributing to credit spreads in the Japanese corporate bond market, in particular when the BOJ expanded its monetary easing. To analyze this question, we constructed a new dataset from data on individual corporate bond issues, issuers' financial data, data on the bookrunner market, and business cycle and macroeconomic data.

We collected data on straight corporate bonds issued publicly by individual corporations from January 1, 1995 until November 30, 2015 from the Thomson One Investment Banking database. This dataset includes credit spreads (spread over JGBs with the same maturity), issue amounts,

the maturity of the issue, mortgages associated with the issue, the bookrunners' names, the number of the issue, and ratings information. We collected details of any mortgages and guarantees associated with the issue collected from the Nikkei newspaper dataset, Nikkei Telecom 21. We gathered information on the bookrunner's type from Nikkei Telecom 21 and the websites of each bookrunner. We calculated the market share of each bookrunner from their annual league tables in the Thomson One Investment Banking database. To maximize the sample size, we used the lowest of the available ratings provided by four ratings institutions, Rating and Investment Information, the Japan Credit Rating Agency, the Japan Bond Rating Institute, and Standard and Poors. We proxied the monthly market size by the total value of new issues of straight corporate bonds in its issuing month based on data obtained from the Japan Securities Dealers Association.

We collected issuers' financial data from the Nikkei NEEDS Corporate Financial Data and *Japanese Company Handbook* quarterly published by Toyo Keizai. We matched issuers' financial data in the accounting year immediately prior to each bond issue with the corporate bond issue dataset. Financial data such as ROE, revenue, and the total debt to total capital ratio for the latest fiscal year, is not available for unlisted companies.

We gathered the monthly data on the business cycle such as corporate goods price index (CGPI), consumer price index (CPI), and index of industrial production (IIP), from the BOJ's website, the Ministry of Economy, Trade and Industry, the Ministry of Internal Affairs and Communications, and Nikkei NEEDS Macro Data. Data on the balance of JGBs held by the BOJ is available at a monthly frequency from January 1996, and quarterly data on the Japanese government's debt-to-GDP ratio (general gross government debt % of gross domestic product) is available for the whole sample period. We collected these data from Thomson Reuters Datastream.

Tables 1 and 2 report the mean values of various bond characteristics. Although this dataset includes only nineteen issuers of general mortgage corporate bonds,[4] Table 1 shows that 13.19% of all issues are general mortgage bonds because electric power companies were among these nineteen issuers. The dataset also contains bonds secured by the issuer's pledge of a specific asset under the Secured Bonds Trust Act, referred to as *Collateral*. Issues of this type of corporate bond is concentrated at the beginning of the sample period. Columns 2 and 3 show that the credit spreads after the Great East Japan earthquake are significantly lower.

[4]A general mortgage corporate bond is a type of secured corporate bond issued by companies founded under the Special Acts, and is naturally backed by all of the issuer's property.

The mean value of issue size is smaller after March 11, 2011. While the lower credit spread after March 11, 2011 means lower fund raising costs, the issue size shrank. This suggests that issuers having raised the larger size of the issue, such as electric companies, do not raise a large sum each time, as was the case before the nuclear disaster. The ratio of issues underwritten by bank subsidiary securities companies after the disaster is about 1.5 times more than before the disaster. The ratio of corporate bonds underwritten by foreign bookrunners after the disaster is about half of the value before the disaster. This implies that mergers and acquisitions by Japanese securities companies during this decade overwhelmed foreign bookrunners' market share.

Table 2 shows that the credit spread after March 11, 2011 is lower across all rating classes than before this date. The mean *Maturity* in Table 1 does not show the significant difference between before and after March 11, 2011. On the other hand, the mean *Maturity* for A and BBB rating classes is larger after March 11, 2011, and is larger for the higher rating classes throughout the sample period. Among the three indices for issuer's financial health, the mean ROE increased after March 11, 2011 across the rating classes. In particular, the ROE for the BBB rating class is about double what it was before. This suggests an improvement in the issuer's profitability. Bank subsidiary bookrunners' market share increased in all rating classes, as the bank subsidiary securities companies continued to grow after their entry to the bond underwriting market in 1993. In contrast, the share of foreign bookrunners decreased notably in the A and BBB rating classes. The results based on cross-sectional means are simple comparisons that ignore the impact of all other variables that differ between groups. However, these results suggest that we should consider the possibility of changes in the corporate bond market caused by the Great East Japan earthquake and unconventional monetary policy.

4 Estimation methodology

In this section, we estimate models to identify factors that help explain credit spreads. Following Krishnamurthy and Vissing-Jorgensen (2012), we assume three factors determining credit spreads: expected default on corporate bonds, risk premium associated with the covariance between default and the pricing kernel, and the convenience yield on Treasuries. The convenience yield in their model is novel in that it incorporates a factor in which agents derive utility directly from holding a convenience asset, which affects the corporate bond spreads.

Under their convenience yield hypothesis, the representative agent maximizes $E\sum_{t=1}^{\infty}\beta^t u(C_t)$, where C_t is the sum of an endowment of c_t plus 'convenience' benefits $\nu(\cdot)$

$$C_t = c_t + \nu(\theta_t^A, \text{GDP}_t;\ \xi_t).$$

The benefits are a function of the real holdings of convenience assets, θ_t^A, which captures the idea that holding more government bonds reduces the costs that would otherwise be incurred by transacting in a less liquid security like corporate bonds. The agent's real holdings of convenience assets θ_t^A include both government bonds, θ_t^T, and any other private sector assets, θ_t^P which provide services similar to government bonds: $\theta_t^A = \theta_t^T + k^P\theta_t^P$. The constant k^P is denoted as a measure of the convenience services provided by the private-sector assets relative to treasuries. The term ξ_t in the convenience function is a preference shock that affects how much utility is derived from convenience assets such as a flight-to-quality during a financial crisis. The convenience function is homogeneous of degree one in GDP_t and θ_t^A, so the liquidity benefits double if both income and convenience assets double,

$$v\left(\frac{\theta_t^A}{\text{GDP}_t};\ \xi_t\right)\text{GDP}_t \equiv \nu(\theta_t^A,\ \text{GDP}_t;\ \xi_t).$$

Then, we assume that the convenience function is increasing in θ_t^A/GDP_t, but the marginal convenience benefit is decreasing in θ_t^A/GDP_t, and has the property $\lim_{\theta_t^A/\text{GDP}_t\to\infty}\nu'(\theta_t^A/\text{GDP}_t;\ \xi_t) = 0$.

Krishnamurthy and Vissing-Jorgensen (2012) consider that the benefits of government bonds are their liquidity and safety attributes. The definition of the yield spread between τ-period corporate and government bonds is:[5]

$$S_{t,\tau} = \sum_{j=t}^{t+\tau-1}\frac{1}{\tau}E_t[v'(\theta_j^A/\text{GDP}_j;\ \xi_j)] + \sum_{j=t}^{t+\tau-1}\frac{1}{\tau}E_t[\lambda_j D_j] - \sum_{j=t}^{t+\tau-1}\frac{1}{\tau}Cov_t(m_{j+1},\ R_{j+1}), \quad (1)$$

where $m_{j+1} = \log M_{j+1}(= \log\beta[u'(C_{j+1})/u'(C_j)](Q_j/Q_{j+1}))$ is the log pricing kernel and R_{j+1} is the one-period excess return of corporate bonds over government bonds.

Although Krishnamurthy and Vissing-Jorgensen (2012) use annual data to test their theoretical model, we examine the convenience yield theory using issue-level data to further explain the remaining variation in corporate bond credit spreads that can be attributed to the financial health of the issuer and issue-specific characteristics.

[5] Appendix A of Krishnamurthy and Vissing-Jorgensen (2012) provides the derivation of this spread expression.

The empirical analysis in this study starts with the baseline specification for corporate bond spreads, which follows Duffie and Singleton (1999) closely, to reflect the probability that the corporate bond may default,

$$P_t^C = [\lambda_t(1 - D_t) + (1 - \lambda_t)]E_t[M_{t+1}P_{t+1}^C] \approx e^{-\lambda_t D_t}E_t[M_{t+1}P_{t+1}^C]. \tag{2}$$

The price for the multi-period bond, P_t^C, is a function of the probability that the corporate bond may default, λ_t.

The set of explanatory variables in the baseline model includes the financial health of the issuer, characteristics of the issue, proxies for business cycle, and bookrunner characteristics. The basic estimated equation for the whole sample period is of the following form:

$$\begin{aligned} CS_{ij} =& \alpha_i + \beta_1 \textbf{Financial health of the issuer}_{ij} + \beta_2 \textbf{Issue characteristics}_{ij} \\ &+ \beta_3 \textbf{Business cycle}_j + \beta_4 \textbf{Bookrunner characteristics}_{ij} + \epsilon_{ij} \end{aligned} \tag{3}$$

where CS_{ij} is the credit spread for issue j by firm i, β_i is a vector of parameters, and ϵ_{ij} is an error term. Based on the literature on credit spreads, the first vector of variables, **Financial health of the issuer**, are the following: the AAA (AA and A) rating is a 0-1 dummy variable taking the value of unity if the issuing firm's rating is AAA+, AAA, or AAA- (AA+, AA or AA-, and A+, A or A-), and zero otherwise. The rating variables AAA (AA and A) relate to the issuer's financial condition.[6] Previous studies suggest that stronger financial conditions for the issuing firm will reduce the probability of default λ; that is, the credit spread is lower. Compared with a base rating of BBB, AAA ratings (AA and A ratings) indicate an improvement in the firm's financial condition and we can expect this to decrease the credit spread.

The second vector, **Issue characteristics**, includes variables to control for the characteristics of issues: LOG(AMOUNT) is the log of the individual bond issue size; MATURITY is the duration to maturity in years; COLLATERAL is a 0-1 dummy variable taking the value of unity if the bond is secured by the issuer's pledge of a specific asset under the Secured Bonds Trust Act (Act No. 52 of 1905), and zero otherwise; GENERAL MORTGAGE BOND is a 0-1 dummy variable taking the value of unity if the bond is a general mortgage bond, and zero otherwise; GUARANTEED (HIGHER RATING) is a 0-1 dummy variable taking the value of unity if the principal and interest of bond is guaranteed by the company for which the rating is higher than that for the issuing

[6]We use no other variable for the issuer's financial condition as a variable in the baseline model to maximize the sample size because this dataset includes many unlisted companies, for which financial data is not available.

company,[7] and zero otherwise; GUARANTEED (SUBSIDIARY) is a 0-1 dummy variable taking the value of unity if the principal and interest of the bond is guaranteed by the issuer's subsidiary,[8] and zero otherwise.

The variable LOG(AMOUNT) relates to the issuer's repayment ability, as a larger sized bond issue requires a future cash flow or level of tangible assets high enough to pay the debt back, so we expect that increases in LOG(AMOUNT) will decrease the credit spread. Additionally, we include MATURITY, COLLATERAL, GENERAL MORTGAGE BOND, GUARANTEED (HIGHER RATING), and GUARANTEED (SUBSIDIARY) to reflect the non-pricing terms of each bond issue. As the term to maturity increases, the investor is concerned more about future economic situation. We would expect a higher credit spread for bonds with a long-term maturity due to the risk associated with time. Secured or guaranteed bonds can be seen as less risky than unsecured bonds are, since bondholders will be compensated for their investment in the event of default before any unsecured bonds are repaid. Therefore, we would expect a lower credit spread for any secured and guaranteed bonds.

The third vector, **Business cycle**, contains a set of macroeconomic variables to control for the differences in economic activity through the sample period: LOG(SIZE) is the log of the market size for straight corporate bonds; ΔCPI is the growth rate of the CPI (2010 base, YoY); ΔIIP is the growth rate of the IIP (2010 base, YoY); ΔCGPI is the growth rate of the CGPI (2010 base, YoY). Stock and Watson (2003) provide an excellent survey showing that asset prices such as corporate bond spreads are forward-looking and reflect the business cycle. These variables control for changes in market conditions and business cycle fluctuations. When the corporate bond market size expands, investors are likely to expect a higher return in the growing market, and we would expect a higher credit spread. Improvement in business activity is likely to boost investor confidence and reduce the risk of corporate defaults, so the higher growth rate of the index of industrial production would lower the credit spread (Athanassakos and Carayannopoulos (2001)).

The fourth vector, **Bookrunner characteristics**, contains variables for the bookrunner of each

[7] In this case, the rating for the bond is higher than that for the issuing company. For example, Yasuda Fire and Marine Insurance, which has a AAA rating, guaranteed the corporate bond issued by Topy Industries, Limited, whose rating was BBB; then, the rating for this corporate bond was AAA. It was reported that for Topy Industries, Limited, the fund raising costs, including the guarantee charge and commission, were lower by more than 0.8% compared to the case without a guarantee (Nikkei Financial Daily, April 23, 1998).

[8] In this case, the subsidiary operational company with more stable cash flow guarantees the bonds issued by its holding company.

bond issue: BOOKRUNNER'S MARKET SHARE is the bookrunner's market share in the year immediately prior to the issuing year, FOREIGN BOOKRUNNER is a 0-1 dummy variable taking the value of unity if the bookrunner is foreign, and BANK SUBSIDIARY is a 0-1 dummy variable taking the value of unity if the bookrunner is a bank subsidiary securities company. We use the bookrunner's market share as a proxy for its ability following previous studies (Carter and Manaster, 1990, Krigman et al., 2001), and given that many studies such as Beatty and Ritter (1986) and Carter (1992) show that the reputation effect would help lower fund raising costs. Thus, we expect a lower spread for a bond issue underwritten by a bookrunner with a large market share. The Financial System Reform Act in 1993 allowed banks to enter the underwriting market through a securities firm subsidiary BANK SUBSIDIARY. Based on the strong firm-bank relationship in the Japanese financial system, (see, e.g., Weinstein and Yafeh (1998) and Aoki and Patrick (1995)), it is possible that the certification effect will exist. With the bank's superior information, the certification effect should lower the credit spreads of the issue whose bookrunner is the bank subsidiary securities company.[9] We expect that foreign bookrunners will have long experience in overseas markets and a network, and its reputation is also likely to lower the credit spread, as Lopes and Spiegel (2014) suggest.

In addition to the baseline model, we include dummy variables for financial crisis and nuclear disaster in the model to capture a flight-to-quality shock, ξ in equation (1). LEHMAN COLLAPSE is a 0-1 dummy variable taking the value of unity if the bond is issued after the Lehman Brothers bankruptcy (September 15, 2008) and before April 1, 2009,[10] and zero otherwise; and NUCLEAR DISASTER is a 0-1 dummy variable taking the value of unity if the bond is issued after March 11, 2011, and zero otherwise. The collapse of Lehman Brothers made investors more sensitive to risk and require a higher risk premium. We expect that the Lehman Brothers bankruptcy would cause an increase in credit spreads. We discuss the effects of the nuclear disaster in Section 2.

Then, we include the key variable, LOG(DEBT/GDP) in the estimation model to test the convenience yield hypothesis. The term θ^A/GDP in equation (1) includes both government bond debt and private-sector convenience assets. Krishnamurthy and Vissing-Jorgensen (2012) point out that the maturity structure of government debt is likely to be endogenous, because both the

[9] Although the examination for the certification effect and underwriter choice is not the focus of this study, Takaoka and McKenzie (2006) use Japanese data to test the endogeneity of a BANK SUBSIDIARY underwriter and show the null hypothesis that BANK SUBSIDIARY is exogenous cannot be rejected.

[10] The end point of the Lehman collapse dummy is when the IIP increased in Japan for the first time after the Lehman collapse. While we tested different end points, the estimation results are essentially the same.

private sector and the issuance of government bonds actively manages the maturity structure of debt. To avoid any endogeneity issues stemming from debt financing behavior, we use the government debt-to-GDP ratio as an instrument for θ_t^T/GDP_t following their estimation strategy of using the instrumental variables (IV) regressions. The theoretical implication in Krishnamurthy and Vissing-Jorgensen (2012) is that the increase in the sock of government bonds will decrease the difference between the corporate and government bond yields; that is, the credit spreads will be lower and we expect a negative sign.

As an additional test to account for the stock of government bonds available to investors and monetary policy stance, we include the balance of government bonds held by the BOJ as a stock of JGB, the JGB HOLDING RATIO, in the regressions. As the amount of JGB available to investors decreases, investors may be willing to pay more of a premium to hold the scarcer remaining JGB. Through a Treasury buyback program in U.S., Longstaff (2004) shows strong empirical support for the hypothesis that the premium reflects the relative importance of Treasuries as a safe haven for investors as the supply of Treasury bonds available to investors decreases. The correlation between the LOG(DEBT/GDP) and JGB HOLDING RATIO is so high (0.91) after March 11, 2011, that we estimate the LOG(DEBT/GDP) and JGB HOLDING RATIO separately. To void any endogeneity issues stemming from managing the maturity structure of debt and government behavior, we use the log of the balance of government bonds held by the BOJ (hundred millions of yen) and quarterly dummies as instrumental variables for the JGB HOLDING RATIO.

5 Estimation Results

We estimated equation (3) using a firm fixed effects model. The Hausman statistic for the specification test to determine the preferred specification of the common effects model indicates that the fixed effects model is the preferred specification for this dataset. Table 3 shows the estimated coefficients and their t-ratios computed with the robust covariance matrix correction for the variables in equation (3). The first column reports estimates for the baseline specification. The base rating group for the issuer's financial health is the BBB rating and each estimated coefficient for the rating dummies are negative, as expected, and the estimated coefficient is larger in absolute value as the rating improves. All three coefficients are significant, indicating that a worsening of the issuer's ratings makes investors seek a higher return. The credit spread for a large issue

size bond is significantly lower, which is consistent with the expectation. The sign of the coefficient on MATURITY is consistent with the expectation, but not significant. The credit spread for general mortgage bonds is not significantly lower. Among the secured and guaranteed bonds, the credit spread for bonds secured by the issuer's pledge of a specific asset is significant.[11] The estimated coefficients for the variables to capture the effect of the business cycle on credit spreads are significant and consistent with expectations.

The specification in the second column adds the bookrunner's characteristics. For a proxy of bookrunner's ability, the positive coefficient on bookrunner's market share is consistent with the reputation effect that reputable bookrunners provide more accurate information to maintain their reputations; rational investors who understand this incentive buys corporate bonds underwritten by a reputable bookrunner with lower returns. The significantly lower spread for bonds underwritten by foreign bookrunners reflects their reputation of having long experience in overseas markets and a network. The certification effect measured by BANK SUBSIDIARY is not significant.

Next, the third column includes dummies for the Lehman collapse and the nuclear disaster events. The theoretical implication for the unexpected disaster is that a flight-to-quality shock would increase credit spreads because investors want to decrease their portfolio exposure to credit risk. The effect of the Lehman collapse is significantly positive, but the credit spread is significantly lower after the nuclear disaster event. The sign of the estimated coefficient for the Lehman collapse is consistent with the theoretical implication, but that for the nuclear disaster is not. Behind this phenomenon, the period for the nuclear disaster (after March 11, 2011 to the endpoint of sample period)[12] may be too long to capture the temporary flight-to-quality shock, but this result implies the possibility of a structural change after March 11, 2011, and we thus divide and examine the sample separately.

Table 4 shows the results of testing the convenience yield hypothesis in the OLS and IV specifications using all observations. Due to data availability, we dropped bonds issued in 1995 from the sample, resulting in no variation in COLLATERAL. Columns 1-4 show that the sign of the log of debt-to-GDP ratio is significantly negative. The estimated coefficients on the remaining variables are similar to those in Table 3. We also see a convenience yield on government bonds in Japan,

[11] The rating for the guaranteed bond is already upgraded to that of the guarantor. While the estimated coefficient for the secured bond is significantly negative, a comparison of other guarantee or general mortgage types is difficult due to the small sample size (only five secured bonds).

[12] The unconventional monetary easing expanded since the nuclear disaster, so the endpoint of this dummy variable is set to the endpoint of the sample period.

even after controlling for the financial health of the issuer, issue characteristics, and bookrunner characteristics. This result seems robust across the estimation methods (OLS and IV).

In order to explore whether the convenience yield has differential effects on issues with different credit quality, we divided the observations in this dataset into three groups: those with high ratings (AAA and AA), those with an upper-medium rating (A), and those with a lower-medium rating (BBB). For these three groups, the estimated models for credit spreads include three variables to control for the financial condition of the issuer within the same rating class: debt to capital ratio, log of sales amounts, and ROE. While we exclude unlisted companies who do not have financial data available, Table 5 shows that the convenience yield is significant in all rating classes, and its effect differs among rating classes. There is a big gap between the BBB rating class and the other rating classes, which is consistent with the effect of the safety attribute of government bonds in Krishnamurthy and Vissing-Jorgensen (2012), in which the effect is larger for spreads in the lower rating class.

Then, we divide the observations into two groups: those issued before and after March 11, 2011. Table 6 shows the results. We see the convenience yield on government bonds in both sample periods. While the estimated coefficients on the rating variables and business cycle are not significant at the 5% level in the latter sample group, the estimated coefficient on the convenience yield, log(debt/GDP), is significant and its size is much larger. As in Section 2 and Figure 1, the biggest event in both the corporate and government bond markets during this period is the unprecedented degree of monetary easing. Due to the BOJ's monetary stimulus program aiming to bolster markets quickly in the wake of the Great East Japan earthquake, the BOJ's balance of JGB dramatically increased after the earthquake, reaching 30% of JGB outstanding amounts. Although the decrease in the amount of government bonds available to investors might increase the premium by reflecting the relative importance of JGBs as a safe haven for investors, the BOJ's unprecedented monetary easing operation decreased many interest rates significantly, and the variable JGB HOLDING RATIO can measure the different effect under the unconventional monetary policy regime.

Table 7 shows the results for three different sample periods: full sample, before March 11, 2011, and thereafter. The correlation between LOG(DEBT/GDP) and JGB HOLDING RATIO is so high (0.91) after March 11, 2011 that we estimated them separately. Their correlation coefficients for the full sample and before March 11, 2011 are -0.05 and -0.76, respectively. The

convenience yield remains significant across sample periods, even after controlling the stock of JGB held by the BOJ. The signs of the estimated coefficients on the JGB HOLDING RATIO are the opposite in the periods before and after March 11, 2011. Its positive coefficient in the period before March 11, 2011 suggests that the higher credit spread reflects the premium investors are willing to pay to hold the scarcer remaining government bonds. On the other hand, assuming this variable as a proxy for the unconventional monetary policy stance after March 11, 2011, the negative coefficient indicates that the BOJ's unprecedented monetary easing was so potent that it decreased corporate bond spreads as the degree of monetary easing expanded.

We also divide the observations after March 11, 2011 into three groups by rating class, as in Table 5, to examine the differing effects of the JGB HOLDING RATIO, which is a proxy for the monetary policy stance. Table 8 gives the results for these three groups. The estimated models include variables to control for the financial condition of the issuer within the same rating class, as in Table 5. The results indicate that the credit spreads for BBB-rated corporate bonds decreased markedly. Monetary easing through the BOJ's massive purchases of JGBs affected corporate bond spreads for all issues, in particular those issued in the lower rating class.

To check the robustness of the results, we estimated the credit spread models after March 11, 2011 with a sample selection model with incidental truncation. The unprecedented degree of monetary easing by the BOJ lowered the interest rates yield curves of JGB and corporate bonds. The extremely low interest rates appear to help firms raise funds by decreasing the cost of funding; however, investors do not find the credit spreads at record lows reflect the compensation they receive for bearing credit risk compared to some risk-free interest rates, such as banks' reserves at the BOJ, that had a positive rate of 0.1 % as of November 2015. In fact, the total amount of corporate bonds issued in 2015 decreased by 18%. It was reported that the credit spreads at record lows increase the risk of being unsold, and some firms gave up plans to issue corporate bonds. The estimations are likely to be biased due to the truncated nature of the sample. We observe only those firms that actually issued corporate bonds, and have not information about firms that wanted to raise funds but had to give up. As a robustness check, we estimate a sample selection model

with incidental truncation (Bloom and Killingsworth (1985)):

$$\begin{aligned} CS &= \beta' x + \epsilon, \\ z^* &= \alpha' w + u, \\ z &= 1 \; if \; z^* > 0, \; z = 0 \; if \; z^* \leq 0, \\ \epsilon, u \; &\sim, N[0, 0, \sigma_\epsilon^2, 1, \rho], \end{aligned} \tag{4}$$

where CS is the credit spread, z^* is a latent variable, and the dependent variable and explanatory variables are observed iff $z^* > 0$. A probit model applies to z. We obtain observations on credit spreads and factors that influence the credit spread level and z^* only when z equals one, but the model is identified as long as ρ is nonzero, and can be estimated by maximum likelihood. The second and fourth columns in Table 9 indicate that the results for the convenience yield and the JGB HOLDING RATIO are qualitatively similar to the main results. Therefore, the findings are not driven by the incidental truncation.

6 Conclusion

This study investigates the factors that contribute to credit spreads in the primary market for Japanese corporate bonds and how these factors changed when the BOJ implemented various unconventional monetary policy measures empirically. In addition, the model incorporates the convenience yield on government bonds, which existing literature largely ignores, especially in firm- and issue-level analyses. Previous studies examining the premium in Treasury bonds or the Treasury convenience yield focus on the aggregate behavior of yield spreads such as credit spreads. However, credit spreads vary with firm- or issue-specific characteristics. The issue-level analysis in this study allowed us to integrate the convenience yield on government bonds with the firm- and issue-specific characteristics that can explain the remaining variations in the credit spreads. The results show that the convenience yield on government bonds, as well as firm- and issue-specific characteristics, are significant factors explaining credit spreads.

Furthermore, the estimation results suggest that the factors explaining the credit spreads changed under the unconventional monetary policy regime. For instance, the variables to measure the business cycle were significant and consistent with the predictions, but became insignificant. Additionally, credit ratings have little explanatory power for the credit spreads under the unconventional monetary policy regime. Investors became less sensitive to the risk of default that issuers with

different credit quality have, partly due to the unprecedented degree of monetary easing. Meanwhile, the Japanese government's debt-to-GDP ratio, which is a measure of the convenience yield on government bonds, is significant throughout the sample period and a driver of credit spreads in Japan.

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References

Aoki, M. and H. T. Patrick (1995). *The Japanese Main Bank System: Its Relevance for Developing and Transforming Economies*. Oxford: Oxford University Press.

Athanassakos, G. and P. Carayannopoulos (2001). An empirical analysis of the relationship of bond yield spreads and macro-economic factors. *Applied Financial Economics 11*(2), 197–207.

Beatty, R. P. and J. R. Ritter (1986). Investment banking, reputation and the underpricing of initial public offerings. *Journal of Financial Economics 15*, 213–232.

Bloom, D. E. and M. R. Killingsworth (1985). Correcting for truncation bias caused by a latent truncation variable. *Journal of Econometrics 27*(1), 131–135.

Carter, R. B. (1992). Underwriter reputation and repetitive public offerings. *Journal of Financial Research 15*, 341–354.

Carter, R. B. and S. Manaster (1990). Initial public offerings and underwriter reputation. *Journal of Finance 45*, 1045–1067.

Cortes, F. (2003). Understanding and modelling swap spreads. *Bank of England Quarterly Bulletin Winter*, 407–416.

Duffie, D. and K. J. Singleton (1999). Modeling term structures of defaultable bonds. *Review of Financial Studies 12*(4), 687–720.

Faust, J., S. Gilchrist, J. H. Wright, and E. Zakrajšek (2013). Credit spreads as predictors of

real-time economic activity: A Bayesian model-averaging approach. *Review of Economics and Statistics 95*(5), 1501–1519.

Gande, A., M. Puri, and A. Saunders (1999). Bank entry, competition, and the market for corporate securities underwriting. *Journal of Financial Economics 54*(2), 165–195.

Gande, A., M. Puri, A. Saunders, and I. Walter (1997). Bank underwriting of debt securities: Modern evidence. *Review of Financial Studies 10*(4), 1175–1202.

Gilchrist, S. and E. Zakrajšek (2012). Credit spreads and business cycle fluctuations. *American Economic Review 102*(4), 1692–1720.

Krigman, L., W. H. Shaw, and K. L. Womack (2001). Why do firms switch underwriters? *Journal of Financial Economics 60*, 245–284.

Krishnamurthy, A. and A. Vissing-Jorgensen (2012). The aggregate demand for treasury debt. *Journal of Political Economy 120*(2), 233–267.

Kumano, Y., I. Muto, and A. Nakano (2014). What explains the recent fluctuations in Japan's output? A structural factor analysis of Japan's industrial production. *Journal of The Japanese and International Economies 34*, 135–153.

Kuroda, H. (2016). The practice and theory of unconventional monetary policy. In J. E. Stiglitz and M. Guzman (Eds.), *Contemporary Issues in Macroeconomics: Lessons from The Crisis and Beyond*, Chapter 1, pp. 7–14. Amsterdam: Palgrave Macmillan.

Longstaff, F. A. (2004). The flight-to-liquidity premium in U.S. treasury bond prices. *Journal of Business 77*(3), 511–526.

Longstaff, F. A., S. Mithal, and E. Neis (2005). Corporate yield spreads: Default risk or liquidity? New evidence from the credit default swap market. *Journal of Finance 60*(5), 2213–2253.

Lopes, J. A. and M. M. Spiegel (2014). Foreign entry into underwriting services: Evidence from Japan's "big bang" deregulation. *Journal of Money, Credit and Banking 46*(2-3), 445–468.

Neely, C. J. (2011). A foreign exchange intervention in an era of restraint. *Federal Reserve Bank of St. Louis Review September/October*, 302–324.

Puri, M. (1996). Commercial banks in investment banking - conflict of interest or certification role? *Journal of Financial Economics 40*(3), 373–401.

Puri, M. (1999). Commercial banks as underwriters: Implications for the going public process. *Journal of Financial Economics 54*(2), 133–163.

Stock, J. H. and M. W. Watson (2003). Forecasting output and inflation: The role of asset prices.

Journal of Economic Literature 41(3), 788-829.

Takaoka, S. and C. R. McKenzie (2006). The impact of bank entry in the Japanese corporate bond market. *Journal of Banking and Finance 30*, 59–83.

Weinstein, D. E. and Y. Yafeh (1998). On the costs of a bank-centered financial system: Evidence from the changing main bank relations in Japan. *Journal of Finance 53*(2), 635–672.

Wu, L. and F. X. Zhang (2008). A no-arbitrage analysis of macroeconomic determinants of the credit spread term structure. *Management Science 54*(6), 1160–1175.

Table 1: Summary Statistics: Corporate Bond Characteristics

	Whole period	Before 3/11/2011	After 3/11/2011
Credit Spread (bps)	45.97	50.34	31.64
Amount (millions of yen)	19,687	20,418	17,291
Maturity (years)	6.98	7.01	6.91
Rating			
AAA (%)	6.02	7.78	0.29
AA (%)	34.67	36.09	30.01
A (%)	47.75	44.50	58.39
BBB (%)	11.56	11.63	11.31
Secured Bonds Types			
Collateral (%)	0.07	0.09	0
General Mortgage (%)	13.19	14.78	7.98
Guaranteed by higher rating firm (%)	0.15	0.20	0
Guaranteed by subsidiary (%)	0.89	0.78	1.22
Bookrunner Type			
Bank Subsidiary (%)	49.28	44.47	65.04
Foreign Bookrunner (%)	4.21	4.78	2.33
Sample Size	7,338	5,622	1,7167

Notes: Sample period: 1995:1- 2015:11; Number of firms=646.
This table contains cross-sectional means of various characteristics.

Table 2: Summary Statistics by Rating Class

	Before March 11, 2011			After March 11, 2011		
Rating Class	AAA-AA	A	BBB	AAA-AA	A	BBB
Credit Spread (bps)	27.22	60.57	98.43	19.98	30.92	66.59
Amount (millions of yen)	26,369	16,427	13,246	17,353	18,435	11,212
Maturity (years)	8.69	5.93	4.79	8.38	6.49	5.12
Issuer's financial health						
Debt to Capital	0.74	0.72	0.78	0.61	0.69	0.75
Sales (billions of yen)	2,759	1,357	864	2,622	1,651	768
ROE	5.57	4.24	2.70	6.42	5.01	5.55
$Bookrunner\ Type$						
Bank Subsidiary (%)	46.31	42.53	44.95	68.65	62.87	66.49
Foreign Bookrunner (%)	4.95	4.56	5.05	4.62	1.60	0
Sample Size	2,466	2,502	654	520	1,002	194

$Notes$: Sample period: 1995:1- 2015:11; Number of firms=646.
This table contains cross-sectional means of various characteristics.
The sample size for the issuer's financial health variables depend on the availability of the variables.

Table 3: Determinants of Credit Spreads in Japan: Firm Fixed Effects

	Characteristics of an issue		Characteristics of a bookrunner		Dummies for Lehman and nuclear events	
Variable	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
AAA rating	-68.52	(8.54)***	-69.25	(8.72)***	-66.43	(8.30)***
AA rating	-50.69	(8.12)***	-51.65	(8.30)***	-51.16	(8.21)***
A rating	-31.55	(5.88)***	-32.12	(6.02)***	-31.47	(5.94)***
log(Amount)	-2.79	(1.74)*	-1.73	(1.06)	-2.01	(1.30)
Maturity	0.05	(0.25)	0.09	(0.43)	0.09	(0.43)
Collateral	-57.14	(14.74)***	-56.76	(14.79)***	-53.30	(12.41)***
General mortgage bond	3.77	(0.49)	2.84	(0.37)	2.69	(0.35)
Guaranteed (higher rating)	-10.08	(0.94)	-9.43	(0.89)	-9.21	(0.84)
Guaranteed (subsidiary)	11.58	(0.45)	10.47	(0.43)	10.14	(0.41)
log(Size)	14.66	(11.30)***	14.06	(10.81)***	13.52	(10.36)***
ΔCPI	3.66	(5.66)***	3.02	(4.81)***	4.64	(6.30)***
ΔIIP	-0.53	(4.97)***	-0.52	(4.93)***	-0.40	(3.08)***
ΔCGPI	-2.69	(6.12)***	-2.54	(5.83)***	-3.24	(6.28)***
Bookrunner's market share			-0.60	(6.63)***	-0.61	(6.81)***
Foreign Bookrunner			-10.70	(2.61)***	-11.20	(2.72)***
Bank Subsidiary			-1.18	(0.87)	-0.91	(0.69)
Lehman collapse					11.87	(2.68)***
Nuclear disaster					-10.47	(3.18)***
Sample Size	7,338		7,338		7,338	
R^2	0.59		0.60		0.60	

$Notes$: Figures in parentheses are the absolute values of asymptotic t-statistics computed with the robust covariance matrix correction. The estimated coefficients and t-ratios of a quarterly trend variable are not reported. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4: Supply of Government Bonds and Credit Spreads: Firm Fixed Effects

	Full Sample (OLS)		Full Sample (IV)	
AAA rating	-82.57	-83.59	-78.47	-74.15
	(9.30)***	(9.70)***	(24.16)***	(22.95)***
AA rating	-56.81	-59.55	-54.63	-53.70
	(8.28)***	(8.63)***	(24.11)***	(23.86)***
A rating	-34.96	-36.22	-33.48	-32.49
	(5.83)***	(6.12)***	(18.97)***	(18.48)***
log(Amount)	-1.31	-1.23	-1.57	-1.31
	(0.90)	(0.88)	(1.96)**	(1.63)
Maturity	0.06	0.07	0.05	0.07
	(0.28)	(0.36)	(0.43)	(0.65)
log(debt/GDP)	-52.06	-83.17	-30.85	-18.60
	(7.23)***	(8.35)***	(26.64)***	(12.04)***
General mortgage bond	1.17	0.85	1.46	1.47
	(0.16)	(0.12)	(0.24)	(0.24)
Guaranteed (higher rating)	-11.65	-9.49	-12.07	-11.02
	(1.10)	(0.91)	(1.14)	(1.05)
Guaranteed (subsidiary)	11.32	9.95	11.40	10.23
	(0.44)	(0.38)	(1.80)*	(1.62)
log(Size)	11.86	9.97	12.15	11.66
	(9.34)***	(8.05)***	(15.65)***	(14.97)***
ΔCPI	-1.17	-0.98	0.78	2.92
	(1.32)	(1.14)	(1.72)*	(5.59)***
ΔIIP	-0.65	-0.62	-0.59	-0.42
	(6.61)***	(5.54)***	(12.70)***	(7.86)***
ΔCGPI	-0.54	-0.41	-1.42	-2.50
	(1.09)	(0.94)	(5.84)***	(9.56)***
Bookrunner's market share		-0.35		-0.46
		(3.80)***		(7.28)***
Foreign Bookrunner		-5.33		-8.87
		(1.35)		(4.22)***
Bank subsidiary bookrunner		-0.47		-0.33
		(0.39)		(0.39)
Lehman collapse		8.75		13.84
		(2.21)**		(4.10)***
Nuclear disaster		-22.66		-9.51
		(5.47)***		(7.44)***
Sample Size	7,103	7,103	7,103	7,103
R^2	0.63	0.64		
$Cor.$			0.79	0.80

$Notes$: As for Table 3. $Cor.$ refers to the correlation between the actual and fitted values.

Table 5: Supply of Government Bonds and Credit Spreads by Rating Class: Firm Fixed Effects (IV specification)

	Rating Class		
	AAA-AA ratings	A rating	BBB rating
Debt to Capital	15.03	85.44	92.23
	(4.18)***	(6.01)***	(2.16)**
log(Sale)	4.78	-7.63	27.93
	(1.96)**	(2.54)**	(3.21)**
ROE	-1.00	-0.73	-0.44
	(12.77)***	(10.86)***	(5.22)***
log(Amount)	-0.35	-0.90	-8.71
	(0.41)	(0.63)	(1.99)**
Maturity	0.55	-0.22	-2.99
	(6.77)***	(0.82)	(2.63)**
log(debt/GDP)	-7.40	-6.43	-50.90
	(4.90)***	(2.14)**	(4.82)***
General mortgage bond	-4.74		
	(1.36)		
Guaranteed (subsidiary)		14.53	26.81
		(0.81)	(1.87)*
log(Size)	9.88	12.25	11.71
	(12.44)***	(9.43)***	(3.17)**
ΔCPI	2.01	6.91	-0.05
	(3.34)***	(7.96)***	(0.02)
ΔIIP	-0.59	-0.47	-0.42
	(11.61)***	(4.96)***	(1.48)
ΔCGPI	0.55	-4.08	-5.63
	(1.95)*	(9.36)***	(4.32)***
Lehman collapse	6.49	8.34	38.86
	(2.65)***	(0.59)	(1.22)
Nuclear disaster	-8.49	-15.41	1.63
	(6.00)***	(6.91)***	(0.27)
Sample Size	2,373	3,006	769
$Cor.$	0.79	0.76	0.83

$Notes$: Sample period: 1996:1-2015:11. As for Table 4. Bonds with collateral or guaranteed by a higher rating firm are not included due to the absence of observations or no variation within a rating class.

Table 6: Supply of Government Bonds and Credit Spreads before and after the Great East Japan Earthquake (March 11, 2011): Firm Fixed Effects (IV specification)

	Before March 11, 2011	After March 11, 2011
AAA rating	-67.44	-20.94
	(16.36)***	(1.80)*
AA rating	-52.82	-10.99
	(18.06)***	(1.90)*
A rating	-33.07	-6.93
	(14.99)***	(1.32)
log(Amount)	-3.57	1.27
	(3.59)**	(1.14)
Maturity	0.08	1.03
	(0.62)	(6.32)***
log(debt/GDP)	-12.59	-174.11
	(6.95)***	(6.03)***
General mortgage bond	0.88	
	(0.14)	
Guaranteed (higher rating)	-16.41	
	(1.45)	
Guaranteed (subsidiary)	21.92	55.21
	(2.50)**	(5.51)***
log(Size)	15.53	0.43
	(14.86)***	(0.47)
ΔCPI	9.73	0.03
	(11.11)***	(0.03)
ΔIIP	-0.26	-0.08
	(4.00)**	(0.81)
ΔCGPI	-4.54	-1.15
	(11.66)***	(2.76)**
Lehman collapse	15.26	
	(4.17)***	
Sample Size	5,387	1,716
$Cor.$	0.81	0.86

$Notes$: As for Table 4. No bond guaranteed by a higher rating firm is issued after March 11, 2011. The model excludes general mortgage bonds after March 11, 2011 due to the lack of within-group variation.

Table 7: Effect of Japanese Government Bonds held by the Bank of Japan on Credit Spreads: Firm Fixed Effects (IV specification)

	Full Sample	Before March 11, 2011	After March 11, 2011	
AAA rating	-75.40	-65.52	-20.94	-19.34
	(23.23)***	(15.60)***	(1.80)*	(1.66)*
AA rating	-55.03	-51.32	-10.99	-11.24
	(24.23)***	(17.17)***	(1.90)*	(1.94)*
A rating	-32.76	-32.20	-6.93	-6.71
	(18.64)***	(14.40)***	(1.32)	(1.28)
log(Amount)	-2.44	-3.46	-1.27	1.19
	(3.05)***	(3.47)***	(1.14)	(1.07)
Maturity	0.09	0.07	1.03	1.06
	(0.77)	(0.55)	(6.32)***	(6.53)***
log(debt/GDP)	-22.61	-8.17	-174.11	
	(15.80)***	(3.26)***	(6.03)***	
JGB holding ratio	-70.18	8.23		-12.58
	(7.25)***	(2.56)**		(6.15)***
General mortgage bond	0.92	1.22		
	(0.15)	(0.19)		
Guaranteed (higher rating)	-10.54	-16.79		
	(1.01)	(1.48)		
Guaranteed (subsidiary)	11.10	22.46	55.21	54.87
	(1.76)*	(2.55)**	(5.51)***	(5.48)***
log(Size)	10.90	15.91	0.43	1.05
	(13.84)***	(15.03)***	(0.47)	(1.18)
ΔCPI	5.60	10.26	0.03	-1.15
	(9.27)***	(11.37)***	(0.03)	(1.42)
ΔIIP	-0.36	-0.26	-0.08	-0.10
	(6.65)***	(3.95)***	(0.81)	(1.05)
ΔCGPI	-3.53	-4.66	-1.15	-0.86
	(12.17)***	(11.87)***	(2.76)***	(2.25)**
Lehman collapse	11.51	16.69		
	(3.42)***	(4.50)***		
Nuclear disaster	-7.19			
	(5.34)***			
Sample Size	7,103	5,387	1,716	1,716
$Cor.$	0.80	0.80	0.86	0.86

$Notes$: Sample period: 1996:1-2015:11. As for Table 4. No bond with collateral or guaranteed by a higher rating firm is issued after March 11, 2011. The model excludes general mortgage bonds due to the lack of within-group variation after March 11, 2011.

Table 8: Effect of Japanese Government Bonds held by Bank of Japan on Credit Spreads by Rating Class: Firm Fixed Effects (IV specification)

	Rating Class		
	AAA&AA ratings	A rating	BBB rating
Debt to Capital	-65.08	-36.96	-19.85
	(2.05)**	(1.94)*	(0.13)
log(Sale)	-22.28	-19.38	104.99
	(2.40)**	(3.29)***	(3.94)***
ROE	0.25	-0.26	-2.96
	(0.86)	(4.03)***	(14.55)***
log(Amount)	-1.35	3.59	-6.49
	(0.89)	(3.60)***	(0.96)
Maturity	0.82	1.79	5.36
	(6.46)***	(9.98)***	(3.88)***
JGB holding ratio	-12.50	-6.14	-38.85
	(3.87)***	(3.20)***	(3.02)***
log(Size)	2.13	0.27	-0.09
	(1.82)*	(0.34)	(0.02)
ΔCPI	1.18	-0.89	-8.61
	(1.10)	(1.20)	(2.46)**
ΔIIP	-0.01	-0.11	-0.21
	(0.06)	(1.12)	(0.46)
ΔCGPI	-1.10	-1.39	2.74
	(2.31)**	(3.90)***	(1.63)
Sample Size	367	829	178
$Cor.$	0.92	0.88	0.95

$Notes$: Sample period: 3/11/2011-11/30/2015. As for Table 4. Bonds with collateral or guaranteed by a higher rating firm are excluded due to the absence of observations or no variation within a rating class.

Table 9: Sample Selection Problem after the Great East Japan Earthquake: Credit Spreads

	Selection Equation (1)	Regression Equation (1)	Selection Equation (2)	Regression Equation (2)
Constant	77.24	42.71	77.25	150.56
	(3.61)***	(2.24)**	(3.00)***	(4.05)***
Debt to Capital	-6.55		-6.55	
	(0.52)		(0.41)	
log(Sale)	1.19		1.20	
	(1.01)		(0.82)	
ROE	0.36		0.37	
	(5.93)***		(5.15)***	
AAA rating		-64.89		-65.42
		(1.65)		(1.37)
AA rating	-1.88	-54.16	-1.88	-53.87
	(0.37)	(14.49)***	(0.29)	(14.44)***
A rating	-1.81	-39.65	-1.81	-39.70
	(0.41)	(17.89)***	(0.34)	(17.99)***
log(Amount)	-7.98	-0.70	-7.96	-0.53
	(5.12)***	(0.48)	(4.45)***	(0.36)
Maturity	-0.09	0.62	-0.08	0.57
	(0.28)	(2.07)**	(0.19)	(1.97)**
log(debt/GDP)				-114.72
				(2.86)***
JGB holding ratio	2.61	-12.26	2.61	
	(0.84)	(3.48)***	(0.68)	
log(Size)		1.15		1.34
		(0.77)		(0.88)
ΔCPI		-1.00		-1.70
		(0.67)		(1.12)
ΔIIP		-0.17		-0.13
		(1.03)		(0.82)
ΔCGPI		-1.17		-1.06
		(1.68)*		(1.39)
σ	21.61 (49.4)***		21.66 (48.14)***	
ρ	0.14 (9.91)***		0.12 (8.95)***	
Sample Size	1,381		1,381	
Log-likelihood	62.75		63.54	

Notes: As for Table 3. The estimated coefficients and t-ratios of industry dummies are not reported.

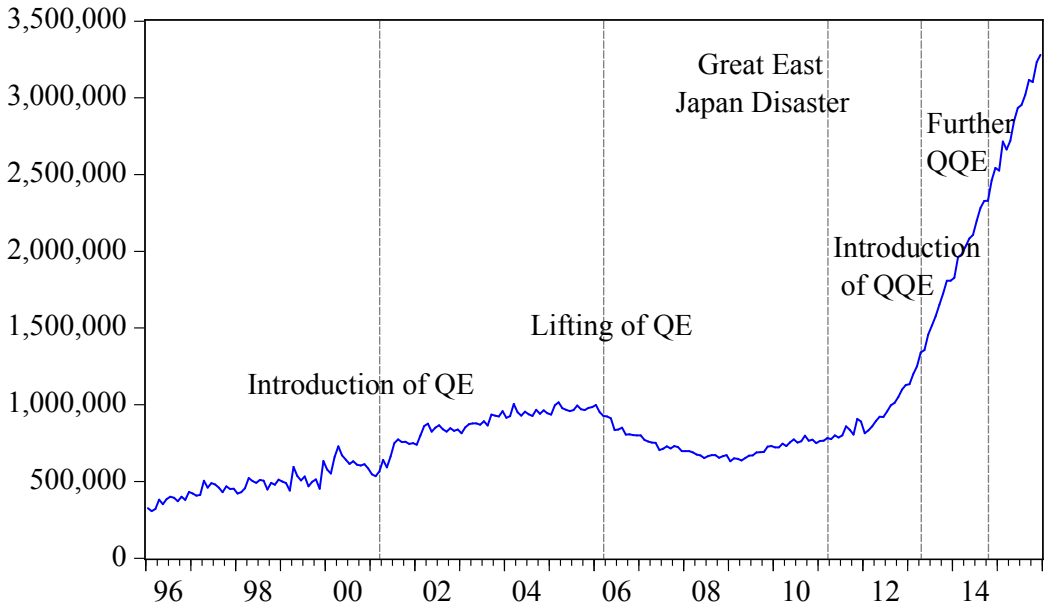

Figure 1: Balance of Japanese Government Bonds held by the Bank of Japan

Notes: Sample period: 1996:1-2015:12. The figure depicts the Bank of Japans holding of Japanese government bonds (Hundreds of millions Japanese Yen, solid line). The vertical dashed lines represent the BOJ's policy decisions and the Great East Japan Disaster.