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The premium and settlement of CCPs during the financial crisis: Evidence from the JGB market



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ABSTRACT

This study evaluates the role of central counterparties (CCPs) in the over-the-counter market during the 2008–2009 global financial crisis. It shows that the CCPs allowed the premium to appreciate in times of stress by taking advantage of the unique feature of JGB futures. We estimate CCP premium by comparing 6.75- and 7-year JGBs, which generate almost the same cash flow, differing in the linkage to CCP's settlement through JGB futures, and find that a CCP premium emerged during the crisis and disappeared afterward. Furthermore, we show that investors' settlement via CCPs drastically increased. Our results support the effectiveness of recent regulatory reforms that mitigate counterparty risk through CCPs.

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1. Introduction

After the 2008–2009 global financial crisis (GFC), the global financial reform spearheaded by the G20 has encouraged standardized derivatives such as interest rate swaps or credit default swaps (CDS) to be cleared through central counterparties (CCPs). The literature also argues in favor of a CCP. Theoretically, CCPs' effect on asset price is that cleared asset prices should increase as long as CCPs can mitigate the counterparty risk.¹ To support the wide adoption of CCPs, investigations of market developments under times of stress are required, which, to our knowledge, no paper has empirically addressed.

In this study, we demonstrate that investors added a special premium for CCPs (CCP premium) during the financial crisis of 2008–2009. We estimate CCP premium by comparing 6.75- and 7-year JGBs, which are both off-the-run JGBs generating almost the same cash flow. The only difference between them is the linkage to JGB futures, which allows the investors to settle JGB via CCP. Using this institutional feature, we can interpret the spread of 7-year JGBs and 6.75-year JGBs as CCP premium. We find that this estimated CCP premium suddenly emerged during the crisis and disappeared after. Fig. 1 contrasts the actual yield curve for JGBs with a theoretical curve just after the failure of Lehman Brothers, in comparison with the curve before the crisis, and clearly shows the additional premium in 7-year JGBs to other yields.²

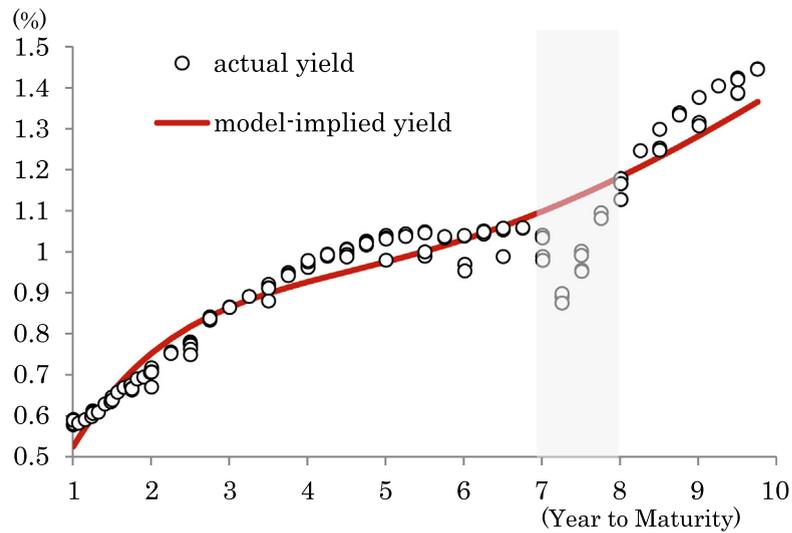
Furthermore, we demonstrate that settlement via CCPs actually increased during GFC. Since the CCP premium appreciated during the crisis, it is a natural conjecture that the settlement via CCPs should also increase to avoid counterparty risk.

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¹ For example, Menkveld and Vuillemeij (2021) state, "Most naturally, if CCPs are successful at eliminating counterparty risk at limited cost, then prices of cleared asset should increase" (p. 9).

² The website of the Japan Exchange Group describes 5-year and 20-year JGB futures, but these futures have not been traded since the 1990s. JGB market investors assume one bond future traded in the JGB market. We describe this institutional feature in Section 3.

(a) The yield curve after the failure of Lehman Brothers (September 16, 2008)



(b) The yield curve before the GFC (September 18, 2007)

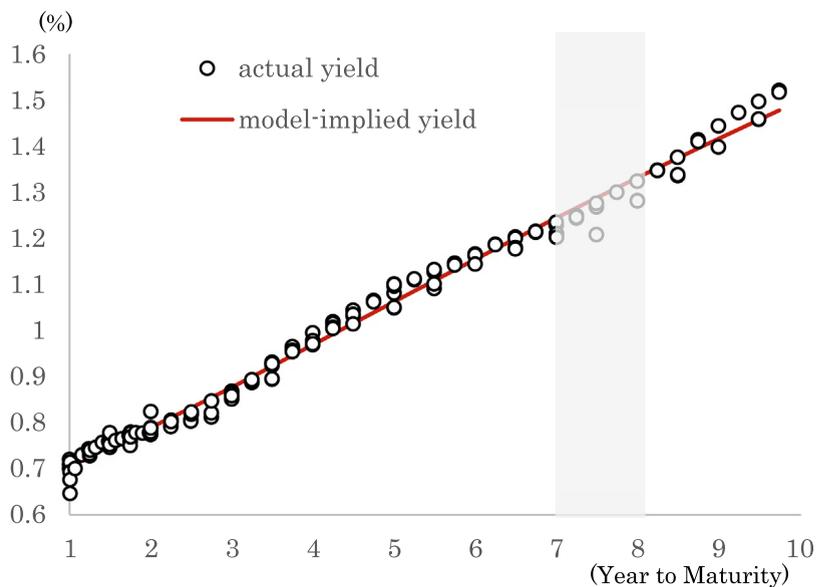


Fig. 1. The term structure of the JGB yield just after the failure of Lehman Brothers. Note: The figure shows the term structure of JGB yields just after the failure of Lehman Brothers on September 16, 2008, and before the financial crisis on September 18, 2007. The model-implied yield was based on Svensson (1994). The highlighted zone is a 7-year zone (more than 7 and less than 8 years), which is highly connected to JGB futures.

The settlement via CCP, especially during the crisis, is not necessarily observable, but JGB futures allow us to observe the actual settlement via CCPs since JGBs are settled in an exchange market, a clear platform to provide the settlement data. As Hull (2017) describes, investors tend to use futures for hedging, and usually neutralize their position before maturity as long as they use JGB futures for hedging purpose.³ However, investors did select settlement via CCP, which increased during the crisis, as clear evidence of investors demanding CCP clearing.

³ Hull (2017) writes: “Many of the participants in futures markets are hedgers. Their aim is to use futures markets to reduce a particular risk that they face” (p.49).

To show that this premium (spread of 7-year JGBs over 6.75-year JGBs) works as a good proxy for the CCP premium, we model CCP premium based on [Bernstein et al. \(2019\)](#), who demonstrate that the CCP premium is theoretically related to counterparty risk and liquidity premiums. By using the JGB data, we confirm that CCP premium, computed as the spread of 7-year over 6.75-year JGBs, is empirically related to counterparty risk and liquidity premiums.

This empirical result is quite robust even if we control for a variety of variables. The potential factor affecting the spread of the 7-year and 6.75-year yields is the low arbitrage among JGB and futures. Arbitrage trading among JGB futures and 7-year JGBs, which could affect the 7-year yield, was not active during the crisis. To capture this effect, we compute net basis as the deviation of forward and futures and control this for estimation. We confirm that net basis is empirically related to this premium, which in turn is still related to the counterparty risk and liquidity premiums.

There could be an alternative explanation for this premium, where the squeezer attempts to make a profit by restricting the supply of 7-year JGBs. To capture this effect, we utilize a feature proposed by [Merrick et al. \(2005\)](#)—squeeze potential—and show that our results are robust even when we include it in the model. Furthermore, the Japanese government has implemented a unique liquidity enhancement auction, which mitigates the risk of a squeeze.⁴ Indeed, Japan can reissue old JGBs so that even if the squeezer buys up 7-year JGBs, an investor can purchase 7-year bonds directly from the Ministry of Finance (MOF).

Our study makes a contribution to the literature by demonstrating that the CCP premium did not only appreciate during GFC, but investors increased their demand for settlements via CCPs in a time of stress. To the best of our knowledge, this provided the first empirical evidence on the phenomenon. The literature, such as [Bernstein et al. \(2019\)](#), focuses on how CCPs affect asset prices. Since the investors demand for settlement via CCP increased, our result supports the story that investors demand clearing via CCPs to mitigate counterparty risk. We also confirm the time series of the CCP premium; we detect it clearly as higher during the crisis period but disappearing before and after the crisis, which also reinforces the theoretical prediction of the CCP's function.

The remainder of this paper is organized as follows. [Section 2](#) describes the literature review, [Section 3](#) describes an institutional feature of JGB futures, [Section 4](#) reports the model and empirical result of our baseline analyses, and [Section 5](#) shows our result is robust when we include control variables. [Section 6](#) discusses the results and [Section 7](#) concludes the paper. In this paper, JGB and CTD bonds mean cash bonds instead of futures, which we clearly refer to as “JGB futures.”

2. Literature review

According to [Menkveld and Vuillemy \(2021\)](#), CCPs play three important roles from a theoretical perspective. First, CCPs allow for efficient posting of costly collateral. If investors exchange collateral bilaterally, it could create duplicates. However, multilateral netting via CCPs enables investors to cancel out duplicate collateral to contribute to efficient posting. The model introduced by [Duffie and Zhu \(2011\)](#) shows that CCPs reduce netting efficiency, increase collateral demands, and lead to higher average exposure to counterparty default.

Second, CCPs work as insurance companies. An important feature is the existence of default funds, which cannot be explained by efficient posting of collateral. Counterparties contribute the funds to avoid a situation where the default of one counterparty affects other counterparties. This function can be interpreted as insurance. However, the existence of insurance might incentivize CCPs not to select proper counterparties, which could trigger a moral hazard. So, while CCP requires a margin to contribute a default fund, it also provides a penalty once the counterparty goes bankrupt. [Biais et al. \(2012, 2016\)](#) introduced the model to depict these features.⁵

Finally, CCPs mitigate fire sales in case of bankruptcy. If CCPs liquidate the member who has defaulted, this could trigger a fire sale. Instead, CCPs properly conduct an auction that mitigates fire sales. [Vuillemy \(2020b\)](#) extends [Brunnermeier and Pedersen \(2009\)](#) to model this rationale.

Empirical studies aligned with this theoretical literature have been conducted. They investigate the empirical relationship between CCPs and asset prices. The challenge here is that the introduction of CCPs is determined endogenously. For identification, [Bernstein et al. \(2019\)](#) examine the establishment of a clearinghouse on the New York Stock Exchange (NYSE) in 1892 and show that the introduction of CCP reduced the annualized volatility of NYSE returns and increased asset values. Using 1892 NYSE data, [McSherry et al. \(2017\)](#) also use the historical event and show that multilateral settlement is advantageous when financial markets are highly stressed. [Loon and Zhong \(2014\)](#) use CDS price by taking advantage of the introduction of CCP by ICE.

Another strand of the literature investigates how CCPs affect not only asset prices but also real variables. For example, [Vuillemy \(2022a\)](#) uses the introduction of Caisse de Liquidation des Affaires en Merchandises (CLAM) for coffee futures in 1882. By using data for trade flows in coffee and other commodities, [Vuillemy \(2022a\)](#) empirically demonstrates that CCP significantly increased trade flows.

As for CCP premium, the literature investigates CCP premium among the difference clearing houses. For example, the swap rate cleared in Chicago Mercantile Exchange (CME) and the spread rate cleared in the London Clearing House (LCH) could be different even though the swap rates are exactly the same except for the clearing house. This spread is called

⁴ See [Hattori \(2019\)](#) for details on the liquidity enhancement auction.

⁵ Previous studies develop the model as the rule of CCPs ([Koepl and Monnet 2010](#)).

CCP basis. Benos et al. (2022) demonstrate an economically significant CCP basis for dollar swap contracts cleared at both CME and LCH, and provide empirical evidence consistent with a collateral cost explanation of this basis.

A study closest to the present one was conducted by Bernstein et al. (2019), whose model we utilize and extend the analysis using the unique feature of JGB futures. Bernstein et al. (2019) point out that the literature has substantially documented these kinds of price spreads among securities paying the same cash flows. Our analysis compares 7-year JGBs and 6.75-year JGBs to compute CCP clearing because the only difference between these two is the CCP linkage. This methodology is in line with Longstaff (2005) and Schwartz (2019), which investigate liquidity premiums by comparing 10-year bonds with short bonds.

This study demonstrates that investors demand settlement via CCPs in times of stress, in the first empirical evidence of its kind. It investigates not only the effect on the asset price but also whether the investors actually demanded settlement via CCPs during the crisis, which has not been explored so far. Studies investigate the effect of CCPs on asset price, but since the investors actually increased their demand for settlement via CCPs, our result supports the story that investors demand CCP clearing to mitigate counterparty risk. We also confirm the time series of the CCP premium; we find that it clearly increased during the crisis but did not exist before and after the crisis, reinforcing the theoretical prediction of CCPs' function.

3. Relationship between JGB futures and 7-year JGBs

3.1. Basic feature of JGB futures

JGB futures are derivative products that provide contractors with opportunities to buy or sell JGBs on a specified date at a predetermined price. Similar to US Treasury futures, the foundation of JGB futures is the standardized bonds listed on the Japan Exchange Group with a set coupon rate and maturity. JGB futures were introduced in 1985, but only 10-year JGB futures have since been traded on the JGB market, in sharp contrast to the US market. Five-year JGB futures were introduced in 1996, but the trading of these futures halted after some time.⁶ In this paper, JGB futures refer to 10-year JGB futures.

JGB futures are the most liquid financial product in Japan's fixed-income market. After the introduction of JGB futures in 1985, the average trading volume is around 4 trillion JPY (40 billion USD) per day. The contract month is on a quarterly cycle (March, June, September, and December), and the contract unit is of 100-million-yen face value. A certain margin (collateral) is required for investors to take a position in JGB futures, calculated using the Standard Portfolio Analysis of Risk (SPAN).⁷

A well-known feature of bond futures is the settlement of cash bonds via CCP. The sellers have the option to deliver bonds among the basket to buyers, called the delivery option. Sellers of JGB futures can select from among 7-year to 10-year JGBs but they select the bond that is cheapest to deliver, called CTD. As we describe later, 7-year JGBs are always CTD under the JGB market.

Only 10-year JGB futures are traded in the JGB market. JPX had introduced 5-year and 20-year JGB futures, but trading in them stopped, perhaps due to a relatively small investor base for 20-year JGB futures, unlike the US treasury futures markets, where investors trade armed with various investment strategies. In addition, Japanese investors tend to prefer concentrating on one type of bond futures (10-year JGB futures) to preserve the liquidity of a single product instead of diversifying into multiple products.

3.2. The settlement in JGB futures

There are two ways of settlement in JGB futures. One is the physical settlement, whereunder sellers deliver 7-year to 10-year JGBs to the buyers on the settlement date. For example, if investors buy the JGB future right now, they will receive the 7-year JGB on the JGB futures settlement date. The settlement date of the JGB futures is set at every quarter end (March, June, September, and December), so when investors purchase JGB futures, they receive 7-year JGBs on the settlement date.

The other way of settlement is "offsetting trades," that is, by offsetting purchases or sales until the last trading day. In case offsetting trades are not executed by the last trading day, settlement by physical delivery and payment of JGB shall take place.

As Hull (2017, p. 49) writes, "many of the participants in futures markets are hedgers." If they continue to buy or sell JGB futures, they should deliver 7-year JGBs, but if their main aim is hedging, they would roll over their positions instead of physical settlement. Hull (2017) describes this rollover strategy as Stack and Roll, as follows:

Time1 : Short futures contract 1

Time2 : Close out futures contract 1, short futures contract 2

Time3 : Close out futures contract 2, short futures contract 3

⁶ The 20-year JGB futures was introduced in 2014 but trading in them halted soon after.

⁷ SPAN, developed by the CME, is also used in major futures. Please see the Japan Securities Clearing Corporation (JSCC) website for details on calculating margin requirements (<https://www.jpjx.co.jp/jscjcc/en/cash/futures/marginssystem/rpf.html>).

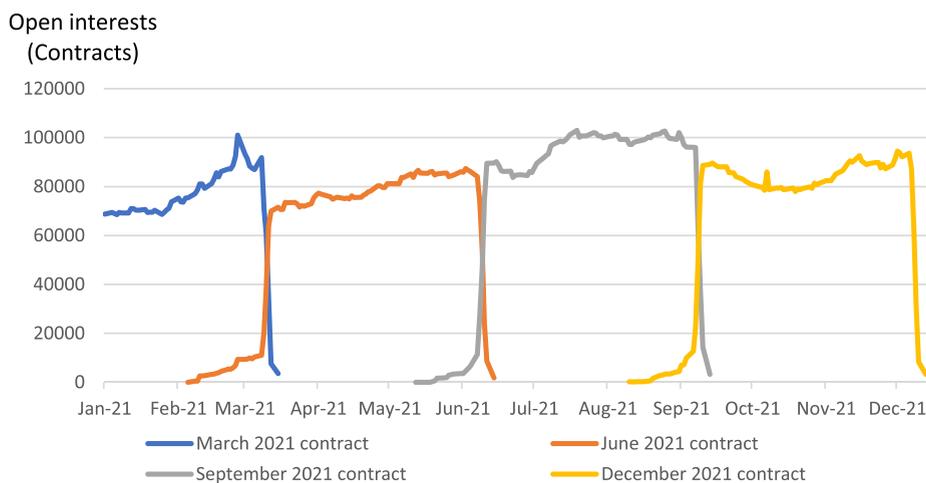


Fig. 2. Changes in the open interests of each JGB futures contract month. Source: Japan Exchange Group.

Fig. 2 shows the changes in the open interests of JGB futures with different contract months since June 2020. Open interest means unsettled positions of all the futures contracts, that is, the amount gradually declines until the last trading day of the respective contract month. This is because investors close out their positions by taking opposite trading before the last trading day to avoid delivering the underlying assets of futures contracts.

3.3. JGB futures and 7-Year JGBs: Mechanism of settlement via CCP

JGB futures are different from US Treasury futures in that only 10-year JGB futures have been traded on the JGB market (several types of bond futures have been traded in the US bond market). This enables us to identify the different effects of the futures on JGBs. Under the rules for 10-year futures, those with maturities of more than 7 years and less than 10 years are eligible for delivery. Under the current JGB futures system, the shortest maturity bonds (7-year JGBs) in the deliverable basket are the CTD bonds (Yu et al. 1996; Hamao and Hoshi 2000; Kikuchi and Shintani 2012). Kikuchi and Shintani (2012, p.98) note that the “maturity of the cheapest-to-deliver of the JGB futures is around seven years.”⁸

Again, the sellers of JGB futures have the option to select the JGBs from the baskets. Since the JGB yield curve is very low, 7-JGB, the shortest bond in the basket, is CTD. The sellers of JGB futures try to select the bonds with minimum cost, or CTD. According to Hull (2017), the CTD bond is one for which the value of the following equation is the least.⁹

$$\text{Gross basis} = \text{JGB price} - (\text{JGB futures price} \times \text{CF})$$

This concept is usually called gross basis. As Hull (2017) describes, when yields are less than 6 %, the system tends to favor the delivery of high-coupon short-maturity bonds.¹⁰ Since the JGB yield is always lower than 6 % after 2000, 7-year JGB is CTD.

Fig. 3 shows the time series of the gross basis of 7-year, 8-year, and 9-year JGBs on the last trading day of JGB futures, computed by Bloomberg. This graph shows the 7-year JGBs are always the lowest, compared with 8-year and 9-year JGBs. They are cheaper by about 2–4 yen than 8-year JGBs and by about 5–8 yen than 9-year JGBs. The maturity of CTDs in JGB futures from January 2007 to December 2009 is presented in the Appendix.

In addition, the strong link between JGB futures and 7-year JGBs creates a high correlation between these variables. The correlation between the prices of JGB futures and 7-year JGBs in 2007–2009 is 0.98; however, that between the prices of JGB futures and 2-year and 5-year JGBs is only 0.81 and 0.92, respectively. As for 10-year JGBs, the correlation between 7-year and 10-year JGBs is very high (0.99), and thus the correlation between JGB futures and 10-year JGBs is high (0.97).¹¹

4. CCP premium

4.1. Comparison between 6.75- and 7-Year JGBs: CCP premium

In this study, we compare 7-year JGBs with 6.75-year JGBs since the latter is the closest in term, but it is not included in the deliverable basket (only more than 7-year and less than 10-year JGBs) of JGB futures. Both are off-the-run bonds. There is

⁸ Kubota and Shintani (2022) use JPY interest rate futures to investigate monetary policy shocks in Japan.

⁹ Hull (2017) writes: “Quoted bond price- (Most recent settlement price×Conversion factor).” In this setup, “quoted bond price” is JGB price and “most recent settlement price” is JGB futures price. Note that net basis is often used to compute CTD in practice.

¹⁰ See Hull (2017, p. 141).

¹¹ For computing the correlation, we use the JGB yield and take the negative value because the yield and the price move in opposite directions.

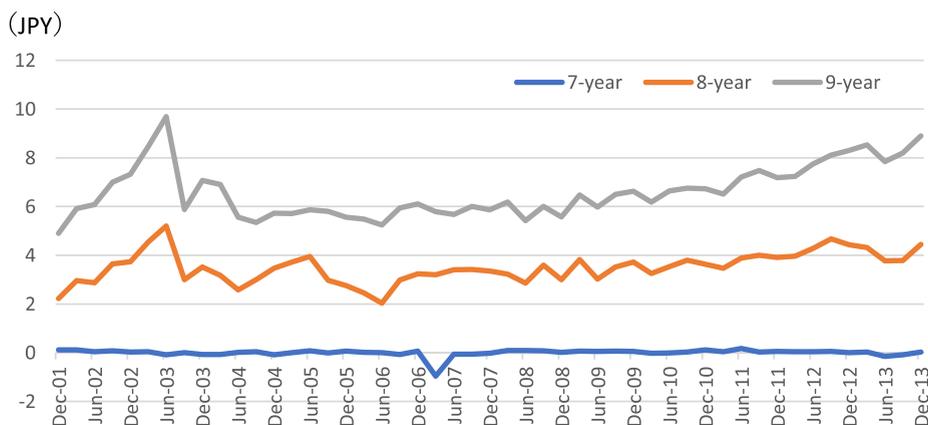
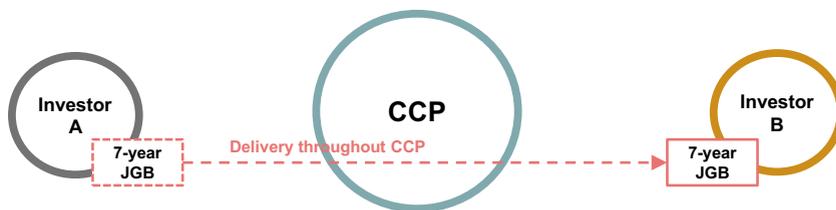


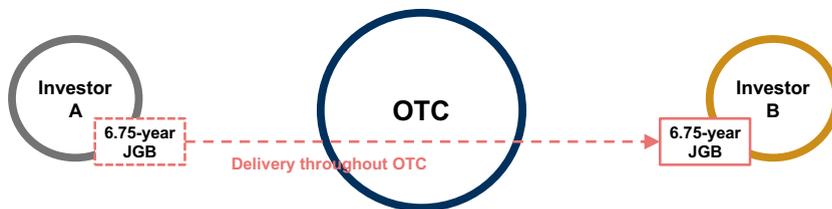
Fig. 3. The time series of gross basis. Note: This graph shows the gross basis computed by 7-year, 8-year, and 9-year JGBs. Gross basis is defined as JGB price- (JGB futures price × CF). Source: Bloomberg.

Table 1
The settlement of 7-year JGBs and 6.75-year JGBs with and without linking to JGB futures.

1. 7-year JGB (CTD) with JGB Futures



2. 6.75-year JGB



Notes: CTD, or Cheapest to Deliver, has a linkage with 7-year JGBs. 6.75-year JGBs are not CTD bonds. CCP stands for central counterparty, and OTC is over-the-counter.

no other institutional feature that makes 7-year JGBs special, than their link with JGB futures, which enables investors to settle via CCP.¹² This should be an ideal situation for extracting the premium that investors pay for settlement via CCP.

As with US Treasury, JGBs (cash bonds) are traded on the OTC market. 7-year JGBs can be cleared via CCPs, but not the 6.75-year JGBs, which could then suffer counterparty risk, especially during the GFC. Table 1 shows the institutional difference between 7-year and 6.75-year JGBs in terms of settlement via CCPs. For example, an investor holding a 7-year JGB can buy (sell) it by longing (shorting) the JGB futures, which enables the settlement of 7-year JGBs via CCP. However, if investors hold a 6.75-year JGB (not cleared via CCP), they must enter the OTC market to sell them, where there is counterparty risk.

To estimate the CCP premium, we take the yield spread of 6.75- and 7-year JGBs. Fig. 4 shows the time series of the yield spread of 6.75- and 7-year JGBs, constructed from the raw JGB yield data. This figure indicates that the spread started to widen during the crisis. In September 2008, the spread jumped drastically from about 0 % to 0.1 %, following the Lehman

¹² Unlike the US Treasury, the MOF has not issued 7-year JGBs; therefore, 7-year JGBs are always off-the-run.

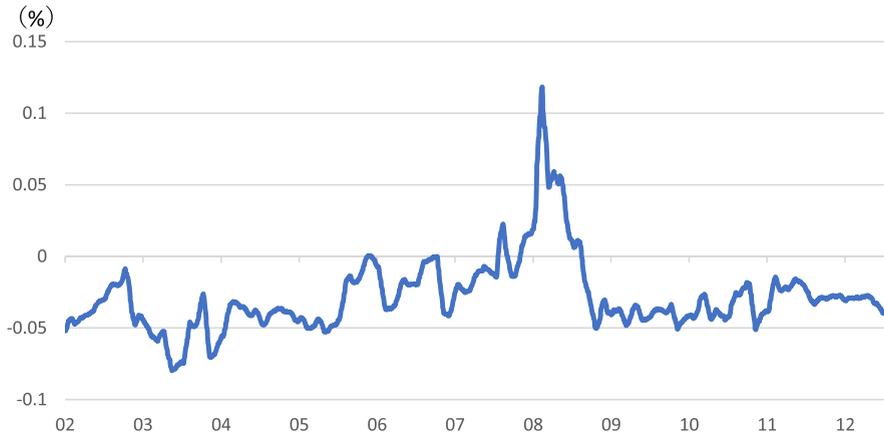


Fig. 4. The time series of the yield spread of 6.75- and 7-year JGBs. Notes: This graph shows the spread of 6.75- and 7-year JGBs with a 1-month moving average.

Table 2

Yield spread of 6.75- and 7-year JGBs in each year.

	2006	2007	2008	2009	2010	2011
6.75-year	1.500	1.391	1.122	0.893	0.655	0.654
7-year	1.524	1.409	1.098	0.916	0.695	0.684
Difference	-0.023	-0.018	0.024	-0.023	-0.040	-0.030

Note: This table shows 6.75-year and 7-year JGB yields and the yield spread.

Brothers collapse. After late 2009, the spread started to decrease and disappeared. During 2006–2007 and 2009–2011, the spread was around $-2 \sim -3$ basis points (Table 2). However, during 2008, the spread in this sector was 2 basis points.

4.2. Evaluating how the yield spread of 6.75-year and 7-year JGBs works as CCP premium

To interpret the yield spread of 7-year and 6.75-year JGBs as CCP premium, we model CCP premium based on Bernstein et al. (2019), who modeled government bond price as follows:

$$P_t = P_t^{Fun} - P_t^{CP} - P_t^{MktLq} + \varepsilon_t, \quad (1)$$

where P_t is the price that is not cleared in CCP, P_t^{Fun} is the fundamental value, P_t^{CP} is the discount caused by counterparty risk premium, P_t^{MktLq} is the discount caused by the market illiquidity premia, and ε_t is an error term. t indicates time.

We model the price not cleared in CCP as follows.

$$P_{t,E} = P_t^{Fun} - P_{t,E}^{MktLq} + \varepsilon_{t,E}, \quad (2)$$

Compared with eq. (1), eq. (2) does not include P_t^{CP} since CCP eliminates counterparty risk premium. By taking the difference between (1) and (2), we obtain the equation:

$$P_{t,E} - P_t = P_t^{CP} + P_t^{MktLq} - P_{t,E}^{MktLq} + \varepsilon_{t,E} - \varepsilon_t \quad (3)$$

We define $P_{t,E} - P_t$ as CCP premium and estimate the equation below:

$$CCPpremium_t = \alpha + \beta Counterpartyrisk_t + \gamma Liquidity_t + \delta Control_t + \varepsilon_t \quad (4)$$

When the counterparty risk premium increases, the unclear bond price (eq. (2)) will be lower, and counterparty risk premium should increase the CCP premium. Therefore, β is expected to be positive. As for liquidity premium, 7-year JGBs and 6.75-year JGBs are on-off-the run bonds, so the liquidity premium could be similar. But since 7-year JGBs have a linkage to JGB futures, their liquidity premium could be lower. Therefore, the sign of γ should be empirically investigated.

For the proxy of CCP premium, we take the yield difference between 7-year and 6.75-year JGB. We use LIBOR OIS spread and CDS premium as a proxy of counterparty risk. LIBOR OIS spread is commonly used as the counterparty risk.¹³ Since

¹³ The LIBOR OIS spread measures financial institutions' short-term default risk, which has been used as a proxy for counterparty risk in several studies (e.g., Taylor and Williams 2008; Baba and Packer 2009).

Bloomberg provides the CDS premiums of Nomura and Daiwa (among the largest investment banks in Japan), we use the average of these CDS premiums (financial CDS). *Liquidity*, reflects the difference between 7-year and 6.75-year JGBs, and both bonds are off the run and the difference is the linkage of JGB futures; we include the bid-ask spread of JGB futures as *Liquidity*.

4.3. Baseline estimation

The estimation result is shown in Table 3. For Column (1), LIBOR-OIS is used for Counterparty risk, while Financial CDS premium is used for Column (2). As the table shows, counterparty risk premium and liquidity premium significantly affect CCP premium. The signs of the estimates are also consistent with our prediction. The estimate of counterparty risk premium is significantly positive, while the estimate of the bid-ask spread is significantly positive, which suggests the liquidity of 7-year JGB is higher than 6.75-year JGB.

This explains why the CCP premium started to appreciate just before the financial crisis and started to decline afterward. Fig. 5 shows the time series of the counterparty risk premium and liquidity premium, indicating that these variables were higher during the crisis but declined afterward. After the crisis, CCP premium also declined since counterparty risk and liquidity premiums declined.

4.4. Actual settlement via CCP

Since the CCP premium appreciated during the crisis, we deduce that settlement via CCPs should increase during the crisis to avoid counterparty risk. The CCP settlement, especially during the crisis, is not necessarily observable, but the CCP settlement from JGB futures is observable since it is traded in the exchange market. As Hull (2017) describes, intending to use futures for hedging purposes, investors neutralize their position before maturity. If the investors use JGB futures for settle-

Table 3
The estimation result: Baseline.

	(1) LIBOR OIS	(2) Financial CDS
CounterpartyRisk	0.117*** (0.00628)	0.833*** (0.0826)
Bidaskspread	0.0637* (0.0369)	0.237*** (0.0601)
Constant	-0.0490*** (0.00137)	-0.0432*** (0.00185)
R-squared	0.4589	0.1201
Observations	2,616	2,616

Note: This result shows the estimation result when we regress the special premium of 7-year JGBs on the counterparty risk premium and liquidity premium. We use the LIBOR-OIS spread and CDS as the proxy for counterparty risk. The data are from Bloomberg and for daily basis. The OLS regression coefficients are reported. Robust standard errors with Newey–West are in parentheses (***) $p < 0.01$, ** $p < 0.05$).

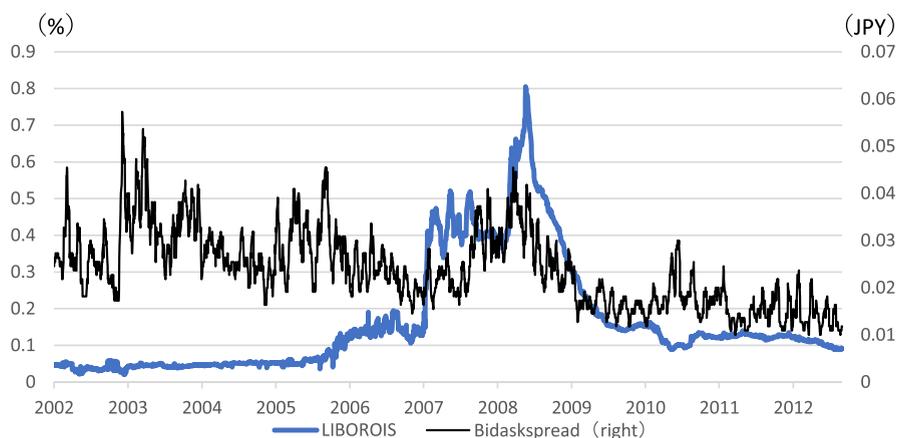


Fig. 5. The time series of the CCP premium and bid-ask spread of JGB futures. Note: This figure shows the LIBOR-OIS and Bid-ask spread of JGB futures. The data are obtained from Bloomberg.

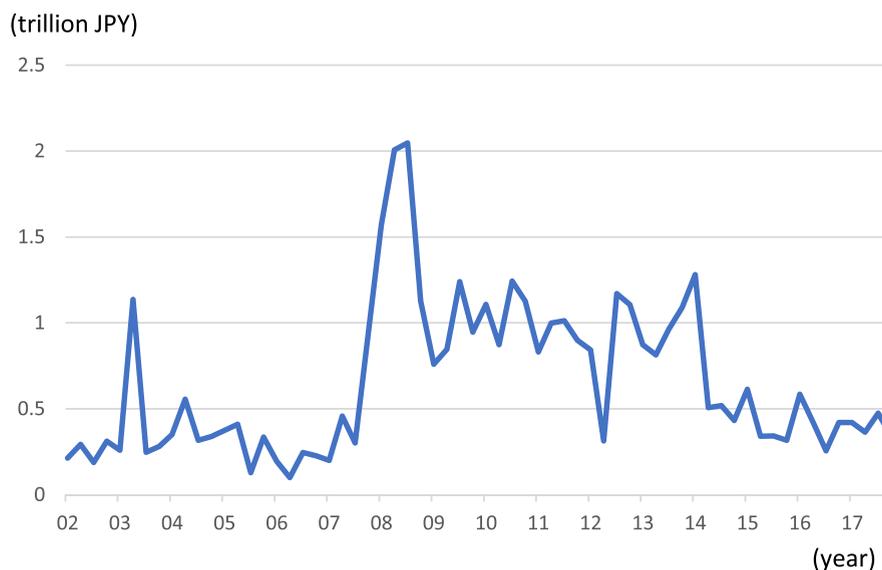


Fig. 6. Amount of JGBs delivered through the JSCC. Notes: The amount of JGBs delivered through JSCC is computed as open interests on the last trading day of each delivery month.

ment via CCP, the actual settlement increases during the crisis. However, if they use JGB futures for hedging purposes, they avoided the settlement by offsetting the position.¹⁴

Fig. 6 shows the actual amount of JGBs settled via CCP coming from the futures. The contract months of JGB futures are March, June, September, and December; thus, the data frequency is quarterly and are obtained from Bloomberg. In September 2008, the amount of settled JGBs in September 2008 jumped to 2.1 trillion JPY (19 billion USD), more than seven times larger than in previous years, providing empirical evidence that investors increased their settlement through CCPs during the crisis.

We also confirm the positive correlation between the CCP premium and the settlement. The estimated correlation is 0.35, and we can obtain a significant relationship at 5 % when we regress the CCP premium on the settlement via CCPs.¹⁵

5. Robustness check

In this section, we confirm that our baseline result is robust, using many control variables.

5.1. Control variables

(a) Degree of arbitrage among 7-year JGB and JGB futures

To control the degree of arbitrage among 7-year JGBs and JGB futures, we include the net basis of JGB futures and 7-year JGBs as a control variable. To capture the degree of arbitrage, “net basis” is widely used for JGB futures, and is defined as the deviation of forward and futures. In JGB futures, the settlement price is determined as “JGB futures price \times CF”; therefore, we can define the net basis as follow:

$$\text{Net basis} = 7\text{-year JGBs forward price} - \text{JGB futures price} \times \text{CF}$$

Hull (2017) writes, “For most purposes it is reasonable to assume that forward and futures prices are the same” (p.118). If the net basis deviates from zero, there could be an arbitrage opportunity; then, we control the net basis to capture the potential arbitrage opportunity.

To compute the JGB forward price, we follow the usual cost of carry model. According to Tuckman and Serrat (2011), the bond forward price is computed as “Cash JGB price - (Coupon income - Repo cost).” Note that we do not have to compute the compound yield because the frequency of coupon payment is 6 months, which is longer than the settlement of JGB forward (less than 3 months in this case). We use the general collateral (GC) repo rate for repo cost. We obtain the data of a net basis from Bloomberg.

(b) Potential Squeeze Proposed by Merrick et al. (2005)

¹⁴ To cancel JGB futures, they just have to take a opposite position of the current one.

¹⁵ *t*-statistics is 2.03, where the standard error is adjusted by Newey and West methodology.

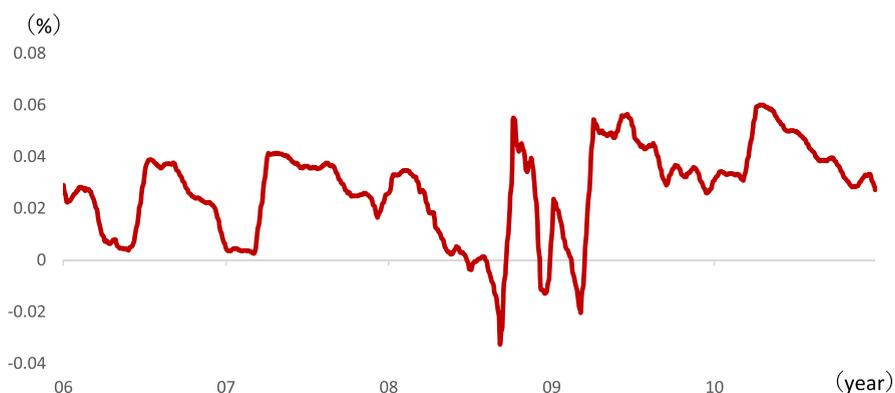


Fig. 7. Squeeze Potential. Note: This figure shows the squeeze potential proposed by Merrick et al. (2005). It is computed as the spread of 7-year and 7.25-year JGBs with a 1-month moving average.

Next, we control potential squeeze by using the measure of squeeze potential proposed by Merrick et al. (2005). Since bond futures use physical settlement, the buyers of JGB futures potentially buy up a lot of 7-year JGBs and avoid delivering them on the settlement day, called squeeze in bond futures. Since the sellers can select the bond to deliver among 7-year to 10-year JGBs, squeeze should be avoided. In addition, there is a special auction called liquidity enhancement auction, which mitigates the risk of squeeze (more on this in the next section).

Merrick et al. (2005) define potential squeeze as the difference between “forward price with squeeze” and “forward price with no squeeze.” In their analysis, Merrick et al. (2005) compare futures contract prices to their full-squeeze and no-squeeze values derived from the values of the first- and second-cheapest deliverable bonds (the relatively unattractive second choice). Following them, we compute the squeeze potential as the 7-year JGB yield spread and that of the relatively unattractive second choice bond in the deliverable basket—7.25-year JGBs. Fig. 7 shows the time series of squeeze potential.

(c) Dynamic effect

To capture the dynamic effect, we also include the lagged value of counterparty risk premium and liquidity premium, as below.

$$CCP_{premium_t} = \alpha + \beta_1 Counterpartyrisk_t + \beta_2 Counterpartyrisk_{t-1} + \gamma_1 Liquidity_t + \gamma_2 Liquidity_{t-1} + \delta Control_t + \varepsilon_t \quad (4)$$

(d) Settlement fails

We also include the settlement fails of JGBs as a control variable. Lehman Brothers was the primary dealer in the JGB market and bid in JGB auctions before their collapse, causing a huge number of settlement fails during the crisis. In September 2008, the MOF in Japan could not issue a planned 288.5 billion yen (\$2.7 billion) of government bonds because Lehman Brothers failed to pay.¹⁶

During the crisis, there was a strong perception of JGB trading counterparty risk in the OTC market. Due to Japan’s T + 3 settlement cycle, the counterparty risk also included the risk of failure to deliver securities on the scheduled date, called a “settlement fail.” Fig. 8 shows that settlement fails surged in September 2008, when Lehman Brother’s default on its settlement obligations triggered a rising number of fails for several days. The Bank of Japan (BOJ 2010) estimated that JGBs and other securities transactions worth several trillion JPY, to which Lehman Brothers was a counterparty, were suspended from the settlement because of their bankruptcy.

The data of the settlement fails are obtained from the BOJ. Note that the settlement fails are monthly data, so our estimation is monthly bases.

(e) Time dummies

As CCP premium could have time effects, we first include a monthly dummy. We also include the dummy of beginning and end of month, where the beginning dummy takes one for the first day of the month while the ending dummy takes one for the last day of the month. We include these dummies when we use daily data.

5.2. Estimation result

Table 4 shows the estimation result, which is consistent with our baseline result. Columns (1) to (3) show the result when the LIBOS OIS spread is used as the proxy of counterparty risk premium. The counterparty risk premium has a positive and significant effect at the 1% level, while the liquidity premium significantly increases the CCP premium at the 5–10% level except in Column (2). For control variables, the net basis has a significantly positive effect, and squeeze potential has a sig-

¹⁶ Lehman failure prevents ¥288.5 bln JGB issuance, <https://www.reuters.com/article/financial-lehman-japan/lehman-failure-prevents-y288-5-blm-jgb-issuance-idUST11999320080922>.

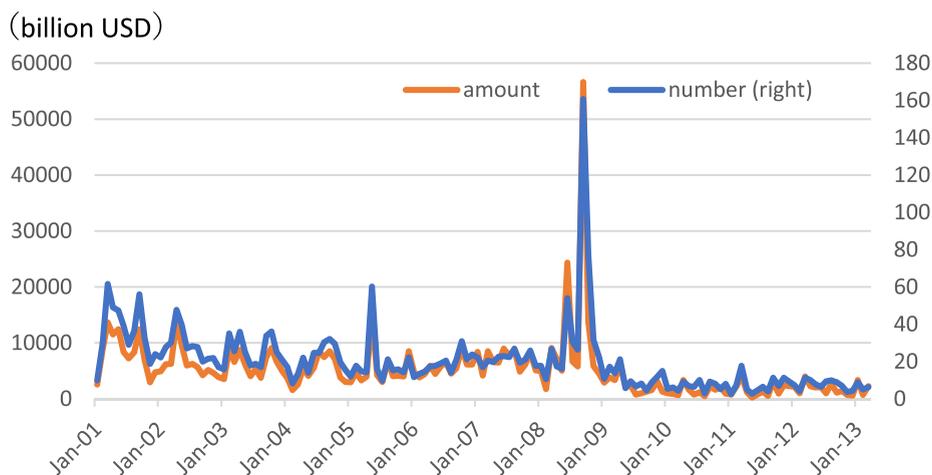


Fig. 8. Settlement Fails in the JGB Market. Note: This graph shows the settlement fails in the JGB market. Source: Bank of Japan.

Table 4

The estimation result with control variables (daily data).

	LIBOR OIS			Financial CDS				
	(1)	(2)	(3)	(4)	(5)	(6)	(5)	(6)
Counterparty	0.0843*** (0.00680)	0.267*** (0.0986)	0.244*** (0.0840)	0.465*** (0.0644)	9.535*** (2.884)	7.573*** (2.588)	40.94** (17.96)	21.62* (11.03)
Liquidity	0.0667** (0.0328)	0.0471 (0.0313)	0.0508* (0.0282)	0.166*** (0.0442)	0.188*** (0.0500)	0.136*** (0.0379)	13.20* (7.648)	10.26 (6.583)
netbasis	0.0413*** (0.00630)	0.0607*** (0.00877)	0.0412*** (0.00633)	0.0607*** (0.00877)		0.0581*** (0.00858)	0.0729 (1.627)	-1.032 (1.183)
Squeeze	-0.485*** (0.0539)	-0.740*** (0.0504)	-0.486*** (0.0538)	-0.740*** (0.0504)		-0.734*** (0.0486)	-23.45** (10.73)	-13.08 (9.544)
L.Counterparty		-0.150 (0.0969)	-0.160* (0.0830)		-8.670*** (2.865)	-7.078*** (2.570)		4.186*** (1.196)
L.Liquidity		0.0539 (0.0335)	0.0519* (0.0305)		0.187*** (0.0505)	-7.078*** (2.570)		10.08 (7.519)
Time dummy	Yes	Yes	Yes	Yes	Yes	Yes	No (9.113)	No (7.631)
Constant	-0.0375*** (0.00314)	-0.0497*** (0.00170)	-0.0380*** (0.00314)	-0.0262*** (0.00331)	-0.0468*** (0.00247)	-0.0282*** (0.00339)	-0.106 (0.549)	-0.929* (0.508)
R-squared	0.5735	0.4601	0.5757	0.4307	0.1436	0.445	0.4185	0.554
Observations	2,594	2,615	2,594	2,594	2,615	2,594	127	127

Note: This table shows the estimation result when we regress the special premium of 7-year JGBs on counterparty risk and liquidity premiums with control variables. We use the LIBOR-OIS spread and CDS as proxy for counterparty risk. The control variables are net basis, potential squeeze, time dummies, and the lag values of counterparty risk premium and liquidity premium. The data are from Bloomberg and for a daily basis. OLS regression coefficients are reported; robust standard errors with Newey-West are in parentheses (** $p < 0.01$, * $p < 0.05$).

nificantly negative effect. As for the dynamic effect, the lag value of counterparty premium and liquidity premium does not have a significant result.

Columns (4) to (6) show the result when financial CDS is used as proxy for counterparty risk premium. The result is mainly the same as before. Again, the counterparty risk premium has a positive and significant effect at the 1% level, while liquidity premium significantly increases CCP premium at 1%. The net basis and squeeze potential show a significant result, and so do the lag values of counterparty and liquidity premiums. Overall, counterparty risk premium and liquidity premium are significantly related to CCP premium, so we obtained the predicted result.

Table 5 shows the estimation when we control for settlement fails. Note that the number of samples is reduced under this estimation by using monthly data. Columns (1) to (2) show the result when the LIBOS OIS spread is used as proxy for counterparty risk premium. The estimation result is mainly the same as the previous result. The counterparty risk premium has a positive and significant effect. The liquidity premium is not significant, but the estimated coefficient is still positive. As for settlement fails, this variable has a significantly positive effect. Columns (3) to (4) show the result when financial CDS is used as the proxy for counterparty risk premium, which is significant only in Column (3), while the liquidity premium is significantly positive at 10%. Again, the signs of the estimated coefficients are all positive. The settlement fails are significantly positive at 1%.

Table 5

The estimation result with control variables (monthly data).

	LIBOR OIS		Financial CDS			
	(1)	(2)	(3)	(4)	(5)	(6)
Counterparty	5.094*** (1.365)	4.094* (2.443)	40.94** (17.96)	72.21 (49.06)	40.94** (17.96)	21.62* (11.03)
Liquidity	10.25 (6.780)	9.440 (6.808)	13.20* (7.648)	12.91* (7.499)	13.20* (7.648)	10.26 (6.583)
netbasis	-0.312 (1.358)	-0.666 (1.337)	0.0729 (1.627)	-0.329 (1.646)	0.0729 (1.627)	-1.032 (1.183)
Squeeze	-10.86 (9.572)	-12.36 (9.703)	-23.45** (10.73)	-25.01** (10.90)	-23.45** (10.73)	-13.08 (9.544)
L.Counterparty		1.022 (2.475)		-30.81 (38.71)		4.186*** (1.196)
L.Liquidity		9.135 (7.462)		12.41 (8.817)		10.08 (7.519)
Fail	25.91*** (7.498)	25.88*** (7.775)	41.34*** (9.113)	37.78*** (9.915)	41.34*** (9.113)	33.85*** (7.631)
Time dummy	NO	NO	NO	NO	No	No
Constant	-0.555 (0.457)	-0.701 (0.457)	-0.0262*** (0.00331)	-0.0468*** (0.00247)	-0.106 (0.549)	-0.929* (0.508)
R-squared	0.5408	0.5429	0.4185	0.554	0.4185	0.554
Observations	127	127	127	127	127	127

Note: This table shows the estimation result when we regress the special premium of 7-year JGBs on counterparty risk and liquidity premium with control variables. We use the LIBOR-OIS spread and CDS as proxy for counterparty risk. The control variables are net basis, potential squeeze, time dummies, and the lag values of the counterparty risk premium and liquidity premium. The data come from Bloomberg and are on a monthly basis. Also reported are the OLS regression coefficients. Robust standard errors with Newey-West are in parentheses (***) $p < 0.01$, ** $p < 0.05$.

6. Discussion

6.1. Why did the additional premium emerge in the JGB market but not in the US treasury market?

It is natural to ask why an additional premium emerged only in the 7-year JGB market. [Musto et al. \(2018\)](#) provide daily yield curve data for the US Treasury market on their website, showing the disparity between bonds (Treasury bonds with 30 years to maturity) and notes (all other coupon-paying US Treasury bonds), although there was no additional premium on the link to the futures market during the crisis in the US.

There are for the above results. First, the settlement cycle of the JGB market was much longer than in other advanced countries such as the US. This suggests that the JGB market counterparty risk was much higher than in the US Treasury market during the financial crisis. In particular, cash bonds contain settlement risk in terms of counterparty risk. BOJ (2010) measures settlement risk by multiplying the outstanding value of unsettled transitions by the duration to settlement. The settlement cycles of JGBs required $T + 3$ days during the crisis, which is two days longer than in the US market ($T + 1$ days), as shown in [Table 6](#). This suggests that the JGB counterparty risk should be three times higher than that of US Treasuries in terms of duration to settlement. As mentioned before, the default of Lehman Brothers caused a large number of settlement fails during the crisis.

Second, there have only been single bond futures in the JGB market, in sharp contrast to the US Treasury market. This practice creates a yield premium associated with the link to the futures market (7-year JGBs). In contrast, US Treasury futures are available for a wide range of maturities: 2-years, 5-years, 10-years, and 30-years. With these multiple bond futures, the deliverable basket of US Treasury futures covers almost all bonds and mitigates the additional premium associated with delivery through CCPs.

The Japan Government Bond Clearing Corporation (JGBCC), the former name of the JSCC, tried to make CCP clearing widely accepted in the JGB market, but failed. One of the reasons for this is that Japanese investors prefer bilateral trade and do not like the fails practice. As BOJ (2009, p. 24) writes, "Traditionally, some investors and financial institutions in Japan were reluctant to accept settlement fails due to a lack of knowledge on fails practice, or did not have the operational capability to process settlement fails."

Table 6

Settlement cycles in major countries in 2009.

Japan	US	UK	Germany
$T + 3$ ($T + 2$)	$T + 1$ ($T + 0$)	$T + 0$ ($T + 0$)	$T + 2$ ($T + 1$)

Notes: This table shows the settlement cycles in major countries during 2009.

Source: [Bank of Japan \(2010\)](#).

Table 7
Result of the liquidity enhancement auction during the global financial crisis.

Name	Auction Date	Amount of issuance	Year to Maturity	Name	Auction Date	Amount of issuance	Year to Maturity
10 year bond 258	2008/7/11	249	5.7	20 year bond 71	2008/9/4	9	15.8
10 year bond 260	2008/7/11	280	5.9	20 year bond 81	2008/9/4	31	17.0
10 year bond 272	2008/7/11	5	7.2	20 year bond 82	2008/9/4	40	17.0
10 year bond 273	2008/7/11	5	7.2	20 year bond 84	2008/9/4	20	17.3
10 year bond 274	2008/7/11	30	7.4	20 year bond 85	2008/9/4	90	17.5
10 year bond 276	2008/7/11	30	7.4	20 year bond 86	2008/9/4	35	17.5
10 year bond 277	2008/7/11	10	7.7	20 year bond 92	2008/9/4	10	18.3
10 year bond 278	2008/7/11	10	7.7	30 year bond 1	2008/9/4	4	21.0
10 year bond 279	2008/7/11	10	7.7	30 year bond 9	2008/9/4	3	24.3
20 year bond 43	2008/7/11	16	11.2	30 year bond 10	2008/9/4	9	24.5
20 year bond 44	2008/7/11	120	11.7	30 year bond 13	2008/9/4	10	25.3
20 year bond 45	2008/7/11	18	11.7	30 year bond 21	2008/9/4	20	27.3
20 year bond 46	2008/7/11	135	12.0	30 year bond 25	2008/9/4	384	28.3
20 year bond 47	2008/7/11	37	12.2	20 year bond 45	2008/10/10	33	11.4
20 year bond 52	2008/7/11	3	13.2	20 year bond 57	2008/10/10	194	13.7
20 year bond 53	2008/7/11	1	13.5	20 year bond 58	2008/10/10	194	14.0
20 year bond 54	2008/7/11	40	13.5	20 year bond 61	2008/10/10	44	14.4
20 year bond 67	2008/8/8	2	15.6	20 year bond 62	2008/10/10	129	14.7
20 year bond 69	2008/8/8	7	15.6	20 year bond 63	2008/10/10	120	14.7
20 year bond 70	2008/8/8	1	15.9	20 year bond 64	2008/10/10	286	15.0
20 year bond 72	2008/8/8	2	16.1	20 year bond 67	2008/10/10	100	15.4
20 year bond 81	2008/8/8	20	17.1	20 year bond 69	2008/10/10	234	15.4
20 year bond 82	2008/8/8	5	17.1	20 year bond 70	2008/10/10	35	15.7
20 year bond 83	2008/8/8	197	17.4	20 year bond 76	2008/10/10	3	16.4
20 year bond 84	2008/8/8	15	17.4	20 year bond 83	2008/10/10	136	17.2
20 year bond 85	2008/8/8	727	17.6	20 year bond 84	2008/10/10	40	17.2
20 year bond 86	2008/8/8	15	17.6	20 year bond 85	2008/10/10	260	17.4
30 year bond 21	2008/8/8	7	23.8	30 year bond 10	2008/10/10	100	24.4
20 year bond 67	2008/9/4	285	15.5	30 year bond 13	2008/10/10	30	25.2
20 year bond 69	2008/9/4	49	15.5	30 year bond 25	2008/10/10	60	28.2

Note: 10-year bond 272 and 273 are CTD.

Source: Ministry of Finance, Japan.

6.2. Special JGB auction for preventing squeezes: liquidity enhancement auction

In April 2006, the Japanese government introduced the unique liquidity enhancement auction, which allows the reissuance of old JGBs that have structural liquidity shortages or temporary liquidity shortages because of increasing demand such as during a squeeze.¹⁷ This means that even if the squeezer attempts to make a profit by restricting the supply of 7-year JGB, investors can ask the MOF to issue the squeezed bonds. This mechanism drastically mitigates the possibility of a squeeze.

From 2007 to 2009, investors in the JGB market could purchase 10 billion JPY of “potentially squeezed bonds” every month. However, investors did not request purchases of 7-year JGBs during the crisis. Table 7 describes the results of liquidity enhancement auctions from July 2008 to October 2008, which clearly shows that investors did not require 7-year JGBs even though they could purchase CTD bonds. During this period, the amount of 7-year JGBs required by investors from liquidity enhancement auctions was only 0.2 % of the total issuance.

7. Conclusion

This study captures the role of CCPs using the JGB market during the financial crisis of 2008–2009. The literature investigates how CCPs affect asset prices during the crisis, but we demonstrate that CCP premiums started to appreciate in times of stress, the first empirical evidence on this issue as far as we know. We compared 6.75-year and 7-year JGB yields to extract the CCP premium, and demonstrated that the estimated CCP premium started to increase during the crisis and went back to normal once it ended.

Furthermore, we show the investors increased the settlement via CCPs drastically. Usually, investors neutralize their position before maturity, but investors did select the settlement via CCP that increased during the crisis, which is clear evidence that the investors demanded CCP clearing due to the crisis. The settlement, especially during the crisis, is not necessarily observable, but JGB futures allow us to observe CCP settlement since it is traded in the exchange market.

¹⁷ The yield-spread-competitive auction under the conventional method for JGB Market Special Participants is used for liquidity enhancement auctions. See MOF (2017) for details of the liquidity enhancement auction.

To confirm that this spread works as a CCP premium, we use [Bernstein et al. \(2019\)](#)'s model, and show the spreads are theoretically related to the counterparty risk and liquidity premiums. First, we show theoretically consistent empirical results, where these two premiums are empirically related to the spread of 6.75-year and 7-year JGB yields. Then, we show that our result is robust using many control variables such as net basis, potential squeeze, and settlement fails.

Japan's recent financial regulation reform attempts to foster trading in OTC derivatives cleared through CCPs. We find that CCP premium clearly increased during the crisis but did not exist before and after, which also reinforces the theoretical prediction of CCP's function. In addition, we demonstrate that investors actually preferred central clearing during the crisis. In this sense, our results support the effectiveness of recent financial regulation reforms and provide empirical justification for Japan's recent reform of financial regulation.

One of the reasons why the CCP premium appreciated during the crisis is the longer settlement cycle in the JGB market, but note that since the crisis, the settlement cycle in JGB has been shortened. The settlement cycles in JGBs were much longer than the other advanced countries during the crisis, which created the CCP premium. JSCC continued to shorten the settlement cycle, which has been T + 1 from 2020, the same level as in other advanced countries.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: The authors declare that the authors did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors except for the database provided by the University of Tokyo. This work was supported by the fund from the University of Tokyo and Japan Society for the Promotion of Science (JSPS) KAKENHI Grant-in-Aid (21K13321).

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Appendix

See [Fig. A1](#).

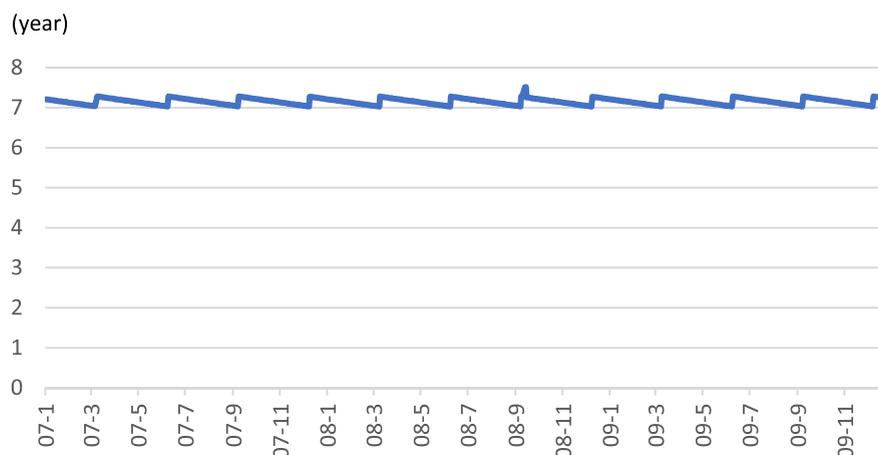


Fig. A1. The maturity of Cheapest to Deliver (CTD) in JGB futures from January 2007 to December 2009. Note: This graph shows the CTD of 10-year JGB futures. The CTD is chosen from the JGBs of more than 7 years' to less than 11 years' maturity. It is computed using coupon rates, prices, and years to maturity. Source: Bloomberg.

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