Macroeconomic announcements and liquidity
―Evidence from JGB Futures market―

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Abstract

This paper presents an investigation of whether liquidity changes on event days, when macroeconomic indicators are announced, and on non-event days in the Japanese Government Bond (JGB) Futures market of the Tokyo Stock Exchange (TSE). Consequently, the following shows about the macroeconomic announcement event effect. First, as for ILLIQ, which is an indicator of liquidity, ILLIQ increases along with announcement of macroeconomic indicators, which means that liquidity falls in a market. Moreover, regarding transaction costs (Spreads), they decrease with announcement of macroeconomic indicators. Therefore, liquidity rises in a market. Furthermore, as for risk (Volatility) in JGB Futures market, volatility becomes large by announcement of macroeconomic indicators, which means that liquidity falls in the JGB Futures market.

JEL classification: G14; G12; G13
Keywords: Macroeconomic announcement; Liquidity; Transaction costs; Risk

1. Introduction

This paper presents an investigation of whether liquidity is changing on an event day, when macroeconomic indicators are announced, and on a non-event day.

Until now, many studies related to liquidity research have been described in the literature. Research in this field has progressed briskly since Kyle (1985). The study of latent liquidity is one example. Mahanti and et al. (2008) estimated latent liquidity of corporate bonds as the weighted average efficiency of the investment horizon of a corporate bond holder, and reported that correlation exists that is strong between latent liquidity and transaction cost, or and Spread. Moreover, ILLIQ of Amihud (2002) used for this study is one which are researched briskly. The liquidity in the market is high, which means that an investor's market participation is easy.

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When liquidity is low, it will be difficult for an investor to carry out market participation. Then, the liquidity definition is checked again here. As O'Hara (1995) shows, the state in which trade can be conducted at the minimum cost is a high-liquidity state, transaction costs become small, and liquidity will improve.

The purpose of this paper is to clarify liquidity and the announcement of macroeconomic indicators. To date, many studies have verified the announcement effect, specifically examining volatility. They analyze market efficiency. For example, Arshanapalli et al. (2006), Wang, Wang, and Liu (2005), and Ederington and Lee (2001) investigated whether a difference would have occurred in return volatility when macroeconomic indicators are announced. This paper clarifies the mutual relation of macroeconomic indicator announcement, liquidity, and volatility.

Consequently, the following is shown for the macroeconomic announcement event effect. First, regarding ILLIQ, which is an indicator of liquidity, ILLIQ increases by announcing macroeconomic indicators, which means that liquidity in the JGB Futures market falls. Moreover, when transaction costs (Spreads) are investigated, transaction costs become small by announcement of macroeconomic indicators. Therefore, the market liquidity rises. Furthermore, as for risk (Volatility) in JGB Futures market, volatility becomes large by announcement of macroeconomic indicators, which means that liquidity falls in the JGB Futures market.

This paper proceeds as follows. Section 2 explains liquidity measurements and other variables used for this study. Section 3 presents models of the empirical framework used for this study. Section 4 explains the data used for analyses and the microstructure of the JGB Futures market. Section 5 presents empirical results. Finally, Section 6 concludes this study.

2. Measurements of liquidity and other variables

Liquidity

Many previous studies have described the concept of liquidity and measurements of that in securities market[2]. Therefore, in this paper, the liquidity index (ILLIQ) proposed by Amihud (2002) is used. The ILLIQ advocated by Amihud is a liquidity index showing the influence (Price impact), that it has on the stock price per trading value unit. This price impact becomes small, as liquidity increases.

ILLIQ in this paper is the averaged value per day. The absolute value of a return per minute is divided by the volume at the interval. This also expresses the rate of change of the market price to volume of JGB Futures: ILLIQ computed by the following formula will be so small that the price impact is small. A small ILLIQ signifies that market liquidity is high.

[2] For instance, Garman (1976), Copeland and Galai (1983), Glosten and Milgrom (1985), Easley and O'Hara (1987), Amihud and Mendelson (1987, 1991a,b), Admati and Pfleiderer (1988), Subrahmanyam (1991), Stoll and Whaley (1990), and Huang and Stoll (1994, 1996), Mahanti et al. (2008).

Liquidity measure: ILLIQt

$$ILLIQ_t = \frac{1}{417}\sum_{j=1}^{417}\frac{|R_{t,j}|}{Volume_{t,j}}$$

Rt,j: *j* expresses the one-day data total; *t* expresses the *t*-th in *j*. Therefore, *Rt,j* expresses the return of the JGB Futures price of the *t*-th interval in *j*. V*olume t,j*: this expresses the *t*-th Volume in *j* data.

Transaction costs

O'Hara (1995) defines liquidity as follows. The state in Liquidity is high when trading can be conducted with minimum costs. The minimum costs mean that Spreads are narrow. Furthermore, minimum cost means that volatility is low. Usually Spreads are defined by the difference of the bid-price and ask-price. The following Effective Spread is used for this study[3].

Effective Spread (*St*)

$$S_t = |P_t - Q_t| \times 2$$

$$Q_t = (a_t + b_t)/2$$

Therein, *St* represents an Effective Spread, *Pt* expresses a contracted price, *Qt* signifies a middle quote, a_t denotes Ask-Price, and b_t stands for the bid-price. Moreover, in terms of market microstructure, a Spread is interpreted as an investor's transaction cost. The Spread widens, which means that transaction costs become large. In contrast, concomitantly with the Spread narrowing, transaction costs become small.

The reason why Spreads are transaction costs is the following. The investor considers the possibility of dealing with an investor who has information (An information trader, an informed trader), when placing an order (bid-price or ask-price). Therefore, when issuing a selling order, an investor considers the possibility that the information trader will have better information and will take out the limit order at a lower price. Then, if an investor does not take out a limit order at an even lower price, then he cannot trade. Conversely, an investor taking out a buy order can be considered. Because it becomes impossible to trade when an information trader places an order for a higher price, an investor will take out a limit order exceeding it. As described above,

[3] Effective half Spreads are also used in this paper. The transaction cost is usually measured using the bid–ask spread. However, when that measure is used, the transaction costs of the investor who orders the bid and the investor who orders the ask are calculated twice, as a “round-trip transaction”.

a liquidity trader will place an order high (at buying order) or low (at selling order) rather than the price that is being considered. Therefore, a Spread will widen, imposing a higher transaction cost.

Transitory volatility

Volatility, a risk index of dealings, is measured by the standard deviation of returns. If an investor is risk-averse she might like to perform dealings at trading hours when volatility is low. Liquidity is low at the time when volatility increases and liquidity is high at the time when volatility decreases. In this paper, the transitory volatility described by Ranaldo (2004) is used . In Ranaldo, the standard deviation is calculated at *t*-interval using the 20-lag return. Then he uses those as a representation of volatility ($Vola_t$). This paper adopts the same representation[4].

3. Models

As described in this paper, the influence on the liquidity by the announcement of macroeconomic indicators is analyzed. This section explains each index and the models used for this study.

To analyze the event effect, each index is measured, respectively, on an event day and on a non-event day. Furthermore, whether a significant effect in each index exists is verified using a dummy variable of macroeconomic announcements. The validation (verification) methodology of the event effect is explained.

Hypothesis 1

NH1: ILLIQ is smaller on an event day than on a non-event day.

As described in this paper, by event generation, risk increases, which implies that liquidity becomes low: Therefore, on a non-event day, ILLIQ is small; ILLIQ takes a larger value on an event day.

Model 1

$$ILLIQ_t = a_0 + a_1 ILLIQ_{t-1} + a_2 D_t + e_t$$

Therein, *Dt* is a dummy variable that takes a value of 1 on the day when macroeconomic indicators are announced; it takes a value of 0 on other days. *ILLIQt-1* is the 1-lag value of *ILLIQt*[5]. If the coefficient ($\mathbf{a_2}$) of this dummy variable is positive and significant, then ILLIQ

[4] To check robustness, the volatility of lag [of 10 terms] and 30 terms and 50 terms is also calculated and analyzed in this paper.

[5] This paper adopted the first order auto-regressive model in ILLIQ, Spreads and Volatility as well, but it needs to check another order models. This is the challenge in the next revision.

increases by event generation. From this result, it can be proven that liquidity decreases because of the announcement of macroeconomic indicators.

Hypothesis 2

NH2: Transaction costs (Spreads) are smaller on an event day than on a non-event day.

As described in this paper, it is considered that Spreads become large by event generation.

However, when the announcement is an expected event (i.e., when an announcement’s information is expected or the information is already discounted in the market price), an investor's reaction might become uniform and Spreads might become the same level or become narrower than on a non-event day.

Model 2

$$S_t = b_0 + b_1 S_{t-1} + b_2 D_t + e_t$$

In that equation, D_t stands for a dummy variable that takes a value of 1 on the day when macroeconomic indicators are announced and which takes a value of 0 on other days. Furthermore, S_{t-1} is 1-lag value of S_t. If the coefficient (**b_2**) of this dummy variable is positive and significant, then S_t increases by event generation. According to O'Hara’s definition, by this result, it is proved that liquidity falls by the announcement of macroeconomic indicators.

Hypothesis 3

NH3: Volatility (transitory volatility) is smaller on an event day than on a non-event day.

As described in this paper, it is considered that volatility becomes large by event generation.

However, because it is the same as Spreads, when the announcement is the expected event (i.e., when an announcement’s information is expected or the information is already discounted in the market price), an investor's reaction might become uniform and Spreads might become the same level or become narrower than on a non-event day.

Model 3

$$Volq_t = c_0 + c_1 Volq_{t-1} + c_2 D_t + e_t$$

In that equation, D_t is a dummy variable that takes a value of 1 on the day when macroeconomic indicators are announced and which takes a value of 0 on other days. Moreover, $Vola_{t-1}$ denotes the 1-lag value of $Vola_t$. If the coefficient (**c_2**) of this dummy variable is positive and significant, then $Vola_t$ increases by event generation. According to O'Hara's definition, by this result it can be proven that liquidity falls by the announcement of macroeconomic indicators.

Expected Sign conditions

Table 1 shows that the expected signs of coefficients of the event dummy (D_t) used by the model 1-3 are positive.

Table 1. Expected Sign condition in event effects

	a_2	**b_2**	**c_2**
Model 1	+		
Model 2		+	
Model 3			+

4. Data and microstructure of the JGB Futures market

Sample period

The sample period used for this study is April 2, 2003 – March 31, 2004. The transactions business days in this sample period constitute 244 days.

Trading hours of data used for this study

When the data sample is created for each minute through following three transaction sessions, they will include 417 samples in a single day: morning session, 9:01 a.m. – 10:59 a.m.; afternoon session, 12:31 p.m. – 14:59 p.m.; and evening session, 15:31 p.m. – 17:59 p.m.

There are 244 transactions business days in this study's sample period. The total number of samples is 101,748. Table 3 presents statistics related to each variable.

Table 3. Statistics of respective variables

	ILLIQ	Effective half Spread	Effective Spread	Vola_20
Average	3.0991E-05	0.614257774	1.228515548	0.00010876
Standard deviation	2.09097E-05	0.504984601	1.009969202	0.000110997
Variance	4.37215E-10	0.255009447	1.02003779	1.23203E-08
Kurtosis	3.524063237	2009.761681	2009.761681	48.02646986
Skewness	1.543415848	30.75442173	30.75442173	4.795214636
Minimum	4.88586E-06	0	0	0
Maximum	0.00014528	47.5	95	0.00219223
Total number of samples	101748	101748	101748	101748

Market microstructure of JGB Futures

JGB Futures data were extracted from "Nikkei NEEDS" (Tick Saiken Sakimono Option). This paper creates sample data for the contract price, volume, and quote price in units of 1 min. When a deal not established during a certain interval and the contracted price is not indicated to book, the contracted price in 1-lag of the interval is used. The JGB Futures market has three trading sessions: morning session, 9:00 a.m. – 11:00 a.m.; afternoon session, 12:30 p.m. – 15:00 p.m.; and evening session, 15:30 p.m. – 18:00 p.m.

Moreover, JGB Futures trading has adopted two matching methods, known as “ITAYOSE[6]” and “ZARABA[7]”. Only the data of intraday trading (ZARABA) are used for this study, thereby removing the influence of the high volume that occurs by ITAYOSE. However, in data of the next intervals, ITAYOSE might not necessarily be conducted. For this study, the following data

[6] The Itayose is used mainly to determine the opening and closing prices of each trading session. The method is used when the market opens and when the market closes. YORITUKI and HIKE (A total of six times) in the morning session (9:00, 11:00), afternoon session (12:30, 15:00) and evening session (15:30, 18:00) have adapted ITAYOSE. At the opening, all quotes (orders) before the contract price are recorded in the order book. They are considered to be simultaneous orders. Each is matched from the highest price order with a high priority level (price priority principle). Moreover, the prices that match quantitatively are decided. The chosen price is assumed to be a single contract price. The bargain (transaction) is concluded with the decided price.

[7] The Zaraba method is used during trading sessions to match orders continuously under price priority and time-precedence principles. This is a method used during transaction times other than opening or closing. After the opening price is decided, this Zaraba method is used until the closing price is decided. Each contract is concluded individually on a first-come-first-served basis during the transaction session; many contract prices are decided continuously.

are removed: 9:00, 11:00, 12:00, 12:30, 15:00, 15:30, and 18:00. Then, this paper uses the data in 9:01 a.m. – 10:59 a.m. and 12:31 p.m. – 14:59 p.m. and 15:31 p.m. – 17:59 p.m.

5. Empirical results

First, using Figs. 1–8, the event effects attributable to the announcement of macroeconomic indicators to each index can be checked visually.

Visual understanding

Here, the changes within one day of ILLIQ, Spreads, and volatility can be observed from Figs. 1–8. Particularly, ILLIQ shows the shape of an upstream shoulder. The Spread and volatility show a U-shape.

ILLIQ on event days and non-event days

First, ILLIQ of a non-event day is compared with ILLIQ of an event day. Then, from the data for ILLIQ non-event dates, it is apparent that the shape is downward-sloping. From the explanation above, this paper describes the salient impact of events on ILLIQ. The resultant average of the ILLIQ on event days and ILLIQ on non-event days is upward-sloping.

Fig. 1 ILLIQ intraday pattern.

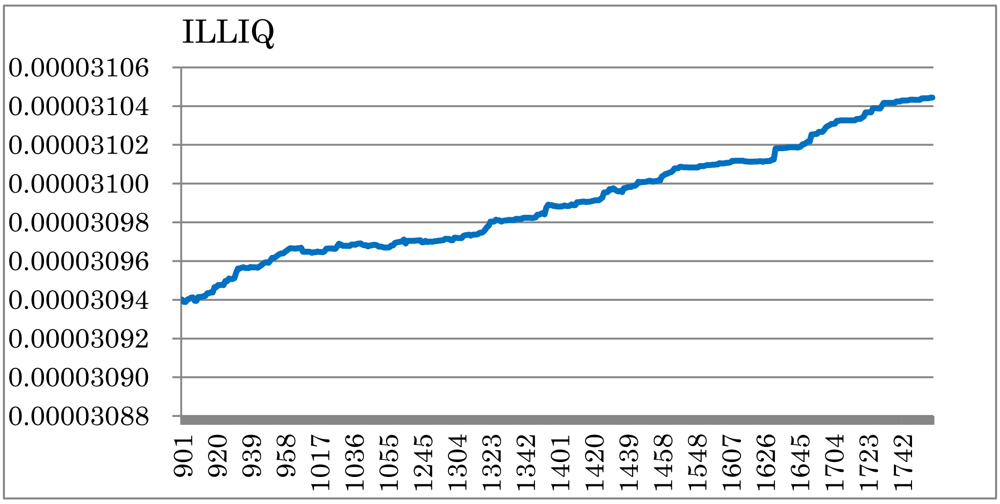
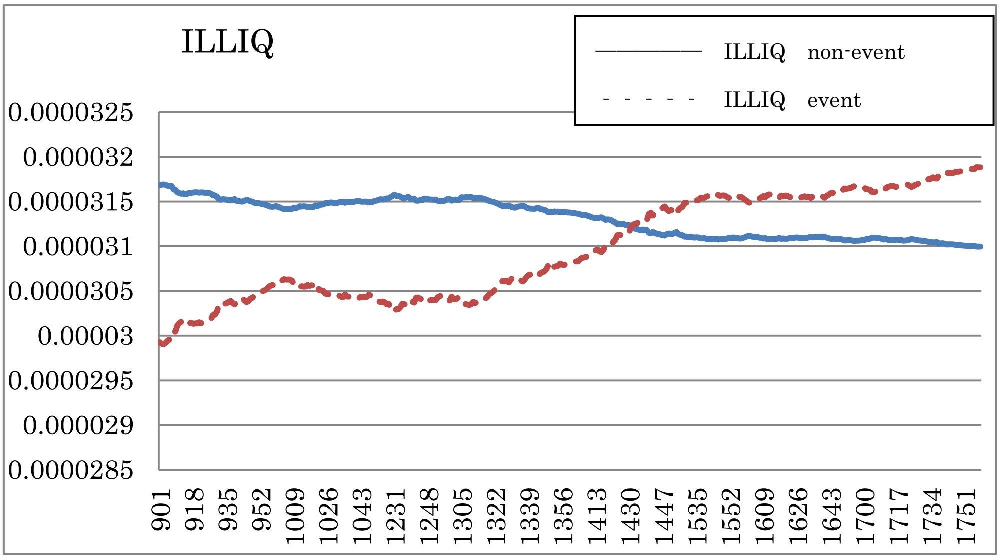


Fig. 2 ILLIQ intraday patterns: event day vs. non-event day.



Effective half Spreads

The intraday pattern of Effective half Spreads is depicted in Fig. 3. Figure 4 shows the intraday pattern of Effective half Spreads on event days and on non-event days.

Moreover, the values of ILLIQ on event days are higher than those of ILLIQ on non-event days: percentage is 41%. The Spreads of 173 of 417 data show higher values on event days than on non-event days.

Fig. 3 Effective half Spreads intraday pattern.

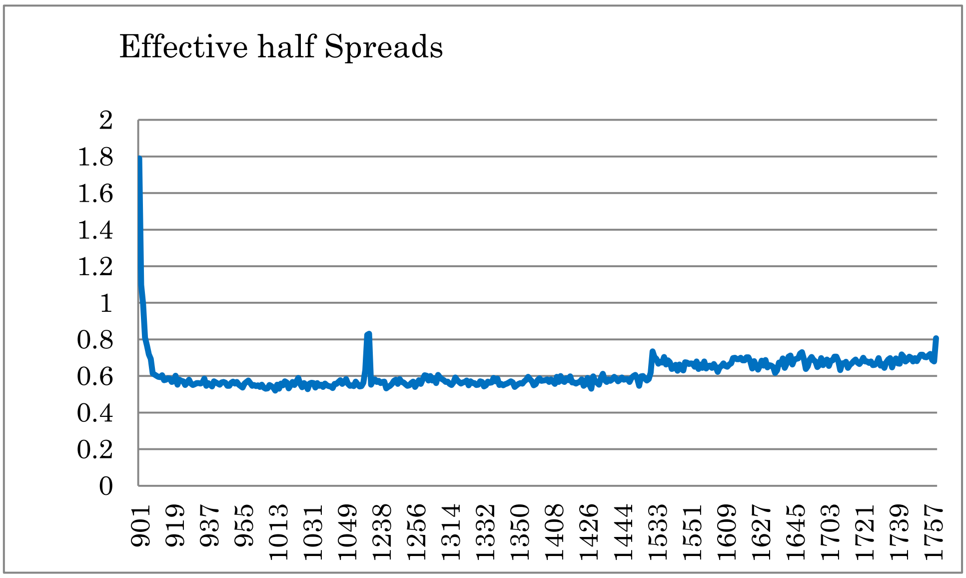
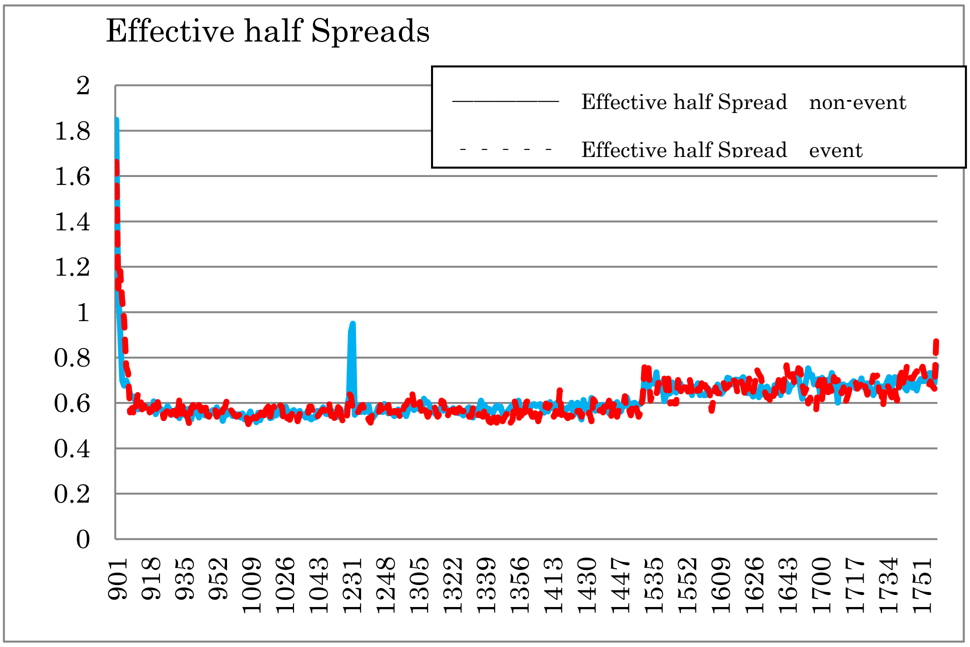


Fig. 4 Effective half Spreads intraday patterns on event days and on non-event days.



Effective Spreads

The intraday pattern of Effective Spreads is presented in Fig. 5. Figure 6 shows the intraday pattern of Effective Spreads on event days and on the non-event days.

When the Effective Spread is examined, the values of ILLIQ on event days are higher than those of ILLIQ on non-event days: percentage is 41%. The Spreads of 173 of 417 data show higher values on event days than on non-event days.

Fig. 5 Effective Spreads intraday pattern.

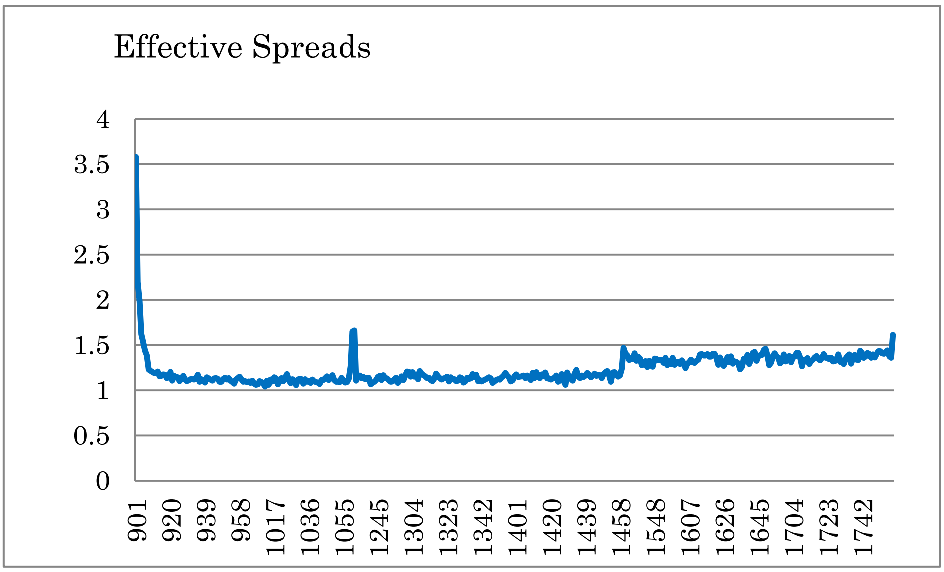
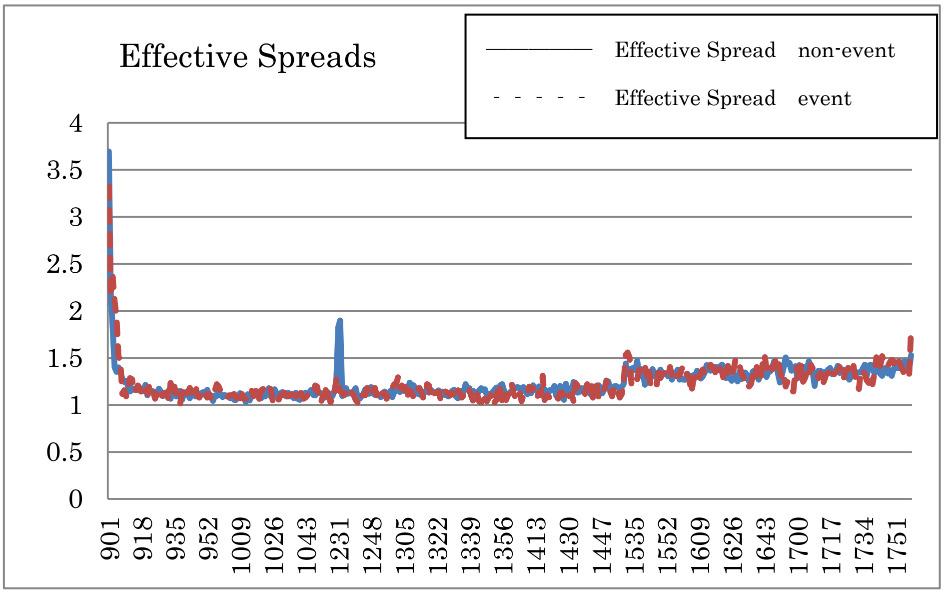


Fig. 6 Effective Spreads intraday patterns on event days and on non-event days.



Volatility_20

The intraday pattern of Volatility_20 is portrayed in Fig. 7. Figure 8 displays the intraday pattern of Volatility_20 on event days and on non-event days. When the Volatility_20 is examined, the percentages of Volatility_20 on event days are larger than on non-event days: 53%. The Volatility_20 of 221 in 417 data show the larger value on event days than on non-event days.

Fig. 7 Volatility_20 intraday pattern.

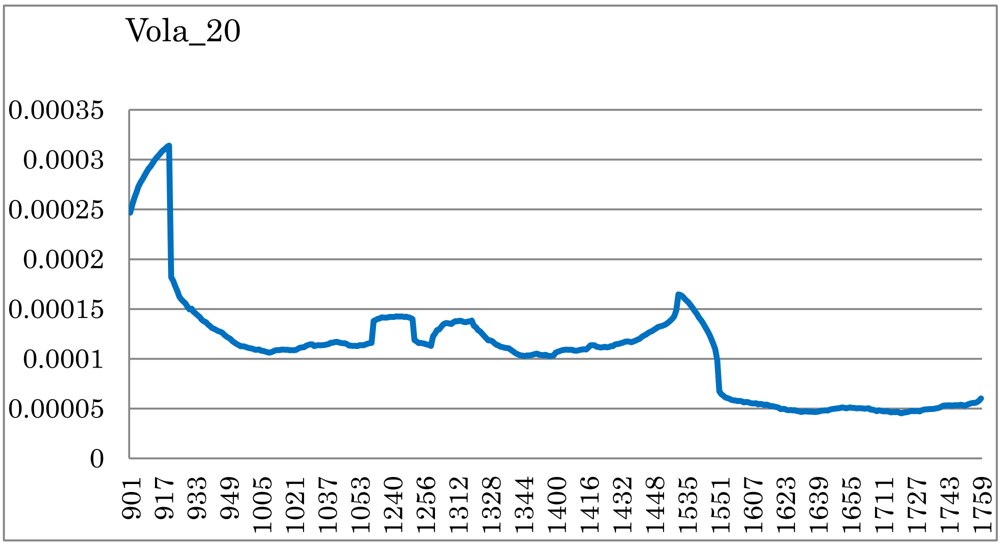
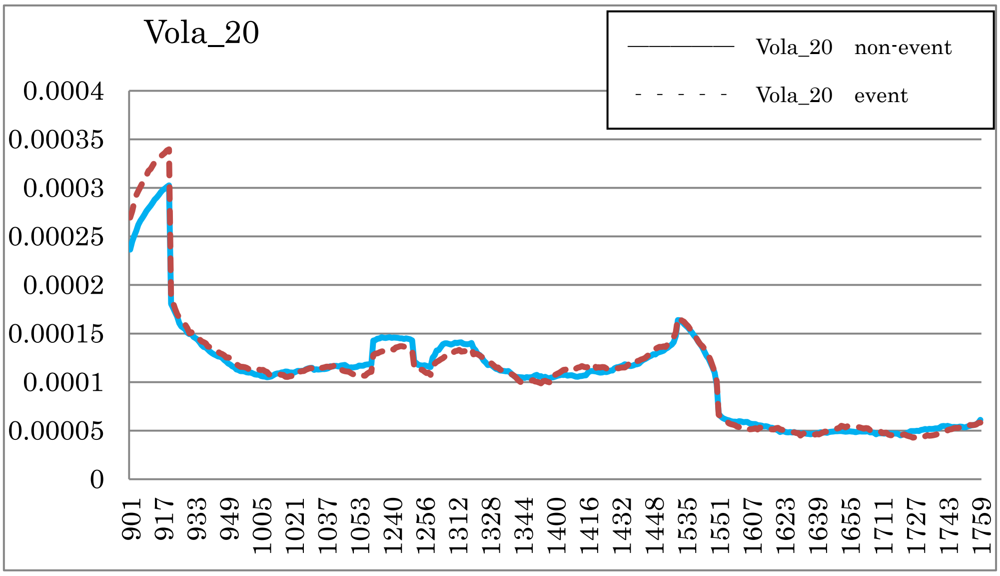


Fig. 8 Volatility_20 intraday patterns on event days and on non-event days.



Results of hypotheses testing (*t*-test)

Next, this paper presents results of analyses using *t*-tests to ascertain whether each index has a significant difference between activity on event days and on non-event days. As Table 4 shows, a significant difference from ILLIQ on event days and on non-event days can be confirmed. Based on this result, Liquidity in the JGB Futures market has been shown to change significantly on the announcement day of macroeconomic indexes. However, no significant difference was found in either Spreads or Volatility, as shown in Table 5, Table 6, and Table 7. Regarding the result of a Spread and Volatility, the following is inferred. When the announcement is an expected event (i.e., when the announcement information is expected or is already factored into the market price), investors' reactions might be uniform and Spreads and Volatility might become the same level or become narrower and smaller than on a non-event day.

Table 4. ILLIQ (*t*-test)

	ILLIQ non-event	ILLIQ event
Average	3.13101E-05	3.0967E-05
Variance	4.3084E-14	3.34148E-13
Total number of samples	417	417
t-value	-121.5833342 ***	
P-value	0	

*** is significant at the 1% significance level.

Table 5. Effective half Spreads (*t*-test)

	Effective half Spreads non-event	Effective half Spreads event
Average	0.615093639	0.611012489
Variance	0.008263093	0.009056301
Total number of samples	417	417
t-value	0.012591972	
P-value	0.494978176	

Table 6. Effective half Spreads (*t*-test)

	Effective Spreads non-event	Effective Spreads event
Average	1.230187279	1.222024977
Variance	0.033052373	0.036225205
Total number of samples	417	417
t-value	-0.142575854	
P-value	0.443329885	

Table 7. Volatility_20 (*t*-test)

	Vola20 non-event	Vola20 event
Average	0.000108497	0.000109341
Variance	2.71235E-09	3.38713E-09
Total number of samples	417	417
t-value	-0.48229538	
P-value	0.314862263	

Results of event effects

Next, the effects are verified using the event dummy of macroeconomic indicators. Table 8, Table 9, Table 10, and Table 11 respectively present results obtained using model 1, model 2, and model 3. Consequently, although ILLIQ has been affected significantly and positively on the event days is confirmed, the significant event effect is not reflected in the transaction costs (Spreads) and in the risk (volatility).

ILLIQ

As shown in Table 8, the coefficient of the event dummy is positive and significant. As this result clarifies, ILLIQ increases when an announcement of macroeconomic indicators occurs, which reflects that the liquidity in the market falls on the days with announcement of macroeconomic indicators. Liquidity changes clearly on those days.

Table 8. Model 1 $ILLIQ_t = a_0 + a_1 ILLIQ_{t-1} + a_2 D_t + e_t$

Explained variable, ILLIQ (*t*);

Explanatory variable, ILLIQ (*t*–1) and event dummy

	coefficient	Std	*P*-value
α0	4.21E-10	1.56E-09	0.786911
ILLIQ*t*–1	0.999924 ***	3.87E-05	0
Event dummy	7.08E-09 ***	1.74E-09	4.83E-05
Adjusted R^2	0.999849		
Total number of samples	101,331		

*** is significant at 1% significance level. The number of observations is 101,331. It is impossible to use single-day (417) data to produce a first-order regression model.

Transaction costs (Spreads)

As presented in Table 9 and in Table 10, the coefficients of the event dummy are not significant. However, the coefficients of an event dummy are negative in the Effective half Spread and Effective Spread, which shows the possibility that transaction costs will decrease when an event occurs. This result means the following. Liquidity in market becomes low, as Spreads become smaller on event days.

Table 9. Model 2 $S_t = b_0 + b_1 S_{t-1} + b_2 D_t + e_t$

Explained variable, Effective half Spread (*t*-1);

Explanatory variable, Effective half Spread (*t*-1) and event dummy

	coefficient		Std	*P*-value
b0	0.299781	***	0.002338	0
Effective half Spread (*t*-1)	0.51304	***	0.002697	0
Event dummy	-0.0014		0.002943	0.634296
Adjusted R^2	0.263201			
Total number of samples	101,331			

*** is significant at 1% significance level. The number of observations is 101,331. It is impossible to use single-day data (417) to produce a first-order regression model.

Table 10. Model 2' $S_t = b_0 + b_1 S_{t-1} + b_2 D_t + e_t$

Explained variable, Effective Spread (*t*-1);

Explanatory variable, Effective Spread (*t*-1) and event dummy

	coefficient		Std	*P*-value
b'0	0.599562	***	0.004676	0
Effective Spread (*t*-1)	0.51304	***	0.002697	0
Event dummy	-0.0028		0.005886	0.634296
Adjusted R^2	0.263201			
Total number of samples	101,331			

*** is significant at 1% significance level. The number of observations is 101,331. It is impossible to use single-day data (417) to produce a first-order regression model.

Risk (Volatility)

As presented in Table 11, the coefficient of an event dummy is not significant. However, the coefficient of an event dummy is positive. Then, the possibility is shown that risk will become large when an event occurs. This result means the following. Liquidity becomes low, as the Volatility becomes larger on event days.

Table 11. Model 3 $Volq_t = c_0 + c_1 Volq_{t-1} + c_2 D_t + e_t$

Explained variable, Vola_20 (*t*-1);

Explanatory variable, Vola_20 (*t*-1) and event dummy

	coefficient		Std	*P*-value
c_0	2.27E-06	***	1.1E-07	5.71E-94
Vola_20 (*t*-1)	0.979088	***	0.000639	0
Event dummy	2.69E-08		1.53E-07	0.860525
Adjusted R^2	0.958618			
Total number of samples	101,331			

*** is significant at 1% significance level. The number of observations is 101,331. It is impossible to use single-day data (417) to produce a first-order regression model.

6. Conclusion

This paper presented an investigation of whether liquidity changes on an event day, on which macroeconomic indicators are announced, and on a non-event day in the Japanese Government Bond (JGB) Futures market of the Tokyo Stock Exchange (TSE).

Consequently, the following results were shown for the macroeconomic announcement event effect. First, as for ILLIQ, which is an indicator of Liquidity, results showed that ILLIQ increases by announcing macroeconomic indicators, which means that liquidity falls in a market. Moreover, when transaction costs (Spreads) were investigated, results showed that transaction cost decreases by announcing macroeconomic indicators. Therefore, liquidity rises in a market. Furthermore, as for risk (Volatility) in the JGB Futures market, volatility increases by announcement of macroeconomic indicators, which means that liquidity falls in the JGB Futures market.

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