The Effects of Open Market Operations on the Price Discovery Process in the Japanese Government Securities Market: An Empirical Study

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Abstract

The objective of the paper is to deepen our understanding of the price discovery process of the government securities market by exploring the effect of notification of open market operations (OMOs) by central banks. The adopted methodology empirically examines the immediate effects of notification of OMOs by the Bank of Japan (BOJ) on trading volume and price volatility for the 10-year benchmark issue in the Japanese government securities market, using tick-by-tick trading data in the interdealer brokers market. The main findings of this paper are as follows: 1) Outright OMOs (outright purchases or coupon passes) increase the spikes in trading volume and price volatility, but temporary OMOs (purchases with sell-back agreements and repos) or outright purchases by the Ministry of Finance do not affect the spikes, and 2) unexpected changes in purchase amounts and notification times of OMOs increase the spikes.

Key words: Open market operation, price discovery process, government securities market

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* The views expressed in this paper are solely those of the author and do not necessarily represent views of the Bank of Japan.

1. Introduction

The arrival of public information is one of the key factors of the price discovery process in the securities markets. In the case of government securities, the role of public information is more pronounced when compared to the case of equities, where trading is likely to be primarily induced by private information. Among the various sources of public information, the notification of open market operations (OMOs) by central banks seems to be an important driver of trading activities. This is because notification may contain new public information on monetary policy. It is also a placement of a large buy/sell order, which could affect the supply-demand conditions of securities in the private sector. These characteristics are what market participants cannot find in private transactions.

In this paper, the immediate effect of the notification of OMOs is examined focusing on the intraday price discovery process in the government securities market. The paper's methodology is to empirically examine the relationship between various aspects of notification of OMOs by the Bank of Japan (BOJ) and the smoothness of the price discovery process by observing the spikes in trading volume and price volatility. The examination is based on tick-by-tick trading data of the benchmark issue in the interdealer brokers market for the five minutes immediately after the notification of OMOs. The underlying assumption of this examination is that smaller observed spikes indicate a smoother price discovery process. The process may be smoother when market participants sense that the BOJ simply wishes to provide liquidity to the market. Large spikes in trading volume and price volatility, which might lead to changes in equilibrium price, may arise if market participants interpret the OMOs as an indication that the BOJ wishes to show its monetary policy intentions.

To the best of my knowledge, this is the first paper to deal with the impact of notification of OMOs in the Japanese government securities (JGSs) market based on intraday tick-by-tick data. This paper attempts to, first, draw policy implications on how OMOs should be conducted in a way to, (or not to,) affect the smoothness of the price discovery process, and second, to empirically draw general implications on the effects of public information on the price discovery process in the government securities market.

An outline of my findings is as follows. 1) Outright OMOs (outright purchases or coupon passes) increase spikes in trading volume and price volatility, but temporary OMOs (purchases with sell-back agreements and repos) or outright purchases by the Ministry of Finance do not affect trading volume and price volatility, and 2) unexpected changes in purchase amounts and notification times of OMOs increase the spikes.

The paper is organised as follows. Section 2 describes the market structure of and the price discovery process in the cash interdealer market for JGSs. Section 3 characterises the data used in the analyses and explain the calculation process for trading volume and price volatility. Section 4 illustrates the features of OMOs in Japan. Section 5 tests a variety of hypotheses on different features of the OMOs. Section 6 draws some conclusions and identifies areas for possible future study.

2. The interdealer market for JGSs

2.1 The market

The interdealer market for JGSs serves two primary purposes. First, it is used for hedging purposes by dealers trying to adjust their positions in cash JGSs created by customer transactions. Second, it offers dealers a market for speculative transactions. The daily trading volume of total interdealer transactions was about 17 billion dollars in 1997 on a two-way basis, according to a BOJ estimate.

Interdealer trading takes the form of either direct transactions between dealers or transactions intermediated by brokers. For the latter, pre-trade and post-trade anonymity are ensured, i.e. the counterparty's name is not revealed even after the trade. Therefore, dealers generally prefer interdealer broker trading. Although official statistics on the breakdown between the two are unavailable, about 70% of all interdealer transactions of JGSs are estimated to be broker intermediated.

There are currently seven interdealer brokers – five domestic and two foreign-owned – operating in the JGS market. In terms of trading volume, the Japan Bond Trading Co. (JBT) handles an estimated 70% share of the market. This paper focuses on JBT trading data.[1]

2.2 The price discovery process

The JBT provides an order-driven market where buy-orders and sell-orders are continuously matched in the order-book according to the "best-price" and "first-in" rule. The JBT is open from 8.40 to 17.00 with a lunch break from 11.05 to 12.25. During operating hours, orders are placed according to yield terms (simple yield), with a tick size (the smallest increment of yield changes) of 0.5bp. Only limit-orders can be placed, meaning that one must specify the amount and yield when placing an order.

Let us first look at the order matching procedure. Suppose dealer A places a two billion yen sell-order for the 182nd issue of 10-year JGS at 1.200% by making a phone call to the JBT. The placed order is shown on the screen of the computer terminal located both at the JBT and at the client dealers of the JBT.[2] When another client dealer, dealer B, finds the order on the screen that fits its needs, dealer B hits the order by making a phone call to the JBT.[3] In this way, the orders are matched. The matched orders are eliminated from the computer screen.

The JBT charges a commission of 0.1/10,000 (remaining maturity of 2 years or less) or 0.18/10,000 (remaining maturity of more than 2 years) of the face value for each side of the trade.

3. Data and basic intraday patterns

3.1 Data

The data cover two years of tick-by-tick contracted yields and trading size of transactions through the JBT. The sample period is from July 1 1996 to June 30 1998 (493 business days), when the market was generally bullish (Figure 1). The paper focuses its analysis on the 10-year benchmark issue (182nd issue), which remained the benchmark throughout this period.[4]

In the sample period, trading seems to be on a declining trend, which indicates a decline in the "benchmarkness" of the 182nd issue. This phenomenon may be explained in the following way. First, assuming that investors/dealers generally prefer securities which have a remaining life close to the "key maturities", a benchmark with a remaining maturity much shorter than 10 years may not be preferred.[5] Second, as time passes, more securities are included in portfolios of investors who employ buy-and-hold strategies. This means less securities are in the hands of active traders, which eventually leads to a decline in the market's trading activity.

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1 Only the JBT publicly discloses trading data.

2 The yield and the size of the order are posted on the screen. However, the name of the dealer placing the order is not shown.

3 Placing and hitting orders are only possible via telephone.

4 Contrary to practices in most markets, there exists only one benchmark for the JGS market. Although no official rule exists, the benchmark is usually a 10-year off-the-run issue which has a large issue amount with a remaining maturity of 7 years or longer.

5 Since the 182nd issue will be redeemed in September 2005, its remaining maturity in the sample period was 9.2 – 7.2 years.

3.2 Measuring trading volume and price volatility

The paper analyses trading volume and price volatility for 5-minute segments. Using JBT's operating hours (8.40 to 17.00, with a lunch break from 11.05 to 12.25), there are 84 segments per day.

Trading volume is measured according to the total face value of securities traded during each 5-minute segment, which is recorded in 500 million yen increments. The calculation is done on a one-way basis, i.e. when dealer A sells one billion yen in securities to dealer B through the JBT, the transaction is recorded as one billion yen, not two billion yen.

Price volatility is measured by the standard deviation of the yield in terms of 0.1 basis points gauged every minute (not every 5 minutes) for the 5-minute segment.[6] For example, suppose that on a certain day the yield of the 182nd issue developed as follows:

Time	Yield
10:10	1.500%
10:11	1.505%
10:12	1.505%
10:13	1.510%
10:14	1.505%
10:15	1.500%

In this case, the price volatility for the 10.10 segment (from 10.10 to 10.15) is calculated as the standard deviation of 1,500, 1,505, 1,505, 1,510, 1,505, and 1,500, which is 3.76. As this method indicates, if the yield does not change at all for each of the five minutes, the volatility would be zero.

3.3 Basic intraday patterns

The trading volume and price volatility show W-shaped intraday patterns (Figures 2 and 3). The trading volume and price volatility show significant increases around 9.00, which can be partly attributed to the concentration of trading needs based on information generated after the market's close on the previous day, and partly to the opening of the futures market on the Tokyo Stock Exchange (TSE) at 9.00, which provides hedging and arbitrage opportunities. As the hours pass, trading becomes gradually subdued, but increases again somewhat before morning session closes at 11.05, prompted by incentives to reduce price risk arising from new information formed during the lunch break.

Immediately following the 12.25 opening of the afternoon session, trading volume and price volatility show slight increases again based on information formed during the lunch break. At around 15.00, corresponding to the close of the TSE futures market, trading increases significantly reflecting the motivation to reduce overnight price risk. After 15.30, trading activity notable decreases.

[6] In this sense, the calculated price volatility is in fact "yield volatility". However, considering that bonds are quoted in price terms in many developed countries, the term "price volatility" instead of "yield volatility" is used in this paper, because the term is more familiar to readers.

4. OMOs in Japan

The BOJ conducts two types of OMOs as a tool of monetary policy in the JGS market. The first type is outright purchases or coupon passes (hereafter "outright OMOs", see Attachment 1 for the notification record)[7] and the second type is purchases with sell-back agreement and repos[8] (hereafter "temporary OMOs").[9]

These OMOs are of a different nature to private transactions. First, the OMOs may contain some information on the BOJ's monetary policy. Second, the OMOs affect bond availability, at least temporarily, for the private sector, and thus, they influence the total supply-demand conditions of the market.

In addition, the Ministry of Finance (MOF) also conducts outright purchases (hereafter "outright MOFPs") and purchases with sell-back agreement (hereafter "temporary MOFPs") in the JGS market, in which the BOJ serves as the agent.[10] Such MOFPs are similar to the BOJ's OMOs in that they affect the availability of securities in the private sector, but are different from OMOs in that MOFPs do not contain information on monetary policy.

Salient features of the OMOs and the MOFPs are provided in Attachment 2.

5. Hypotheses and regression results

5.1 The regression model

This section examines various hypotheses regarding the effect of the notification of OMOs on trading volume and price volatility. The statistical model used in the following analyses is in the form of the following equations,

(1) $$Q_{it} = \alpha_{Qi} + X\beta_Q + T\gamma_Q + \varepsilon_{Qit}$$

(2) $$P_{it} = \alpha_{Pi} + X\beta_P + T\gamma_P + \varepsilon_{Pit}$$

where Q_{it} is trading volume of the benchmark issue, P_{it} is price volatility of the benchmark issue, α_{ji} is the vector of dummy variables for each 5-minute segment, X is the vector of dummy variables, T is

7 The purchase amount for outright OMOs is 100 billion or 200 billion yen, which is about 0.7 or 1.4 billion dollars.

8 In this context, repos are cash-collateralised securities borrowing, and *gensaki's* are purchases of securities with sell-back agreements. Repos and *gensaki's* are similar in that both temporarily affect the supply-demand conditions of the securities.

9 In the JGS market, the BOJ also conducts OMOs in the Treasury bills (TBs) market. TBs are short-term discount securities issued by the Japanese government. In Japan, TBs are issued with original maturities of 3 months and 6 months. OMOs on TBs are not discussed in this paper because tick-by-tick transaction data on TBs are not available.

10 These purchases are conducted by the Trust Fund Bureau (TFB) of the MOF. The TFB invests the funds raised mainly through the Postal Savings and Insurance and the Public Pension Funds.

the trend variable,[11] ε_{jit} is the independently identically distributed error term, β_j and γ_j are the set of parameters to be estimated, subscript *i* shows the 5-minute segment per day, subscript *j* stands for *P* or *Q*, and *t* denotes the number of days in the sample period. Changing the set of dummy variables allows examination of various hypotheses.

5.2. Hypotheses on the structural effect of notification

In this part, the paper explores the information content of the notification of OMOs from the viewpoint of the structural effect on the price discovery process. Structural effects, as opposed to surprise effects, apply to the process throughout the sample period. First, the paper examines if the outright OMOs themselves affect the price discovery process, and investigates if the difference in purchase amount systematically affects the spike. Second, the paper examines whether there are any differences between outright OMOs and outright MOFPs. Finally, the relative significance between outright OMOs and temporary OMOs is evaluated.

Hypothesis 1: Notification of outright OMOs increases spikes

(a) Analysis of trading volume

Basic results

The first step in examining other hypotheses is to examine whether notification of outright OMOs, made at 10.10,[12] increases the spikes in trading volume. Presumably, notification would positively correlate with the spike, because notification itself is new public information and placement of a large buy order. Also, the trend dummy assumes a negative sign since the trading volume would decrease as "benchmarkness" decays. To this end, equation (1) is estimated by setting α_{Qi} to be constant, *X* to be the dummy variable which takes the value of one if notification of outright OMOs is made at 10.10, and zero if not.

The estimation results are summarised in column (a) of the upper panel of Table 1. Observe that the coefficient of the dummy variable for outright OMOs, a1, is 17.15 (t-value 3.04). The other parameters are also statistically significantly different from zero and assume correct signs as presumed. The F-value of testing the null hypothesis by holding the constant, a1, and trend dummy to be zero, takes the value of 12.268, which is rejected at the 1% significance level. Overall results confirm the hypothesis that notification of outright OMOs positively affects the trading volume of the 5-minute segment from 10.10 to 10.15.

Effect of the difference in the purchase amount

Note that the purchase amount of outright OMOs is either 100 billion or 200 billion yen. One might wonder if the difference in the purchase amount systematically affects trading volume. To this end, the dummy variable for outright OMOs is separated into two dummy variables: a2, which takes the value of one if notification is for 100 billion yen, and a3, which takes the value of one if notification is for 200 billion yen.

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[11] Since "benchmarkness" decays as time passes, i.e. trading becomes less active, a trend variable was added which takes the value of the number of the business days in which the 182nd issue had benchmark status. This variable takes the value of 86 on the first day of the sample period, which means it was the 86th day that the 182nd issue was the benchmark. While a quadratic trend variable was also tested, the results seemed insignificant. Therefore, a linear trend variable was included in the analyses in the paper for both trading volume and price volatility for the symmetrical analyses for trading volume and price volatility.

[12] Although the BOJ has not officially committed, OMOs have usually been notified at 10.10. Among the 49 outright OMOs in the sample period, 47 were notified at 10.10. The two exceptional cases will be discussed later.

The regression results are shown in column (b) of the upper panel of Table 1. Observe that the coefficients of the two dummies, a2 and a3, are marginally different. The test statistics which hold a2 and a3 to be equal, F*, takes the value of 0.04. Therefore it is safe to conclude that notification of the OMOs affect trading volume, but the difference in purchase amount does not structurally affect it throughout the sample period.

Possible extension to longer time horizon

Although the model is designed to capture the immediate effect of notification, the same regression model is used to roughly estimate the intermediate effect of the OMOs, for reference purposes. Equation (1) is estimated by setting α_{Qi} to be constant, *X* to be the dummy variable which takes the value of one for 55 minutes, i.e. eleven 5-minute segments, if notification of outright OMO is made at 10.10, and zero if not. The effect is tested for up to 55 minutes after notification because the JBT takes a lunch break at 11.05, making it impossible to capture the intermediate effect of notification over 55 minutes after the 10.10 notification.

The estimation results are summarised in columns (c) and (d) of the upper panel of Table 1. Observe that the results are qualitatively the same as those in columns (a) and (b), although the dummy variable for the notification of OMOs of 200 billion yen, a3, is somewhat more pronounced. Again, the test statistics holding a2 and a3 to be equal, F*, takes the value of 2.12. Therefore, it is safe to conclude that notification itself affects trading volume for 55 minutes after notification, but the difference in purchase amount does not.

(b) Analysis of price volatility

Basic results

The next step is to test the effect of notification on price volatility. Presumably, notification positively correlates with the spike, because, as in the case of trading volume, notification is new public information and a placement of a large buy order. To this end, equation (2) is estimated by setting α_{Pi} to be constant, *X* to be the dummy variable which takes the value of one if the notification of outright OMOs is made at 10:10, and zero if not.

The estimation results are summarised in column (a) of the lower panel of Table 1. Observe that the coefficient of the dummy variable for outright OMOs, a1, is 0.99 (t-value 3.34). The F-value for testing the null hypothesis holding the constant, a1, and trend dummy to be zero, takes the value of 7.523, which is rejected at the 1% significance level. Overall results confirm the hypothesis that notification of outright OMOs positively affects price volatility.

Effect of the difference in purchase amount

The paper also tests whether the difference in purchase amount, 100 billion or 200 billion yen, systematically affects spikes in price volatility. To this end, the dummy variable for outright OMOs is separated into two dummy variables, a2 and a3, representing 100 billion and 200 billion yen, respectively, similar to the above analysis of trading volume. The regression results are shown in column (b) of the lower panel of Table 1. Observe that the coefficient of the two dummies, a2 and a3, are, again, marginally different. The test statistics holding a2 and a3 to be equal, F*, takes the value of 2.66. Therefore, it is safe to say that notification affects price volatility, but the difference in purchase amount does not structurally affect it throughout the sample period.

Possible extension to longer time horizon

The same regression model is used to make a rough estimate of the effect 55 minutes after notification. Equation (2) is estimated by setting α_{Pi} to be constant, *X* to be the dummy variable which takes the value of one for the eleven 5-minute segments if notification of outright OMO is made at 10.10, and zero if not.

The estimation results are summarised in columns (c) and (d) of the lower panel of Table 1. Observe that the coefficients of the dummy variables are qualitatively the same as those for immediate impact in columns (a) and (b). Again, the test statistics holding a2 and a3 to be equal, F*, takes the value of 1.78. Therefore, it is safe to conclude that notification itself affects price volatility for 55 minutes after notification, but the difference in purchase amount does not.

Hypothesis 2: The difference in the purchaser (BOJ or MOF) influences spikes

OMOs contain different information content than MOFPs. Although both contain information as a large buy-order, only OMOs may contain information on monetary policy. Whether this difference affects the spikes is examined. Presumably, the spike would be larger for OMOs, because OMOs contain more information than MOFPs.

(a) Analysis of trading volume

Basic result

The paper examines whether notification of outright OMOs and outright MOFPs, made at 10:10, causes spikes in trading volume. Equation (1) is estimated by setting α_{Qi} to be constant, X to be the dummy variable which takes the value of one if the notification of outright OMO or outright MOFPs is made at 10:10, and zero if not.

The estimation results are summarised in column (a) of the upper panel of Table 2. Observe that the coefficients of the dummy variable for OMOs and MOFPs, a1, is 14.46 (t-value 3.43). The F-value of testing the null hypothesis holding the constant, a1, and trend dummy to be zero, takes the value of 13.589, which is rejected at the 1% significance level. Overall results confirm the hypothesis that notification of outright OMOs and outright MOFPs increases the trading volume for five minutes after notification.

Next, the paper tests whether the identity of the purchaser, BOJ or MOF, systematically affects trading volume. To this end, the dummy variable for OMOs and MOFPs is separated into two dummy variables: a2, which takes one if notification was from the BOJ, and a3, which takes one if notification was from the MOF. The regression results are shown in column (b) of the upper panel of Table 2. Observe that the coefficient for notification by the MOF, a3, is not significantly different from zero (t-value 1.88), which indicates that MOFPs do not affect the trading volume. In fact, the coefficient for notification by the BOJ (18.27), a3, is almost the same as that for the outright OMOs (17.15), a1 in column (a) of the upper panel of Table 1. Therefore, it may be safe to conclude that only notification from the BOJ affects trading volume. This may indicate that OMOs contain more information than MOFPs.

Possible extension to longer time horizon

Again the same regression model is used to roughly estimate the effect 55 minutes after notification in the same manner as in Hypothesis 1. The estimation results are summarised in columns (c) and (d) of the upper panel of Table 2. Observe that the coefficients of the dummy variables are qualitatively the same. Again, it may be safe to conclude that notification by the BOJ affects trading volume for 55 minutes after notification, but MOF notification does not.

(b) analysis of price volatility

Basic result

The next step is to test the effect on price volatility. Equation (2) is estimated by setting α_{Pi} to be constant, X to be the dummy variable which takes the value of one if notification of outright OMOs or outright MOFPs is made at 10:10, and zero if not. The estimation results are summarised in column (a) of the lower panel of Table 2. Observe that the coefficient of the dummy variable for outright OMOs, a1, is 0.46 (t-value 2.07). The F-value for testing the null hypothesis holding the constant, a1, and trend dummy to be zero, takes the value of 4.066, which is rejected at the 5% significance level. The overall results confirm the hypothesis that notification of outright OMOs and outright MOFPs increases price volatility for five minutes after notification.

Next, the paper tests whether the identity of the purchaser, BOJ or MOF, systematically affects price volatility, in the same way as the above analysis on trading volume. The regression results are shown in column (b) of the lower panel of Table 2. Observe that the coefficient for notification by the MOF is not statistically significantly different from zero (t-value 0.20). Therefore, it may be safe to conclude that only notification by the BOJ affects price volatility. This may indicate that OMOs contain more information than MOFPs.

Possible extension to longer time horizon

Again the same regression model is used to roughly estimate the effect on 55 minutes after notification in the same manner as in Hypothesis 1. The estimation results of are summarised in columns (c) and (d) of the lower panel of Table 2. Observe that the coefficients of the dummy variables are qualitatively the same. Again, it may be safe to conclude that notification by the BOJ affects price volatility for 55 minutes after notification, but that by the MOF does not.

Hypothesis 3: The difference in the type of OMOs (outright or temporary) influences spikes

Outright OMOs influence long-term supply-demand conditions of the JGS market, but temporary OMOs may not. The paper examines whether this difference affects the spikes. Presumably, the spike would be larger for outright OMOs, because outright OMOs have a longer effect in influencing supply-demand conditions.

(a) analysis of trading volume

(comparison between temporary OMOs)

Before testing the difference between outright and temporary OMOs, it is necessary to investigate whether there is any difference between the two types of temporary OMOs, repos and *gensaki's*. Since OMOs for repos are notified at 9:30 and those for *gensaki's* are at 10:10, it is difficult to regress in one single equation. Alternatively, the relative impact in using the regression model (1) is independently estimated. First, equation (1) is estimated by setting α_{Qi} to be constant, *X* to be the dummy variable which takes the value of one if notification of repos is made at 9:30, and zero if not. Next, the same equation by setting *X* as a dummy variable for notification of *gensaki's* is examined.

The estimation results are summarised in columns (a) and (b) of the upper panel of Table 3. Observe that the coefficient of the dummy variable for repos, a4, is 0.14 (t-value 0.02), and for *gensaki's*, a3, is –2.19 (t-value 0.45). Therefore, the immediate effect of notification on trading volume is not confirmed for the notification of repos or *gensaki's*.

(comparison between temporary and outright OMOs)

The next step is to test the difference between the effects temporary OMOs (*gensaki's*) and outright OMOs, both notified at 10:10, on trading volume using the same methodology as in Hypotheses 1 and 2. The dummy variable for outright OMOs and *gensaki's*, a1, is separated into two dummy variables: a2, which takes the value of one if notification is for outright OMOs, and a3, which takes the value of one if the notification is for *gensaki's*.

The regressions results are shown in column (d) of the upper panel of Table 3. Observe that only the coefficient for outright OMOs (17.11, t-value 3.00), a2, is statistically significantly different from zero, as suggested by previous analyses. Therefore, it may be safe to conclude that only notification of outright OMOs affects trading volume for five minutes after notification.

(b) analysis of price volatility

(comparison between temporary OMOs)

Next, the paper investigates whether there is any difference between the effect from the two types of temporary OMOs, repos and *gensaki's*, on price volatility in the same manner as in the above analysis on trading volume. The estimation results are summarised in columns (a) and (b) of the lower panel of Table 3. Observe that the coefficient of the dummy variable for repos, a4, is –0.16 (t-value 0.46), and for *gensaki's*, a3, is –0.18 (t-value 0.71). Therefore, the immediate effect of the notification on price volatility is not confirmed for notification of repos or *gensaki's*.

(comparison between temporary and outright OMOs)

The next step is to test the difference between temporary OMOs (*gensaki's*) and outright OMOs, both notified at 10:10. The methodology is the same as in the analysis of trading volume.

The regression results are shown in column (d) of the lower panel of Table 3. Observe that only the coefficient for the outright OMOs (0.97, t-value 3.27), a2, is statistically significantly different from zero, as suggested in previous analyses. Therefore, it may be safe to conclude that only notification of outright OMOs affects price volatility for five minutes after notification.

5.3. Hypotheses on the surprise effect of notification

Next, this paper explores the surprise effect of the information content in the notification of OMOs on the price discovery process. Surprise effects, as opposed to structural effects, apply on a couple of occasions with the changes in purchase amount and/or notification time. In addition, the effect applies to a regime change in the settlement practice which caused less predictability of notification dates. First, the analysis examines if changes in purchase amount and/or notification time affect the price discovery process. Second, the analysis examines whether the price discovery process is affected by the lower predictability of notification dates.

Hypothesis 4: Changes in purchase amount and notification time increase spikes

Here, the focus is on the effect of changes in purchase amount and notification time for outright OMOs. In the sample period, the purchase amount was either 200 billion yen or 100 billion yen. It decreased from 200 billion yen to 100 billion yen on December 24, 1996, and increased to 200 billion yen on November 25, 1997. With regard to the notification time, 47 of 49 outright OMOs in the sample period were notified at 10:10. However, two outright OMOs, notified on November 25, 1997 and December 3, 1997, were notified at 9:20.[13] To put differently, the situation can be summarised in the following two-by-two-matrix:

	Change in offered amount (surprise)	**No change in offered amount (no surprise)**
Notified at 9:20 (surprise)	One OMO (25 Nov. 1997)	One OMO (3 Dec. 1997)
Notified at 10:10 - (no surprise)	One OMO (24 Dec. 1996)	Other 46 OMOs

Due to an insufficient number of cases, it may not be meaningful to use the regression model. Instead, the average figures for trading volume and price volatility are inserted for each element of the matrix.

[13] The change in notification time corresponds to the financial crisis of November 1997. Specifically, the collapse of Yamaichi Securities occurred one day before the OMO of November 25, 1997, when the purchase amount increased and the notification time was changed. Against this background, the change of November 25 was reportedly perceived by market participants as a sign of BOJ's commitment to provide abundant liquidity to the financial markets.

	Change in offered amount (surprise)	No change in offered amount (no surprise)
Notified at 9:20 (surprise)	T=35, V=20	T=100, V=13
Notified at 10:10 (no surprise)	T=75, V=8	T=44 (SD 44.68), V=2 (SD 2.28)

Note: T, V, and SD denote trading volume, price volatility, and standard deviation, respectively.

The matrix indicates that the spikes in trading volume are not so pronounced, because trading volume for each day is within two standard deviations of the average (44). However, the spikes in price volatility are statistically significant, because they are above two standard deviations of the average (2).

Hypothesis 5: Lower predictability of notification dates increases spikes

In October 1996, the settlement practice was changed from "5th and 10th day settlement" to T+7 rolling settlement. Before the change, since almost all outright OMOs were conducted in line with the settlement dates, it was easier to predict notification dates. However, after the change, it became more difficult to predict when the next OMO would be notified. In this sense, the degree of surprise increased after the change.

The paper examines whether the spikes are influenced by the change to a rolling settlement practice. Presumably, the spike would be larger under the rolling settlement practice because of the lower predictability of notification dates.

To this end, equation (1) is estimated by setting a dummy variable *X* to capture the change to a rolling settlement practice for OMOs notified after October 1996. If the presumption is correct, the coefficient for the rolling-practice dummy should be positive and significantly different from zero. The estimation results are summarised in the upper panel of Table 4. Observe that the coefficient for rolling settlement is positive, but not significantly different from zero.

Finally, a hypothesis regarding price volatility is also tested using equation (2). The estimation results are shown in the lower panel of Table 4. Observe that the coefficient for rolling settlement is positive and significantly different from zero.

In sum, it may be safe to conclude that lower predictability due to the shift to a rolling settlement practice increases the spikes in price volatility.

6. Implications and areas for future study

6.1 Implications

6.1.1 Basic finding – only outright OMOs matter

Regression results suggest that while purchase amount does not matter, notification of outright OMOs positively affects trading volume and price volatility for five minutes immediately after notification. However, MOFPs and temporary OMOs do not seem to have such an effect. To put differently, the notification effect could be summarised in the following two-by-two matrix.

[When are trading volume and price volatility affected?]

		Information content of monetary policy	
		Exists (OMOs)	Does not exist (MOFPs)
Long-term effect on supply-demand conditions for securities	Exists (outright purchases)	Affected	Not affected
	Does not exist (temporary purchases)	Not affected	n.a.

A possible implication of this finding from the viewpoint of a price discovery process in the government securities market could be the following. While the arrival of public information can lead to new price discovery in the government securities market accompanied by spikes in trading volume and price volatility, what matters is the content of the public information as perceived by market participants. Market participants seem to react when public information may contain some information on monetary policy and has a long-term effect on the supply-demand conditions in the securities market.

6.1.2 Surprises lead to higher spikes

Surprises, or unexpected changes in the purchase amount and notification time, seem to increase the spikes in price volatility. More generally, it could be said that the level of predictability for notification of OMOs seems to affect the level of the smoothness in the price discovery process, i.e. the lower/higher the predictability, the higher/lower the spikes.[14] This may imply the possibility that a central bank could send a policy signal to the market by notifying an OMO in an unexpected manner.

6.2 Possible future work

This paper analysed the instantaneous effects of notification of OMOs on trading volume and price volatility for the benchmark issue of 10-year bonds. However, it would also be interesting to explore if the notification has a persistent effect. This examination would require a different explicit regression model on trading volume and price volatility.

Another area of interest would be to investigate the effect on the short-term interest rate, although this would not be an easy task, because tick-by-tick data on the short-term money market is currently unavailable and a tractable model incorporating the whole yield curve is necessary.

<reference>

Miyanoya, Atsushi, Hirotaka Inoue, and Hideaki Higo, "Microstructure and Liquidity in the Japanese Government Securities Market", Working Paper Series released by Financial Markets Department, No 99-1 (forthcoming).

[14] Results of an earlier regression exercise (Hypothesis 5) indicate that the lower the predictability of notification dates due to a shift to a rolling settlement practice, the higher the spikes in price volatility, which may also support this argument.

Attachment 1

Notification record of outright OMOs

Notification date	Purchase date	Amount (bil. yen)	Time
05 Jul 96	10 Jul 96	200	10:10
22 Jul 96	25 Jul 96	200	10:10
07 Aug 96	12 Aug 96	200	10:10
21 Aug 96	26 Aug 96	200	10:10
04 Sep 96	09 Sep 96	200	10:10
19 Sep 96	25 Sep 96	200	10:10
08 Oct 96	14 Oct 96	200	10:10
23 Oct 96	08 Oct 96	200	10:10
05 Nov 96	08 Nov 96	200	10:10
19 Nov 96	22 Nov 96	200	10:10
04 Dec 96	09 Dec 96	200	10:10
24 Dec 96	27 Dec 96	100	10:10
08 Jan 97	13 Jan 97	100	10:10
22 Jan 97	27 Jan 97	100	10:10
06 Feb 97	12 Feb 97	100	10:10
19 Feb 97	24 Feb 97	100	10:10
05 Mar 97	10 Mar 97	100	10:10
21 Mar 97	26 Mar 97	100	10:10
11 Apr 97	16 Apr 97	100	10:10
28 Apr 97	02 May 97	100	10:10
09 May 97	14 May 97	100	10:10
23 May 97	28 May 97	100	10:10
04 Jun 97	09 Jun 97	100	10:10
20 Jun 97	25 Jun 97	100	10:10
04 Jul 97	09 Jul 97	100	10:10
25 Jul 97	30 Jul 97	100	10:10
08 Aug 97	13 Aug 97	100	10:10
22 Aug 97	27 Aug 97	100	10:10
03 Sep 97	08 Sep 97	100	10:10
19 Sep 97	25 Sep 97	100	10:10
07 Oct 97	13 Oct 97	100	10:10
24 Oct 97	29 Oct 97	100	10:10
07 Nov 97	12 Nov 97	100	10:10
20 Nov 97	26 Nov 97	100	10:10
25 Nov 97	28 Nov 97	200	9:20
03 Dec 97	08 Dec 97	200	9:20
19 Dec 97	25 Dec 97	200	10:10
12 Jan 98	16 Jan 98	200	10:10
23 Jan 98	28 Jan 98	200	10:10
06 Feb 98	12 Feb 98	200	10:10
23 Feb 98	26 Feb 98	200	10:10
04 Mar 98	09 Mar 98	200	10:10
23 Mar 98	26 Mar 98	200	10:10

Attachment 1 (contd.)

Notification record of outright OMOs

Notification date	Purchase date	Amount (bil. yen)	Time
09 Apr 98	14 Apr 98	200	10:10
22 Apr 98	27 Apr 98	200	10:10
07 May 98	12 May 98	200	10:10
22 May 98	27 May 98	200	10:10
05 Jun 98	10 Jun 98	200	10:10
22 Jun 98	25 Jun 98	200	10:10

Attachment 2

Features of OMOs and MOFPs

	OMOs			MOFPs	
	Outright OMOs	Temporary OMOs		Outright MOFPs	Temporary MOFPs
	Outright purchases	Purchases with sell-back agreement	Repos	Outright purchases	Purchases with sell-back agreement
Monetary policy aspect					
Relevance to monetary policy	Yes	Yes	Yes	No	No
Influence on long-term supply-demand conditions	Yes	No	No	Yes	No
Influence on short-term supply-demand conditions	Yes	Yes[15]	Yes[16]	Yes	Yes[17]
Operational aspect					
Notification time	10.10	10.10	9.30	10.10	10.10
Issues eligible to be purchased	20 issues designated by BOJ (18 10-year bonds and 2 20-year bonds)	All 10 and 20-year bonds listed on the Tokyo Stock Exchange, excluding those maturing before the sell-back date	All 10 and 20-year bonds listed on the Tokyo Stock Exchange, excluding those maturing before the due date	15 issues (all 10-year bonds)	All 10 and 20-year bonds listed on the Tokyo Stock Exchange, excluding those maturing before the sell-back date
Purchase amount (\ billion)	100-200	200-400	300-500	100	300-500
Number of notification during the sample period	49	70	38	47	125

[15] In some cases, the answer is "No" when an OMO/MOFP is simply a roll-over of a previous OMO/MOFP. [16] Same as footnote 1. [17] Same as footnote 1.

Table 1

Effect of outright OMOs

	5 min. estimates		55 min. estimates	
Dependent variable: trading volume				
	(a)	(b)	(c)	(d)
Constant	42.95 ** (10.11)	42.97 ** (10.10)	36.44 ** (29.48)	36.48 ** (29.51)
a1: Outright total	17.15 ** (3.04)		3.40 * (2.07)	
a2: Outright 100 bil. yen only		16.02 * (2.03)		1.07 (0.47)
a3: Outright 200 bil. yen only		18.23 * (2.36)		5.63 (2.50)
Trend dummy	- 0.05 ** (3.90)	- 0.05 ** (3.90)	- 0.04 ** (11.49)	- 0.04 ** (11.52)
Residual SS	664,879.81	664,822.73	6,850,514.02	6,847,833.15
R^2	0.044	0.042	0.024	0.024
F(2,490) and F(2,5420)	12.268 **		68.221**	
F(3,489) and F(3,5419)		8.177 **		46.197 **
F*	0.04		2.12	
Number of observations	493	493	5,423	5,423
Dependent variable: price volatility				
Constant	1.58 ** (7.11)	1.57 ** (7.08)	1.32 ** (22.74)	1.32 ** (22.70)
a1: Outright total	0.99 ** (3.34)		0.33 ** (4.26)	
a2: Outright 100 bil. yen only		1.45 * (3.53)		0.43 ** (3.98)
a3: Outright 200 bil. yen only		0.54 (1.34)		0.23 * (2.20)
Trend dummy	- 0.001 (1.96)	- 0.001 (1.92)	- 0.001 ** (5.88)	- 0.001 ** (5.84)
Residual SS	1,816.70	1,806.88	15,086.22	15,081.25
R^2	0.026	0.029	0.009	0.009
F(2,490) and F(2,5420)	7.523 **		26.467 **	
F(3,489) and F(3,5419)		5.918 **		18.242 **
F*	2.66		1.78	
Number of observations	493	493	5,423	5,423

F* denotes test statistics for the null hypothesis, a2=a3. If F* significantly differs from zero, it can be concluded that a2 differs from a3. * and ** denote significance at 5% and 1% levels, respectively. Estimation is by OLS method.

Table 2
OMOs and MOFPs

	5 min. estimates		55 min. estimates	
Dependent variable: trading volume				
	(a)	(b)	(c)	(d)
Constant	41.86 ** (9.78)	41.84 ** (9.78)	36.16 ** (28.98)	36.16 ** (28.98)
a1: OMOs and MOFPs	14.46 ** (3.43)		3.17 ** (2.58)	
a2: OMOs only		18.27 ** (3.22)		3.68 * (2.22)
a3: MOFPs only		10.64 (1.88)		2.66 (1.61)
Trend dummy	- 0.05 ** (3.92)	- 0.05 ** (3.91)	- 0.04 ** (11.49)	- 0.04 ** (11.49)
Residual SS	661,484.53	660,117.34	6,847,498.73	6,847,233.50
R^2	0.049	0.049	0.025	0.024
F(2,490) and F(2,5420)	13.589 **		69.444 **	
F(3,489) and F(3,5419)		9.397 **		46.360 **
F*	1.01		0.21	
Number of observations	493	493	5,423	5,423
Dependent variable: price volatility				
Constant	1.59 ** (7.03)	1.58 ** (7.06)	1.33 ** (22.71)	1.33 ** (22.73)
a1: OMOs and MOFPs	0.46 ** (2.07)		0.10 (1.73)	
a2: OMOs only		0.98 ** (3.30)		0.32 ** (4.07)
a3: MOFPs only		- 0.06 (0.20)		- 0.12 (1.50)
Trend dummy	- 0.001 (1.96)	- 0.001 (1.96)	- 0.001** (5.89)	- 0.001** (5.88)
Residual SS	1,841.91	1,816.55	15,128.28	15,079.96
R^2	0.012	0.024	0.007	0.010
F(2,490) and F(2,5420)	4.066 *		18.859 **	
F(3,489) and F(3,5419)		5.019 **		18.398 **
F*	6.83 **		17.36 **	
Number of observations	493	493	5.423	5.423

F* denotes test statistics for the null hypothesis, a2=a3. If F* significantly differs from zero, it can be concluded that a2 differs from a3. * and ** denote significance at 5% and 1% levels, respectively. Estimation is by OLS method.

Table 3
Outright and temporary OMOs

Dependent variable: trading volume

	5 min. estimates			
	(a)	(b)	(c)	(d)
Constant	52.53 **	45.15 **	42.39 **	43.01 **
	(10.34)	(10.27)	(9.56)	(9.73)
a1: Outright and gensaki			6.78	
			(1.72)	
a2: Outright				17.11 **
				(3.00)
a3: gensaki		- 2.19		- 0.25
		(0.45)		(0.05)
a4. Repo	0.14			
	(0.02)			
Trend dummy	- 0.06 **	- 0.05 **	- 0.04 **	- 0.05 **
	(3.99)	(3.91)	(3.71)	(3.88)
Residual SS	923,815.62	677,099.85	673,319.96	664,876.06
R^2	0.032	0.026	0.032	0.042
F(2,490)	9.005 **	7.625 **	9.043 **	
F(3,489))				8.163 **
F*			6.21 **	
# of observations	493	493	493	493

Dependent variable: price volatility

	(a)	(b)	(c)	(d)
Constant	2.42 **	1.72 **	1.56 **	1.60 **
	(10.86)	(7.46)	(6.71)	(6.91)
a1: Outright and gensaki			0.35	
			(1.71)	
a2: Outright				0.97 **
				(3.27)
a3: gensaki		- 0.18		- 0.07
		(0.71)		(0.27)
Repo	- 0.16			
	(0.46)			
Trend dummy	- 0.003 **	- 0.001 *	- 0.001	- 0.001 *
	(4.23)	(2.02)	1.79	1.98
Residual SS	1,776.97	1,856.11	1,846.93	1,816.42
R^2	0.039	0.005	0.010	0.024
F(2,490)	11.067 **	2.161	3.389 *	
F(3,489)				5.031 **
F*			8.21 **	
# of observations	493	493	493	493

F* denotes test statistics for the null hypothesis, a2=a3. If F* significantly differs from zero, it can be concluded that a2 differs from a3. * and ** denote significance at 5% and 1% levels, respectively. Estimation is by OLS method.

Table 4
Effect of rolling settlement

Dependent variable: trading volume	
	(a)
a1: 5th and 10th day settlement	57.23** (3.02)
a2: rolling settlement	30.94 (1.33)
Trend Dummy	- 0.11* (2.17)
Residual SS	83,895.08
R^2	0.056
F (2,44)	2.37
Number of observations	47
Dependent variable: price volatility	
a1: 5th and 10th day settlement	2.31* (2.03)
a2: rolling settlement	3.00* (2.14)
Trend dummy	- 0.01* (2.54)
Residual SS	305.00
R^2	0.101
F(2,44)	3.58*
Number of observations	47

Figure1. Yield Movement in Benchmark JGS

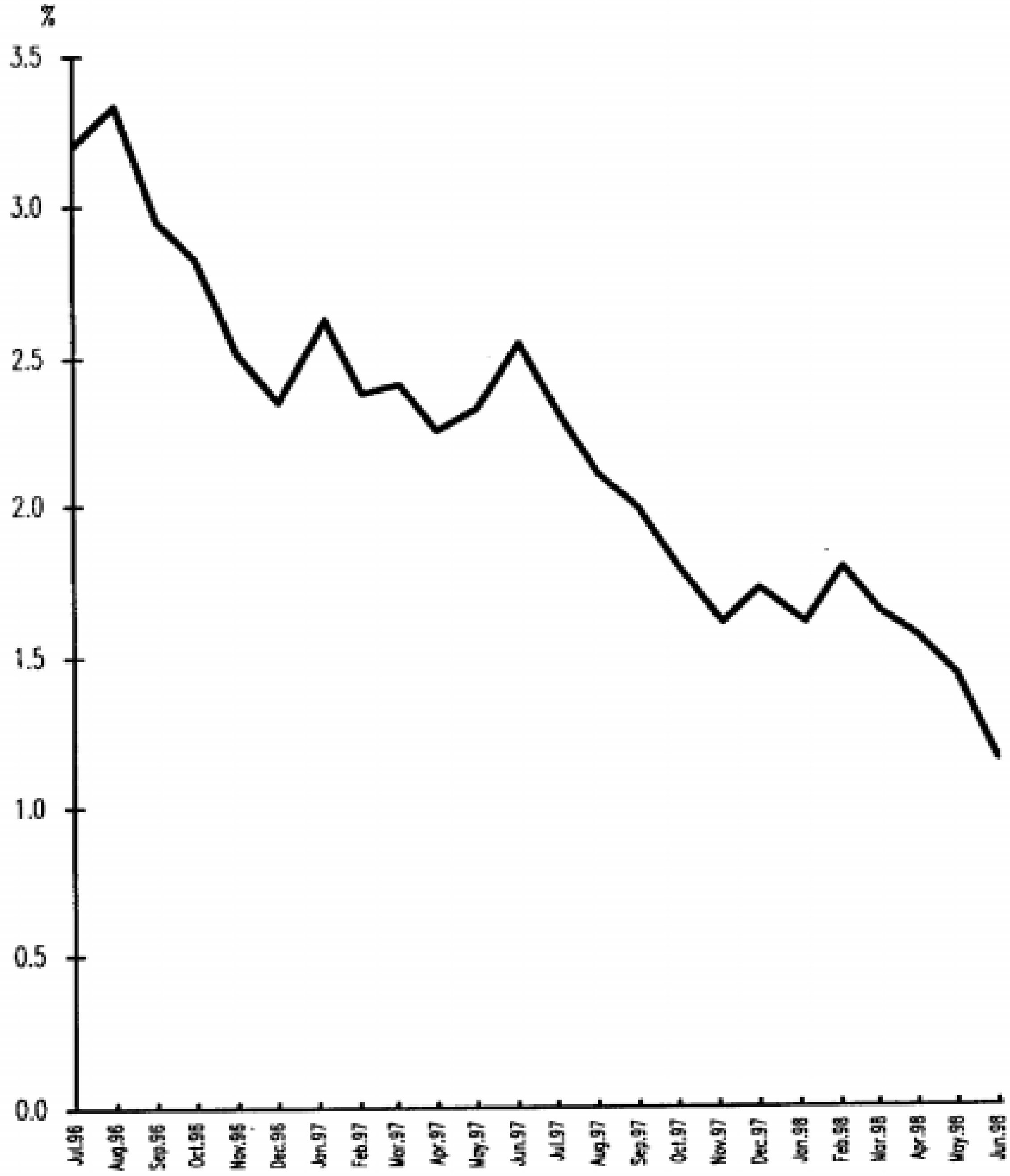

Figure 2. Introday Pattens in Trading Volume

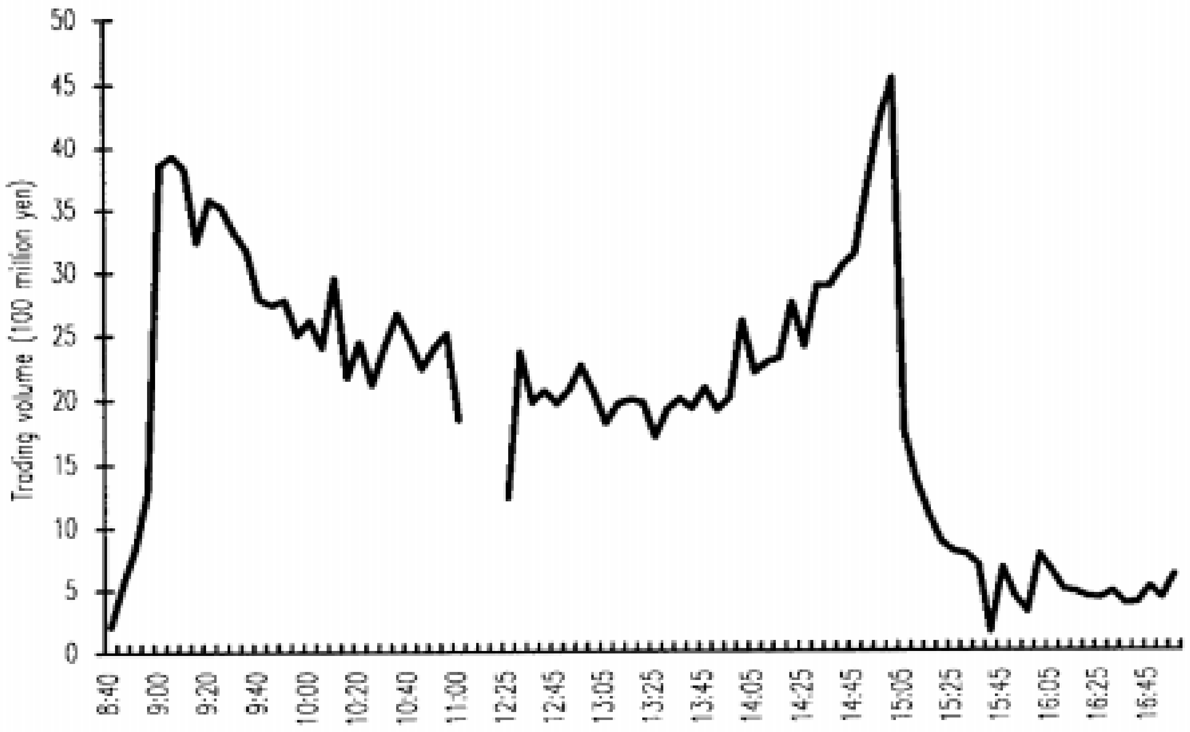

Figure 3. Intraday Patterns in Price Volatility