

Indicators Related to Liquidity in JGB Markets

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Japanese government bonds (JGBs) have a range of uses in broad market trading. To ensure that market transactions involving JGBs operate smoothly, sufficient liquidity in JGB markets is an important condition. There are a number of concepts for evaluating liquidity in JGB markets, and the indicators corresponding to them are accordingly diverse. In assessing liquidity in JGB markets, it is important to monitor indicators as broadly as possible and grasp market liquidity comprehensively. This paper introduces some of the indicators related to liquidity in JGB markets.

Introduction

JGBs have a range of uses in broad market trading. In general, JGBs are safe investment instruments for a variety of investors, and they are also used as collateral for funding through bond repos by financial institutions, for example. In addition, yields on JGBs serve as base rates for the setting of interest rates and prices of a wide range of financial transactions.

To ensure that market transactions involving JGBs operate smoothly, sufficient liquidity in JGB markets is an important condition. Evaluations of liquidity in JGB markets focus on numerous concepts, such as "trading volume," "trading cost," "whether markets can absorb shocks," and "whether investors can smoothly execute their intended trades."

In the measuring of market liquidity, several types of indicators are used for each concept mentioned above. This paper describes major concepts for evaluating liquidity in JGB markets and introduces some specific indicators.

Concept of Market Liquidity

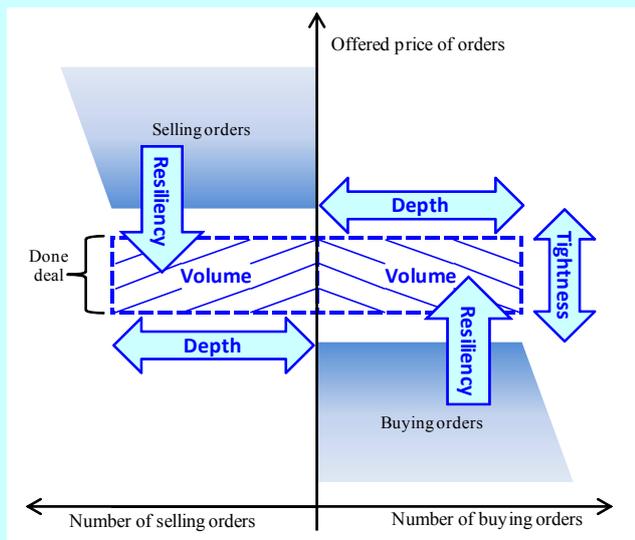
There is no established, strict, and exclusive definition of market liquidity. However, the definition presented by Bank for International Settlements (1999) is often cited and broadly shared: "A liquid market is a market where participants can rapidly execute large-volume transactions with a small impact on prices." The following four concepts are often used to examine and

evaluate market liquidity.

The first is "volume," namely market size. When market size is large, frequent and large-scale transactions over a short time can be made more easily. The second is "tightness," the spread between the selling price and the buying price. When the spread of these prices is tight, traders can execute transactions at a price closer to their intended prices. Traders consider the spread from their intended prices as an additional trading cost. The third is "resiliency." When there are shocks to the prices, traders can execute transactions smoothly and rapidly if the speed at which the prices revert to the "equilibrium level" is fast. The fourth is "depth." When the market is deep with a large number of orders at the current price level, the difference between the investors' intended prices and the actual prices can be smaller.

Chart 1 plots these four evaluation concepts. The vertical axis is the offered price of orders, and the horizontal axis is the number of orders. The box in the upper left shows selling orders, and that in the lower right shows buying orders. The number of orders at each price presented by the buyers and sellers is "depth." The spread between prices presented by the buyers and sellers is "tightness," which is considered an additional trading cost. "Volume" is the space where transactions are executed as a result of a price cut by sellers and a price rise by buyers. The speed of transactions is "resiliency."

[Chart 1] Concept of Market Liquidity



Note: Based on Engle and Lange (1997), etc.

Each concept above can evaluate an aspect of the market liquidity -- with a liquid market defined as "a market where participants can rapidly execute large-volume transactions with a small impact on prices" -- but cannot evaluate all aspects of this definition comprehensively. This suggests the importance of monitoring a wide range of indicators to evaluate liquidity in financial markets.

Indicators Related to Liquidity in JGB Markets

There are a number of concepts for evaluating market liquidity, and the indicators corresponding to them are accordingly diverse. This chapter discusses four such indicators: (1) turnover and the turnover ratio, which indicate the trading volume; (2) the bid-ask spread, which indicates the trading cost; (3) the daily price range to turnover ratio, which approximates market resiliency; and (4) information on the trading board, which indicates market depth.^{1,2}

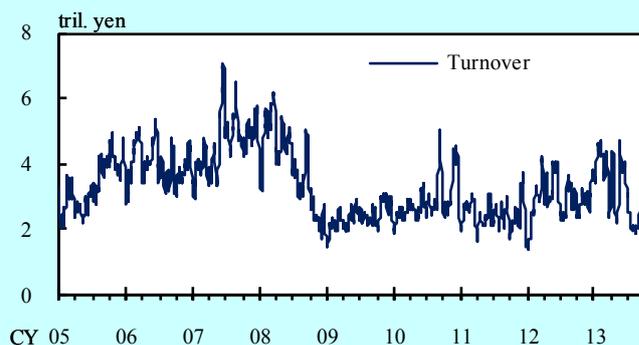
(1) Liquidity Indicator: Turnover and Turnover Ratio

Turnover in JGB markets captures trading volume directly. It is the most frequently used indicator, because it is easy to obtain data and make a time-series comparison.

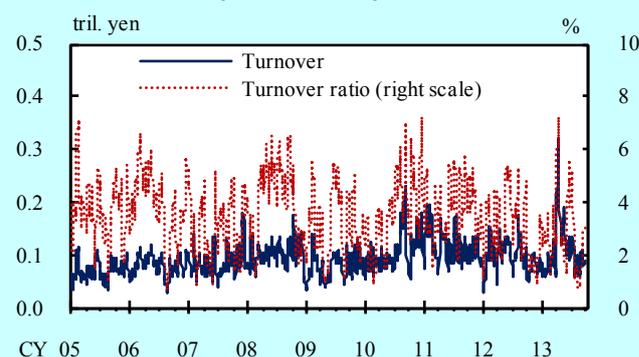
Chart 2 illustrates the daily turnover of JGB futures and newly issued 10-year JGBs from 2005 until recently. The turnover of JGB futures fell significantly after the failure of Lehman Brothers in

September 2008, and has gradually increased since around 2012. After the Bank of Japan's introduction of a new monetary policy framework called quantitative and qualitative monetary easing (QQE) in April 2013, turnover temporarily declined, but overall it has been moving within the average range recorded since 2009. As for newly issued 10-year JGBs, their turnover declined temporarily after the introduction of QQE but has generally remained within the past average range.

[Chart 2] Turnover and Turnover Ratio <JGB Futures>



<Newly issued 10-year JGBs>



Note: 10-day backward moving average. Turnover ratio is defined as turnover divided by issuance amount.
Sources: QUICK, Ministry of Finance.

The lower graph in Chart 2 additionally illustrates the turnover ratio, defined as the turnover divided by the issuance amount, for newly issued 10-year JGBs. The reciprocal of this ratio can be considered as the average holding period for JGBs. Therefore, a higher turnover ratio means a shorter average holding period for JGBs. Developments in the turnover ratio, especially recently, have mostly reflected the movement of turnover in the numerator.

Developments in turnover and the turnover ratio contain information on liquidity in JGB markets in terms of volume. However, the turnover tends to increase with a larger daily price range, so even if trading volume is large, it is possible that transactions are being executed with large price movements. Therefore, whether "participants can rapidly execute

large-volume transactions with a small impact on prices in the market" needs to be evaluated by referring also to other indicators. In addition, in the case of products with relatively lower credit risk such as government bonds, investors can execute transactions relatively easily even in the case of lower turnover and a lower turnover ratio. Thus, attention should be drawn to the point that these lower figures do not necessarily indicate the difficulty of transactions.

(2) Liquidity Indicator: Bid-Ask Spread

The bid-ask spread is defined as the difference between a bid price offered by buyers and an ask price offered by sellers. When the bid-ask spread is large, it is more difficult for traders to execute transactions around their intended prices and they face higher trading costs. Because it is easy to obtain timely data on the bid-ask spread, many market participants use this indicator to grasp market liquidity along with turnover.³

Chart 3 illustrates the daily bid-ask spread. This chart plots time-series data on the bid-ask spread, which are observed daily at a fixed time. The bid-ask spread for JGB futures widened immediately after the failure of Lehman Brothers, but then tightened and remained at a tighter level than prior to the failure of Lehman Brothers. This situation has not changed dramatically since the introduction of QQE. As for newly issued 10-year JGBs, the spread widened somewhat after the introduction of QQE but has moved within the past average range.

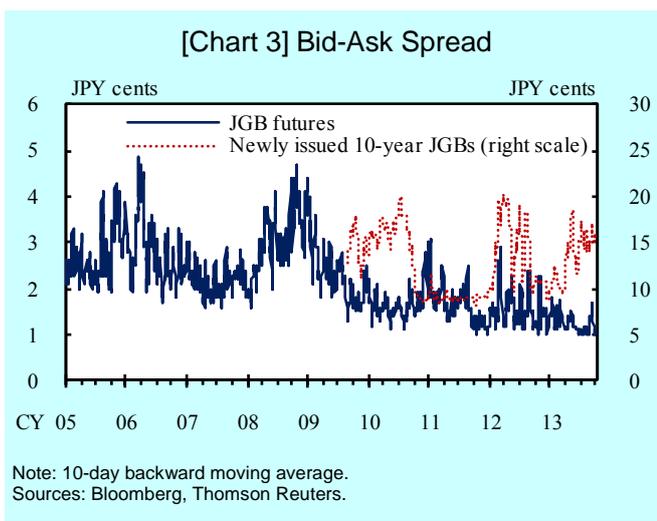
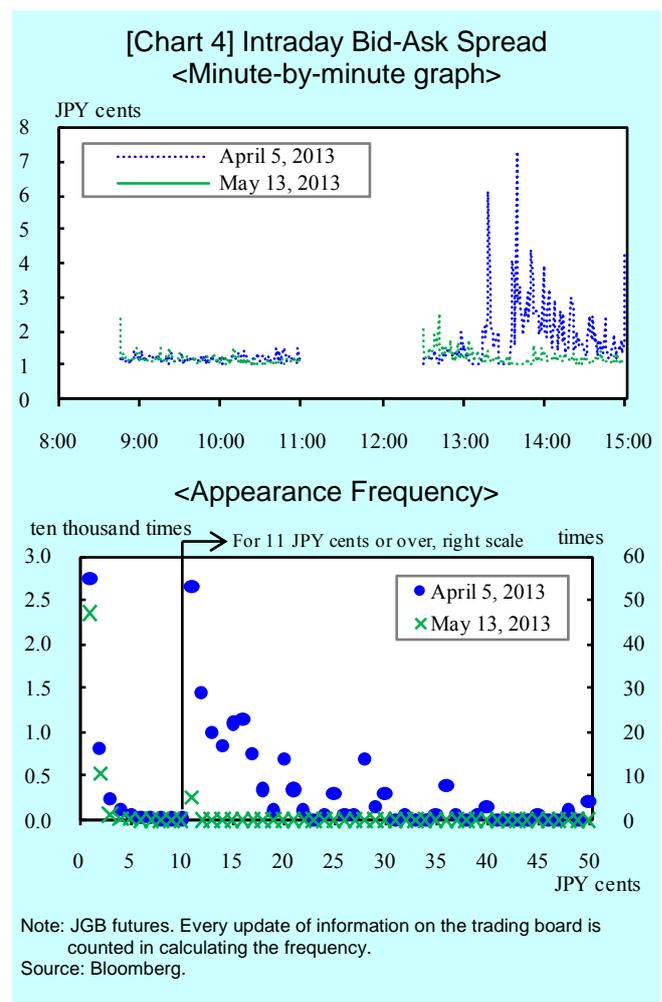


Chart 4 illustrates the intraday bid-ask spread for JGB futures. The chart shows the data on April 5 and May 13, 2013, when interest rates on JGBs rose significantly. In the case of April 5, the circuit breaker -- the system to halt transactions after rapid price

movements -- was exercised twice between 13:00 and 14:00. The minute-by-minute graph shows that the spread expanded dramatically just before and after the exercise of the circuit breaker. In addition, the distribution of how frequently each bid-ask spread appeared ("appearance frequency") has a heavy tail, implying a strong awareness of high trading costs. By contrast, on May 13 the spread remained generally stable at a lower level while interest rates on JGBs rose as significantly as they had on April 5. The distribution of the appearance frequency of the bid-ask spread has a light tail, and does not indicate that traders faced high trading costs.

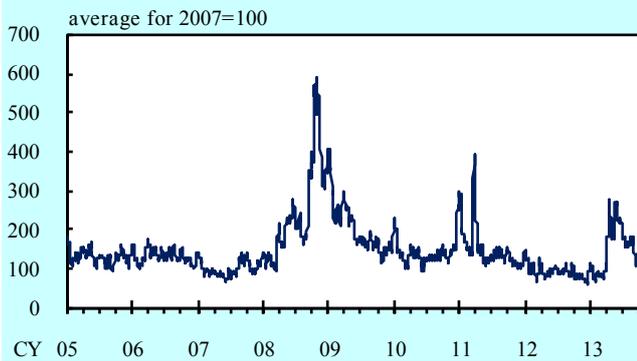


Developments in the bid-ask spread contain information on liquidity in JGB markets in terms of trading costs. However, it is difficult to calculate trading costs accurately merely from the price information. For example, even if the bid-ask spread is tight, it may be difficult for traders to execute transactions at the best bid or best ask prices if there are very few orders at the best bid or best ask prices -- that is, if the trading board is "thin." In particular, traders might have to pay a higher cost than the bid-ask spread when they execute large transactions.

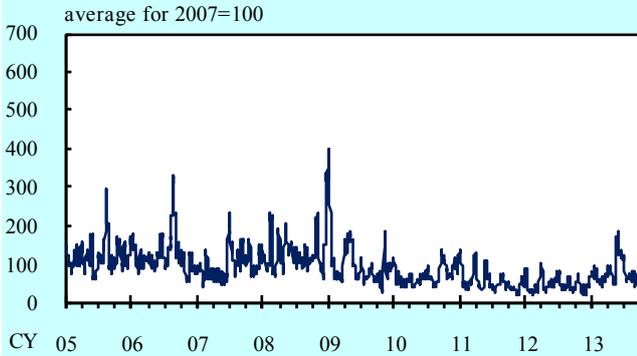
(3) Liquidity Indicator: Daily Price Range to Turnover Ratio

The daily price range to turnover ratio is defined as the daily price range, that is, the difference between the highest and the lowest transaction price of the day divided by turnover in a trading day. Roughly speaking, this indicator shows the price movement per transaction during the day.⁴ The smaller the ratio, the smaller the price movement per trade. A small ratio can be interpreted to mean that market conditions are more resilient, and traders might be able to execute transactions smoothly and rapidly.

[Chart 5] Daily Price Range to Turnover Ratio
<JGB Futures>



<Newly issued 10-year JGBs>



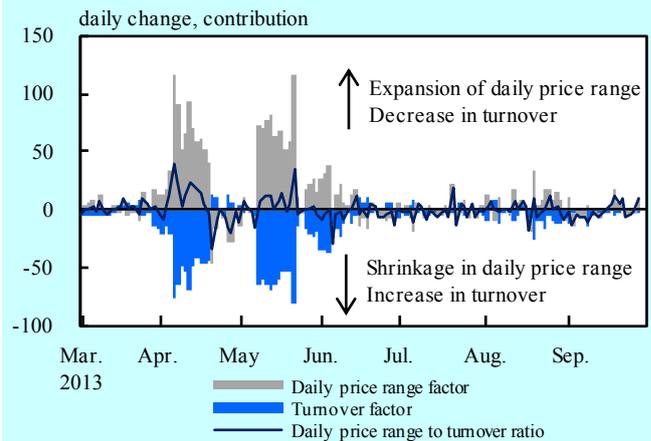
Note: 10-day backward moving average.
Source: QUICK.

Chart 5 plots the daily price range to turnover ratio for JGB futures and newly issued 10-year JGBs from 2005 until recently. Although the ratio for JGB futures rose dramatically after the failure of Lehman Brothers, it tended to decline except for the temporary rises in response to the rise in spot interest rates in Japan and the United States from the end of 2010 to the beginning of 2011 as well as the Great East Japan Earthquake. After the introduction of QQE, the ratio rose temporarily, but thereafter it declined moderately to the past average range. As for newly issued 10-year JGBs, although the ratio rose temporarily after the introduction of QQE, it declined thereafter and

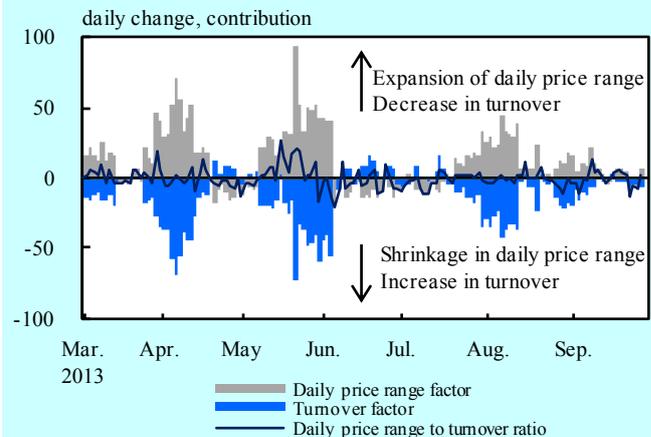
returned to the past average range.

Chart 6 plots daily changes in the ratio that are decomposed into the daily price range factor and the turnover factor. Turnover tends to increase (decrease) when daily price range expands (shrinks). When the ratio rose temporarily after the introduction of QQE, the daily price range widened more than the increase in turnover. When the ratio subsequently declined, the daily price range stabilized.

[Chart 6] Changes in Daily Price Range to Turnover Ratio
<JGB Futures>



<Newly issued 10-year JGBs>



Note: Factor decomposition of daily price range to turnover ratio that is indexed to an average for 2007=100 (Chart 5). 10-day backward moving average.
Source: QUICK.

Developments in the daily price range to turnover ratio contain information on liquidity in JGB markets in terms of market resiliency. However, this ratio also has limitations as an indicator. For example, even if the difference between the highest and the lowest price is small, resulting in a relatively small ratio, it might be difficult for market participants to execute transactions if the price moves frequently between the highest and lowest price during the day.

(4) Liquidity Indicator: Information on the Trading Board and Price Movements

Among the concepts for evaluating market liquidity, market participants refer to market depth frequently. However, its measurement has been limited because of the massive volume of data involved. This paper tries to obtain information on the depth of JGB markets from price movements on the trading board.

The trading board displays the number of orders at each bid and ask price, that is, the distribution of bids and asks. The trading board is said to be "thick" when orders center around the best bid and ask prices and "thin" when orders scatter among a wide range of prices. When the trading board is "thick," transactions can be executed without causing the price to move compared to when the trading board is "thin."

Chart 7 gives an example involving the JGB futures trading board at a certain time. In this situation, if a buyer tries to purchase 50 units (with a face value of 5 billion yen), the buyer buys JGB futures at a price range from 140.01 yen to 140.03 yen and the price moves by 0.02 yen. By contrast, if there are more than 50 units of orders at the best ask price (140.01 yen in this case), the price does not move after a buyer purchases 50 units. Therefore, the trading board is "thick" and transactions can be made without causing the price to move.

[Chart 7] Example on the Trading Board

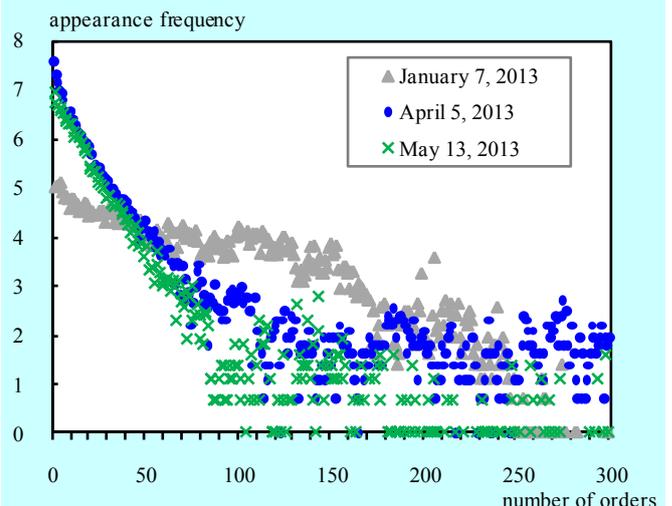
yen, number of orders				
Selling orders		Price	Buying orders	
Accumulated orders	Orders		Orders	Accumulated orders
100	45	140.04-		
55	15	140.03		
40	30	140.02		
10	10	140.01		
0	0	140.00	0	0
		Best ask	5	5
		Mid price of bid-ask	20	25
		Best bid	10	35
		-139.96	15	50

Moving 0.02 yen with the purchase of 50 units

In addition, this example shows that average purchase price tends to be lower when the trading board is "thick." In the case of Chart 7, the average purchase price adds up to 140.02 yen for the purchase of 50 units. By contrast, if the trading board is thicker -- namely, if there are more than 50 units of orders at the best ask price -- then the average purchase price stays at 140.01 yen and the difference from the mid price between the bid and ask prices remains only 0.01 yen.

Chart 8 depicts the distribution of the appearance frequency of the number of orders for JGB futures at the best ask price (10 units in Chart 7) on April 5 and May 13, 2013, when the interest rate rose sharply. Every update of information on the trading board is counted in calculating the frequency. An update occurs every several seconds on average and occurs several times per second when transactions are concentrated. Thus, the sum of the appearance frequency (the number of samples) in a day often reaches several tens of thousands. Chart 8 also illustrates the distribution at the beginning of 2013 (January 7, 2013) as a benchmark. The distributions on both April 5 and May 13 have a higher frequency for the small number of orders and a lower frequency for the large number of orders. These observations imply that the trading boards on at least these two days were "thinner" compared with the benchmark of January 7.⁵

[Chart 8] Appearance Frequency of the Number of Orders at the Best Ask Price



Note: JGB futures. Every update of information on the trading board is counted in calculating the frequency. Expressed in logarithms.
Source: Bloomberg.

Although Chart 8 implies that the trading boards on April 5 and May 13 are "thinner" compared with the benchmark, the chart does not contain time-series information, which is important for monitoring and evaluating the situation compared with other days.

Chart 9 plots the median of the number of orders at the best ask price daily from the distribution of the appearance frequency as time-series data. This chart shows that the number of orders at the best ask price declined sharply after the introduction of QQE in April 2013. The number recovered gradually from around June 2013, but at the end of September 2013 it had not returned to the level before the introduction of QQE.

The data obtained from the trading board contain information on liquidity in JGB markets in terms of market depth. However, these data represent information only from a quantitative aspect. To grasp market liquidity, it is important to evaluate fully and comprehensively the information also obtained from various indicators, such as the bid-ask spread, which captures the trading cost from price-related information.

[Chart 9] Median of the Number of Orders at the Best Ask Price



Note: JGB futures. Daily price range to turnover ratio is the 10-day backward moving average.
Sources: QUICK, Bloomberg.

Conclusion

This paper has introduced some indicators related to liquidity in JGB markets. These indicators contain information on liquidity in JGB markets in terms of trading volume, trading cost, market resiliency, and market depth. A look at liquidity in JGB markets after the introduction of QQE in April 2013 shows that some indicators, such as the bid-ask spread and the daily price range to turnover ratio, have been recovering within the range of their past averages, after having deteriorated temporarily. Meanwhile, the indicator of market depth, which had deteriorated temporarily, has been recovering as a trend but has not returned to the range of its past average. Therefore, in evaluating liquidity in JGB markets, it is imperative to make a comprehensive assessment by monitoring a wide range of indicators.

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¹ In this paper, although charts mainly illustrate developments in JGB futures and newly issued 10-year JGBs, similar developments can be observed in JGBs with other maturities.

² There are studies focusing on the distortion of prices among issues. Specifically, if the liquidity in government bond markets is sufficient, the prices of on-the-run and off-the-run bonds are likely to converge because of arbitrage trading. Based on this idea, some studies use the on-the-run/off-the-run spread as an indicator of market liquidity. At meetings of market participants in the United States, not only the volume and bid-ask spread but also the on-the-run/off-the-run spread is used to grasp liquidity in the U.S. Treasury markets. See, for example, U.S. Department of the Treasury, 2013, "Quarterly Refunding." In addition, the Bank of England has purchased gilts through the Asset Purchase Facility (APF) and has paid attention to the gilts repo market. See, for example, Bank of England, 2010, "Quarterly Bulletin 2010 Q4."

³ The Federal Reserve Bank of New York shows trading volume and the bid-ask spread as indicators related to liquidity in government bond markets, for example, in its "Domestic Open Market Operations during 2012" published in 2013.

⁴ Volatility of government bond prices is often referred to as an indicator of liquidity in government bond markets. Volatility moves basically toward the same direction as the daily price range, the numerator of the daily price range to turnover ratio. Hence, the daily price range to turnover ratio is considered to contain a great deal of information on volatility.

⁵ The same exercise for the number of orders at the best bid price gives almost the same results as that for the best ask price.

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