Financial Crises and Risk Premiums in International Interbank Markets *

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Abstract

In this paper, we analyze how the risk premiums in the Tokyo international interbank markets went through under the financial crisis. First, we briefly look back upon the financial situations under Japan’s financial crisis at the end of the 1990s and under the global financial crisis that occurred from the summer of 2007 to 2009. We then examine what happened to the risk premiums in the two crises. We use the interest rates of TIBOR and LIBOR for our analysis. In normal times since the two markets are almost completely integrated, the TIBOR is almost interlocked with the LIBOR regardless of their currency denomination. On the contrary, in the time of the financial crisis, there was a significant gap observed between them. However, the type of gaps that occurred depended largely upon the type of crisis. At the end of the 1990s, the TIBOR surpassed the LIBOR regardless of their currency denomination. On the other hand, under the global financial crisis at the end of the 2000s, the TIBOR fell below the LIBOR in the dollar denomination, but the former still overran the latter in the dollar denomination.

The different correlation between the TIBOR and the LIBOR in the yen and the dollar is not explained only by the difference in relative credit risks among financial institutions in the two markets. The regression results show that liquidity risk in addition to credit risk is useful in explaining this apparently paradoxical phenomenon. They also show that the central banks’ supply of US dollar liquidity was effective in the global financial crisis. Under increased global liquidity risk, there was an absolute liquidity shortage of US dollar in each market in the global financial crisis. The supply of US dollar liquidity by central banks was a policy measure to alleviate the liquidity shortage in such international financial markets.

Key words: liquidity risks, short-term financial markets, risk premiums, world financial crisis
JEL Classification codes: G15; G12; F36

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I. Introduction

Money markets where banks mutually manage and raise their funds are known as interbank markets. Banks raise funds through deposits and manage them through lending and trading securities such as bonds and stocks. However, managed and raised funds resulting from these transactions often do not match so that they need to adjust the differences in interbank markets. In Japan, the call market has developed over time as a typical interbank market where banks manage temporary excess or shortage of funds. At the same time, the interbank market where overseas banks mutually manage and raise their funds has been expanding significantly since the 1990s through the liberalization and globalization of financial services. Prior to Japan’s Big Bang, such an interbank market developed as an offshore market where transactions between overseas banks took place. However, transactions between domestic and foreign banks have also made significant growth in the market where interest rates acutely reflected market supply and demand conditions since the Big Bang.

The well-functioned interbank market is essential to financial market stability. In the domestic interbank market, the central bank not only adjusts macro-level excess or shortage of funds through supplying and absorbing funds but also contributes to interbank market stability as the “lender of last resort”. As a result, the domestic interbank market remains stable even if credit and liquidity risks become conspicuous in the market. By contrast, in the international interbank market, there is no central bank which contributes to overall global stability. As a result, the global market tends to be unstable when a financial crisis occurs. When Japan’s banking crisis became apparent in the late 1990s, the so-called Japan premium arose in the Tokyo market and funding cost of Japanese banks increased due to the increase in counterparty risk in the global transactions. 1 This suggests that the global transactions require additional premium to be paid which domestic transactions do not, when a financial crisis occurs.

In today’s globalized international financial market, it is vital to see how the international interbank market becomes destabilized in a financial crisis and what kinds of policies are effective to stabilize it. In the face of these issues, this paper analyzes how risk premiums have changed in two international interbank markets – Tokyo and London – in the late 1990s and in the late 2000s. The analysis starts with a review of the trends seen in the late 1990s when Japan’s financial crisis became apparent. It then compares the shift in risk premiums in the Tokyo and London markets in the global financial crisis between the summer of 2007 and 2009. The interest rates used in the analysis are the Tokyo Inter-Bank Offered Rate (TIBOR) and the London Inter-Bank Offered Rate (LIBOR). In order to avoid the problem of exchange risks, this paper compares the interbank offered rates in the two markets in both dollars and yen. Using the interbank rates in each currency, we

1 In previous literature, authors such as Hanajiri (1999), Covrig, Low, and Melvin (2004), Ito and Harada (2004), and Peek and Rosengren (2001) have analyzed sources of the Japan premium.
examine how risk premiums have arisen in international interbank markets in a financial crisis.

Nowadays, the Tokyo and London markets are almost completely integrated. Thus, the spread between TIBOR and LIBOR is negligible regardless of the currency denomination in normal times. By contrast, the spread becomes significant in a financial crisis. However, the degree of and the type of the spread differed greatly in the late 1990s and in the late 2000s. In the late 1990s when the financial crisis became apparent in Japan, TIBOR exceeded LIBOR regardless of the currency denomination. This reflected the fact that Japanese banks had higher credit risk than Western banks at the time. After the crash of speculative bubble, Japanese banks had faced serious non-performing loan problems. Overseas banks regarded this as a critical problem that should be reflected as a risk premium in the interbank market. On the other hand, TIBOR fell below LIBOR in yen-denomination in the global financial crisis of the late 2000s.\(^2\) We can interpret this as reflecting the fact that Western banks’ credit risk was increased but that of Japanese banks was not in the global financial crisis. However, in dollar-denomination, TIBOR exceeded LIBOR in the global financial crisis. The different correlation in dollar or yen-denomination cannot be explained simply by differences in the relative credit risk of banks in the global financial crisis. This paper demonstrates that the existence of liquidity risks in addition to credit risk is useful to explain such an apparent paradoxical result.

The following analysis explores sources of risk premiums in interbank markets by comparing interest rates in the Tokyo and London markets on the same day in the same currency. The reason for comparing interest rates in the same currency is to remove the effect of exchange rate risks. In previous literatures, numerous attempts have been made to examine how interest rates denominated in the same currency differ between interbank markets in different countries. For example, Bartolini, Prati and Hilton (2007) have demonstrated that divergences in interest rates hardly occurred in normal times in relation to the New York and London interbank markets. At the same time, McAndrews (2008) has demonstrated that risk premiums in the London interbank market exceeded those in the US in the global financial crisis.\(^3\) Taylor and Williams (2009) have analyzed the correlation between LIBOR in dollar and TIBOR in yen in the global financial crisis. Afonso, Kovner, and Schoar (2011) have examined the importance of liquidity hoarding and counterparty risk in the US overnight interbank market during the global financial crisis. However, with the exception of attempts such as Fukuda (2011a, 2012), there has been insufficient discussion in the attempt to examine what happened to risk premiums in the Tokyo and London interbank markets in the 2007-2009 global financial crisis.

This paper also examines how effective the central banks’ supply of US dollar liquidity

\(^2\) Gorton and Metrick (2012) have showed that changes in the LIBOR-OIS spread, a proxy for counterparty risk, were strongly correlated with changes in credit spreads and repo rates for securitized bonds in the global financial crisis.

\(^3\) Baba and Packer (2009) and Fukuda (2011b) have performed similar tests using the covered interest parity formula.
was in the global financial crisis. Under increased global liquidity risk, there was an absolute liquidity shortage of US dollar in each market in the global financial crisis. The supply of US dollar liquidity by central banks was a policy measure to alleviate the liquidity shortage in such international financial markets. In previous literature, the effectiveness has been demonstrated by Goldberg, Grittini, and Miu (2011) and Aizenman and Pasricha (2009). Reaffirming these results, this paper also demonstrates that its effectiveness is asymmetric, varying widely depending on the market.

While the relative importance of the Tokyo market has been declining, it remains a global financial center ranking next to London and New York. However, Japan’s international financial transactions still heavily rely on the US dollar. Table 1 reports currency shares of foreign exchange turnover in the Tokyo Market. It indicates that more than 70% of the foreign exchange turnovers in the Tokyo Market have been those from the US dollar to either Japanese yen or to Euro. This implies that the role of the US dollar as a medium of exchange is extremely significant in Japan’s international transactions and that securing its liquidity is indispensable for assuring the smooth financial transactions. This was particularly true in the global financial crisis when the liquidity shortage of the US dollar was substantial in the global economy in the aftermath of the Lehman Shock. Our regression results strongly suggest the importance for Japan to secure liquidity of the US dollar under the crisis.

### Table 1  Currency Shares of Foreign Exchange Turnover in the Tokyo Market

<table>
<thead>
<tr>
<th></th>
<th>Apr-04</th>
<th>Apr-07</th>
<th>Apr-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yen ↔ US Dollar</td>
<td>60.6</td>
<td>58.2</td>
<td>62.3</td>
</tr>
<tr>
<td>Euro ↔ US Dollar</td>
<td>11.7</td>
<td>10.8</td>
<td>9.5</td>
</tr>
<tr>
<td>Euro ↔ Yen</td>
<td>6.9</td>
<td>5.9</td>
<td>8.6</td>
</tr>
<tr>
<td>Others</td>
<td>20.8</td>
<td>25.1</td>
<td>19.7</td>
</tr>
</tbody>
</table>

(Note) This table reports currency shares of foreign exchange turnover in the Tokyo Market. The data is from the Bank of Japan.

This paper is structured as follows. Section 2 briefly reviews how liquidity shortages occurred in Japan in the late 1990s and in the global financial crisis. After providing an outline of TIBOR and LIBOR in section 3, section 4 explains the two risks in interbank markets and offers an estimated formula. Using this, a quantitative analysis is performed to examine the determinants of risk premiums in interbank markets in section 5. Section 6 provides a summary and discusses its implications.

### II. Liquidity shortages in Japan during financial crises

Before analyzing the determinants of the risk premiums in the Tokyo and London interbank markets, this section reviews how liquidity shortages occurred in Japan during


This subsection overviews the Japanese banking crisis and investigates how liquidity shortage developed during the crisis. After the collapse of the bubble economy in the early 1990s, a number of financial institutions had suffered from non-performing loans, owing to failures of its aggressive management, especially real estate-related investment during the bubble period. Before 1997, the failures were limited to small and medium-size banks, so that their macroeconomic impacts were rather marginal. However, the failure of Sanyo Securities Co. on November 3rd, 1997 resulted in the first default in the uncollateralized call market. This had a negative impact on many financial institutions and led to the failures of large financial institutions: Hokkaido Takushoku Bank (November 17th, 1997), Yamaichi Securities Co. (November 24th, 1997), Long-Term Credit Bank of Japan (October 23rd, 1998), and Nippon Credit Bank (December 1998).

Since the overseas investment by Japanese investors during the bubble period caused the outflow of funds, financial markets in Japan faced a shortage of funds for the international transactions in the banking crisis. It follows that Japanese financial institutions had to raise funds in international markets. However, Japanese accounting system was based on the historical cost convention, so that overseas investors became skeptical about how large unrealized losses Japanese banks had in those days. As a result, Japanese financial institutions were required to pay the so-called Japan premium when raising money from foreign financial institutions.

Figure 1 depicts the Japan Premium from January 1997 to December 2004, which is available on the website of the Bank of Japan. The figure shows that the Japan Premium which had stayed around 0.1% at the first half of 1997 soared to nearly 0.7% in November 1997. After the collapse of Sanyo Securities Co. on November 3rd, 1997, the Japan Premium increased substantially, due to the turmoil in the uncollateralized call market. Hokkaido Takushoku Bank which had failed to raise funds in the call market went bankrupt on November 17th, and then, Yamaichi Securities Co. was obliged to decide the voluntary closure of its operations on November 24th. Reflecting the successive collapse of the major financial institutions, the Japan premium recorded 0.657% in November and its peak reached 0.687% in December in 1997. Although the Japan premium temporarily declined to around 0.2% at the beginning of 1998 owing to the injection of public funds, it

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4 Fukuda and Koibuchi (2006, 2007) have analyzed the roles of banks against such liquidity shortages of firms by focusing on Long-Term Credit Bank of Japan and Nippon Credit Bank, which went bankrupt during Japanese financial crisis and had similar loan customers. Since the banks adopted different management strategies after the bankruptcy, a comparison of the impacts on profitability of corporate customers ranging from small and medium-sized enterprises to large companies gives a natural experiment to understand the role of the banks’ liquidity provisions.
started to rise again to 0.375% in June 1998, and then recorded 0.655% in October 1998. The significant Japan premium had persisted until the Bank of Japan started the zero interest rate policy in February 1999 and the large-scale injection of public funds in March 1999.

Figure 1. The Japan Premium from January 1997 to December 2004

![Graph showing the Japan Premium from January 1997 to December 2004.](Source: The Bank of Japan)

The Japanese banking crisis, the demand for liquidity also arose in the domestic loan market. Figure 2 depicts short-term liquidity ratio of Japanese firms from the first quarter of 1990 to the fourth quarter of 2006, based on “Principal Enterprises Tankan” surveyed by the Bank of Japan. The figure shows that the short term liquidity ratio increased from 1997. The financial crisis in 1997 led to substantial increases of precautionary demand against liquidity risks or a flight-to-liquidity from riskier projects to more liquid assets.

Figure 2. Short-term liquidity ratio of Japanese firms from 1990 to 2006

![Graph showing the short-term liquidity ratio of Japanese firms from 1990 to 2006.](Source: “Principal Enterprises Tankan” surveyed by the Bank of Japan.)
In the Japanese banking crisis, non-preforming loan problems were serious. While banks continued to lend to some inefficient large companies, they tightened their lending stance against small and medium-sized enterprises. Figure 3 depicts lending attitudes of financial institutions from the first quarter of 1995 to the fourth quarter of 2006, based on “Tankan” surveyed by the Bank of Japan. The figure shows that the lending attitudes became tight after the banking crisis in the fourth quarter of 1997. The contraction in the loan market made it difficult for small and medium-sized firms to borrow from banks. The tight lending attitudes had persisted until the first quarter of 1999 when unconventional monetary policy and the large-scale public fund injection stabilized the financial system.

Figure 3. Lending attitudes of financial institutions from 1995 to 2006

(Source) “Tankan” surveyed by the Bank of Japan.


This subsection overviews the global financial crisis and explores the degree of liquidity shortages in the markets in the crisis. Before the subprime mortgage problem surfaced, the global markets functioned normally although housing prices in the US had started to decline at the end of 2006. However, when investment funds affiliated to BNP Paribas froze redemptions in August 2007, risk premium suddenly jumped up in the financial markets, which aggravated the liquidity problem in the global economy. In particular, in September 2008, two GSEs were placed under government control due to the declines of the prices in Agency bonds and Agency MBS. In the same month, Lehman Brothers went into bankruptcy, which marked a turning point from “disorder” period to “crisis” period.
On September 15th, 2008, Lehman Brothers went into bankruptcy without being bailed out. On the same day, a merger of Merrill Lynch and Bank of America was announced. These incidents raised mutual mistrust in financial soundness among financial institutions, which caused liquidity shortages and the rise in the risk premium in the short-term money market. Moreover, the financial crisis of AIG on September 16th strengthened a perception of counterparty risk in the market, although the company escaped bankruptcy through a revolving credit facility of FRB. Reflecting the increased credit risks of financial institutions, stock prices of investment banks sharply dropped after the Lehman shock and the CDS spreads for major financial institutions in the US jumped up.

The TED spread which is calculated as the gap between LIBOR rates and rates on Treasury bills is one of the measures to capture counterparty risk or liquidity risk. Figure 4 depicts the TED spread from January 2007 to December 2011, based on “3-Month London Interbank Offered Rate (LIBOR)” and “3-Month Treasury Bill (Secondary Market Rate)” which were collected in “Federal Reserve Economic Data” of the FRB of St. Louis. This figure shows that reflecting a surge in the risk premium after Paribas shock in August 2007, the TED spread soared from about 0.5% to about 1.3%. Afterwards, the spread continued to rise to nearly 2% as liquidity problems became serious toward the end of 2007. Although the spread temporarily dropped into the 1% range once, it rose to 1.5% when Bear Stearns virtually went bankrupt and was merged into J.P. Morgan in March 2008. In particular, when the Lehman shock broke out in September 2008, the TED spread which had been about 1% in August were expanded to about 2% in September and about 3.5% in October.

Figure 4. TED spread from January 2007 to December 2011

(Source) “Federal Reserve Economic Data” of the FRB of St. Louis. TED spread = “3-Month London Interbank Offered Rate (LIBOR)” minus “3-Month Treasury Bill (Secondary Market Rate)”. 
Moreover, as soon as MMF which was an alternative to bank savings accounts fell below par, investors rushed to liquidate their MMF. The run on MMF not only deteriorated the funding of wholesale banks relying on MMF but also made it difficult to newly issue CP except for extremely short-term CP such as an overnight CP. The spreads on corporate bonds, mainly those with low ratings, also widened. A sense of anxiety and uncertainty concerning financial soundness of each financial institution, triggered by the Lehman shock, dried up liquidity and damaged financing of financial institutions and firms in the US financial markets.

European financial markets, which had already been in financial turmoil due to the direct effect of the subprime mortgage problem, also plunged into the financial crisis after the Lehman shock. Major financial institutions faced deterioration of the fund-raising situation, which expanded the CDS spreads for European financial institutions. Such financial turmoil led to a merger between Lloyds TSB and HBOS, the bailout for Hypo Real Estate by the German government and the injection of public funds to rescue Fortis and Dexia, for example. The aggravation of the financial crisis made investors including financial institutions in the U.S. and Europe risk averse and generated “flight-to-quality”, where investors shifted funds from risky assets to safe assets such as government bonds of developed countries.

Although Japan was not an epicenter of the global financial crisis, its real GDP growth rate was the lowest among developed countries. However, in spite of the serious stagnation of Japanese economy, Japanese financial institutions kept having relatively sound and healthy balance sheet during the global crisis. Figure 5 depicts non-performing loan ratios of Japanese banks from 1999 to 2011. The ratios steadily increased from 1999 to 2001. This indicates that the credit quality of Japanese banks deteriorated substantially during the Japanese banking crisis in the late 1990s and the early 2000s. By contrast, the ratios started to decline substantially after 2002 and remained low throughout the 2000s. During the global financial crisis, the credit quality of European and US banks deteriorated substantially, but that of Japanese banks did not.

Smaller credit risk in Japan, however, does not necessarily mean smaller liquidity risk in Japan. This is particularly worthwhile to be noted for international financial transactions in the short-term money market. Reflecting size of Japanese economy, the role of Tokyo market as a financial center remained large during the past decades. However, Japan’s international transactions still rely heavily on the US dollar. This implies that it is important to mitigate shortage of the US dollar especially in the Tokyo market during the global financial crisis.

In the following analysis, we examine the impact of the global financial crisis as a liquidity crisis on the short-term money market by comparing the responses of TIBOR-LIBOR spreads denominated in the US dollar and in yen. We will then explore what extent the risk measures and liquidity measures affect the TIBOR-LIBOR spreads by assuming that counterparty credit risk and liquidity risk consist of both currency-specific and market-specific factors.
III. TIBOR and LIBOR: Outline of data

In the following sections, we examine the determinants of risk premium in the Tokyo market during the two crises. The interest rates used in the analysis are TIBOR (Tokyo Inter-Bank Offered Rate) and LIBOR (London Inter-Bank Offered Rate), both of which are representative interest rates in international interbank markets, the former applicable to interbank transactions in Tokyo and the latter to those in London. Rates at different maturities including one week, one month to twelve months are available for both TIBOR and LIBOR. Of these, the analysis below uses daily data for the 3-month rate for TIBOR and LIBOR in both yen and dollars.5

TIBOR is an abbreviation of “Tokyo Inter-Bank Offered Rate”, being the interest rate applicable to interbank transactions in Tokyo. TIBOR in yen uses Japanese Bankers Association (JBA) TIBOR, which JBA publishes each business day by aggregating the rates reported by specified leading banks (reference banks). There are two JBA TIBOR rates. Japanese Yen TIBOR reflects the actual situation on the unsecured call market and Euroyen TIBOR reflects the actual situation on the Japan Offshore Market. Japanese Yen TIBOR and Euroyen TIBOR are determined as simple averages from rates presented by 15 banks for the former and 14 banks for the latter where the top two and bottom two values

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5 The LIBOR may have measurement errors because some panel banks acted strategically when quoting rates to the LIBOR survey during the global financial crisis (see, for example, Mollenkamp and Whitehouse [2008]).
are eliminated. The analysis below only uses Euroyen TIBOR as there has been very little difference between the two in recent years. Unfortunately, TIBOR in dollars is not published by the Japanese Bankers Association, but Bloomberg and Nikkei Quick News Inc. publish data on TIBOR in dollars. For the analysis below, this data has been downloaded from Nikkei Financial QUEST.

On the other hand, LIBOR is an abbreviation of “London Inter-Bank Offered Rate”, being the interest rate applicable to interbank transactions in London. The London interbank market has large transaction volumes. Its interest rates are considered to be as benchmark rates for the world’s interbank transactions and transactions take place in many currencies. Of these, LIBOR in yen and dollars are used in the analysis below. Both are published each business day by the British Bankers’ Association (BBA) which aggregates the rates reported at 11:00 local time by specified leading banks (reference banks). This data has been downloaded from Datastream for the analysis below.

Extending the data set in Fukuda (2012), Figure 6 depicts the TIBOR-LIBOR spreads in both the Eurodollar and the Euroyen markets during the two crisis periods: the period covering the Japanese banking crisis (January 4, 1995 to December 30, 1999) and the period covering the global financial crisis (January 1, 2007 to May 31, 2011). During the Japanese banking crisis, both Eurodollar and Euroyen TIBOR-LIBOR spreads started to take positive values in September 1995. The spreads temporarily shrunk from April 1996 to October 1997, and then grew drastically after the collapse of major Japanese financial institutions in November 1997. The spreads remained large throughout March 1999. A key feature during this period is that the TIBOR-LIBOR spreads had very large positive values in both markets, although they were larger in the Eurodollar rate than in the Euroyen rate. There is a strong co-movement of the spreads between the Eurodollar and Euroyen rates.

By contrast, during the global financial crisis, the TIBOR-LIBOR spreads started to move in opposite directions in the two markets. Before August 2007, the spreads were close to zero in both the markets. However, the spreads started to take positive values in the Eurodollar market and negative values in the Euroyen market since August 2007. Before the summer of 2008, the absolute values of the deviations were slightly higher in the Euroyen than in the Eurodollar market. Then, since September 2008, it became higher in the Eurodollar than in the Euroyen market. These asymmetric impacts in the two markets are in marked contrast to what was observed during the Japanese banking crisis. The asymmetric deviations continued until the beginning of 2009. Since January 2009, the TIBOR-LIBOR spreads started to take positive values in both markets. This may reflect the fact that recession increased the credit risk in Japan, whereas European and US banks recovered their credit quality in 2009. Both Eurodollar and Euroyen spreads gradually stabilized in 2010. This tendency continued even after Great East Japan Earthquake in Japan on March 11, 2011, although we see marginal upward deviations in Eurodollar spread after the earthquake.
Figure 6. TIBOR-LIBOR spreads during the two crisis periods

(1) Japanese banking crisis

(2) Global financial crisis

(Source) Nikkei Financial QUEST.
IV. The two risks in the interbank market

When we purchase goods or services, we have an obligation to pay money or deliver a product (a right to receive in the eyes of the counterparty). The actual delivery of money to eliminate the relationship between receivables and payables is known as “settlement”. Broadly speaking, there are two risks in the period prior to settlement. The first of these is known as “credit risk”, the possibility that money expected to be received cannot be received as a result of, for example, the insolvency of the counterparty. The second is known as “liquidity risk”, the possibility that money owed is not received on time when one wants to use it, as a result of which one in turn cannot pay amounts which one has to pay on time.

In the last section, we showed that during the global financial crisis where the magnitude correlation between TIBOR and LIBOR reversed depending on whether they were in yen or dollars. It suggested that in explaining this apparently paradoxical result, the increase in risk premiums cannot solely be explained by the relative differences in banks’ credit risk and considering the incidence of liquidity risk is important. From this perspective, the following analysis explores the mechanism - what kinds of factors have determined the difference between TIBOR and LIBOR in dollar and yen during the global financial crisis.

There is a possibility that credit risk and liquidity risk vary depending not only on the location of the interbank market, but also on the transaction currencies. Accordingly, the interest rate in the interbank market transacted at time $t$ in market $k$ ($k=\text{Tokyo, London}$) in currency $h$ ($h=\text{US dollar, Japanese yen}$) is defined as $i(h, k)_t$ and expressed as a linear relationship as follows.

$$i(h, k)_t = Rf(h)_t + \text{Risk}(h, k)_t + \text{Liquidity}(h, k)_t,$$

where $Rf(h)_t$ is the risk free rate in currency $h$ at time $t$, $\text{Risk}(h, k)_t$ is the credit risk in currency $h$ in market $k$ at time $t$, and $\text{Liquidity}(h, k)_t$ is the liquidity risk in currency $h$ in market $k$ at time $t$. If there is no risk premium, the risk free rate in the same currency is identical in all markets and $Rf(h)_t$ depends only on $h$ and not on market $k$.

The price of a 5-year CDS (credit default swap), which represents the cost to insure against a bank’s default, is used below to reflect credit risk in each market. Specifically, we used CDS (Japan) – the CDS price for Japan’s financial sector as a whole – for the Tokyo market, and CDS (UK) and CDS (US) – the CDS price for the UK and US banking sectors – for the London market. If the credit risk in each market is raising risk premiums in each interbank market, the CDS price for Japan – CDS (Japan) – would be expected to have a significant positive effect in the Tokyo market, while the CDS price for the UK and the US – CDS (UK) and CDS (US) – would be expected to have a significant positive effect in the London market. For both sets of data, daily data based on CMA Data Vision has been downloaded from Datastream. However, as the CDS price for Japan is subject to large
volatility, its logarithmic value was used to represent CDS (Japan).

Compared to credit risk, it is not easy to find direct proxy variables for liquidity risk. However, central banks of various countries acted in concert to boldly provide liquidity to the markets in the face of the global financial crisis. In particular, the FRB (Federal Reserve Board) – the US central bank – entered into US dollar swap agreements with the central banks of the world’s principal countries. As a result, central banks such as the Bank of Japan and the Bank of England conducted dollar funds-supplying operations to domestic banks as necessary using their own judgment.

In order to capture the effect of this, dummy variables (FX-Swap (BOJ-1) and FX-Swap (BOE)) were produced to represent a reduction in liquidity risk for the analysis below: a value of 1 was assigned to the days on which the Bank of Japan and the Bank of England conducted dollar funds-supplying operations, and a value of 0 to other days. For the Bank of Japan, a second set of dummy variables (FX-Swap(BOJ-2) was produced at the same time where the value of the dollars supplied (100 millions of yen) was assigned to the days on which the Bank of Japan conducted dollar funds-supplying operations, and a value of 0 to other days. In addition, another dummy variable (FRB Announcement) was produced to examine the effect of the FRB’s announcement of US dollar swap agreements with the Bank of Japan and other central banks. Here, a value of 1 was assigned to the days on which the FRB announced US dollar swap agreements and a value of 0 to other days. If the liquidity risk in each market raises risk premiums in each interbank market, the Bank of Japan’s dollar funds-supplying operations would be expected to have a significant negative effect in the Tokyo market, while the Bank of England’s dollar funds-supplying operations would be expected to have a significant positive effect in the London market.

Also, in relation to liquidity risk, the FRB itself conducted dollar funds-supplying operations to banks in the US, while the Bank of Japan conducted yen funds-supplying operations to banks in Japan, which may have reduced liquidity risk in the two markets. In order to consider this point, dummy variables (TAF (USA), BOJ (CP) and BOJ (Corporate)) were produced to additionally examine the extent to which the FRB’s TAF Program to supply dollar funds and the Bank of Japan’s “outright purchases of CP” and “Special funds-supplying operations to facilitate corporate financing” each might have reduced liquidity risk of the dollar and the yen. Here again, a value of 1 was assigned to the days on which funds-supplying operations were conducted and a value of 0 to other days.

V. Quantitative analysis

In the analysis below, the difference in risk premiums in interbank markets is calculated by comparing interest rates in the Tokyo and London markets on the same day in the same currency. The reason for comparing interest rates in the same currency here is to eliminate the effect of exchange rate fluctuations. In other words, as the interest parity formula indicates, even in completely integrated international financial markets, interest
rates in the various countries do not coincide when exchange rates move. Consequently, it is necessary to examine either the covered interest parity formula, which uses futures rates and spot rates, or the difference in interest rates denominated in the same currency in order to compare the interest rates in the various countries in an economically meaningful way. As discussed in the introduction, previous research on the “Japan premium” has taken the latter approach, basically examining risk premiums in each region by comparing rates of interest in the same currency.

For both dollar (Eurodollar) and yen (Euroyen) denominated interest rates, the TIBOR-LIBOR spread (3-month) is calculated, and the former being defined as the “Eurodollar spread,” and the latter the “Euroyen spread.” Then, setting each one as an explanatory variable, we regress it on the proxy variables for credit risk and liquidity risk explained in the previous section as follows.

\[
\text{Eurodollar spread}_t = \text{constant} + \sum_h \sum_k \text{Risk}(h, k)_t + \sum_h \sum_k \text{Liquidity}(h, k)_t, \tag{2}
\]

\[
\text{Euroyen spread}_t = \text{constant} + \sum_h \sum_k \text{Risk}(h, k)_t + \sum_h \sum_k \text{Liquidity}(h, k)_t, \tag{3}
\]

where \( h = \text{US dollar or Japanese yen and } k = \text{Tokyo, London, or New York}. \)

 Needless to say, the difference in interest rates in the various interbank markets does not simply reflect a risk premium alone. For instance, there is some divergence due to time differences as the markets are open in different time zones. Additionally, regulations differ by country, giving rise to interest rate variations by market reflecting the difference in regulations. However, these factors are expected to produce interest rates differences in the same way both in no financial crisis and in a financial crisis. Therefore, should distinctive large differences in interest rates arise during a financial crisis, these could be considered as reflecting differences in risk premiums.

Further, in order to consider factors other than the proxy variable for credit risk and liquidity risk explained in the previous section, OIS in dollars, OIS in yen, deviations from the covered interest parity (CIP) formula, and the VIX were added as control variables to the explanatory variables in the estimation. Here, OIS (overnight index swap) in dollars and OIS in yen are both risk free interest rates. The VIX is an index computed and published by the Chicago Board Options Exchange based on the volatility of S&P 500 index options transactions. It is considered a proxy variable for market risk where the higher the value, the more uncertain investors are about the future market prices.

The estimation period runs from January 4, 2007 to December 30, 2009. This period corresponds roughly to the period starting immediately prior to the outbreak of the global financial crisis until its impact largely came to an end. Table 2 shows how the TIBOR-LIBOR spread in dollars (Eurodollar spread) correlates with credit risk and liquidity risk in the various markets and Table 3 shows how the TIBOR-LIBOR spread in yen (Euroyen spread) correlates with them. In both tables, the estimation results are nearly identical regardless of the existence of control variables.
In particular, neither table indicates that the CDS price – the proxy variable for credit risk – for the US was significant, while both tables indicate that the CDS prices for Japan and the UK took the expected sign and were statistically significant. In other words, in both yen and dollars, through raising relative credit risk for the Tokyo market, the increase in credit risk for Japan (the increase in CDS (Japan), the CDS price for Japan) had the effect of widening the TIBOR-LIBOR spread significantly. By contrast, through raising relative credit risk for the London market, the increase in credit risk for the UK (the increase in CDS (UK), the CDS price for the UK) had the effect of narrowing the TIBOR-LIBOR spread significantly.

Table 2. Determinants of Eurodollar TIBOR-LIBOR spread

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.6424</td>
<td>-0.20</td>
<td>-0.4999</td>
<td>-0.16</td>
<td>-8.4833</td>
<td>-6.76***</td>
</tr>
<tr>
<td>Lagged Dollar Spread (-1)</td>
<td>0.4785</td>
<td>14.81***</td>
<td>0.4615</td>
<td>14.43***</td>
<td>0.6309</td>
<td>22.24***</td>
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<tr>
<td>Yen Spread (-1)</td>
<td>0.0527</td>
<td>1.46</td>
<td>0.0634</td>
<td>1.76*</td>
<td>-0.1104</td>
<td>-4.62***</td>
</tr>
<tr>
<td>ΔDollar Spread (-1)</td>
<td>0.2466</td>
<td>7.32***</td>
<td>0.2581</td>
<td>7.66***</td>
<td>0.1621</td>
<td>4.78***</td>
</tr>
<tr>
<td>ΔYen Spread (-1)</td>
<td>0.0409</td>
<td>0.29</td>
<td>0.0168</td>
<td>0.12</td>
<td>-0.0151</td>
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</tr>
<tr>
<td>Credit CDS (Japan)</td>
<td>1.0128</td>
<td>2.09**</td>
<td>1.0128</td>
<td>2.07**</td>
<td>2.2675</td>
<td>7.14***</td>
</tr>
<tr>
<td>Credit CDS (UK)</td>
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<td>-2.94***</td>
<td>-0.0184</td>
<td>-2.77***</td>
<td>-0.0190</td>
<td>-2.81***</td>
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<tr>
<td>Credit CDS (USA)</td>
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<td>-0.81</td>
<td>-0.0024</td>
<td>-0.91</td>
<td>-0.0008</td>
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<tr>
<td>Provision of FX Swap (BOJ-1)</td>
<td>-0.2389</td>
<td>-0.27</td>
<td>-1.8336</td>
<td>-2.59***</td>
<td>-0.6557</td>
<td>-0.71</td>
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<tr>
<td>Provision of FX Swap (BOJ-2)</td>
<td>-0.1447</td>
<td>-2.97***</td>
<td>-0.1720</td>
<td>-3.37***</td>
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<tr>
<td>Provision of FX Swap (BOE)</td>
<td>1.3713</td>
<td>2.76***</td>
<td>1.3130</td>
<td>2.63***</td>
<td>2.4746</td>
<td>4.91***</td>
</tr>
<tr>
<td>FRB Announcement</td>
<td>23.0231</td>
<td>8.30***</td>
<td>22.7510</td>
<td>8.17***</td>
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<td>Provision of BOJ (Corporate)</td>
<td>0.2174</td>
<td>0.42</td>
<td>0.1924</td>
<td>0.37</td>
<td>0.0724</td>
<td>0.13</td>
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<tr>
<td>Provision of BOJ (CP)</td>
<td>0.1872</td>
<td>0.32</td>
<td>0.0873</td>
<td>0.15</td>
<td>0.0005</td>
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<td>Auxiliary VIX</td>
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<td>0.0234</td>
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<tr>
<td>Auxiliary CIP Deviation</td>
<td>3.9578</td>
<td>8.08***</td>
<td>4.0743</td>
<td>8.30***</td>
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<td></td>
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<tr>
<td>Auxiliary OIS (Yen)</td>
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<td>Auxiliary OIS (Dollar)</td>
<td>-0.1624</td>
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<td>Adj. R-squared</td>
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<td>0.803</td>
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<td>LM Test</td>
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<td>32.897</td>
<td>57.634</td>
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</tbody>
</table>

Notes 1) See Appendix for definition of the variables.
2) The LM test expresses the F value of the Breusch-Godfrey serial correlation LM test.
3) *, **, *** express significance levels of 10%, 5%, 1% respectively.
Table 3. Determinants of Euroyen TIBOR-LIBOR spread

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>Coefficient</th>
<th>t-Statistic</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.1926</td>
<td>-0.1553</td>
<td>-1.3824</td>
<td>-4.29**</td>
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<tr>
<td>Lagged</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Yen Spread</td>
<td>0.9442</td>
<td>98.39***</td>
<td>0.9470</td>
<td>98.64***</td>
<td>0.9751</td>
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<tr>
<td>Dollar Spread (-1)</td>
<td>0.0162</td>
<td>1.89*</td>
<td>0.0118</td>
<td>1.38</td>
<td>-0.0035</td>
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<tr>
<td>ΔYen Spread (-1)</td>
<td>0.0578</td>
<td>1.54</td>
<td>0.0515</td>
<td>1.37</td>
<td>0.0687</td>
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<tr>
<td>ΔDollar Spread (-1)</td>
<td>0.0039</td>
<td>0.43</td>
<td>0.0069</td>
<td>0.77</td>
<td>0.0140</td>
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<tr>
<td>Credit</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CDS (Japan)</td>
<td>0.3141</td>
<td>2.43***</td>
<td>0.3141</td>
<td>2.42***</td>
<td>0.3629</td>
</tr>
<tr>
<td>CDS (UK)</td>
<td>-0.0069</td>
<td>-3.93***</td>
<td>-0.0067</td>
<td>-3.76***</td>
<td>-0.0057</td>
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<tr>
<td>CDS (USA)</td>
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<td>0.84</td>
<td>0.0005</td>
<td>0.74</td>
<td>-0.0002</td>
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<td>Provision of US dollar liquidity</td>
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<tr>
<td>FX Swap (BOJ-1)</td>
<td>0.1834</td>
<td>0.78</td>
<td>-0.2339</td>
<td>-1.24</td>
<td>0.2624</td>
</tr>
<tr>
<td>FX Swap (BOJ-2)</td>
<td>-0.0379</td>
<td>-2.92***</td>
<td>-0.0352</td>
<td>-2.68***</td>
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<tr>
<td>FX Swap (BOE)</td>
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<td>0.05</td>
<td>-0.0085</td>
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<td>-0.0803</td>
</tr>
<tr>
<td>FRB Announcement</td>
<td>1.0812</td>
<td>1.46</td>
<td>1.0100</td>
<td>1.36</td>
<td>0.1365</td>
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<tr>
<td>TAF (USA)</td>
<td>-0.1397</td>
<td>-1.01</td>
<td>-0.1463</td>
<td>-1.05</td>
<td>-0.1106</td>
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<tr>
<td>Provision of yen liquidity</td>
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<tr>
<td>BOJ (Corporate)</td>
<td>0.0867</td>
<td>0.56</td>
<td>0.0606</td>
<td>0.39</td>
<td>0.1229</td>
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<td>BOJ (CP)</td>
<td>0.0110</td>
<td>0.08</td>
<td>0.0065</td>
<td>0.05</td>
<td>0.0207</td>
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<td>Auxiliary</td>
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<td>VIX</td>
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<td>-0.0107</td>
<td>-1.83</td>
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<tr>
<td>CIP Deviation</td>
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<td>-2.80***</td>
<td>-0.3346</td>
<td>-2.56***</td>
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</tr>
<tr>
<td>OIS (Yen)</td>
<td>-1.5739</td>
<td>-2.77***</td>
<td>-1.5992</td>
<td>-2.80***</td>
<td></td>
</tr>
<tr>
<td>OIS (Dollar)</td>
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<td>-0.48</td>
<td>-0.0339</td>
<td>-0.46</td>
<td></td>
</tr>
<tr>
<td>Adj. R-squared</td>
<td>0.991</td>
<td>0.991</td>
<td>0.991</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM Test</td>
<td>3.020</td>
<td>3.102</td>
<td>2.300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes
1) See Appendix for definition of the variables.
2) The LM test expresses the F value of the Breusch-Godfrey serial correlation LM test.
3) *, **, *** express significance levels of 10%, 5%, 1% respectively.

In contrast to this, the effect of liquidity risk differed in yen or dollar. Firstly, Table 2 – which sets the TIBOR-LIBOR spread in dollar (Eurodollar spread) as the explanatory variable – indicates that while the Bank of Japan’s dollar funds-supplying operations (FX-Swap(BOJ-1) and FX-Swap(BOJ-2)) took on a significant negative sign, those of the Bank of England (FX-Swap(BOE)) took on a significant positive sign. These results suggest, in the case of dollar, that while the Bank of Japan’s dollar funds-supplying operations had the effect of narrowing the TIBOR-LIBOR spread significantly through lowering relative liquidity risk for the Tokyo market, the Bank of England’s dollar funds-supplying operations had the effect of widening the TIBOR-LIBOR spread significantly through lowering relative liquidity risk for the London market. Further, it was observed that also through lowering relative liquidity risk for the London market, the announcement of US dollar swap agreements (FRB Announcement) had the effect of widening the TIBOR-LIBOR spread significantly.6

On the other hand, Table 3 – which sets the TIBOR-LIBOR spread in yen (Euroyen

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6 However, no significant effect was observed for the FRB’s dollar funds supply through the TAF Program (TAF(USA)).
spread) as the explanatory variable indicated that central banks’ liquidity supply operations did not take on a significant sign with the exception of certain cases where the Bank of Japan’s dollar funds-supplying operations took on a significant negative sign. In particular, none of the dummy variables which reflect the Bank of Japan’s supply of yen funds were significant. This result suggests that the effect which central banks’ supply of yen funds had on lowering liquidity risk in the various markets was limited, given the ample liquidity of yen funds during the global financial crisis, owing in part to the Bank of Japan’s previous large-scale funds-supplying operations.

VI. Conclusion

The world’s financial markets have integrated further through the advanced globalization of financial service. The integration is especially notable in the money markets. The correlation between rates in the various markets adjusted to the same currency is becoming extremely tight in interbank markets where banks lend and borrow among themselves. Yet, even with today’s advanced global financial integration, the correlation between rates decreases due to risk premiums in individual markets in the event of a financial crisis. This paper considered the effect of financial crisis on Japan’s financial markets from the perspective of risk premiums in international interbank markets.

As is well-known, the Japan premium arose in the financial crisis of the late 1990s, whereby Japanese banks (overseas Japanese banks) had to pay higher interest rates than Western banks when raising funds in international interbank markets. On the other hand, the global financial crisis of the late 2000s was very different from the crisis of the late 1990s, since the epicenter of the crisis was the US and Europe. Yet during the global financial crisis, while in a superior position to Western banks for transactions in yen, Japanese banks still paid high risk premiums for transactions in dollars in interbank markets. These results suggest that it is important for Japanese banks to secure dollar liquidity in international financial markets; and that, in relation to this point, additional policy frameworks and safety nets are needed in Asian financial markets, including Japan.

The US dollar swap agreements which the FRB (Federal Reserve Board) agreed with the central banks of the world’s principal countries were beneficial in that they offset the lack of liquidity of the international currency, the dollar, in financial markets following the Lehman Shock. In international financial markets which operate round the clock, the expansion and enhancement of US dollar swap agreements is considered an important policy measure to contribute towards money market stability in a crisis. However, it does not mean that there is no alternative political framework in the Asian region. For example, the “Chiang Mai Initiative” is a mechanism established by East Asian countries following the Asian Currency Crisis with the aim of mutually accommodating the liquidity of the dollar during a crisis by drawing on the foreign exchange reserves in dollars held by each country. Although there are restrictions on receiving funds, such as complying with IMF conditionality, its scale and scope of countries (multilateralization) have expanded in recent
years and there are high expectations of its role as a safety net for dollar funds in the Asian region.
Appendix: The Definitions of Explanatory Variables Used in the Estimations

Lagged Variables (unit = basis point)

“Dollar Spread (-1)” = Eurodollar TIBOR – LIBOR with one-period lag, “Yen Spread (-1)” = Euroyen TIBOR – LIBOR with one-period lag, “△Dollar Spread (-1)” = time difference of Dollar Spread (-1), and “△Yen Spread (-1)” = time difference of Yen Spread (-1).

Proxies for credit risk (unit = basis point)

“CDS (Japan)” = log of five-year financial service sector CDS index for Japan. “CDS (UK)” and “CDS (US)” = five-year banks sector CDS index for the United Kingdom and the United States respectively.

Variables on provision of US dollar liquidity

“FX Swap (BOJ-1)”, “FX Swap (BOE)”, and “FX Swap (ECB)” = swap-line dummy that is one when dollar liquidity was provided by BOJ, BOE, and ECB respectively and zero otherwise. “FX Swap (BOJ-2)” = a variable that equals to the amount (unit = 100 million yen) of dollar liquidity provided by BOJ. “FRB Announcement” = a dummy that is one when FRB announced swap line agreements and zero otherwise. “TAF (USA)” = a dummy that is one on the dates of TAF operation and zero otherwise.

Variables on provision of Japanese yen liquidity

“BOJ (CP)” = a dummy that is one on the dates of BOJ’s outright purchases of CP and zero otherwise. “BOJ (Corporate)” = a dummy that is one on the dates of BOJ’s special funds-supplying operations to facilitate corporate financing and zero otherwise.

Auxiliary variables

“CIP Deviation” = deviation from the CIP condition with unit of percentage point. “OIS (yen)” and “OIS (Dollar)” = yen-denominated and dollar-denominated three-month overnight index swap (OIS) rate (%) respectively.
References


