OSE 3-Month TONA Futures and BOJ Monetary Policy

Alexis Stenfors[*]

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Abstract

On 19 March 2024, the Bank of Japan finally abandoned its policy framework of yield curve control and negative interest rates. However, international financial markets have evolved dramatically since the last rate hike in 2007. Most notably, derivative instruments indexed to LIBOR have been phased out, and Euroyen TIBOR is scheduled to disappear by the end of 2024. In light of these developments, this paper provides an overview of the Japanese alternative risk-free rate, TONA, and the OSE 3-month TONA futures, which was launched by Osaka Exchange (part of JPX) on 29 May 2023. Through the lens of three hypothetical case studies, the paper provides an insight into how the Japanese "product menu" has changed and what it means for traders, investors, and other market observers taking a view on the next move by the Bank of Japan.

Keywords: BOJ, futures, interest rates, LIBOR, monetary policy, OIS, TIBOR, TONA, regulation, risk management, trading

* Dr. Alexis Stenfors is a financial economist and the author of *Barometer of Fear: An Insider's Account of Rogue Trading and the Greatest Banking Scandal in History* (Bloomsbury) and co-editor of *Unconventional Monetary Policy and Financial Stability: The Case of Japan* (Routledge). He has published widely in areas including monetary policy, market microstructure, liquidity and OTC market manipulation. Before returning to academia in 2009, Alexis spent 15 years as a foreign exchange and interest rate derivatives trader at HSBC, Citi, Crédit Agricole and Merrill Lynch in Stockholm, London and Tokyo. He is currently an Associate Professor in Economics and Finance at the University of Portsmouth. He has also held academic positions at SOAS University of London, the University of Leeds, Washington University in St. Louis, Peking University HSBC Business School, Meiji University, and the University of California Berkeley. Alexis Stenfors also advises on financial market risk, regulation, and trade surveillance technology.

Contact email: alexis.stenfors@port.ac.uk

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1. Introduction

After several decades of low and stable price developments, global inflation returned with a vengeance in late 2021. It came as a shock since, from the 1990s onwards, advanced economies had gradually grown accustomed to a low-inflation environment. During that time, an increasing number of central banks adopted inflation-targeting as a monetary policy regime. In this system, decisions about their interest rates were handed over from governments to central banks, with the government retaining just the formal power of setting a target for inflation that central banks were supposed to achieve with their monetary policy. By the time of the aftermath of the 2007–09 global financial crisis, near-zero interest rates had become the norm, and extraordinary policy measures such as quantitative easing (QE) had become part of the standard monetary policy toolbox. However, as the COVID-19 pandemic abated and the global economy started to recover, inflation suddenly returned, with a backdrop of years of QE, near-zero interest rates, global supply-chain strains, and soaring energy prices following the war in Ukraine.

In line with the inflation-targeting mandate, the rise in inflation has since triggered an unprecedented number of successive rate hikes across the world (Figure 1).
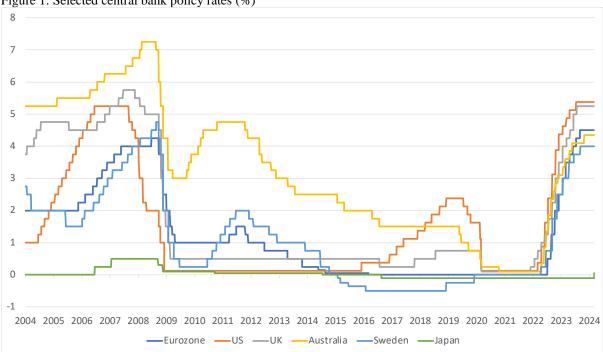
Figure 1: Selected central bank policy rates (%)

Sources: Bank of England, Bank of Japan, European Central Bank, Federal Reserve Bank of St. Louis (FRED), Reserve Bank of Australia, Sveriges Riksbank.

However, there has been one major exception: Japan. Since the banking crisis of the 1990s, Japan has not only stood out with its low short-term policy rates and bond yields. The country has also been a pioneer concerning unconventional monetary policy and financial stability measures. For instance, in February 1999, the Bank of Japan introduced a Zero Interest Rate Policy (ZIRP) and quantitative and qualitative monetary easing (QQE) was launched in 2013 (BOJ, 2000; Kuroda, 2013). Indeed, the Bank of Japan has arguably gone further than any other major central bank in its attempt to recover the dynamism of the domestic economy (Stenfors, 2020; Stenfors et al., 2022). More recently, this included the introduction of *Quantitative and*

Qualitative Monetary Easing with a Negative Interest Rate in January 2016, which was followed by the launch of *Quantitative and Qualitative Monetary Easing with Yield Curve Control* in September of the same year. This policy entailed that the Bank of Japan would keep the official short-term interest rate at minus 0.10% and purchase Japanese government bonds (JGBs) so that the 10-year yield would remain around 0% (BOJ, 2016). As can be seen in Figure 2, the yield curve control policy had an immediate impact on long-term JGB yields.

Figure 2: JGB benchmark yields (%)

Source: Bloomberg

The yield curve control policy remained in place for the remainder of Haruhiko Kuroda's governorship. However, higher inflationary pressures, lately also in Japan, put pressure on the Bank of Japan and Kuroda's successor, Kazuo Ueda (who took office in April 2023), to abandon its ultra-loose monetary policy framework.

Up until the end of 2023, the yield control policy was modified three times. First, at the monetary policy meeting on 20 December 2022, the yield curve control policy was tweaked to state that the Bank of Japan "[…] will expand the range of 10-year JGB yield fluctuations from the target level: from between around plus and minus 0.25 percentage points to between around plus and minus 0.5 percentage points […]" (BOJ, 2022). Second, at the monetary policy meeting on 28 July 2023, the policy statement was amended to state that "[…] The Bank will continue to allow 10-year JGB yields to fluctuate in the range of around plus and minus 0.5 percentage points from the target level, while it will conduct yield curve control with greater flexibility, regarding the upper and lower bounds of the range as references, not as rigid limits, in its market operations […]" (BOJ, 2023b). Third, at the monetary policy meeting on 31 October 2023, the statement on monetary policy included a revision outlining that the Bank of Japan "[…] will regard the upper bound of 1.0 percent for 10-year JGB yields as a reference in its market operations […]" (BOJ, 2023c). Despite gradually relaxing the yield curve control policy targeting the 10-year JGB yield, the official short-term interest rate on financial institutions' current account balances at the BOJ remained unchanged at -0.10% until the mid-March 2024.

Finally, following the monetary policy meeting on 18-19 March 2024, the BOJ concluded that the policy framework of *Quantitative and Qualitative Monetary Easing with Yield Curve Control* and the *Negative Interest Rate Policy* had fulfilled their roles. The overnight interest rate was raised to range at around 0 to 0.10% (BOJ, 2024).

However, it is not only interest rates that have changed. Since the Bank of Japan raised its short-term interest rate last time (17 years ago), international financial markets have changed dramatically. Most notably, the London Interbank Offered Rate (LIBOR), the by far most widely used benchmark in the money market and sometimes dubbed "the world's most important number," no longer exists. Instead, new benchmarks have emerged as replacements for IBOR-based instruments, and new products have been created for traders, investors, and customers to expose themselves to or hedge against movements in short-term interest rates.

To this end, Osaka Exchange (OSE), part of the Japan Exchange Group (JPX), launched the 3-month TONA futures contract on 29 May 2023 (JPX, 2023). This paper provides an overview of the transformation to this new "product menu" and illustrates how TONA futures can be used by hedgers and speculators within the rapidly changing Japanese interest rate environment. The remainder of the paper is organised as follows: Section 2 provides a background on the transition from LIBOR to risk-free rates (RFRs), and Section 3 outlines the key differences between the two benchmark types. Section 4 describes the Japanese version (TONA) and the OSE 3-month TONA futures contract. Through the lens of three different case studies, Section 5 illustrates how OSE 3-month TONA futures can be used in practice to hedge against or speculate on monetary policy changes by the Bank of Japan and how the futures contract differs from other widely used financial instruments. Section 6 concludes.

2. The end of LIBOR and the transition to alternatives

LIBOR and the subsequent IBOR benchmarks in other financial centres (such as the Tokyo Interbank Offered Rate (TIBOR) and the pre-euro Frankfurt Interbank Offered Rate (FIBOR), were originally designed to capture the activity in the interbank money market for a range of currencies. The fixing mechanism underpinning the benchmark was widely assumed to provide accurate daily snapshots of where banks borrowed from and lent to each other for various maturities. Traders, investors, portfolio managers, and treasurers paid particular attention to the 3-month maturity because of its role as a floating-rate benchmark for vast amounts of derivatives, bonds, and loans. Central bankers, on the other hand, used the benchmark to assess the effectiveness of its monetary policy and financial stability measures. LIBOR was, namely, not only supposed to reflect the current official central bank interest rate and market expectations of changes in the near term, but also elements of credit and liquidity risk (Stenfors, 2014).

However, the LIBOR scandal, which erupted in 2012, revealed that the estimate-based benchmark was susceptible to systematic manipulation and collusion. Problematically, it also turned out that the underlying term money market was considerably less liquid than previously thought—and sometimes nonexistent. These findings eventually led to a death sentence for the benchmark. In a speech given in 2017, Andrew Bailey, Chief Executive of the UK Financial Conduct Authority (FCA), stated that "the underlying market that LIBOR seeks to measure—the market for unsecured wholesale term lending to banks—is no longer sufficiently active.

[…] If an active market does not exist, how can even the best-run benchmark measure it?" (FCA, 2017).

As a result, financial regulators around the world recommended a transition away from IBOR-like benchmarks towards risk-free rates (RFRs) that were based upon actual transactions and had sufficient liquidity in underlying markets (BIS, 2013; IOSCO, 2013). Since then, countries have chosen different alternatives as robust RFRs to replace LIBOR. For instance, the US has opted for the Secured Overnight Financing Rate (SOFR), a secured overnight interest rate, whereas the UK has chosen the Sterling Overnight Index Average (SONIA), a transaction-based average rate based on banks' GBP overnight borrowing from financial institutions and institutional investors (BOE, 2023a). Japan has selected the Tokyo Over-Night Average (TONA) rate. TONA is the uncollateralized overnight call rate in Japan (BOJ, 2023a).

Importantly, up until the recent surge in global inflation and the subsequent rate hikes, IBOR-indexed exchange-traded futures contracts, as well as forward rate agreements (FRAs) and interest rate swaps (IRSs) traded over-the-counter (OTC), were the most widely used products to hedge against or speculate on changes in short-term interest rates. When the Chicago Mercantile Exchange (CME) launched the 3-month Eurodollar futures contract in 1981, it quickly became the most actively traded short-term interest rate contract globally (Stenfors and Lindo, 2018). The Eurodollar future became indexed to the 3-month USD LIBOR in 1997, and similar products appeared in other global financial centres. Short Sterling futures, Euroyen futures, etc. came to be indexed against the prevailing money market benchmarks, such as the 3-month GBP LIBOR and the 3-month JPY Euroyen TIBOR.

The transformation towards RFRs has already had a dramatic impact on the market structure for instruments referencing LIBOR, TIBOR, and other equivalent benchmarks. For example, the global daily turnover in OTC FRAs decreased from $1.9 trillion in 2019 to $0.5 trillion in 2022. FRAs denominated in USD, GBP, CHF, and JPY declined by more than 90%. An evolution has also taken place in the IRS market, a traditional stronghold for IBOR benchmarks. Figure 3 shows the percentage of OTC interest rate derivatives traded as an RFR up until November 2023. Trade volumes are weighted according to DV01 (dollar value per basis point) to account for differences in maturity. As can be seen, by late 2022, nearly 100% of GBP, JPY, and CHF IRSs referenced SONIA, TONA, or the Swiss average overnight rate (SARON), respectively. The transformation has been most dramatic for JPY, where less than 10% of the IRS market referenced TONA as late as 2019 (Huang and Todorov, 2022).
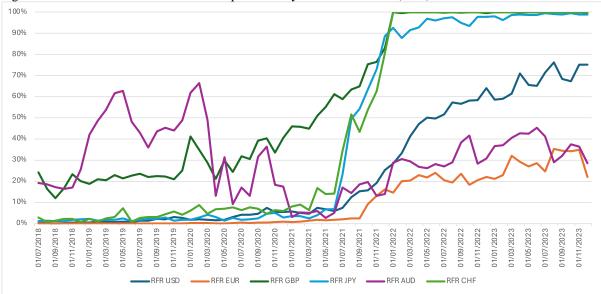
Figure 3: DV01 of interest rate derivatives per currency traded as an RFR (in %)

Source: ISDA (2023)

The impact on the exchange-traded market has also been profound. By 2022, the share of RFR-based futures had jumped to 100% for GBP and CHF. However, perhaps the most visible and symbolic change has been the disappearance of the 3-month Eurodollar futures contract in 2023. CME launched SOFR futures in May 2018, and the contract has become the *de facto* replacement of the historic Eurodollar futures contract.

3. Differences between LIBOR and RFRs

Although LIBOR and other IBOR-type benchmarks were intended to reflect prices in the market, they were not based on actual transactions. Instead, the relevant and widely used IBOR fixings were calculated from daily "quotes" and "estimates" provided by panels consisting of large banks active in the respective market.

Arguably the most important feature in the shift from IBORs to RFRs has been the adoption of *actual transactions*, rather than non-binding or essentially indicative quotes and estimates, as the basis for the benchmark calculation. Other features vary depending on the currency area, such as whether the RFR is based on secured or unsecured transactions, and whether transactions with non-bank institutions are included (see Table 1).

Another crucial difference concerns *maturity*. IBORs included a range of maturities, but 3 months was the most commonly used index. Acknowledging that the underlying interbank term money market has all but dried up, all major RFRs are now referencing the overnight money market rate rather than maturities of up to 3 months and beyond.

Table 1: Overview of IBORs and alternative RFRs in selected currency areas

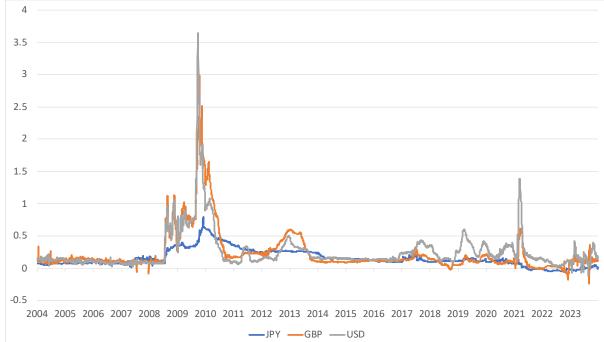| Currency area	US	UK	Euro area	Switzerland	Japan
IBOR	LIBOR	LIBOR	LIBOR EURIBOR	LIBOR	LIBOR TIBOR
Alternative RFR	SOFR	SONIA	ESTER	SARON	TONA
Wholesale non-bank counterparties	Yes	Yes	Yes	No	Yes
Secured	Yes	No	No	Yes	No
Overnight rate	Yes	Yes	Yes	Yes	Yes

Source: Schrimpf and Sushko (2019)

These differences have two major practical implications for investors, traders, and customers.

First, since IBORs are fixed and known at the start of the contract period, they are so-called "forward-looking" term rates. However, a 3-month contract with an RFR is "backward-looking" because it requires the actual overnight rates to be compounded in arrears after the 3 months have passed.

Second, IBORs include credit risk and funding liquidity risk, whereas RFRs do not (Michaud and Upper, 2008). For instance, the 3-month Euroyen TIBOR should reflect the rate "[…] which reference banks deem as prevailing market rates, assuming transactions between prime banks on the underlying market (Japan Offshore Market) […]" (JBA TIBOR Administration, 2023). In practice, this rate should not only capture the current and expected future central bank rate but also the perceived credit risk among the counterparties and the cost of accessing liquidity over the 3-month horizon.

The importance of the latter is visible in Figure 4, which depicts the difference between 3-month JPY, GBP, and USD IBORs and the corresponding 3-month overnight index swaps (OISs), which use daily compounding. The floating rate indices used for the OISs are TONA (JPY), SONIA (GBP), and Fed Funds Effective (USD). Consequently, they essentially only reflect the current and expected future overnight rate, not term credit and funding liquidity risk. As can be seen, the difference can be substantial during periods of crises, stress, and uncertainty in the financial system.

Figure 4: 3-month IBOR-OIS spreads (%)

Sources: Bloomberg and author's calculations. Notes: JPY = 3M Euroyen TIBOR – 3M TONA (OIS), GBP = 3M LIBOR – 3M SONIA (OIS), USD = 3M LIBOR – 3M OIS.

4. The case of Japan: TONA and OSE 3-month TONA futures

Historically, financial instruments referencing both LIBOR *and* TIBOR (split into "DTIBOR" and Euroyen TIBOR (or "ZTIBOR")) have been common in the Japanese market. The cessation of LIBOR has already resulted in an all-but-complete shift from IBOR-based to OIS-based swap trading in the OTC market (see Figure 3 above). It is important to note that TONA, like the UK-based and relatively comparable SONIA, was widely used as the reference rate for OISs before the LIBOR manipulation scandal broke, whereas new RFRs have been created in the US, the Euro area, Switzerland, and several other jurisdictions.

The 3-month Euroyen TIBOR futures contract has traditionally represented the exchange-traded interest rate derivatives market. Although a LIBOR-based futures contract was also trialled, the TIBOR-based futures contract remained the flagship contract for a quarter of a century. However, with a permanent end of the Euroyen TIBOR scheduled for December 2024 (FSA, 2023), trading more or less dried up in early 2023. As shown in Figure 5, episodes of substantial trading volume in the 3-month Euroyen TIBOR futures contracts coincide with the era of the "Japan premium" and volatile TIBOR-LIBOR spreads in the mid to late 1990s (Peek and Rosengren, 1999; Spiegel, 2001), the rate hike and ZIRP in 2000-2001, the (anticipated) rate hikes in 2006-2007, and the global financial crisis of 2007-2009.
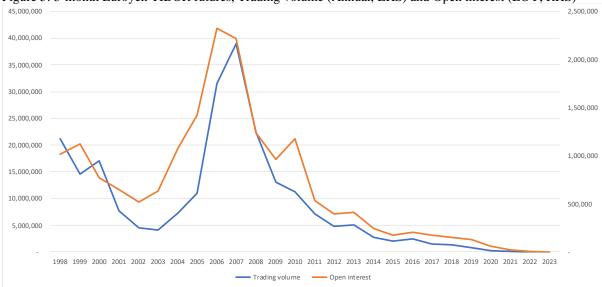
Figure 5: 3-month Euroyen TIBOR futures, Trading volume (Annual, LHS) and Open interest (EOY, RHS)

Source: TFX (2024)

The OSE 3-month TONA futures contract was launched on 29 May 2023 not only as its replacement but also as a new alternative to hedge against and speculate on movements in the Japanese short-term interest rate using TONA as the benchmark.

The Tokyo Over-Night Average (TONA) rate is the uncollateralized overnight call rate in Japan. Also referred to as the *Mutan* rate, it reflects unsecured borrowing and lending in the call money market. Figure 6 depicts the daily TONA from 5 January 1998 to 19 January 2024. As can be seen, the TONA rate tracks the official central bank rate closely (compare Figure 1).
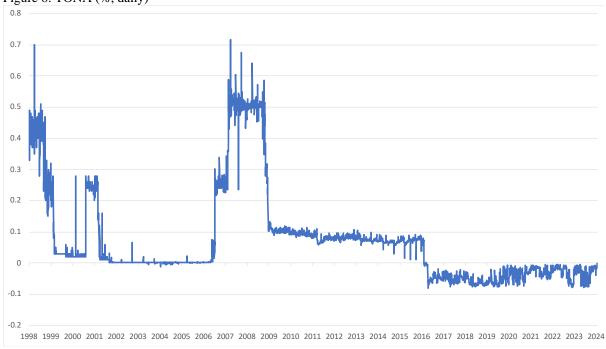
Figure 6: TONA (%, daily)

Source: BOJ

TONA is underpinned by *actual* transactions in the uncollateralized overnight call rate. The average daily volume traded in this market has ranged between 6 and 12 trillion yen during the last few years (see Figure 7).
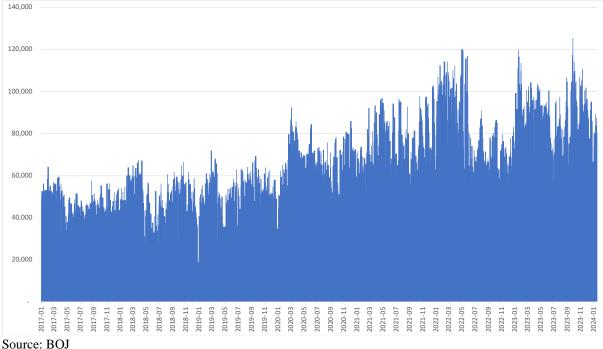
Figure 7: Daily volume of uncollateralized overnight call transactions (in ¥100 million)

Source: BOJ

The compounded TONA (R), which is used for the final settlement price of 3-month TONA futures, is calculated as follows:

$$R = \left\{ \prod_{i=1}^{M} \left(1 + TONA_i \times \frac{D_i}{365}\right) - 1 \right\} \times \frac{365}{a} \tag{1}$$

Where *M* is the total number of business days during the interest rate reference period for each relevant contract month, *i* is the relevant business day of the interest rate reference period, $TONA_i$ is the TONA value confirmed for the *i*th business day, and *a* is the total number of calendar days in the interest rate reference period (Osaka Exchange, 2022).

Table 2 summarises the key contract specifications for the OSE 3-month TONA futures contract.

Table 2: OSE 3-month TONA futures contract specifications

Underlying	100 minus 3-month compounded TONA per annum during Interest Rate Reference Period (Act/365, %)
Trading Hours	8:45-11:02, 12:30-15:02, 15:30-6:00 JST Note: An order acceptance period ("pre-closing") is established for 2 minutes （5 minutes in the Night Session） before the Itayose on close.
Contract Months	20 months in the March quarterly cycle (March, June, September and December)
Interest Rate Reference Period	From the 3rd Wednesday of each contract month (March, June, September, December) to the Tuesday preceding the 3rd Wednesday of the month (June, September, December, March) that falls 3 months later
Last Trading Day	The business day prior to the 3rd Wednesday of the three months after each contract month (to be moved up in order if the date falls on a non-business day)
Contract Unit	(100 minus 3-month compounded TONA) × ¥250,000
Tick Size	0.0025 points (¥625 per Contract Unit) Note: ¥625 = 100 million × 0.25 years × 0.0025% (1/4 basis point per annum)
Final Settlement Price	The final settlement price is 100 minus the annualized rate rounded to 4 decimal places, which is calculated by multiplying the interest rate calculated by daily cumulative compounding of confirmed TONA for each business day in the Interest Rate Reference Period for the relevant contract month by (365 / actual number of days in the Interest Rate Reference Period). Note: For each a non-business day, the confirmed TONA value for the preceding business day will apply without compounding.

Source: JPX

5. Three hypothetical case studies

The shift from LIBOR, TIBOR, and 3-month Euroyen futures towards TONA and OSE 3-month TONA futures has implications for traders, investors, and businesses. In this section, we look at three hypothetical case studies to gain a deeper understanding of OSE 3-month TONA futures and how they can be used to hedge against or speculate on possible BOJ monetary policy changes.

5.1. Hedging against an imminent BOJ rate hike

In Case Study 1, suppose a pension fund wants to hedge against an immediate BOJ rate hike. Assume that the date is 31 October 2023. The pension fund is facing a funding gap and needs to borrow ¥500 million from 1 November to 20 December 2023. The consensus view among economists and market participants is that the Bank of Japan will leave the short-term interest rate unchanged at its monetary policy meeting on 30-31 October 2023. The announcement is due shortly, and the next monetary policy meeting is scheduled for 18-19 December 2023.

On 31 October 2023, the OSE Sep-2023 TONA futures contract is trading at 100.0225, implying that the compounded TONA from 20 September to 20 December 2023 is expected to settle at -0.0225%. Assume that, despite not expecting an imminent rate hike, the fund prefers to hedge the position of needing to fund ¥500 million for a month and a half in the cash market. In the worst-case scenario, the Bank of Japan decides to raise interest rates by 25 basis points, i.e. by the same magnitude as the rate hikes in July 2006 and February 2007. If so, the overnight rate (i.e., the funding cost) throughout the period from 1 November to 20 December 2023 would increase by an expected 0.25%. The futures contract size is ¥100 million, and the fund therefore sells 5 OSE Sep-2023 TONA futures contracts at 100.0225.

Now, suppose the Bank of Japan, surprisingly, decides to raise interest rates at its 30-31 October meeting. As a result, the TONA rate settles at 0.23% for the remaining interest rate reference period of the futures contract. Following Equation 1 in Section 4 and using the TONA as per "Case 1" in Table 3 below, the compounded TONA can be calculated as:

$$\left\{\left(1 + (-0.056\%) \times \frac{1}{365}\right)\left(1 + (-0.049\%) \times \frac{1}{365}\right)\ldots\left(1 + (0.23\%) \times \frac{1}{365}\right) - 1\right\} \times \left(\frac{365}{91}\right) = 0.1108\% \quad (2)$$

Table 3: Expected TONA and actual TONA in Case Study 1

Date	Case 1	Actual	Days	Date	Case 1	Actual	Days	Date	Case 1	Actual	Days
20/09/2023	-0.056	-0.056	1	20/10/2023	-0.01	-0.01	3	21/11/2023	0.23	-0.012	1
21/09/2023	-0.049	-0.049	1	23/10/2023	-0.012	-0.012	1	22/11/2023	0.23	-0.012	2
22/09/2023	-0.039	-0.039	3	24/10/2023	-0.014	-0.014	1	24/11/2023	0.23	-0.012	3
25/09/2023	-0.042	-0.042	1	25/10/2023	-0.018	-0.018	1	27/11/2023	0.23	-0.017	1
26/09/2023	-0.051	-0.051	1	26/10/2023	-0.019	-0.019	1	28/11/2023	0.23	-0.021	1
27/09/2023	-0.064	-0.064	1	27/10/2023	-0.013	-0.013	3	29/11/2023	0.23	-0.022	1
28/09/2023	-0.063	-0.063	1	30/10/2023	-0.016	-0.016	1	30/11/2023	0.23	-0.022	1
29/09/2023	-0.062	-0.062	3	31/10/2023	-0.02	-0.02	1	01/12/2023	0.23	-0.015	3
02/10/2023	-0.044	-0.044	1	01/11/2023	0.23	-0.016	1	04/12/2023	0.23	-0.013	1
03/10/2023	-0.031	-0.031	1	02/11/2023	0.23	-0.011	4	05/12/2023	0.23	-0.011	1
04/10/2023	-0.021	-0.021	1	06/11/2023	0.23	-0.011	1	06/12/2023	0.23	-0.01	1
05/10/2023	-0.015	-0.015	1	07/11/2023	0.23	-0.01	1	07/12/2023	0.23	-0.01	1
06/10/2023	-0.016	-0.016	4	08/11/2023	0.23	-0.01	1	08/12/2023	0.23	-0.01	3
10/10/2023	-0.03	-0.03	1	09/11/2023	0.23	-0.011	1	11/12/2023	0.23	-0.011	1
11/10/2023	-0.033	-0.033	1	10/11/2023	0.23	-0.014	3	12/12/2023	0.23	-0.01	1
12/10/2023	-0.029	-0.029	1	13/11/2023	0.23	-0.014	1	13/12/2023	0.23	-0.009	1
13/10/2023	-0.019	-0.019	3	14/11/2023	0.23	-0.012	1	14/12/2023	0.23	-0.008	1
16/10/2023	-0.028	-0.028	1	15/11/2023	0.23	-0.011	1	15/12/2023	0.23	-0.009	3
17/10/2023	-0.015	-0.015	1	16/11/2023	0.23	-0.027	1	18/12/2023	0.23	-0.013	1
18/10/2023	-0.011	-0.011	1	17/11/2023	0.23	-0.015	3	19/12/2023	0.23	-0.01	1
19/10/2023	-0.01	-0.01	1	20/11/2023	0.23	-0.013	1				

Sources: Bank of Japan, author's calculations

Consequently, the final settlement price of the OSE Sep-2023 TONA futures contract will be:

$$100 - 0.1108 = 99.8892 \quad (3)$$

The profit/loss for the pension fund after having sold 5 contracts is:

$$(100.0225 - 99.8892) \times 2,500 \times 100 \times 5 = ¥166,625 \quad (4)$$

Thus, the profit of ¥166,687 generated from the short position in the OSE Sep-2023 TONA futures would offset the higher borrowing costs from 1 November to 20 December 2023.

In hindsight, however, we know that the BOJ left interest rates unchanged at the meeting on 30-31 October 2023. The confirmed TONA rates for the interest rate reference period have, since then, also been made public. Again, using Equation 1 and the "Actual" TONA in Table 3 above, the compounded TONA became:

$$\left\{\left(1 + (-0.056\%) \times \frac{1}{365}\right)\left(1 + (-0.049\%) \times \frac{1}{365}\right)\ldots\left(1 + (-0.01\%) \times \frac{1}{365}\right) - 1\right\} \times \left(\frac{365}{91}\right) = -0.0199\% \quad (5)$$

The final and actual settlement price of the OSE Sep-2023 contract was:

$$100 - (-0.0199) = 100.0199 \quad (6)$$

From the perspective of the pension fund, the profit/loss after the final settlement would have been:

$$(100.0225 - 100.0199) \times 2500 \times 100 \times 5 = ¥3{,}250 \tag{7}$$

Thus, the P/L was minimal (and, in fact, slightly positive), given that the actual TONA remained more or less unchanged for the remaining interest rate calculation period.

Notice that there are similarities between the OSE 3-month TONA future and the classic 30-day Federal Funds future traded on CME (CME, 2024). Federal Funds futures are priced against the arithmetic average of daily effective federal funds rates during each contract month. With monthly contracts listed for 60 consecutive months and a string of FOMC meeting dates known in advance, the Federal Funds futures prices can be used to *derive* the future path of central bank policy rates as expected by market participants.

Conveniently, the remaining "unknown" period of the OSE Sep-2023 TONA futures contract in the example above coincided with such a possible central bank policy shift. Suppose, instead, the OSE Sep-2023 TONA futures contract had been trading at 99.9425 on 31 October 2023. By simply rearranging Equation 1 in Section 4, we could have calculated that the price corresponded to market expectations of a 0.15% rate hike at the October meeting. A price of 99.8350 would have implied a 0.35% hike, and so on.

To sum up, the OSE 3-month TONA future serves a similar role as the 3-month Euroyen TIBOR future in being the go-to exchange-traded instrument to hedge against or speculate on changes in short-term interest rates. However, because the OSE 3-month TONA future uses compounded overnight rates in arrears as the underlying, rather than the forward-looking TIBOR, the risk versus reward assessment can be made with greater precision. In the case study above, the Sept-2023 Euroyen TIBOR future would already have settled, and no TIBOR-based futures contract could have captured the period between the BOJ October and December meetings. Selling the Dec-2023 Euroyen TIBOR future could, arguably, have been a possibility, but it would have involved a maturity mismatch and a greater cost given that the yield curve, at the time, was positive. As such, the OSE 3-month TONA future resembles short-term TONA OISs traded in the OTC market. This includes so-called BOJ-dated TONA OISs, which are forward-starting contracts with start and end dates coinciding with the BOJ monetary policy meetings as per the announced calendar.

5.2. Positioning ahead of (hawkish) BOJ communication

In Case Study 2, suppose an investor expects more hawkish language from the Bank of Japan in response to the higher inflation. On 8 September 2023, the investor decides to put on a calendar spread position in the OSE 3-month TONA futures market. We will shortly look closer at the TONA futures trade, but let us first study what eventually happened in the markets during the following days and weeks.

On Saturday 9 September 2023, The Yomiuri Shimbun published extracts of an interview with BOJ Governor Kazuo Ueda, which stated that "the central bank's lifting of its negative interest rate policy will become an option if wages and prices rise" (The Yomiuri Shimbun, 2023). The article was widely seen by economists and market participants as hawkish. It was interpreted as an indication that a rate hike could be somewhat nearer in time than previously thought.

Before the interview, on Friday 8 September 2023, the 1Y, 2Y, 3Y, and 5Y JGBs closed at -0.092%, 0.005%, 0.036%, and 0.218%, respectively. The 1Y, 2Y, 3Y, and 5Y TONA OIS were trading at 0.007%, 0.131%, 0.241%, and 0.413% (see Figure 8).
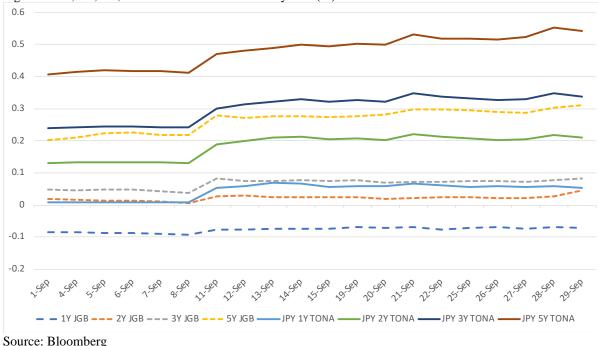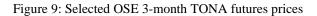
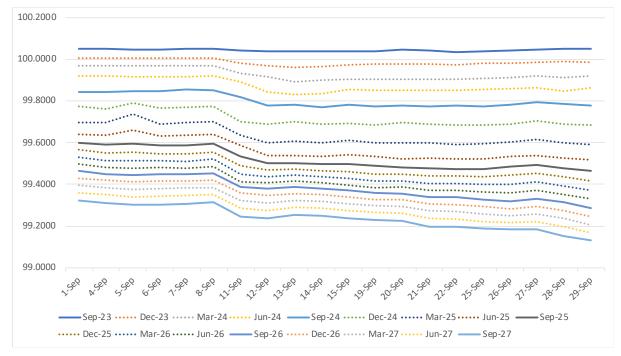Figure 8: 1Y, 2Y, 3Y, and 5Y JGB and TONA OIS yields (%)

Source: Bloomberg

The reaction in the short-term JGB market to the newspaper article was relatively muted. During the week, the 3Y and 5Y government bond yields rose 3.2 and 5.6 basis points, respectively, whereas the 1Y and 2Y yields only increased by 1.6 and 1.2 basis points. However, the response was considerably stronger in the TONA OIS market. On Friday 15 September 2023, the 1Y, 2Y, 3Y, and 5Y closed at 0.057% (+4.9 bps during the week), 0.203% (+7.1 bps), 0.322% (+7.9 bps), and 0.495% (+7.9 bps). The different reactions between the JGB and the TONA OIS markets highlight that they, despite having identical maturities, are fundamentally different concerning their supply and demand factors. Whereas government bond yields are driven by many factors (beyond the scope of this paper), the TONA OIS is a derivative instrument that more specifically captures the current and expected future uncollateralized overnight call rate in Japan.

However, an even more nuanced picture may be obtained via the OSE 3-month TONA futures market. Most importantly, the strip of consecutive OSE 3-month TONA futures contracts and the spread between them allow for a detailed examination of when the BOJ is expected to raise interest rates and how these expectations changed as a result of the Yomiuri Shimbun article.

Figure 9 depicts the settlement prices of 17 consecutive OSE 3-month TONA futures contracts, beginning with the Sep-2023 contract, before and after the newspaper article. The drop in futures prices from Monday 11 September is clearly visible. Notice that, initially, the expected additional BOJ tightening is allocated almost exclusively among the first six contracts. This is logical, given that the newspaper article suggested that the probability of an exit from the negative interest rate policy at some point in 2024 had increased, rather than providing any strong hints of the likely path in 2025 and beyond. During the following weeks, however, the sell-off is driven by the futures contracts maturing in late 2025 and beyond, in line with the

medium-term yield curve steeping shown in both the TONA OIS and JGB markets shown in Figure 8 above.

Figure 9: Selected OSE 3-month TONA futures prices

Source: JPX

Let us return to our second hypothetical case study, with an investor having put on a calendar spread position in the OSE 3-month TONA futures market on 8 September. Assume the investor had bought 100 Sep-2023 contracts at 100.0500 and sold 100 Sep-2024 contracts at 99.8525 (i.e., a yield curve steepener at -19.75). Table 4 provides an overview of a string of calendar spreads, the change throughout September, and the associated P/L per contract.

Table 4: Spread trade example

TONA futures contract	08 Sep	Spread vs Sep-2023	15 Sep	Spread vs Sep-2023	Change in bps	P/L per contract	29 Sep	Spread vs Sep-2023	Change in bps	P/L per contract
Sep-2023	100.0500		100.0400				100.0500			
Sep-2024	99.8525	-19.75	99.7825	-25.75	-6.00	¥15,000	99.7775	-27.25	-7.50	¥18,750
Sep-2025	99.5950	-45.50	99.4975	-54.25	-8.75	¥21,875	99.4650	-58.50	-13.00	¥32,500
Sep-2026	99.4525	-59.75	99.3700	-67.00	-7.25	¥18,125	99.2875	-76.25	-16.50	¥41,250
Sep-2027	99.3125	-73.75	99.2350	-80.50	-6.75	¥16,875	99.1300	-92.00	-18.25	¥45,625

Source: JPX and authors' calculations.

For instance, by 15 September, the Sep-2023/Sep-2024 position would have generated a P/L of ¥15,000 per contract, i.e., ¥1.5 million. Consistent with the gradual steepening of the yield curve further out shown in Figures 8 and 9, the Sep-2023/Sep-2025, Sep-2023/Sep-2026, and Sep-2023/Sep-2027 calendar spreads would have paid off even more (although naturally involving considerably more risk).

In sum, OSE 3-month TONA futures can be used to construct yield curve steepeners and flatteners, like in the short- to medium-term TONA OIS market, echoing the connectedness between the exchange-traded and OTC-traded LIBOR and TIBOR interest rate derivatives markets in the past.

This also includes strategies such as arbitrage or relative value trades between OSE 3-month TONA futures and TONA OISs. Consider, for instance, the pension fund, which wanted to hedge against an immediate BOJ rate hike in Case Study 1. According to data obtained from Bloomberg, the 1-month TONA OIS was trading at -0.021% on 31 October 2023, i.e. closely in line with the expectations derived from the Sep-2023 TONA futures contract. A 1-month TONA OIS price of, say, -0.05% would have presented good value for the pension fund. However, it might also have attracted traders to put on a spread trade: to buy the 1-month TONA OIS and buy the Sep-2023 TONA futures contract with the expectation that they will converge.

Here, two important differences between TONA and LIBOR/TIBOR are notable, though.

First, the reset (or fixing) risk has decreased dramatically due to the adoption of overnight rather than 3-month underlying maturities.

Second, OSE 3-month TONA futures are cleared at Japan Securities Clearing Corporation (JSCC), an internationally recognised centralised clearing counterparty (CCP) aligned with global best practices introduced after the 2007–09 financial crisis. Moreover, the market volatility in global fixed-income markets at the height of the COVID-19 pandemic was partly rooted in liquidity shocks triggered by liquidations of well-hedged portfolios. This led stakeholders, including policymakers, to promote a wider adoption of cross-margining between closely correlated products (Younger, 2021). With cross-margining between OTC IRS cleared at JSCC and OSE 3-month TONA futures having been launched on 4 March 2024, cross-product trading, risk management, and monitoring have been facilitated, and the collateral burden has been reduced (JSCC, 2023).

5.3. Speculating on the precise timing of a BOJ rate hike

In Case Study 3, consider a proprietary trader who has a very specific view of when the Bank of Japan will raise interest rates and by how much. Case Study 2 focused on the relative yields of two points or segments on the yield curve, that is, the *slope*. A butterfly spread trade involves two sections of the yield curve, i.e., the *relative slopes*, and a position in three (often consecutive) futures contracts using a 1:2:1 ratio (Dym, 2010). Recall the steepening of the yield curve following the hawkish newspaper article in the Daily Yomiuri on 9 September 2023. Suppose that a trader had sold 200 Dec-2024 contracts and bought 100 Sep-2024 and 100 Mar-2025 contracts. Table 5 shows the market reaction during the following week.

Table 5: Butterfly example

Date	Sep-2024	Change (bps)	Dec-2024	Change (bps)	Mar-2025	Change (bps)	Butterfly	Net P/L
08/09/2023	99.8525		99.7750		99.7025		-0.50	
11/09/2023	99.8175	-3.50	99.7000	-7.50	99.6375	-6.50	-5.50	¥1,250,000
12/09/2023	99.7775	-4.00	99.6875	-1.25	99.6000	-3.75	-0.25	-¥62,500
13/09/2023	99.7825	0.50	99.7000	1.25	99.6075	0.75	1.00	-¥375,000
14/09/2023	99.7700	-1.25	99.6875	-1.25	99.6000	-0.75	0.50	-¥250,000
15/09/2023	99.7825	1.25	99.6925	0.50	99.6100	1.00	-0.75	¥62,500

Sources: JPX and author's calculations.

Notice, in particular, the sharp move in the butterfly on Monday 11 September. Although all three TONA futures closed lower on that day, the largest decrease was recorded in the Dec-2024 contract (-7.5 bps). The price move implied that market participants believed that a BOJ rate hike was more likely to take place by early 2025 but less likely to take place during Q2 2025. In other words, the Sep-2024/Dec-2024 yield curve spread steepened, whereas the Dec-2024/Mar-2025 yield curve flattened. This significant relative slope move caused the butterfly price to move from -0.5 to -5.5. This generated a positive P/L of ((100 x (-3.5) – 200 x (-7.5) + 100 x (-6.5)) x ¥2,500) = ¥1,250,000.

However, also observe how the butterfly returned and stabilised close to zero quickly thereafter. Again, the explanation can be found in how market participants shifted their expectations. A higher probability of a rate hike before the end of 2024 caused the Sep-2024/Dec-2024 yield curve spread to flatten. Likewise, a higher probability of a rate hike in Q2 2025 resulted in a steeper Dec-2024/Mar-2025 yield curve. The episode is visible in Figure 10, which depicts the daily settlement price of the Sep-2024/Dec-2024/Mar-2025 butterfly from 29 March 2023 to 12 January 2024. As can be seen, butterflies are relatively low-risk trading strategies aimed at capturing differences in yield curve slopes that are too, or not sufficiently, sharp.
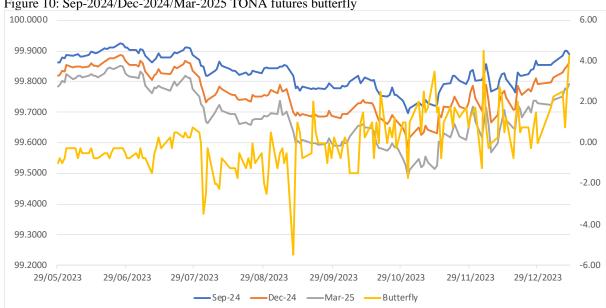
Figure 10: Sep-2024/Dec-2024/Mar-2025 TONA futures butterfly

Sources: JPX and author's calculations.

Now, suppose the proprietary trader has the following expectations on 12 January 2024:

- The BOJ will leave interest rates unchanged until late 2024.
- The BOJ will raise interest rates by 25 basis points at the meeting on 19 December 2024.
- No further interest rate changes will take place until at least mid-2025.

To capture this, the investor/trader decides to capture the expected move by putting on the following calendar butterfly spread:

- Buy 100 Sep-2024 TONA futures contracts at 99.8900.
- Sell 200 Dec-2024 TONA futures contract at 99.8625.
- Buy 100 Mar-2025 TONA futures contracts at 99.7925.

Thus, the butterfly is executed at ((99.8625 x 2) – 99.8900 – 99.7925) = 4.25. Notice that this price touches the peak in Figure 10.

There are, of course, numerous outcomes that are possible. However, for the sake of simplicity, consider four different scenarios.

- The BOJ leaves interest rates unchanged until at least the end of June 2025.
- The BOJ raises interest rates by 25 basis points in March 2025 (only).
- The BOJ raises interest rates by 25 basis points in December 2024 (only).
- The BOJ raises interest rates by 25 basis points in December 2024 and March 2024.

Table 6 provides a summary of possible (but not guaranteed, since the overnight cash market fluctuates) settlement prices for the three different 3-month TONA futures contracts and the butterfly.

Table 6: Butterfly scenarios

TONA future	Trade	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Sep-2024	99.8900	100.0200	100.0200	100.0200	100.0200
Dec-2024	99.8625	100.0200	100.0200	99.7700	99.7700
Mar-2025	99.7925	100.0200	99.7700	99.7700	99.5200
Butterfly	4.25	0.00	25.00	25.00	0.00
P/L		¥106,250	–¥518,750	¥731,250	¥106,250

Source: JPX, author's calculations

Scenario 3 is the best-case scenario since the outcome is precisely in line with the expectations of the proprietary trader. Scenario 2 is the worst-case scenario because it involves a later BOJ rate hike than expected. Scenario 1 (unchanged rates) and Scenario 4 (two rate hikes) would typically result in a small positive P/L because the butterfly was trading at +4.25 (rather than 0) at the time of execution.

Finally, it is important to remember that 3-month TONA futures, in contrast to 3-month Euroyen TIBOR futures, do not include the credit and funding liquidity risk that is typical of IBOR benchmarks. As illustrated in Figure 4 in Section 3, these risk premia can be substantial, particularly during periods of stress and uncertainty in the financial system or more regular quarter-end or year-end liquidity squeezes.

To this end, Figure 11 shows the 3-month Euroyen TIBOR, the 3-month compounded TONA in arrears, and the 3-month forward-looking TONA OIS following the IMM quarterly cycle (i.e., the 3rd Wednesday in March, June, September, and December). Thus, the 3-month Euroyen TIBOR is the underlying benchmark for the historical 3-month Euroyen futures contract. The 3-month compounded TONA in arrears is the underlying reference interest rate for the OSE 3-month TONA futures contract. The forward-looking 3-month TONA OIS (using indicative prices from the traded OTC market) is, essentially, the expected compounded TONA over the following 3 months. As can be seen, during the last decades, the credit and funding liquidity risk premium has consistently been positive, and often substantially positive. The only exception includes the COVID-19 pandemic.
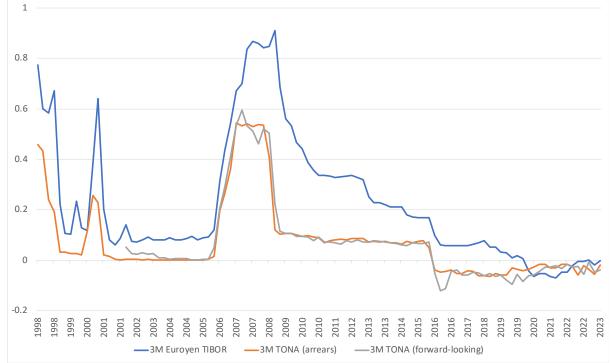
Figure 11: 3M Euroyen TIBOR, 3M TONA (arrears) and 3M TONA (forward-looking)

Sources: Bank of Japan, Bloomberg, author's calculations.

To sum up, the OSE 3-month TONA future can be used to construct butterflies and other yield curve strategies that take a view on the magnitude, likelihood, and timing of interest rate changes. However, compared to 3-month Euroyen TIBOR futures, the market is considerably less affected by stress, uncertainty, credit issues, and liquidity squeezes in the financial system, which may have a significant impact on the curve structure.

6. Summary and conclusions

On 19 March 2024, the Bank of Japan *finally* abandoned its policy framework of yield curve control and negative interest rates.

Whereas economists, commentators, and Bank of Japan officials may express different opinions about the probability, timing, and magnitude of a short-term interest rate changes, the views of market participants are distilled in financial market prices. However, financial markets have evolved dramatically since the last Bank of Japan rate hike in 2007. LIBOR, the most widely watched money market benchmark by market participants and central bankers alike, has ceased to exist. Other variants, including TIBOR, are being phased out in favour of alternative benchmarks, requiring a complete update of the interest rate derivatives product menu.

In light of this, this paper has delved into the Japanese alternative, TONA, and the OSE 3-month TONA futures contracts, which were launched by Osaka Exchange (part of JPX) on 29 May 2023. Through the lens of 3 hypothetical case studies, 4 key benefits of the new product have been highlighted.

First, the underlying interest rate reference rate (TONA) is based upon actual transactions in the uncollateralized overnight call market rather than non-binding or indicative quotes and estimates. This makes the benchmark underpinning the OSE 3-month TONA futures market considerably less susceptible to manipulative or collusive attempts than LIBOR or TIBOR.

Second, since 3-month LIBOR and TIBOR are fixed and known at the start of the contract period, they are "forward-looking" term rates. However, the underlying benchmark for the OSE 3-month TONA futures contract is "backward-looking" because it requires the actual overnight rates to be compounded in arrears after the 3 months have passed. Because the calendar of BOJ monetary policy meetings is announced far in advance, more mathematically precise and granulated trading and hedging strategies can be crafted ahead of monetary policy announcements. The contract can also be used to derive the future path of central bank policy rates as expected by market participants.

Third, the OSE 3-month TONA future is exchange-traded and, therefore, has the same "standardisation" benefits as the 3-month Euroyen TIBOR future. Two important changes are notable, though. First, the reset (or fixing) risk has decreased dramatically due to the adoption of overnight rather than 3-month underlying maturities. Second, with cross-margining between OTC IRS cleared at Japan Securities Clearing Corporation (JSCC) and OSE 3-month TONA futures having been launched on 4 March 2024, cross-product trading, risk management, and monitoring have been facilitated, and the collateral burden has been reduced.

Fourth, LIBOR was a benchmark for borrowing and lending in the interbank term money market. This means that the rate was not only determined by the current and expected future central bank interest rates. It was also influenced by the perceived credit risk among the counterparties and the cost of accessing liquidity over the 3-month horizon. The credit and liquidity risk premia could be significant, particularly during periods of stress, uncertainty, and crises in the banking and financial systems. However, compared to 3-month Euroyen TIBOR futures, OSE 3-month TONA futures are virtually immune to money market risk premia in the underlying, which may have a significant impact on the curve structure.

Whether, when, and by how much the Bank of Japan will change interest rates again soon remains to be seen. Regardless, however, the OSE 3-month TONA futures market is likely to play a central role for central bankers, market participants, and analysts going forward.

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