Bank of Japan Review 2024-E-8

Changes in Risk Perceptions on Yen Interest Rates and Exchange Rates Observed in Options Markets: Developments in Implied Probability Distributions amid Rate Hikes in the United States and Europe from 2022 to 2023

Financial Markets Department
YONEYAMA Akihito*, TSUCHIYA Akitaka**, FUKUMA Noritaka

August 2024

In this paper, we extract the implied probability distributions from daily option prices for the future levels of yen swap rates and the U.S. dollar/yen exchange rate, which came under upward pressure amid rate hikes by central banks in the United States and Europe from 2022 to 2023, using data through the end of 2023. The extracted implied probability distributions allow us to understand the overall picture of market participants' risk perceptions, which cannot be captured by other simpler indicators such as risk reversal. The results suggest that caution about a higher interest rate increased significantly in the yen interest rate swaps market toward the middle of 2022, as overseas interest rates rose. Such caution further heightened after the Bank of Japan decided to expand the range of 10-year Japanese government bond (JGB) yield fluctuations from the target level at the Monetary Policy Meeting (MPM) held in December 2022, but subsequently eased. In the U.S. dollar/yen market, caution about future yen depreciation heightened toward fall 2022 as the yen weakened. However, when the yen weakened against U.S. dollar again to around the same level in fall 2023, market participants did not become as cautious as in fall 2022 about the future yen depreciation.

Introduction

Long-term interest rates in the United States and Europe significantly increased from 2022 as central banks, especially those in the United States and Europe, rapidly raised interest rates in response to elevated global inflation (upper panel of Chart 1). With overseas interest rate rising, Japanese long-term interest rates, particularly in the swaps market, came under upward pressure, although fluctuations in those rates were contained under the Bank's conduct of yield curve control (YCC). In the foreign exchange market, the yen depreciated against the U.S. dollar, as the U.S.-Japan yield differential widened amid a difference in the direction of monetary policy between the two economies (lower panel of Chart 1).

As such, Japanese interest rates and the U.S. dollar/yen exchange rate were brought under upward pressure from 2022. Under these circumstances, market participants' risk perceptions on the future levels of Japanese interest rates and the U.S. dollar/yen exchange rate likely changed, partly reflecting their views on the future course of monetary policy in the United States and Europe, as well as their outlooks on Japan's economic and price developments and speculation about the Bank's future conduct of monetary policy.

In this paper, we extract implied probability distributions of the future levels of yen swap rates and the U.S. dollar/yen exchange rate from daily option prices using data through the end of 2023, and summarize the characteristics of changes in market participants' risk perceptions.

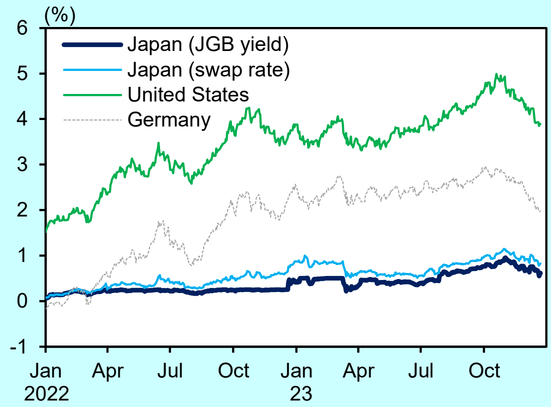
Overview of Analysis Methodology

Options are a form of financial derivatives instruments (derivatives) that give the holder the right to buy (call) or sell (put) a specific asset (underlying asset) at a specific price (strike price) at some point in the future (expiration date). Various types of underlying assets are involved in option trading. For example, in foreign exchange markets, options are based on a currency pair (e.g., the U.S. dollar/yen exchange rate). In interest rate markets, options on an interest rate swap (a transaction where two parties exchange different types of interest payments, such as fixed and floating rates, called a swaption) are traded.[1]

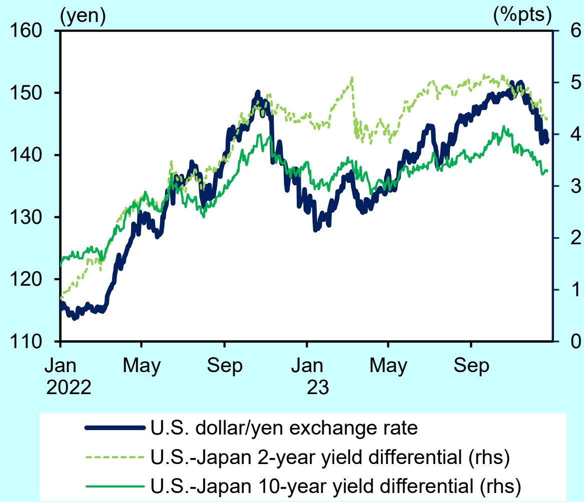
The price of an option is determined based on market participants' expectations about the future price of the underlying asset. As such, information about market participants' expectations about the future performance of the underlying asset can be derived from option prices.

[Chart 1] Long-Term Interest Rates and U.S. Dollar/Yen Exchange Rate

<Long-Term Interest Rates (10-year)>



<U.S. Dollar/Yen Exchange Rate>



Note: "Japan (swap rate)" is the OIS rate based on the uncollateralized overnight call rate (TONA). Latest data as of December 22, 2023.

Sources: Bloomberg; LSEG Eikon.

For example, implied volatility (IV), an estimate of the volatility (standard deviation) of the underlying asset price at a future time extracted from an option price, is widely used in financial markets. Also, risk reversal (RR), the difference between the IV of a call option and that of a put option, is used in foreign exchange markets particularly, as an indicator of the bias in market participants' risk perceptions.[2]

However, while IV and RR are relatively easy to calculate, they represent only two of the numerous parameters (moments) that characterize the probability distribution of future underlying asset prices and therefore cannot capture the overall risk perception of market participants, especially with regard to tail risk.

In this paper, we extract the entire probability distributions of the market's expectation about future levels of yen swap rates and the U.S. dollar/yen exchange rate from daily option prices (see BOX 1 for an overview of the estimation procedure).[3] The distributions thus extracted are called implied probability distributions and have several advantages over other simpler indicators such as IV and RR. For instance, they can capture market participants' perceptions of tail risk (see BOX 2).

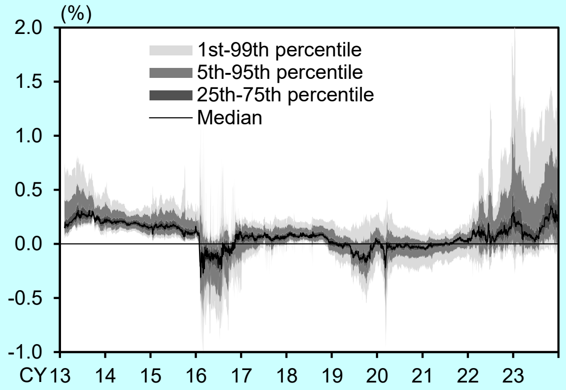
Yen Interest Rate Swaps Market

We extract the implied probability distributions of 2-year and 10-year yen swap rates from transaction prices of swaptions expiring three months after the trade date.[4,5] Please note that the implied probability distributions calculated in this paper do not necessarily correspond to the probability distribution of cash JGBs yields, which are another kind of yen interest rates.[6] This is because yen swap rates and cash JGB yields have diverged rate levels and move in different manners (upper panel of Chart 1), and also there is a difference in the composition of trading entities between the two markets; for instance, the yen swap rate market has a relatively high proportion of overseas participants.[7]

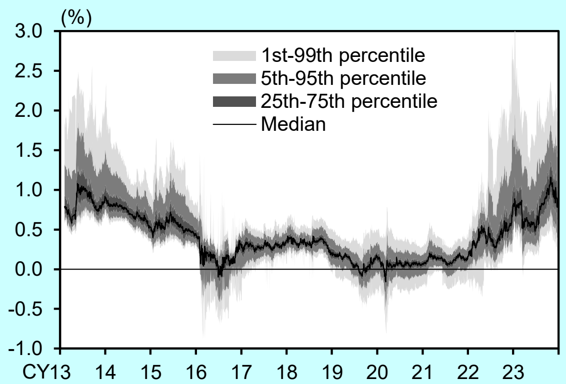
Looking at the extracted implied probability distributions from a long-term perspective, the dispersion of the distributions (i.e., the dispersion of market participants' views) increased, particularly for the 10-year rate, after the Bank introduced Quantitative and Qualitative Monetary Easing (QQE) in April 2013 (Chart 2). The distributions became further dispersed with a longer tail in the direction of lower interest rates following the Bank's decision to introduce negative interest rates in January 2016. This was particularly notable for the 2-year rate, which is highly correlated with the outlook for policy rates, indicating that market participants' forecasts became more dispersed and skewed toward a cautious stance toward a decline in interest rates. After the introduction of YCC in September 2016, however, the distributions became less dispersed for both the 2-year and 10-year rates. Thereafter, while the dispersion temporarily increased around March 2020 in response to the instability in financial markets at the onset of the COVID-19 pandemic, the distributions generally stayed within a limited range compared to the pre-YCC period until the beginning of 2022.

[Chart 2] Implied Probability Distributions

<2-Year Rate>



<10-Year Rate>

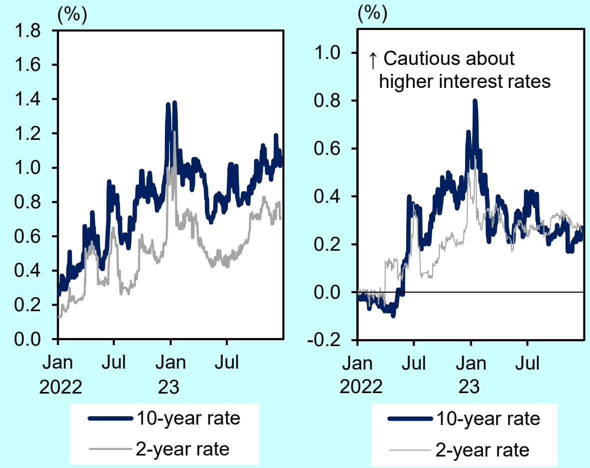


Note: Estimated from swaptions whose underlying asset is swap rates based on 6-month yen LIBOR for figures through May 26, 2022 (synthetic yen LIBOR for figures from the beginning of 2022 through May 26, 2022) and those based on uncollateralized overnight call rate (TONA) for figures during the subsequent period. Please note that there is a discontinuity between the data before and after May 26, 2022 (the same applies hereafter). Latest data as of December 22, 2023.

Source: Authors' estimates based on Bloomberg, TraditionData, and LSEG Eikon.

[Chart 3] Dispersion and Skewness of Probability Distributions

<Dispersion> <Skewness>



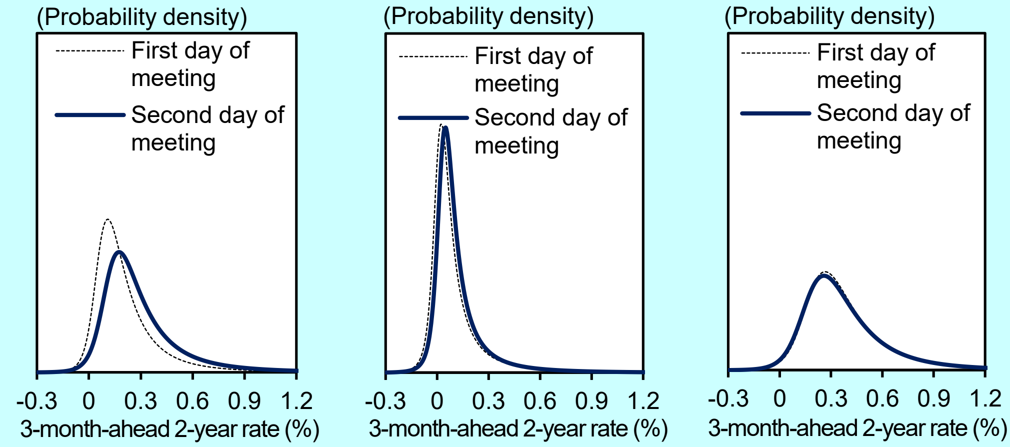
Note: "Dispersion" indicates the range between the 95th percentile (tail in the direction of higher interest rates) and the 5th percentile (tail in the direction of lower interest rates). "Skewness" is calculated by subtracting the range between the 5th percentile and the median (caution about lower interest rates) from the range between the 95th percentile and the median (caution about higher interest rates). Latest data as of December 22, 2023.

Source: Authors' estimates based on Bloomberg, TraditionData, and LSEG Eikon.

From 2022 onward, the probability distributions of both the 2-year and 10-year rates became fat-tailed in the direction of higher interest rates, and the distributions became more dispersed and skewed toward a cautious stance toward higher interest rates (Chart 2 and 3).[8] Specifically, (1) the distributions began to disperse after March 2022, when the Federal Reserve started raising interest rates, and (2) the distributions became further dispersed and significantly skewed in the direction of a cautious stance toward higher interest rates (i.e., market participants became cautious about an increase in interest rates) around June 2022, when overseas interest rates were rising further (upper panel of Chart 1). (3) Thereafter, caution about higher interest rates, particularly for the 10-year rate, kept increasing toward December 2022, except for isolated occasions, as U.S. and European interest rates continued to rise. (4) After the MPM held in December 2022, where the Bank decided to 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, caution about higher interest rates further heightened for both the 2-year and 10-year rates. (5) Subsequently, caution about higher interest rates eased for both the 2-year and 10-year rates, as the Bank decided to maintain its monetary policy and enhance the Funds-Supplying Operations against Pooled Collateral at the MPM held in January 2023 and overseas interest rates declined in response to the failure of and deterioration in the business conditions of some financial institutions in the United States and Europe in March 2023. (6) From September 2023 onward, although there were some occasions when the dispersion of the distributions, particularly of the 2-year rate, increased and caution about higher interest rates heightened somewhat with speculation over the Bank's monetary policy, in none of them did the dispersion reach the levels seen after the December 2022 MPM.

[Chart 4] Implied Probability Distributions of Yen Swap Rates (2-Year)

<December 2022 MPM> <July 2023 MPM> <December 2023 MPM>

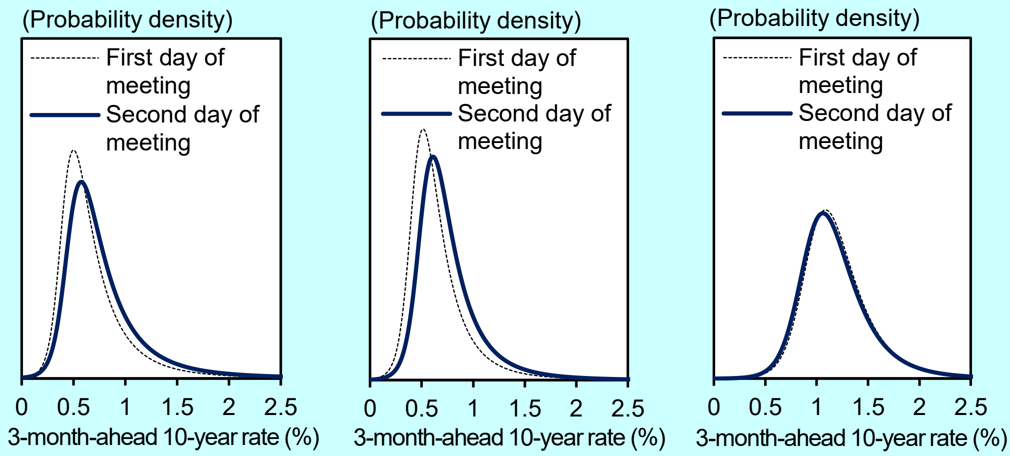


Note: The horizontal axis indicates the level of the yen swap rate (2-year) on the expiration date. "Second day of the meeting" indicates the implied probability distribution after the policy decision (the same applies hereafter).

Source: Authors' estimates based on Bloomberg and TraditionData.

[Chart 5] Implied Probability Distributions of Yen Swap Rates (10-Year)

<December 2022 MPM> <July 2023 MPM> <December 2023 MPM>



Note: The horizontal axis indicates the level of the yen swap rate (10-year) on the expiration date.

Source: Authors' estimates based on Bloomberg and TraditionData.

Meanwhile, the Bank decided at the MPM held in July 2023 to conduct YCC with greater flexibility regarding the 10-year JGB yield fluctuation range of around ±0.5 percentage points as a reference. Furthermore, at the MPM held in October 2023, it decided to further increase the flexibility in the conduct of YCC regarding the upper bound for 10-year JGB yields of 1.0 percent as a reference. In the following, we compare the implied probability distributions of the yen swap rates before and after the MPMs in December 2022 and July and October 2023.

With regard to the 2-year rate, the probability distribution became fat-tailed in the direction of higher interest rates after the December 2022 MPM (Chart 4). Given the high correlation of the 2-year rate with the outlook for the policy rate, there may have been heightened caution about possible policy changes, including a policy rate hike, ahead of the next MPM in January 2023. In contrast, the shape of the distribution remained largely unchanged before and after the MPMs in July and October 2023, suggesting that caution about a near-term change in the policy rate did not increase much.

As for the 10-year rate, the probability distribution became fat-tailed in the direction of higher interest rates after the December 2022 and July 2023 MPMs (Chart 5). In contrast, the shape of the distribution was largely unchanged before and after the October 2023 MPM, indicating that risk perceptions regarding future long-term interest rates did not change significantly.

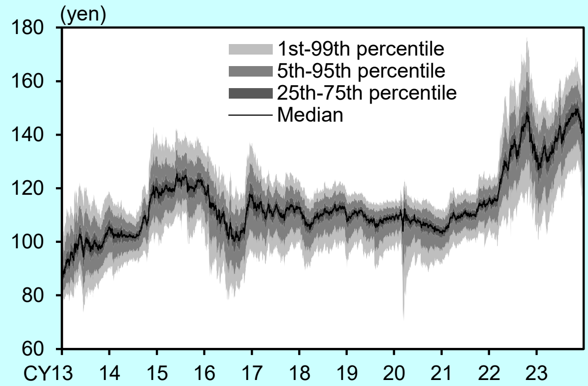
U.S. Dollar/Yen Market

Next, we extract the implied probability distribution of the U.S. dollar/yen exchange rate from transaction prices of options expiring three months after the trade date.[9]

Looking at the extracted implied probability distribution of the U.S. dollar/yen exchange rate from a long-term perspective, the dispersion of the distribution increased in 2013, when the U.S. dollar/yen spot rate rose in response to mainly the introduction of QQE in April of that year (Chart 6). The distribution subsequently became less dispersed, with the spot rate remaining more or less unchanged. However, it dispersed again, mainly due to the expansion of QQE, in October 2014 and remained so until around the end of 2016. The distribution became particularly dispersed and skewed in the direction of a cautious stance toward yen appreciation toward the first half of 2016. This was against the backdrop of risk-off yen buying due to concerns about a slowdown in the global economy, particularly China, as well as heightened uncertainty over overseas political developments such as the referendum on the United Kingdom's withdrawal from the European Union. The dispersion declined moderately as a trend from 2017 onward, and the distribution generally stayed within a limited range until the beginning of 2022, compared to around the mid-2010s, although the dispersion temporarily increased around March 2020 in response to the instability in financial markets at the onset of the COVID-19 pandemic.

From 2022 onward, the distribution significantly dispersed as the yen weakened against the U.S. dollar with the widening of the yield differential between Japan and the United States (Charts 6 and 7). Specifically, (1) the distribution became more dispersed and skewed in the direction of a cautious stance toward yen depreciation, as the U.S. dollar/yen spot rate rose to around 150 in fall 2022 (the lower panel of Chart 1). However, (2) caution about yen appreciation heightened toward March 2023, as the U.S. dollar/yen spot rate declined. This was mainly against the background of a decline in U.S. interest rates due to weaker-than-expected U.S. CPI data released in November and December 2022, the Bank's decision to expand the range of 10-year JGB yield fluctuations from the target level at the December 2022 MPM, and the failure of and deterioration in the business conditions of some financial institutions in the United States and Europe in March 2023. (3) Thereafter, there was no significant increase in the dispersion, nor was there a significant increase in caution about yen depreciation, unlike the second half of 2022. However, the dispersion of the distribution remained larger than that in and before 2021.

[Chart 6] Implied Probability Distribution
<U.S. Dollar/Yen Exchange Rate>

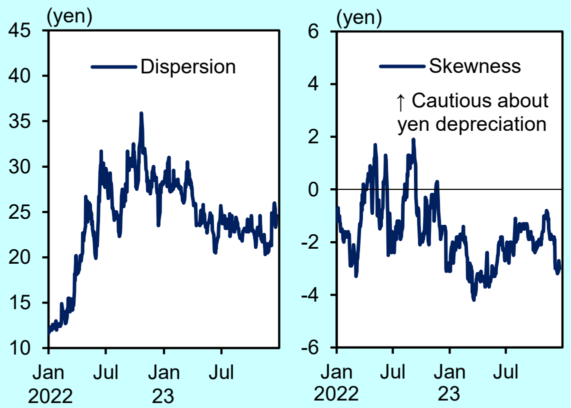


Note: Latest data as of December 22, 2023

Source: Authors' estimates based on LSEG Eikon.

[Chart 7] Dispersion and Skewness of Probability Distribution

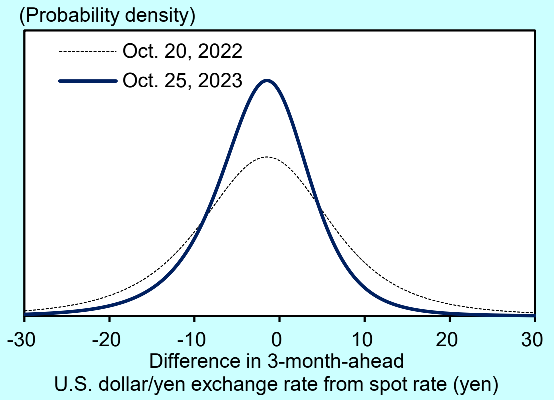
<Dispersion> <Skewness>



Note: "Dispersion" indicates the range between the 95th percentile (tail in the direction of yen depreciation) and the 5th percentile (tail in the direction of yen appreciation). "Skewness" is calculated by subtracting the range between the 5th percentile and the median (caution about yen appreciation) from the range between the 95th percentile and the median (caution about yen depreciation). Latest data as of December 22, 2023.

Source: Authors' estimates based on LSEG Eikon.

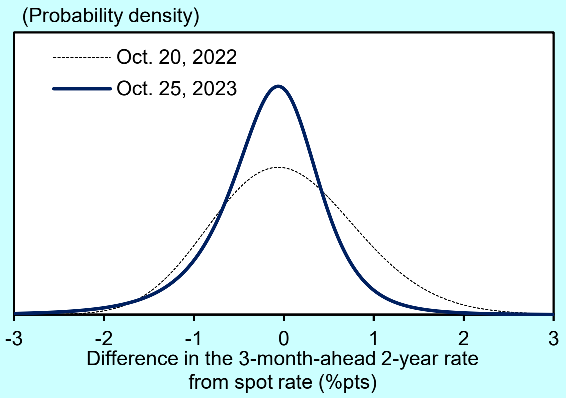
[Chart 8] Implied Probability Distributions of U.S. Dollar/Yen Exchange Rate



Note: The horizontal axis indicates the difference in the U.S. dollar/yen exchange rate on the expiration date from the spot rate. The data are on the days when the U.S. dollar/yen closed above 150 (at 5 p.m. in New York) for the first time that year.

Source: Authors' estimates based on LSEG Eikon.

[Chart 9] Implied Probability Distributions of USD Swap Rates (2-year)



Note: The horizontal axis indicates the difference in the USD swap rate on the expiration date (2-year, based on SOFR) from the spot rate. The data are on the days when the dollar/yen closed above 150 (at 5 p.m. in New York) for the first time that year.

Source: Authors' estimates based on LSEG Eikon.

The U.S. dollar/yen spot rate rose to around 150 in fall 2022, but slid back below 130 thereafter. However, the rate rose again to about 150 toward fall 2023 (lower panel of Chart 1). Nevertheless, a comparison of the implied probability distributions when the yen depreciated in fall 2022 and fall 2023 (on the days when the closing price of the U.S. dollar/yen exchange rate in the New York market exceeded 150 for the first time that year) shows that the distribution was less dispersed in fall 2023 than in fall 2022, with a particularly thin tail in the direction of yen depreciation (Chart 8). In other words, in fall 2023, the dispersion of expectations about the future level of the U.S. dollar/yen exchange rate did not increase as much as in fall 2022, and caution about yen depreciation did not heighten.

In regard to this, when comparing the implied probability distributions of the 2-year US dollar swap rate at the same days of the year, it can be inferred that the distribution was less dispersed in fall 2023 than in fall 2022, with a particularly thin tail in the direction of higher interest rates (Chart 9). This is because, while the dispersion in market participants' views on the final destination of the U.S. policy rate (the terminal rate) could reasonably be called considerable in fall 2022, when the policy rate was being increased in the United States, the variation in views on the future U.S. policy rate was not as significant as in fall 2022 and there was limited caution about a further rise in interest rates in fall 2023, as more market participants expected a near-term end of the tightening cycle. This difference in risk perception regarding U.S. interest rates between the two periods may have been one of the reasons why caution about future yen depreciation was not as strong in fall 2023 when the yen weakened as in fall 2022.

Concluding Remarks

In this paper, we extracted the implied probability distributions from daily option prices for the future levels of yen swap rates and the U.S. dollar/yen exchange rate, which came under upward pressure amid rate hikes by central banks in the United States and Europe from 2022 to 2023. The results showed that, in the yen interest rate swaps market, caution about higher interest rates increased significantly toward the middle of 2022, as overseas interest rates rose. Such caution further increased after the Bank's decision at the December 2022 MPM to expand the fluctuation range for 10-year JGB yields from the target level, but subsequently eased. In the U.S. dollar/yen market, caution about future yen depreciation heightened toward fall 2022 with the weakening of the yen. However, even as the yen weakened to the same level as the previous year in fall 2023, caution about future yen depreciation did not increase as much as in fall 2022.

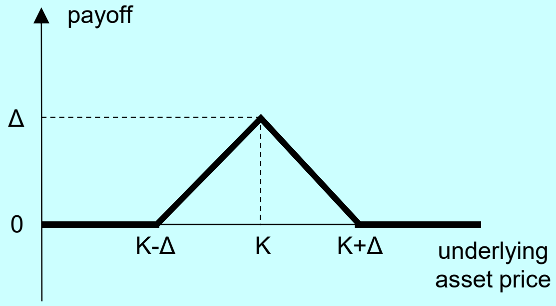
Implied probability distributions represent the risk perceptions of option market participants and are not necessarily strong predictors of future price movements.[10] However, as observed in this paper, estimating implied probability distributions enables us to analyze market participants' risk perceptions, including with regard to tail risk, in a more interpretable form. Thus, implied probability distributions are expected to be further utilized in financial market monitoring, along with existing questionnaire surveys and indicators.

BOX 1: Extracting an Implied Probability Distribution from Option Prices

Implied probability distributions can be computed by converting the transaction prices of options at various strike prices into IVs, interpolating these IVs to plot volatility smiles, and then converting these into probabilities. Volatility smiles are converted into probabilities by calculating the cost of creating a butterfly spread position (an option trading strategy for betting that the price of the underlying asset will be near a certain strike price on the expiration date). Below is the specific procedure of computing an implied probability distribution.[11]

1. Create a function V(K) that gives the volatility at strike price K by converting market transaction prices of options at various strike prices into IVs and then interpolating them.[12]
2. Convert V(K) into a call option price C(K) using an option price valuation formula (in this paper, the Bachelier formula for yen swap rates and the Black-Scholes formula for the U.S. dollar/yen exchange rate).[13]
3. Take an appropriate tick size Δ (in this paper, 0.01 percentage points for yen swap rates and 0.1 yen for the U.S. dollar/yen exchange rate), and for each K, calculate the cost BF(K) of establishing a butterfly spread position at a strike price K as $C(K+\Delta) + C(K-\Delta) - 2C(K)$ (BOX 1 Chart).[14]
4. Plot an implied probability distribution by putting strike price K on the horizontal axis and the cost of building a butterfly spread position BF(K) on the vertical axis and rescaling the vertical axis so that it can be interpreted as a probability at a given time point.

[BOX 1 Chart] Payoff of a butterfly spread



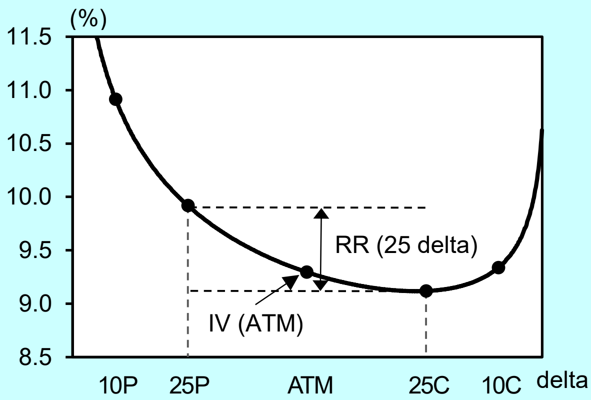
BOX 2: Usefulness of Implied Probability Distributions

There are a variety of indicators that represent the risk perceptions of option market participants. Typical examples include IVs of at-the-money options in each market and delta 25 RRs in foreign exchange markets. However, these examples are merely single values of the volatility smile at a particular observation point (IV) and reflect only certain of the numerous parameters (moments) that characterize the probability distribution. Compared to these indicators, implied probability distributions are useful in the following ways.

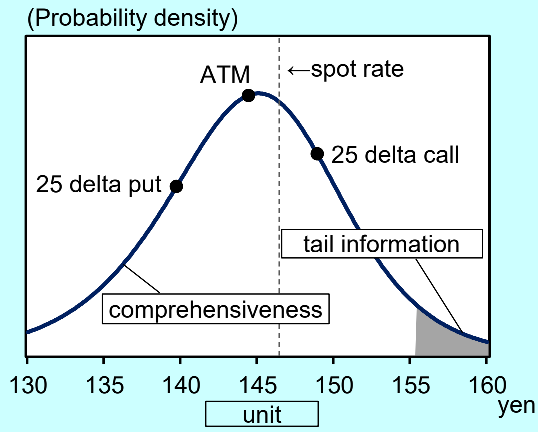
1. Implied probability distributions represent a wide range of market participants' assumptions, because they reflect information from the entire volatility smile (comprehensiveness).
2. Implied probability distributions can capture risk perceptions of large price movements, such as those above 25 delta (tail information).
3. Risk perceptions can be assessed in terms of both the level of the underlying asset price and its probability of realization (unit).

[BOX 2 Chart] Volatility Smile and Implied Probability Distribution

<Volatility Smile>



<Implied Probability Distribution>



Note: Based on the volatility smile of the U.S. dollar/yen exchange rate on August 25, 2023, as an example. "C" and "P" in the left chart indicate "call" and "put," respectively. "Tail information" in the right chart indicates the area above the 95th percentile.

Source: Author's estimates based on LSEG Eikon.

*Currently, Fukuoka Branch

**Currently, Personnel and Corporate Affairs Department

[1] The term "swaption" originally referred to an option on a swap transaction in general. However, in today's financial markets, a "swaption" usually refers to an option on an interest rate swap, which is the definition we use in this paper. Among swaptions, options on an interest rate swap that give the right to receive a fixed rate and pay a floating rate are called receiver swaptions. Conversely, options on an interest rate swap that give the right to pay a fixed rate and receive a floating rate are payer swaptions. For instance, when the holder of a receiver swaption exercises their right on the expiration date, they can receive a pre-contracted fixed rate while paying a floating rate for a pre-contracted period of time.

[2] In the Japanese foreign exchange market, RRs are often used for hedging purposes, mainly by domestic non-financial corporations, and thus have high representativeness compared to RRs of other assets.

[3] It should be noted that the implied probability distributions calculated in this paper are risk-neutral probability distributions and not natural probability distributions. See the following for a study on the conversion of a risk-neutral probability distribution into a natural probability distribution.

Ross, S., "The Recovery Theorem," J. Finance, 70 615-648 (2015).

[4] Besides swaptions, another type of yen interest rate options are options on JGB futures. However, in this paper, the analysis is focused on swaptions, because they are easier to handle for the following reasons.

(i) Swap periods can be freely set, so interest rates with various maturities can be analyzed.

(ii) Since the expiration is not fixed on specific dates, data with a fixed tenor can be obtained.

(iii) Swaptions are usually European options, which are easy to handle theoretically.

The traded swaption price data used in the analysis are IVs at each of the following 13 strike prices: At the Money (ATM); ±25 bps; ±50 bps; ±75 bps; ±100 bps; ±150 bps; and ±200 bps. The underlying asset of the swaptions is the swap rate based on 6-month yen LIBOR through May 26, 2022 (synthetic yen LIBOR from the beginning of 2022 through May 26, 2022) and the overnight uncollateralized call rate (TONA) for the subsequent period.

[5] For example, the following is an analysis based on implied probability distributions in Japan.

Suganuma, K., and Yamada, T., "Mainasu kinri o kōryo shita fōwādo rēto moderu to sijō no kinri mitōshi" [Forward rate models considering negative interest rates and market outlook for interest rates] <available only in Japanese>, IMES Discussion Paper Series, 2017-J-18.

[6] For example, see the following for a study that uses highly granular data to organize facts about the yen interest rate swaps market.

Inoue, S., Miki, S., and Gemma, Y., "The Japanese Yen Interest Rate Swap Market Observed from OTC Derivative Transaction Data: the Impact of COVID-19," Bank of Japan Review Series, 2021-E-3.

[7] Swaptions at strike prices whose interest rate levels are substantially distant from the ATM are considered less liquid than those near the ATM. For this reason, some latitude should be given to the interpretation of the extreme tails of the distributions.

[8] With the discontinuation of the publication of Yen LIBOR at the end of 2021, swap transactions have shifted to TONA-based ones. However, due to data constraints, the data in this paper are based on synthetic Yen LIBOR-based interest rate swaps for figures from the beginning of 2022 through May 26, 2022, as described in note 4. Therefore, the results for the above period should be interpreted with some latitude.

[9] Data on currency options are usually provided by vendors in five series: IV at ATM; RRs at delta 10 and delta 25; and the strangles at delta 10 and delta 25. By adding and subtracting these series, the IVs of a call option at deltas 10, 25, 50, 75, and 90 can be obtained. To convert delta into a strike price, an explicit formula for delta obtained from the Black-Scholes formula is solved for the strike price.

[10] For example, the following paper points out that the time-difference correlation coefficient between the 25 delta RR and spot rate for the U.S. dollar/yen exchange rate is low and the predictive power of RRs for future spot rates is low.

Kato, H., Fukunaga, I., and Yamada, K., "Risuku ribāsaru kara mita kawase hendō eno risuku ninshiki" [Risk perceptions on exchange rate fluctuations observed from risk reversals] <available only in Japanese>, Bank of Japan Review Series, 2012-J-14.

[11] For more details on the method of extracting implied probability distributions from option prices, see, for example, the following.

Malz, A. M., "A Simple and Reliable Way to Compute Option-Based Risk-Neutral Distributions," New York Fed Staff Reports, No. 677 (2014).

[12] Interpolation methods for volatility smiles can be classified into nonparametric methods, such as spline interpolation, and parametric methods based on modeling volatilities. When spline interpolation is applied, the corresponding obtained distribution tends to be non-intuitive, with multimodality. For this reason, this paper uses a parametric interpolation formula (the Hagan approximation) based on the SABR model. For more information on this interpolation formula, see the following.

Hagan, P. S., Kumar, D., Lesniewski, A. S. and Woodward, D. E., "Managing Smile Risk," The Best of Wilmott, 1 249-296 (2002).

[13] With respect to the yen swap rate, the Black-Scholes model does not assume a situation where the value of the underlying asset is negative. Given the recent market developments where interest rates can be negative, either an appropriate shift range should be introduced or a Bachelier model that assumes that the price of the underlying asset follows a normal distribution (rather than a log-normal distribution) should be applied.

[14] A butterfly spread is specifically a portfolio consisting of selling two units of call options at strike K and buying one unit of call options at each strike price $K \pm \Delta$ (Δ is an appropriate tick size).

The Bank of Japan Review Series is published by the Bank to explain recent economic and financial topics for a wide range of readers. This report, 2024-E-8, is a translation of the Japanese original, 2024-J-1, published in January 2024. Views expressed are those of the authors and do not necessarily reflect those of the Bank. If you have any comments or questions, please contact Financial Markets Department (E-mail: emu-.fmd51_post@boj.or.jp). The Bank of Japan Review Series and the Bank of Japan Working Paper Series are available at https://www.boj.or.jp/en/index.htm.