Bank of Japan Review

2022-E-6

Impact of COVID-19 Turmoil on the Foreign Exchange Option Market: Evidence from the Japanese OTC Derivative Transaction Data

Financial Markets Department
TAKIZUKA Yasutaka*, SUZUKI Kazuya**

August 2022

This report investigates granular transaction data for USD/JPY options, focusing on the individual transactions around March 2020 in order to visualize the impact of the COVID-19 pandemic on the market. The main results are as follows. First, through March 2020, entity-level implied volatility indicates that the market perception about Foreign Exchange (FX) risk was widely dispersed, and liquidity in the FX option market dropped. Second, under such market conditions, prices of large-size put options, which are used for hedging yen appreciation risk, were especially higher than usual, and market participants seemed to deal with the price hike by breaking trades into smaller blocks and diversifying their counterparties.

Introduction

A Foreign Exchange (FX) option is a right to buy or sell a certain currency (e.g., the US dollar) at a specified exchange rate on or before a specified date. Various entities such as banks trade FX options actively as one type of derivatives. Their transactions and prices can reflect those entities' market views and risk awareness.

Derivative transactions, including FX options, mainly take place through over-the-counter (OTC) transactions, so detailed information of the market is not always available. At a G20 summit, leaders pledged to reform data arrangements of OTC derivative transactions, and since then international cooperation has progressed.[1] As a part of global efforts, the Financial Service Agency (FSA) of Japan collects granular OTC derivative transaction data in order to reduce systemic risks in the market and improve its transparency. The Bank of Japan and FSA of Japan have conducted various analyses about the market with this data.[2]

This report investigates the granular transaction data for USD/JPY options, focusing on the individual transaction around March 2020 in order to visualize the impact of the COVID-19 pandemic on the market. The transaction-level data allow us to conduct rigorous numerical analyses, such as of entity-level implied volatility, the transaction network, and entity-level profit margin, which are harder to complete using only existing derivative statistics and other existing databases.

OTC derivative transaction data

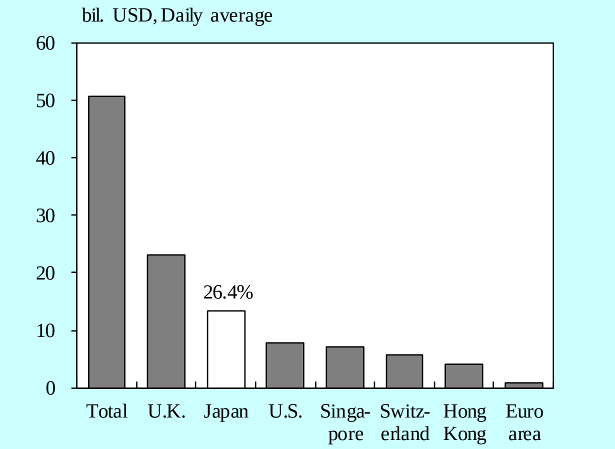
The OTC derivative transaction data at large include individual transactions' execution dates, transaction parties, etc. In the FX option dataset in particular, there is a variety of information about the options such as the currency pair (e.g., USD/JPY), whether the contract type is "right to buy (call option)" or "right to sell (put option)," and whether the option's holder can exercise it" only at expiration date (European option)" or "at any time up to the expiration date (American option)." Moreover, the dataset includes such detailed information about the transactions as the strike prices, maturities, and other information related to the option characteristics.

This report analyzes the FX European option transaction data from among all the OTC derivative transaction data collected in Japan. This is because most USD/JPY option transactions in Japan are European option trades.[3] In addition, in the process of performing calculations, we remove a portion of the dataset that has outliers and missing data in terms of strike prices or other items.[4] The dataset covers transactions where at least one of the parties is a Japanese financial institution or a foreign institution based in Japan, while the data do not include the transactions within companies in the same group (e.g., transactions between a headquarters and branches) or transactions between non-residents.[5]

An overview of the USD/JPY option market in Japan

To begin with, we present an overview of the USD/JPY option market in Japan. The Japanese market has about a quarter of the global market's trading, which is second only to the U.K. (Chart 1).

[Chart 1] USD/JPY Option Transactions by Country and Area

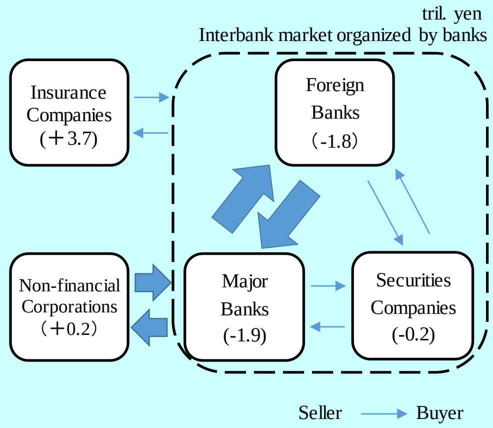


Note: As at April 2019. Total does not match the sum of country breakdowns as it excludes the double-counting of transactions between local and cross-border dealers. Euro area represents the sum of 13 countries which belong to the European Union and whose data are available.

Source: BIS "Triennial Central Bank Survey of Foreign Exchange and Over-the-counter (OTC) Derivatives Markets."

In the Japanese market, banks (including major banks, foreign banks, securities companies, etc.) play a central role as market intermediaries (Chart 2). Customers, including non-financial corporations and insurance companies, exist outside of the network of banks and make orders in terms of FX options to the banks. Banks passively provide opportunities to buy or sell FX options in response to the customers' needs. The trades between banks and customers also play a role in transferring FX risk exposure between participants. As such, in the OTC derivative market, banks have a strong presence as market makers as they trade frequently and widely.

[Chart 2] Trading Structure of the USD/JPY Options in the Japanese Market



Note: Calculated from the USD/JPY (European) options whose settlement dates are from January 2016 to December 2021. The size of arrows represents transaction volume made by each counterparty. Net European option transaction volumes settled are written in brackets. Positive values mean net long. Negative values mean net short.

Source: OTC Derivative Transaction Data

Market developments in March 2020 through the lens of existing derivative statistics and other existing databases

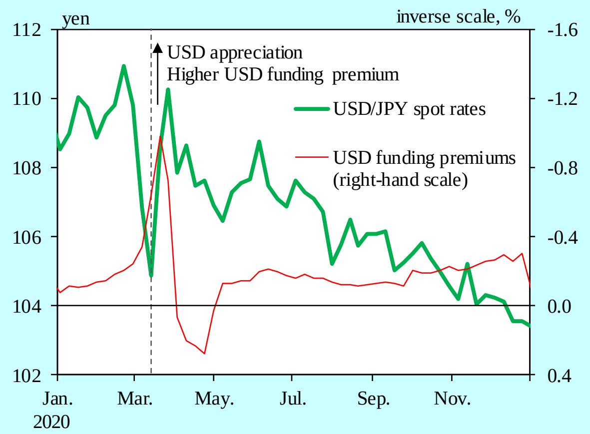
Next, we will present features of the USD/JPY market in March 2020, when the international financial market became destabilized, through the data of existing derivative statistics and other existing databases.

Spot rate, funding premium, risk reversal

The USD/JPY spot rate went down mainly because of yen appreciation due to the reduced risk appetite under the spread of the COVID-19 pandemic and the shrunken Japan-U.S. interest rate differentials after the FRB's unscheduled rate cuts. Thereafter the USD/JPY spot rate bounced back quickly due to the global tightening of the supply-demand balance in the US dollar.[6] These market developments increased the volatility of USD/JPY spot rate. Besides, a US dollar funding premium in the FX swap market shows a tightened supply-demand balance at that moment (Chart 3).

Individual banks' efforts to stabilize their US dollar funding, as well as the effectiveness of supplying US dollar funds by the six major central banks, prevented a major disruption in Japanese banks' US dollar funding,[7] despite the supply-demand crunch in the global US dollar funding market. Nonetheless, uncertainty about the FX market remained high for a while. USD/JPY risk reversal continued to be in an area of more persistent perception of yen appreciation than usual even around the moment that the USD/JPY spot rate rose (Chart 4).

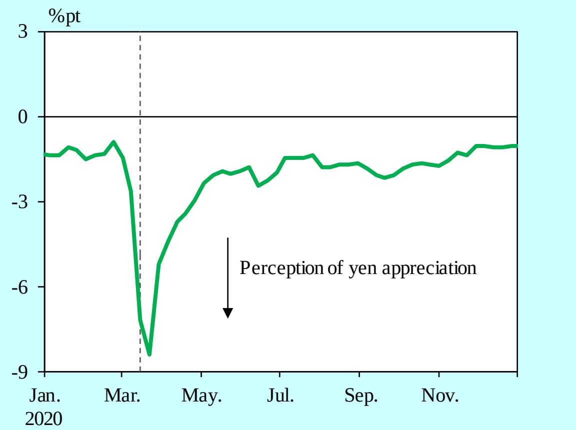
[Chart 3] USD/JPY Spot Rates and US Dollar Funding Premiums



Note: The dotted vertical line in the chart indicates the week of March 9-13, 2020. USD/JPY and US dollar funding premiums are weekly data. US dollar funding premiums are calculated with 3-month LIBOR. Latest data as of end-December 2020.

Source: Bloomberg

[Chart 4] USD/JPY Risk Reversals



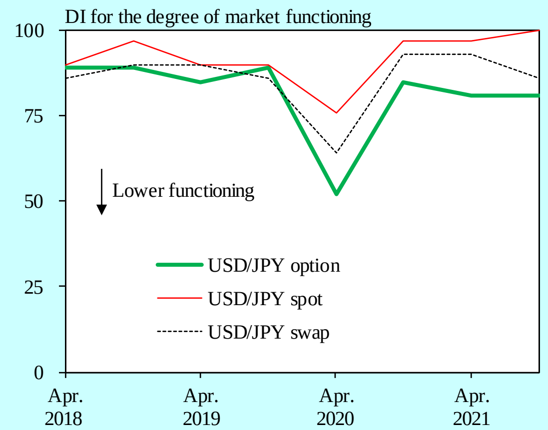
Note: The dotted vertical line in the chart indicates the week of March 9-13, 2020. Weekly data of 3-month 25 delta risk reversals. Latest data as of end-December 2020.

Source: Bloomberg

Market liquidity

In the responses to a survey, FX market participants indicated a decline in the market functioning of USD/JPY in the spring of 2020 (Chart 5). The results of the survey also reveal that market making such as cover deals got more difficult. In addition, bid-ask spread and the amount of best quotes (depth), which are major measurements of market liquidity,[8] showed a decline in liquidity in the spot market (Chart 6) The background of this lowering liquidity seems to be market disruption coming from the unprecedented combination of events of the COVID-19 pandemic and the introduction of remote working as a counter-strategy to the spread of the infection, which temporally reduced FX activity.

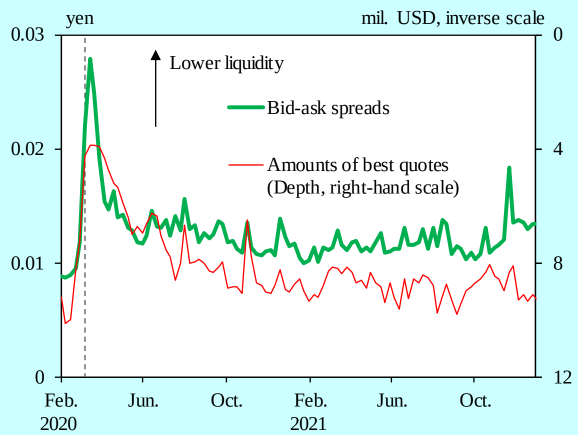
[Chart 5] Overall Evaluation on the Functioning of Tokyo FX Market



Note: Latest data as of October 2021.

Source: Tokyo Foreign Exchange Market Committee.

[Chart 6] Bid-ask Spreads and Amounts of Best Quotes (Depth)



Note: The bid-ask spread is shown as weekly average of the spread (from 5 p.m. to 5 p.m. next day in NY time). The amount of best quotes (depth) indicates weekly averages of the total volumes in best bid and best ask quotes. In the calculation, market closing days in both Japan and the United States are excluded. Latest data as of end-December 2021.

Source: EBS; Bloomberg.

As was touched on in the previous section, existing derivative statistics and other existing databases have limited information such as price data without the transaction parties' information and transaction volume by industries. On the other hand, the OTC derivative transaction data include the transaction parties' names and details of the individual transactions[9] that allow us to do more rigorous numerical investigations than those allowed by existing statistics. This is useful because it is likely that each entity confronted various problems and carried out different strategies under the unprecedented events around COVID-19. Based on this thought, this report utilizes the OTC derivative transaction data to discuss the market developments around March 2020.

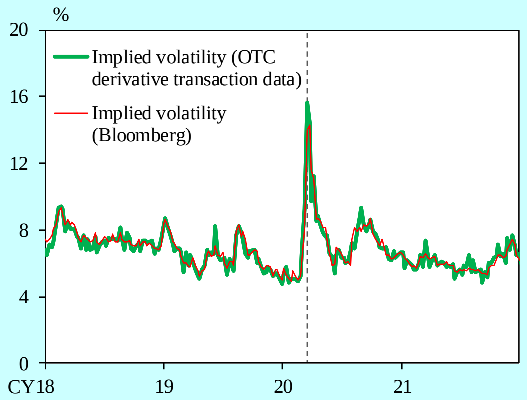
Market developments in March 2020 through the lens of the OTC derivative transaction data

In this section, we will explain USD/JPY option market developments in March 2020 by using OTC derivative transaction data.

Entity-level implied volatility

The median of the implied volatility, one of the most popular risk indicators, computed from the OTC derivative transaction data[10] moves very closely with the implied volatility in the Bloomberg dataset (Chart 7). This fact shows that the OTC derivative transaction data firmly capture market developments.

[Chart 7] Implied Volatilities



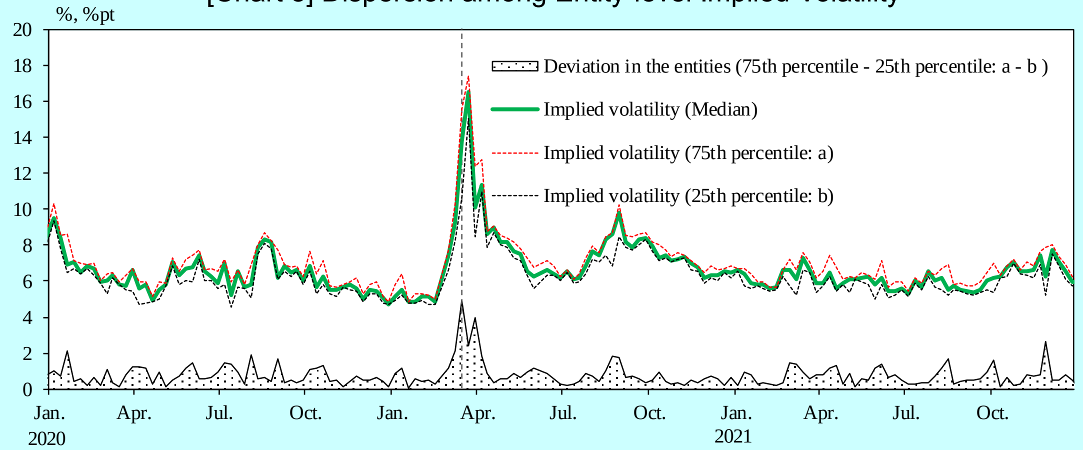
Note: The dotted vertical line in the chart indicates the week of March 9-13, 2020. Weekly data of 3-month ATM implied volatilities. Implied volatility in OTC derivative transaction data is calculated as the median of 3-month ATM options. ATM options are options whose strike price are equal to the spot rate at which the trades are executed. Latest data as of end-December 2021.

Source: OTC derivative transaction data; Bloomberg.

We divided computed implied volatility into entity-level data (Chart 8). Under normal conditions, each entity among the banks transacts at almost the same level of implied volatility. However, in March 2020, the dispersion in the entity-level implied volatility became much larger.

In detail, the deviation between the implied volatility of the 75th-percentile entity and that of the 25th-percentile entity sharply increased in March 2020. As the FX market became destabilized, the market

[Chart 8] Dispersion among Entity-level Implied Volatility



Note: The dotted vertical line in the chart indicates the week of March 9-13, 2020. Weekly data of 3-month ATM implied volatility. We calculated banks' (the market intermediaries: major banks, foreign banks, securities companies, etc.) entity-level implied volatilities and the dispersion by the following method. First, we extract the 3-month ATM options for which at least one of the counterparties is categorized as a bank. Second, we calculate the median of implied volatility within each entity. Third, we find the median, 75th percentile, and 25th percentile across the entity-level implied volatility. Fourth, we find the difference between the 75th and 25th percentiles, which represents the deviation among in the entities. Latest data as of end-December 2021.

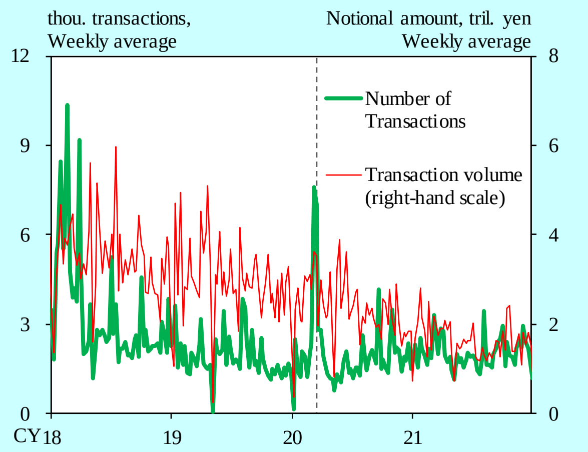
Source: OTC derivative transaction data; Bloomberg.

participants had more diverse views about FX risk, and the decline in liquidity in March 2020 would be expected to cause an increase in dispersion in the implied volatility (see the BOX).[11]

Increased difficulty in large transactions and downsizing in the trades

The decline in the option market liquidity can be seen in the change in the market transactions. The transaction volume in USD/JPY options (Chart 9) had less remarkable changes around March 2020. In contrast, a spike in the number of transactions shows that the market participants broke their trades into smaller blocks. It seems that large-size transactions became more difficult in March 2020.

[Chart 9] Number of Option Transactions and Transaction Volumes

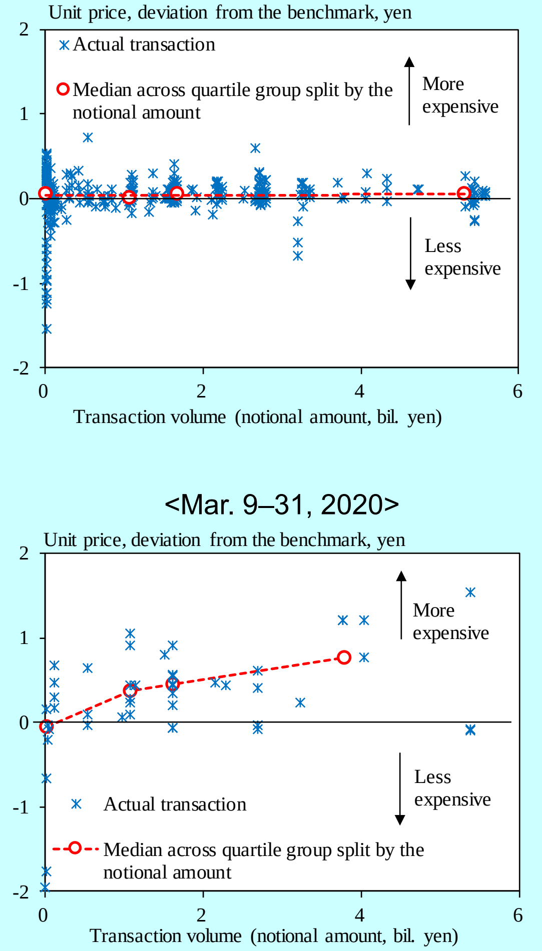


Note: The dotted vertical line in the chart indicates the week of March 9-13, 2020. Weekly data of the number of option transactions and transaction volumes. Covers all the European USD/JPY option transactions. Latest data as of end-December 2021.

Source: OTC derivative transaction data.

Increased difficulty in large-size transactions is also confirmed in the change in the unit price of the options. In normal times, the unit price of put options, which are used for hedging yen appreciation risk, differs little depending on transaction volume (in 2019; Chart 10). However, in March 2020, especially in the week of March 9 when a large yen appreciation occurred, the unit prices in large-size transactions tended to be higher than those in smaller transactions. This means that higher hedging costs are required especially for large-size transactions in order to hedge yen appreciation.[12]

[Chart 10] Comparisons between the Unit Prices and the Transaction Volumes in Put Options



Note: The relationship between unit prices of 3-month ATM options and their transaction volumes. Transaction volume (x-axis) is represented by the notional amount. Unit price (y-axis) is in terms of deviation from the benchmark price, "price of option per 1 dollar unit of notional amount from the OTC derivative transaction data" – "price of option per 1 dollar unit of notional amount from Bloomberg." The red dotted lines pass through the medians of notional amounts and medians of unit prices across the quartile groups (0-25%, 25-50%, 50-75%, 75-100%) split by notional amount.

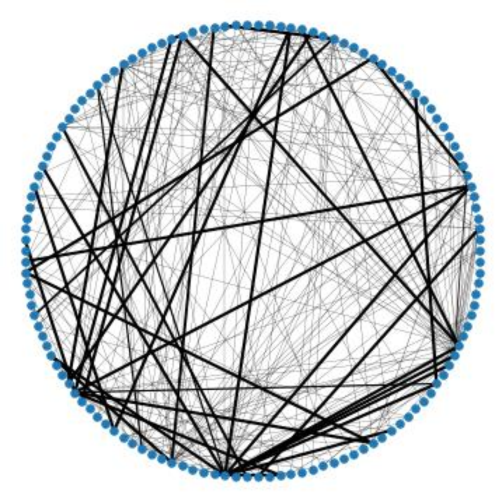
Source: OTC derivative transaction data; Bloomberg.

Transaction network

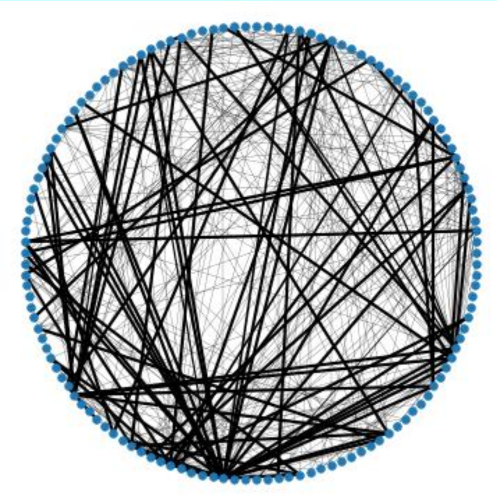
To see the change in the overall trade relationship between market participants, we compared transaction networks in March 2019 and March 2020. Compared to the situation in March 2019, market participants diversified their counterparties and the overall network was more complex in March 2020 (Chart 11). As the market participants were breaking their trades into smaller blocks, they seemed to control risks and continue market-making by diversifying their counterparties and thus finding trade partners.[13]

[Chart 11] Change in the Transaction Network

<Mar. 2019>



<Mar. 2020>



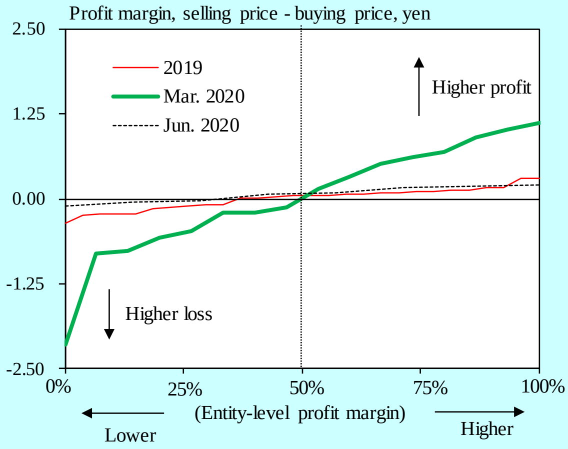
Note: Network topology of the USD/JPY option transactions, covering all the European USD/JPY options. The width of each line depends on the number of transactions between the pair of entities.

Source: OTC derivative transaction data.

Entity-level profit margin

Finally, we would like to confirm the dispersion in the entity-level profit margin among banks. Market intermediaries (e.g., major banks, foreign banks, securities companies, etc.) sell and buy options actively as market makers. Before the pandemic, in 2019, the option price deviation between the sell and buy prices (profit margin) did not differ so much between entities. On the other hand, in March 2020, when the international market became destabilized, option prices fluctuated partly due to a decline in the liquidity, and the entity-level profit margin had greater dispersion among banks (Chart 12).

[Chart 12] Dispersion among Entity-level Profit Margin coming from Option Trades



Note: We calculated banks' (the market intermediaries: major banks, foreign banks, securities companies, etc.) entity-level profit margins through the transaction of 3-month ATM options by the following method. First, we extract selling prices and buying prices of 3-month ATM options in banks' transaction. Second, we calculate the median of a call option's selling price per 1 dollar unit of notional amount and the median of a call option's buying price per 1 dollar unit of notional amount, entity by entity. Third, we find the differences between the selling price medians and buying price medians for the call options. Fourth, we perform the same steps for the put options. Fifth, we take the average of the call options' profit margins and the put options' profit margins, entity by entity. In the chart, we plot them from left to right in ascending order.

Source: OTC derivative transaction data; Bloomberg.

Concluding remarks

This report analyzes granular transaction data for USD/JPY options, focusing on the individual transactions around March 2020 in order to visualize the impact of the COVID-19 pandemic on the market.

The main results are as follows. First, through March 2020, the entity-level implied volatility indicates that the market perception about FX risk was widely dispersed, and the liquidity in the FX option market dropped. Second, under such market conditions, prices of large-size put options, which are used for hedging yen appreciation risk, were especially higher than usual, and market participants seemed to deal with the price hike by breaking trades into smaller blocks and diversifying their counterparties.

Looking ahead, market participants are expected to pay close attention to global monetary policies, progress with vaccination programs, and infection levels throughout the world, as well as other geopolitical risks. Under the circumstance, OTC derivative transaction data are beneficial for deepening our knowledge about the developments in the markets. In the international discussions, including that by the Financial Stability Board (FSB), further developments and expansions are expected to follow regarding the collection of OTC derivative transaction data.[14] We expect continued use of this OTC derivative transaction data in Japan.

BOX: What we can get from the "Implied Volatility"

In the main part of this report, we provide analysis focusing on implied volatility. However, some readers may not be used to the term, "implied volatility." Thus, in this box, we specify what information implied volatility has.

(Relationship between option price and implied volatility)

An FX option price is determined by macro-economic variables (e.g., USD/JPY spot rate, US interest rate, and Japanese interest rate), characteristics of the option (e.g., maturity and strike price), and uncertainty about the future (volatility) (see Chart B-1). Implied volatility is a volatility which is derived from the inverse function of a theoretical option pricing formula with an actually executed option price. In general, a measure of volatility is not easy to find from observable data,[15] so many professionals like to use an implied volatility obtained from the inverse function of the theoretical option pricing formula when they are interested in topics related to volatility.

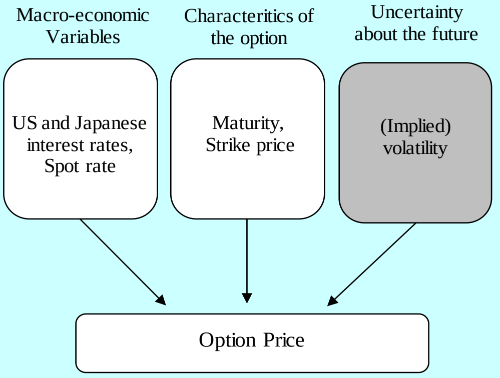
(Information that implied volatility includes)

The more uncertainty an FX market has, the higher the FX option price tends to be. A higher FX option price translates into a higher implied volatility from the theoretical model. In other words, implied volatility reflects FX risk expected by market participants.[16]

Although it is not often that market liquidity variables explicitly appear in the classical theoretical formula,[17] market liquidity does affect option prices in the real world. For example, when market participants have difficulty executing large transactions, like in March 2020, the FX option market cannot absorb the demand for a huge amount of currency hedging, and the option price goes up. Therefore, implied volatility obtained from an option price also reflects this kind of market liquidity.

In the general case of implied volatility analysis and monitoring, many professionals select specified options with specified maturities (such as 3-month) and specified strike prices to carry out a fixed-point observation. In this report, we also used specific implied volatility, which is computed from 3-month maturity and has strike prices equivalent to the USD/JPY spot rate at which the trades are executed. Furthermore, the fact is that macro-economic variables defined in the theoretical formula are the same as long as options are traded in the same time period. Thus, in such a case, implied volatility and option price move closely together (see Chart B-2).

[Chart B-1] Determinant Factors of Option Price based on a Theoretical Formula



Note: Implied volatility is a volatility which is derived from the inverse function of the theoretical formula with an actually executed option price.

[Chart B-2] Relationship between Implied Volatility and 3-month ATM Option Price based on the Theoretical Formula

Note: 3-month ATM option prices per 1 dollar unit of notional amount. The calculation is based on Garman-Kohlhagen model with US interest rate = 0%, Japanese interest rate = 0%, and USD/JPY spot rate = 100 yen. In this case, the option's Vega is constant (approximately 0.20), making the option price almost directly proportional to implied volatility.

* Currently at the Financial System and Bank Examination Department

** Currently at the Secretariat of the Policy Board

[1] In the G20 Pittsburgh summit leaders' statement, 2009 September, there was a commitment to make OTC derivative transactions more transparent through the development of a data collection and reporting system via trade repositories. In addition, in the G20 Seoul summit leader's declaration, 2010 November, there was an agreement to strengthen regulation and oversight of shadow banking.

[2] Some other investigations besides that reported here which use the OTC derivative transaction data are given below.

Washimi K. [2020] "Revisiting Determinants of Investor Sentiment in the FX Option Market by Machine Learning Approaches," Proceedings of 2020 IEEE Symposium Series on Computational Intelligence (SSCI).

Maruyama R. and K. Washimi. [2021] "Cross-Currency Swap Market through the Lens of OTC Derivatives Transaction Data: Impact of COVID-19 and Subsequent Recovery," Bank of Japan Review Series 2021-E-1.

Inoue S., S. Miki, and Y. Gemma. [2021] "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.

Takizuka Y. and R. Maruyama. [2021] "Foreign Exchange Option Market through the Lens of OTC Derivative Transaction Data: Recent Market Developments," Bank of Japan Review Series 2021-E-7.

Kawai D., M. Hasegawa, and R. Yagi. [2021] "An Analysis of the Transaction Network in the Japanese OTC Derivatives Markets," Financial Services Agency.

In addition, the BOJ has released securities financing transaction data since 2020. For instance, see the following.

Sasamoto K., A. Nakamura, T. Fujii, T. Semba, K. Suzuki, and K. Shinozaki. [2020] "New Initiatives to Improve the Transparency of Securities Financing Markets in Japan: Publication of Statistics on Securities Financing Transactions in Japan," Bank of Japan Review Series 2020-E-1.

[3] Most of USD/JPY option trades in the OTC derivative transaction data are European option trades. For instance, see the following.

Takizuka Y. and R. Maruyama. [2021] "Foreign Exchange Option Market through the Lens of OTC Derivative Transaction Data: Recent Market Developments," Bank of Japan Review Series 2021-E-7.

[4] It should be noted that the results could vary depending on the aggregation method or data cleansing. In regard to this point, this report eliminates double counting of the FX option transactions as much as possible when two reporting entities reported the same transaction data. Although a complete dataset is necessary to eliminate all the double counting, the OTC derivative transaction dataset has some missing data, so it should be noted that this report still retains some double counting.

Furthermore, we recognize the names of banks with SWIFT/BIC codes and LEI codes collected from the reporting banks, and aggregate the data by entity. It also should be noted that some of the reporting banks in the OTC derivative transaction data use other identifiers to denote counterparties' names. Because of this, the results could vary depending on the method of entity-based aggregation.

[5] The precise scope of the reporting entities is defined by Article 6 of the "Cabinet Office Ordinance on the Regulation of Over-the-counter Derivatives Transactions." Specifically, the data cover the transactions where either or both of the parties are a Financial Instruments Business Operator that conducts Type I Financial Instruments Business, a bank, the Shoko Chukin Bank, Ltd., the Development Bank of Japan Inc., the Federation of the Shinkin Banks (the district of which is the entire nation), or the Norinchukin Bank or an insurance Bank.

[6] The global changes in the USD funding conditions and their spillovers to the other financial markets are given below.

BIS [2020], "US Dollar Funding: an International Perspective," CGFS Papers No. 65.

[7] For instance, the paper below focused on the foreign currency funding of major Japanese banks after the beginning of the pandemic.

Aoki R., K. Antoku, S. Fukushima, T. Yagi, and S. Watanabe. [2021] "Foreign Currency Funding of Major Japanese Banks - Review of the March 2020 Market Turmoil -," Bank of Japan Review Series 2021-E-4.

[8] "Resiliency" is one of the liquidity indicators in FX markets, together with tightness and depth. For example, "price impact" captures the degree of new order flows' impact on the FX spot rate (either appreciation or depreciation). We also estimated price impact, and obtained approximately similar implication to tightness and depth indicators, though they are not included in this report.

[9] For example, we can investigate the individual trade features on the basis of call/put, maturities, strike prices, and option prices with the OTC derivative transaction data. On the other hand, as is written later in the report, the research that only uses the existing derivative statistics have some limitations.

Takizuka Y. and R. Maruyama. [2021] "Foreign Exchange Option Market through the Lens of OTC Derivative Transaction Data: Recent Market Developments," Bank of Japan Review Series 2021-E-7.

[10] This report uses the 3-month ATM option, which has relatively high liquidity and widely referred by market participants. ATM (at the money) means that its strike price is equal to the USD/JPY spot rate at which the trade was executed. Furthermore, we confirmed that we can replicate these investigations instead using the 1-month ATM option or 6-month ATM option and end up with similar implications to those in this report.

[11] In addition to that, because our computed implied volatility is on a weekly basis, the time difference in the transactions may affect entity-level implied volatility and its dispersion. However, as banks are market intermediaries, they are likely to trade options smoothly during a week, and the smooth operation would minimize the effects from the time differences. Furthermore, we confirm that dispersion in the implied volatility rose around March 2020 even based on daily data, which are at the most granular level of the OTC derivative transaction data.

[12] Chart 2 shows that customers such as insurance companies and non-financial corporations hold net long positions. Even if we only look at the put option market, customers continue to have net long positions. Related to this issue, the paper below concludes that low liquidity induces option price increases when the customers have net long positions.

Gârleanu, N., L. H. Pedersen, and A. M. Poteshman. [2009], "Demand-Based Option Pricing," ***The Review of Financial Studies***, vol. 22(10), pages 4259–4299.

[13] The report below similarly got the conclusion the USD/JPY currency swap market that its transaction network diversified and the market makers broke their trades into smaller blocks in March 2020.

Maruyama R. and K. Washimi. [2021] "Cross-Currency Swap Market through the Lens of OTC Derivatives Transaction Data: Impact of COVID-19 and Subsequent Recovery," Bank of Japan Review Series 2021-E-1.

[14] Other papers have also mentioned this point, such as FSB [2019] "OTC Derivative Market Reforms 2019 Progress Report on Implementation."

[15] Some researchers use historical volatility, the standard deviation of price changes in a certain period, as an alternative indicator of volatility. However, because historical volatility uses the past records of price changes for the calculation, it does not always correspond to the uncertainty about the future.

[16] In theory, without any friction in the market, even if entities have dispersed perception about FX risk, the no-arbitrage condition makes implied volatility not have dispersion. However, in reality, the market has some frictions, including transaction costs and trade prices, and implied volatility has some level of dispersion even under normal conditions.

[17] For instance, the paper below incorporated matching costs, which reflect market liquidity in the OTC market in the pricing model.

Duffie, D., N. Garleanu, and L. H. Pedersen. [2005], "Over-the-counter Markets," ***Econometrica***, vol. 73(6), pages 1815–1847.

For example, the paper below associates a market maker's inventory costs and asymmetric information among market participant with option prices because those have relationships with supply-demand factors such as liquidity. The paper also decomposes the price impact into several factors.

Muravyev, D. [2016], "Order Flow and Expected Option Returns," ***The Journal of Finance***, vol. 71(2), pages 673–707.

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