

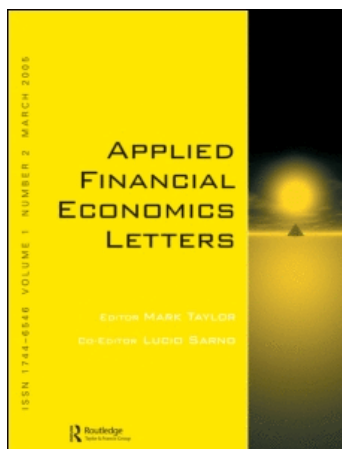
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### Trading volume, volatility and bank of Japan intervention

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# Trading volume, volatility and bank of Japan intervention

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This study examines the relationship between JPY/USD futures trading activities and foreign exchange intervention by the Bank of Japan from 1991 through 2000. It finds that there is a positive relationship between JPY/USD futures volume and volatility as predicted by the mixture of distribution hypothesis. This effect remains significant even when volume and volatility are conditioned on contemporaneous or lagged intervention by the Bank of Japan. It concludes that positive correlation between volume and volatility could result from information other than intervention by the Bank of Japan.

## I. Introduction

Since the introduction of a floating exchange rate system for JPY/USD rates in February 1973, the Japanese economy has experienced large fluctuations in foreign exchange rates, with the yen on a long rising trend. In order to mitigate the negative influence of such fluctuations on the Japanese economy, foreign exchange market interventions have been conducted from time to time. This study examines the relationship between daily JPY/USD futures trading volume, volatility in the TIFFE (Tokyo International Financial Futures Exchange) and foreign exchange intervention by the Bank of Japan.

Empirical research on the relationship between currency trading volume and volatility can help to discriminate among differing hypotheses about market structure (Karpoff, 1987). According to the mixture of distribution hypothesis, volatility and volume are positively correlated through their dependence on an information-flow variable (Tauchen and Pitts, 1983). Chaboud and LeBaron (2001) show that intervention by the Federal Reserve is correlated with an increase in trading volumes in currency futures markets. Using a recently released data set

of intervention by the Bank of Japan, this issue is further explored by investigating whether similar patterns exist when the Bank of Japan intervenes in the JPY/USD exchange rate markets.

The relationship between futures trading volume and volatility has been documented by Batten and Bhar (1995) and Jorion (1996). Batten and Bhar (1995) explore the link between volume and volatility for JPY/USD futures across the International Money Market and the Singapore International Monetary Exchange. They find that volume and volatility correlations are similar across different exchanges. Jorion (1996) uses trading volumes taken from the Chicago Mercantile Exchange for DEM/USD currency futures and shows that futures trading volume is positively correlated with volatility.

The empirical work on the spot currency market has suffered from problems that good data on trading volumes are not available to researchers.<sup>1</sup> To circumvent this constraint, we use JPY/USD futures data from the TIFFE and explore the impact of intervention by the Bank of Japan on JPY/USD trading activities. The results show that there is positive and significant relationship between futures trading volume and volatility as predicted by the mixture of

<sup>1</sup> Lyons (2000) provides a comprehensive review of the trading volume data in currency markets.

distribution hypothesis. This effect remains significant even when volume and volatility are conditioned on contemporaneous or lagged intervention by the Bank of Japan. Though there is evidence that intervention by the Bank of Japan is correlated with an increase in JPY/USD volatility, we do not find a significant relationship between intervention by the Bank of Japan and JPY/USD trading volume. This indicates that positive correlation between volume and volatility could result from information other than intervention by the Bank of Japan.

The remainder of the paper is organized as follows. Section II describes the data sources. The testing methodology and empirical results are presented in Section III and a final section concludes.

## II. Data and Testing Methodology

### Data

The data used in this paper consists of the Bank of Japan intervention data, daily trading volume and volatility of the JPY/USD futures rates. The sample period covers 15 February 1991 to 28 December 2000 and includes 1728 observations.<sup>2</sup> A summary statistic of these variables is provided in Table 1. The intervention data contains daily amounts, measured by billions of yen, spent by the Bank of Japan on purchases or sales of US dollars against the Japanese yen in the Tokyo market. The JPY/USD futures rates are obtained from the TIFFE (Tokyo International Financial Futures Exchange).

The volatility of the JPY/USD futures rates are measured using the daily high-low price range. The high-low range is used extensively in the literature to measure market volatility at a daily frequency (Parkinson, 1980; Chaboud and LeBaron, 2001). It is defined as the log differences between the daily high and daily low prices multiplied by 100.

## III. Testing Methodology and Empirical Results

Regression analysis of the link between trading volume, volatility, and intervention by the Bank of Japan requires that all data series involved are stationary; otherwise the  $t$  statistic might be spurious. A Dickey–Fuller unit root test was conducted on the stationarity of these variables and the results are presented in Table 2.

**Table 1. JPY/USD futures and BOJ intervention summary statistics**

|                     | Trading volume | High-low volatility | BOJ intervention |
|---------------------|----------------|---------------------|------------------|
| Mean                | 261.03         | 0.21                | 11.11            |
| Std. Dev.           | 423.00         | 0.26                | 100.94           |
| Min.                | 1.00           | 0.00                | 0.00             |
| Max.                | 8415.00        | 3.12                | 2620.10          |
| No. of observations | 1728           | 1728                | 1728             |

*Notes:* There are a total of 2441 business days in the sample. Observations with zero trading volume of JPY/USD futures were excluded and the total numbers of observations are 1728.

**Table 2. Tests for a unit root for volume and volatility of JPY/USD futures**

| Variable     | $t$ -value |
|--------------|------------|
| Volume       | -8.63**    |
| Volatility   | -11.74**   |
| Intervention | -22.92**   |

*Notes:* \*\*Indicates significance at the 5% level.

The unit root test results indicate that the three variables are stationary. Therefore, we estimate the following regressions in order to explore the link between trading volume, volatility, and intervention by the Bank of Japan:

$$\text{Volume}_t = \alpha_1 + \lambda_1 \text{Trend} + \beta_1 \text{Volume}_{t-1} + \theta_1 \text{Volatility}_t + \gamma_1 I_t + \sum_{i=1}^4 \phi_i D_i + \xi_t \quad (1)$$

$$\text{Volatility}_t = \alpha_2 + \lambda_2 \text{Trend} + \beta_2 \text{Volatility}_{t-1} + \theta_2 \text{Volume}_t + \gamma_2 I_t + \sum_{i=1}^4 \phi_i D_i + \eta_t \quad (2)$$

$$I_t = \alpha_3 + \lambda_3 \text{Trend} + \beta_3 I_{t-1} + \theta_3 \text{Volume}_t + \gamma_3 \text{Volatility}_t + \sum_{i=1}^4 \phi_i D_i + \varepsilon_t \quad (3)$$

where volume measures the total trading volume on all active futures contracts in the TIFFE. Volatility is calculated from the daily JPY/USD high-low range. Term  $I_t$  is the intervention variable that contains daily amounts spent by the Bank of Japan on purchases or sales of US dollars against the Japanese yen in the Tokyo market.

<sup>2</sup> We exclude observations that have zero trading volume in the sample period.

Table 3. Results of volume, volatility, and BOJ intervention equations

| Independent variables     | Dependent variable |                  |                |
|---------------------------|--------------------|------------------|----------------|
|                           | Volume             | Volatility       | BOJ            |
| Constant                  | 3.18 (23.08)**     | -0.81 (-12.26)** | 8.44 (0.55)    |
| Volume                    |                    | 0.14 (14.78)**   | -1.00 (-0.44)  |
| Volume <sub>t-1</sub>     | 0.46 (22.97)**     |                  |                |
| Volatility                | 0.60 (14.00)**     |                  | 30.08 (6.30)** |
| Volatility <sub>t-1</sub> |                    | 0.41 (19.99)**   |                |
| BOJ                       | 0.00 (1.51)        | 0.00 (7.13)**    | -              |
| BOJ <sub>t-1</sub>        | -                  | -                | 0.06 (2.72)**  |
| Trend                     | -0.00 (-19.00)**   | 0.00 (15.60)**   | -0.00 (-0.19)  |
| D1                        | -0.03 (-0.44)      | 0.02 (0.48)      | -0.72 (-0.09)  |
| D2                        | 0.09 (1.33)        | -0.03 (-0.83)    | -6.43 (-0.86)  |
| D3                        | 0.16 (2.33)**      | -0.01 (-0.38)    | -9.80 (-1.30)  |
| D4                        | 0.06 (0.90)        | 0.01 (0.24)      | -14.52 (-1.93) |

Notes: Lagged volume, volatility and Bank of Japan intervention are denoted by volume<sub>t-1</sub>, volatility<sub>t-1</sub>, and BOJ<sub>t-1</sub>. A time trend variable denoted by Trend, and four weekday dummy variables denoted by D1 to D4 are also included in each equation. \*\*indicates significance at the 5% level and *t* ratios are in parentheses.

Following Jorion (1996), the trading volume is modelled against a time trend, lagged volume, volatility, intervention by the Bank of Japan, and four day-of-the-week dummy variables in the first equation. Volatility and Bank of Japan intervention are modelled in a similar way in Equations 2 and 3.

Table 3 presents results of Equations 1 to 3. It is seen from the first column of Table 3 that trading volume is significantly related to volatility and the lagged trading volume, time trend, and Wednesday dummy variables are all significant at the 5% level. However, there is no significant relationship between intervention by the Bank of Japan and trading volume. The second column of Table 3 contains results for the volatility equation conditioned on the intervention by the Bank of Japan and trading volume. The results indicate that intervention, trading volume, lagged volatility, and time trend variables are positively related to the JPY/USD volatility. The third column of Table 3 shows that intervention by the Bank of Japan is significantly affected by volatility and the lagged intervention variables. However, the relationship between trading volume and intervention by the Bank of Japan is not significant at the 5% level.

It is found that JPY/USD futures trading volume is correlated with an increase in volatility as predicted by the mixture of distribution hypothesis after controlling intervention by the Bank of Japan. This indicates that the positive correlation between volume and volatility is contributed from new information, other than intervention by the Bank of Japan, arriving to the market.

#### IV. Conclusions

This paper studies the relationship between daily dollar-yen futures trading volume on the TIFFE and intervention by the Bank of Japan from 1991 to 2000. New evidence is provided on the link between intervention by the Bank of Japan and trading activity in the JPY/USD futures market. It is shown that intervention by the Bank of Japan is significantly affected by volatility and the lagged intervention variables. However, the relationship between trading volume and intervention by the Bank of Japan is not significant at the 5% level. In addition, the results indicate that there is a positive and significant relationship between futures trading volume and volatility as predicted by the mixture of distribution hypothesis. This effect remains significant even when volume and volatility are conditioned on contemporaneous or lagged intervention by the Bank of Japan. It is concluded that positive correlation between volume and volatility could result from information other than intervention by the Bank of Japan.

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