FOREIGN-EXCHANGE TRADING VOLUME AND FEDERAL RESERVE INTERVENTION

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We find a large positive correlation between daily trading volume in currency futures markets and foreign-exchange intervention by the Federal Reserve over the period 1979 to 1996. Neither contemporaneous nor predicted volatility can fully account for the increases in trading activity. Whether or not the intervention operation is publicly reported appears to be an important determinant of trading volume. © 2001 John Wiley & Sons, Inc. Jrl Fut Mark 21:851–860, 2001

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INTRODUCTION

Researchers almost universally agree that sterilized central bank intervention in foreign-exchange markets is unlikely to affect the level of exchange rates in the long term. In the very short term, however, central bank intervention is often associated with sharp price movements in currency markets, and reports of intervention are crucial pieces of information in these markets (Dominguez & Frankel, 1993; Goodhart & Hesse, 1993; Edison, 1993). As is the case for other financial asset prices, the process by which the information content of intervention and other market events is incorporated into currency prices is still poorly understood, and various models of price discovery in asset markets follow different approaches in mapping the link between the flow of information deemed relevant and the price of the asset. Most of the models, however, often descendants of the original mixture of distribution hypothesis literature (Clark, 1973; Epps & Epps, 1976), predict that as new information is being incorporated, increases in trading volume will accompany movements in prices. That prediction has been tested extensively in equity markets but much less in foreign-exchange markets, principally because of data constraints.

Among recent works on the price discovery process in foreign-exchange markets, both the issue of what constitutes relevant information and the issue of how information is disseminated have been studied with price data. Andersen and Bollerslev (1998) found that their analysis of price volatility in the dollar–mark market is consistent with the hypothesis that both public announcements and the trading process itself contain relevant information. Peiers (1997), examining high-frequency price quotes, studied information asymmetry among traders following Bundesbank intervention. She stated that evidence of information-based leadership around times of central bank intervention should also be observable through changes in quantities traded.

This article presents evidence that, from 1979 to 1996, foreign-exchange intervention operations by the Federal Reserve have been correlated with increases in currency trading volume in the dollar–yen and dollar–mark futures markets. These increases in trading volume do not appear to be fully explained by market volatility, in the sense that, even after conditioning for daily volatility, trading volume is higher on intervention days. For a portion of the sample, we also differentiate between volume responses associated with announced interventions versus secret interventions. This latter point may shed some light on the relative importance of public announcements versus the trading process itself in the price discovery mechanism.

DATA AND METHODOLOGY

The study uses intervention and trading volume data in the dollar–yen and dollar–mark markets, covering June 1979 to March 1996 at a daily frequency (4255 trading days). Intervention data, provided by the Federal Reserve Board, consist of the daily amounts spent by the Federal Reserve and the U.S. Treasury on purchases or sales of U.S. dollars in the Japanese yen (JY) and German mark (DM) spot markets in New York. There are 450 intervention days in the mark and 211 in the yen during our sample period, with much of the difference due to the higher number of intervention days in the mark early in the period. The following unconditional and conditional probabilities of intervention on day t (where I is intervention and NI is no intervention) show that, besides being relatively rare, intervention operations are clustered in time:

DM: $p(\mathrm{I}_t) = 0.1058$ $p(\mathrm{I}_t/\mathrm{I}_{t-1}) = 0.5889$ $p(\mathrm{NI}_t/\mathrm{NI}_{t-1}) = 0.9516$

JY: $p(\mathrm{I}_t) = 0.0496$ $p(\mathrm{I}_t/\mathrm{I}_{t-1}) = 0.5261$ $p(\mathrm{NI}_t/\mathrm{NI}_{t-1}) = 0.9753$

For volume data, we use the total trading volume on all active futures contracts (usually four for each currency) on the International Monetary Market of the Chicago Mercantile Exchange, as collected by Tick Data Inc. These data are the only available source of currency market trading volume at a daily frequency over our entire sample period, and they have been used frequently as a proxy for overall spot market trading volume (e.g., Frankel & Froot, 1990; Jorion, 1996).[1] Daily trading volume increases dramatically over the sample period. In the mark, for instance, the mean number of contracts traded per day increases from less than 1000 in 1979 to more than 30,000 in the 1990s. To deal with this nonstationarity, we create the following normalized volume variable (NVOL) in each currency. NVOL is the ratio of today's trading volume to a moving average of the previous 100 daily trading volumes:

$$\mathrm{NVOL}_t = \frac{\mathrm{vol}_t}{\sum_{s=1}^{100} \mathrm{vol}_{t-s}} \tag{1}$$

[1]Despite the common assertion that, in markets where both spot and futures trading volumes are observed, they are usually highly correlated, using foreign-exchange futures volume data as a proxy for spot volume data requires caution. Trading in futures markets is only a small fraction of the overall currency trading, and it can be argued that whatever motivates a futures trader to hedge may not necessarily motivate a spot trader to buy or sell. Also, because the contracts are not cash-settled, high trading volumes, unlikely to be matched in spot markets, are often observed for a short period during the 4 settlement months. This adds noise to the volume series and raises the bar for statistical significance. The growing use of electronic trading systems in recent years carries with it the hope that volume data for a large share of the market may be routinely available in the future.

BASIC RESULTS

We first compute the mean values of NVOL for the whole sample, on days with intervention and on days without intervention. Table I reports these results for the two currencies. The table also reports a t statistic for the difference of means between intervention and no-intervention days and the p value from the following simulation procedure. Using the transition probabilities for the interventions reported previously, we create 1000 simulated intervention series of length 4255 and match them with the actual normalized trading volume series. We then calculate the mean trading volumes on days with and without simulated intervention, and we report as a bootstrap p value the fraction of the 1000 replications where the difference in mean trading volume between intervention days and days without intervention is at least as large as in the actual data. This simulation procedure allows us to study the statistical significance of the difference in mean trading volumes without the assumption of a Gaussian distribution for the volume series. It also takes into account the clustering properties of the actual intervention series.

The results are unequivocal. Trading volume on intervention days is, on average, higher than on days when the Federal Reserve chooses not to intervene. The differences in mean are highly statistically significant with or without the assumption of normality, which is not too surprising given the large number of observations, but the magnitude of the differences is also quite large. The results show an increase in trading volume of over 25% in both currencies on intervention days relative to the mean volume of the 100 previous days.

As shown in Figures 1 and 2, the high mean numbers on intervention days are not just the result of a few observations with high trading volume. The figures show the kernel density estimates of the probability density functions of the NVOL variables, on days with intervention and on days without intervention.[2] For both the yen and the mark, the whole distribution of daily trading volumes clearly shifts to the right for

TABLE I
Mean Normalized Trading Volume

	Whole Sample	*Intervention*	*No Intervention*	t	*Bootstrap p*
DM NVOL	1.0443	1.2630	1.0184	9.39	0.000
JY NVOL	1.0413	1.2947	1.0281	7.34	0.000

[2]The density functions are estimated with Gaussian kernels, with the kernel bandwidth chosen optimally with the leave-one-out cross-validation technique.

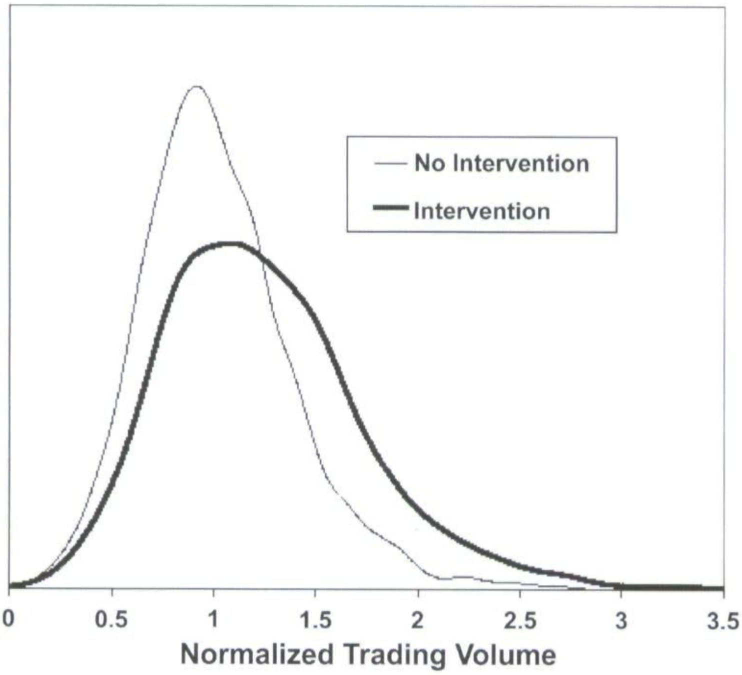

FIGURE 1
Distribution of daily trading volume (DM).

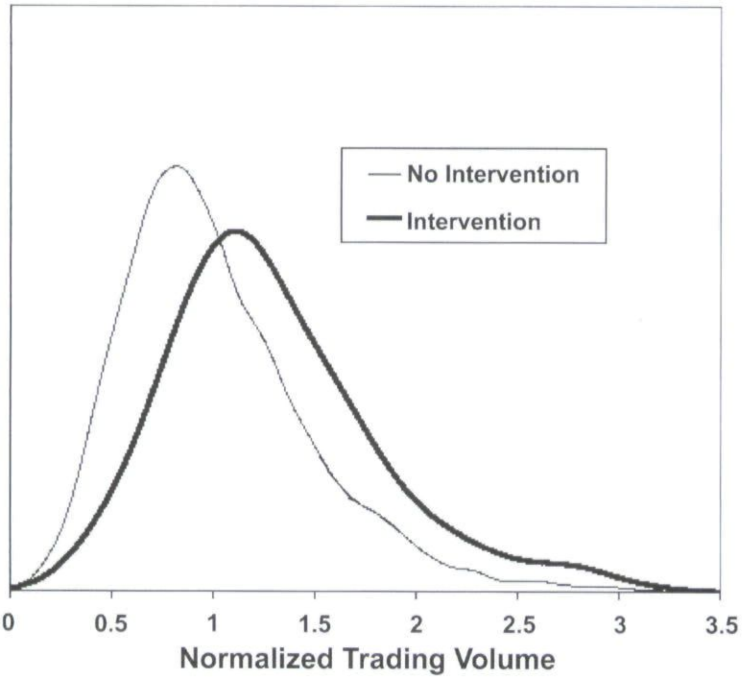

FIGURE 2
Distribution of daily trading volume (JY).

intervention days, indicating that, on a substantial majority of those days, abnormally high trading volumes are observed. Note also that, particularly in the mark, the dispersion of normalized trading volumes increases for intervention days.

The positive correlation between trading volume and intervention cannot, however, be interpreted as proof that intervention causes an increase in trading. It may be that intervention truly causes a volume increase, it may be that high volume causes intervention, or it may be that a common process drives both intervention and volume.

VOLATILITY AND TRADING VOLUME

The prime candidate to drive both intervention and volume is volatility. The link between volatility and volume is well documented (e.g., Bhar & Malliaris, 1998), and recent work (Almekinders & Eijffinger, 1994; Baillie & Osterberg, 1997) has presented some evidence of a causal relationship between volatility and the decision to intervene. Dominguez (1998) also found that intervention is correlated with volatility but argued, however, that the causation may go from intervention to volatility. In any case, if trading volume and intervention are each independently correlated with market volatility, one possible explanation for the results in Table I is, therefore, simple simultaneity. It is, of course, likely that the relationship between intervention, volatility, and volume is far more complex.

We investigate the relationship between volatility, volume, and intervention in the following way. We gauge volatility with a scaled measure of the daily high–low range, creating the HILO variable:

$$\mathrm{HILO}_t = [\log(\mathrm{high}_t) - \log(\mathrm{low}_t)] \cdot 100 \tag{2}$$

We then rank the data in order of increasing daily volatility and break them down into quintiles. We report for each quintile the number of intervention operations, as well as the mean normalized trading volume and mean volatility on days with intervention and on days without. This

TABLE II

DM Mean Daily Trading Volume by High–Low Volatility Quintiles

		Quintile 1	*Quintile 2*	*Quintile 3*	*Quintile 4*	*Quintile 5*
	N	$n = 109$	$n = 81$	$n = 84$	$n = 83$	$n = 93$
Intervention	NVOL	1.0023	1.1466	1.2631	1.4056	1.5424
	HILO	0.3423	0.5313	0.6843	0.9056	1.6184
	N	$n = 742$	$n = 770$	$n = 767$	$n = 768$	$n = 758$
No intervention	NVOL	0.7688	0.8857	1.0143	1.1177	1.3010
	HILO	0.3521	0.5274	0.6881	0.9035	1.4637

TABLE III
JY Mean Daily Trading Volume by High–Low Volatility Quintiles

		Quintile 1	*Quintile 2*	*Quintile 3*	*Quintile 4*	*Quintile 5*
	N	$n = 22$	$n = 29$	$n = 45$	$n = 57$	$n = 58$
Intervention	NVOL	0.9724	1.0198	1.2063	1.2648	1.6525
	HILO	0.3058	0.4360	0.5622	0.7635	1.7511
	N	$n = 829$	$n = 822$	$n = 806$	$n = 794$	$n = 793$
No intervention	NVOL	0.6895	0.8702	1.0259	1.1492	1.4269
	HILO	0.2798	0.4279	0.5650	0.7588	1.3164

method allows us to isolate the effects of intervention and volatility on trading volume, even in the presence of nonlinear relationships. Tables II and III report the results.

First, volatility and volume are, as expected, positively correlated for both currencies (NVOL always increases from quintile to quintile). Second, the frequency of intervention appears to be correlated with our measure of volatility for the yen, but not for the mark. Third, and most strikingly, within each quintile the mean trading volume is, in every case, higher for intervention days than for days without intervention. Intervention appears, therefore, to be associated with an additional boost in trading volume beyond what the link between volatility and volume would be expected to generate.

The high–low range we have used is often considered to be the best measure of market volatility for data at a daily frequency (Parkinson, 1980; Rogers & Satchell, 1991). It appears likely, however, that an intervention operation on a particular day will affect the high–low range on the same day, with the direction of the effect depending on the direction of the intervention operation relative to the market trend (with the wind or, more often, against the wind). Because this could potentially bias our results (one way or the other), we address this issue by repeating the exercise of Tables II and III using, as a measure of volatility, the predicted daily conditional variance from a generalized autoregressive conditional heteroskedasticity (GARCH)(1,1) model. The model is fitted to the series of log differences of daily closing prices for each currency, yielding the following parameter estimates, with h_t representing conditional variance and r_t representing daily returns:

$$\begin{aligned} \text{DM:}\quad & h_t = 0.908h_{t-1} + 0.070r_{t-1}^2 \\ \text{JY:}\quad & h_t = 0.896h_{t-1} + 0.064r_{t-1}^2 \end{aligned} \tag{3}$$

Table IV reports for both currencies the number of intervention operations and the mean normalized trading volumes on days with intervention and

TABLE IV
Mean Volume Movement by GARCH(1,1) Volatility Quintiles

	Quintile 1	*Quintile 2*	*Quintile 3*	*Quintile 4*	*Quintile 5*
DM intervention count	$n = 162$	$n = 61$	$n = 73$	$n = 80$	$n = 74$
DM NVOL (intervention)	1.2400	1.4410	1.2601	1.2369	1.1979
DM NVOL (no intervention)	0.9530	0.9654	1.0682	1.0431	1.0559
JY intervention count	$n = 20$	$n = 36$	$n = 73$	$n = 80$	$n = 74$
JY NVOL (intervention)	1.5212	1.3183	1.2404	1.3073	1.2446
JY NVOL (no intervention)	0.9201	0.9803	1.0675	1.0646	1.1205

on days without intervention, by the GARCH(1,1) volatility quintiles. Again, within each quintile and for both currencies, mean trading volume is higher for intervention days than for days without intervention. This is additional evidence against the possibility that all we are observing is simultaneity. In addition, the correlation between trading volume and the GARCH conditional variance appears very poor on intervention days and only marginal on days without intervention.

INTERVENTION NEWS AND TRADING VOLUME

Using a data set of news reports of intervention operations over the period 1983 to 1990 compiled by Dominguez and Frankel (1993), we study mean trading volume movements under three sets of circumstances. An announced intervention occurs when the Federal Reserve conducts an intervention operation and news stories correctly report activity in foreign-exchange markets by the central bank. A secret intervention occurs when there is central bank activity in foreign-exchange markets but no news report appears. A false intervention occurs when news reports of intervention appear but the Federal Reserve does not intervene in that particular currency. Table V reports the mean normalized trading volumes in both currencies broken down into these categories.

The announcement effect is large in both currencies, with trading volume appreciably higher when intervention is announced than when it is not.[3] Trading volume on days with secret intervention is very low for the mark (lower than on days without intervention) but somewhat higher for the yen. This is an instance where inferring a direction of causality may be difficult, as some researchers (Goodhart & Hesse, 1993;

[3]Despite the small sample sizes, testing for differences of mean trading volumes between announced and secret interventions yields t values of 2.53 for the mark and 1.96 for the yen.

TABLE V
Mean Trading Volume and News Reports (1983–1990)

	All	*No Intervention*	*Intervention*	*Announced*	*Secret*	*False*
DM	$n = 1942$	$n = 1743$	$n = 199$	$n = 144$	$n = 55$	$n = 64$
DM NVOL	1.044	1.036	1.107	1.146	1.005	1.027
JY	$n = 1942$	$n = 1768$	$n = 174$	$n = 128$	$n = 46$	$n = 80$
JY NVOL	1.031	1.007	1.272	1.315	1.153	1.141

Hung, 1997) have argued that a central bank may prefer to intervene secretly on days with low trading volume.[4]

The announcement effect, although obviously very important, may not fully explain the increase in trading volume, as mean trading volume under false announcements, that is, when news reports of intervention are fiction, is much smaller than when intervention is correctly reported. These results should be read with a dose of caution because the sample size is small and the news data, when reporting intervention by the Federal Reserve, do not differentiate between intervention in the mark and in the yen.

CONCLUSION

We have presented clear evidence that foreign-exchange intervention by the Federal Reserve is correlated with an increase in trading volume in currency futures markets. This effect remains important even when volume is conditioned on contemporaneous or predicted volatility. The effect is also much stronger for announced intervention operations than for secret intervention operations.

The results appear to support the old saying that it takes volume to move prices. What we certainly do not see in the data is an immediate price adjustment to a new postintervention level, all without any volume effect. Instead, as market participants take time to digest the information content of the intervention, trading volume increases significantly. The increase in trading volume suggests that the information may impact traders in a heterogeneous fashion.

Without relying on price data, the evidence also reaffirms the importance of the announcement channel for intervention. Yet the relatively muted reaction to erroneous press reports of intervention operations is consistent with the idea that the trading process itself, not

[4]Mean normalized trading volume for the day immediately preceding a secret intervention is 0.925 for the mark and 1.069 for the yen, clearly lower than on the day of the intervention, perhaps adding weight to the argument advanced by Goodhart and Hesse (1993) and Hung (1997).

just intervention news, carries information relevant to the price discovery process in these markets.

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