working paper 03 09

An Analysis of Japanese Foreign Exchange Interventions, 1991–2002

by Alain P. Chaboud and Owen F. Humpage

FEDERAL RESERVE BANK OF CLEVELAND

Working Paper 03-09 September 2003

An Analysis of Japanese Foreign Exchange Interventions, 1991–2002

by Alain P. Chaboud and Owen F. Humpage

The effectiveness of Japanese interventions over the past decade depended in large part on the frequency and size of the transactions. Prior to June 1995, Japanese interventions only had value as a forecast that the previous day's yen appreciation or depreciation would moderate during the current day. After June 1995, Japanese purchases of dollars had value as a forecast that the yen would depreciate. Probit analysis confirms that large, infrequent interventions, which characterized the later period, had a higher likelihood of success than small, frequent interventions.

Keywords: Intervention, foreign-exchange rates, Japan
JEL Classification: F3

Alain P. Chaboud is at the Board of Governors of the Federal Reserves System. He can be reached at Division of International Finance, Board of Governors of the Federal Reserve System, Mail Stop 18, Washington, D.C., 20551, or (202) 452-3756. Owen F. Humpage is at the Federal Reserve Bank of Cleveland. He can be reached at Research Department, Federal Reserve Bank of Cleveland, P.O. Box 6387, Cleveland, Ohio, 44101-1387, (216) 579-2019, or owen.f.humpage@clev.frb.org.

1. Introduction

Since the early 1990s, the monetary authorities of the major industrialized countries, with one notable exception, have greatly curtailed their foreign-exchange interventions. That exception has been Japan, where the Ministry of Finance (MoF), using the Bank of Japan as its agent, has continued to intervene frequently—and at times massively—in foreign-exchange markets. Although press reports of Japanese interventions have often been available, and although the MoF has sometimes announced such operations, Japanese authorities did not release actual data until recently.

This paper analyzes the short-term effectiveness of Japanese exchange-market operations using the official Japanese intervention data. We apply a technique developed in Hendriksson and Merton (1981) and Merton (1981) and used in Leahy (1995) and Humpage (1999, 2000) to analyze U.S. interventions. This procedure allows us to determine if the observe number of successful interventions exceeds the amount that would randomly occur given the martingale nature of exchange-rate changes. As such, the technique is not an investigation of any particular channel through which intervention might operate. Nevertheless, this approach is compatible with the signaling channel.

We show that official Japanese purchases of U.S. dollars after June 14, 1995, were highly successful at predicting a near-term yen depreciation. (The very few sales of dollars after that date were not effective by most standards.) Prior to June 1995, official Japanese interventions only had value as a forecast that recent yen movements would moderate, but not reverse (i.e., leaning against the wind). Our probit regressions indicated that the MoF could increase the probability of success by undertaking large, but infrequent interventions. We also find some evidence that coordinated interventions had

a higher that expected success rate, but because of the small number of coordinated interventions in our sample, we are unable to derive strong inferences about the importance of joint activities.

This paper proceeds as follows: Section 2 discusses the theoretical connections between official intervention and exchange rates. Section 3 offers basic summary statistics for the official Japanese intervention data. Section 4 explains our test procedure and presents our success criteria. Section 5 evaluates the success counts. Section 6 shows the results of probit regression on our general success criteria. Section 7 summarizes our results and compares them with relevant recent papers.

2. Channels of Intervention Effectiveness

The traditional approach to the analysis of the effectiveness of sterilized intervention has focused on two avenues of influence, the signaling or expectations channel and the portfolio-balance channel. Empirical evidence in favor of a portfolio-balance channel is generally weak. Dominguez and Frankel (1993) is a notable exception. The signaling channel, however, has received a bit more support. According to the signaling channel, central bank can use sterilized foreign exchange intervention to transmit private information to the market (see Baillie, Humpage, Osterberg, 2000).

Recently, economists have proposed new channels of influence. One is related to the well-known Keynesian beauty contest, in which individuals vote on the contestant that they think is most likely to win, instead of the most beautiful entrant (see Keynes, 1936). In the same vein, an exchange rate could stay misaligned because of bandwagon effects or collective action problems (see Ramaswamy and Samiei, 2000, and Sarno and Taylor, 2001.) Under such circumstances, even if most traders felt that the current level

of an exchange rate was inappropriate, no one would be willing to be first to buy or sell the currency. No one would want to make the first move in a game theoretic common knowledge setting. The behavior of each trader in this setting would be individually rational, and the misalignment of the exchange rate could persist. Sterilized intervention might provide an exit from this misalignment by offering an opportunity for traders to coordinate toward the "correct" equilibrium rate. This realignment could occur if central bank intervention provided a new focal point for the correct exchange rate—a variant of the signaling channel—or if intervention, particularly repeated intervention, reduced traders' perceived risks in making the first move away from the current equilibrium.

Another potential channel of intervention effectiveness at very short horizons is simple through the immediate impact of the order flow on price. Lyons (2001) discusses this channel in the context of secret intervention operations, where market makers treat the appearance of order flow from a central bank as they would any other sizable order. They see the order flow as potentially revealing private information held by other counterparties. More generally, they can regard order flow as a reflection of changing parameters among other market participants, such as a shift in the market's attitude toward risk. Either way observing the order flow will lead the market makers to adjust their prices.

Whether secret or not, a sizeable central bank intervention would probably affect the exchange rate, at least temporarily, even if market makers did not believe that it revealed private information or changing market parameters. Market makers adjust their prices to protect themselves against the risk of holding a sizeable position for a period of time. As an intervention pushes the inventory position of market makers further and

further away from neutrality, the compensation that they require grows, and the exchange rate movement increases. Because of this inventory effect, central bank interventions that are large enough, all other things equal, should result in an almost mechanical adjustment in exchange rates, at least temporarily. The size of this adjustment depends on the market's liquidity.

Being able to move the exchange rate temporarily by such "brute force" may have more permanent effects. One possibility is that, absent a commonly perceived equilibrium exchange rate, market participants may view the new level of the exchange rate as a starting point for a random walk. Moreover, pushing the exchange rate even temporarily beyond a certain level may force a number of market participants to liquidate losing positions, reinforcing the central bank's actions. (see Osler, 2003)

3. Japanese Intervention

According to official Ministry of Finance data, Japan undertook frequent and massive foreign-exchange-market interventions during the 1990s, usually in a manner consistent with promoting a yen depreciation or limiting a yen appreciation (figure 1). Between May 13, 1991, and December 31, 2002, Japanese monetary authorities intervened on 215 occasions against U.S. dollars; 85% of these transactions involved official purchases of dollars (see table 1). The intervention amounts ranged from a $25 million (equivalent) purchase of yen on August 11, 1992, to an extremely large $20.4 billion (equivalent) purchase of yen on April 10, 1998. The median amount of a Japanese intervention was $493 million, but the median dollar purchase ($504 million) was more than twice as large as the median dollar sales ($223 million). As table 1 indicates, the

Japanese operations were substantially greater than the corresponding U.S. interventions against yen over this period.

The Japanese transactions generally were not sporadic, but occurred in fairly persistent strings of activity punctuated with substantial periods of no action. Out of the 215 interventions, for example, Japan undertook 59 (only 27%) after a lag of at least 4 business days from the previous intervention. Often, as figure 1 indicates, the lag was very long. The other interventions occurred in closer proximity of each other.

On 22 occasions, the United States joined with Japan in a coordinated intervention effort. Unlike Japanese interventions, which occurred in clumps, the U.S. interventions were usually isolated events. Almost all of these coordinated efforts were yen sales.

Tables 2 and 3 present the same data as table 1, but for the two subperiods: March 19, 1991, to June 14, 1995, and June 15, 1995, to December 31, 2002 (see Ito, 2002). June 15, 1995, was the first intervention operation under Dr. Sakakibara, the new Director General of the MoF's International Finance Division. These two episodes differ in three important respects that appear to have some bearing on the success of the operations. First, interventions after June 15, 1995, were substantially larger than before that date. Second, although substantially larger in size, interventions in the second period occurred far less frequently (2.6% of the days) than in the first period (15.4% of the days). Third, the Japanese monetary authorities were less likely to undertake long strings of intervention in the second period. Out of the 50 interventions after June 15, 1995, 54% took place after a lag of at least 4 business days. Out of the 165 interventions before that date, only 19% followed a lag of at least 4 business days.

4. Success Criteria

We evaluate the success of Japanese interventions using four specific criteria and an aggregate criterion that incorporates the first four. We count the number of successes according to each criterion and evaluate them under the assumption that the success count is a hypergeometric random variable. The approach follows a test that Hendriksson and Merton (1981) and Merton (1981) developed to evaluate the performance of investment managers. Leahy (1995) applied this procedure to an analysis of U.S. profits from intervention, and Humpage (1999, 2000) used it to analyze the success of U.S. interventions.

The test assumes that Japanese monetary authorities do not directly affect underlying exchange-rate fundamentals when they intervene. Prior to March 18, 2001, the Bank of Japan conducted monetary policy with an overnight interest-rate target, a procedure that requires them to automatically sterilize any interventions that altered the supply of reserves in breach of the target. To be sure, monetary authorities could alter a target interest rate to achieve an exchange-rate objective, but then any accompanying interventions may be entirely superfluous.[1] After March 18, the Bank of Japan operated with a reserve (current-account) target, but the Bank continued to sterilize the Ministry of Finance's interventions in the sense of not allowing interventions to directly affect current-account balances.[2]

Although our methodology merely investigates the "randomness" of intervention successes, it provides a necessary condition by which to judge whether Japanese interventions might operate through a signaling, or expectations, channel. When a monetary authority takes an open position in a foreign currency, it has—like any

speculator—an expectation about the chances for an imminent changes in that currency. If the monetary authority's success rate is significantly higher than random, its intervention will have value as a forecast of near-term exchange-rate movements. Knowledge that the monetary authority is intervening will cause private traders to alter their prior estimates of the distribution of exchange-rate changes.

Testing the forecast value of private speculators involves a search for profitable trading strategies, but monetary authorities do not generally intervene for profit. The success criteria defined below offer reasonable alternatives. These definitions may not encompass all possibilities, but each is readily verifiable.[3] The Hendriksson and Merton (1981) test requires us to consider purchases and sales of foreign exchange separately.

4.1. Appreciate or depreciate the yen.

The first success criterion presumes that when a monetary authority buys or sells yen against dollars, they expect the yen to immediately appreciate or depreciate, as the case may be, against the U.S. dollar. Accordingly, the first success criterion for official sales of yen against dollars is:

1) $$W1s_t = \begin{cases} 1 \text{ if } I_t > 0, \text{and } \Delta S_t > 0, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

The corresponding criterion for official purchases of Japanese yen is:

2) $$W1b_t = \begin{cases} 1 \text{ if } I_t < 0, \text{and } \Delta S_t < 0, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

In these expressions, I_t refers to intervention of day t with positive and negative values indicating sales or purchases of Japanese yen, respectively. The exchange-rate change, ΔS_t, is measured as the difference between today's closing rate and yesterday's closing rate in the New York market. The exchange-rate change brackets each U.S. and

Japanese intervention, irrespective of whether they take place in the New York or Tokyo markets. Chang and Taylor (1998), Cheung and Chinn (2001), Dominguez (2003), among others, suggest that exchange markets respond to interventions within minutes or hours, not days.

4.2. Reversing the direction of the exchange-rate movement.

Our second and more stringent success criterion assumes that when monetary authorities intervene, they expect the yen to reverse its recent appreciation or depreciation. Accordingly, an intervention sale of Japanese yen is successful if:

3) $$W2s_t = \begin{cases} 1 \text{ if } I_t > 0, \text{and } \Delta S_t > 0, \text{and } \Delta S_{t-1} < 0, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

An intervention purchase of Japanese yen is successful if:

4) $$W2b_t = \begin{cases} 1 \text{ if } I_t < 0, \text{and } \Delta S_t < 0, \text{and } \Delta S_{t-1} > 0, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

4.3. Moderate exchange-rate movements

Empirical estimates of intervention reaction function typically report that monetary authorities attempt to smooth exchange-rate movements or lean against the wind (e.g., Edison 1993, Almekinders 1995). Our third success criterion is compatible with this evidence. We assume that monetary authorities take a position in the foreign-exchange market when they expect that a recent appreciation or depreciation has proceed too quickly, will subsequently slow, but will not reverse itself. Accordingly,

5) $$W3s_t = \begin{cases} 1 \text{ if } I_t > 0, \text{and } \Delta S_t > \Delta S_{t-1}, \text{and } \Delta S_t < 0, \text{and } \Delta S_{t-1} < 0, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

6) $$W3b_t = \begin{cases} 1 \text{ if } I_t < 0, \text{and } \Delta S_t < \Delta S_{t-1}, \text{and } \Delta S_t > 0, \text{and } \Delta S_{t-1} > 0, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

4.4. Accentuating exchange-rate movements

Our final individual success criterion assumes that the monetary authorities sell or purchase yen against dollars when they believe that a recent yen depreciation or appreciation, as the case may be, will proceed at a faster clip (leaning *with* the wind). Reflecting this criterion:

7) $$W4s_t = \begin{cases} 1 \text{ if } I_t > 0, \text{and } \Delta S_t > \Delta S_{t-1}, \text{and } \Delta S_{t-1} > 0, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

8) $$W4b_t = \begin{cases} 1 \text{ if } I_t < 0, \text{and } \Delta S_t < \Delta S_{t-1}, \text{and } \Delta S_{t-1} < 0, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

3.5. A general success criteria

The following general success criteria aggregates all of the previous criteria:

9) $$W5s_t = \begin{cases} 1 \text{ if } I_t > 0, \text{and } \Delta S_t > 0, \text{or } \Delta S_t > \Delta S_{t-1}, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

10) $$W5b_t = \begin{cases} 1 \text{ if } I_t < 0, \text{and } \Delta S_t < 0, \text{or } \Delta S_t < \Delta S_{t-1}, \text{and} \\ 0 \text{ otherwise.} \end{cases}$$

We will use these general success criteria primarily in sections 6.

A monetary authority, unlike a private speculator, hopes to influence the market by conveying any or all of these exchange-rate expectations to the private sector. Exchange markets, however, will regard the monetary authority as having positive forecast value only if their interventions are highly accurate predictors of these exchange-rate patterns.

5. Forecast Value

Given the martingale nature of exchange-rate changes, one would expect to observe a fairly high number of intervention successes merely by chance. To have

forecast value, the frequency with which a particular exchange-rate pattern coincides with interventions—a success—must significantly exceed the frequency with which it occurs irrespective of any interventions. If the yen appreciates against the dollar on 50 percent of the trading days, then one should not be surprise to find that 50 percent of all official dollar sales are associated with yen appreciations.

We evaluate the probability of observing a specific number of successes under the assumption that their occurrence is a hypergeometric random variable. The hypergeometric distribution does not require individual events to be independent and does not depend on the presumed probability of an individual success. Our null hypothesis states that the actual number of successes equals the expected number of successes. If the probability of observing a greater number of successes than we actually found is 5 percent or less, we reject the null hypothesis and conclude that Japanese monetary authorities have forecast value.[4]

Our results appear in table 4 (March 19, 1991, to December 31, 2002), table 5 (March 19, 1991, to June 14, 1995) and table 6 (June 15, 1995, to December 31, 2002). The first column of each table lists the success criteria for all Japanese interventions in the top half and for coordinated interventions in the bottom half. The second column presents a count of the total intervention by each monetary authority during the sample period. The Japanese bought dollars on 182 days and sold dollars on 33 occasions over the sample period. The United States sold yen on only 18 days and purchased yen on only 4 days in concert with Japan. Column 3 lists the number of interventions that were successful according to each of the specific criterion, while column 4 records those successes as a percentage of the total interventions. Of the 182 Japanese purchases of

dollars in the entire sample (table 4), for example, 87 or 47.8% were associated with a dollar appreciation against the yen.

The next two columns in table 4, 5, and 6 are labeled *virtual* successes and refer to exchange-rate movements independent of intervention. Column 5 records the number of times that the exchange rate moved in conformity with the corresponding success criterion whether or not intervention took place. Between March 19, 1991, and December 31, 2000, for example, the dollar appreciated on 1437 days, these include days with and without official interventions (see table 4). Column 6 expresses the data in column 5 as a percentage of the total observations in the relevant sample period. As one might expect, the dollar appreciated approximately one-half of the time.

The next three columns relate to the hypergeometric distribution. Columns 7 and 8 show the expected number of success and their standard deviation. The last column shows the probabilities associated with the observed number of success.

5.1. Table 4 (March 19, 1991, to December 31, 2002)

Three aspects of table 4 stand out: 1) Japanese interventions have positive forecast value with respect to signaling that the yen's recent appreciation or depreciation would moderate. 2) The frequent and large Japanese purchase of dollars had value as a forecast that a yen appreciation would reverse. 3) The count of successful coordinated intervention typically exceeds the expected number, but the p-value is usually large. We discuss each finding in turn.

Over our sample of 2971 business days, we would expect to randomly find 19 official yen sales out of 182 such transactions associated with moderating yen appreciations. Similarly, we would expect to randomly find 4 yen purchases out of 33

such transactions associated with moderating yen depreciations. Instead, the actual numbers of successes in both cases (30 and 8, respectively) are significantly greater than the anticipated amounts. Japanese intervention had value as a forecast that yen movements would moderate on the day of the intervention relative to their movements on the previous day.

We would randomly expect 46 of the 182 official Japanese sales of yen to be contemporaneously associated with a change from a yen appreciation to a yen depreciation. The actual number in our sample is 55, which is significantly greater than the anticipated amount. Under the corresponding criteria for yen purchases, the actual number of success (9) exceeds the expected number (8), but the difference is not statistically significant at the 95% confidence interval.

Because the number of coordinated interventions—18 yen sales and 4 yen purchases—in our sample is small, we are unable to derive strong inferences about the importance of joint activities. In all but one case, the p-value suggests rejecting the null hypothesis, but the actual number of successes almost always exceeds the expected number.

Similarly, over the entire sample, for both unilateral and coordinated interventions, the actual number of successes under the "general" success criteria always exceeds the expected number. The difference, however, is not great enough to reject the null hypothesis at the 95% confidence interval. (A similar finding holds for a few other criteria in the table.)

5.2. Table 5 (March 19, 1991, to June 14, 1995)

During our first subperiod, interventions were more frequent, relatively smaller, and more likely to proceed in long strings than after June 14, 1995. Before mid-1995, Japanese interventions—unilateral and coordinated—had value almost exclusively as a forecast that recent yen movements would moderate. The sole exception involved coordinate purchases on yen against the criterion of fostering a faster yen appreciation. Because of the small sample size, we are somewhat suspicious of any inference about concerted interventions. As in the full sample period, the actual number of successes exceeds the expected number is some other cases—including most of the general success criteria—but not by enough to reject the null hypothesis.

5.3. Table 6 (June 14, 1995, to December 31, 2002)

The results after June 14, 1995, are dramatically different than those for the first subperiod. The 44 Japanese interventions to purchase dollars, whether unilateral or coordinated—have forecast value with respect to all criteria except moderating movements. Of the 44 official Japanese purchase of dollars 33 are associated with a dollar appreciation, and of these 33, 22 are associated with a change in the direction of the yen's movement and 11 are associated with accentuating a yen appreciation. The confidence level associated with these findings exceeds 95% in all cases. The success of the 6 Japanese purchases of yen over this period is much more limited. They only have value as a forecast that a yen appreciation will continue.

During this second subperiod, Japan coordinated very few of its interventions with the United States, so it is difficult to make much of our results for coordinated interventions. This is particularly true for the single coordinate purchase of yen.

Nevertheless, the results are consistent with the general description of official Japanese interventions over this period.

6. Predicting Success

The frequencies presented in tables 4, 5, and 6 correspond to unconditional probabilities of success. In this section, we show that Japanese monetary authorities can increase their success rate by undertaking very large, infrequent interventions.

Because we do not know which of the individual success criteria (1 through 8) Japanese monetary authorities maintained at specific times over our sample period, we designed the general success criteria (9 and 10) to incorporate all of the others. The virtual success counts in table 4, suggest that random Japanese sales and purchases of yen should be successful in terms of the general criteria 61.5% and 60.8% of the time, respectively. Although the actual interventions show a slightly higher frequency of success in both cases—65.4% for yen sales and 69.7% for yen purchases—we cannot reject the null of no forecast value at a 95% confidence level in either case.

The techniques that Japan employs for specific interventions could increase the prospects for success. Large interventions, for example, might indicate a high degree of confidence among monetary authorities and may be more closely associated with success than small or medium sized transactions. Similarly, a coordinated intervention could imply that U.S. monetary authorities concur with Japan's outlook for the yen. If so, Japanese interventions undertaken in concert with the United States could demonstrate a higher frequency of success than unilateral interventions. Likewise, the first intervention in a consecutive series of transactions may be more closely associated with success than subsequent interventions. If monetary authorities do not realize their near-term

expectation about exchange rates on the day that they initially take a position in the market, their chances for success may not improve with subsequent interventions. Their initial failure may indicate that they are misreading market conditions.

Similarly, if monetary conditions change while Japan intervenes, the transactions may appear to be successful when, in fact, the exchange rate is adjusting to monetary policy. We, therefore, control for changes in the overnight call-money rate and the official Japanese discount rate.

We analyzed the ability of these influences, and others, to predict the likelihood of a successful intervention in probit regression models. As table 4 indicates, of the total 215 interventions, 142 were successful under the general success criteria, and the remaining 73 were unsuccessful. The bivariate independent variable in the probit regressions equals 1 if an intervention is successful under the general success criteria and 0 otherwise. The dependent variables are:

a) a dummy variable that takes a value of one after June 15, 1995 (SAMPLE2);
b) the absolute-value amount of an intervention in billions of yen;
c) a dummy variable that equals one if a Japanese intervention is coordinated with the United States;
d) a dummy variable that equals one when intervention occurs after a hiatus of at least four business days;
e) the percentage-point change in the overnight call-money interest rate;
f) the percentage point change in the official Japanese discount rate, and
g) a dummy variable for the first business day in a week.

We configured the changes in the two interest rates to correspond with the direction of the interventions. For Japanese purchases (sales) of dollars, we enter either the percentage point decline (increase) in an interest rate or zero on the belief that only corresponding changes would contribute to success.

Table 7 presents the results of regressing the bivariate dependent variable for success on each of the dependent variables individually. T-statistics appear in parentheses under the relevant coefficient, and the likelihood-ratio tests for adding an individual regressor to the constant term appear in the last column of table 7. The 95% chi-square critical value for one degree of freedom is 3.84.

The results suggest—as did our comparison of tables 5 and 6—that interventions after June 14, 1995, were highly successful (SAMPLE2). Beyond that, however, the probit regressions suggest that only two variables significantly influence the probability of success—the amount of intervention and whether the intervention occurred first in a sequence of transactions. The other variables were not statistically significant.

To estimate the probability of success, we combined the amount-of-intervention term and the dummy for an initial intervention in a single probit regression, but these two dependent variables appeared to be collinear, yielding inefficient estimates. To break the collinearity, we split the amount of intervention into: (1) the amount of an initial intervention (A_f) and (2) the amount of a subsequent intervention (A_s). Once we made these adjustments, the SAMPLE2 dummy had no explanatory power, suggesting that this term is collinear with the A_f and A_s terms. Indeed, interventions after June 14, 1995, were larger and less frequent. We, therefore, dropped the SAMPLE2 dummy.

This experiment produced the following result:

11) $I = 0.227 + 0.004\ A_f + 0.001\ A_s$

(2.156) (2.234) (1.307)

where I is the unobservable probit and where t-statistics appear under the appropriate regressors. The likelihood ratio test for the significance A_f and A_s against just the constant is 17.63, which is significant at the 5% level. In table 8, we evaluated equation 11 at various values of A_f and, separately, at the median value of A_s to derive conditional probabilities of success. (Note, however, that the coefficient on *As* is insignificant, so strictly speaking the probability that a subsequent interventions will be successful is indistinguishable from zero.)

Table 8 shows that the probability of success increases with the amounts of an initial intervention (A_f). The median amount of an initial Japanese intervention was ¥58.0 billion, which is substantially larger than the overall median amount of a Japanese intervention (¥29 billion). An initial intervention at the median had only a 45.6% probability of success. This is substantially below the observed frequency of success under the general success criteria, 66% and substantially below the observed frequency of virtual successes under this same criterion, 61%. The largest 25% of the initial interventions centered around ¥429.0 billion. An initial intervention of this magnitude had a 96.3% probability of success. The smallest 25% of the initial interventions centered around ¥21.8 billion and had a 38.4% probability of success. The probit results suggest that to achieve a probability of success greater than either the observed or virtual success frequencies, Japanese monetary authorities had to undertake an initial intervention of approximately ¥160 billion. Over our sample period, 22 of the 59 initial Japanese interventions exceeded ¥160 billion.

7. Summary and Discussion

A change to fewer, but larger transactions after June 14, 1995, improved the effectiveness of official Japanese exchange-market interventions. Prior to June 15, 1995, Japanese interventions only had value as a forecast that the previous day's yen appreciation or depreciation would moderate during the current day. Over that time period, official Japanese purchases and sales of yen were not associated with yen appreciation or depreciation, even if the yen had done so on the day before the intervention. After June 14, 1995, official sales of yen had value as a forecast that the yen would appreciate, even if it had depreciated the day before the intervention. Official purchases of yen had a very low success rate, but there were only 6 such transactions after June 15, 1995.

Intervention in the second period was generally larger and less frequent than in the first period. Using probit regressions, we confirmed that large, initial interventions had a higher likelihood of being successful than small interventions occurring in persistent strings.

These findings are similar to those reported in Ito (2002), the first paper to use official Japanese data. His data set runs from 1991 through 2000. Ito conducts some similar success counts, but he does not undertake a statistical analysis of the counts. He also analyzes the data using regressions with GARCH error structures. Ito attributes the switch in effectiveness after June 1995 to a change in intervention tactics—larger, less frequent operations—following the appointment of Dr. Sakakibara as Director General of MoF's International Finance Bureau.

An earlier paper by Ramaswamy and Samiei (2002) uses information collected from the financial press to identify the timing of Japanese intervention operations from 1995 through 1999. In the context of an interest rate differential model of exchange-rate determination, they conclude that intervention operations conducted by Japan alone had a small but persistent impact about 50% of the time. Our overall success rate under the general criterion (66%) was somewhat higher, but these results are not strictly comparable.

Fatum and Hutchinson (2003) apply an event study to analyze the MoF's intervention data. They separate the intervention activity over the period into 43 intervention episodes and study exchange-rate movements in subsequent windows of up to 15 days after the end of each episode. They conclude that intervention operations over the period showed some effectiveness in altering the path of dollar-yen exchange rates.

These studies and others typically find that concerted actions increase the effectiveness of intervention. We typically found that coordinated interventions had a slightly higher than expected success rate. We hesitate to draw strong conclusions, however, because of the small number of coordinated interventions in our sample. Coordinated interventions, nevertheless, tended to be isolated events; they rarely occurred in strings. Moreover coordinated interventions were substantially larger that unilateral Japanese interventions. We show that large and isolated Japanese interventions generally have higher rates of success.

Endnotes

[1] See Bonser-Neal, et.al. (1998) and Humpage (1999).

[2] See Ito's (2002) discussion of sterilization in Japan.

[3] For a discussion of intervention strategies similar to our criteria, see Minutes of the Federal Open Market Committee, July 17, 1973, p. 19 and pp. 30–31.

[4] Official actions that are consistently wrong can also convey useful information to the market. Neely and Weller (1997) and LeBaron (1999) found that profitable technical trading rules often recommend trading against the Federal Reserve System's interventions.

Tables

TABLE 1: INTERVENTION STATISTICS AND COUNTS
Full Sample: March 19, 1991 to December 31, 2002; 2971 observations

	Count	Average	Median	St. Dev.	Max	Min
Japan interventions			(in billions of yen)			
Yen purchased, dollars sold	33	¥148	¥29	¥462	¥2620	¥3
Dollars purchased, yen sold	182	156	51	258	1406	5
Total (absolute value)	215	155	49	297	2620	3
No interventions	2756					
Japan interventions			(in millions of dollars)			
Yen purchased, dollars sold	33	$1,145	$223	$3,593	$20,366	$25
Dollars purchased, yen sold	182	1450	504	2302	13207	45
Total (absolute value)	215	1404	493	2534	20366	25
No interventions	2756					
U.S. interventions			(in millions of dollars)			
Yen purchased, dollars sold	4	$258	$75	$384	$833	$50
Dollars purchased, yen sold	18	408	372	188	800	165
Total	22	381	352	230	833	50
No interventions	2949					
Japan coordinated interventions			(in millions of dollars)			
Yen purchased, dollars sold	4	$610	$349	$762	$1,691	$51
Dollars purchased, yen sold	18	1102	657	1618	7426	160
Total	22	1013	622	1496	7426	51
No interventions	2949					
Combined interventions			(in millions of dollars)			
Yen purchased, dollars sold	4	$868	$424	$1,129	$2,524	$101
Dollars purchased, yen sold	18	1510	1051	1675	7926	325
Total	22	1393	1002	1587	7926	101
No interventions	2949					

NOTE: The first Japanese intervention in our data occurs on May 13, 1991 .
NOTE: All U.S. interventions were coordinated.

TABLE 2: INTERVENTION STATISTICS AND COUNTS
Subperiod: March 19, 1991 to June 14, 1995; 1069 observations

	Count	Average	Median	St. Dev.	Max	Min
Japan interventions			(in billions of yen)			
Yen purchased, dollars sold	27	¥29	¥21	¥20	¥77	¥3
Dollars purchased, yen sold	138	51	39	45	339	5
Total (absolute value)	165	47	37	43	339	3
No interventions	904					
Japan interventions			(in millions of dollars)			
Yen purchased, dollars sold	27	$223	$151	$155	$598	$25
Dollars purchased, yen sold	138	514	388	490	3917	45
Total (absolute value)	165	467	350	465	3917	25
No interventions	904					
U.S. interventions			(in millions of dollars)			
Yen purchased, dollars sold	3	$67	$50	$29	$100	$50
Dollars purchased, yen sold	15	414	374	202	800	165
Total (absolute value)	18	356	335	227	800	50
No interventions	1051					
Japan coordinated interventions			(in millions of dollars)			
Yen purchased, dollars sold	3	$249	$99	$303	$598	$51
Dollars purchased, yen sold	15	750	645	384	1457	160
Total	18	666	552	412	1457	51
No interventions	1051					
Combined interventions			(in millions of dollars)			
Yen purchased, dollars sold	3	$316	$199	$292	$648	$101
Dollars purchased, yen sold	15	1164	1100	532	2207	325
Total	18	1023	926	591	2207	101
No interventions	1051					

NOTE: The first Japanese intervention in our data occurs on May 13, 1991 .
NOTE: All U.S. interventions were coordinated.

TABLE 3: INTERVENTION STATISTICS AND COUNTS
Subperiod: June 15, 1995 to December 31, 2002; 1902 observations

	Count	Average	Median	St. Dev.	Max	Min
Japan interventions			(in billions of yen)			
Yen purchased, dollars sold	6	¥684	¥256	¥972	¥2620	¥76
Dollars purchased, yen sold	44	488	434	353	1406	43
Total (absolute value)	50	512	420	297	2620	43
No interventions	1852					
Japan interventions			(in millions of dollars)			
Yen purchased, dollars sold	6	$5,296	$1,948	$7,567	$20,366	$595
Dollars purchased, yen sold	44	4386	4004	3147	13207	498
Total (absolute value)	50	4495	3794	3824	20366	498
No interventions	1852					
U.S. interventions			(in millions of dollars)			
Yen purchased, dollars sold	1	$833	$833	$0	$833	$833
Dollars purchased, yen sold	3	378	333	107	500	300
Total (absolute value)	4	492	417	244	833	300
No interventions	1898					
Japan coordinated interventions			(in millions of dollars)			
Yen purchased, dollars sold	1	$1,691	$1,691	$0	$1,691	$1,691
Dollars purchased, yen sold	3	2864	668	3952	7426	498
Total	4	2571	622	3280	7426	498
No interventions	1898					
Combined interventions			(in millions of dollars)			
Yen purchased, dollars sold	1	$2,524	$2,524	$0	$2,524	$2,524
Dollars purchased, yen sold	3	3242	1001	4058	7926	798
Total	4	3062	1762	3333	7926	798
No interventions	1898					

NOTE: All U.S. interventions were coordinated.

TABLE 4: THE LIKELIHOOD OF SUCCESS

March 19, 1991 to December 31, 2002; 2971 observations

	Interventions			Virtual		Expected	Standard	P-Value
	Total	Successes		Successes		Successes	Deviation	1-CDF
	#	#	%	#	%	#	#	
Japan								
Appreciation / Depreciation								
Dollars purchased, yen sold	182	87	47.8	1437	48.4	88.0	6.5	0.532
Yen purchased, dollars sold	33	15	45.5	1492	50.2	16.6	2.9	0.646
Change Direction								
Dollars purchased, yen sold	182	55	30.2	749	25.2	45.9	5.7	0.047
Yen purchased, dollars sold	33	9	27.3	757	25.5	8.4	2.5	0.321
Moderate movements								
Dollars purchased, yen sold	182	30	16.5	307	10.3	18.8	4.0	0.003
Yen purchased, dollars sold	33	8	24.2	364	12.3	4.0	1.9	0.015
Accentuate movements								
Dollars purchased, yen sold	182	20	11.0	351	11.8	21.5	4.2	0.584
Yen purchased, dollars sold	33	6	18.2	354	11.9	3.9	1.9	0.089
General success								
Dollars purchased, yen sold	182	119	65.4	1822	61.3	111.6	6.4	0.107
Yen purchased, dollars sold	33	23	69.7	1817	61.2	20.2	2.8	0.115
COORDINATED with USA								
Appreciation / Depreciation								
Dollars purchased, yen sold	18	10	55.6	1437	48.4	8.7	2.1	0.198
Yen purchased, dollars sold	4	2	50.0	1492	50.2	2.0	1.0	0.316
Change Direction								
Dollars purchased, yen sold	18	6	33.3	749	25.2	4.5	1.8	0.143
Yen purchased, dollars sold	4	0	0.0	757	25.5	1.0	0.9	0.692
Moderate movements								
Dollars purchased, yen sold	18	3	16.7	307	10.3	1.9	1.3	0.107
Yen purchased, dollars sold	4	1	25.0	364	12.3	0.5	0.7	0.076
Accentuate movements								
Dollars purchased, yen sold	18	3	16.7	351	11.8	2.1	1.4	0.155
Yen purchased, dollars sold	4	2	50.0	354	11.9	0.5	0.6	0.006
General success								
Dollars purchased, yen sold	18	13	72.2	1822	61.3	11.0	2.1	0.114
Yen purchased, dollars sold	4	3	75.0	1817	61.2	2.4	1.0	0.140

TABLE 5: THE LIKELIHOOD OF SUCCESS

March 19, 1991 to June 14, 1995; 1069 observations

	Interventions			Virtual		Expected	Standard	P-Value
	Total	Successes		Successes		Successes	Deviation	1-CDF
	#	#	%	#	%	#	#	
Japan								
Appreciation / Depreciation								
Dollars purchased, yen sold	138	54	39.1	512	47.9	66.1	5.5	0.983
Yen purchased, dollars sold	27	12	44.4	539	50.4	13.6	2.6	0.668
Change Direction								
Dollars purchased, yen sold	138	33	23.9	274	25.6	35.4	4.8	0.648
Yen purchased, dollars sold	27	8	29.6	277	25.9	7.0	2.2	0.246
Moderate movements								
Dollars purchased, yen sold	138	26	18.8	121	11.3	15.6	3.5	0.002
Yen purchased, dollars sold	27	7	25.9	111	10.4	2.8	1.6	0.004
Accentuate movements								
Dollars purchased, yen sold	138	9	6.5	117	10.9	15.1	3.4	0.955
Yen purchased, dollars sold	27	4	14.8	131	12.3	3.3	1.7	0.228
General success								
Dollars purchased, yen sold	138	82	59.4	643	60.1	83.0	5.4	0.539
Yen purchased, dollars sold	27	19	70.4	656	61.4	16.6	2.5	0.119
COORDINATED with USA								
Appreciation / Depreciation								
Dollars purchased, yen sold	15	7	46.7	512	47.9	7.2	1.9	0.434
Yen purchased, dollars sold	3	1	33.3	539	50.4	1.5	0.9	0.506
Change Direction								
Dollars purchased, yen sold	15	4	26.7	274	25.6	3.8	1.7	0.334
Yen purchased, dollars sold	3	0	0.0	277	25.9	0.8	0.8	0.594
Moderate movements								
Dollars purchased, yen sold	15	3	20.0	121	11.3	1.7	1.2	0.079
Yen purchased, dollars sold	3	1	33.3	111	10.4	0.3	0.5	0.030
Accentuate movements								
Dollars purchased, yen sold	15	2	13.3	117	10.9	1.6	1.2	0.221
Yen purchased, dollars sold	3	1	33.3	131	12.3	0.4	0.6	0.041
General success								
Dollars purchased, yen sold	15	10	66.7	643	60.1	9.0	1.9	0.219
Yen purchased, dollars sold	3	2	66.7	656	61.4	1.8	0.8	0.231

TABLE 6: THE LIKELIHOOD OF SUCCESS

June 15, 1995 to December 31, 2002; 1902 observations

	Interventions			Virtual		Expected	Standard	P-Value
	Total	Successes		Successes		Successes	Deviation	1-CDF
	#	#	%	#	%	#	#	
Japan								
Appreciation / Depreciation								
Dollars purchased, yen sold	44	33	75.0	980	51.5	22.7	3.3	0.000
Yen purchased, dollars sold	6	3	50.0	898	47.2	2.8	1.2	0.293
Change Direction								
Dollars purchased, yen sold	44	22	50.0	475	25.0	11.0	2.8	0.000
Yen purchased, dollars sold	6	1	16.7	480	25.2	1.5	1.1	0.472
Moderate movements								
Dollars purchased, yen sold	44	4	9.1	186	9.8	4.3	1.9	0.434
Yen purchased, dollars sold	6	1	16.7	253	13.3	0.8	0.8	0.184
Accentuate movements								
Dollars purchased, yen sold	44	11	25.0	234	12.3	5.4	2.2	0.005
Yen purchased, dollars sold	6	2	33.3	223	11.7	0.7	0.8	0.024
General success								
Dollars purchased, yen sold	44	37	84.1	1179	62.0	27.3	3.2	0.000
Yen purchased, dollars sold	6	4	66.7	1161	61.0	3.7	1.2	0.249
COORDINATED with USA								
Appreciation / Depreciation								
Dollars purchased, yen sold	3	3	100.0	980	51.5	1.5	0.9	0.000
Yen purchased, dollars sold	1	1	100.0	898	47.2	0.5	0.5	0.000
Change Direction								
Dollars purchased, yen sold	3	2	66.7	475	25.0	0.7	0.7	0.016
Yen purchased, dollars sold	1	0	0.0	480	25.2	0.3	0.4	0.252
Moderate movements								
Dollars purchased, yen sold	3	0	0.0	186	9.8	0.3	0.5	0.266
Yen purchased, dollars sold	1	0	0.0	253	13.3	0.1	0.3	0.133
Accentuate movements								
Dollars purchased, yen sold	3	1	33.3	234	12.3	0.4	0.6	0.042
Yen purchased, dollars sold	1	1	100.0	223	11.7	0.1	0.3	0.000
General success								
Dollars purchased, yen sold	3	3	100.0	1179	62.0	1.9	0.8	0.000
Yen purchased, dollars sold	1	1	100.0	1161	61.0	0.6	0.5	0.000

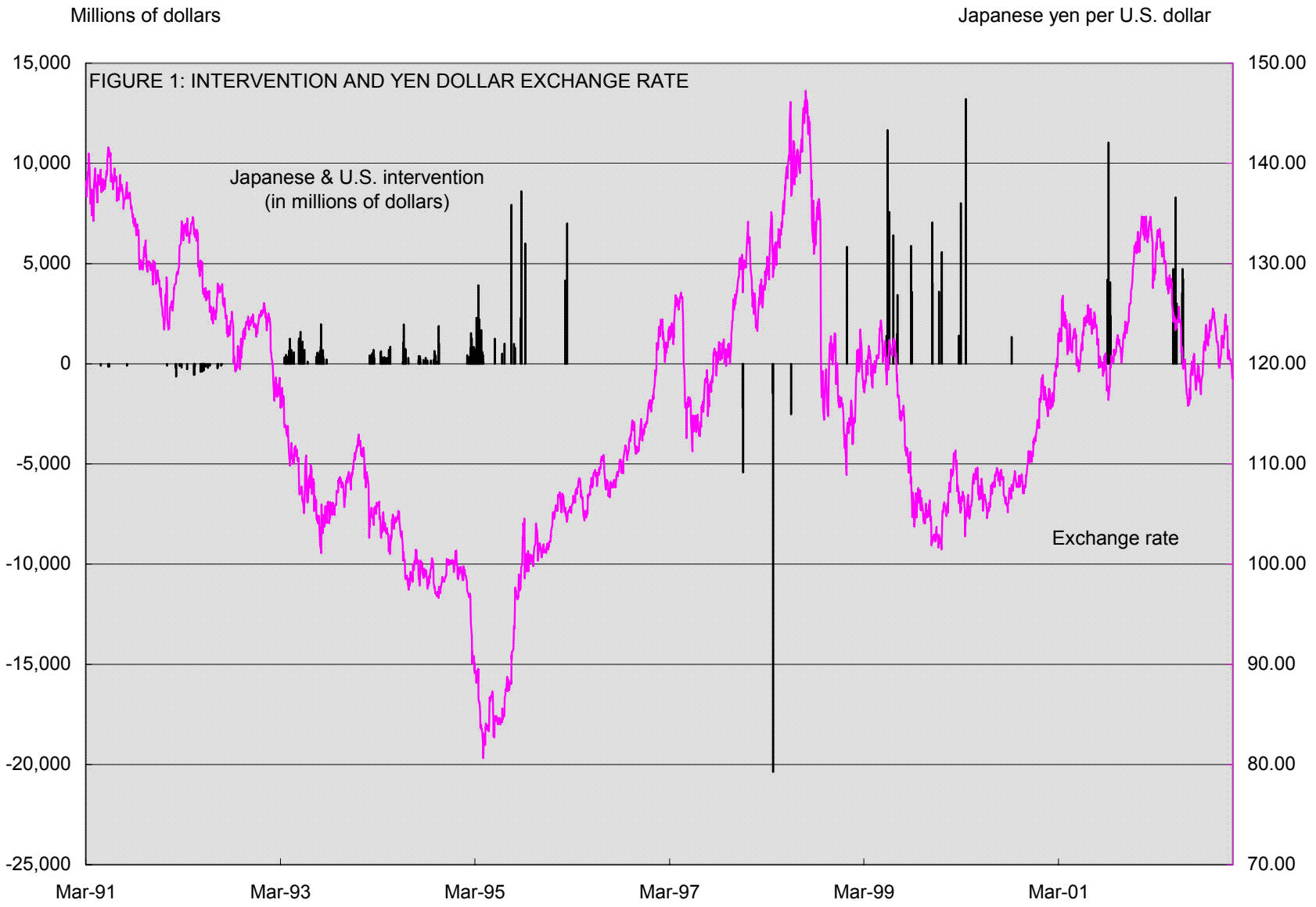
Table 7: Individual Factors in Probit Regressions

DEPENDENT VARIABLES	Constant t-Statistic	Coefficient t-Statistic	Log Likelihood	Likelihood Ratio Test
Constant only	**0.414**		-137.76	
	4.692			
SAMPLE2 (dummy)	**0.285**	**0.631**	-133.75	8.00
	2.877	2.747		
Amount of intervention (abs.value)	**0.229**	**0.002**	-132.28	10.94
	2.163	2.699		
Coordinated with USA (dummy)	**0.393**	**0.212**	-137.50	0.50
	4.236	0.704		
First intervention in a series (dummy)	**0.293**	**0.478**	-135.05	5.41
	2.878	2.289		
Call-money rate change (perc.points)	**0.442**	**2.051**	-136.88	1.74
	4.855	1.295		
Discount rate change (perc.points)	**0.420**	**0.859**	-137.57	0.38
	4.728	0.605		
First busines day (dummy)	**0.393**	**0.096**	-137.65	0.20
	3.936	0.450		

Note: Official interest rate increases (decreases) correspond to official yen purchases (sales).
Chi-Square critical value for 95% confidence level with 1 degree of freedom in 3.84.

TABLE 8: CONDITIONAL PROBABILITIES OF SUCCESS

First Interventions Amounts:	**Probability**
Y 21.8 billion (lower 25%)	0.384
Y 57.9 billion (median)	0.456
Y 429.0 billion (upper 25%)	0.963
Subsequent Interventions:	0.357
Unconditional Probability of a General Success:	0.660
Virtual Successe (perc. of total):	0.613


Millions of dollars
Japanese yen per U.S. dollar
FIGURE 1: INTERVENTION AND YEN DOLLAR EXCHANGE RATE
Japanese & U.S. intervention
(in millions of dollars)
Exchange rate
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00
70.00
Mar-91
Mar-93
Mar-95
Mar-97
Mar-99
Mar-01

References

Almekinders, G. J. 1995. *Foreign exchange intervention: theory and evidence*. Elgar, Brookfield, Vt.

Baillie, R. T., Humpage, O.F., Osterberg W.P., 2000. Intervention from an information perspective. *Journal of International Financial Markets, Institutions, and Money* 10, 407-422.

Bonser-Neal, C., Roley, V. V., Sellon, G. H. Jr., 1998. Monetary policy actions, intervention, and exchange rates: a reexamination of the empirical relationships using federal funds rate target data. *Journal of Business*, 71 2 147-177.

Chang, Y., Taylor, S. J., 1998. Intraday effects of foreign exchange interventions by the Bank of Japan. *Journal of International Money and Finance* 17, 191-210.

Cheung, Y. Chinn, M.D., 2001. Currency traders and exchange rate dynamics: a survey of the US market. *Journal of International Money and Finance* 20, 439-471.

Dominguez, K., 2003. The market microstructure of central bank intervention. *Journal of International Economics* 59, 25-45.

Dominguez, K., Frankel, J., 1993. Does foreign exchange intervention matter? The portfolio effect. *American Economic Review* 83, 1356-1369.

Edison, H. 1993. The effectiveness of central bank intervention: a survey of the literature after 1982. Princeton University, Special Papers in International Economics, No. 18.

Fatum, R., Hutchison, M. M., 2003. Effectiveness of official daily foreign-exchange-market intervention operations in Japan. NBER Working Paper 9648.

Henriksson, R. D., Merton, R.C., 1981. On market timing and investment performance. II. statistical procedures for evaluating forecasting skills. *Journal of Business* 54, 513-533.

Humpage, O.F. 2000. The United States as an informed foreign-exchange speculator. *Journal of International Financial Markets, Institutions, and Money* 10, 287-302.

Humpage, O.F. 1999. U.S. intervention: assessing the probability of success. *Journal of Money, Credit, and Banking* 31, 731-747.

Ito, T., 2002. Is foreign exchange intervention effective?: the japanese experiences in the 1990s. NBER Working Paper 8914.

Keynes, J.M., 1936. The general theory of interest, employment and money. London: Macmillan.

Leahy, M. P., 1995. The profitability of US intervention in the foreign exchange markets. *Journal of International Money and Finance* 14, 823-844.

LeBaron, B., 1999. Technical trading rule profitability and foreign exchange intervention. *Journal of International Economics* 49, 125- 143.

Lyons, R. K., 2001. *The microstructure approach to exchange rates*. Cambridge, MA: The MIT Press.

Merton, R. C., 1981. On market timing and investment performance. I. an equilibrium theory of value for market forecasts. *Journal of Business* 54, 363-406.

Minutes of the Federal Open Market Committee. July 17, 1973.

Neely, C., and Weller, P., 1997. Technical analysis and central bank intervention. Federal Reserve Bank of St. Louis Working Paper 97-002A.

Osler, C., 2003. Currency orders and exchange rate dynamics: an explanation for the predictive success of technical analysis. *Journal of Finance*, October.

Ramaswamy, R., Samiei, H., 2000 The yen-dollar rate: have interventions mattered? IMF Working Paper 00/95.

Sarno, L., Taylor, M., 2001. Official intervention in the foreign-exchange market: is it effective and, if so, how does it work? *Journal of Economic Literature* 39, 839-868.

Federal Reserve Bank
of Cleveland
Research Department
P.O. Box 6387
Cleveland, OH 44101

Address Correction Requested:
Please send corrected mailing label to the
Federal Reserve Bank of Cleveland
Research Department
P.O. Box 6387
Cleveland, OH 44101

PRST STD
U.S. Postage Paid
Cleveland, OH
Permit No. 385