Board of Governors of the Federal Reserve System

International Finance Discussion Papers
Number 824
January 2005

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Abstract: We analyze the short-term price impact of Japanese foreign exchange intervention operations between 1991 and 2004, using official data from Japan's Ministry of Finance. Over the period as a whole, we find some evidence of a modest "against the wind" effect, but interventions do not have value as a forecast that the exchange rate will move in a direction consistent with the operations. Interventions conducted between 1995 and 2002, which were large and infrequent, met with a much higher degree of success. For the most recent episode of intervention, in 2003 and 2004, despite the record size and frequency of the overall episode, it is difficult to statistically distinguish the pattern of exchange rate movements on intervention days from that of all the days in that particular subperiod, showing little effectiveness. Still, while the evidence of Japanese intervention effectiveness is modest overall, it appears to be stronger than that found using similar techniques for U.S. intervention operations conducted in the 1980s and 1990s.

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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. In the latest episode of intervention, for instance, from January 2003 to March 2004, the MoF intervened on 126 days, purchasing a total of about $315 billion. The record size and frequency of Japan's operations over the past few years afford researchers the opportunity to reexamine the effectiveness of intervention operations under the current structure of foreign exchange markets.

Using official MoF data at daily frequency, this paper analyzes the short-term effectiveness of Japanese foreign exchange intervention operations in the dollar-yen spot market from April 1991 through March 2004. Generally speaking, we study whether intervention operations are associated with very specific changes in the distribution of daily exchange rate movements. We first define several "success" criteria of varying stringency, each consisting of a pattern of exchange-rate movements that the monetary authority may wish to attain. Next, following techniques first proposed by Henriksson and Merton (1981) and Merton (1981) to evaluate the performance of market forecasters, we study whether the observed frequency of each type of intervention success exceeds the frequency that would randomly occur in the sample of exchange rate movements under study. In other words, to use the language of Henriksson and Merton (1981), we examine whether intervention operations have "forecast value" for the dollar-yen exchange rate. Finally we assess whether the probability of success depends on specific aspects of the intervention operations,

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including, among others, their size, their frequency, whether Japan coordinated the operations with the United States and whether the market anticipated the interventions. Although our approach is not an investigation of any particular theoretical means through which intervention might operate, the analysis is compatible with an expectations (or signaling) channel.

We show that, over our sample as a whole, MoF interventions did not have value as a forecast that the exchange rate would move in the direction consistent with intervention operations. However, even though the presence of intervention was therefore a poor predictor of the direction of exchange rate movements, we also find that it was associated with an higher-than-expected frequency of moderation in the magnitude of exchange rate movements. Dollar purchases also had a higher-than-expected frequency of changes in the direction of daily exchange rate movements. This evidence is generally consistent with a modest "against-the-wind" effect of Japanese intervention over the 1991-2004 period.

Our study also shows that the nature of the forecast value varied within the sample period, pointing to different levels of intervention effectiveness for different intervention strategies. Between June 15, 1995 and December 31, 2002, for instance, a period of large and infrequent interventions, MoF purchases of dollars had value as a forecast that the dollar would appreciate, whether or not it had depreciated on the previous day. For the most recent intervention episode, in 2003 and 2004, we find that, despite the record size and frequency of the overall episode, it is difficult to statistically distinguish the pattern of exchange rate movements on intervention days from that of the period as a whole. Finally, we demonstrate that, over our entire sample, the probability of an intervention scoring a success—defined as either moving the exchange rate in the desired direction or, if not, at least moderating the

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exchange rate movement—increases when the operation is large. Intervention operations coordinated with that of U.S. monetary authorities did meet with that particular definition of success with a higher frequency than those of the MoF alone over the period, but not high enough, given the relatively small number of joint operations, to allow us to derive strong statistical conclusions about their effectiveness.

The paper proceeds as follows. After this introduction, section 2 discusses possible theoretical connections between official intervention and exchange rate movements, including some newer, less traditional, concepts. Section 3 briefly reviews some of the recent empirical literature on Japanese intervention. Section 4 introduces the data on Japanese intervention since 1991, including an important breakdown into three periods, based on clear differences in intervention strategy. Section 5 presents our five criteria for assessing the success of individual intervention operations. Section 6 discusses the testing of MoF intervention effectiveness under the assumption that individual successes are hypergeometric random variables; results are presented for the whole sample and for each subperiod. Section 7 presents probit regressions that show how various characteristics of an intervention influence the probability of success. Here we also consider whether or not the market may have anticipated a specific intervention. Section 8 summarizes and concludes.

2. Theoretical Channels of Intervention Effectiveness

The traditional theoretical approach to the effectiveness of sterilized intervention has focused on two avenues of influence, the portfolio-balance channel and the expectations (or signaling) channel. The portfolio-balance channel builds upon the assumption that investors may view assets denominated in different currencies as imperfect substitutes. As an

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intervention operation changes the currency composition of the pool of assets available to private investors, an exchange rate movement may be required to induce them to hold that pool. Empirical evidence in favor of a portfolio-balance channel has generally been found to be weak, although Dominguez and Frankel (1993) is a notable exception. The unprecedented size of recent Japanese intervention operations, may, however, warrant a new look. The expectations channel, in contrast, has received a bit more support in past studies. According to the expectations channel, monetary authorities can use sterilized foreign exchange intervention to transmit private information to the market, thereby affecting the market participants' assessment of the equilibrium rate of exchange (see Baillie, Humpage, Osterberg, 2000).

New theoretical channels of influence for sterilized foreign exchange intervention have recently been proposed. One is related to the idea of the well-known Keynesian beauty contest, in which individuals vote on the contestant that they think is most likely to attract the most votes from other judges, instead of the contestant that they view as most beautiful (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. The behavior of each trader in this setting would be individually rational, and the misalignment of the exchange rate could persist. Sterilized intervention could provide departure from this misalignment by offering an opportunity for traders to coordinate toward the "correct" equilibrium rate. This realignment may occur if central bank intervention provided a new focal point for the correct exchange rate—perhaps a variant of the signaling

channel—or if intervention, particularly repeated intervention, reduced the risks perceived by traders in making the first move away from the current equilibrium.

Another potential channel of intervention effectiveness at very short horizons is simply through the immediate impact of the order flow on price. Lyons (2001) discusses this channel in the context of secret intervention operations. In this context, market makers treat the appearance of such order flow from a central bank as they would any other sizable order, with the order flow potentially revealing private information held by their counterparties or changes in parameters dispersed among market participants, such as the market's attitude toward risk. Observing the order flow induces the market makers to adjust their prices, leading to short term intervention effectiveness. Dominguez (2005) discusses how, in this order flow framework, trader heterogeneity and the lack of common knowledge may magnify the impact of foreign exchange interventions.

Whether secret or not, a sizeable central bank intervention would likely affect the exchange rate, at least in the very short run, even if market makers did not believe that it revealed private information or that it reflected 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, almost by definition, would depend on the market's liquidity at the time of the operations. It is very likely that at least some of the intervention operations conducted by Japanese authorities over our sample period,

particularly after June 1995, were of sufficient size to have temporarily affected the exchange rate in such a way. Being able to move the exchange rate temporarily by such "brute force" could then have more permanent effects. One possibility is that, absent a commonly perceived equilibrium exchange rate, market participants would view the new level of the exchange rate as a starting point for a new random walk. Moreover, pushing the exchange rate even temporarily beyond a certain level may lead a number of market participants to liquidate losing positions, reinforcing the central bank's action (see Osler, 2003).[1]

3. Some Recent Empirical Literature on Japanese Intervention

The recent release by Japanese authorities of historical data on foreign exchange intervention has allowed researchers to begin to study what has clearly been the most active intervention policy among industrial nations in the past decade. After many years of complete confidentiality, the MoF released to the public in July 2001 historical data, with currency pair details, at a daily frequency going back to April 1991. In addition, the MoF now releases cumulative monthly intervention totals (in yen) at the end of each month, and quarterly updates of daily intervention data about a month after the end of each quarter.

Takatoshi Ito, fresh from a high-level appointment at Japan's Ministry of Finance, was the first researcher to produce work using the newly released data. Ito (2003) provides a well-informed narrative of Japanese intervention operations from 1991 to 2001, noting changes in the strategy used by the MoF over the period. The paper then briefly uses several different

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[1] These are also reasons why the study of the short-term effects of intervention is important, even though the goal of monetary authorities in intervening is usually a longer-term effect. In any case, it is difficult to imagine a framework under which long-term intervention "effectiveness" could be achieved without any type of short term effect.

techniques to assess the success and the profitability of Japanese operations over the period. The author concludes that intervention operations conducted in the second half of the 1990s often appeared to produce the intended effect on the exchange rate. He also finds that, over the full sample period, the Japanese authorities made a large profit on their intervention operations, arising from both exchange rate movements and interest rate differentials. Ito and Yabu (2004) develop and estimate a complex intervention reaction function for the Japanese authorities; their specification includes a "political cost" which must be taken into account by the authorities when deciding whether or not to enter the market. They find that interventions often came in reaction to large exchange rate movements on the previous days, and that deviations from a long-term moving average also tended to lead to a decision to intervene.

Fatum and Hutchinson (2003) use an event study methodology to study the effectiveness of Japanese intervention over the period 1991-2000. They construct intervention episodes separated by periods of inaction of at least five days, and analyze exchange rate movements around these episodes. They conclude that evidence of short-term effectiveness is present, and that effectiveness is boosted by the size of the intervention episode and by coordination with the Federal Reserve.

Frenkel et. al. (2005) find a positive correlation between official Japanese intervention and implied volatility derived from options contracts on exchange-rate futures. Their finding that intervention increases exchange rate volatility is similar to investigations of dollar-yen volatility that relied on news reports of Japanese intervention (see Bonser-Neal and Tanner 1996, Dominguez 1998). In a market characterized by information imperfections, increased volatility is often associated with the transmittal of new information; the Frenkel et. al (2005)

finding is therefore not necessarily incompatible with intervention having the desired effect on the level of the exchange rate.

Galati, Melick, and Micu (2005) use MoF intervention data from 1993 to 2000 to study the effect of intervention on the risk-neutral distribution of future exchange rates, as derived from option prices. They find no evidence that intervention systematically affected the mean or higher moments of the distribution of expected exchange rates one month ahead.

4. Japanese Intervention Operations since 1991: the Data

According to official Ministry of Finance data, Japan undertook frequent and, at times, massive foreign-exchange-market interventions between 1991 and early 2004, most of the time in a manner consistent with promoting a yen depreciation or limiting a yen appreciation. Between April 1, 1991 and March 31, 2004, Japanese monetary authorities intervened on 340 days against the U.S. dollar; about 90% of these transactions involved official purchases of dollars, that is Japanese authorities were more often attempting to counter or slow an appreciation of the yen (see table 1).[2] The intervention amounts ranged from less than $1 million (equivalent) purchase of dollars on November 21, 2003, to an extremely large $20.4 billion (equivalent) sale of dollars on April 10, 1998.[3] The median amount of a Japanese intervention (in absolute terms) was $695 million, but the median dollar purchase ($789 million) was more than three times as large as the median dollar sale ($223 million). On 22

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[2] Japan undertook eight interventions on U.S. holidays. We rolled these amounts forward to the next business day. In four of these instances, interventions also took place on the next business day, so we combined the intervention amounts.

[3] The Ministry of Finance data are in yen. We convert daily intervention amounts into dollars using exchange rate quotes taken at 5:00 p.m. New York time (source: Bloomberg).

occasions during our sample period, the United States joined Japan in a coordinated intervention effort.   Unlike Japanese interventions, which often occurred in fairly persistent strings of activity punctuated with substantial periods of inaction, the coordinated interventions were usually isolated events. A large majority of these coordinated efforts (82%) were dollar purchases.

Table 2 presents much of the same data as table 1, but for three subperiods that differ in the amount, frequency, and persistence of intervention, as well as in the degree of coordination with the United States. The chosen breaks in the sample also correspond to personnel changes at the top of the Ministry of Finance's International Bureau, which bears responsibility for intervention strategy within the MoF.

The first period, from April 1, 1991 to June 14, 1995 was characterized by frequent, persistent, and relatively small interventions. Japan intervened on 165 days over the period, with a median intervention size of $348 million. Eighteen of the 22 joint operations with the United States occurred during this early period.

Our second period, from June 15, 1995 to December 2002, marks a clear shift in strategy to large, infrequent interventions. Its beginning coincides with the appointment of Eisuke Sakakibara as Director General of the International Bureau (see Ito 2003). Between June 28, 1995 and the end of 2002, the MoF undertook only 49 interventions, including 4 jointly with U.S. authorities. With a median (absolute) size of $3,989 million, these operations were more than 10 times larger than in the first period. The unconditional probability of intervention in the second period was 2.6%, substantially below the 18.3% intervention frequency recorded in the first period. The mean lapse time between interventions (table 3) rose to 49 days from just 6 days in the first subperiod.

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MoF intervention operations during our final time period, January 1, 2003, through March 31, 2004, were exclusively unilateral purchases of dollars. The median amount of an intervention operation during this last period ($1,753 million) was less than one-half that of our second period, but still more than 4 times larger than in our first time period. The unconditional probability of intervention rose substantially, to 40.3%, and the mean lapse time fell to just 3 days. As a consequence, this period saw what is likely to have been, to date, the largest overall intervention episode by any monetary authority. The massive effort to prevent or slow yen appreciation resulted in a substantial increase in Japanese foreign reserves, to more than $800 billion.

The change of tactic at the beginning of 2003 coincided with the appointment of Hiroshi Watanabe as Director General of the MoF's International Bureau. Importantly, the MoF requested that the Bank of Japan, its agent, modify its usual mode of operation in order to make its operations more stealthy. According to press reports and to testimony by Japanese officials, the BoJ, instead of actively conducting foreign exchange trades as it had in most previous intervention periods, placed confidential standing orders with a limited number of dealing banks, who then entered the market under their own names to purchases dollars at agreed-upon levels. As a result, while intervention operations, according to MoF data, began in mid-January, there were no reports of possible MoF interventions in the financial press until February.

5. Success Criteria

We evaluate the success of each Japanese intervention operation using four specific criteria and an aggregate criterion that incorporates the first four.

5.1. *Appreciate or depreciate the yen.*

The first, and most common, success criterion tests whether, when the MoF buys or sells U.S. dollars, the dollar immediately appreciates or depreciates, respectively, against the yen. Accordingly, the first success criterion for official purchases of dollars against yen is:

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

The corresponding criterion for official sales of dollars is:

$$W1s_t = \begin{cases} 1 \text{ if } I_t < 0, \text{ and } \Delta S_t < 0, \text{ and} \\ 0 \text{ otherwise.} \end{cases} \tag{2}$$

In these expressions, I_t refers to intervention on day t with positive and negative values indicating purchases or sales of U.S dollars against 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, at the end of each trading day (the time of the change in value date) in foreign exchange markets. Thus, the exchange-rate movement brackets each U.S. and Japanese intervention, irrespective of whether it took place during Tokyo, London, or New York trading hours.

5.2. *Reversing the direction of the exchange-rate movement.*

Our second criterion, a subset of the first, is more stringent. It assumes that when the MoF intervenes, the yen reverses its recent appreciation or depreciation. Accordingly, an intervention purchase of dollars against Japanese yen is successful if:

$$W2b_t = \begin{cases} 1 \text{ if } I_t > 0, \text{ and } \Delta S_t > 0, \text{ and } \Delta S_{t-1} < 0, \text{ and} \\ 0 \text{ otherwise.} \end{cases} \tag{3}$$

An intervention sale of dollars against yen is successful if:

$$W2s_t = \begin{cases} 1 \text{ if } I_t < 0, \text{ and } \Delta S_t < 0, \text{ and } \Delta S_{t-1} > 0, \text{ and} \\ 0 \text{ otherwise.} \end{cases} \tag{4}$$

5.3. Accentuating exchange-rate movements

Our third criterion is also a subset of the first. It assumes that, when the MoF purchases or sells dollars against yen, the recent (yesterday's) dollar appreciation or depreciation, as the case may be, will proceed at a faster clip ("leaning with the wind"). Reflecting this criterion:

$$W3b_t = \begin{cases} 1 \text{ if } I_t > 0, \text{ and } \Delta S_t > \Delta S_{t-1}, \text{ and } \Delta S_{t-1} > 0, \text{ and} \\ 0 \text{ otherwise.} \end{cases} \tag{5}$$

$$W3s_t = \begin{cases} 1 \text{ if } I_t < 0, \text{ and } \Delta S_t < \Delta S_{t-1}, \text{ and } \Delta S_{t-1} < 0, \text{ and} \\ 0 \text{ otherwise.} \end{cases} \tag{6}$$

5.4. Moderating exchange-rate movements

Empirical estimates of intervention reaction functions often report that monetary authorities attempt to smooth exchange-rate movements, that is "lean against the wind" (see Edison 1993, Almekinders 1995). Our fourth success criterion is compatible with this evidence. It tests whether, when the MoF takes a position in the foreign-exchange market, today's appreciation or depreciation slows, but does not reverse itself. Accordingly,

$$W4b_t = \begin{cases} 1 \text{ if } I_t > 0, \text{ and } \Delta S_t > \Delta S_{t-1}, \text{ and } \Delta S_t \leq 0, \text{ and } \Delta S_{t-1} < 0, \text{ and} \\ 0 \text{ otherwise.} \end{cases} \tag{7}$$

$$W4s_t = \begin{cases} 1 \text{ if } I_t < 0, \text{ and } \Delta S_t < \Delta S_{t-1}, \text{ and } \Delta S_t \geq 0, \text{ and } \Delta S_{t-1} > 0, \text{ and} \\ 0 \text{ otherwise.} \end{cases} \tag{8}$$

The following general success criterion aggregates all of the previous criteria (in the sense that it represents the union of the previous criterion, and not their intersection). It tests whether, following a MoF intervention operation, the exchange rate moves in the desired direction, or, if not, at least slows its movement in the "wrong" direction.

$$W5b_t = \begin{cases} 1 \text{ if } I_t > 0, \text{and } \Delta S_t > 0, \text{or } \Delta S_t > \Delta S_{t-1}, \text{and} \\ 0 \text{ otherwise.} \end{cases} \tag{9}$$

$$W5s_t = \begin{cases} 1 \text{ if } I_t < 0, \text{and } \Delta S_t < 0, \text{or } \Delta S_t < \Delta S_{t-1}, \text{and} \\ 0 \text{ otherwise.} \end{cases} \tag{10}$$

We will use this general success criterion in section 6 to test, through probit regressions, how specific strategic factors appear to affect the probability of intervention success.

6. Testing for Forecast Value

Following the approach developed by Hendriksson and Merton (1981) and Merton (1981) to evaluate the performance of investment managers, we test whether knowledge of Ministry of Finance intervention has "forecast value" for foreign exchange market participants. Humpage (1999, 2000) used this technique to investigate the effectiveness of U.S. interventions, finding limited evidence of success. Exchange market participants will regard the monetary authority as having positive forecast value only if its interventions are accurate predictors, in a statistical sense, of certain patterns of exchange rate movements. If the monetary authority has forecast value, knowledge of its intervention operation may then cause market participants to alter their prior estimates of the expected distribution of exchange rate changes.

The test assumes that Japanese monetary authorities do not directly affect underlying exchange-rate fundamentals when they intervene. As discussed in Ito (2002), the fact that the reserves used in intervention operations belong to and accrue to the MoF and not to the Bank of Japan ensure that intervention operations are automatically fully sterilized in the long run. In any case, the Bank of Japan routinely acts, if needed, to prevent MoF interventions from altering even the short-run supply of yen reserves in breach of its monetary policy operating targets.[4]

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 an intervention—a success—must significantly exceed the frequency with which it occurs irrespective of interventions. If, for example, we knew that the dollar appreciated against the yen on 55 percent of all the trading days in our sample, then finding that 55 percent of all official dollar purchases were associated with dollar appreciations (a 55 percent frequency of success under our first criterion) would carry no forecast value.

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

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[4] Japanese intervention operations have therefore been sterilized under the standard (narrow) definition of sterilization. It is clear, however, that changes in the monetary policy stance of the BoJ occurred in the midst of some of the recent episodes of intervention, particularly in 2003. This led some analysts to call the most recent intervention episode "partially unsterilized," using a broader, less common, definition of sterilization. We test for the effects of monetary policy changes on intervention effectiveness in section 7.

presumed probability of an individual success. Our null hypothesis states that the actual number of successes equals the expected (unconditional) number of successes.

Our results appear in table 4, for the entire sample, and in tables 5 through 7, for each of our subperiods. The first column of each table lists the success criteria for unilateral MoF interventions in the top half and for coordinated interventions (if any) in the bottom half. The second column presents a count of the total interventions by each monetary authority during the sample period. For example, the second column of table 4 reports that the MoF bought dollars on 307 days and sold dollars on 33 days between April 1, 1991 and March 31, 2004. The United States sold yen on 18 days and purchased yen on 4 days in concert with Japan during the entire sample. Column 3 lists the number of interventions that were successful according to each of the specific criteria, while column 4 records those successes as a percentage of the total interventions. For example, of the 307 MoF purchases of dollars in the entire sample, 140, or 45.6%, were associated with a dollar appreciation against the yen. We therefore count these 140 as "successful" interventions under the first criterion.

The next two columns in tables 4 through 7, labeled *virtual successes*, refer to unconditional exchange-rate movements over the sample period. 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. As shown in table 4, between April 1, 1991 and March 31, 2004, the dollar appreciated on 1616 days, including days with and without official interventions. Column 6 expresses the data in column 5 as a percentage of the total observations in the relevant sample period. In our case, the dollar appreciated nearly half of the time over the whole sample; it was unchanged about 1 percent of the time.

The three rightmost columns relate to the hypergeometric distribution. Columns 7 and 8 show the expected number of successes under each criterion and its standard deviation given the particular sample size (either the whole sample or each of our three subperiods). Column 9 reports the *p*-value associated with rejecting the null hypothesis that the observed number of successes is equal to the expected number of successes. In other words, column 9 shows the p-value associated with a one sided test that, under a hypergeometric distribution based on the unconditional frequencies of each sample period, the conditional frequency of success exceeds the unconditional frequency of success.

6.1. The Whole Sample: April 1, 1991 to March 31, 2004 (Table 4)

Table 4 shows that, over the whole sample, the frequency with which, conditional on there being an intervention, the dollar moved in the direction consistent with each intervention operation (up for purchases or down for sales of dollars) was about 45%. Overall, on an unconditional basis, the dollar appreciated or depreciated almost 50% of the time. Therefore, MoF interventions clearly did not have forecast value with respect to signaling that the exchange rate would move in the direction of the intervention. However, of the 140 times when the dollar appreciated on the day of an official purchase of dollars, 92 of those came on a day following a depreciation of the dollar, a higher frequency of change in direction than would have been expected on an unconditional basis. With a p-value of about 0.02, MoF purchases, despite their lack of overall predictive power about the direction of exchange rate movements, therefore had forecast value that the frequency of a change in the direction of movements would exceed the unconditional frequency.

Interventions also had forecast value over our entire sample period that exchange rate movements, if they continued to move in a direction not consistent with an intervention

operation, would at least moderate, an "against the wind" effect. Over our sample of 3,268 business days, we would expect to find that 36.2 out of 307 official dollar purchases were associated with a moderating dollar depreciation. Similarly, we would expect randomly to find that 4.0 out of 33 dollar sales were associated with a moderating dollar appreciation. Instead, the actual numbers of successes (56 and 6, respectively) are significantly greater than the anticipated amounts, with p-values of 0.000 and 0.099, respectively. MoF intervention then had value as a forecast that dollar movements would moderate on the day of the intervention relative to their movements on the previous day.

As for our general success criterion (the exchange rate moving in a direction consistent with the intervention operation or, if not, a moderation in the exchange rate movement), we find that the criterion was met 196 times out of 307 intervention purchases of dollars. However, based on the unconditional frequency of success, we would have expected to find that pattern on 188 occasions, almost as many. Therefore, with a p-value of about 0.15, we cannot claim, within standard statistical significance levels, that MoF intervention operations had forecast value under our general success criterion.

For intervention operations coordinated with U.S. monetary authorities (18 purchases and 4 sales of dollars over the sample), we note that the frequency with which coordinated interventions were associated with exchange rate movements in a direction consistent with the operation (our first criterion) exceeds what a random draw would have predicted and what we found for interventions by the MoF alone. Also, out of 22 coordinated intervention operations, 17 meet our general success criterion, exceeding both the expected unconditional frequency and the frequency found for uncoordinated interventions. However, because Japan and the United States undertook coordinated interventions on only 22 days, the small sample

size does not permit us to draw strong statistical conclusions about the importance of coordination. Although we cannot proclaim that coordination has, strictly speaking, forecast value, we nevertheless interpret these results as offering tentative evidence that coordinated intervention was somewhat more effective that uncoordinated intervention.

6.2. April 1, 1991 to June 14, 1995 (Table 5)

As we have described, between April 1, 1991 and June 14, 1995, Japanese interventions were frequent, relatively small in size, and likely to proceed in long strings. During this first subperiod, MoF interventions, both purchases and sales of dollars, had value only as a forecast that the previous day's dollar movements would moderate. Out of 138 Japanese purchases of dollars, the pace of the previous day's dollar depreciation slowed, but did not reverse, on 28 occasions on the current day. This count was substantially greater than the expected 18.3, yielding a very small p-value from the relevant hypergeometric distribution. Similarly, of the 27 official dollar sales, 5 successfully predicted that the previous day's dollar appreciation would moderate over the current day, above the 2.8 successes that we would expect to occur randomly. However, relative to our first success criterion, the dollar-yen exchange rate moved in a direction consistent with the intervention operations with a lower frequency than that expected from a random draw. As for our general success criterion, it was met on intervention days with a frequency a bit lower or very close to that found in the subperiod as a whole.

The number of coordinated interventions over this period—15 dollar purchases and 3 dollar sales—is too small to draw firm statistical inferences about the value of joint interventions. We note, however, that the frequency of "general success" for coordinated interventions

exceeds what a random draw would have predicted, clearly better than for unilateral Japanese interventions.

6.3. June 15, 1995 to December 31, 2002 (Table 6)

The results for the second period, June 15, 1995 to December 31, 2002, when MoF intervention grew much larger but became far less frequent, were dramatically different than those for the first period. Of the 43 official MoF purchases of dollars—the dominant type of intervention—33 (76.7%) successfully "predicted" that the dollar would appreciate on the current day. We would have randomly expected only 22.3 such successes in our sample, yielding clear statistical significance, an obvious contrast to our first subperiod. Of these 33 successes, 22 were a reversal of the previous day's depreciation, a substantially greater count than the expected number (10.8). The frequency of success under our general success criterion (83.7 percent) is also well above that seen in the whole sample (62.1%), yielding a very small p-value. All in all, therefore, the MoF's intervention operations during this period appeared to be far more effective than those of our first subperiod and had clear forecast value of exchange rate movement in a direction consistent with the operation. The 4 instances of intervention coordinated with the USA met with success under our general criterion.

6.4. January 1, 2003 to March 31, 2004 (Table 7)

During the last 15 months of our study, the MoF conducted only purchases of dollar, none of which were coordinated with the United States. As described above, the operations remained large and their frequency and persistence increase substantially. For this last subperiod, however, we find that these interventions purchases of dollar generally did not have a high rate of success, based on any of our criteria. Only under our third success criterion (moderating movements) can we reasonably claim to have uncovered some forecast

value, with a p-value of about 0.08. Our general success criterion is fulfilled on 80 occasions out of 126 intervention operations, barely above the 77.3 expected on an unconditional basis. Based on this analysis, therefore, the most recent period of Japanese intervention, despite its unprecedented magnitude, does not appear to have met with a high level of success.

It is not unlikely, however, that the intervention strategy apparently followed by the Ministry of Finance for much of 2003 and 2004 may have rendered the detection of the impact of intervention more difficult. Market commentary reported at the time that the MoF appeared to have given instructions to buy dollars if the exchange rate declined to certain levels (with these levels varying over time). However, the MoF reportedly often did not appear to have instructed the dealers to attempt to move the exchange rate substantially up from those levels. As a result, the dollar-yen exchange rate, during periods of intervention, often seemed to remain very near a given floor and showed little net movement. Under these circumstances, assessing the impact of foreign exchange intervention without a good counterfactual model of exchange rate movements (which, of course, does not exist) would be particularly difficult.

7. Factors affecting Intervention Success

We now consider whether a number of contemporaneous factors influenced the probability of an intervention's outcome over our entire sample. As we cannot presume to know which of the success criteria was used by the MoF in judging the effectiveness of its own operations (and that choice likely changed over time), we use the general success criterion, the union of the other criteria discussed in section 4, to assess the success of each intervention operation. The probit regressions in section 7.2 are then based on the list of

"successes" and "failures" derived under this criterion. We start by testing whether unanticipated interventions are more successful under this general criterion than anticipated interventions. We then proceed to consider a number of other variables that might affect the flow of information or that control for other policy actions. We show that the size of an official transaction appears to significantly affect the probability of its success.

7.1. Expected Interventions

The effect of policy changes on financial variables often depends on whether or not market participants correctly anticipated the official actions. To see if unanticipated interventions had a higher frequency of success than anticipated interventions, we first used probit regression to calculate the day-to-day probability of an intervention's occurrence over the entire sample period (see Frenkel, et. al. 2005). We conditioned these probabilities on two variables. First, since interventions very often occur in strings of activity, we included lagged interventions into the regressions. Second, we included the difference between the actual yen-dollar exchange rate on the day prior to an intervention and the sample median (¥117.5). This allows us to proxy for most target ranges that the MoF might have adopted without guessing as to possible values (see Ito 2001 and Frenkel, et. al. 2005).

Table 8 contains our estimated probit regressions for intervention sales and purchases of dollars. T-statistics appear below the relevant coefficients. No more than two lags on the interventions were significant in either regression. Deviations from the median, lagged one day, were significant in both equations.

We use these fitted equations to calculate the probabilities of intervention for each day in the sample period. We then use the estimated probabilities in the regressions below to see if anticipated interventions had a different effect on the probability of success than

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unanticipated interventions, combining the results for dollar purchases and sales by creating a single dummy variable that equals one on any day for which the predicted probability of an intervention is greater than 50%.

7.2. The Likelihood of Success

How and when the MoF undertakes an intervention is likely to have some bearing on its ability to affect market expectations about near-term yen movements. Using probit regressions, we investigate the individual influence of sixteen variables on the likelihood of scoring a success according to our general criterion. We start by combining the success counts for official purchases and sales of dollars into a single bivariate independent variable containing 340 observations. Of these, 217, or 64%, were successful under the general success criterion, which is a bit higher than the unconditional frequency of success (61%) observed over the entire sample period (see table 4). We regress the bivariate success variable on the sixteen individual explanatory variables listed in the first column of table 9. The next two columns of table 9 present the estimated parameters from the probit regressions of the bivariate success variable on each of the individual explanatory variable. Corresponding t-statistics appear under each coefficient. The likelihood function and the likelihood ratio test statistic appear the final two columns of table 9.

Only a few of the variables have individual explanatory power at commonly-accepted significance levels. First, the probability of an intervention scoring a success increases with the size of the intervention, whether this is a unilateral intervention or the combined amount of a coordinated intervention. In an expectations framework, large interventions may be seen as evidence by market participants that the MoF maintains a higher than usual degree of confidence in its near-term outlook for the yen. We also see that the dummy variable for our

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second subperiod (1995-2002) is strongly positive and significant, while the dummy variable

for the first period (1991-1995) is negative, confirming our earlier results. We find positive

effects, but not clearly statistically significant, for the time elapsed since the previous

intervention, coordination with the United States, and intervention by the MoF on a holiday in

U.S. financial markets. The predicted probabilities of an intervention—our proxy for the

likelihood that the market anticipated the action—had no apparent bearing on the chances of

success. Although, as we saw previously, the level of deviation in the exchange rate from its

median helped predict the likelihood of an intervention, it has little apparent bearing on the

probability of success.

The last two variables in table 9 control for developments in money markets—we use

changes in the call-money rate (a market rate) and changes in the Bank of Japan's discount

rate—that could have affected exchange rates independent of an intervention. 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. We find, however, that neither variable is statistically significant. We also included

a dummy variable equal to one during the Bank of Japan's quantitative easing period (March

19, 2001 through March 31, 2004). The dummy variable was not significant, indicating that

this change in policy operations had no obvious statistical impact on the effectiveness of MoF

interventions.

Next, we consider the joint significance of several of the variables that appeared to

have some effect on the probability of intervention success. Table 10 records the results for

five probit regressions containing various combinations of the variables that appear in the first

column: the size of MoF intervention, whether or not the operation was coordinated with the United States, the time elapsed since the last intervention, and a dummy for the 1995-2002 period. We consistently find again that the probability of success under the general success criterion increases with the amount of a MoF intervention. The time elapsed since the previous intervention and the dummy for coordinated interventions are not statistically significant once the amount of intervention is included in the regression, while coordination with the United States appears to bring a marginal amount of explanatory power. The dummy variable for the second time period seems to be somewhat collinear with the amount of intervention, showing lower statistical significance in a joint regression relative to the individual regression. This is not surprising given that large, infrequent interventions are the hallmark of the second time period.

8. Conclusions

In contrast to the other major industrial nations, Japan has continued to intervene frequently in foreign exchange markets since the mid 1990s. In particular, the most recent episode of intervention, in 2003 and early 2004, was notable for the large size and high frequency of its operations. Using official intervention data from Japan's Ministry of Finance, and applying a set of tools developed by Humpage (1999, 2000) to study the impact of U.S intervention operations, we have studied the short-term effectiveness of Japanese intervention since 1991. We find that, for the sample as a whole, Japanese intervention operations had little predictive power as to the daily direction of exchange rate movements. In other words, to use the language of Henrikson and Merton (1981), Japanese operations over the period had no forecast value relative to the sign of daily dollar-yen exchange rate

movements. However, consistent with an "against-the-wind" effect of intervention we find that Japanese intervention operations between 1991 and 2004 were associated with a substantially higher-than-expected frequency of both moderation and reversals in daily exchange rate movements, and therefore had forecast value relative to these two types of events.

The impact of Japanese intervention operations varied over time and appeared to be affected by the strategy used by the Ministry of Finance. In particular, intervention operations conducted between June 1995 and December 2002, which tended to be extremely large and relatively infrequent, had, in contrast to the sample as a whole, clear forecast value relative to the direction of exchange rate movements. As for the intervention episode of 2003 and 2004, despite the high number of data points and the large size of the operations, we are unable to statistically detect a clear impact on exchange rate movements associated with these intervention operations. We caution, however, that the tactics employed by the Japanese Ministry of Finance during this latest episode of intervention may have made detection of any impact more difficult.

We find that intervention operations conducted in coordination with those of U.S. monetary authorities, which occurred mainly in the early part of our sample period, met with a slightly higher frequency of success under several of our criteria than those of the Japanese authorities alone. The relatively small number of joint operations since 1991 does not allow us, however, to draw strong statistical conclusions as to their overall effectiveness. Of the numerous factors that we consider in explaining intervention effectiveness, only the size of an intervention operation has a clear, undeniable effect on its probability of success. The time

elapsed since another intervention operation and whether or not the operation was coordinated with the United States also appear to have some explanatory power for success.

Our findings are consistent with the conclusion that, for the period 1991-2004 as a whole, Japanese foreign exchange interventions had a modest, but clearly detectable, impact, on short-term movements in the dollar-yen exchange rate. In addition, the large and rather infrequent operations conducted between mid-1995 and the end of 2002 met with a higher degree of success under several of our criteria. These findings, although still modest, are more favorable to the effectiveness of intervention than much of the previous work based on U.S. intervention operations only.

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TABLE 1: INTERVENTION STATISTICS AND COUNTS
      April 1, 1991 to March 31, 2004; 3268 observations

	Count	Average	Median	St. Dev	Max	Min
Japan interventions				(in millions of dollars)		
Yen purchased, dollars sold	33	$1,145	$223	$3,594	$20,366	$25
Dollars purchased, yen sold	307	1880	789	2551	15604	<1
Total (absolute value)	340	1809	695	2672	20366	<1
No interventions	2928					
Japan interventions				(in billions of yen)		
Yen purchased, dollars sold	33	¥148	¥29	¥462	¥2620	¥3
Dollars purchased, yen sold	307	207	84	284	1666	<1
Total (absolute value)	340	201	72	305	2620	<1
No interventions	2928					
Coordinated						
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	3246					
Japan interventions				(in millions of dollars)		
Yen purchased, dollars sold	4	$609	$348	$762	$1,691	$49
Dollars purchased, yen sold	18	1101	657	1614	7411	161
Total	22	1012	621	1493	7411	49
No interventions	3246					
Combined interventions				(in millions of dollars)		
Yen purchased, dollars sold	4	$868	$423	$1,130	$2,524	$99
Dollars purchased, yen sold	18	1509	1052	1672	7911	326
Total	22	1392	1002	1584	7911	99
No interventions	3246					

NOTE: 2 observations lost to 1st differencing and lags.

TABLE 2: INTERVENTION STATISTICS AND COUNTS BY SUBPERIOD

APRIL 1, 1991 to JUNE 14, 1995	Count	Average	Median	St. Dev	Max	Min
Japan interventions		(in millions of dollars)				
Yen purchased, dollars sold	27	$223	$151	$155	$598	$25
Dollars purchased, yen sold	138	514	388	490	3915	45
Total (absolute value)	165	466	348	465	3915	25
No interventions	893					
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	18	356	335	227	800	50
No interventions	1040					
Combined interventions		(in millions of dollars)				
Yen purchased, dollars sold	3	$315	$199	$292	$648	$99
Dollars purchased, yen sold	15	1164	1101	533	2212	326
Total	18	1022	927	591	2212	99
No interventions	1040					
June 15, 1995 to December 31, 2002						
Japan interventions		(in millions of dollars)				
Yen purchased, dollars sold	6	$5,296	$1,948	$7,567	$20,366	$595
Dollars purchased, yen sold	43	4456	4018	3148	13207	496
Total (absolute value)	49	4559	3989	3835	20366	496
No interventions	1848					
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	4	492	417	244	833	300
No interventions	1893					
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	3236	1001	4050	7911	796
Total	4	3056	1762	3326	7911	796
No interventions	1893					
January 2, 2003 to March 31, 2004						
Japan interventions		(in millions of dollars)				
Yen purchased, dollars sold	0	$0	$0	$0	$0	$0
Dollars purchased, yen sold	126	2498	1753	2758	15604	<1
Total (absolute value)	126	2498	1753	2758	15604	<1
No interventions	187					

NOTE: In first subperiod, two observations are lost to differencing and lags.

TABLE 3: FREQUENCY AND PERSISTENCE OF INTERVENTIONS

PROBABILITIES OF INTERVENTION CONDITIONAL ON DAYS OF CONSECUTIVE INTERVENTION

Number of interventions in a row

April 1, 1991 to Mar. 31, 2004	1	2	3	4	8	12	16
Japanese dollar sales	1.0%	0.3%	0.1%	0%	0%	0%	0%
Japanese dollar purchases	9.4%	6.2%	4.6%	3.3%	1.1%	0.3%	0.0%

April 1, 1991 to June 14, 1995	1	2	3	4	8	12	16
Japanese dollar sales	2.6%	0.6%	0%	0%	0%	0%	0%
Japanese dollar purchases	13.0%	9.0%	6.3%	4.3%	0.9%	0.5%	0.1%

June 15, 1995 to Dec. 31, 2002	1	2	3	4	8	12	16
Japanese dollar sales	0.3%	0.2%	0.1%	0%	0%	0%	0%
Japanese dollar purchases	2.3%	0.5%	0.2%	0.1%	0%	0%	0%

Jan. 2, 2003 to Mar. 31, 2004	1	2	3	4	8	12	16
Japanese dollar sales	0%	0%	0%	0%	0%	0%	0%
Japanese dollar purchases	40.3%	31.6%	25.2%	20.1%	8.6%	1.9%	0%

DAYS SINCE LAST INTERVENTION

	mean	mode	max.
April 1, 1991 to Mar. 31, 2004	10	1	455
April 1, 1991 to June 14, 1995	6	1	160
June 15, 1995 to Dec. 31, 2002	49	1	455
Jan. 2, 2003 to Dec. 31, 2004	3	1	136

Note: Zero entry with a decimal point indicates a small number.

TABLE 4: THE LIKELIHOOD OF SUCCESS
April 1, 1991 to March 31, 2004; 3268 observations

	Interventions			Virtual		Expected	Standard	P Value
	Total	Successes		Successes		Successes	Deviation	1-CDF
	#	#	%	#	%	#	#	
JAPANESE INTERVENTION								
Appreciation / Depreciation								
Dollars purchased, yen sold	307	140	45.6	1616	49.4	151.8	8.3	0.913
Yen purchased, dollars sold	33	15	45.5	1615	49.4	16.3	2.9	0.611
Change Direction								
Dollars purchased, yen sold	307	92	30.0	829	25.4	77.9	7.3	0.023
Yen purchased, dollars sold	33	9	27.3	832	25.5	8.4	2.5	0.320
Accentuate movements								
Dollars purchased, yen sold	307	29	9.4	382	11.7	35.9	5.4	0.885
Yen purchased, dollars sold	33	5	15.2	398	12.2	4.0	1.9	0.206
Moderate movements								
Dollars purchased, yen sold	307	56	18.2	385	11.8	36.2	5.4	0.000
Yen purchased, dollars sold	33	6	18.2	399	12.2	4.0	1.9	0.099
General success								
Dollars purchased, yen sold	307	196	63.8	2001	61.2	188.0	8.1	0.147
Yen purchased, dollars sold	33	21	63.6	2014	61.6	20.3	2.8	0.342
COORDINATED with USA								
Appreciation / Depreciation								
Dollars purchased, yen sold	18	10	55.6	1616	49.4	8.9	2.1	0.225
Yen purchased, dollars sold	4	2	50.0	1615	49.4	2.0	1.0	0.304
Change Direction								
Dollars purchased, yen sold	18	6	33.3	829	25.4	4.6	1.8	0.147
Yen purchased, dollars sold	4	0	0.0	832	25.5	1.0	0.9	0.691
Accentuate movements								
Dollars purchased, yen sold	18	3	16.7	382	11.7	2.1	1.4	0.150
Yen purchased, dollars sold	4	2	50.0	398	12.2	0.5	0.7	0.007
Moderate movements								
Dollars purchased, yen sold	18	3	16.7	385	11.8	2.1	1.4	0.154
Yen purchased, dollars sold	4	2	50.0	399	12.2	0.5	0.7	0.007
General success								
Dollars purchased, yen sold	18	13	72.2	2001	61.2	11.0	2.1	0.112
Yen purchased, dollars sold	4	4	100.0	2014	61.6	2.5	1.0	0.000

NOTE: 2 observations lost to 1st differencing and lags.

TABLE 5: THE LIKELIHOOD OF SUCCESS IN SUBPERIOD #1
April 1, 1991 to June 14, 1995; 1058 observations

	Interventions			Virtual		Expected	Standard	P Value
	Total	Successes		Successes		Successes	Deviation	1-CDF
	#	#	%	#	%	#	#	
JAPANESE INTERVENTION								
Appreciation / Depreciation								
Dollars purchased, yen sold	138	52	37.7	491	46.4	64.0	5.5	0.983
Yen purchased, dollars sold	27	12	44.4	549	51.9	14.0	2.6	0.722
Change Direction								
Dollars purchased, yen sold	138	36	26.1	274	25.9	35.7	4.8	0.432
Yen purchased, dollars sold	27	8	29.6	272	25.7	6.9	2.2	0.238
Accentuate movements								
Dollars purchased, yen sold	138	7	5.1	108	10.2	14.1	3.3	0.982
Yen purchased, dollars sold	27	3	11.1	134	12.7	3.4	1.7	0.453
Moderate movements								
Dollars purchased, yen sold	138	28	20.3	140	13.2	18.3	3.7	0.004
Yen purchased, dollars sold	27	5	18.5	110	10.4	2.8	1.6	0.053
General success								
Dollars purchased, yen sold	138	80	58.0	631	59.6	82.3	5.4	0.633
Yen purchased, dollars sold	27	17	63.0	659	62.3	16.8	2.5	0.398
COORDINATED with USA								
Appreciation / Depreciation								
Dollars purchased, yen sold	15	7	46.7	491	46.4	7.0	1.9	0.388
Yen purchased, dollars sold	3	1	33.3	549	51.9	1.6	0.9	0.528
Change Direction								
Dollars purchased, yen sold	15	4	26.7	274	25.9	3.9	1.7	0.343
Yen purchased, dollars sold	3	0	0.0	272	25.7	0.8	0.8	0.590
Accentuate movements								
Dollars purchased, yen sold	15	2	13.3	108	10.2	1.5	1.2	0.191
Yen purchased, dollars sold	3	1	33.3	134	12.7	0.4	0.6	0.044
Moderate movements								
Dollars purchased, yen sold	15	3	20.0	140	13.2	2.0	1.3	0.125
Yen purchased, dollars sold	3	2	66.7	110	10.4	0.3	0.5	0.001
General success								
Dollars purchased, yen sold	15	10	66.7	631	59.6	8.9	1.9	0.207
Yen purchased, dollars sold	3	3	100.0	659	62.3	1.9	0.8	0.000

NOTE: 2 observations lost to 1st differencing and lags.

TABLE 6: THE LIKELIHOOD OF SUCCESS IN SUBPERIOD #2
June 15, 1995 to December 31, 2002; 1897 observations

	Interventions			Virtual		Expected	Standard	P Value
	Total	Successes		Successes		Successes	Deviation	1-CDF
	#	#	%	#	%	#	#	
JAPANESE INTERVENTION								
Appreciation / Depreciation								
Dollars purchased, yen sold	43	33	76.7	985	51.9	22.3	3.2	0.000
Yen purchased, dollars sold	6	3	50.0	896	47.2	2.8	1.2	0.293
Change Direction								
Dollars purchased, yen sold	43	22	51.2	477	25.1	10.8	2.8	0.000
Yen purchased, dollars sold	6	1	16.7	482	25.4	1.5	1.1	0.476
Accentuate movements								
Dollars purchased, yen sold	43	8	18.6	239	12.6	5.4	2.2	0.005
Yen purchased, dollars sold	6	2	33.3	225	11.9	0.7	0.8	0.025
Moderate movements								
Dollars purchased, yen sold	43	3	7.0	193	10.2	4.4	2.0	0.652
Yen purchased, dollars sold	6	1	16.7	261	13.8	0.8	0.8	0.195
General success								
Dollars purchased, yen sold	43	36	83.7	1178	62.1	26.7	3.1	0.000
Yen purchased, dollars sold	6	4	66.7	1157	61.0	3.7	1.2	0.249
COORDINATED with USA								
Appreciation / Depreciation								
Dollars purchased, yen sold	3	3	100.0	985	51.9	1.6	0.9	0.000
Yen purchased, dollars sold	1	1	100.0	896	47.2	0.5	0.5	0.000
Change Direction								
Dollars purchased, yen sold	3	2	66.7	477	25.1	0.8	0.8	0.016
Yen purchased, dollars sold	1	0	0.0	482	25.4	0.3	0.4	0.254
Accentuate movements								
Dollars purchased, yen sold	3	1	33.3	239	12.6	0.4	0.6	0.043
Yen purchased, dollars sold	1	1	100.0	225	11.9	0.1	0.3	0.000
Moderate movements								
Dollars purchased, yen sold	3	0	0.0	193	10.2	0.3	0.5	0.275
Yen purchased, dollars sold	1	0	0.0	261	13.8	0.1	0.3	0.138
General success								
Dollars purchased, yen sold	3	3	100.0	1178	62.1	1.9	0.8	0.000
Yen purchased, dollars sold	1	1	100.0	1157	61.0	0.6	0.5	0.000

TABLE 7: THE LIKELIHOOD OF SUCCESS IN SUBPERIOD #3
January 2, 2003 to March 31, 2004; 313 observations

	Interventions Total #	Interventions Successes #	Interventions Successes %	Virtual Successes #	Virtual Successes %	Expected Successes #	Standard Deviation #	P Value 1-CDF
JAPANESE INTERVENTION								
Appreciation / Depreciation								
Dollars purchased, yen sold	126	55	43.7	140	44.7	56.4	4.3	0.578
Yen purchased, dollars sold								
Change Direction								
Dollars purchased, yen sold	126	34	27.0	78	24.9	31.4	3.8	0.204
Yen purchased, dollars sold								
Accentuate movements								
Dollars purchased, yen sold	126	11	8.7	35	11.2	14.1	2.7	0.828
Yen purchased, dollars sold								
Moderate movements								
Dollars purchased, yen sold	126	25	19.8	52	16.6	20.9	3.2	0.079
Yen purchased, dollars sold								
General success								
Dollars purchased, yen sold	126	80	63.5	192	61.3	77.3	4.2	0.224
Yen purchased, dollars sold								

Note: The United States did not intervene in dollar-yen after June 17, 1998.

TABLE 8: PROBIT REGRESSIONS TO DETERMINE EXPECTED JAPANESE INTERVENTIONS

INDEPENDENT VARIABLES	Dollar Sales	Dollar Purchases
Constant	**-2.8482**	**-2.0089**
	-19.15	-37.33
Intervention at t-1	**1.2091**	**1.5169**
	4.66	14.64
Intervention at t-2	**1.0743**	**1.0696**
	4.03	10.18
Exchange Rate minus median exchange rate at t-1	**0.0510**	**-0.0225**
	5.25	-6.13
Log Likelihood	-130.85	-567.80
Likelihood Ratio Test (against constant only)	107.27	900.78
Number of Observations:	33	307

Note: Dependent variable is a dummy taking a value of one for Japanese intervention dollar sales or dollar purchases.

TABLE 9: INDIVIDUAL DETERMINANTS OF THE LIKELIHOOD OF SUCCESSFUL INTERVENTION

INDEPENDENT VARIABLES	Constant t-Statistic:	Coefficient t-Statistic:	Log Likelihood:	Likelihood Ratio Test:
constant only	**0.3537**		-222.51	
	5.09			
amount of Japanese intervention (abs. value)	**0.1610**	**0.0011**	-215.22	14.57
	1.85	3.41		
amount of U.S. & Japanese intervention (abs. value)	**0.1543**	**0.0011**	-214.96	15.09
	1.76	3.46		
time since last intervention (days)	**0.3100**	**0.0058**	-220.46	4.08
	4.22	1.57		
anticipated (dummy)	**0.3345**	**0.0428**	-222.46	0.09
	3.58	0.31		
coordinated (dummy)	**0.3290**	**0.4188**	-221.52	1.97
	4.59	1.37		
purchases of dollars (dummy)	**0.3488**	**0.0055**	-222.50	0.00
	1.56	0.02		
sales of dollars (dummy)	**0.0006**	**-0.0055**	-222.50	0.00
	4.84	-0.02		
April 1, 1991 to June 14,1995 (dummy)	**0.4837**	**-0.2616**	-220.74	3.52
	4.89	-1.88		
June 15, 1995 to December 31, 2002 (dummy)	**0.2748**	**0.6267**	-218.20	8.61
	3.69	2.83		
January 2, 2003 to March 31, 2004 (dummy)	**0.3590**	**-0.0140**	-222.50	0.01
	4.09	-0.10		
Holiday (dummy)	**0.3248**	**0.6426**	-220.75	3.52
	4.56	1.79		
Deviation from median exchange rate	**0.4303**	**-0.0067**	-222.20	0.62
	3.59	-0.79		
Lagged exchange rate change (squared)	**0.3241**	**0.0364**	-221.85	1.30
	4.36	1.10		
Call-money rate change (perc.points)	**0.3682**	**-1.1662**	-222.22	0.57
	5.10	-0.75		
Discount rate change (perc.points)	**0.3452**	**-37.5910**	-221.15	2.71
	4.95	0.00		
Quantitative easing (dummy)	**0.3186**	**0.0860**	-222.32	0.37
	3.5295	0.6075		

NOTE: U.S. and Japanese intervention is in billions of yen.
   Critical Chi-Square value at the 95% confidence level for 1 d.f. is 3.84.
   We measures a percentage point increase (or decrease) in the call-money and discount rates
when the MoF is purchasing (or selling) yen.
   Dependent variable is a dummy taking a value of one for success under the general success criterion
listed in table 4. 340 observations
   The Bank of Japan inaugurated its policy of quantitative easing on March 19, 2001.

TABLE 10: COMBINED DETERMINANTS OF THE LIKELIHOOD OF SUCCESSFUL INTERVENTION

INDEPENDENT VARIABLES	Equation #1	Equation #2	Equation #3	Equation #4	Equation #5
Constant	**0.1610**	**0.1218**	**0.1280**	**0.0915**	**0.1507**
	1.85	1.35	1.43	0.99	1.73
Amount of Japanese intervention (absolute val.)	**0.0011**	**0.0011**	**0.0011**	**0.0011**	**0.0009**
	3.41	3.52	3.30	3.41	2.65
Coordinated (dummy)		**0.5205**		**0.5090**	
		1.69		1.65	
Time since last intervention (days)			**0.0053**	**0.0051**	
			1.41	1.37	
June 15, 1995 to December 31, 2002 (dummy)					**0.3627**
					1.49
Log Likelihood	-215.22	-213.71	-213.63	-212.21	-214.09
Likelihood Ratio Test (against constant only)	14.57	17.60	17.75	20.60	16.83
Likelihood Ratio Test (one less)		3.02	3.18	3.00	2.26

	5% p-value
Critical Chi-Square value 1 d.f.	3.84
Critical Chi-Square value 2 d.f.	5.99
Critical Chi-Square value 3 d.f.	7.81

Note: Intervention is in billions of yen. Likelihood Ratio Test (one less) is a test of an equation against an equation with one fewer regressor. In cases of multiple possible comparisons, we report the highest LR test.

Dependent variable is a dummy taking a value of one for success under the general success criterion listed in table 4. 340 observations.