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Interventions and Japanese Economic Recovery

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Abstract

This paper attempts to explain possible reasons and objectives behind the 35 trillion yen (7% of GDP) interventions conducted by the Japanese monetary authorities from January 2003 to March 2004, and to discuss whether the interventions achieved the presumed objectives: making the movement of the yen flexible but orderly, and helping economic recovery. The motivation of starting intervention in January 2003 was to keep the yen from appreciating in the midst of financial and macroeconomic weakness. The economy started to show some strength in the second half of 2003, but interventions continued, with a brief pause in September. Reasons for interventions after September are two-fold. First, the interventions provided opportunities for unsterilized interventions. Second, the monetary authorities were extremely sensitive to speculative activities in the market.

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1. Introduction

The Japanese monetary authorities (the Ministry of Finance and the Bank of Japan) intervened in the yen/dollar market, selling 35 trillion yen, during the 15-month period from January 2003 to March 2004. The size of interventions was unusually large, reaching 7 percent of GDP, and exceeding the total amount of interventions during the 11-year period from April 1991 to December 2002. Why did intervention by the Japanese authorities reach such a large amount?

This paper attempts to explain possible reasons and objectives behind interventions conducted by the Japanese monetary authorities in 2003 and 2004, and to discuss whether interventions achieved presumed objectives, made the movement of the yen flexible but orderly, and helped economic recovery to take place. In the discussion of interventions, it is necessary to pay significant attention to macroeconomic conditions as well as to exchange rate movements, as decisions of interventions should be understood in the context of macroeconomic conditions at the time. When the 15-month episode of interventions started in January 2003, the Japanese economy was in a very weak condition. Several major banks were regarded in the market to be near-insolvent if proper accounting and evaluation of assets were applied.[1] The economic growth rate was very low, and deflation was getting worse. Stock prices were going down sharply. The motivation of starting intervention in January 2003 was to keep the yen from appreciating in the midst of financial and macroeconomic weakness. Stock prices continued to decline until April, and the economy looked quite fragile in the spring.

The economy started to show some strength in the second half of 2003, but interventions continued, with a brief pause in September. Reasons for interventions after September are two-fold. First, interventions provided opportunities for unsterilized interventions. Second, the monetary authorities were extremely sensitive to speculative activities in the market. Whenever net

[1] In order to clear the 8% capital adequacy standard, major banks were relying on deferred tax assets, which have zero liquidation value. The subsequent failures of the Resona Bank in May 2003 and revelation of large losses of UFJ Bank suggested that solvency of some of the major banks in the spring of 2003 was quite doubtful.

positions of the yen in the futures market turned long, interventions were conducted. This continued until March 2004. The intervention stopped in mid-March, and the yen remains at around the level of the last day of intervention (January 2005).

The remainder of this paper is organized as follows. Interventions and the macroeconomic conditions from a broader perspective are described in Section 2, and a more detailed analysis of intervention strategies is conducted in Section 3. Section 4 attempts to explain the reasons for heavy interventions from January 2003 to March 2004, and Section 5 concludes.

2. Macroeconomic Conditions

Repeated recessions have long plagued Japan since the end of the bubble period in the early 1990s. The average growth rate between 1992 and 2003 is about 1%, compared to the average of 4% from the mid-1970s to 1992. Between 1992 and 2003, there were three times that the economic growth rate exceeded 2.5%, or roughly a recovery speed. The recovery of 1996 was followed by low growth and a banking crisis in 1997-98. The growth rate of 1998 was negative. The recovery of 2000, partly fueled by an IT bubble was followed by another recession in 2001 and negative growth rate in 2002. The recovery in 2003 was the third attempt to get back on a growth track in the last ten years.[2] Although there were a few times that the growth rate exceeded 3%, the recovery was followed by the recession. In 1998 and 2002, the growth rate became negative, first time since 1974, which was the year after the first oil crisis. Financial crisis and economic slump reinforced each other from 1998 to 2002.

Let us look at the developments of macroeconomic fundamentals from 2001 to June 2004. Appendix Table A-1 contains the opening paragraphs of monthly reports of the Bank of Japan (BOJ) during this period. I attached the numerical value to each paragraph as my interpretation of the BOJ interpretation of the direction of the economy at the time. The BOJ was most concerned with the decline in economic activity from December 2001 to February 2002. During the rest of

[2] See Bayoumi and Collyns (2000) and Callen and Ostry (2003) for IMF views on factors explaining poor macroeconomic performance of the Japanese economy in the 1990s. Ito and Mishkin (2004) analyzed the role of monetary policy for the slow growth of the decade.

2002, the BOJ was very cautious in assessing the economic situation, although the decline had been stopped.[3] The assessment became slightly positive only in October 2003.[4] The assessment became more optimistic only in April 2004.[5] The history shows that the BOJ was most concerned about the health of the economy from June 2001 to May 2002, and remained non-optimistic until September 2003. This is important in assessing the appropriateness of interventions if interventions were conducted to help economic recovery.

Now, let us look at the macroeconomic indicators, and compare those indicators with the intervention timings. Appendix Table A-2 shows: the monthly (percent) changes in stock prices and the yen/dollar rate; quarterly growth rate; inflation rate; and the BOJ view that is indicated in Table A-1. These are relevant variables that may help explain intervention behavior as well as other policy actions. Interventions between January 2001 and December 2002 are concentrated in two clusters, in September 2001 and in May-June 2002. The September 2001 episode can be explained by yen appreciation (4.7 % in August 2001) with the background of very weak macro fundamentals (negative growth and sharp declines in stock prices (20% in three months from May to August 2001). The BOJ view on the economy was quickly turning pessimistic. Indeed, yen appreciation when macro fundamentals were weakening was regarded as inappropriate. Intervention in September 2001 was to fight against movement of the exchange rate that was not consistent with macro fundamentals. Similarly, the economy was regarded as very weak as the growth rate had been negative for four quarters in a row prior to May 2002, and the BOJ view on the economy was still very pessimistic. Yen appreciation by ten percent in three months during the period of the weak economy was again considered to be harmful to continuous economic recovery. Therefore rapid appreciation during the weak economy, which was considered to be movement in the wrong direction, prompted interventions. In short, interventions in September 2001 and May-June 2002 can be understood as the officials sending a strong signal that the market was wrong

[3] "Japan's economy has stabilized as a whole" (Monthly Report, October 2002 to January 2003), "Economic activity remains flat" (Monthly Report, February to May 2003), and "Economic activity remains virtually flat" (Monthly Report, June-September 2003).
[4] "Japan's economy is recovering gradually" (Monthly Report, October 2003).
[5] "Japan's economy continues to recover gradually, and domestic demand is becoming firmer."

to drive the yen up when macroeconomic fundamentals were weak.

Ito (2003; 2004a) showed that there have been two different regimes of interventions since April 1991, the beginning of the period when data are disclosed. The first regime, April 1991 to June 1995, is characterized by small-scale, frequent interventions, the second regime, from June 1995 to December 2002, by large-scale, infrequent interventions. Ito attributed the difference to the deliberate switch of strategy by Mr. Sakakibara, who became Director General in June 1995. The Sakakibara strategy was succeeded by Mr. Kuroda, who became in charge of intervention in July 1999. Mr. Kuroda retired on January 14, 2003, and was succeeded by Mr. Mizoguchi. The third regime started with Mr. Mizoguchi intervening on January 15, 2003, the first intervention of what would become the third regime—large-scale, frequent interventions. Table 1 summarizes the total amounts of intervention, the number of intervention days, the minimum and maximum of interventions, sorted by quarters from 2001:I to 2004:II.

The two interventions, September 2001 and May-June 2002, were typical of the Sakakibara-Kuroda interventions. When the foreign exchange market was considered to be heading in the wrong direction—wrong judged from macro-fundamentals—and the movement too rapid, large interventions were employed to send strong messages.

The new type of intervention, under Mr. Mizoguchi, started in January 2003 and continued until March 2004. During these fifteen months, macroeconomic fundamentals continued to improve. In the beginning of 2003, the Japanese economy was in a precarious position. Stock market prices were declining and economic activities were "flat." The Nikkei stock price index declined to 7,600, one-fifth of the peak that was recorded thirteen years earlier.[6] The decline in the stock prices weakened many financial institutions that held large amounts of equities on their balance sheets. The mood was near crisis, and any help, including interventions to prevent yen appreciation, was welcome and justifiable. From January to March 2003, interventions to stop yen appreciation when the economy was weak were understandable, although the frequency of

[6] Since the index composition has been changed, the direct comparison of the Nikkei index of 2003 with 1989 is not totally accurate.

interventions was much higher than was the case under the Sakakibara-Kuroda regime (1995-2002). Interventions from May to August 2003 were conducted when the economy started to show signs of recovery. The GDP growth rate in the second quarter of 2003 was more than 4%, although it was not until August that the figure was known to the public. The BOJ view of the economy was still "virtually flat" from June to September 2003. The CPI inflation rate was rising from minus 0.8 in January 2003 to minus 0.1% in August 2003. This was another sign that the worst was over, but it was uncertain at the time to make such a judgment. Despite large-scale interventions, the yen appreciated from 119 yen/dollar at the beginning of 2003 to 107 yen/dollar at the end of 2003. The interventions from January to December 2003 can be characterized as an operation to prevent a sharp yen appreciation that might have kept the economy from getting back on a recovery track. Interventions moderated the speed of yen appreciation, while the flexibility of the exchange rate was maintained. Interventions in 2003 bought time until the economy recovered and stock prices rose to a comfortable level.

The BOJ view was pointing out a "gradual recovery" from October 2003 to May 2004. Stock prices were also rising in this period. The mood was definitely brighter for many industries at end-2003, compared to the previous year. In retrospect, the Japanese economy was making a strong recovery, in terms of its growth rate, in the fourth quarter of 2003 and the first quarter of 2004—7.6% and 6.4%, respectively—but that information was not available in real time.[7]

At the time of this writing (January 2005), the Japanese economy may finally be getting out of a long stagnation. The growth rate is nearing what many consider the potential rate. Deflation is also almost over. But recovery is driven by exports and fixed investment. Consumption has yet to grow strongly.

[7] The first estimate of Japanese GDP statistics is announced a month-and-half after the end of the quarter. The revised, second estimate is announced more than two months after the end of the quarter. Revisions are often very large.

3. Interventions in 2003-2004: How did they start and end?

The intervention on January 15, 2003, the first time in six months, was carried out without notice of the market. The amount was 8.3 billion yen (or about 70 million dollars), a very small amount as fas as Japanese interventions go. The interventions were conducted without announcement or an intentional or unintentional leak. Interventions were conducted in 8 days in the second half of January, but all without announcement or confirmation. This was in contrast to the previous regime under Mr. Sakakibara and Mr. Kuroda. Interventions without announcement, later nicknamed as "stealth intervention," became a hallmark of the tactics employed by Mr. Mizoguchi.[8]

The yen appreciated sharply from 125 yen toward the end of December 2002 to 120 yen in mid-January 2003, so the intervention could have been justified as a "smoothing" operation if an announcement had to be made. Moreover, further yen appreciation, however "smooth" it might be, was considered to be harmful to a fragile economy. At the time, the 2002 growth rate was expected to be negative. As already explained, the economy at the beginning of 2003 was still considered to be very weak, stock prices were declining, and deflation was worsening. Another financial crisis was feared in the spring of 2003—and indeed the Resona Bank was nationalized in May 2003. Both the speed of yen appreciation and the level of the yen were a concern. Sharp appreciation was viewed not to be consistent with macro fundamentals: why should the currency of a very weak economy on the verge of a financial crisis have to appreciate? When the market is taking the currency to a level not consistent with macro fundamentals, would not intervention be a valid policy tool as a signal of displeasure and caution? Should not the currency appreciation, under these circumstances, if possible, be corrected by intervention? Interventions from January to March can be explained by this logic. Interventions were conducted on and off from January to March 2003, keeping the yen/dollar rate, most of the time, in the tight range between 117 and 120 yen/dollar. The market became aware of interventions, due to the monthly disclosure of the change

[8] See Edison (1993) for a survey on the old literature of interventions, which were more or less negative on their effectiveness. See Sarno and Taylor (2001) for a survey of recent literature on interventions. Dominguez and Frankel (1993) and Dominguez (1998, 2003) showed some effectiveness of interventions. See also Galati and Merick (2002) for comparative research on interventions by different countries.

in the account that is closely linked to intervention. But the market was still uninformed about daily details of interventions. As the intervention details (days of interventions and amounts) of the first quarter were announced in May 8, 2003, the public became aware of the switch of intervention policy, to a regime of more frequent interventions. The first intervention since the end of March were conducted on May 8, as the yen appreciated beyond 117.

It became clear to market participants in May, that the yen was trading in the narrow range between 117 and 120. Interventions were conducted when the yen/dollar rate approached 116, but when the yen depreciated toward 119, the interventions were withdrawn. This appeared to be a narrow target zone. For example, when the yen was at 115.10 (intra-day high in the Tokyo market) on May 19, 2004, heavy interventions, selling of the yen amounting to 1 trillion yen, were conducted and they pushed the yen back to 117 yen/dollar by the closing of that day's New York market.

In May, stock prices reverted from their downward trend to an upward trend. The crisis seems to have been averted. Interventions continued, however, as appreciation pressure continued. Intervention continued in May, June and July, keeping the yen/dollar rate most of the time between 116 and 120. There were 11 intervention days in May, 7 days in June, and 9 days in July. By September, the intervention was considered to have been a success in the sense that it prevented appreciation that would have pushed the Japanese economy off the recovery path. Stock prices had risen comfortably from the trough in April 2003.

However, from June to September, as the Japanese economic recovery seemed to have become more certain, and stock prices rose sharply, criticism from abroad became voiced more frequently. There were allegations that Japanese intervention was subsidizing exports, hurting U.S. manufacturers. Japan, with large trade surpluses, should not intervene and by preventing appreciation, the pressure of dollar decline became an unfair burden imposed on the euro.

There was no intervention between July 16 and August 29, 2003. From July 16 until August 21, the yen/dollar rate stayed between 118 and 121. From August 21 to 29, the yen rate appreciated in small steps from 118.00 to 117.00. Toward the end of August, the yen started to

appreciate further. In the process that the yen moved toward 117.00 (the intra-day high in Tokyo), interventions were conducted in the amount of 412 billion yen on August 29, when the yen appreciated beyond 117. The first defense line at this point seems to be 117.00.[9] Once the intervention started, interventions continued on and off for 11 days (out of 13 business days) between August 29 and September 16. These interventions were partly countering yen appreciation pressure that was built up on the speculation that the United States and Europe were becoming increasingly dissatisfied with Japanese and other Asian countries' interventions, including China's dollar peg policy. The yen/dollar rate stayed between 116.00 and 118.00.

Toward the end of August, criticism of intervention had been circulated in the United States and in some European countries. Nevertheless, interventions continued in the first half of September.

On September 11, Secretary Snow was reportedly to have said that Japan must keep intervention to a minimum. This stimulated speculation to be long on the yen. There was a large intervention on September 12 to keep the yen at 117. The interventions continued until Tuesday, September 16, but there was no intervention after September 17. The yen (New York close) started to appreciate from 116.10 on September 16, to 115.20 on September 18, to 114.00 on September 19, without Japanese interventions. The psychological barrier (would-be target zone floor at the time) of 115 yen/dollar was broken.

On September 20, 2003, the G7 Finance Ministers and Central Bank Governors Meeting took place in Dubai. At the conclusion of the G7 Meeting, a communiqué with an unusual paragraph was issued. The statement included a paragraph stating the desirability of "flexibility" of the exchange rate:

> We reaffirm that exchange rates should reflect economic fundamentals. We continue to monitor exchange markets closely and cooperate as appropriate. In this context, we emphasize that more flexibility in exchange rates is desirable for major countries or economic areas to promote smooth and widespread adjustments in the international financial system, based on market mechanisms.

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[9] Officials at the Ministry of Finance deny that there was such a defense line, but many market participants believed that orders defending a certain level were placed by the monetary authorities.

The market interpreted the paragraph in the communiqué as criticism by the United States and European countries of the exchange rate policies of China and Japan—massive interventions and the piling up of foreign reserves.[10] The yen appreciated to 112.10 yen/dollar on Monday, September 22—a jump of 2 yen over the G7 weekend.

With the disclosed data of interventions, we now know that interventions did not take place from September 17 to 29—and rumors of no-intervention had it right at the time. Many market participants thought that the Japanese authorities were told by other G7 countries not to intervene. The Japanese authorities publicly said that there had been no change in Japanese exchange rate policy. But still investors were moving cautiously toward yen appreciation. Only when the yen/dollar rate approached 110, the intervention of September 30 was conducted with force (Selling of 1 trillion yen in the day) and prominence (intervening in the New York market as well, according to the market), as if the Japanese authorities wanted to show a license to intervene.

Heavy interventions continued in the fourth quarter of 2003. Despite intervention, the yen/dollar rate rose gradually from 110 to 105. Many market participants thought that the intervention policy may not have been changed, but the defense line was changing, first from 115 to 110 at the time of September G7, and then from 110 to 105 by the end of December 2003.[11]

Interventions from January to March 2004 were extremely frequent and heavy again. The Japanese authorities sold about 15 trillion yen during the first three months of 2004. The yen/dollar rate was kept from appreciating beyond 103.

The Japanese authorities intervened on 18 days out of 21 business days in January 2004. (The authorities intervened even on the days when the Japanese financial markets were on holiday—January 2 and 12.) The per-day intervention amount ranged from 2 billion yen on January 26 to 1,664 billion yen on January 9. The size of the January intervention amounted to 7 trillion

[10] Japanese officials privately argue that this paragraph of the communiqué was directed at China, but not Japan. However, several officials in Europe, when publicly asked, did not deny an interpretation that the paragraph was applicable also to Japan.

[11] Again, no officials even privately confirm such a defense line interpretation.

yen—a record high for one month. This intervention amount rivals the amount of intervention in the third quarter of 2003.

Another G7 meeting took place on February 7, 2004. The communiqué basically repeated the same paragraph as the one of September 2003, but added one sentence and one clause (as underlined):

> We reaffirm that exchange rates should reflect economic fundamentals. *Excess volatility and disorderly movements in exchange rates are undesirable for economic growth.* We continue to monitor exchange markets closely and cooperate as appropriate. In this context, we emphasize that more flexibility in exchange rates is desirable for major countries or economic areas *that lack such flexibility* to promote smooth and widespread adjustments in the international financial system, based on market mechanisms.

The second sentence was interpreted by the market participants as endorsement to Japanese intervention if it was to reduce "excess" volatility. The additional clause of "that lack such flexibility" qualified the "major countries or economic areas." Since the yen had appreciated by about 14% in the 14 months period prior to this statement, the market interpreted that the qualification excluded Japan from "major countries" that are urged to allow flexibility. This time, the market participants took it as the endorsement of the Japanese intervention policy between the two G7 meetings.

In February, the Japanese authorities continued heavy intervention, 18 days out of 20 business days, but the amount was less than half of January. In March, the Japanese authorities intervened from March 1 to March 16, every business day but one (March 12). In particular, on March 5, more than 1 trillion yen was sold, and the yen/dollar rate apparently changed up from 108 yen/dollar to 111 yen/dollar. On March 8, more than 800 billion yen was sold again, to push the rate to 112 yen/dollar (intraday low of the yen in Tokyo). Pushing the dollar up (rather than preventing the dollar from going down (lean-against-the-wind) raised some eyebrows in Japan and the United

States.[12] In retrospect, it can be argued that the monetary authorities tried to push the yen to depreciate to create room for flexibility above 100 yen before terminating intervention.[13]

Interventions abruptly ended on March 16, 2004, after intervening 11 days out of 12 business days in the first half of the month. No intervention after March 17 was conducted without any announcement of not doing interventions—the information was again not disclosed until May 12, 2004. The market was guessing whether stealth intervention continued or not in the second half of March and throughout April.[14] The yen appreciated to 103 yen/dollar toward the end of the month, but changed direction and started to depreciate, without intervention. The exit was completed.

In April, there was a debate in policy circles that the monetary authorities may have inflicted a loss on the Japanese people, by intervening substantially and the yen/dollar rate appreciated beyond the intervention point. At the end of March, unrealized losses from intervention operations in the previous fourteen years were estimated to have exceeded 1 trillion yen. The usual rebuttal to this criticism is that in the case of Japanese intervention, the operation is like borrowing at a zero interest rate and investing in dollar securities with 1% to 2% coupon rates, so that the interest income more than compensate the unrealized losses.

The total amount of interventions during the fifteen months from January 2003 to March 2004 reached roughly 35 trillion yen, or US$ 320 billion. (From April to July 2004, there was no intervention since March 16, and the yen fluctuated mostly at around 108-110 until October 2004.)

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[12] Newspapers had noticed the large amount of intervention, and commented that it would be difficult to get out of large interventions. (Asahi Shinbun, March 9, 2004, p. 11)

[13] In other words, this interpretation is that the authorities wanted to score an insurance run before finishing the game.

[14] Although the monthly aggregate of April was disclosed at the end of April, with no intervention record, so that the market knew as of the end-April that intervention did not take place in April, the market did not know about the details of intervention in the second half of March, until the May 12 disclosure.

4. Why so much for so long?

4.1. Fighting Speculators

In general, interventions tend to occur when exchange rate changes are large and moving toward the direction that the authorities consider inconsistent with macro fundamentals. The relationship between macro fundamentals and interventions was examined in Section 2. In an analysis with macro fundamentals based on monthly observations, interventions from January 2003 to August 2003 can be understood as helping economic recovery by preventing sharp yen appreciation. However, this explanation may not apply after September 2003, especially in the fourth quarter of 2003 and the first quarter of 2004, as many macro variables were showing signs of economic recovery. In this section, I will add further explanation for those interventions after August 2003.

It appeared to the market and researchers that the "defense line" was changed from the 116 level before the G7 meeting of September to the 110 level after the G7 meeting, since the first intervention was carried out on September 30, when the yen was at the 110 level (110.48 at 5pm in the Tokyo market). This change may have reinforced speculative forces. Although speculative positions are difficult to estimate, one of the indicators is the net long position of currency futures in the Chicago Mercantile Exchange (IMM).

Figure 1 shows the weekly data of net long yen position in IMM and interventions, from January 2003 to June 2004. First, the correlation seems to be clear: when net long positions become large (positive), then intervention tended to occur with selling of yen (positive direction). (Note that the units of accounts of the left and right scales are different. For IMM, it is the number of units of transactions at the exchange, while for intervention, it is in 100 million yen.) Second, the net long position suddenly became large in August 2003, and continued to be large until mid-February 2004. This corresponds to the period of heavy intervention, except for the four weeks from mid-February to mid-March, when intervention continued while net long positions disappeared (in fact, they turned to net short positions). It is possible to argue that interventions from September 2003 to March 2004 were fighting speculative pressures.

4.2 Reaction Function

Ito (2003) showed that Japanese interventions can be explained by a reaction function that includes the recent changes of the exchange rate, and the deviation from the long-run averages. Below I propose an additional term involving the net long position of the yen in the IMM.

"Smoothing operations" refer to interventions that would make changes slower but not necessarily with an intention to stop the movement or reverse the trend. This may be captured by variables such as the change of the preceding day, $(s_{t-1} - s_{t-2})$, where s_t is the log of the yen/dollar rate on day t. Even when the exchange rate moves quickly, if the movement is in the direction that is desirable (from the viewpoint of the monetary authorities), then interventions would not be triggered. In other words, interventions are more likely to occur if the exchange rate is moving away from the long-term equilibrium, as determined by the long-term backward moving average, $(s_{t-1} - s^{MA}_{t-1})$. Since interventions tend to occur in clusters, the lagged interventions may have some explanatory power. In the end, we have the following specification for the intervention reaction function:

$$(1)\ Int_t = \phi_1(s_{t-1} - s_{t-2}) + \phi_2(s_{t-1} - s^{MA}_{t-1}) + \phi_3 Int_{t-1} + \phi_4 IMM_t 1(IMM_t > 0) + \phi_5 IMM_t 1(IMM_t < 0) + \nu_t$$

where l(X>0) and l(X<0) are indicator functions. This specification allows the asymmetric response of the monetary authorities.

Weekly IMM positions survey are taken on Tuesday and made public on Friday. There are two possibilities on how the information can be known to the Japanese monetary authorities. The monetary authorities, by collecting information from the market on the market conditions including position taking of large financial institutions, might be able to guess more or less the net long/short positions on the yen in real time. If the monetary authorities know in real time the IMM position by communication with the market, then it is appropriate to model the weekly intervention based on Tuesday. If the monetary authorities are as ignorant as the public, then it is more appropriate to base the weekly model on the Friday–to–Friday periodicity. The truth would be in between. Two models are estimated, one on the Tuesday periodicity and the Friday periodicity.

Results, shown in Table 2, can be interpreted as follows. $\varphi_1 > 0$ implies that the yen-selling intervention tends to occur if the yen appreciated the day before (from the two days earlier). $\varphi 4 > 0$ implies that yen-selling interventions tend to occur if IMM net long positions become large, evidence of fighting against yen appreciation pressures exerted by speculators. $\varphi 5 < 0$ implies that yen-selling interventions tend to occur when the net short position becomes large, reflecting the yen depreciation pressure. It shows that the monetary authorities did respond to IMM, but with asymmetric reactions. When the yen long position is large, interventions were conducted to prevent appreciation; when a yen short position develops, the monetary authorities also take advantage to depreciate the yen. The latter situation was most prominent from mid-February to mid-March 2004. The authorities conducted both lean-against interventions and lean-in interventions, to cause the yen to depreciate.

4.3. Effectiveness

An interpretation of the intervention episode of January 2003 to March 2004 is that it helped the economy recover from a depth of recession to a growth path, not in the sense that it actively depreciated the yen but in the sense that it slowed down the pace of yen appreciation. The growth rate increased from negative territory in 2002 to at or above the potential growth rate in 2003-04, and the stock price increased by 50% from April 2003 to April 2004. If helping an economic recovery was an objective, it was certainly achieved the objective.

Another test of evaluating intervention is tactical effectiveness. If slowing down the yen appreciation was the objective, did intervention have an impact on the exchange rate on the day of intervention? Ito (2003) proposed a method of evaluating the effectiveness of Japanese intervention. The change in the daily exchange rate is regressed on the change in the past exchange rate (lagged once, and the cumulative change for a week in the past, and the deviation from the

long-run average) and interventions (Japanese intervention, US intervention, and Japanese first-of-the-week intervention).[15] The specification is:

$$(2)\ \Delta s_t = \beta_0 + \beta_1 \Delta s_{t-1} + \beta_2 (s_{t-1} - s_{t-1}^{MA}) + \beta_3 Int_t + \beta_4 IntUS_t + \beta_5 IntIN_t + \varepsilon_t$$

where $\Delta s_t = s_t - s_{t-1}$, s_t is the NY close of the yen/dollar exchange rate, and s^{MA} is the long-run, here 180 days, backward moving average. The first three terms in the right-hand-side are supposed to capture movement of the yen/dollar rate without interventions. If one strongly believes that the exchange rate follows a random walk, then a condition, $\beta_0 = \beta_1 = \beta_2 = 0$, should be imposed. However, in general, a short-run bandwagon effect ($0 < \beta_1 < 1$) and a medium run mean-reversion ($\beta_2 < 0$) may be present, and this specification allows for such behavior. Int_t is the Japanese intervention amounts; $IntUS_t$ is the U.S. intervention amounts (in yen). $IntIN_t$ denotes the first-in-the-week interventions (that is the cross of the indicator function of no intervention in the past five days and Int_t): $IntIN_t = Int_t$ if $Int_t \neq 0$ and $Int_{t-1} = Int_{t-2} = \ldots = Int_{t-5} = 0$, or, otherwise, $IntIN_t = 0$. This term captures the power of infrequent, "surprise" interventions, as opposed to continuous interventions. Interventions are often done in clusters, that is, one intervention tends to be followed by others. This can be explained by political costs for interventions (obtaining an approval and forming consensus carries bureaucratic costs) being lower once intervention is done. (See Ito and Yabu (2004) for more details on this line of thought.)

Equation (2) has been estimated for the three subperiods (pre-Sakakibara, Sakakibara-Kuroda, and Mizoguchi). The results are shown in Table 5. Interventions were effective in that the yen-selling interventions depreciated the yen, and the yen-buying interventions appreciated the yen in the second and third subperiods. Effectiveness of the interventions (β_3) was halved in period 3 compared to period 2. One-trillion yen interventions depreciated the yen only 0.7% in the second period and 0.38% in the third period. Moreover, one trillion yen

[15] See Dominguez and Frankel (1993), Dominguez (2003), and Sarno and Taylor (2001) for general references on the effectiveness of interventions. This specification follows Ito (2003). See Truman (2003) for a skeptical view on the effectiveness of interventions.

first-time-in-a-week intervention (effects of $\beta_3+\beta_5$) depreciated the yen by 2.1 percent in the second sub-period (1995-2003), while it depreciated the yen only by 0.45% in the third period (2003-2004). In sum, the interventions were effective in the Mizoguchi stealth interventions but the degree of impact declined to the level of 1/2 in general, and 1/5 in first-time-in-a-week interventions.

Taking these estimates and multiplying by 35 (the amount of intervention in the 15 months), we have an estimate of 13% depreciation (from the level otherwise). (Assuming 0.38% of depreciation per 1 trillion yen, 35 x 0.38 = 13.3% depreciation.) In other words, by selling 35 trillion yen, the Japanese authorities achieved the range from 105 to 115 in the spring-summer of 2004, rather than 90 to 100.

There may be several reasons for the decline in the effectiveness in the third period, compared to the second period. First, stealth intervention may be a worse tactic. If signaling was to be given, then announcement of the fact that interventions are carried out should amplify the effect. The weight of intervention in the total turnovers every day is very small even with a large intervention. So, any effect has to be working on the expectation of the market participants. Intervention cannot be very effective if the fact of interventions is deliberately kept confidential. Second, too frequent interventions may reduce the effectiveness of intervention. Surprise intervention is highly effective by sending new information to the market. However, continuous interventions do not convey any information to the market. Third, the market detected disagreement—whether true or false—between the Japanese and other G7 authorities over the desirability of the Japanese interventions. This was most highlighted in August-September 2003. The fact that speculative positions were built up so much in late August 2003 was the result of this. In a sense, the Japanese authorities kept intervening from September 2003 to March 2004 to reverse expectations of speculators (broadly defined). In the meantime, more interventions did not move the rate. That interventions stopped soon after net long positions disappeared in Chicago attest to this interpretation. Fourth, suppose that the Japanese authorities were defending a particular rate, which they deny. Then the success means that the rate does not move. That econometric results show no effect on the exchange rate when interventions were carried out is not a sign of ineffectiveness

but a sign of effectiveness. In a sense, the regression is mis-specified, if the objective was to defend the line but not to rebound.

4.4. Cost of Intervention

For developing countries, large-scale interventions to sell domestic currencies and build up large foreign reserves, usually are considered to be too costly, because the domestic interest rate is higher than the U.S. interest rate. However, in the case of Japan, the domestic interest rate was significantly lower than the U.S. interest rate. Therefore funding intervention by issuing yen-denominated Financial Bills (FBs) and purchasing U.S. Treasury Bills and U.S. Treasury Bonds has been a profitable operation. Ito (2003) estimated such net interest revenues, amounting to a total of 4.6 trillion yen, from 1991 to 2002:Q1. When the same calculation is extended to the end of 2004:Q1, the cumulative net interest income amounted to 5.4 trillion yen. In particular, since 1999, the funding cost of FBs has been virtually zero, reflecting the BOJ zero interest-rate policy. Any interest income generated by assets, that is, mostly U.S. government securities, is net interest income. As the increase in the cumulative intervention becomes higher, interest income becomes higher.

Another possible risk of intervention can be the depletion of foreign reserves, when the monetary authorities are selling foreign assets. However, in Japan, the direction of intervention has been to purchase foreign assets since 1998, so that theoretically, there is no limit for such an operation. Therefore, Japanese interventions were not costly on either dimension.

The realized and unrealized gains at the end of each quarter from 2002:Q1 to 2004:Q1 have been calculated. Cumulative realized gains, cumulative unrealized losses, and cumulative interest income are shown in the first three columns of Table 4. The yen/dollar rate at the end of each quarter and inventory cost is also shown in the table.

The possible cost of intervention in terms of realized and unrealized losses from trading and holdings of foreign-currency-denominated assets if the yen further appreciates can be estimated from the average inventory cost of foreign securities. Ito (2003) estimated that the average inventory cost of foreign securities holdings (those as a result of intervention since April 1991) at

the end of 2002:Q1, was about 106 yen/dollar, and unrealized gains were about 5 trillion yen with the market rate of 132 yen/dollar. At the end of 2002:Q4, the inventory cost rose to 109 yen/dollar, and the unrealized gains shrank to 2.2 trillion yen. As a result of heavy interventions from January 2003 to March 2004, the inventory cost rose to 110 yen/dollar. The market rate became 104 yen/dollar, and the unrealized valuation yielded losses of 3.3 trillion yen. Since no yen-purchase intervention has been conducted since 1998, realized gains have remained the same since 1998. However, the total profit/loss of intervention operations (sum of interest income, realized gains and unrealized gains) since 1999 is about 3 trillion yen of profits at the end of 2004.

4.5. Consistency with Monetary Policy

In order to fight deflation, the BOJ has adopted the zero interest rate policy.[16] Funding for 35 trillion yen operations was virtually at no borrowing cost, while investing in U.S. paper carried 2 to 3% interest rates depending on the maturities. Therefore, the more foreign reserves, the more net interest income.[17]

When deflation is a problem, small inflationary pressure resulting from unsterilized intervention is no harm. In fact, Svensson (2001) advocated unsterilized, unlimited intervention as a fool-proof way of getting out of intervention in Japan. Since the institutional framework for intervention in Japan—issuing fiscal bills to obtain yen cash and intervene to purchase foreign securities—guarantees automatic sterilization, the BOJ has to expand the monetary base in tandem with interventions if unsterilized intervention is pursued. Although there was no explicit cooperation for unsterilized intervention from the BOJ, the monetary base was expanded in 2003, unlike the earlier episode. This was implemented by an increase in the target of the current account at the BOJ, that is, effectively excess reserves.[18] For the first half of 2003, there were some similarities in the increase in the cumulative intervention and cumulative increase in the monetary

[16] See Ito and Mishkin (2004) on this appraisal of Japanese monetary policy in the last twenty years.
[17] This positive spread has been the case since 1992. The cumulative interest income from positions built by interventions from 1991 to 2002 is estimated to be around 4 trillion yen according to Ito (2003).
[18] See Ito (2004b) for the political economy of the relationship between the BOJ and the Ministry of Finance (MOF).

base, as shown in Figure 2. However, this was probably no more than coincidence.[19] The point is that interventions themselves were no cost or constraint to monetary policy in the deflationary environment in 2003, whether or not the BOJ was willing to expand monetary base.

5. Concluding Remarks

This paper has reviewed the experience of Japanese macroeconomic development and currency intervention from 2001 to 2004, with an emphasis on the experience from January 2003 to March 2004. The regime changed in January 2003 from infrequent, announced large-scale intervention to frequent, unannounced large-scale interventions. The regime change coincided with the change in the personnel in charge of intervention. Japanese interventions tended to occur when there was sharp appreciation of the yen, when macro fundamentals were weak, and when speculative positions were built up in 2003 and 2004.

Since the economy resumed a growth track in 2004, interventions to prevent premature yen appreciation can be regarded as a success in general. The costs of large-scale interventions were small in the environment of slow growth, zero interest rate, and deflation. However, from a tactical perspective, the effectiveness of intervention was much less in this later episode. Reasons for the loss of effectiveness include both the stealth character of the intervention and its unusual frequent use. Since the intervention started in January 2003 at the level that was far above the average inventory cost of accumulated intervention, the average inventory cost became higher. Also, the appearance of losing a battle toward the end of September encouraged more speculative yen-long positions. Interventions from October 2003 to March 2004 were basically to fight off these speculative positions rather than preventing yen appreciation in the backdrop of a weak

[19] The Deputy Governor commented on the rough correspondence between intervention amounts and additional monetary base increases on October 1, 2003, as follows: "The amount of intervention so far this year is 13.5 trillion yen, while the additional liquidity supplied by the Bank of Japan this year has been 10 trillion yen. Although *it was coincidence*, the amount of additional liquidity supply and intervention amounts were approximately equal. The combination of intervention and additional domestic liquidity has, ex post, the same effect as the unsterilized intervention. Or, again, ex post, the combination has the same effect as the purchase of US government bonds by the Bank of Japan." (Emphasis added by the author)

economy. With all these caveats, the exit was clean and the market seems to have regained stability, as of this writing (January 2005).

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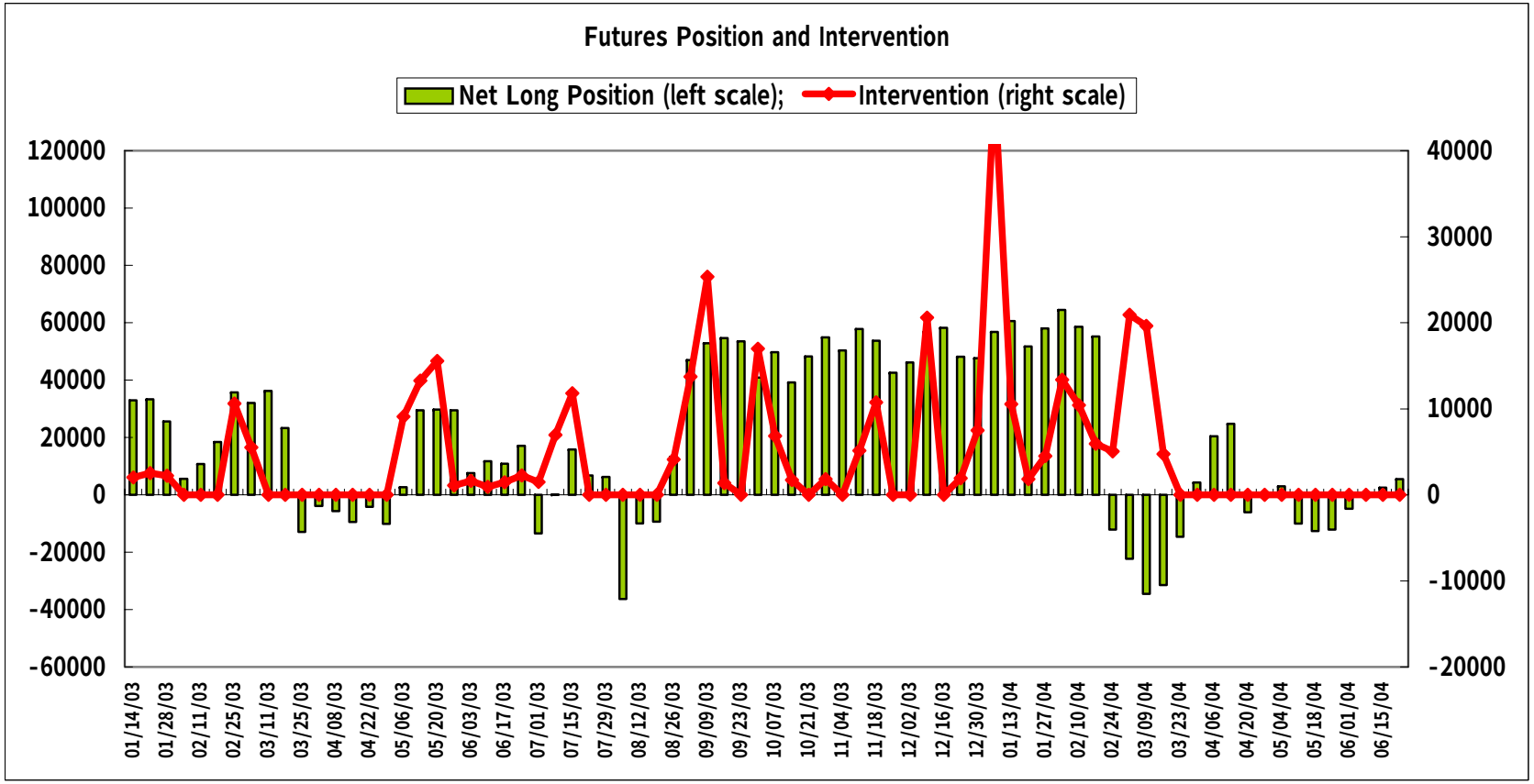
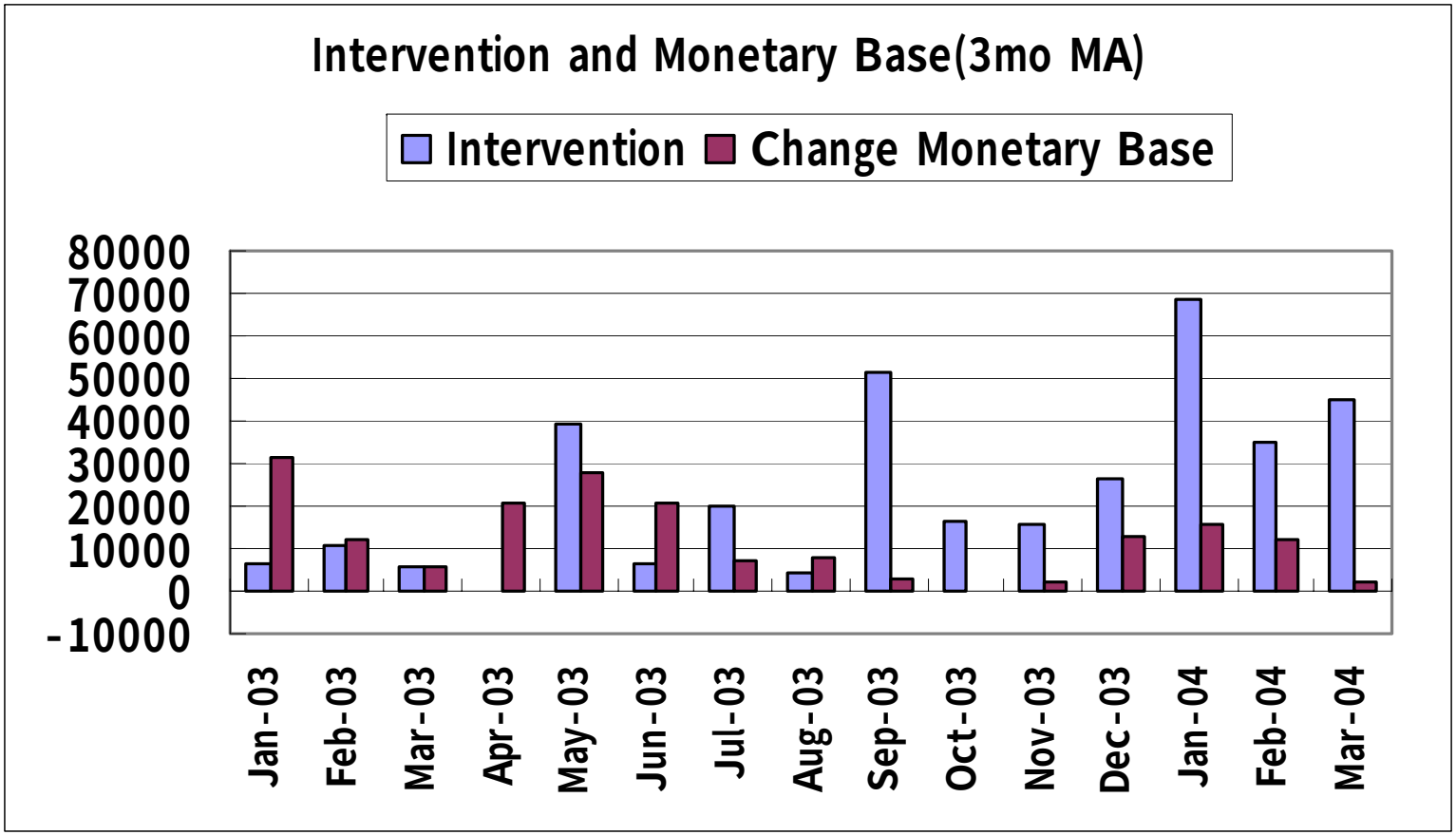
Figure 1: Futures Position and Intervention, January 14, 2003 to June 15, 2004



Source: Chicago Mercantile Exchange IMM

Figure 2: Unsterilized intervention, January 2003 to March 2004



Source: Bank of Japan

Table A-1: Views of the Bank of Japan on the economy

2001	Bank of Japan, Monthly Reports, Opening Paragraph	BOJ view
Jan	Japan's economy continues to recover gradually, but the pace is slowing due to decelerating export growth.	+0.5
Feb	Japan's economy continues to recover gradually, but the pace is slowing due to decelerating export growth.	+0.5
Mar	The recovery in Japan's economy has recently come to a pause, reflecting a decrease in exports.	0.0
Apr	Adjustments in economic activities have been under way, as production is declining reflecting a fall in exports.	-0.5
May	Adjustments in economic activities have been under way, as production is declining reflecting a fall in exports.	-0.5
Jun	Adjustments in economic activities are gradually intensifying, as production is declining substantially reflecting a fall in exports.	-1.0
July	Adjustments in economic activities are intensifying, as production is declining substantially reflecting a fall in exports.	-1.0
Aug	Adjustments in economic activities are intensifying further, reflecting a substantial decline in exports and production.	-1.0
Sept	Adjustments in economic activity are becoming more severe, as the substantial decline in production, starting from a fall in exports, is beginning to have a negative influence on employment and income conditions.	-1.5
Oct	Adjustments in economic activity are becoming more severe, as the substantial decline in production has a negative influence on employment and income conditions. In addition, the terrorist attacks in the U.S. have further heightened uncertainty in Japan's economy.	-1.5
Nov	Adjustments in economic activity are becoming more severe, as the substantial decline in production is beginning to have an adverse effect on private consumption through decreases in employment and income.	-1.5
Dec	Japan's economy is deteriorating broadly, as private consumption is weakening in addition to a decline in exports and business fixed investment.	-2.0

2002		BOJ view
Jan	Japan's economy is deteriorating broadly, as private consumption is weakening in addition to a decline in exports and business fixed investment.	-2.0
Feb	Japan's economy continues to deteriorate.	-2.0
Mar	Japan's economy still continues to deteriorate as a whole, although the downward pressure from exports and inventories is gradually abating.	-1.5
Apr	Japan's economy still continues to deteriorate as a whole, but the pace has moderated somewhat.	-1.0
May	The pace of deterioration in Japan's economy has moderated, with production starting to pick up reflecting the increase in exports and progress in inventory adjustment.	-1.0
Jun	Japan's economy shows signs of stabilizing with a distinct increase in exports and a pick-up in production, although domestic private demand remains weak.	-0.5
July	Japan's economy, despite continued weakness in domestic demand, has almost stabilized as a whole with an increasing upward impetus from exports and production, and an improvement in corporate profits and business sentiment.	0.0
Aug	Japan's economy, despite persistent weakness in domestic demand and increasing uncertainty regarding the global economy, has almost stabilized as a whole with exports and production continuing to increase.	0.0
Sept	Japan's economy, despite persistent weakness in domestic demand and large uncertainty regarding the global economy, has almost stabilized as a whole with exports and production continuing to increase.	0.0
Oct	Japan's economy has stabilized as a whole, but clear signs of recovery have not yet been observed partly due to large uncertainty regarding the global economy.	0.0
Nov	Japan's economy has stabilized as a whole, but there is greater uncertainty toward recovery.	0.0
Dec	Japan's economy has stabilized as a whole, but there is still substantial uncertainty toward recovery.	0.0

2003		BOJ view
Jan	Japan's economy has stabilized as a whole, but there is still substantial uncertainty about the prospects for a recovery.	0.0
Feb	Economic activity remains flat amid substantial uncertainty about the outlook for the economy.	0.0
Mar	Economic activity remains flat amid substantial uncertainty about the outlook for the economy.	0.0
Apr	Economic activity remains flat as a whole, despite some signs of improvement, with greater uncertainty about the economic outlook partly due to Iraq-related developments.	0.0
May	Economic activity remains flat as a whole, but there is greater uncertainty about the economic outlook.	0.0
Jun	Economic activity remains virtually flat as a whole, although exports are currently showing some weakness.	0.0
July	Economic activity remains virtually flat.	0.0
Aug	Economic activity remains virtually flat.	0.0
Sept	Economic activity still continues to be virtually flat as a whole, although signs of improvement have been observed in such areas as the environment for exports.	0.0
Oct	The foundation for a gradual recovery in Japan's economy is being laid, as the environment for exports and business sentiment have improved.	0.5
Nov	Japan's economy is starting to recover gradually.	0.5
Dec	Japan's economy is recovering gradually.	0.5

2004		BoJ view
Jan	Japan's economy is recovering gradually.	0.5
Feb	Japan's economy is recovering gradually.	0.5
Mar	Japan's economy is recovering gradually.	0.5
Apr	Japan's economy continues to recover gradually, and domestic demand is becoming firmer.	0.5
May	Japan's economy continues to recover gradually, and domestic demand is becoming firmer.	0.5
Jun	Japan's economy continues to recover, and the increases in production and corporate profits are exerting positive effects on employment.	1.0

Note: Author's interpretation of BOJ opening statements of the monthly report on the direction of the economy, from –2.0 to +2.0. The original monthly reports are available from the Bank of Japan homepage: http://www.boj.or.jp/en/seisaku/0*/seisak_f.htm, where t=1,2,3,4.

Table A-2: Macro Fundamentals, January 2001 to June 2004

	Stock prices eom	Chg Stock p	Yen/$ rate eom	yen chg	BOJ view	Growth rate	Core inflatio	Intervention	Chg M base
2001Ja	13,843.55	0.4	116.38	1.3	0.5		-0.8	0	**1692**
Feb	12,883.54	-6.9	116.44	0.1	0.5		-0.8	0	**-33414**
Mar	12,999.70	0.9	125.27	7.6	0.0	1.4	-0.9	0	**9495**
Apr	13,934.32	7.2	124.06	-1.0	-0.5		-0.8	0	**10364**
May	13,262.14	-4.8	119.06	-4.0	-0.5		-1.0	0	**1929**
Jun	12,969.05	-2.2	124.27	4.4	-1.0	-4.4	-0.9	0	**85**
July	11,860.77	-8.5	124.79	0.4	-1.0		-0.9	0	**18087**
Aug	10,713.51	-9.7	118.92	-4.7	-1.0		-0.9	0	**-5095**
Sept	9,774.68	-8.8	119.29	0.3	-1.5	-3.2	-0.8	-31455	**23625**
Oct	10,366.34	6.1	121.84	2.1	-1.5		-0.7	0	**11146**
Nov	10,697.44	3.2	123.98	1.8	-1.5		-0.8	0	**16276**
Dec	10,542.62	-1.4	131.47	6.0	-2.0	-2.7	-0.9	0	**60646**
2002Ja	9,997.80	-5.2	132.94	1.1	-2.0		-0.8	0	**46394**
Feb	10,587.83	5.9	133.89	0.7	-2.0		-0.8	0	**-14655**
Mar	11,024.94	4.1	132.71	-0.9	-1.5	-2.4	-0.7	0	**45330**
Apr	11,492.54	4.2	127.97	-3.6	-1.0		-0.9	0	**38900**
May	11,763.70	2.4	123.96	-3.1	-1.0		-0.8	-21174	**-42164**
Jun	10,621.84	-9.7	119.22	-3.8	-0.5	5.1	-0.8	-18750	**-13897**
July	9,877.94	-7.0	119.82	0.5	0.0		-0.8	0	**6474**
Aug	9,619.30	-2.6	117.97	-1.5	0.0		-0.9	0	**75**
Sept	9,383.29	-2.5	121.79	3.2	0.0	4.1	-0.9	0	**-3412**
Oct	8,640.48	-7.9	122.48	0.6	0.0		-0.9	0	**1830**
Nov	9,215.56	6.7	122.44	-0.0	0.0		-0.8	0	**34701**
Dec	8,578.95	-6.9	119.37	-2.5	0.0	0.7	-0.7	0	**55444**
2003Ja	8,339.94	-2.8	119.21	-0.1	0.0		-0.8	-6781	**4224**
Feb	8,363.04	0.3	117.75	-1.2	0.0		-0.7	-10614	**-23394**
Mar	7,972.71	-4.7	119.02	1.1	0.0	-0.1	-0.6	-5518	**36185**
Apr	7,831.42	-1.8	119.46	0.4	0.0		-0.4	0	**48986**
May	8,424.51	7.6	118.63	-0.7	0.0		-0.4	-38997	**-1898**
Jun	9,083.11	7.8	119.82	1.0	0.0	4.3	-0.4	-6289	**14085**
July	9,563.21	5.3	120.11	0.2	0.0		-0.2	-20271	**8731**
Aug	10,343.55	8.2	117.13	-2.5	0.0		-0.1	-4124	**1085**
Sept	10,219.05	-1.2	110.48	-5.7	0.0	2.2	-0.1	-51116	**-1116**
Oct	10,559.59	3.3	108.99	-1.3	0.5		0.1	-16687	**-321**
Nov	10,100.57	-4.3	109.34	0.3	0.5		-0.1	-15872	**7351**
Dec	10,676.64	5.7	106.97	-2.2	0.5	7.6	0.0	-26196	**31629**
2004Ja	10,783.61	1.0	105.88	-1.0	0.5		-0.1	-68215	**8329**
Feb	11,041.92	2.4	109.08	3.0	0.5		0.0	-34766	**-2750**
Mar	11,715.39	6.1	103.95	-4.7	0.5	6.4	-0.1	-45332	**668**
Apr	11,761.79	0.4	110.44	6.2	0.5		-0.2	0	**1720**
May	11,236.37	-4.5	109.56	-0.8	0.5		-0.3	0	**5370**
Jun	11,858.87	5.5	108.69	-0.8	1.0	1.3	-0.1	0	**-15371**

Notes and Sources:

Stock: The percentage change in the Nikkei stock price index from the end of month t-1 to the end of month t. The level is available from the Bank of Japan homepage: http://www.boj.or.jp/stat/dlong_f.htm

Yen: The percentage change in the yen/dollar rate from the end of month t-1 to the end of month t. Negative numbers imply yen appreciation. The level is available from the Bank of Japan homepage: http://www.boj.or.jp/stat/dlong_f.htm

Intervention: The aggregated amounts of yen/dollar intervention in the month, excluding the yen/euro interventions. Negative numbers imply yen-selling, dollar-purchasing interventions. The original data are available at the Ministry of Finance homepage:
http://www.mof.go.jp/english/e1c021.htm

GDP: The real GDP growth rate, annualized rates of quarter to quarter changes. The quarterly GDP is seasonally adjusted.

The GDP statistics are available from Cabinet Office: http://www.esri.cao.go.jp/en/sna/menu.html

Inflation: The percentage change in the CPI excluding fresh food. CPI is available from Statistics Bureau, Ministry of Internal Affairs and Communication: http://www.stat.go.jp/data/cpi/1.htm

Table 1. Intervention Regimes before and after January 2003

Quarter	Total Y/$ Intervention Billion yen	Number of Days	Average Amount Intervention	Smallest	Largest	
2001Q3	3,210.7	7	449.4	94.3	1,287.4	
2001Q4	0					
2002Q1	0					
2002Q2	4,016.2	7	570.3	94.3	1,287.4	
2002Q3	0					
2002Q4	0					
2003Q1	2,386.7	17	134.8	0.4	361.5	
2003Q2	4,611.6	18	251.6	7.0	1,040.1	
2003Q3	7,551.2	21	359.6	23.6	1,066.7	
2003Q4	5,875.5	26	226.0	0.1	1,283.8	
2004Q1	14,831.4	47	315.6	2.1	1,666.4	
2004Q2	0					
Notes: Calculation by the author Original data: Ministry of Finance, Japan.						

Table 2. Net long futures in the Intervention Reaction Function

OLS (2003/1/1-2004/3/16)

$$Int_t = \phi_1(s_{t-1} - s_{t-2}) + \phi_2(s_{t-1} - s_{t-1}^{MA}) + \phi_3 Int_{t-1} + \phi_4 IMM_t 1(IMM_t > 0) + \phi_5 IMM_t 1(IMM_t < 0) + \nu_t$$

	Tuesday	Friday
Φ_1	132850 (65960)*	179787 (70423)**
Φ_2	-28787 (28878)	2759 (49778)
Φ_3	0.21 (0.09)*	0.15 (0.10)
Φ_4	-0.16 (0.04)**	-0.12 (0.07)†
Φ_5	0.34 (0.19)†	0.37 (0.20)†
OBS	64	63

Notes: Heteroskedasticity-and-autocorrelation-consistent (HAC) standard errors are given in parentheses.

†Statistically significant at the 10-percent level.

*Statistically significant at the 5-percent level.

**Statistically significant at the 1-percent level

Table 3. Effectiveness

$$\Delta s_t = \beta_0 + \beta_1 \Delta s_{t-1} + \beta_2 (s_{t-1} - s_{t-1}^{MA}) + \beta_3 Int_t + \beta_4 IntUS_t + \beta_5 IntIN_t + \varepsilon_t$$

	April 1, 1991 – June 20, 1995	June 21, 1995 – January 13, 2003	January 14, 2003 – March 31, 2004
β_0	-0.0008 (0.0002)**	0.0001 (0.0002)	-0.001 (0.0005)*
β_1	-0.028 (0.031)	-0.0022 (0.026)	-0.033 (0.053)
β_2	-0.0158 (0.0053)**	0.0019 (0.002)	-0.0038 (0.0089)
β_3	0.0000047 (0.0000008)**	-0.0000007 (0.0000002)**	-0.00000038 (0.00000016)*
β_4	-0.000012 (0.000005)**	-0.000054 (0.000008)**	Na
β_5	0.0000008 (0.0000057)	-0.0000014 (0.0000005)**	-0.00000007 (0.0000003)
R2	0.0031	0.0068	0.0037
#Obs	1101	1962	308

Estimated with a GARCH model. ** statistically significant at the 1-percent level.
* statistically significant at the 5-percent level. † statistically significant at 10-percent level.

Notes: see Ito (2003) for the details of the first two periods, and see Ito (2004) for the third period.

Table 4. Profit/Cost of Intervention

Unit: 100 million yen

Qtr	Realized gains (1)	Unrealized gains (2)	Cumulative interest income (3)	Cumulative Gains (1)+(2)+(3)	Cumulative Intervention	End-qtr yen/dollar	Inventory cost
02.1	9962.7	50547.0	45634.3	106144.0	1926.7	132.7	106.5
02.2	9962.7	23816.2	46857.1	80636.1	2251.9	119.4	108.8
02.3	9962.7	28770.3	47958.0	86691.0	2251.9	121.6	108.8
02.4	9962.7	22239.9	48872.8	81075.4	2251.9	118.7	108.8
03.1	9962.7	20727.9	49710.8	80401.4	2446.6	118.0	109.5
03.2	9962.7	26262.6	50576.7	86802.0	2835.2	119.8	110.5
03.3	9962.7	-282.0	51515.1	61195.8	3484.2	111.5	111.6
03.4	9962.7	-15940.1	52517.5	46540.1	4024.1	107.3	111.2
04.1	9962.7	-33142.3	53924.8	30745.2	5400.7	104.2	110.3

See Ito (2003) for precise definitions of each item.