

CENTER ON JAPANESE ECONOMY AND BUSINESS

日本経済経営研究所

Working Paper Series

March 2011, No. 294

The Great Intervention and Massive Money Injection: The Japanese Experience 2003-2004

Tsutomu Watanabe and Tomoyoshi Yabu

This paper is available online at www.gsb.columbia.edu/cjeb/research

The Great Intervention and Massive Money Injection: The Japanese Experience 2003-2004

Tsutomu Watanabe* Tomoyoshi Yabu[†]

November 10, 2010

Abstract

From the beginning of 2003 to the spring of 2004, Japan's monetary authorities conducted large-scale yen-selling/dollar-buying operations in what John Taylor has labeled the "Great Intervention." This paper examines the relationship between this "Great Intervention" and the quantitative easing policy the Bank of Japan was pursuing at that time. First, we find that about 40 percent of the yen funds supplied to the market by yen-selling interventions were not offset by the BOJ's monetary operations, and remained in the market for a while; this is in contrast with the preceding period, when almost 100 percent were immediately offset. Second, comparing interventions and other government payments, the extent to which the funds were offset were much smaller in the case of interventions, suggesting that the BOJ differentiated between and responded differently to interventions and other government payments. These two findings indicate that it is likely that the BOJ intentionally did not sterilize yen-selling interventions to achieve its policy target of maintaining current account balances of commercial banks at the BOJ at a high level. Finally, we find that an unsterilized intervention had a greater impact on the yen-dollar rate than a sterilized one did, indicating that it matters whether an intervention is sterilized or not even when the economy is in a liquidity trap.

JEL Classification Number: F30; E52; E58

Keywords: foreign exchange intervention; sterilization; quantitative easing

*Correspondence: Tsutomu Watanabe, Research Center for Price Dynamics and Institute of Economic Research, Hitotsubashi University, Kunitachi, Tokyo 186-8603, Japan. E-mail: tsutomu.w@srv.cc.hit-u.ac.jp We would like to thank John Taylor, Takatoshi Ito, John Leahy, Mototsugu Shintani, Kazuo Ueda, and Lars Svensson for useful conversations and comments. This research is a part of the project entitled: Understanding Inflation Dynamics of the Japanese Economy, funded by JSPS Grant-in-Aid for Creative Scientific Research (18GS0101). The second author acknowledges financial supports from the JSPS (Grants-in-aid for Young Scientists B20730203).

[†]Faculty of Business and Commerce, Keio University. E-mail: tyabu@fbc.keio.ac.jp

1 Introduction

During the period from 2001 to 2006, the Japanese monetary authorities pursued two interesting policies. The first of these is the quantitative easing policy introduced by the Bank of Japan (BOJ) in March 2001. This step was motivated by the fact that although the overnight call rate, the BOJ's policy rate, had reached its lower bound at zero percent, it failed to sufficiently stimulate the economy. To achieve further monetary easing, the BOJ therefore changed the policy variable from the interest rate to the money supply. The quantitative easing policy remained in place until March 2006, by which time the Japanese economy had started to recover. The second major policy during this period were interventions in the foreign exchange market by Japan's Ministry of Finance (MOF) and the BOJ, which engaged in large-scale selling of the yen from January 2003 to March 2004. Taylor (2006) has called this the "Great Intervention." The interventions during this period occurred at a frequency of once every two business days, with the amount involved per daily intervention averaging 286 billion yen and the total reaching 35 trillion yen. Even for Japan's monetary authorities, which are known for their active interventionism, this frequency as well as the sums involved were unprecedented.

The main interest of this paper is on how these two policies were related to each other. Researchers often maintain that monetary policy and exchange rate interventions are independent policies.¹ That is, in a normal situation, monetary policy is conducted by setting a target level for very short-term interest rates (e.g., the federal funds rate in the US, the overnight call rate in Japan) and adjusting the quantity of base money on a daily basis to maintain that level. If the amount of yen funds circulating in the market increases or decreases as a result of foreign exchange interventions, overnight interest rates will deviate from the target level. Then the central bank will use open market operations to offset the funds supplied to or absorbed from the market by the foreign exchange interventions. The central banks of the advanced economies sterilize foreign exchange interventions in this way - an observation that has been confirmed by a large number of empirical studies. As long as such sterilization is conducted, monetary policy and foreign exchange interventions are not mutually related.

But did such sterilization also occur even during the period of the "Great Intervention"? In addressing this question, it should be noted that the target level of the overnight call rate was practically zero during this period. Therefore, even if yen funds

¹See, for example, Craig and Humpage (2001).

are supplied to the market by yen-selling interventions, the overnight rate, which is already zero, will not deviate from the target level, so that the BOJ does not need to sterilize those interventions. Rather, the BOJ has a reason to actively choose not to sterilize them, because the yen funds supplied by intervention help them to increase base money, thereby achieving the target for current account balances of commercial banks at the BOJ.

Taylor (2006) points out that the reason why the US Treasury, which in the past had been critical of Japan's yen-selling interventions, approved such interventions at this period is that they provided additional support for the BOJ's quantitative easing policy. According to this view, Japan's MOF conducted large-scale yen-selling interventions, which the BOJ did not sterilize, thus allowing an increase in base money, which eventually led to the recovery of the Japanese economy.² In contrast, the BOJ maintained that there was no causal relationship between large-scale yen-selling interventions and quantitative easing. For example, responding to the report in August 2003 that both yen-selling interventions and the increase in the outstanding balance of current accounts at the BOJ since the beginning of the year amounted to about 10 trillion yen, the Deputy Governor of the BOJ, Kazumasa Iwata, simply stated that this was "coincidence."³

Using daily data of current account balances at the BOJ and the amount of foreign exchange interventions, we find that around 60 percent of the yen funds supplied to the market by yen-selling interventions were offset by monetary operations by the BOJ (i.e., sterilized), while the remaining 40 percent were not offset. Moreover, the funds that were not offset remained in the market for a while. This is in contrast with the preceding period when nearly 100 percent were offset immediately. We also find that, comparing interventions and other government payments, the extent to which the funds were offset were much smaller in the case of interventions, suggesting that the BOJ differentiated between and responded differently to interventions and other government payments. These two findings indicate that it is likely that the BOJ intentionally did not sterilize yen-selling interventions to achieve its policy target of maintaining current account balances of commercial banks at the BOJ at a high level. Finally, we find that an unsterilized intervention had a greater impact on the yen-dollar rate than a sterilized

²The same point was made at the time by Svensson (2001) and Hamada (1999) among others.

³However, the Governor in a statement in December 1999 acknowledged that the BOJ employed the method of increasing the money base by leaving the funds of yen-selling foreign exchange interventions in the market, saying that "the BOJ has been flexibly providing ample funds to the short-term money market taking account of factors including yen liquidity arising from foreign exchange intervention."

one did, indicating that it matters whether an intervention is sterilized or not even when the economy is in a liquidity trap. This result suggests that unsterilized interventions affected the exchange rate through a change in market participants' expectations about future money supply.

The rest of this paper is organized as follows. The next section explains the quantitative easing policy and the "Great Intervention" in more details. Section 3 investigates the contemporaneous correlation between interventions and changes in current account balances at the BOJ, while Section 4 examines dynamic relationship between the two. Section 5 asks whether sterilized and unsterilized interventions had different effects on the exchange rate even when the economy is in a liquidity trap. Section 6 concludes the paper.

2 The Quantitative Easing Policy and the Great Intervention

2.1 The quantitative easing policy

The BOJ decided to introduce its quantitative easing policy on March 19, 2001 (see Table 1 for a chronology of monetary policy measures in Japan).⁴ The aim of this policy was to stimulate effective demand by providing ample supplies of base money. The target level of outstanding current account balances at the BOJ was initially set at 5 trillion yen, meaning that the target level exceeded the level of required reserve, which was approximately 4 trillion yen, by about 1 trillion yen.

We would like to highlight two features of the quantitative easing policy, which are often overlooked by researchers but have some important implications in examining the relationship with foreign exchange interventions. The first of these is that there were frequent changes in the target level of current account balances at the BOJ. After the initial level had been set at 5 trillion yen in March 2001, this was raised to 6 trillion yen less than half a year later, in August 2001. By December of that year, the target level was further increased to a range of 10-15 trillion yen, and the target continued to be raised at relatively short intervals until it finally reached 30-35 trillion yen in January 2004. What is important is not only that the target of current account balances was

⁴The BOJ adopted its zero interest rate policy aiming to keep the target level of the overnight interest rate at zero in February 1999 and maintained this until August 2000. Although the zero interest rate policy and the quantitative easing policy have in common that they aim to maintain the overnight interest rate at zero, the latter differs in the way that it seeks to affect aggregate demand not through the price channel (i.e. the interest rate channel) but through the various quantity channels, including the so-called portfolio rebalance channel.

Table 1: Chronology of Monetary Policy Decisions in 1999-2006

Dates	Events
09/09/98	The BOJ reduces the target O/N rate to 0.25 from 0.50 percent
02/12/99	The BOJ introduces a zero interest rate policy (ZIRP)
04/13/99	Governor Masaru Hayami announces the BOJ will continue the ZIRP until “deflationary concerns are dispelled”
10/13/99	The BOJ expands the range of money market operations
08/11/00	The BOJ terminates the ZIRP and increases the target O/N rate to 0.25 percent
02/09/01	The BOJ introduces Lombard-type lending facility and reduces the official discount rate to 0.375 from 0.5 percent
02/28/01	The BOJ reduces the target O/N rate to 0.125 percent and the official discount rate to 0.25 percent
03/19/01	The BOJ introduces a quantitative easing policy and announces to continue it until “the core CPI records a year-on-year increase of zero percent or more on a stable basis.”
	The BOJ sets the target current account balance (CAB) at 5 trillion yen
08/14/01	The BOJ raises the target CAB to 6 trillion yen
09/18/01	The BOJ raises the target CAB to above 6 trillion yen
12/19/01	The BOJ raises the target CAB to 10–15 trillion yen
10/30/02	The BOJ raises the target CAB to 15–20 trillion yen
04/01/03	The BOJ raises the target CAB to 17–22 trillion yen
04/30/03	The BOJ raises the target CAB to 22–27 trillion yen
05/20/03	The BOJ raises the target CAB to 27–30 trillion yen
10/10/03	The BOJ raises the target CAB to 27–32 trillion yen. The BOJ announces more detailed description of its commitment regarding the timing to terminate quantitative easing policy
01/20/04	The BOJ raises the target CAB to 30–35 trillion yen
03/09/06	The BOJ terminates quantitative easing policy
07/14/06	The BOJ terminates the ZIRP and sets the target O/N rate at 0.25 percent

at a high level, but also that it was revised quite frequently.

Second, since December 2001, the target of current account balances was no longer a point value but a range. For example, in January 2004, the range was set at 30-35 trillion yen, meaning that fluctuations up to 5 trillion yen were acceptable. Although the BOJ has not explained why it set a target *range* or on what basis it decided that this range would be 5 trillion yen, looking at the BOJ’s actual monetary policy conduct in Figure 1, it is clear that it actually permitted fluctuations within this range. This pattern is especially obvious in the period since 2003, the main period of interest for this paper. To examine this point in more detail, Figure 2 depicts the distribution of the actual values of daily current account balances during the period when the target range was 30-35 trillion yen, i.e., from January 2004 to March 2006. It shows that the mode of the distribution is at 33.7 trillion yen and the frequency declines toward the fringes of the range. Thus, it can be conjectured that even though the BOJ had set a provisional target level of 33.7 trillion yen, it was prepared to accept divergences from that level at times of large autonomous disturbances through the inflow and

outflow of funds, such as foreign exchange interventions. We will discuss more about the implications of these two properties of the quantitative easing policy in Section 4.

2.2 The Great Intervention

Figure 3 shows the daily value of foreign exchange interventions between 2001 and 2007. As can be seen, the pattern of interventions is quite remarkable, showing a high frequency of interventions during the period from January 15, 2003 to March 16, 2004. As described by Ito (2003), it is the MOF, and in particular the Vice Minister of Finance for International Affairs, who plays a leading role in foreign exchange interventions, and it is conspicuous that interventions were concentrated in the period when Zembei Mizoguchi was in this post. Compared with the period of his predecessors, Sakakibara and Kuroda (who held the post between June 1995 and January 2002), the frequency of interventions increased remarkably from, on average, once every forty days to once every two days. Moreover, whereas the total amount of interventions under Sakakibara and Kuroda came to 26 trillion yen, under Mizoguchi it reached 35 trillion yen, providing further indication of the heavy intervention during a short period.

3 Contemporaneous Correlation between Interventions and Changes in Current Account Balances

We now turn to examining whether there is a correlation between changes in current account balances and foreign exchange interventions. If there is a positive correlation between the two, this would mean that foreign exchange interventions were not sterilized. Conversely, no correlation would mean that interventions were sterilized.⁵

Let us begin by examining the relationship between the two with a simple scatter plot. Figure 4 plots daily data with the horizontal axis depicting the value of interventions and the vertical axis showing the change in current account balances. The sample consists of observations from 1992 onward and is divided into the periods before and after December 19, 2001, the date on which the BOJ first set a target *range*

⁵In order to conduct yen-selling interventions, the MOF has to finance yen funds. One way to do so is to issue financing bills (FBs) on the same day as the intervention is conducted. In that case, because the MOF immediately returns the yen funds that it obtained by issuing FBs to the market through the intervention, the amount of yen funds circulating in the market does not change at all. However, in practice, such an automatic sterilization does not take place because there is a time gap of about two months between foreign exchange interventions and the issuing of FBs; as a result, when the MOF intervenes by selling yen, the amount of yen funds circulating at that point in time actually increases unless the BOJ conducts monetary operations to absorb them. For details on the practicalities of foreign exchange market interventions in Japan, see Ito (2003).

for current account balances. Current account balances at the end of day t are denoted by R_t , while the value of yen sales/dollar purchases conducted on day t is denoted by I_t . The vertical axis shows ΔR_t , while the horizontal axis depicts I_{t-2} . The value of interventions at $t - 2$ is used because the settlement of funds takes place two business days after interventions were executed. As can be seen from Figure 4, there is almost no correlation between the two in the first half of the sample period. In contrast, in the latter half of the sample period, a weak correlation can be observed.

We examine this difference by estimating a simple equation of the form:

$$\Delta R_t = \mu + \beta I_{t-2} + u_t \quad (1)$$

where u_t is an iid disturbance term.⁶ This specification has been widely used in existing studies to measure the extent of sterilization. For example, a similar specification was employed by Fatum and Hutchison (2005) and Ito (2004) to investigate the BOJ's behavior in the recent period. The results are presented in Table 2. As for the first period, we find that the estimated value of β at -0.004 is close to zero and we cannot reject the null hypothesis of $\beta = 0$. In other words, we cannot reject the hypothesis that interventions during this period were completely sterilized. In contrast, for the latter period, at 0.389, β is positive and statistically significant, suggesting that approximately 60 percent of the value of foreign exchange interventions was sterilized, while the remaining 40 percent was not.⁷

We use equation (1) to conduct a rolling regression in order to examine the change in the coefficient β over time. The window of the rolling regression is the preceding 750 days. The results are presented in Figure 5, which shows the estimated value of β as well as the 90 percent confidence interval. The figure indicates that while until 2000, β is zero or below zero, it turns positive in September 2001 and from March 2003 onward becomes large and significantly different from zero. Moreover, after 2003, the value of β is relatively stable at around 0.4.

⁶By definition, ΔR_t is equal to commercial banks' net receipt of yen funds on day t from the government and the central bank. The amount of intervention to be settled on day t , I_{t-2} , is a part of the net receipt from the government, and the amount of monetary operations for sterilization, which is denoted by $-(1 - \beta)I_{t-2}$, is also a part of the net receipt from the central bank. We sum up these two (i.e., $I_{t-2} - (1 - \beta)I_{t-2} = \beta I_{t-2}$) to obtain equation (1). Note that all other kinds of commercial banks' receipt of yen funds from the government and the central bank are included in the disturbance term u_t .

⁷During the period of the Great Intervention, foreign exchange interventions totaling 35 trillion yen were carried out. At the same time, current account balances at the BOJ during this period increased from 20 trillion yen to 33 trillion yen. Interestingly, the increase in current account balances of 13 yen trillion is equivalent to approximately 40 percent of the value of foreign exchange interventions.

Table 2: Contemporaneous Correlation between Interventions and Changes in Current Account Balances

	Entire sample period	1992/1/1-2001/12/18	2001/12/19-2006/3/9
Constant	-0.016 (0.009)*	-0.006 (0.011)	-0.046 (0.020)**
I_{t-2}	0.188 (0.103)*	-0.004 (0.151)	0.389 (0.116)***
$\overline{R^2}$	0.052	0.016	0.162
OBS	3496	2461	1035

Note: Heteroskedasticity-and-autocorrelation-consistent (HAC) standard errors are in parentheses. The symbols *, **, and *** represent statistically significant at the 10-percent level, at the 5-percent level, and at the 1-percent level.

4 Dynamic Relationship between Interventions and Current Account Balances

4.1 Did interventions have permanent impacts on current account balances?

The analysis in the previous section clearly indicates that yen-selling interventions affected current account balances at least on the day of intervention (more precisely, on the settlement day of intervention) during the Great Intervention period. But how persistent were they? Did interventions have permanent impacts on the level of current account balances? These are key questions asked by researchers who study optimal monetary policy in a liquidity trap. Specifically, Jeanne and Svensson (2007) and Eggertsson (2006) argue that a permanent increase in base money resulting from a yen-selling intervention will effectively stimulate aggregate demand even when the economy is caught by a liquidity trap. According to them, the purchase of foreign currencies by issuing money (i.e., unsterilized intervention) is an effective device to make a credible commitment about future reflation, because it will incur balance-sheet losses if the central bank (and the government) reneges on an inflation promise, thereby causing an exchange rate appreciation.

In addressing whether interventions had permanent impact or not, it is important to note that a permanent increase in current account balances would never be allowed if the quantitative easing policy is operated by specifying a target level of current account balances (rather than a target range of them) *and* there is no overtime change in the target level, since, in this type of rigid rule, a permanent increase in current

Table 3: Convergence Speed Inside and Outside the Target Range

	2003/5/20-2006/3/9
Constant	10.226 (0.966) ^{***}
R_{t-1}	0.646 (0.033) ^{***}
R_{t-1}^*	-0.012 (0.007) [*]
I_{t-2}	0.459 (0.091) ^{***}
$\overline{R^2}$	0.832
OBS	690

Note: See the note for Table 2.

account balances resulting from a yen-selling intervention would simply mean a failure of targeting policy. However, as we saw in Section 2.1, the quantitative easing policy adopted by the BOJ was not something like this: the target was specified by the range *and* it was updated quite frequently.

There are two possibilities in which interventions have a permanent impact on current account balances under such a flexible policy rule. The first possibility is that a yen-selling intervention is settled exactly on the day when the target of current account balances is updated; therefore yen funds supplied to the market through the yen-selling intervention can remain there permanently without violating the target of current account balances. To examine this possibility, we compare the timing of interventions and the timing of changes in the target of current account balances during the Great Intervention period. There are five episodes of changes in the target of current account balances during the Great Intervention period. In Figure 6, we show the amounts of interventions to be settled on days before and after the day of a change in the target of current account balances, day T , for each of the five episodes. Figure 6 clearly shows that almost all of large-scale interventions took place without accompanying a change in the target of current account balances, with an exception of a large-scale intervention that was settled on May 21, 2003, one day after the target of current account balances was updated from 22-27 trillion yen to 27-30 trillion yen.

The second possibility is that the target range was wide enough to allow for persistent change in current account balances resulting from interventions. To investigate

this possibility in more detail, we estimate a policy reaction function of the form:

$$R_t = \mu + \rho R_{t-1} + \rho^* R_{t-1}^* + \beta I_{t-2} + u_t. \quad (2)$$

The variable R_t^* is defined as $R_t^* \equiv R_t * 1(R_t > R_t^U \text{ or } R_t < R_t^L)$, where R_t^U stands for the upper limit of the target range and R_t^L for the lower limit, and $1(\cdot)$ represents an indicator function that takes a value of one if the statement in the bracket is true, and zero otherwise. That is, R_t^* equals to R_t when R_t is outside the target range; otherwise it equals to zero. The parameter ρ is associated with dynamic adjustment of current account balances to the desired level, which is given by $\frac{\mu}{1-\rho}$, when current account balances are inside the target range: the closer ρ is to 1, the slower is the convergence to the desired level. On the other hand, $\rho + \rho^*$ is associated with adjustment to the desired level when current account balances are outside the target range. The null hypothesis is that the BOJ permits current account balances to move freely within the target range (and thus there is no convergence whatsoever), but once current account balances are outside the range, they converge to the desired level. Under the null hypothesis, we should expect $\rho = 1$ and $|\rho + \rho^*| < 1$.

The estimation result is presented in Table 3. In the estimation, dummy variables for changes in the target of current account balances are included. Specifically, six dummy variables for the following dates are included: 2002/10/30, 2003/4/1, 2003/4/30, 2003/5/20, 2003/10/10, and 2004/1/20. Each dummy variable takes a value of one from that date onward, and zero otherwise. The result obtained from a regression using the entire sample period shows that ρ is positive but significantly different from unity, implying that convergence does occur even inside the target range. More importantly, since ρ^* is not significantly different from zero, the difference in the speed of convergence between inside and outside the target range is not significantly large. These results reject the null hypothesis that the BOJ permitted current account balances to move freely within the target range, thereby allowing interventions to have a permanent effect on the level of current account balances.⁸

⁸Note that it is assumed in equation (1) that the coefficient on R_{t-1} is equal to unity, therefore R is a non-stationary process. This is clearly inconsistent with the result in Table 3. To examine whether R is a stationary or non-stationary process in a formal way, we conducted a unit root test by estimating an equation of the form: $R_t = \mu + \rho R_{t-1} + u_t$ with the six dummy variables associated with changes in the target of current account balances. The critical values of this unit root test are calculated through simulation. We rejected the null by finding that ρ , which is estimated to be 0.819, is lower than unity at the 1 percent significance level.

4.2 Temporary nonsterilization

The above results clearly rule out the possibility that yen funds supplied through yen-selling interventions stayed in the market permanently. However, the estimates of ρ and β in equation (2) are both positive and significantly different from zero, implying that some portion of yen funds supplied through interventions stayed in the market for a while. In other words, non-sterilization is not permanent but temporary. Using the estimates of ρ and β of equation (2), we calculate in Figure 7 how quickly (or slowly) yen funds supplied through yen-selling interventions are offset over time by the BOJ's subsequent operations. The figure shows that about 60 percent of one trillion yen supplied through interventions are offset two days after the intervention is implemented (i.e. the settlement day of the intervention), so that 400 billion yen remains in the market at that time. The amount of yen funds that remain in the market decrease over time to reach 250 billion yen four days later, 170 billion yen six days later, 70 billion yen ten days later, and the yen funds disappears from the market almost completely twenty days later. Comparing this with the preceding period in which almost 100 percent of funds are offset two days later, yen funds supplied through interventions tended to stay in the market much longer during the Great Intervention period.

4.3 Comparison with government payments other than foreign exchange interventions

The government pays funds to the private sector in various forms, for example in the form of pension payments. The supply of yen funds to the market through yen-selling interventions is just one form of such government payments. If the BOJ did not sterilize any form of government payments during the period of quantitative easing, then the previous findings that interventions were not 100 percent sterilized may not be so surprising. Therefore we need to know whether or not the central bank distinguishes between foreign exchange interventions and other government payments, and increases the degree of nonsterilization in the case of foreign exchange interventions.

We denote net government payments on day t by G_t , and gross government payments and receipts by GP_t and GR_t . Specifically, the variables GP_t and GR_t are defined as $GP_t \equiv G_t * 1(G_t > 0)$ and $GR_t \equiv G_t * 1(G_t < 0)$, respectively. Note that the variable GP_t defined here includes only government payments other than yen-selling interventions, although yen-selling interventions are usually included in government payments

Table 4: Interventions and Other Government Payments

	Eq. (4) 2001/12/19-2006/3/9	Eq. (5) 2001/12/19-2006/3/9
Constant	2.653 (0.369)***	2.647 (0.368)***
R_{t-1}	0.834 (0.025)***	0.833 (0.025)***
I_{t-2}	0.473 (0.092)***	0.481 (0.091)***
G_t	0.206 (0.019)***	
GP_t		0.240 (0.038)***
GR_t		0.191 (0.023)***
$\overline{R^2}$	0.992	0.992
OBS	1034	1034

Note: See the note for Table 2.

in the statistics released by the BOJ. We estimate modified versions of equation (2):

$$R_t = \mu + \rho R_{t-1} + \beta I_{t-2} + \gamma G_t + u_t \quad (3)$$

$$R_t = \mu + \rho R_{t-1} + \beta I_{t-2} + \gamma_P GP_t + \gamma_R GR_t + u_t \quad (4)$$

The coefficients β and γ in equation (3) (or β and γ_P in equation (4)) should be identical if the BOJ does not distinguish between interventions and other government payments. In contrast, if the BOJ does distinguish between them and only leaves interventions unsterilized, then β should be positive, while γ in (3) (or γ_P in (4)) should be equal to zero.

The estimation results for equations (3) and (4) are presented in the second and third columns of Table 4. Starting from the result for equation (3), the estimated value for β is 0.473 and the 95 percent confidence interval is $0.294 < \beta < 0.651$. On the other hand, the estimated value for γ is 0.206 and the 95 percent confidence interval is $0.169 < \delta < 0.242$. The confidence intervals of β and γ do not overlap each other, implying that the BOJ did distinguish between interventions and other government payments and offset less for the case of interventions. Turning to the result for equation (4), the estimate of β is 0.481 and the 95 percent confidence interval is $0.304 < \beta < 0.657$, while the estimate of γ_P is 0.240 and the 95 percent confidence

interval is $0.166 < \gamma_P < 0.313$. As before, the extent to which interventions are offset is smaller than the extent to which other government payments are offset, although the difference is not statistically significant in this case because the confidence intervals slightly overlap each other.

5 Sterilization vs. Nonsterilization: Does It Matter at Near-Zero Interest Rates?

5.1 Expectation channel of unsterilized interventions on the exchange rate

To this point, we have examined the relationship between interventions and the BOJ's monetary operations during the Great Intervention period, and found that about 40 percent of the yen funds injected to the market through yen-selling interventions were not sterilized on their settlement days, remaining in the market for some time. We now turn to a basic question: did interventions have different effects on the exchange rate depending on whether they were sterilized or not.

A sterilized yen-selling intervention is nothing but an exchange of yen-denominated bonds and dollar-denominated bonds between the monetary authorities and the private sector. On the other hand, an unsterilized intervention is, by definition, the combination of a sterilized intervention and an injection of yen funds to the market through the purchase of yen-denominated bonds. To the extent that the injection of yen funds has an additional effect on the exchange rate by lowering nominal interest rates, an unsterilized intervention has a greater impact on the exchange rate than a sterilized one does (See, for example, Sarno and Taylor 2001).

However, Okina and Shiratsuka (2000) and Spiegel (2003) among others argue that an unsterilized intervention has no extra effects on the exchange rate if the economy is in a liquidity trap, because an injection of yen funds in such a case has no impacts on short-term interest rates, which have already reached the zero lower bound anyway. Put differently, once money supply exceeds a satiation level, at which the marginal utility of money is equal to zero, then an additional injection of money does not have any consequences on the resulting equilibrium.

It is important to note that their argument is based on an implicit assumption that money supply increases only momentarily; namely, the central bank does not offset an increase in yen funds resulting from an intervention in the current period, but fully sterilizes it in the next period, so that an increase in the BOJ's current account

balances occurs only in the current period. What will happen if yen funds injected through interventions remain in the market for longer periods?

Recent discussions about optimal monetary policy in a liquidity trap suggests the presence of a new expectation channel through which an unsterilized intervention will have an extra impact on the exchange rate, compared to the case of a sterilized intervention, even if short-term interest rates are currently zero. Suppose that a yen-selling intervention is conducted when the economy is in a liquidity trap, and that it is not sterilized not only in the current period but also in the future periods. In other words, we now think about the case of permanent nonsterilization, which has a permanent impact on the level of current account balances. An important thing to note is that the yen funds injected through the intervention remains in the market not only when the economy is in the trap, but also when the economy recovers to a normal situation in which the natural rate of interest (i.e., the equilibrium real interest rate) returns to a normal (positive) level. Market participants expect, prior to observing the intervention, that short-term nominal interest rates will be above zero in the future periods when the natural rate of interest returns to a positive level. After observing the intervention, they update their expectations in that short-term nominal interest rates in those future periods will be lower due to the increase in current account balances, and thus the yen will be lower (i.e., depreciation). This updated expectation yields a depreciation of the yen in the current period. The importance of this expectation channel has been emphasized by various researchers, especially by Svensson (2000) and Jeanne and Svensson (2007).

The above two arguments can be summarized by using a simplified version of equation (2):

$$R_t = \rho R_{t-1} + \beta I_{t-2} \tag{5}$$

A *momentary* nonsterilization corresponds to the case of $\beta > 0$ and $\rho = 0$. In this case, a yen selling intervention, which is conducted in period $t - 2$ and settled in period t , leads to an increase in R_t by βI_{t-2} in period t , but does not have any effect on R_{t+1} . This is the case discussed by Okina and Shiratsuka (2000) and Spiegel (2003) among others. On the other hand, a *permanent* nonsterilization corresponds to the case of $\beta > 0$ and $\rho = 1$, in which a yen selling intervention, which is implemented in period $t - 2$, has effects not only on R_t but also on $R_{t+1}, R_{t+2}, R_{t+3}, \dots$ by the same amount.

However, as we saw in the previous sections, ρ is neither zero nor unity: it is in between. In this case, a yen selling intervention in $t - 2$ leads to changes in current

account balances in and after period t by βI_{t-2} , $\beta\rho I_{t-2}$, $\beta\rho^2 I_{t-2}$, and so on. Suppose market participants expect, prior to the implementation of a yen selling intervention in period $t - 2$, that the nominal interest rate will return to a positive level in period $t + j$. In this case, an increase in current account balances in period $t + j$ resulting from the yen-selling intervention in $t - 2$, which is given by $\beta\rho^j I_{t-2}$, would be negligible if ρ is far away from unity and/or j is very large. If this is the case, there would be no significant difference between sterilized and unsterilized interventions in their effects on the current exchange rate. However, if ρ is sufficiently close to unity and/or j is not so large, an unsterilized intervention would have a greater impact on the current exchange rate than a sterilized intervention does. Thus, it is an empirical question whether there is a significant difference between sterilized and unsterilized interventions in terms of their effects on the exchange rate.

5.2 Empirical results

We estimate an equation for exchange rate dynamics proposed by Ito (2003, 2004) with some modification:⁹

$$\Delta s_t = \phi_0 + \phi_1 \Delta s_{t-1} + \phi_2 (s_{t-1} - s_{t-1}^T) + \phi_3 (1 - B_t) I_t + \phi_4 B_t I_t + \epsilon_t \quad (6)$$

where s_t is the NY close of the yen/dollar exchange rate, and $\Delta s_t \equiv s_t - s_{t-1}$. Following Ito (2003, 2004), we put a term capturing a short-run bandwagon effect, Δs_{t-1} , and a term capturing a medium-run mean-reversion effect, $s_{t-1} - s_{t-1}^T$, where s^T represents the backward moving average of the yen/dollar rate. B_t is a new variable which takes a value between zero and one, and represents the degree of nonsterilization on day $t + 2$ for the intervention implemented on day t (and settled on day $t + 2$). B_t is equal to unity if the intervention is not sterilized at all, and B_t is equal to zero if it is fully sterilized. Note that the degree of nonsterilization on day $t + 2$ is not observable on day t , so that B_t represents an expectation made by market participants on day t . The term $(1 - B_t)I_t$ represents the amount of sterilized interventions, while the term $B_t I_t$ represents the amount of unsterilized interventions.

⁹Ito (2004) estimates a GARCH-type exchange rate equation, reporting that an intervention of one trillion yen moves the yen/dollar rate by 0.70 percent in the period prior to the Great Intervention period (June 1995 to January 2003), but only 0.38 percent during the Great Intervention period (January 2003 to March 2004). Fatum and Hutchison (2005) estimate the efficacy of interventions using a matching algorithm, reporting that interventions during the Great Intervention period did not have any significant effect on the yen/dollar rate. These results indicate that interventions were less effective during the Great Intervention period. However, to our knowledge, there is no research about the difference between sterilized and unsterilized interventions in terms of their effects on the exchange rate during this period.

Table 5: Effects of Sterilized and Unsterilized Interventions on the Yen-Dollar Rate

	B_t is defined as the correlation between interventions and changes in current account balances	B_t is defined by eq. (7) and $k = 0.5$	B_t is defined by eq. (7) and $k = 0.6$
	2003/1/15-2006/3/9	2003/1/15-2006/3/9	2003/1/15-2006/3/9
Constant	-0.0000 (0.0004)	-0.0003 (0.0002)	-0.0003 (0.0002)
$s_{t-1} - s_{t-2}$	-0.0599 (0.0358)*	-0.0429 (0.0365)	-0.0431 (0.0365)
$s_{t-1} - s_{t-1}^T$	0.0071 (0.0052)	-0.0050 (0.0041)	-0.0050 (0.0041)
$(1 - B_t)I_t$	-0.0005 (0.0001)***	0.0014 (0.0020)	0.0013 (0.0020)
$B_t I_t$	0.0195 (0.0064)***	0.0027 (0.0011)**	0.0029 (0.0012)**
OBS	752	752	752

Note: See the note for Table 2.

We construct B_t in two different ways. The first definition is based on an assumption of backward-looking expectation; specifically, we define B_t as a contemporaneous correlation coefficient between interventions and changes in current account balances over the last three months. For example, market participants expect that the intervention to be settled two days later is likely to be unsterilized (therefore B_t will be higher) if they observe a close correlation between the two variables over the last three months, and vice versa. The second definition is based on an assumption of perfect foresight; namely, we assume that market participants are able to make a perfect forecast about the degree of nonsterilization on day $t + 2$, $\Delta R_{t+2}/I_t$, even on day t . Specifically, we assume that market participants had expected a full nonsterilization, $B_t = 1$, on days when the actual value of $\Delta R_{t+2}/I_t$ turned out to be sufficiently large, and a full sterilization, $B_t = 0$, on the other days. That is, we define B_t as follows:

$$B_t = \begin{cases} 1 & \text{if } \Delta R_{t+2}/I_t \geq k \\ 0 & \text{if otherwise} \end{cases} \quad (7)$$

where k is a parameter taking a value between zero and unity.

The regression results are presented in Table 5, in which the second column shows the result when B_t is defined as a correlation coefficient between interventions and

changes in current account balances over the last three months, and the third and fourth columns show the results when B_t is defined as described in equation (7) with $k = 0.5$ on the third column and $k = 0.6$ on the fourth column. The result on the second column shows that the estimates of ϕ_3 and ϕ_4 are -0.005 and 0.0190 , respectively, indicating that interventions that are fully sterilized have almost no effect on the exchange rate, while interventions that are not sterilized at all have a statistically significant effect on the exchange rate: a yen-selling intervention of one trillion yen with no sterilization moves the yen/dollar rate by 1.9 percent.¹⁰ These results show the presence of a substantial difference between sterilized and unsterilized interventions in the effects on the exchange rate. In fact, the estimates of ϕ_3 and ϕ_4 differ at the one percent significance level.

Turning to the case in which B_t is defined as in (7), the estimates of ϕ_3 and ϕ_4 are 0.0014 and 0.0027 , respectively, indicating again that sterilized interventions are not effective while unsterilized ones are effective, although we fail to find a statistically significant difference between the estimates of ϕ_3 and ϕ_4 . We confirm a similar result for the case of $k = 0.6$. In sum, the regression results in Table 5 indicate that, during the Great Intervention period, interventions had different effects on the exchange rate depending on whether they were sterilized or not, thereby suggesting the possibility that market participants updated their expectations about future money supply based on the observation of interventions that were not sterilized.

6 Conclusion

Using daily data on foreign exchange interventions and current account balances at the Bank of Japan, this paper examined the relationship between interventions and monetary policy during the period from January 2003 to March 2004. The findings can be summarized as follows. First, roughly 60 percent of the funds supplied to the market through yen-selling foreign exchange interventions were offset (i.e., sterilized) by monetary adjustment by the Bank of Japan, while the remaining 40 percent were not offset. Moreover, the funds that were not offset remained in the market for some time. This result contrasts with the situation before this period, when 100 percent of the funds of foreign exchange interventions were offset, showing that the extent to which interventions were not sterilized during January 2003 to March 2004 was quite remarkable.

¹⁰These results imply that a yen-selling intervention with 60 percent sterilization (this is the estimated degree of sterilization in Table 3) of one trillion yen moves the yen/dollar rate by 0.7 percent.

Second, comparing yen funds supplied through foreign exchange interventions and yen funds supplied through other government payments (such as pension payments), it was found that the extent to which such funds remained in the market was greater and the time span was longer in the case of the former. This suggests that the BOJ in its monetary operations distinguished between foreign exchange interventions and other government payments.

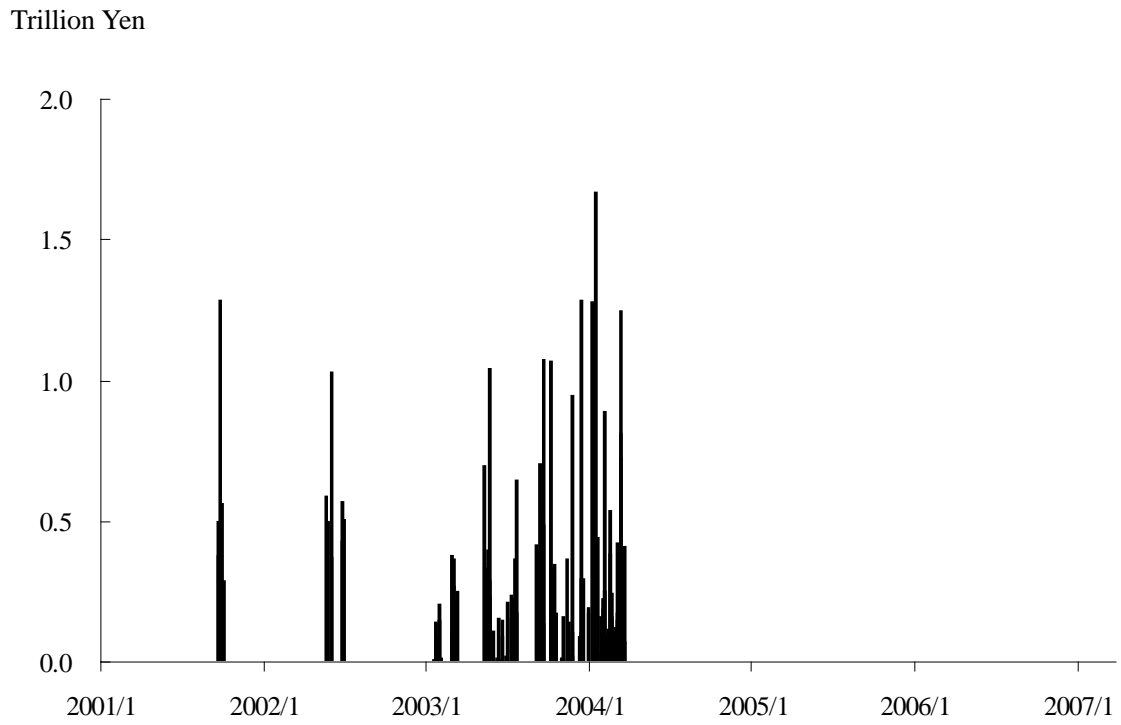
Third, an unsterilized yen-selling intervention had a greater impact on the exchange rate than a sterilized one did during this period, indicating that it matters whether an intervention is sterilized or not even when the economy is in a liquidity trap. This result suggests that market participants updated their expectations about future money supply based on the observations of unsterilized yen-selling interventions.

References

- [1] Bank of Japan (2004). “Money Market Operations in Fiscal 2003,” available at <http://www.boj.or.jp/en/type/ronbun/ron/research/data/ron0408a.pdf>
- [2] Craig, Ben and Owen Humpage (2001). “Sterilized Intervention, Nonsterilized Intervention, and Monetary Policy,” Federal Reserve Bank of Cleveland Working Paper 01-10.
- [3] Eggertsson, Gauti (2006). “The Deflation Bias and Committing to Being Irresponsible,” *Journal of Money, Credit and Banking* 38, 283-322.
- [4] Fatum, Rasmus and Michael M. Hutchison (2005). “Foreign Exchange Intervention and Monetary Policy in Japan, 2003-04,” EPRU Working Paper Series, University of Copenhagen.
- [5] Hamada, Koichi (1999). “Nichigin no Futaika Seisaku wa Machigatte Iru” (The Bank of Japan is Wrong to Take Sterilized Intervention), *Shukan Toyo Keizai*, November 13, 1999 (in Japanese).
- [6] Ito, Takatoshi (2003). “Is Foreign Exchange Intervention Effective? The Japanese Experiences in the 1990s,” in Mizen, P. (eds.) *Monetary History, Exchange Rates and Financial Markets, Essays in Honor of Charles Goodhart*, Cheltenham, U.K., Edward Elgar Pub.
- [7] Ito, Takatoshi (2004). “The Yen and the Japanese Economy, 2004,” in C. F. Bergsten and J. Williamson (eds.) *Dollar Adjustment: How Far? Against What?*, Institute for International Economics, Washington D.C.

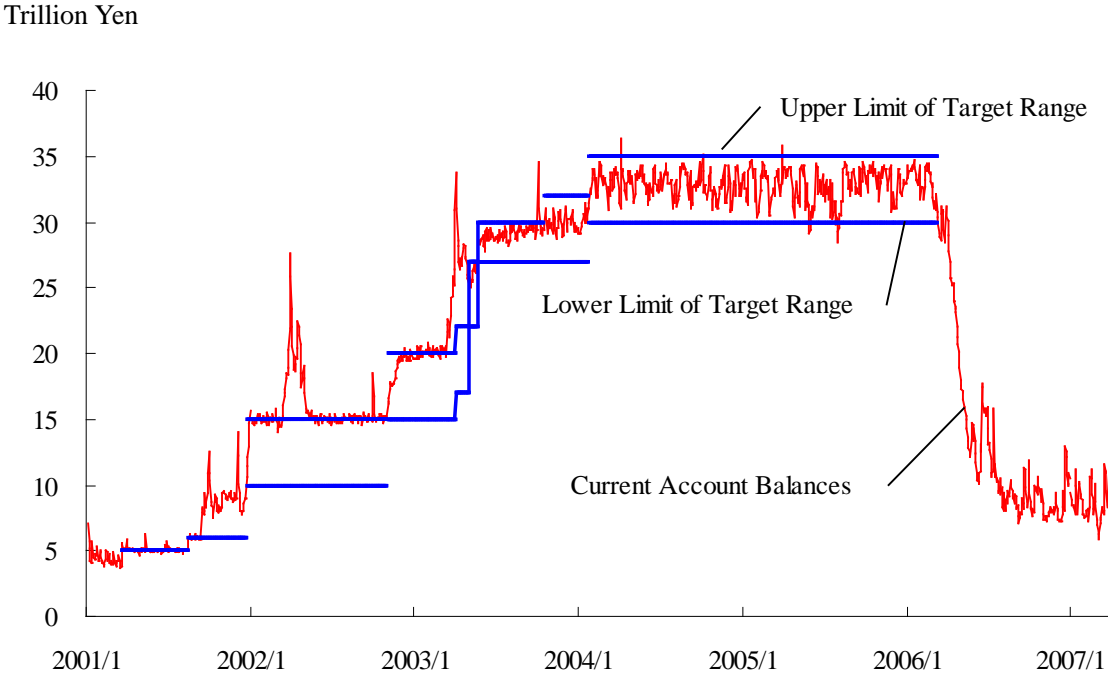
- [8] Ito, Takatoshi and Tomoyoshi Yabu (2007). “What Prompts Japan to Intervene in the Forex Market: A New Approach to a Reaction Function,” *Journal of International Money and Finance*, Vol. 26, pp. 193-212.
- [9] Jeanne, Olivier, and Lars E.O. Svensson (2007). “Credible Commitment to Optimal Escape from a Liquidity Trap: The Role of the Balance Sheet of an Independent Central Bank,” *American Economic Review* 97, 474-490.
- [10] Okina, Kunio and Shigenori Shiratsuka (2000). “The Illusion of Unsterilized Intervention,” *Shukan Toyo Keizai*, January 15, 2000. English version is available at <http://www.imes.boj.or.jp/japanese/kouen/ki0001en.html>
- [11] Silverman, B. W. (1986). *Density Estimation for Statistics and Data Analysis*, New York, Chapman and Hall.
- [12] Spiegel, Mark (2003). “Japanese Foreign Exchange Intervention,” *FRBSF Economic Letter* No. 2003-36.
- [13] Svensson, Lars E. O. (2001). “The Zero Bound in an Open-Economy: A Foolproof Way of Escaping from a Liquidity Trap,” *Monetary and Economic Studies* 19, 277-312.
- [14] Taylor, John (2006). “Lessons from the Recovery from the ‘Lost Decade’ in Japan: The Case of the Great Intervention and Money Injection,” Paper presented at the ESRI International Conference, Cabinet Office, Government of Japan, September 14, 2006. Available at <http://www.stanford.edu/~john-tayl/JapanCabinetOfficePresentation.pdf>

**Figure 1: Daily amounts of yen-selling interventions
from January 2001 to March 2007**



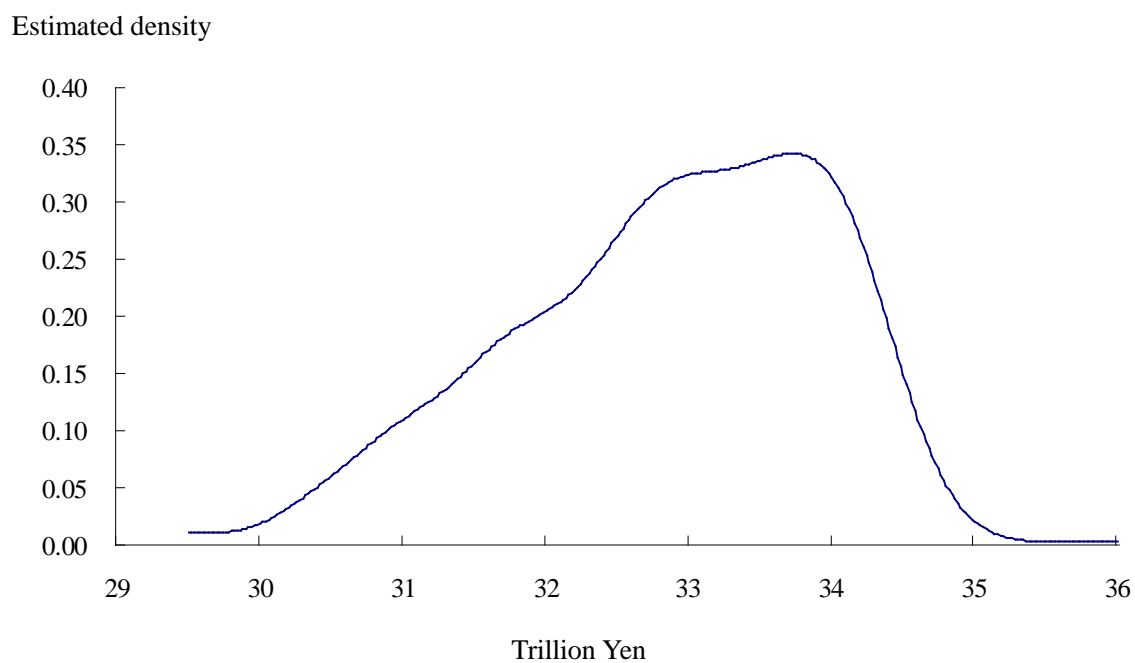
Source: Ministry of Finance.

Figure 2: Current account balances at the Bank of Japan



Source: Bank of Japan.

**Figure 3: Frequency distribution of current account balances
from January 2004 to March 2006**

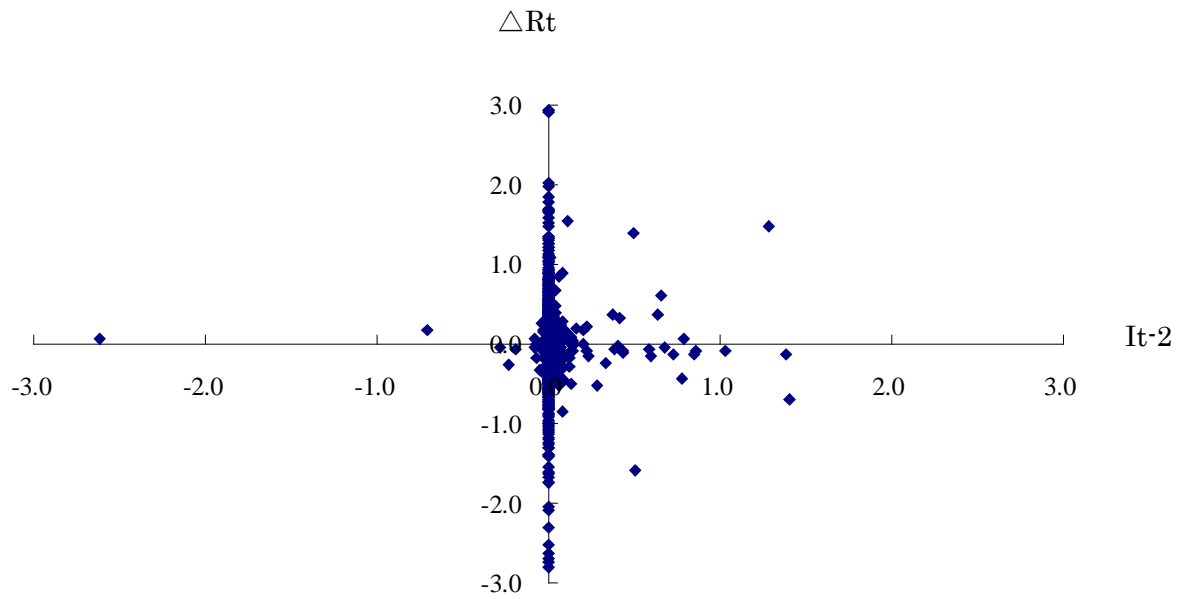


Note: This figure shows the distribution of daily current account balances during the period of January 20, 2004 to March 9, 2006, when the target range was set at 30-35 trillion. To estimate the probability density function, we use a normal kernel and the likelihood cross-validation method to select the bandwidth (See Silverman 1986).

Source: Bank of Japan.

Figure 4: Contemporaneous correlation between interventions and changes in current account balances

1992/1/1-2001/12/18



2001/12/19-2006/3/9

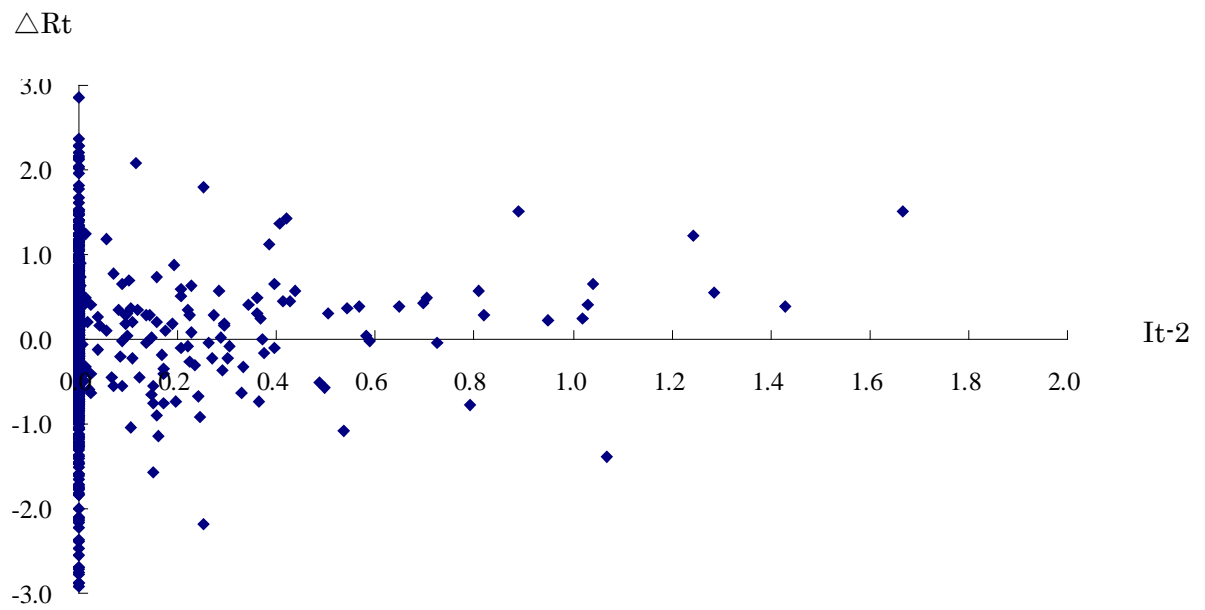
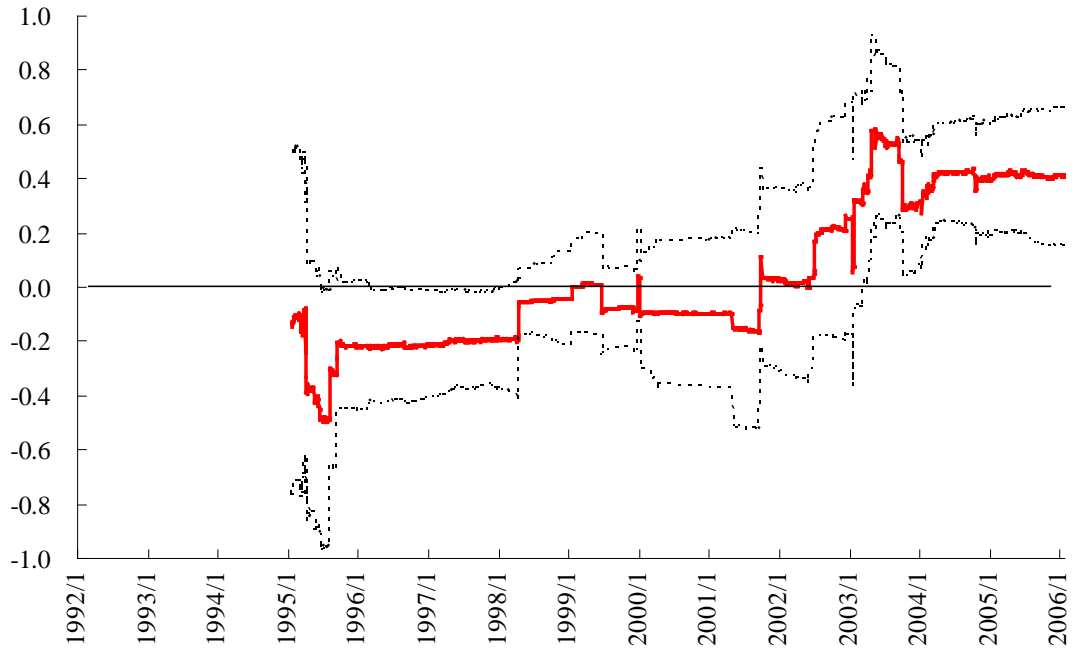


Figure 5: Rolling regression of the degree of nonsterlization



Notes: Bold line is the estimated value of β and the dotted lines are the upper and lower bound of the 90% confidence interval. The window of the rolling regression is the preceding 750 business days.

Figure 6: Amounts of interventions around the day of a policy change

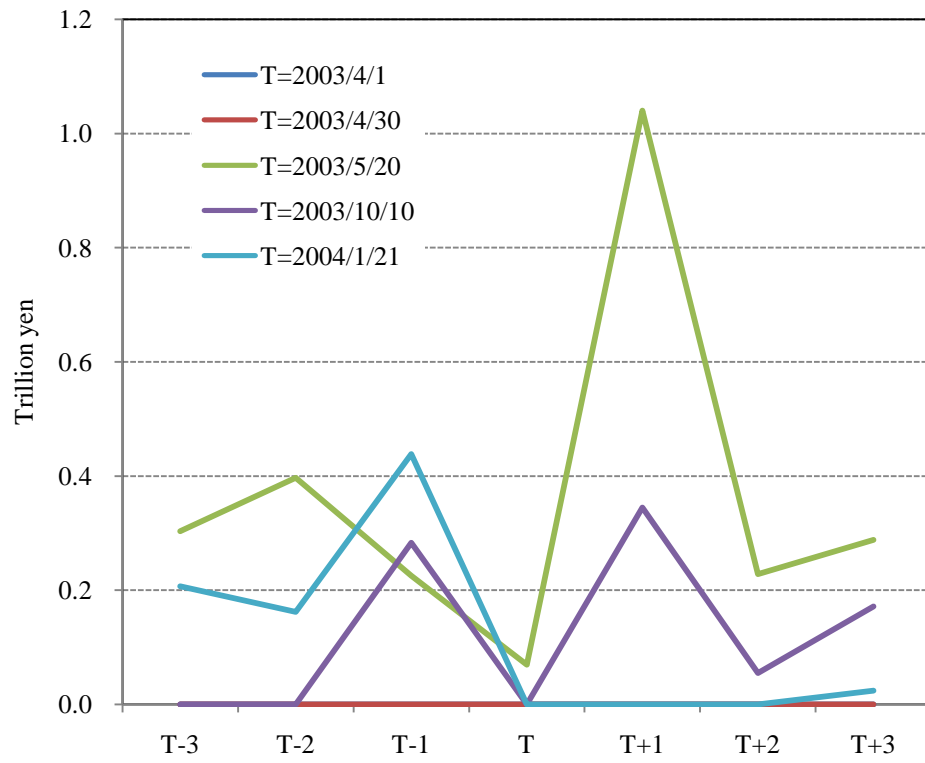


Figure 7: The degree of sterilization over time

