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

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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 Taylor (2006) 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 was 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 the 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, suggesting that it matters whether an intervention is sterilized or not even when the economy is in a liquidity trap.

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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.[1] 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 focus 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.[2] That is, under normal circumstances, 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 would deviate from the target level. To avoid this, the central bank offsets 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 for the

[1] In Japan, it is the MOF which is in charge of foreign exchange interventions. It conducts interventions in conjunction with the BOJ.

[2] See, for example, Craig and Humpage (2001).

overnight call rate was practically zero during this period. Therefore, even if yen funds are additionally 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 reason to actively choose not to sterilize them, because the yen funds supplied through interventions help it to increase base money and thereby achieve its target for commercial bank current account balances 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 of 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 contributed to the recovery of the Japanese economy.[3] However, 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."[4]

To empirically examine whether there was a relationship between foreign exchange interventions and monetary policy during that period, we use 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 was 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-

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

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

selling interventions to achieve its policy target of maintaining commercial bank current account balances 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, 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 the paper is organized as follows. The next section explains the quantitative easing policy and the "Great Intervention" in more detail. Section 3 investigates the contemporaneous correlation between interventions and changes in current account balances at the BOJ, while Section 4 examines the dynamic relationship between the two. Next, 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.

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).[5] The aim of this policy was to stimulate effective demand by providing ample supplies of base money. The target level for outstanding current account balances at the BOJ was initially set at 5 trillion yen, meaning that the target level exceeded the level of required reserves, which were 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 important implications when examining the relationship with foreign exchange interventions. The first is that there were frequent changes in the target level for current account balances at the BOJ. After the initial level had been set at 5 trillion yen in March 2001, the target level was raised to 6 trillion yen less than half a year later, in August 2001. By December of that year,

[5]Before introducing quantitative easing, the BOJ had adopted, between February 1999 and August 2000, a zero interest rate policy, which aimed to keep the target level for the overnight interest rate at zero. 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, they differ in that the latter 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 rebalancing channel.

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

Date	Event
09/09/98	The BOJ reduces the target overnight (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 a 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 for current account balances (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 provides a more detailed description of its commitment to monetary easing and the conditions necessary for terminating it
01/20/04	The BOJ raises the target CAB to 30–35 trillion yen
03/09/06	The BOJ terminates the quantitative easing policy
07/14/06	The BOJ terminates the ZIRP and sets the target O/N rate at 0.25 percent

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

Second, since December 2001, the target for 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, which is shown in Figure 1, it is clear that it actually permitted fluctuations within this range. This pattern is especially obvious in the period from 2003, the period of main interest in 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. The figure 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 the implications of these two characteristics 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 intervention is quite remarkable, showing a high frequency of intervention during the period from January 15, 2003 to March 16, 2004. As described by Ito (2003) and Ito and Yabu (2007), 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 intervention 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 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 fully sterilized.[6]

[6]In order to conduct yen-selling interventions, the MOF has to raise 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).

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 intervention amounts 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* 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. Thus, the vertical axis in Figure 4 shows ΔR_t and the horizontal axis 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 the figure, 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

$$\Delta R_t = \mu + \beta I_{t-2} + u_t, \tag{1}$$

where u_t is an iid disturbance term.[7] This specification has been widely used in previous studies to measure the extent of sterilization, including Fatum and Hutchison (2005) and Ito (2004), both of which 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 null 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.[8]

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

[7] By definition, ΔR_t is equal to commercial banks' net receipts of yen funds on day t from the government and the central bank. The intervention amount to be settled on day t, I_{t-2}, is part of the net receipts from the government, and the amount of monetary operations for sterilization, which is denoted by $-(1-\beta)I_{t-2}$, is also part of the net receipts 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 types of commercial banks' receipts of yen funds from the government and the central bank are included in the disturbance term u_t.

[8] During 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. As it happens, this 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*	-0.006	-0.046**
	(0.009)	(0.011)	(0.020)
I_{t-2}	0.188*	-0.004	0.389***
	(0.103)	(0.151)	(0.116)
$\overline{R^2}$	0.052	0.016	0.162
Obs.	3,496	2,461	1,035

Notes: Heteroskedasticity and autocorrelation consistent (HAC) standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level, respectively.

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.

4 The Dynamic Relationship Between Interventions and Current Account Balances

4.1 Did interventions have a permanent impact on current account balances?

The analysis in the previous section indicates that yen-selling interventions affected current account balances at least on the day of intervention (more precisely, on the settlement day of interventions) during the Great Intervention period. But how persistent were they? Did interventions have a permanent impact on the level of current account balances? These are key questions asked by previous papers on the 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 in a liquidity trap. They suggest that the purchase of foreign currency by issuing money (i.e., unsterilized intervention) is an effective way to make a credible commitment to future reflation, because it will incur balance-sheet losses if the central bank (and the government) reneges on its inflation promise, thereby causing an exchange rate appreciation.

The first thing to note when addressing whether interventions had a permanent

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

Notes: Same as Table 2.

impact on current account balances is that this question only arises because of the way that the quantitative easing policy was implemented. That is, a permanent increase is possible only because the BOJ specified a target range rather than a target level for current account balances *and* updated it over time. Without such flexibility, any permanent increases in current account balances resulting from yen-selling interventions would simply mean a failure of the BOJ's targeting policy.

There are two ways how interventions possibly can have a permanent impact on current account balances in this policy setting. The first is that a yen-selling intervention is settled exactly on the day when the target for 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 for current account balances. To examine this possibility, we compare the timing of interventions and the timing of changes in the target for current account balances during the Great Intervention period. There are five episodes of a change in the target for current account balances during the Great Intervention period. Figure 6 shows the intervention amounts to be settled on days before and after the day of a change in the target for current account balances, day T, for each of the five episodes. As can be clearly seen, almost all large-scale interventions took place without accompanying a change in the target for current account balances, with the 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 a per-

sistent change in current account balances resulting from interventions. To investigate this possibility, we estimate a policy reaction function of the following form:

$$R_t = \mu + \rho R_{t-1} + \rho^* R^*_{t-1} + \beta I_{t-2} + u_t. \tag{2}$$

The variable R^*_t is defined as $R^*_t \equiv R_t \times 1(R_t > R^U_t \text{ or } R_t < R^L_t)$, where R^U_t stands for the upper limit of the target range and R^L_t 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 R_t when R_t is outside the target range; otherwise it equals zero. The parameter ρ is associated with the 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 quickly converge to the desired level. Under the null hypothesis, we should expect $\rho = 1$ and $|\rho + \rho^*| < 1$.

The regression result is presented in Table 3. In the estimation, dummy variables for changes in the target for 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 regression result when 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.[9]

[9]Note 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 formally examine whether R is a stationary or non-stationary process, 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 for changes in the target for current account balances. The critical values of this unit root test are calculated through simulation. The estimate for ρ is 0.819, which is lower than unity at the 1 percent significance level, and therefore rejected the null.

4.2 Temporary nonsterilization

The above results 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. Using the estimates of ρ and β from equation (2), we calculate how quickly (or slowly) yen funds supplied through yen-selling interventions are offset over time by the BOJ's subsequent operations. The result is shown in Figure 7, which indicates 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 remain in the market at that time. The amount of yen funds that remain in the market decreases over time to 250 billion yen four days later, 170 billion yen six days later, and 70 billion yen ten days later, and twenty days later the yen funds have disappeared almost completely from the market. Comparing this with the preceding period, in which almost 100 percent of funds were 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 public 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 finding that interventions were not 100 percent sterilized may not be very 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.

To examine this, 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 $GP_t \equiv G_t \times 1(G_t > 0)$ and $GR_t \equiv G_t \times 1(G_t < 0)$, respectively. Note that although yen-selling interventions are usually included in government payments in the statistics released by the BOJ, the variable GP_t defined here includes only government payments other than yen-selling interventions. We estimate the following

Table 4: Interventions and Other Government Payments

	Eq. (3) 2001/12/19-2006/3/9	Eq. (4) 2001/12/19-2006/3/9
Constant	2.653***	2.647***
	(0.369)	(0.368)
R_{t-1}	0.834***	0.833***
	(0.025)	(0.025)
I_{t-2}	0.473***	0.481***
	(0.092)	(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.	1,034	1,034

Notes: Same as Table 2.

modified versions of equation (2):

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

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

The coefficients β and γ in equation (3) (and 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 zero.

The estimation results for equations (3) and (4) are presented in Table 4. Starting with 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, implying that the BOJ did distinguish between interventions and other government payments and offset the former less than the latter. 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.

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

5.1 The effect of unsterilized interventions on the exchange rate through the expectations channel

So far, we have examined the relationship between interventions and the BOJ's monetary operations during the Great Intervention period. We found that about 40 percent of the yen funds injected into the market through yen-selling interventions were not sterilized on the settlement day and remained in the market for some time. Two questions naturally arise: Why did the BOJ leave yen-selling interventions partially unsterilized? And 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 the injection of yen funds into 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 (see, for example, Sarno and Taylor 2001). However, Okina and Shiratsuka (2000) and Spiegel (2003), among others, argue that an unsterilized intervention has no additional 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 impact on short-term interest rates, which have already reached the zero lower bound anyway. Put differently, once money supply exceeds the satiation level, at which the marginal utility of money is equal to zero, then the additional injection of money does not have any consequences on the resulting equilibrium.

It is important to note that their argument is based on the implicit assumption that money supply increases only momentarily; that is, 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. But what happens if yen funds injected through interventions remain in the market for longer periods?

Recent studies on optimal monetary policy in a liquidity trap suggest that there may be an "expectations channel" through which unsterilized intervention has an additional impact on the exchange rate when compared with sterilized intervention, even if short-term interest rates are zero. Suppose that a yen-selling intervention is conducted when the economy is in a liquidity trap, and that the intervention is not sterilized not only in the current period but also in future periods. In other words, the case we are considering here is 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 remain in the market not only while the economy is in the liquidity trap, but also when it returns to a normal situation in which the natural rate of interest (i.e., the equilibrium real interest rate) reverts to a normal (positive) level. Market participants expect, prior to observing the intervention, that short-term nominal interest rates will be above zero in future periods when the natural rate of interest returns to a positive level. After observing the intervention, they update their expectations, taking into account that short-term nominal interest rates in future periods will be lower due to the increase in current account balances and that, as a consequence, the foreign exchange value of the yen will be lower. This updated expectation results in a depreciation of the yen in the current period. The importance of this expectations channel has been highlighted by various researchers, especially Svensson (2000) and Jeanne and Svensson (2007).

The effect of unsterilized intervention on the exchange rate through the expectations channel can be examined by using a simplified version of equation (2):

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

A *momentary* nonsterilization here 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 an effect not only on R_t but also on $R_{t+1}, R_{t+2}, R_{t+3}, \ldots$ of the same amount.

However, as we saw in the previous sections, ρ is neither zero nor unity: it is in

between. That means 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 $t+j$. 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 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 effect on the current exchange rate. However, if ρ is sufficiently close to unity and/or j is not that large, an unsterilized intervention would have a greater impact on the current exchange rate than a sterilized intervention. 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 a slightly modified version of an equation for exchange rate dynamics proposed by Ito (2003, 2004):[10]

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

where s_t is the New York close of the yen/dollar exchange rate, and $\Delta s_t \equiv s_t - s_{t-1}$. Following Ito (2003, 2004), we include a term capturing short-run bandwagon effects, Δs_{t-1}, and a term capturing medium-run mean-reversion effects, $s_{t-1} - s_{t-1}^T$, where s^T represents the backward moving average of the yen/dollar rate.[11] 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

[10] Ito (2004) estimates a GARCH-type exchange rate equation and reports 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 by 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 and find 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 on the difference between sterilized and unsterilized interventions in terms of their effects on the exchange rate during this period.

[11] One of the difficulties in estimating the effect of interventions is the endogeneity problem: the error term ϵ_t and I_t in eq. (6) are not independent, since the central bank reacts to fluctuations in the exchange rate. Chen et al. (2011), for example, consequently argue that the efficacy of interventions is considerably underestimated due to the endogeneity problem. However, addressing this issue is beyond the scope of this paper. See Kearns and Rigobon (2005) and Chen et al. (2011) for more on this issue as well as some methods to eliminate endogeneity bias.

is equal to unity if the intervention is not sterilized at all and 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.

We construct B_t in two different ways. The first way is based on the assumption of backward-looking expectation; namely, we assume that market participants expect that an intervention conducted today and to be settled two days later is likely to be unsterilized if they observe unsterilized interventions in the recent past, and vice versa. Specifically, we define B_t as

$$B_t = \begin{cases} 1 & \text{if} \quad \beta_t \geq k \\ 0 & \text{otherwise} \end{cases} \tag{7}$$

where β_t is the rolling regression estimate of β in equation (1) whose time series is given in Figure 5, and k is a parameter taking a value between zero and unity. The window of the rolling regression is the preceding 750 days.[12] The second way to construct B_t is based on the assumption of perfect foresight; that is, we assume that market participants are able to make a perfect forecast on day t about the degree of nonsterilization on day $t+2$, $\Delta R_{t+2}/I_t$. Specifically, we assume that market participants had expected 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 full sterilization, $B_t = 0$, on the other days. That is, we define B_t as follows:

$$B_t = \begin{cases} 1 & \text{if} \quad \Delta R_{t+2}/I_t \geq k \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

The regression results are presented in Table 5. Specifically, the table shows the results when B_t is defined as described in equations (7) and (8) and when $k = 0.4$ and $k = 0.5$ are chosen. In addition to a simple OLS regression, we also run a GARCH regression over the period of January 2003 to March 2004. The result for the first OLS regression shows that the estimates of ϕ_3 and ϕ_4 are 0.0025 and 0.0045, respectively, indicating that interventions that are fully sterilized have only a weak (and statistically insignificant) effect on the exchange rate, while interventions that are not sterilized

[12] An alternative would be to directly use β_t as a proxy of B_t rather than converting β_t to B_t as described in eq. (7). Doing so, we find that the regression results are essentially the same.

Table 5: The Effects of Sterilized and Unsterilized Interventions on the Yen/Dollar Exchange Rate

	B_t is defined as in equation (7)				B_t is defined as in equation (8)			
	$k = 0.4$		$k = 0.5$		$k = 0.4$		$k = 0.5$	
	OLS	GARCH	OLS	GARCH	OLS	GARCH	OLS	GARCH
ϕ_0	-0.001*	-0.001*	-0.001*	-0.001*	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ϕ_1	-0.038	-0.042	-0.039	-0.043	-0.047	-0.054	-0.045	-0.048
	(0.061)	(0.065)	(0.060)	(0.064)	(0.061)	(0.067)	(0.061)	(0.065)
ϕ_2	-0.006	-0.005	-0.007	-0.006	-0.004	-0.003	-0.004	-0.003
	(0.009)	(0.011)	(0.009)	(0.011)	(0.009)	(0.011)	(0.009)	(0.011)
ϕ_3	0.0025	0.0024**	0.0025	0.0023**	0.0014	0.0006	0.0026	0.0022
	(0.0017)	(0.0012)	(0.0016)	(0.0012)	(0.0022)	(0.0018)	(0.0023)	(0.0016)
ϕ_4	0.0045***	0.0044**	0.0052***	0.0051**	0.0045***	0.0045***	0.0038***	0.0038***
	(0.0011)	(0.0020)	(0.0012)	(0.0023)	(0.0012)	(0.0014)	(0.0011)	(0.0014)
$\phi_4 - \phi_3$	0.0020	0.0021	0.0027	0.0027	0.0030	0.0038*	0.0013	0.0016
	(0.0019)	(0.0022)	(0.0019)	(0.0025)	(0.0022)	(0.0020)	(0.0024)	(0.0020)
Obs.	300	300	300	300	300	300	300	300

Notes: The sample period is January 15, 2003 to March 31, 2004. The window of the rolling regression is the preceding 750 days. The GARCH specification is GARCH(1,1). In addition, the same notes as for Table 2 apply.

at all have a statistically significant effect on the exchange rate.[13] This result remains basically unchanged even when we employ a GARCH model (see the next column) and when we use a different value for k. However, as shown in the row labeled "$\phi_4 - \phi_3$," the difference between ϕ_4 and ϕ_3 is still small relative to the standard error, so that we cannot reject the null hypothesis that the impact of sterilized and unsterilized interventions on the exchange rate is identical. Turning to the case in which B_t is defined as in equation (8), we see again that sterilized interventions are not effective while unsterilized ones are effective. Overall, the regression results indicate that, during the Great Intervention period, interventions had different effects on the exchange rate depending on whether they were sterilized or not, thus pointing at the possibility that market participants updated their expectations about future money supply based on the observation that interventions were not fully sterilized.

[13]The regression result indicates that a yen-selling intervention of one trillion yen moves the yen/dollar rate by 0.25 percent when it is fully sterilized, while it move the exchange rate by 0.45 percent when it is not sterilized at all. Thus, a yen-selling intervention of one trillion yen with 60 percent sterilization (this is the estimated degree of sterilization in Table 3) moves the yen/dollar rate by 0.33 percent. This estimate is almost the same as the one Ito (2004) obtains for the Great Intervention period (i.e., 0.38 percent per one trillion yen) without discriminating between sterilized and unsterilized interventions.

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 operations 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 considerable.

Second, comparing yen funds supplied through foreign exchange interventions and yen funds supplied through other government payments (such as pension payments), we found that the extent to which funds remained in the market was greater, and the time span longer, in the case of the former than the latter. 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 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 observation that yen-selling interventions were not fully sterilized.

In this paper, we focused on the Great Intervention period. The Japanese monetary authorities stopped intervening at the end of this period (i.e., March 2004) and then did not intervene at all for 77 months. However, recently, they have restarted yen-selling interventions to counteract the rapid appreciation of the yen. On the other hand, the BOJ restarted with massive money injections in response to the global financial crisis in the fall of 2008. In this sense, the same combination of monetary and intervention policies as before has reemerged. Are the recent interventions sterilized or not? Do they have different impacts on the exchange rate depending on whether they are sterilized or not? Are there any differences from what we found for the Great Intervention period? Addressing these questions using the empirical framework we developed in this paper would be an important step to check the robustness of the empirical results we obtained

for the Great Intervention period. This is a task we hope to address in the future.

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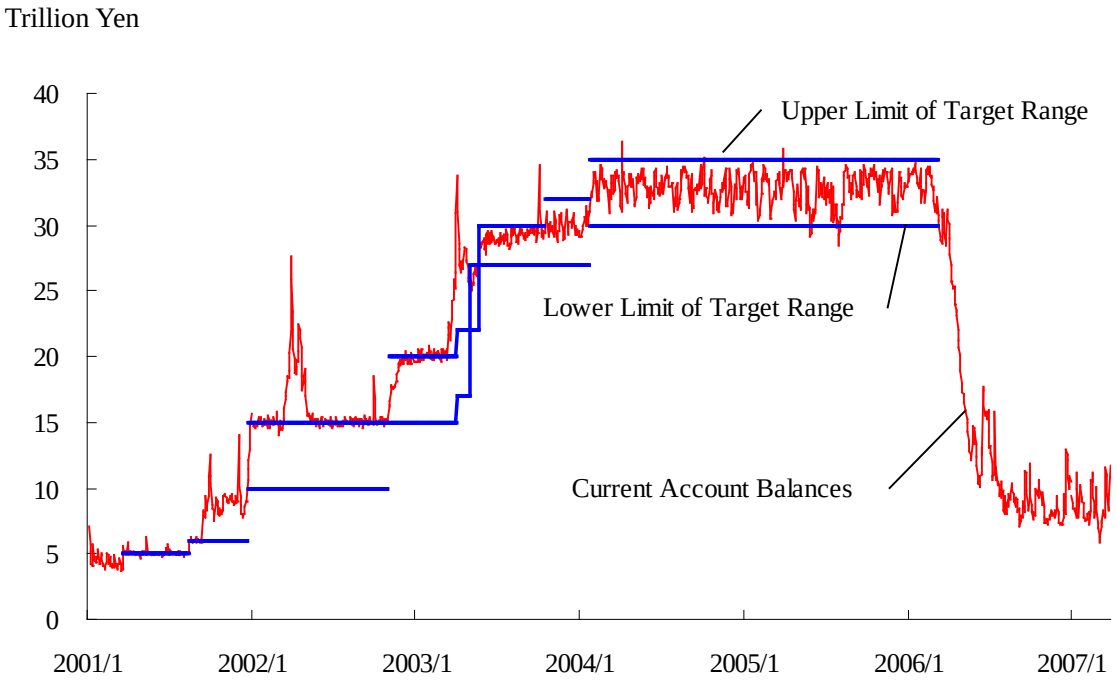
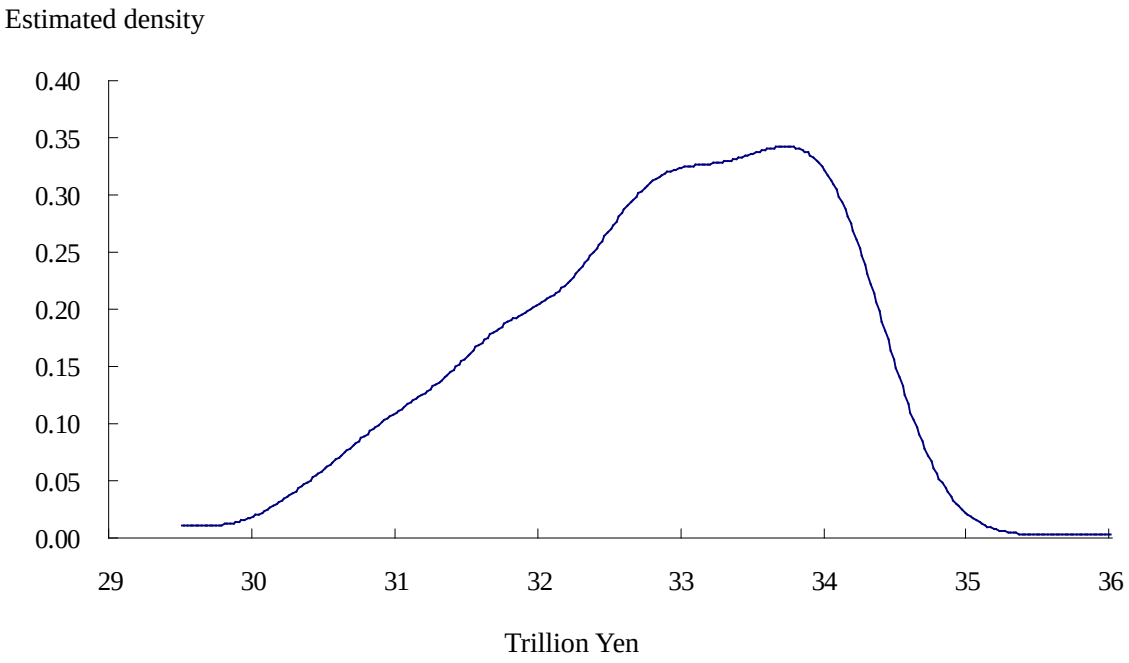
Figure 1: Current account balances at the Bank of Japan



Source: Bank of Japan.

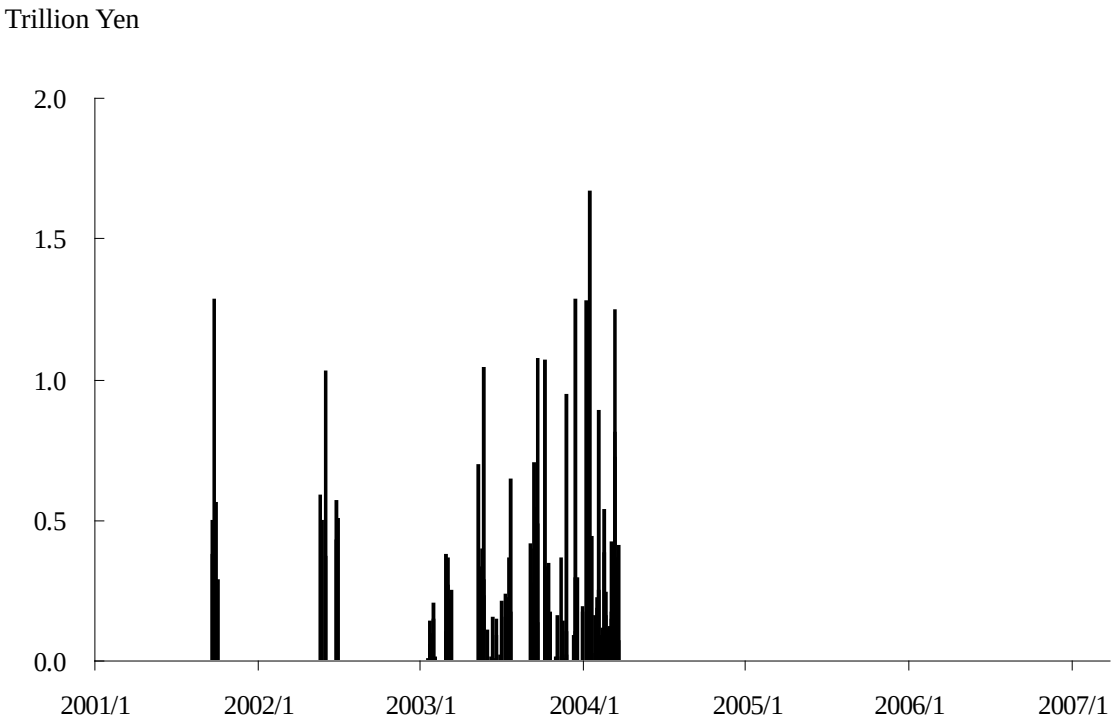
Figure 2: Frequency distribution of current account balances from January 2004 to March 2006



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.

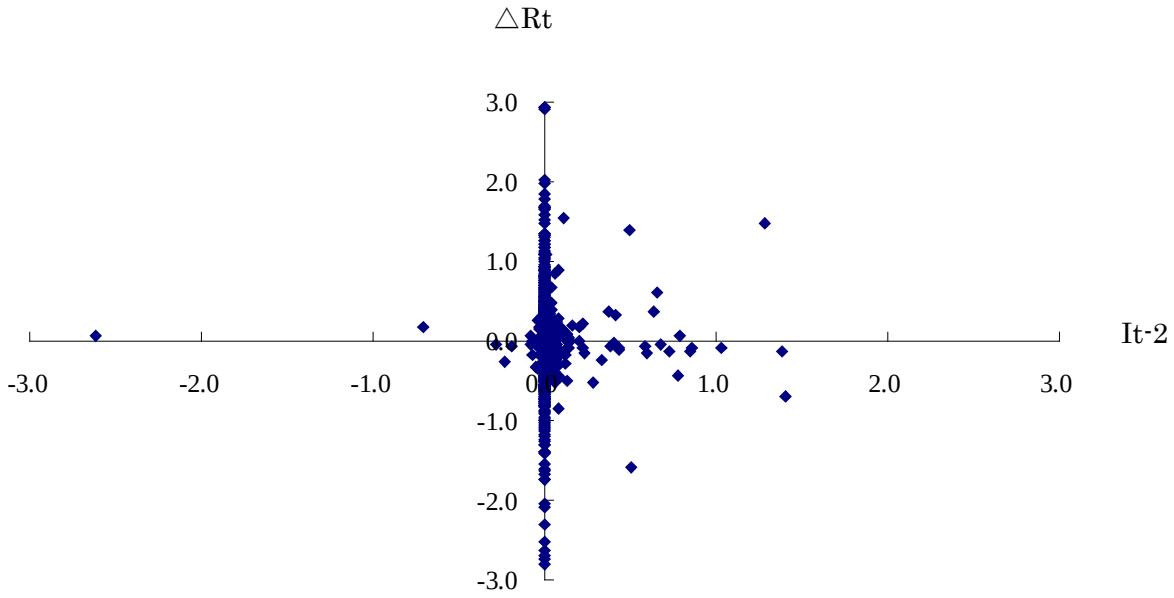
Figure 3: Daily amounts of yen-selling interventions from January 2001 to March 2007



Source: Ministry of Finance.

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

1992/1/1-2001/12/18



2001/12/19-2006/3/9

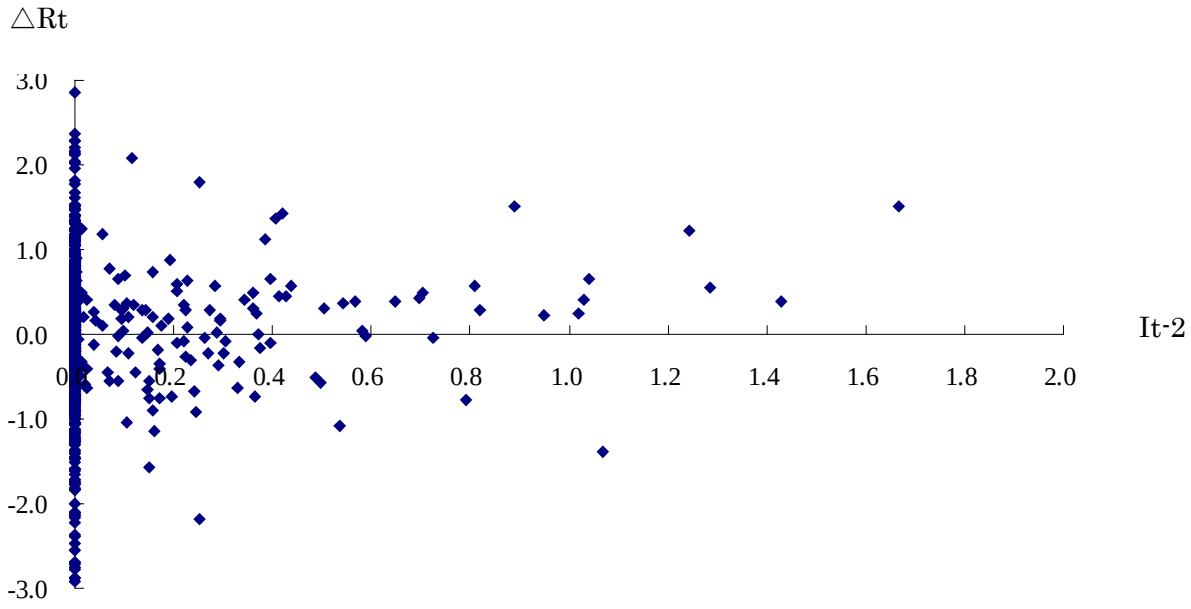
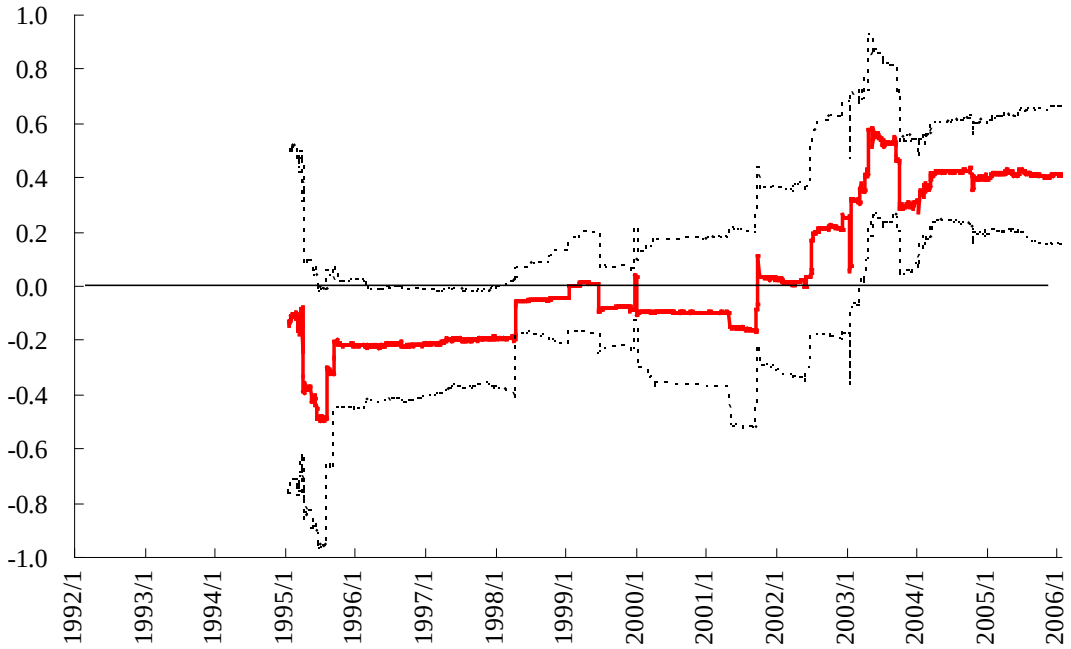


Figure 5: Rolling regression of the degree of nonsterilization



Notes: The bold line represents the estimated value of β, while 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: Intervention amounts to be settled around the day of a policy change

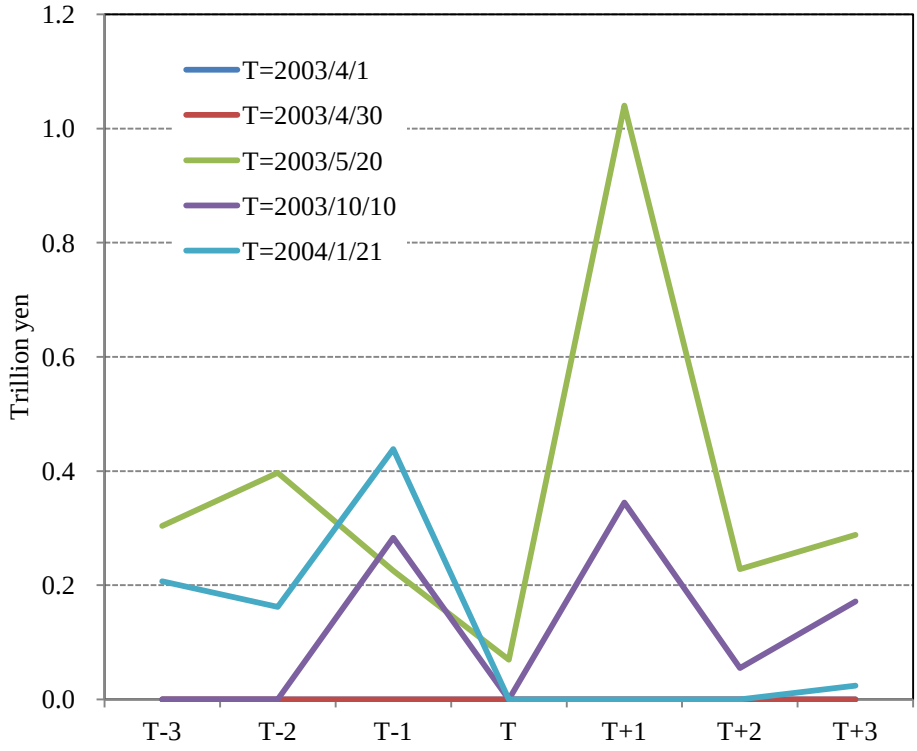


Figure 7: The degree of sterilization over time