International Capital Flows and U.S. Interest Rates: Lessons from Japan's Foreign Reserve Investment*

Kenji Abe†
The Johns Hopkins University

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Abstract

This paper investigates how foreign capital flows can hold down U.S. interest rates from the relationship between Japan's foreign exchange policy and U.S. interest rates. In contrast to previous studies, I examine the dynamics of, as well as the direction of causality in the relationship. By regressing one-day changes in Treasury yields on current and lagged Japanese foreign exchange interventions while controlling for the impact of macroeconomic news, I find that declines in Treasury yields associated with Japan's policy are temporary and hump-shaped. By making a distinction between Japan's investment in securities and deposits, I clarify that the direction of causality runs from Japan's investment in securities to Treasury yields. I then consider the leading explanations underlying the relationship, those reflecting the portfolio balance effect and the liquidity effect. They are not enough to explain the observed size and dynamics of the effect. Some amplifying mechanism, such as the noise trader effect, could be involved. I finally calculate the accumulative effect of Japan's foreign reserve investment on long-term interest rates. Japan's continuous investment held down long-term interest rates significantly and persistently from 2003 to 2004, with the maximum impact being estimated to be 1.2% for March 2004.

Keywords: Bond yields, Japan, China
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†Mergenthaler Hall, 3400 N. Charles Street, Baltimore, MD 21218, USA. E-mail: kenji.abe@jhu.edu

1 Introduction

The large increases in the foreign capital flows coming into the U.S. from foreign central banks or oil exporting countries have stimulated research as to their effect on U.S. interest rates.[1] This topic has attracted attention because the declines in U.S. interest rates could increase the value of a wide range of assets, among them housing, while lowering borrowing costs, and thus encouraging Americans to consume—this in turn could sustain the strong consumption-driven economic growth of the U.S., thus causing the already large U.S. current account deficit to widen further. This paper seeks to shed light on this topic by examining the relationship between Japan's foreign reserve investment—which was propelled by Japan's world record dollar-buying intervention from 2003 to 2004—and U.S. interest rates.

There were two eye-catching developments in the financial markets in 2003 and 2004. The first development concerned Japan's foreign exchange intervention, which was of an unprecedented size. The Japanese Ministry of Finance conducted a huge dollar-buying foreign exchange intervention, amounting to $315 billion in 2003 and 2004; most of the purchased dollars were invested in U.S. Treasury securities. The purpose of the intervention was to avoid the negative impact of the appreciation of the yen against the U.S. dollar on the Japanese economy, which had suffered from deflation since the late 1990s (the left graph in Figure 1).

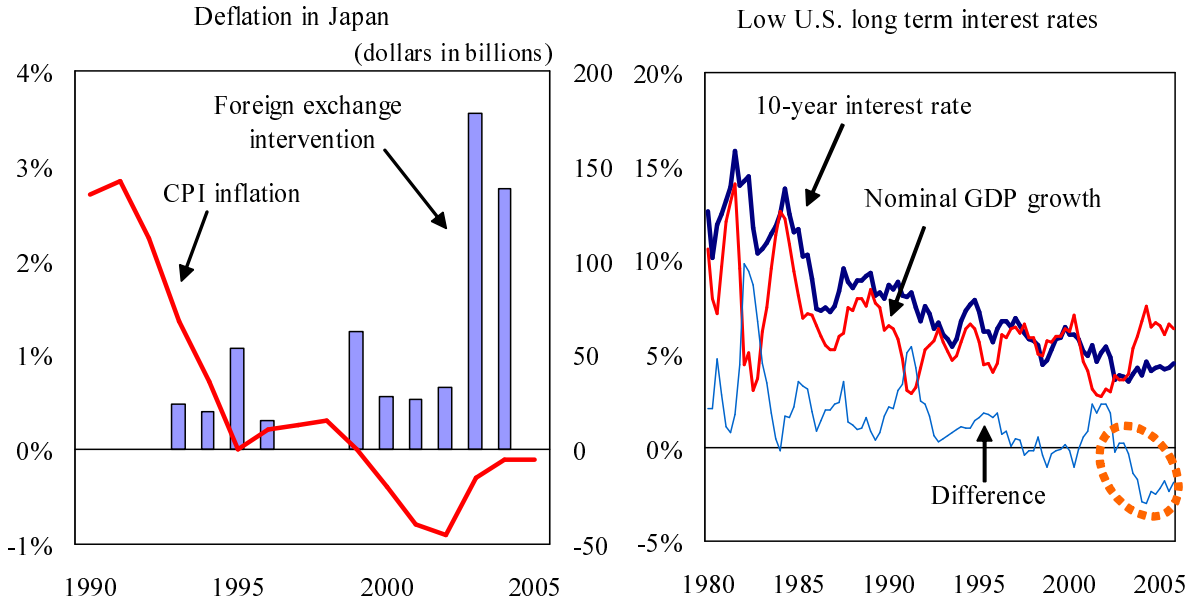
The second development was low U.S. long-term interest rates, something unusual given the economic conditions—that is, the fact there was a robust expanding economy, rising energy prices, and a deteriorating fiscal situation. The relation between the nominal GDP growth rate and the 10-year nominal Treasury yield provides suggestive evidence. For most of the time, from 1980 to 2001, the nominal 10-year Treasury yield had been higher than the nominal GDP growth rate; this relationship, however, reversed itself in 2003, with the difference widened to about 3% in the 1st quarter of 2004 (the right graph in Figure 1).

At the time, the financial news media often pointed out the connection between the two developments. For example, on March 25, 2004, *The Economist* wrote, "[i]ntervention has helped finance America's twin deficits and hold down its long-term bond yields." Against this background, this paper asks, "Does the connection really exist? And if so, how does it work?"

The most closely related paper to the present one is that of Bernanke, Reinhart, and Sack (2004), henceforth denoted as BRS. BRS measure the contemporaneous correlation between Japan's foreign exchange policy and U.S. interest rates by regressing three-day changes in Treasury yields on the volume dollar of Japan's foreign exchange intervention, and find a highly statistically significant negative corre-

[1] Bernanke, Reinhart, and Sack (2004), Warnock and Warnock (2006) and International Monetary Fund (2006).

Figure 1: The background



Source: Websites of the Japanese Ministry of Internal Affairs and Communication, the Japanese Ministry of Finance, the Bureau of Economic Analysis and the Treasury Department. The effect of consumption tax increases on inflation is adjusted.

lation. In contrast to BRS, this paper clarifies the dynamics of, as well as the direction of causality in the relationship between Japan's foreign exchange policy and U.S. interest rates.

The rest of this paper comprises seven sections. Section 2 gives the background concerning Japan's foreign exchange policy. Section 3 presents the result concerning the dynamics of the relationship. I regress one-day changes in the 10-year Treasury yield on current and lagged Japanese foreign exchange interventions while controlling for the effect of macroeconomic news. My estimation indicates that the declines in the 10-year Treasury yield associated with Japanese interventions are temporary and hump-shaped. The 10-year Treasury yield declines by about 0.9 basis points in about 5-10 business days following a Japanese intervention of $1 billion, and returns to its original level in about 40-50 business days.

Section 4 considers the direction of causality. There is a possibility that the negative correlation found in BRS may only reflect reverse causality. For example, weak economic data release could cause Treasury yields to fall and the U.S. dollar to weaken, the latter phenomenon prompting Japan's intervention. In order to clarify the direction of causality, I use the distinction between Japan's investment in securities and that in deposits. According to data on the composition of Japan's foreign reserve, the Japanese Min-

istry of Finance invests about half of its purchased dollars in securities, putting the rest in dollar deposits immediately after the respective intervention; the dollar deposits are then reinvested in securities over time. I regress changes in Treasury yields on both. If reverse causality is present, Japan's intervention, regardless of whether it is invested in securities or deposits, should have a negative correlation with Treasury yields; this would imply that the coefficients on both Japan's investment in securities and that in deposits are negative and statistically significant. As it turns out, the estimated coefficients on Japan's investment in deposits are close to zero and are not statistically significant; those on Japan's investment in securities are negative and statistically significant. This indicates that Japan's foreign exchange policy affects Treasury yields through the demand-supply relationship of Treasury securities.

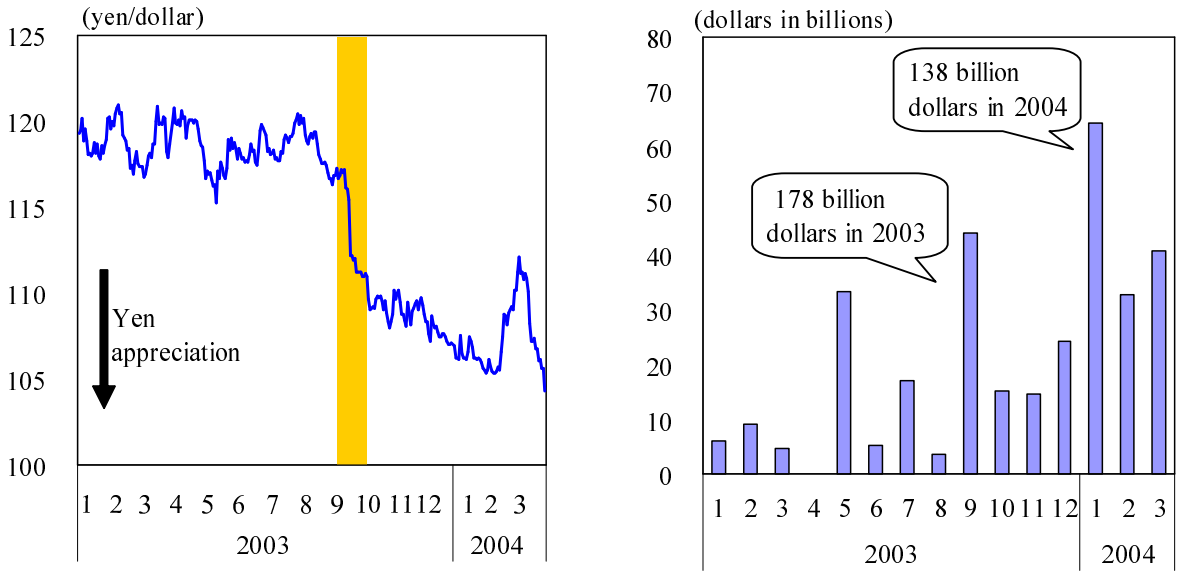
Section 5 investigates how Japan's foreign reserve investment holds down U.S. interest rates. I discuss two leading channels, the portfolio balance effect and the liquidity effect. These two channels are not enough to explain the observed size and length of the effect of Japan's foreign reserve investment on U.S. interest rates. Some amplifying mechanisms, such as the noise trader effect and the bandwagon effect, could be involved.

Section 6 checks for robustness. Section 7 calculates the extent to which Japan's foreign reserve investment held down the 10-year Treasury yield between 2000 and 2005. I find that Japan's continuous foreign reserve investment held down the 10-year Treasury yield significantly and persistently from 2003 to 2004, with the maximum impact being estimated to be 1.2 percent for March 2004. Section 8 concludes.

2 The background concerning Japan's foreign exchange policy

In this section, I provide the background concerning Japan's foreign exchange policy. First, I discuss the surrounding economic conditions by way of explaining why Japan conducted a world record foreign exchange intervention. Second, I review the movement of the Yen/Dollar exchange rate and suggest one reason why the yen showed rapid appreciation against the U.S. dollar in September 2003. Third, I compare the size of Japan's intervention in 2003-2004 with past episodes of interventions in order to show that it was the largest intervention in history. Fourth, I explain the investment policy of the Japanese Ministry of Finance by way of demonstrating that Japan invested the dollars purchased through its interventions in securities and deposits immediately after each intervention; the deposits were reinvested in securities over time. Fifth, I provide some evidence that most of the securities in Japan's foreign reserve are Treasury securities. Finally, I show that the share of Japan's investment in Treasury securities relative to the total foreign official investment in Treasury securities is indicative of the fact that most of the

Figure 2: Trends in the Yen/USD exchange rate and Japan's foreign exchange intervention



Source: Bloomberg and website of the Japanese Ministry of Finance.

increases in foreign official holding Treasury securities in recent years can be attributed to Japanese and Chinese investment.

2.1 Economic conditions

Since the 1990s until recently, Japan had been in a severe recession, what Kuttner and Posen (2001) call the Great Recession. Weak demand produced an output slump as well as deflation, and ordinary policy tools to stimulate demand were disabled. Monetary policy was facing a zero-interest rate bound and a fragile financial system. The growing budget debt problem made it difficult to adopt an expanding fiscal policy. Under the situation, the last thing Japan wanted was a strong yen. Some economists, for example Svensson (2003; 2004), even argued that pursuing a weaker yen through foreign exchange intervention would be the best way to beat deflation.

2.2 The Yen/Dollar exchange rate movement

In reality, however, the yen started to appreciate against the U.S. dollar, gradually starting at the beginning of 2002, and then rapidly appreciating in September 2003 (the left graph in Figure 2), partly due to a G-7 statement that month which "emphasize[d] that more flexibility in exchange rates [was] desirable for major countries or economic areas." Anecdotal evidence suggests that private investors expected that this

G-7 statement would prevent Japan from intervening in the foreign exchange market; this expectation led to a rapid appreciation of the yen against the U.S. dollar.[2] Appreciation pressure continued after September, with the yen appreciating against the U.S. dollar by 10.9% from 117.1 yen/dollar at the end of August in 2003 to 104.3 yen/dollar at the end of March in 2004.

2.3 The size of intervention

To slow down or counter the movement of the exchange rate, the Japanese Ministry of Finance conducted huge dollar-buying foreign exchange interventions totaling $177 billion in 2003 and $138 billion in the first quarter of 2004 (the right graph in Figure 2). As is clear from the left graph in Figure 1, this was the largest intervention episode in the history of Japan. The level of intervention in 2003 nearly tripled the previous record of $62 billion for 1999. Since other developed countries had curtailed foreign exchange interventions as of the early 1990s, the intervention ending up being the world record as well. Though the record has since arguably been broken by China,[3] the gigantic size of Japan's intervention attracted much attention and raised concerns that it could affect the prices of Treasury securities.

2.4 The investment policy of the Japanese Ministry of Finance

As a result of the interventions ($JFEI$), the Japanese Ministry of Finance obtained a lot of U.S. dollars. The Ministry invested the newly obtained U.S. dollars in securities ($JFRIS$) and deposits ($JFRID$):

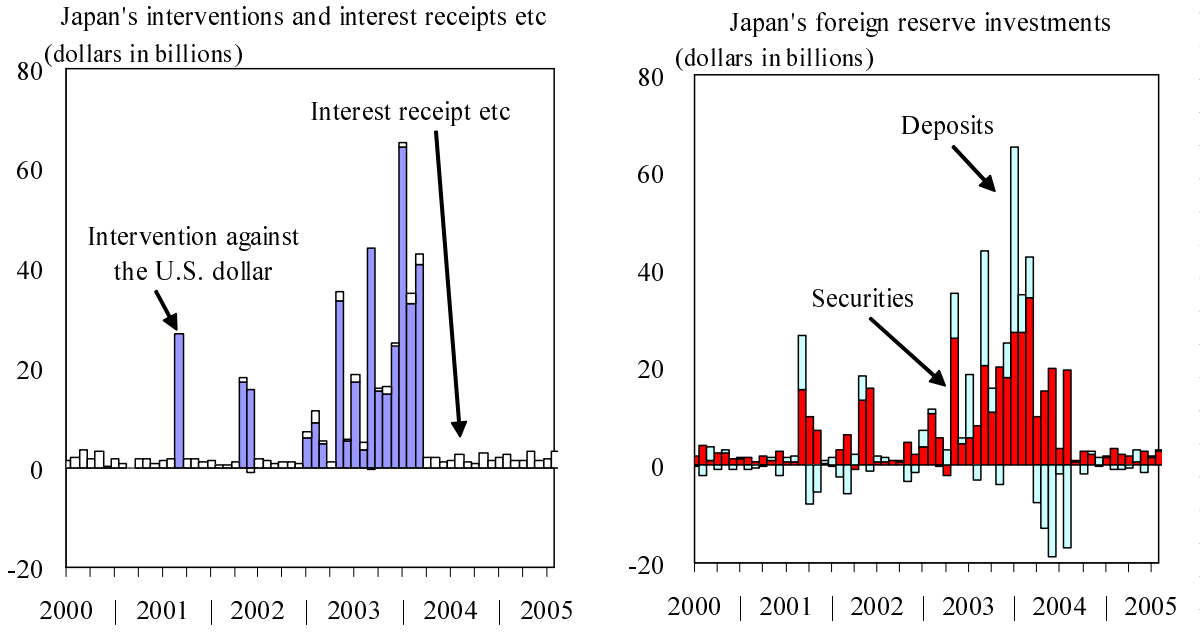
$$JFEI_t \approx JFRIS_t + JFRID_t. \tag{1}$$

The left hand side and the right hand side of equation (1) do not exactly match, as the Ministry invests not only the dollars purchased in interventions but interest receipts from existing assets as well. The left graph in Figure 3 depicts how much Japan added to its foreign reserve each month from 2000 to 2005. This graph shows that the contribution from interest receipts is much smaller than that from dollar-buying interventions. The right graph depicts how much Japan invested in securities and deposits each month from 2000 to 2005. In constructing the time series of Japan's investment in securities and deposits from

[2] *The Economist*, on February 5, 2004, wrote regarding this phenomenon, noting that "'more flexibility' in exchange rates,... [was] interpreted [by some] as a veiled message to China and Japan to stop intervening in the foreign-exchange market and let their currencies rise." G-7 countries inserted 'that lack such flexibility' after the phrase "major countries and economic areas" in the G-7 statement for February 2004. This suggests that G-7 countries tried to change the market's interpretation of the statement.

[3] China's foreign reserve increased by $117 billion in 2003, $206 billion in 2004 and $204 billion in 2005. These increases include interest receipts and valuation changes, as well as intervention.

Figure 3: Japan's foreign exchange interventions and foreign reserve investments in securities



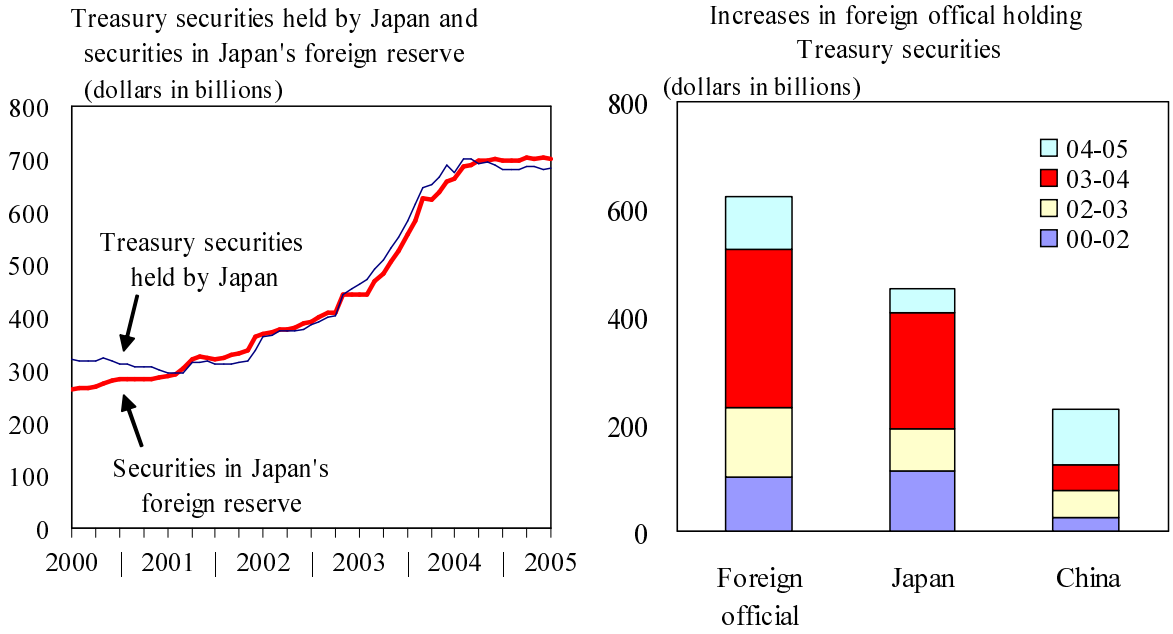
Source: Website of the Japanese Ministry of Finance and author's calculations.

data on the market value of Japan's foreign reserve and balance of payment statistics, I was particularly careful not to include valuation changes. The procedure is explained in the appendix. This data is available only at a monthly frequency, and not a daily frequency.

These two graphs show that the Ministry invests the dollars purchased in interventions in securities and dollar deposits immediately after the respective intervention; the dollar deposits are reinvested in securities over time. For example, with respect to the huge foreign exchange interventions of September 2003 and January 2004, the Ministry invested only half of the purchased U.S. dollars in securities. Japan's foreign exchange intervention stopped in March 2004. From April to August 2004, we find an increase in securities and a decreases in deposits in Japan's foreign reserve. This means that the Ministry shifted money from dollar deposits to securities during this period. The bottom line here is that Japan's intervention can be split into investments in securities and investments in deposits, as in equation (1). I use the distinction to analyze the direction of causality in section 4.3, which is the most unique aspect of this paper.

Japan's Finance Minister Tanigaki clearly stated that the Ministry preferred investing in securities rather than dollar deposits, as securities provide higher yields. The fact that the Ministry delayed some investments in securities suggests that the Ministry was trying to reduce distortions in the Treasury secu-

Figure 4: Japan's investment policy and total foreign official holdings of U.S. Treasury securities



Source: Websites of the Japanese Ministry of Finance and Treasury Department, Notes: In the right graph, the columns for Japan and China plot increases in the securities being held in Japan's foreign reserve and increases in Chinese holdings of U.S. Treasury securities respectively.

rity market by decreasing the amount of investment in securities per month.

2.5 Securities in Japan's foreign reserve

The data on Japan's foreign reserves does not indicate the composition of the securities in Japan's foreign reserve. Japan's Finance Minister Tanigaki, nonetheless, admitted that most of the assets denominated in the U.S. dollars were made up of Treasury securities.[4] This investment policy can be confirmed by the left graph in Figure 4. The figure illustrates that there was a simultaneous growth in the securities in Japan's foreign reserve and in the U.S. Treasury securities held by Japan (inclusive of both private and government holdings), something which indicates that most of securities in Japan's foreign reserve are,

[4]"Foreign reserve is the source of future dollar-selling foreign exchange interventions. Therefore, we must have assets appropriate for future interventions. They need liquidity and safety." (The Japanese Finance Minister, Tanigaki, in his answer to Senator Nishida's question in the Diet on May 12, 2005)

"It is true that, in Japan's foreign reserve, a lot of assets are denominated in the U.S. dollar and most of these are Treasury securities." (The Japanese Finance Minister, Tanigaki, in his answer to Mr. Matsubara's question in the Diet on January 28, 2004)

in fact, Treasury securities.

2.6 Total foreign official purchases of U.S. Treasury securities

I now compare the size of Japan's foreign reserve investment in Treasury securities with the size of the total foreign official purchases of Treasury securities. According to the 'Major Foreign Holders of Treasury Securities' statistics of the U.S. Treasury Department, the foreign official holdings of Treasury securities increased by $624 billion from April 2000 to June 2005. Securities held in Japan's foreign reserve increased by $451 billion during the same period. Since most of the securities in Japan's foreign reserve are Treasury securities, it would be safe to consider that Japan's foreign reserve investment explains about 70% of the increases in total foreign official holdings of Treasury securities. Chinese holdings (both private and public) of Treasury securities increased by $226 billion, which accounts for 35% of the total increases, during the same period. These statistics suggest that two Asian countries, Japan and China, account for most of the increases in the foreign official holdings of Treasury securities for the period 2000-2005 (The right graph of the Figure 4). In section 6.1.2, I examine the effect of China's investment, as well as Japan's investment, on Treasury yields.

3 The dynamic relationship between Japan's foreign exchange policy and Treasury yields

In this section, I study the dynamic relationship between Japan's foreign exchange intervention and the 10-year Treasury yield.

3.1 The event-study analysis

Bernanke, Reinhart, and Sack (2004), denoted as BRS, study the contemporaneous correlation between Japan's foreign exchange intervention and the 10-year Treasury yield by regressing changes in the 10-year Treasury yield from one day prior to two days after an intervention on the amount of the intervention:

$$i_{10,t+2} - i_{10,t-1} = \beta JFEI_t + \varepsilon_t. \tag{2}$$

BRS find negative and significant coefficients (Table 1). These results indicate a significant negative correlation between Japan's foreign exchange policy and the 10-year Treasury yield, but do not reveal anything about the dynamics of the relationship. It is therefore not possible to tell whether Japan's foreign exchange policy can be associated with a permanent or only temporary decline in Treasury yields.

Table 1: Contemporaneous correlation between the 10-year Treasury yield and Japan's intervention

Basis point change associated with $1 billion intervention

Dependent variables	On-the-run yields	Excluding Days of U.S. Major Data Releases
10 year rate	-0.73	-0.66
	(2.29)**	(2.14)**
No. Samples	140	112

Notes: The numbers in brackets are t-values, calculated using serial correlation-adjusted standard errors, following the approach of Hodrick (1992). The second column excludes those days where there was the release of an employment report, GDP, ISM, retail sales, or consumer confidence. *** indicates significance at the 1-percent level, ** at the 5-percent level, and * at the 10-percent level.

3.2 Dynamic correlation

The simplest exercise for studying the dynamic relationship between Japan's foreign exchange intervention and Treasury yields is to include lags of $JFEI_t$ in the BRS regression:

$$i_{10,t} - i_{10,t-1} = \sum_{k=0}^{60} \beta_k JFEI_{t-k} + \sum_{j=1}^{J} \gamma_j S_{j,t} + \varepsilon_t, \tag{3}$$

where S denotes macroeconomic news. In order to avoid overlaps, I change the dependent variable for the 10-year Treasury yield from a three-day change to a one-day change. I include 60 lags of $JFEI$ in the regression in order to be as parsimonious as possible while avoiding serial correlation of residuals. In order to control for the effect of macroeconomic news, I include surprise components of monetary policy and macroeconomic data releases. I calculate the surprise components of monetary policy using the method developed in Kuttner (2001). The surprise components of macroeconomic data releases[5] represent the differences between actual data and the market consensus forecast from briefing.com.[6]

Since β_k represents a change in the 10-year Treasury yield k days after Japan's intervention of $1billion, the sum of the coefficients, $B_K = \sum_{k=0}^{K} \widehat{\beta}_k$, equals the accumulated change from the point at which Japan intervened in the foreign exchange market to a point K days after the intervention. In other words, B_K is the level of the 10-year Treasury yield K days after Japan's intervention, where the level of the

[5]The macroeconomic data includes ISM, new home sales, the initial claim, the non-farm payroll, the unemployment rate, the PPI (core), retail sales, the Michigan sentiment index (preliminary), capacity utilization, the CPI (core), housing starts, the trade balance, the Philadelphia Fed business-conditions index, consumer confidence, the employment cost index, the advance GDP, the revise GDP, the final GDP, the Michigan Sentiment index (revised), and leading indicators. Preceding studies report that the surprise components of the data release affect financial variables such as the U.S. interest rates or the exchange rates of the U.S. dollar.

[6]γs are not reported to save space.

10-year Treasury yield is set at 0 before Japan's intervention. B_K is plotted in the left graph in Figure 5 with a 90% confidence interval. The confidence interval is constructed using the percentile-t bootstrap method.

It seems that the negative correlation is hump-shaped. The 10-year Treasury yield reaches its lowest level, at about 0.9 basis points below the starting point, within 5-10 business days. It then starts to rise and returns to its original level within 40-50 business days following Japan's intervention. I cannot conclude from the figure, however, whether there is a hump or not, since the $\widehat{B}_K$ is a pointwise estimate. I therefore conduct a statistical test to determine whether or not there exists a hump. Firstly, I examine the timing by which the 10-year Treasury yield reaches its lowest point. Using the iterated other percentile bootstrap method, which is explained in Doyle and Faust (2005), I constructed a 90% confidence interval of the timing. The confidence interval runs from 8 to 13 business days following Japan's intervention. The fact that the confidence interval does not include 0 days supports the existence of a hump. Secondly, I look at the size of the hump, which is the difference between the lowest point and the point immediately following Japan's intervention. Formally, the null hypothesis is $\widehat{B}_k^{\min} - \widehat{B}_0 \geq 0$ where $\widehat{B}_k^{\min}$ is the smallest $\widehat{B}_k$ in all $\widehat{B}_k$ for $k = 1, 2, 3, ...60$. The alternative hypothesis is that the null is false. Using the percentile-t bootstrap method, I find the p-value of the test is 3.1%. This test also supports the existence of a hump.

Notably, my analysis on the dynamics is consistent with the BRS analysis on contemporaneous correlation. The BRS analysis indicates that a decline in the 10-year Treasury yield associated with Japan's intervention of $1 billion is 0.73 basis points, while my analysis suggests that it is 0.85 basis points at its peak. Broadly speaking then, the two analyses are consistent.

3.2.1 Polynomial distributed lags

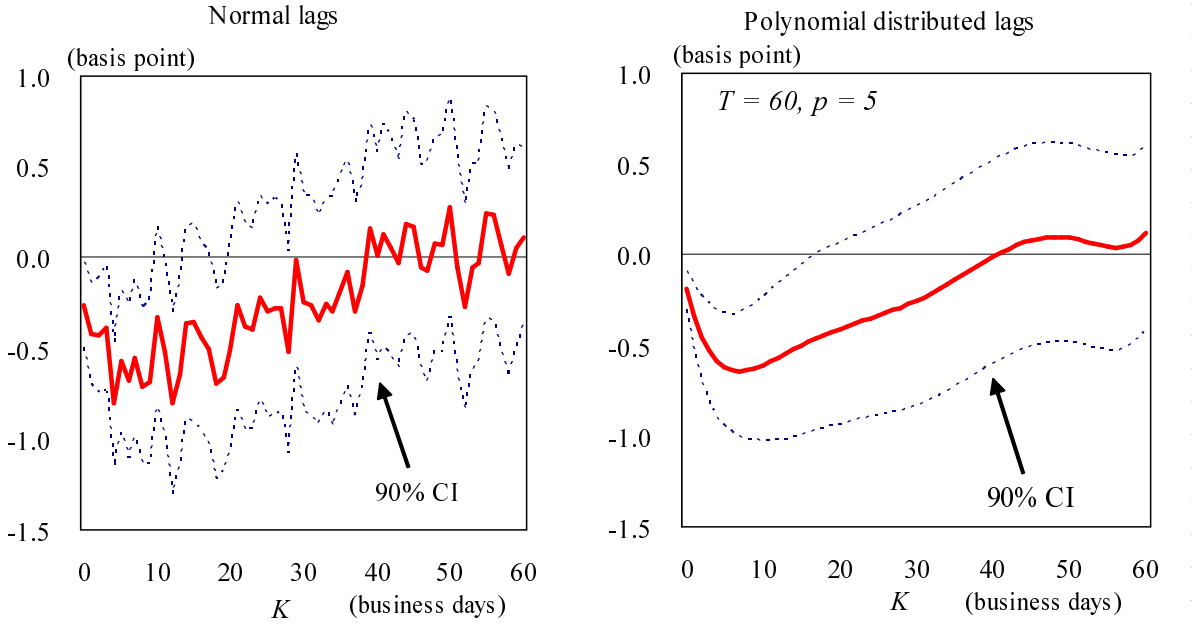
An estimation of equation (3) could be inefficient because of too many lags. I try using polynomial distributed lags. Polynomial distributed lags have the advantage of reducing the number of parameters being estimated, something which should lead to a more efficient estimation. Polynomial distributed lags are specified as follows:

$$i_{10,t} - i_{10,t-1} = \sum_{k=0}^{T} \beta_k^{poly} JFEI_{t-k} + \sum_{j=1}^{J} \gamma_j S_{j,t} + \varepsilon \tag{4}$$

$$\beta_k^{poly} = \gamma_1 + \gamma_2(k - \overline{c}) + \gamma_3(k - \overline{c})^2 + \gamma_4(k - \overline{c})^3 + ... + \gamma_{p+1}(k - \overline{c})^p$$

$$\overline{c} = T/2 \text{ when } T \text{ is even, and } (T-1)/2 \text{ when } T \text{ is odd.}$$

Figure 5: Declines in Treasury yields associated with an intervention of 1 billion dollars



Source: Author's calculations.

p determines the degree of the polynomial—that is, the number of parameters to be estimated. I set $p = 5$ by AIC, which reduces the number of parameters related to Japan's intervention from 61 to 6. A confidence interval is constructed using the percentile-t bootstrap method. The overall shape of the sum of coefficients estimated by the polynomial distributed lags specification, $\widehat{B}_K^{poly} = \sum_{k=0}^{K} \widehat{\beta}_k^{poly}$ (the right graph in Figure 5), is similar to $\widehat{B}_K$. The confidence interval band is narrower, which indicates a gain in efficiency.

Equation (4) is a restricted model of the equation (3). Using a log-likelihood ratio test, I examine whether or not the restrictions imposed by the polynomial distributed lags are too restrictive. The p-value of the test is 15.2%. Consequently, I am unable to reject the restrictions imposed by the polynomial distributed lags at the conventional level.

3.3 Summary

The analysis in this section suggests that declines in the 10-year Treasury yield associated with Japan's foreign exchange policy are temporary and hump-shaped. The 10-year Treasury yield reaches its lowest point within 5-10 business days following a Japanese intervention; it then starts to rise, returning to its original level within 40-50 business days. I look for a theory which matches this dynamics in section 5.

4 Direction of causality

In the previous section, I only analyzed the correlation between Japan's foreign exchange intervention and Treasury yields. In this section, I try to clarify the direction of causality.

4.1 The BRS approach

Although the results of the event study approach of BRS in section 3.1 are suggestive of Japan's foreign exchange policy playing an important role in determining Treasury yields, they suffer from potential problems related to reverse causality. For example, weak economic data could cause Treasury yields to fall and the dollar to weaken, with the latter prompting a foreign exchange intervention by the Japanese Ministry of Finance. In trying to address this problem, BRS exclude samples on major data release days.[7] Their exclusion produces a smaller and less statistically significant coefficient (the second column in Table 1), but the results remain broadly unchanged. Based on these results, BRS claim that causality runs from Japan's foreign exchange policy to Treasury yields.

BRS provide one evidence against reverse causality. There are some weaknesses, however, in their approach. Major economic data release is only one factor possibly affecting Treasury yields and potentially prompting Japanese intervention. Many other factors could also be a source of reverse causality—for example, monetary policy, other data release not excluded by BRS,[8] speeches made by Fed officials or government officials, geopolitical news, or changes in investors' preferences. Further examination of the direction of causality is warranted.

4.2 Investors' confidence

As one check on reverse causality, I examine the changes in investors' confidence when Japan intervenes in the foreign exchange market. When some bad news on the U.S. economy causes Treasury yields to fall and the U.S. dollar to weaken, with the latter prompting Japanese intervention, investors' confidence in the U.S. economy is likely to be damaged. Consequently, if I find a significant negative correlation between investors' confidence and Japanese intervention, it constitutes evidence supporting reverse causality. A lack of such a correlation may be considered as providing evidence against reverse causality.

[7] Days that are excluded are those related to the release of reports on employment, GDP, business activity (ISM), retail sales, and consumer confidence.

[8] Gurkaynak, Sack, and Swanson (2005) reports that surprise components of macroeconomic data not excluded by BRS, such as capacity utilization, the CPI (core), the employment cost index, leading indicators, the NAPM, new home sales, and the PPI (core), and monetary policy surprises significantly affect one-year forward rates ending 5-year or 10-year ahead.

Table 2: Corporate bond risk premium

	Baa-Aaa	Baa	Aaa
JFEI	-0.01	-0.53	-0.52
	(0.09)	(2.20)**	(2.17)**
No. samples	147	147	147

Notes: The numbers in parentheses are t-values, calculated using serial correlation-adjusted standard errors, following the approach of Hodrick(1992). *** indicates significance at the 1-percent level, ** at the 5-percent level, and * at the 10-percent level.

It is not possible to measure investors' confidence directly. I use the corporate bond risk premium,[9] defined as the difference in yields on corporate bonds with Aaa and Baa ratings, as a proxy for investors' confidence. The corporate bond risk premium is a good proxy for investors' confidence, as investors require a lager risk premium when their confidence is damaged.

I employ the event study approach. Three-day changes in the corporate bond risk premium are regressed on the amount of foreign exchange intervention:

$$(i_{Baa,t+2} - i_{Aaa,t+2}) - (i_{Baa,t-1} - i_{Aaa,t-1}) = \eta JFEI_t + \varepsilon_t. \tag{5}$$

The coefficient on Japan's intervention is very close to zero and, with t-value of 0.1, is not statistically significant (the first column of Table 2). This suggests that investors do not require a larger risk premium when Japan intervenes in the foreign exchange market; correspondingly, we can say that investors' confidence is not damaged. The analysis here then provides little support for reverse causality.

4.3 Investment in securities and deposits

As the basis for another approach to studying the direction of causality, I use the fact that Japan's intervention can be categorized as investments in securities and investments in deposits, as explained in section 2.4. First, I explain how the distinction can shed light on the direction of causality. I then report the results. The analysis constitutes what is most unique aspect of this paper.

[9] Another candidate is stock prices, but stock prices are theoretically discounted present values of expected future dividends. Safe asset yields are used for discounting. When reverse causality is present, expected future dividends should fall; at the time, however, safe asset yields used for discounting should also fall. Consequently, it is hard to tell which way stock prices should move in the presence of reverse causality. I therefore choose to use here the corporate bond risk premium.

Table 3: Japan's investment in securities and investment in deposits

Dependent variable: $i_{10,t} - i_{10,t-1}$			
JFRIS	-0.54	-1.37	-2.01
	(1.44)	(2.69)***	(3.56)***
JFRIS(-1)		1.06	0.53
		(2.16)**	(1.01)
JFRIS(-2)			1.12
			(2.10)**
JFRID	-0.25	-0.20	-0.20
	(0.49)	(0.39)	(0.39)
JFRID(-1)		0.36	0.47
		(0.69)	(0.92)
JFRID(-2)			0.72
			(1.40)
$Adj - R^2$	0.02	0.07	0.14
No of observations	64	63	62
	2000:5-2005:8	2000:6-2005:8	2000:7-2005:8

Notes: The numbers in parentheses are t-values. *** indicates significance at the 1-percent level, ** at the 5-percent level, and * at the 10-percent level.

4.3.1 How to analyze causality

Using monthly data, I am able to analyze the relationship between the 10-year Treasury yield and Japan's foreign exchange intervention ($JFEI$), using the following equation:

$$i_{10,m} - i_{10,m-1} = \beta JFEI_m + \epsilon_m. \tag{6}$$

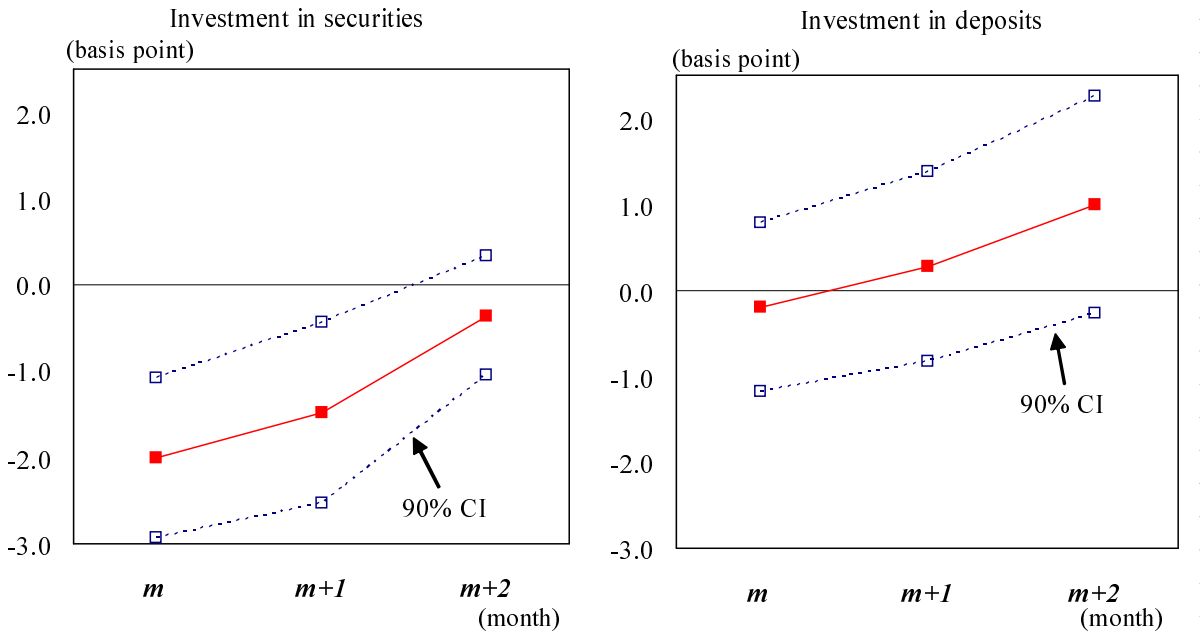
I modify equation (6) by splitting $JFEI$ into investments in securities ($JFRIS$) and investments in deposits ($JFRID$):

$$i_{10,m} - i_{10,m-1} = \beta_S JFRIS_m + \beta_D JFRID_m + \epsilon_m. \tag{7}$$

If reverse causality is true, declines in Treasury yields should correlate with Japan's intervention regardless of whether it is invested in securities or deposits; this means that investments in securities and those in deposits should correlate with Treasury yields in the same way. If this is the case, then both β_S and β_D should be negative by the same amount.

On the other hand, if Japan's foreign exchange policy affects Treasury yields through some demand-supply relationship with Treasury securities, declines in Treasury yields should have a stronger negative correlation with investments in securities than investments in deposits.

Figure 6: The effect of Japan's foreign reserve investment in securities and deposits on the 10-year Treasury yield



Source: Author's calculations.

The analysis in section 3.2 suggests that the declines in Treasury yields associated with Japan's interventions are temporary. Treasury yields rise to their original level within 40-50 business days following their initial decline. To control this rise, I add lags for investment in securities and deposits to equation (7). Since 40-50 business days is the equivalent of two-months, two lags are added. Note that the data on investments in securities and deposits are available only at a monthly frequency. I regress the following equation:

$$i_{10,m} - i_{10,m-1} = \sum_{k=0}^{2} \beta_{S,k} JFRIS_{m-k} + \sum_{k=0}^{2} \beta_{D,k} JFRID_{m-k} + \epsilon_m. \tag{8}$$

4.3.2 The estimation results

The estimation results are given in the third column of Table 3. The coefficient on current investment in securities is -2.0[10] and highly statistically significant, with a t-value of 3.6 while the coefficient on

[10]This size may seem inconsistent with an analysis using Japan's daily interventions as a regressor. They are, however, broadly consistent, for the following reason. Suppose that a decline in the 10-year Treasury yield associated with a Japanese intervention of $1 billion is -0.85 basis points as in section 3.2; additionally, that Japan invests $0.5 billion in securities, which in turn affects the 10-year Treasury yield. The coefficient on Japan's investment in securities then would be 1.70.

Japan's current investment in deposits is -0.2 and not statistically significant, with a t-value of 0.4. This suggests that Japan's foreign exchange policy does affect Treasury yields through investments in securities, something which rejects reverse causality.

The coefficients on lagged investments in securities are positive, which implies that the effect of Japan's investment in securities on the 10-year Treasury yield is temporary. After Japan's investment in securities of $1 billion, the 10-year Treasury yield declined by 2.0 basis points; after two months it rose to about its original level (the left graph in Figure 6).

4.4 Summary

The analysis in this section suggests that causality runs from Japan's foreign reserve investment in securities to Treasury yields and that reverse causality is weak or non-existent.

5 Explanations

In this section, I consider how Japan's foreign reserve investment affects Treasury yields. There are two leading explanations, those reflecting the portfolio balance effect or the liquidity effect.

5.1 The portfolio balance effect

One common explanation in the literature on the effectiveness of foreign exchange interventions reflects what is known as the portfolio balance effect (Dominguez and Frankel (1993)). [11] The portfolio balance effect postulates that investors require a smaller return from an asset as the share of the asset in the investors' portfolios decreases. Japan's foreign reserve investment in Treasury securities could have affected Treasury yields by decreasing the share of Treasury securities in investors' portfolios.

I examine the plausibility of this explanation by comparing it with the effect a change in budget debt has on U.S. interest rates. If the portfolio balance effect is the main channel, the size of the effect of Japan's foreign reserve investment on U.S. interest rates should not be too different from the effect of a

[11] Another common explanation concerning the effectiveness of foreign exchange intervention is the signaling channel (Baillie, Humpage, and Osterberg (2000)). According to this explanation, the monetary authorities can use sterilized foreign exchange intervention to transmit private information to the market, thereby affecting the market participants' assessment of the equilibrium interest rates. This would not be a good explanation for the effect of Japan's foreign exchange policy on U.S. interest rates because Japan's intervention would signal Japan's target level of the exchange rate or the weakness of the Japanese economy, but there is little reason that this kind of information should affect U.S. interest rates.

change in the budget debt on U.S. interest rates; notably, this would also change the share of Treasury securities in investors' portfolios.

Since there are many alternative assets relative to Treasury securities —such as mortgage backed securities—the size of the portfolio balance effect is considered to be small. The effect of a decrease in the budget debt of 1% of U.S. GDP on the 10-year real Treasury yield is estimated to be 5 basis points at most, according to Laubach (2003).[12] According to the coefficient obtained by BRS, Japan's foreign exchange intervention of 1% of U.S. GDP leads to a decline of about 80 basis points in the 10-year Treasury yield.[13] If the portfolio balance effect is the main channel, it is puzzling that the effect of Japan's foreign exchange intervention on the Treasury yield is more than 15 times larger than the effect of a decrease in the budget debt on the Treasury yield. I think that the portfolio balance effect does work, but not enough to explain the size of the effect of Japan's foreign exchange policy on Treasury yields.

5.2 The liquidity effect

The analysis in section 3.2 suggests that the short-run impact of Japan's foreign exchange policy on U.S. interest rates is larger than its long-run impact. The prevailing explanation for this phenomenon reflects the liquidity effect. The related theory tells that when the market faces a large increase in demand for a certain asset, it has to raise the price of the asset temporarily in order to find sellers—the lower the liquidity of the market, the larger the change in the price. For example, when the housing market faces a large increase in the demand for houses, it takes time to find sellers; the housing market therefore has to temporarily raise the price of houses in order to find sellers, since the liquidity of the housing market is relatively low.

It is possible that Japan's large foreign reserve investment in Treasury securities causes a temporary decline in U.S. interest rates through the same mechanism.[14] In order to evaluate the relevance of this

[12]Laubach (2003) estimates the interest rate effect caused by the budget debt and the deficit. They use two specifications. In the first specification, the level of the real interest rate is regressed on the debt to GDP ratio. In the second specification, the level of the real interest rate is regressed on the deficit to GDP ratio. The results, reported above, are from the first specification since the specification in the BRS—whereby a change in the interest rates is regressed on the foreign exchange intervention—is closer to the first differenced version of the first specification. Engen and Hubbard (2004) support the first specification by arguing that standard growth theory predicts the relationship between the level of the real interest rate and the level of debt; likewise, between the changes in the interest rate and the changes in debt. The result from the second specification in Laubach (2003) is 23-36 basis points. These numbers are also much smaller than those implied by the results in the BRS.

[13]If it is assumed that expected inflation does not change significantly within three days, the coefficient estimated in the BRS can be interpreted as the effect of Japan's foreign exchange intervention on real Treasury yields.

[14]Federal Reserve Chairman Bernanke made a speech entitled "Reflections on the Yield Curve and Monetary Policy" on

theory, I compare it with the potential liquidity effect of Japan's foreign reserve investment with the liquidity effect found in the stock market. If the liquidity effect is the main channel, the length of the effect of Japan's foreign reserve investment on U.S. interest rates should be close to the liquidity effect found in the stock market, inasmuch as the liquidity levels in the two markets would not be so different.

Since both the U.S. stock market and the U.S. Treasury securities market are the most liquid markets in the world, the liquidity effects in the two markets would not last long. Campbell, Grossman, and Wang (1993) find that the liquidity effect in the U.S. stock market lasts only a few days. In contrast, the analysis in the previous sections suggests that the effect of Japan's foreign exchange policy on Treasury yields lasts for close to two months. I think the liquidity effect works, but other mechanisms, which can amplify the liquidity effect, are necessary to explain the observed length of the effect. In the following sections, I explore two potential amplifying mechanisms.

5.2.1 The noise trader effect

One potential mechanism which can amplify the liquidity effect is the noise trader effect. I explain how this effect works using the model in De Long, Shleifer, Summers, and Waldmann (1990). In their model, there are two investors. One is a noise trader, who has a non-fundamental valuation of financial assets. The other is an arbitrager, who has a fundamental valuation of financial assets. Their investment performances are evaluated at a certain fixed time T in the future. I let t denote the present time. As long as the arbitrager expects fundamental prices at T, he takes a position of fully offsetting any deviation of prices from the fundamental value at t caused by the noise trader. But once the arbitrager recognizes a possibility that the noise trader may cause non-fundamental prices at T, the arbitrager does not fully offset the deviation of prices at t, because arbitrage at t will aggravate the investment performance of the arbitrager if the prices at T are lower than the fundamentals. As a result, non-fundamental prices at t remain. The gist of the model is that the possibility of non-fundamental prices at the time that investment performances are evaluated implies current non-fundamental prices.

Before explaining how the noise trader effect amplifies the liquidity effect, I report the serial correlation of Japan's investment in securities. To do this, I regress Japan's foreign reserve investment in securities on a constant and its own lags. The result is that the coefficients for the first and the second lags are statistically significant at a conventional level (Table 4). This means that it is reasonable for

March 20, 2006. In the speech, he stated that, "longer-term yield came under significant downward pressure during episodes of heavy official purchases of dollars...However, these observations speak more to the existence of a short-term impact of large purchases and sales—the result of limits to liquidity in the very short run—than to the perhaps more important question of whether those transactions have a lasting effect on yields. On the latter issue, clear evidence is harder to come by."

Table 4: Partial autocorrelation of $JFRIS$

Dependent variable: $JFRIS$					
constant	3.38	2.18	1.77	1.75	1.97
	(2.87)***	(1.81)*	(1.42)	(1.34)	(1.44)
JFRIS(-1)	0.49	0.32	0.24	0.24	0.24
	(4.39)***	(2.60)**	(1.87)*	(1.78)*	(1.76)*
JFRIS(-2)		0.35	0.29	0.28	0.30
		(2.90)***	(2.24)**	(2.09)**	(2.10)**
JFRIS(-3)			0.21	0.21	0.23
			(1.62)	(1.53)	(1.60)
JFRIS(-4)				0.01	0.03
				(0.07)	(0.19)
JFRIS(-5)					-0.07
					(0.55)
$Adj - R^2$	0.23	0.31	0.33	0.31	0.30
No of obs	63	62	61	60	59

Notes: The numbers in parentheses are t-values. *** indicates significance at the 1-percent level, ** at the 5-percent level, and * at the 10-percent level.

private investors to predict Japan's investment in securities for the two subsequent months on the basis of Japan's investment for the current month.

I now describe how this noise trader effect can amplify the liquidity effect with respect to Japan's foreign reserve investment. Japan's foreign reserve investment lowers U.S. interest rates through the liquidity effect. At the same time, Japan's foreign reserve investment signals future investment and suggests the possibility of non-fundamental prices in the future. As investors recognize the possibility of non-fundamental prices in the future, they fail to fully offset current declines in U.S. interest rates brought about by the liquidity effect, thus allowing the non-fundamental prices to remain.

Since most financial institutions report quarterly profits and loss, the investment performances of private investors may be considered as being evaluated at least once a quarter; anecdotal evidence suggests that in some cases, the investment performances of investors are evaluated monthly. I also note that the partial autocorrelation of Japan's foreign reserve investment in securities is significant for two months which matches the estimated length of the effect of Japan's foreign reserve investment on U.S. interest rates. On March 18, 2004, *The Economist* wrote, "at the start of the year, ten-year Treasuries yielded 4.3 percent, which most investors thought absurdly low. They must think today's prices even sillier: recently the yield tumbled below 3.7 percent." This suggests non-fundamental prices for bonds in early 2004, which is consistent with the noise trader effect.

5.2.2 The bandwagon effect

Another potential mechanism which can amplify the liquidity effect is the bandwagon effect. If some investors follow positive feed back strategies —that is, they buy when prices rise and sell when prices fall—a decline in Treasury yields brought by Japan's foreign reserve investment as manifested in the liquidity effect would be reinforced.

The key assumption of this explanation is the existence of positive feedback investors. Technical or chart analysis of the financial markets involves providing forecasts or trading advice on the basis of the largely visual inspection of past prices, without regard to any underlying economic or 'fundamental' analysis. Advice based on technical analysis often leads to positive feedback investment strategies. Taylor and Allen (1992) provide interesting facts on the foreign exchange market in London. They find that at least 90 percent of respondents to their survey place some weight on this form of non-fundamental analysis when forming views at one or more time horizons. The findings in Taylor and Allen (1992) are old and apply to a different market. Nonetheless, the technical analysis is currently still popular. For example, "Yahoo!! Finance," which is one of the most popular financial news websites, provides technical analysis information on Treasury yields. The hump-shaped response of the 10-year Treasury yield to Japanese foreign exchange intervention is consistent with the existence of the bandwagon effect.

5.3 A summary of the explanations

In this section, I discuss two leading channels, the portfolio balance effect and the liquidity effect, concerning the effect of Japan's foreign reserve investment on U.S. interest rates. The two channels are not enough to explain the observed size and length of the effect of Japan's foreign reserve investment on U.S. interest rates. I then explore potential mechanisms, which can amplify the liquidity effect, such as the noise trader effect and the bandwagon effect, contending in the end that these mechanisms could have been at work. At the same time, it has to be recognized that the evidence underpinning the amplifying mechanisms are not strong. Consequently, I leave for the future further investigation regarding the explanations.

6 Robustness checks

In section 4.3, I regress changes in the 10-year Treasury yield on Japan's foreign reserve investments in securities and that in deposits, and find that the coefficients on investment in securities are negative and statistically significant. Here, I conduct several robustness checks. First, I include other explanatory

variables, such as investors' confidence, monetary policy, and China's investment in Treasury securities. Second, I examine the relationship between Japan's foreign reserve investment in securities and other U.S. interest rates.

6.1 Other explanatory variables

6.1.1 Investors' confidence and monetary policy

In order to reduce the risk of omitted variable bias, I include other factors which can affect Treasury yields. One important determinant of Treasury yields is investors' confidence regarding the future economic conditions. I use stock prices (S&P500) as a proxy for confidence. Another important determinant of Treasury yields is the monetary policy stance. I use the target federal fund rate to represent the monetary policy stance.

The results are given in the first and second columns in Table 5. S&P500 has a strong correlation with the 10-year Treasury yield. Monetary policy has a significant correlation with the 10-year Treasury yield at the 10 percent level. The inclusion of these variables does not affect the coefficients on Japan's foreign reserve investment, indicating the robustness of the result in section 4.3. The coefficient on Japan's foreign reserve investment in deposits is close to zero, which does not support reverse causality.

6.1.2 China's investment

If the Chinese yuan is under appreciation pressure against the U.S. dollar at the same time as the yen, Japan's foreign reserve investment and China's foreign reserve investment can be correlated. As explained in section 2.6., China was the second largest foreign reserve investor in Treasury securities in 2003 and 2004. China's investment is another potential cause of omitted variable bias.

Since there is no data for China's foreign reserve investment in Treasury securities, I use increases in Chinese holdings of Treasury securities as a proxy for China's foreign reserve investment in Treasury securities. As Prasad and Wei (2005) point out, the quality of data is not good. Unfortunately, there is no other choice. The result is presented in Table 5. The inclusion of China's investments in Treasury securities leads to larger coefficients on Japan's foreign reserve investment and a more precise estimation. This result shows that the negative correlation between Japan's foreign reserve investment in securities and the 10-year Treasury yield is robust. The coefficients on China's investment are not statistically significant for all regressions. The timing is lagged by one month. The pattern of coefficients, negative first and positive later, is similar to that for Japan. Since the quality of Chinese data is not good, I refrain from drawing any conclusions regarding China's investments.

Table 5: Other explanatory variables

Dependent variable: $i_{10,t} - i_{10,t-1}$						
Constant	-5.33	-5.32		-6.96	-5.19	
	(1.14)	(1.15)		(1.20)	(0.95)	
Dlog(S&P500)*100	2.80	2.80		2.71	2.67	2.98
	(3.86)***	(3.91)***		(3.66)**	(3.61)***	(4.22)***
D(Target FF rate)	-22.68	-22.66		-23.93	-23.49	-18.29
	(1.67)	(1.69)*		(1.74)*	(1.73)*	(1.43)
JFRIS	-1.71	-1.72	-2.10	-2.07	-1.82	-2.15
	(3.44)***	(3.66)***	(3.64)***	(4.09)***	(3.84)***	(4.58)***
JFRIS(-1)	0.91	0.91	0.50	0.78		0.66
	(1.95)*	(1.96)*	(0.91)	(1.60)		(1.43)
JFRIS(-2)	1.04	1.05	1.47	1.52	1.80	1.36
	(2.17)**	(2.20)**	(2.57)**	(2.96)***	(3.74)***	(2.75)***
JFRID	-0.01					
	(0.03)					
D(Chinese holding USTS (-1))			-1.28	-1.25	-1.23	-1.61
			(1.26)	(1.33)	(1.32)	(1.91)**
D(Chinese holding USTS (-2))			-0.02	0.40		
			(0.02)	(0.42)		
D(Chinese holding USTS (-3))			1.64	1.65	2.00	1.29
			(1.59)	(1.74)*	(2.16)**	(1.48)
$Adj - R^2$	0.32	0.34	0.14	0.36	0.35	0.36
AIC	9.38	9.35	9.61	9.36	9.34	9.32
No of observations			62			
			2000:7-2005:8			

Notes: The numbers in parentheses are t-values. D is a first difference operator. *** indicates significance at the 1-percent level, ** at the 5-percent level, and * at the 10-percent level.

6.2 Other interest rates

As another robustness check, I study the relationship between Japan's foreign reserve investment in securities and other U.S. interest rates.

First, I examine its relationship with other term Treasury yields. The result is shown in Table 6. Japan's foreign reserve investment has a statistically significant negative correlation with other term Treasury yields. The size of the current month decline is larger as the maturity lengthens. This means that Japan's foreign reserve investment flattens the yield curve at the point of initial impact.

Second, I examine its relationship with other U.S. interest rates, such as the conventional 30-year mortgage rate, the 20-year local government bond yield, and corporate bond yields. The result is sum-

Table 6: Other term Treasury yields

	1-year	2-year	5-year	7-year	10-year
Constant	-2.74	-4.07	-5.28	-5.41	-5.32
	(0.76)	(0.86)	(1.06)	(1.12)	(1.15)
Dlog(S&P500)*100	2.54	3.38	3.41	3.15	2.80
	(4.55)***	(4.61)***	(4.40)***	(4.19)***	(3.91)***
D(Targeted FF rate)	51.97	26.15	-7.22	0.91	-22.66
	(4.97)***	(1.90)*	(0.50)	(1.16)	(1.69)*
JFRIS	-0.79	-1.17	-1.62	-1.71	-1.72
	(2.18)**	(2.45)**	(3.21)***	(3.47)***	(3.66)***
JFRIS(-1)	0.36	0.61	0.86	0.91	0.91
	(1.00)	(1.28)	(1.73)*	(1.87)*	(1.96)*
JFRIS(-2)	0.71	0.89	1.06	1.07	1.05
	(1.92)*	(1.84)*	(2.07)**	(2.16)**	(2.20)**
$Adj - R^2$	0.45	0.33	0.32	0.33	0.34
No of observations			62		
			2000:7-2005:8		

Notes: The numbers in parentheses are t-values. D is a first difference operator. *** indicates significance at the 1-percent level, ** at the 5-percent level, and * at the 10-percent level.

marized in Table 7. Japan's foreign reserve investment has a statistically significant correlation with these domestic interest rates. This result means that the impact of Japan's foreign reserve investment is not limited to Treasury yields.

7 The accumulative effect of Japan's investment on long-term interest rates

In the introduction, I quoted from *The Economist*: "Intervention has helped finance America's twin deficits and hold down its long-term bond yields." Using the coefficients estimated in the previous section, I calculate how much Japan's foreign reserve investment in securities held down the 10-year Treasury yield from 2000 to 2005. Though each foreign reserve investment had at best only a temporary effect on Treasury yields, Japan's continuous investments over the course of 2003 and 2004 could have pushed down U.S. interest rates persistently. I calculate the accumulative effect of Japan's foreign reserve investment in securities on the level of the 10-year Treasury yield using the following equation, using the following equation:

$$ACE_m^{10} = \theta_0 JFRIS_m + (\theta_0 + \theta_1) JFRIS_{m-1} + (\theta_0 + \theta_1 + \theta_2) JFRIS_{m-2}, \tag{9}$$

Table 7: Other domestic interest rates

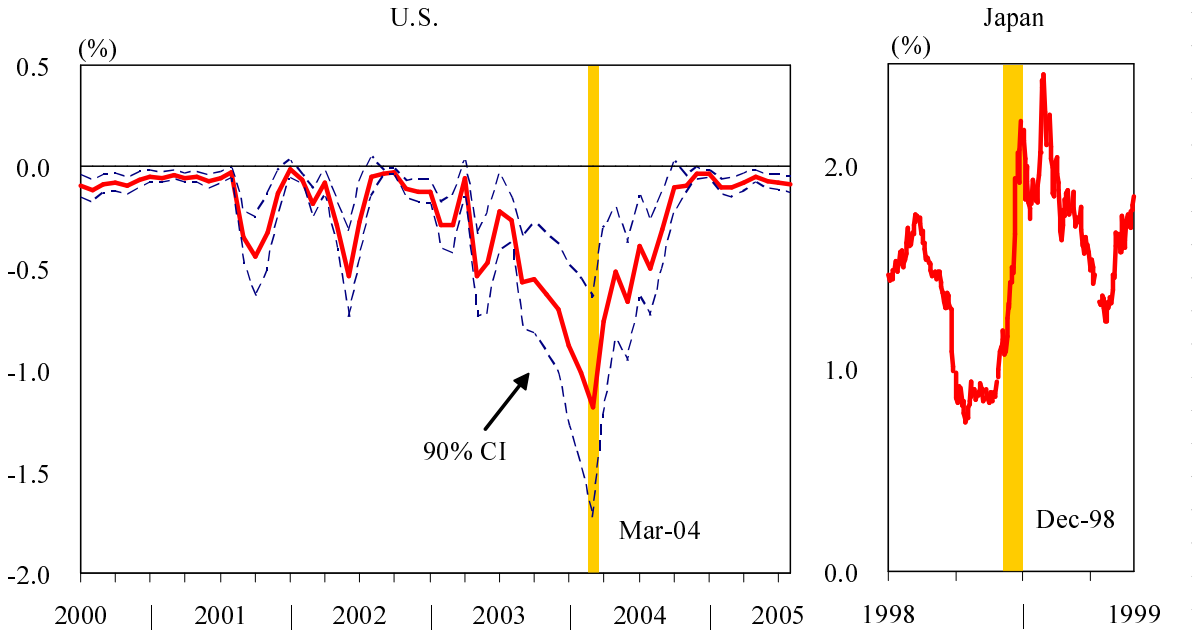
	30y mortgage rate	20y local state gov bond	Aaa	Baa
Constant	-5.58	-3.88	-6.14	-5.00
	(1.45)	(1.21)	(1.63)	(1.30)
Dlog(S&P500)*100	1.49	0.73	89.12	0.60
	(2.50)**	(1.46)	(1.53)	(1.01)
D(Targeted FF rate)	-4.77	-8.47	-13.35	-4.82
	(0.43)	(0.91)	(1.22)	(0.43)
JFRIS	-1.17	-0.63	-0.92	-0.75
	(3.01)***	(1.94)*	(2.38)**	(1.93)*
JFRIS(-1)	0.40	0.46	0.53	0.32
	(1.03)	(1.44)	(1.40)	(0.84)
JFRIS(-2)	1.04	0.35	0.73	0.56
	(2.64)**	(1.06)	(1.88)**	(1.42)
Dummy for Dec 2001			-49.47	
			(2.39)**	
$Adj - R^2$	0.20	0.05	0.14	0.02
No of observations		62		
		2000:7-2005:8		

Note: The numbers in parentheses are t-values. D is a first difference operator. *** indicates significance at the 1-percent level, ** at the 5-percent level, and * at the 10-percent level.

where ACE_t^{10} is the accumulative effect of Japan's foreign reserve investment in securities on the level on 10-year interest rate the during month m, θ_0, θ_1, and θ_2 are the coefficients on the current, first lagged, and second lagged Japanese investment in securities from the sixth column in Table 5; investors' confidence, the monetary policy stance, and China's investment are included as regressors. I choose this specification because it has the lowest AIC. The results are described in the left graph in Figure 7. Although each foreign reserve investment only has a significant effect on the level of the interest rate for two months, Japan's continuous foreign reserve investment held down the 10-year rate significantly and persistently in 2003 and 2004. The effect disappeared, however, at the end of 2004. The maximum impact is estimated to be 1.2 percent for March 2004.

The estimated size of the effect may seem too large to be plausible. To assess the plausibility of the estimated size, I present one relevant episode, known as 'the Trust Fund Bureau Shock,' from the Japanese government bond market for 1998-1999 (the right graph of the Figure 7). In December 1998, Japan's long-term interest rates climbed by 113 basis points, from 1.1 percent. This was the largest change in one month since the 1980s. The long-term interest rate reached 2.4 percent in February. Many market participants considered the change in the investment policy of the Trust Fund Bureau, which

Figure 7: Declines in the 10-year Treasury yield caused by Japan's foreign reserve investments and Japan's Trust Fund Bureau Shock



Sources: Bloomberg and author's calculations.

became apparent in December 1998, as a primary cause; hence they called it 'the Trust Fund Bureau Shock.' According to Bank of Japan's 'Flow of Fund' statistics, The Trust Fund Bureau (that is, the Fiscal Loan Fund) cut its investment in Japanese government bonds to a mere -0.3 trillion yen in fiscal year 1999, down from 13.2 trillion yen in fiscal year 1998. The size of the change is 2.7 percent of Japan's GDP for fiscal year 1999, which is comparable with Japan's foreign reserve investment in securities from 2003 to 2004—that is, 2.6% of the U.S.'s GDP. The comparison with this episode suggests that the estimated effect of Japan's foreign reserve investment on U.S. interest rates is not too large, though I admit that the comparison here is very casual. Also, anecdotal evidence suggests that the effect of 'The Trust Fund Bureau Shock' is temporary, which is also consistent with the analysis on the effect of Japan's foreign reserve investment on U.S. interest rates in this paper.

8 Conclusion

Here, I summarize my analysis. This paper examines the relationship between Japan's foreign exchange policy and U.S. interest rates. In contrast to previous studies, I examine the dynamics of, as well as the

direction of causality in the relationship. The main results obtained in this paper are as follows. First, Japan's foreign reserve investment in Treasury securities leads to a temporary and hump-shaped decline in Treasury yields. Second, the leading two explanations underlying the relationship, those reflecting the portfolio balance effect and the liquidity effect, are not enough to explain the size and the length of the declines in Treasury yields. Some amplification mechanism, such as the noise trader effect and the bandwagon effect, could be involved. Third, Japan's continuous investment in securities held down U.S. long-term interest rates significantly and persistently from 2003 to 2004 with the maximum impact being estimated to be 1.2 percent for March 2004.

Finally, I talk about the implications of my analysis with respect to monetary policy. BRS and Kuttner (2006) examine the possibility of using long-term interest rates as an alternative monetary policy instrument. BRS argue that if the changes in the relative supplies of Treasury securities brought about by Japan's foreign exchange policy can affect long-term yields, the Fed can lower long-term yields—and thus stimulate the U.S. economy—by changing the relative supply of Treasury securities even when its conventional policy tool, short-term interest rates, is facing a zero interest rate bound. The analysis in this paper suggests that, while the central bank may affect long-term interest rates by purchasing a large amount of Treasury securities, the effect would be temporary.

In this paper, I focus on the relationship between Japan's foreign reserve investment and U.S. interest rates. The declines in U.S. interest rates caused by Japan's foreign reserve investment can affect other financial variables, such as foreign interest rates and the exchange rates of the U.S. dollar, by making U.S. assets less attractive to both domestic and foreign investors. Abe (2006b) investigates this possibility. Furthermore, the changes in those financial variables caused by Japan's foreign reserve investment can affect macroeconomic variables such as the output gap and inflation in the global economy. Abe (2006a) pursues this possibility. An investigation on the macroeconomic effects of Japan's foreign reserve investment provides important clues for understanding the current global economy where large capital flows from China and oil exporting countries into the U.S. influence macroeconomic variables through changes in asset prices.

Appendix

A Valuation change adjustment

1. I calculate one-month changes in the foreign reserve without a valuation change from monthly balance of payment statistics, taking into consideration the fact that Japan's intervention during

the last two days of month t is included in month $t + 1$.

2. I calculate the overall valuation changes by subtracting the one-month changes in foreign reserve without the valuation changes from the one-month changes in the market value of the foreign reserve.

3. I calculate the valuation changes brought about by changes in the SDR/dollar exchange rate by multiplying the amount of the SDR with the changes in the SDR/dollar rate.

4. I calculate the valuation changes in deposits caused by changes in the euro/dollar exchange rate by regressing the changes in deposit on changes in the euro/dollar exchange rate.

5. I calculate the valuation changes in securities by subtracting the valuation changes calculated in steps 3 and 4 from the overall valuation changes.

6. I subtract the valuation changes in securities from the increases in the market value of the securities in the foreign reserve.

7. I subtract the valuation changes in deposits from the increases in the market value of the deposits in the foreign reserve.

References

Abe, K. (2006a): "International Capital Flows and the Dynamics of Output and Inflation," Mimeo, The Johns Hopkins University.

——— (2006b): "Japan's Foreign Reserve Investment and the Global Transmission of Interest Rates," Mimeo, The Johns Hopkins University.

Baillie, R. T., O. F. Humpage, and W. P. Osterberg (2000): "Intervention from an information perspective," *Journal of International Financial Markets, Institutions and Money*, 10(3-4), 407–421.

Bernanke, B. S., V. Reinhart, and B. Sack (2004): "Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment," *Brookings Papers on Economic Activity*, 2004(2), 1–78.

Campbell, J. Y., S. J. Grossman, and J. Wang (1993): "Trading Volume and Serial Correlation in Stock Returns," *The Quarterly Journal of Economics*, 108(4), 905–39.

De Long, J. B., A. Shleifer, L. H. Summers, and R. J. Waldmann (1990): "Noise Trader Risk in Financial Markets," *Journal of Political Economy*, 98(4), 703–38.

Dominguez, K. M., and J. A. Frankel (1993): "Does Foreign-Exchange Intervention Matter? The Portfolio Effect," *American Economic Review*, 83(5), 1356–69.

Doyle, B. M., and J. Faust (2005): "Breaks in the Variability and Comovement of G-7 Economic Growth," *The Review of Economics and Statistics*, 87(4), 721–740.

Engen, E. M., and R. G. Hubbard (2004): "Federal Government Debt and Interest Rates," in *NBER Macroeconomics Annual 2004*, ed. by G. Mark, and K. S. Rogoff. Cambridge: MIT Press.

Gurkaynak, R. S., B. Sack, and E. Swanson (2005): "The Sensitivity of Long-Term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models," *American Economic Review*, 95(1), 425–436.

Hodrick, R. J. (1992): "Dividend Yields and Expected Stock Returns: Alternative Procedures for Inference and Measurement," *Review of Financial Studies*, 5(3), 357–386.

International Monetary Fund (2006): "Oil Prices and Global Imbalances," in *World Economic Outlook April 2006—Globalization and Inflation*, ed. by International Monetary Fund.

Kuttner, K. (2006): "Can Central Banks Target Bond Prices?," NBER Working Paper 12454, National Bureau of Economic Research.

Kuttner, K. N. (2001): "Monetary policy surprises and interest rates: Evidence from the Fed funds futures market," *Journal of Monetary Economics*, 47(3), 523–544.

Kuttner, K. N., and A. S. Posen (2001): "The Great Recession: Lessons for Macroeconomic Policy from Japan," *Brookings Papers on Economic Activity*, 2001(2), 93–160.

Laubach, T. (2003): "New evidence on the interest rate effects of budget deficits and debt," Finance and Economics Discussion Series 2003-12, Board of Governors of the Federal Reserve System.

Prasad, E., and S.-J. Wei (2005): "The Chinese Approach to Capital Inflows: Patterns and Possible Explanations," NBER Working Paper 11306, National Bureau of Economic Research.

Svensson, L. E. O. (2003): "Escaping from a Liquidity Trap and Deflation: The Foolproof Way and Others," *Journal of Economic Perspectives*, 17(4), 145–166.

——— (2004): "The Magic of the Exchange Rate: Optimal Escape from a Liquidity Trap in Small and Large Open Economies," Mimemo, The Princeton University.

Taylor, M. P., and H. Allen (1992): "The use of technical analysis in the foreign exchange market," *Journal of International Money and Finance*, 11(3), 304–314.

Warnock, F. E., and V. C. Warnock (2006): "International Capital Flows and U.S. Interest Rates," NBER Working Paper 12560, National Bureau of Economic Research.