CHAPTER 11

The signaling effect of foreign exchange intervention: the case of Japan

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11.1 Introduction

Large-scale foreign exchange intervention by the central banks of major industrial countries since the Plaza Agreement has revived discussion concerning the effectiveness of official intervention. One of the common findings in the recent literature is the importance of the signaling channel of official intervention: market participants observing official intervention revise their expectations of future monetary policy, which induces a change in the current level of the exchange rate. For example, according to Dominguez and Frankel (1990), a $100 million of official intervention had an estimated effect of 4 percent on the exchange rate through the signaling channel, while the effect through the portfolio balance channel was less than 0.1 percent. Also, in a comparative discussion of the Carter administration’s dollar support operations of late 1978 and the Plaza Agreement of 1985, Marston (1988) points out that the effectiveness of sterilized intervention depends crucially on the ex-

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1 For example, Dominguez and Frankel (1990), using the dollar–mark data of October 1984 to December 1987, estimate a two-equation simultaneous system that considers both the signaling and portfolio balance channels and find that official intervention had a statistically significant effect on the movement of the exchange rate. The same method is applied by Dominguez (1990) to the dollar–yen exchange rate from January 1985 to December 1988. Humphage (1988) examines U.S. intervention from August 1984 to August 1987 and finds that there were three instances when intervention clearly affected the exchange rates. Klein and Rosengren (1991), looking at intervention in the United States and Germany from September 1985 to October 1989, report that coordinated intervention had a statistically significant impact on daily exchange rate changes.

tent to which the intervention changes the market’s expectations about future monetary policy.

In the context of an incomplete-information game between market participants and a central bank with inside information about future monetary policy, the signaling hypothesis can be broken down into two parts. The first relates to the optimizing behavior of the central bank. Given a functional relationship between intervention signals and market expectations about future monetary policy, the central bank minimizes some well-specified loss function by choosing the amount of intervention. The second relates to the formation of market expectations about future monetary policy. Given a functional relationship between inside information and intervention signals, market participants use Bayesian methods of inference to form expectations about future monetary policy conditional on intervention signals. A perfect Bayesian equilibrium is defined as the functional relationship between inside information and intervention signals that is compatible with both the central bank’s optimizing behavior and the market’s Bayesian inference.

Corresponding to such a decomposition of the signaling hypothesis, there are two methods of empirically testing the hypothesis. The first is to examine the behavior of a central bank by focusing on the link between intervention signals and future monetary policy. In the context of Japan, we can test whether the Bank of Japan’s sale of dollars tends to be followed by monetary tightening. The second method is to examine the market’s expectations about future monetary policy. A testable implication is that market participants tend to expect tight monetary policy in the future when they observe the Bank of Japan selling dollars.

From a viewpoint of studying the signaling effect of intervention on the current exchange rate, the second approach appears to be simple, straightforward, and therefore more attractive. If the market’s expectations about future monetary policy were observable, we could directly test the signaling hypothesis. Unfortunately, however, no such data are available. For this reason, the first approach will be adopted in this essay. In particular, we will empirically examine in Section 11.3 the behavior of the Bank of Japan by looking at the correlation between intervention and monetary policy.

1 For a game-theoretic framework to deal with intervention signaling, see Watanabe (1991).

1 It is important to note that we deal only with a necessary condition of the signaling hypothesis. It is true that if there exists no link between intervention and monetary policy, market participants who are rational in the Bayesian sense would never revise their expectations about future monetary policy when observing official interven-
The core mechanism of the signaling hypothesis is that inside information about future monetary policy flows from a central bank to market participants through intervention. Since the role of intervention is to provide “news” for market participants, intervention should not be fully anticipated if it were to have any effect on the exchange rate. Fully anticipated intervention gives no surprise to the market, and would thus never influence the current exchange rate. Section 11.3 empirically examines the extent to which interventions of the Bank of Japan were anticipated.

This essay is organized as follows. Section 11.2 presents a simple theoretical model to deal with the signaling channel of official intervention and derives two testable implications of the model: (i) intervention should precede monetary policy changes in a predictable manner; (ii) effective intervention should not be anticipated by market participants. The first implication is examined empirically in Section 11.3 and the second in Section 11.4. Section 11.5 concludes the essay.

11.2 Implications of the signaling hypothesis

11.2.1 A simple model

Let us begin the analysis with the assumption that the current spot exchange rate is determined by a scalar measure of exchange rate fundamentals and the expected change in the exchange rate. That is,

$$s_t = f_t + \beta E(s_{t+1} - s_t | \Omega_t).$$  (11.1)

where \(s_t\) is the logarithm of the yen-dollar rate, \(f_t\) the factor representing fundamentals, \(\Omega_t\) the set of information currently available to market participants, and \(\beta\) the elasticity of the current exchange rate with respect to expectations. In the target zone model of Krugman (1991), where equation (11.1) is derived in a simple flexible-price monetary model, \(f_t\) is a linear function of variables that enter money market equilibrium, including the logarithm of the money supply.

Assuming away the possibility of bubble solutions, the solution of this difference equation is given by

$$\Delta s = (1 + \beta)^{-1} \sum_{t=0}^{\infty} \beta(1 + \beta)^{-1} E(f_{t+1} | \Omega_t).$$  (11.2)

which simply says that the current exchange rate is essentially determined by market expectations about the future values of fundamentals conditional on currently available information.

Suppose market participants observe the Bank of Japan intervening in the foreign exchange market at time \(t\). Let \(x_t\) denote the yen value of the net purchase of foreign currencies. Because the focus of this essay is on the signaling effect of official intervention, we assume that (i) official intervention is completely sterilized, and (ii) sterilized intervention is ineffective through the portfolio balance channel. These assumptions, which are introduced mainly for simplification, seem realistic to some extent. For example, Takagi (1991) finds that foreign exchange intervention by the Bank of Japan had no significant effect on the monetary base during the period 1973–89. As for the second assumption, Dominguez and Frankel (1990), among others, report that the effect of sterilized intervention through the portfolio balance channel is trivial. Unless otherwise mentioned, these two assumptions will be maintained throughout this essay.

The sole consequence of central bank intervention under these assumptions is to alter the information set \(\Omega\). Denoting the information set before and after the observation of the intervention by \(\Omega\) and \(\Omega'\), respectively, we can express the change in the exchange rate at time \(t\) induced by the official intervention, \(\Delta s\), as

$$\Delta s = (1 + \beta)^{-1} \sum_{j=0}^{\infty} \beta(1 + \beta)^{-1} \gamma(j)$$

$$\times E(f_{t+j} | \Omega'_t) - E(f_{t+j} | \Omega_t).$$  (11.3)

According to equation (11.3), sterilized intervention is effective to the extent that it influences market expectations about the future values of exchange rate fundamentals.

To extract further implications from equation (11.3), we add some assumptions. First, we specify the information set as follows. Let \(Y\) denote an \(n\)-vector of random variables that are observable to market participants at time \(t\). Assuming, for simplicity, that \(Y\) has a Markov property, the state of the economy at time \(t\) is represented by \(\{Y_t\}\). Then the information sets \(\Omega\) and \(\Omega'\) are expressed as

$$\Omega = \{Y_t\}; \quad \Omega' = \{Y_{t+t}, x_t\}.$$
Second, we assume that $Z_{jt} = (f_{jt}, Y_{jt})$, which is an $(n + 2)$-vector of random variables and obeys a multivariate normal distribution, and we denote the expectation of $Z_{jt}$ by $\mu_j$ and the variance–covariance matrix of $Z_{jt}$ by $\Sigma_j$, which is partitioned as

$$
\Sigma_j = \begin{pmatrix} 
\Sigma_{11} & \Sigma_{12} & \Sigma_{13} \\
\Sigma_{21} & \Sigma_{22} & \Sigma_{23} \\
\Sigma_{31} & \Sigma_{32} & \Sigma_{33} 
\end{pmatrix},
$$

(11.4)

where $\Sigma_{11}, \Sigma_{22}, \Sigma_{33}, \Sigma_{13},$ and $\Sigma_{33}$ are scalars, $\Sigma_{21}$ and $\Sigma_{32}$ are $(n \times 1)$-vectors, $\Sigma_{12}$ and $\Sigma_{22}$ are $(1 \times n)$-vectors, and $\Sigma_{22}$ is an $(n \times n)$-matrix. For simplicity, we assume that $\Sigma_{22}$ is a diagonal matrix. Third, we assume that market participants know the distribution of $Z_{jt}$.

Under this setting, we may explicitly calculate $\Delta x$ in equation (11.3). In particular, we are interested in the coefficient associated with $x_n$, which shows how $\Delta x$ would respond to a change in the amount of intervention. The coefficient of $x_n$ in $E(f_{jt+1} | Y_{jt}, x_t)$ turns out to be

$$
(\Sigma_{13} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{23})/k_j, \quad j > 0,
$$

(11.5)

where $k_j = \Sigma_{23} - \Sigma_{22}\Sigma_{22}^{-1}\Sigma_{23} > 0$ is a positive scalar. As long as this term is nonzero, sterilized intervention at time $t$ affects expectations about the value of fundamentals at time $t + j$. In order to study the effectiveness of sterilized intervention through the signaling channel, therefore, it is necessary to check empirically whether this term is significantly different from zero. This is essentially how we will proceed in the empirical section of the essay.

11.2.2 Covariance between intervention and future monetary policy

The first term in the parentheses of equation (11.5), $\Sigma_{13}$, represents the covariance between intervention at time $t$, $x_t$, and the scalar measure of exchange rate fundamentals at time $t + j$, $f_{jt+j}$, where $j > 0$. If this covariance is positive, the net sale of dollars by the Bank of Japan on a sterilized basis induces an appreciation of the yen.

It might seem reasonable to expect positive covariance. Since both current intervention policy and future monetary policy are determined by a single agent (the Bank of Japan), it might be reasonable to expect the two policies to be consistent. For instance, when desiring an appreciation of the yen, the Bank of Japan would sell dollars today and adopt a tight monetary policy at future dates (see, e.g., Mussa, 1981; Klein and Rosengren, 1991).

Although the idea that multiple decisions made by a single agent should be consistent with one another seems persuasive at first sight, there is a serious theoretical problem arising from the fact that decisions concerning intervention and monetary policy are made at different points of time. That is, "once the government has persuaded people [through intervention signaling] to expect that it will follow a future monetary policy that assists in achieving its current objectives, there is nothing to insure that the government will actually follow the future policy that people expect" (Mussa, 1981: 16). If this kind of dynamic inconsistency exists, market participants, realizing the absence of a positive correlation between intervention policy and future monetary policy, would ignore intervention signals sent by a central bank and never revise their expectations about the future values of fundamentals. As a consequence, central bank intervention would have no effect on the current exchange rate.

Several hypotheses have been offered to explain the mechanism through which central banks could send credible intervention signals. Mussa (1981) proposes the idea that intervention provides concrete evidence of the seriousness of a central bank's future policy intentions by staking its capital in support of them. For example, consider a central bank that acquires a short position in the foreign currency and a long position in the domestic currency through intervention. The central bank, paying attention to profits or losses associated with intervention, then has an incentive to adopt consistently a tight monetary policy following sales of the foreign currency.

To explain the signaling mechanism, Watanabe (1991: ch. 2) uses a foreign exchange intervention game between market participants and a central bank with inside information about future monetary policy. He argues that an important necessary condition for an intervention signal to be credible is that sending the signal is costly for the central bank. For example, if sterilized intervention disturbs domestic financial markets in the sense that intervention, even if sterilized, affects domestic interest rates, intervention signals become costly for the central bank to transmit. The unique equilibrium obtained there is characterized by full revelation of the central bank's inside information and a monotonic relationship between the amount of intervention and future money supply.\(^3\)

\(^3\) Another explanation is suggested by Dominguez (1999). On the basis of the "reputation" story of the Barro–Gordon type, Dominguez argues that the central bank has the in-
11.2.3 Covariance between intervention and state variables

As the second term in the parentheses of equation (11.5) indicates, a positive covariance between intervention and future monetary policy alone does not guarantee the effectiveness of intervention through the signaling channel. To understand the meaning of the second term, suppose that the realized value of $Y$ at time $t$ is the sole determinant of both intervention policy and future monetary policy; that is, $x_{t+1}$ and $f_{t+1}$ are functions only of $Y_t$. Although the covariance between $x_{t}$ and $f_{t+1}$ in this case would be nonzero, this does not mean that $\Delta\sigma$ is also nonzero. Since intervention itself gives no additional information to market participants, there is no difference between the two information sets $\Omega$ and $\Omega'$. Therefore, intervention has no influence on the current level of the spot exchange rate ($\Delta\sigma = 0$).

As this simple example suggests, it is important to distinguish the direct relationship between $x_{t}$ and $f_{t+1}$ from the indirect relationship between the two through $Y_t$. Since the indirect correlation reflects the backward-looking policy response of a central bank, intervention gives no surprise to market participants. On the other hand, the direct correlation implies that the central bank owns information that is not available to market participants. In this case, as private information flows from the central bank to market participants through intervention, the current exchange rate responds to central bank intervention. Equation (11.5) shows that in order to evaluate the signaling effect of intervention, it is necessary to subtract the indirect covariance between $x_{t}$ and $f_{t+1}$ through $Y_t$ (the second term in parentheses) from the overall covariance (the first term in parentheses).

Past studies of the Bank of Japan's policy response function such as those of Hutchison (1984), Takagi (1991), and Glick and Hutchison (Chapter 10, this volume) suggest that the behavior of the Bank of Japan in the foreign exchange market is characterized by a leaning-against-the-wind policy: the Bank of Japan buys (sells) foreign currencies when the yen is appreciating (depreciating). An important aspect of this type of intervention policy is that the direction and scale of intervention depend exclusively on the direction and speed of a change in the exchange rate that occurred just before the intervention. In our terminology, an element of $Y_t$, which represents a change in the exchange rate between $t-1$ and $t$, is the sole determinant of $x_t$.

If the Bank of Japan faithfully follows this type of intervention policy, intervention itself would never surprise market participants. Thus, there would be no room for the signaling channel to be effective.

11.3 Consistency of intervention policy with monetary policy

11.3.1 Intervention and discount rate policy

The direction of the Bank of Japan's monetary policy can be ascertained from the official discount rate. Therefore, it is important to examine the temporal relationship between intervention and changes in the discount rate.

Table 11.1 shows the relationship between discount rate changes and the direction of past intervention during the period from April 1973 to April 1992. The first two columns of the table summarize discount rate changes during this period, and the third (fourth) column reports the amount of intervention during the month (three months) before each discount rate change.* Monthly intervention data used in the table, which are taken from the "Supply and Demand of Funds in Money Markets" statistics published by the Bank of Japan, represent the yen value of net purchases of foreign currencies. Throughout the essay, we will use the same data for the Bank of Japan's foreign exchange intervention.

Because a reduction in the discount rate induces a depreciation of the yen through a change in exchange rate fundamentals, a necessary condition for the effectiveness of the signaling channel is that a change in the discount rate be negatively correlated with the amount of intervention defined above.

A comparison of the second column with the third or fourth column clearly indicates that a reduction (increase) in the discount rate was consistently preceded by purchases (sales) of foreign currencies. Moreover, a turning point of monetary policy where tight (loose) policy changes into loose (tight) policy tends to coincide with a turning point of intervention policy where intervention changes from sales (purchases) of dollars to purchases (sales) of dollars. There are five such turning points of monetary policy during this period: April 1975, April 1979, August 1980, May 1989, and July 1991. In four of these five, the direction of intervention policy changed simultaneously, clearly indicating that a

* See the note to Table 11.1 for details on the figures in the third and fourth columns.
|---|
| Column (amount of intervention in 3 months): Either of the amount of intervention in the present month or the amount of intervention in the previous month. The lower limit in the first column (amount of intervention in past 1 month) represents the amount of intervention in the March 1, 2023, and April 1, 2023, which are each divided into the amount of intervention in the past month.
| **Table 11.1. Discount Rate Policy and Intervention in Japan** |
| **3 months** | **2 months** | **1 month** |
| **Effective discount rate (%)** | **Ineffective discount rate (%)** | **Change in discount rate (%)** |
| **Date of intervention** | **Change in intervention in past month** | **Change in intervention in past 3 months** |
| **Discount at 1%** | **Discount at 2%** | **Discount at 3%** |
| | | |
| | | | |
consistent link existed between the Bank of Japan’s intervention policy and its discount rate policy during the sample period.⁷

According to Table 11.1, there were nine instances in which a change in the discount rate was not consistent with the direction of intervention in the three preceding months.⁸ As shown in the columns of Table 11.1 presenting “factors cited in statements by the chairman of the policy board of the Bank of Japan announcing changes in the discount rate,” a common characteristic almost always observed in these instances is that the Bank of Japan faced an urgent need to stimulate extremely weak economic activity caused by various shocks. Put differently, when the stability of the foreign exchange rate becomes relatively less important as a policy objective, the Bank of Japan’s monetary policy tends to deviate from the course implied by preceding interventions.

11.3.2 Intervention and the control of money supply

A casual comparison between the time series of the amount of intervention and the time series of broad money (M₂ + CDs) divided by the GNP deflator indicates that there is a close correlation between the two time series.⁹

Figure 11.1 compares the monthly amount of intervention with the growth rate of real M₂ + CDs from the previous quarter. It is clearly observed in the period of 1976–92 that changes in intervention tended to precede changes in the growth rate of real M₂ + CDs in a consistent manner, although no systematic relationship can be seen in the period 1973–5. More surprisingly, there is a tendency such that the more the

Bank of Japan purchases foreign currencies, the higher is the growth rate of real M₂ + CDs.

Table 11.2 reports coefficients of correlation between the growth rate of the money supply and intervention based on quarterly data. It is observed that intervention is positively correlated with the future growth rates of money supply but is uncorrelated or negatively correlated with the past growth rates, clearly indicating that intervention tended to precede changes in the money supply. This observation depends neither on the choice of the sample period (before or after the Plaza Agreement) nor on the definition of the money supply (real or nominal).

To capture the dynamic relationship between intervention and real M₂ + CDs, we estimate a two-variable vector autoregressive model composed of the yen value of net purchases of foreign currencies, the
Table 11.2. Correlations between intervention and M2 + CDs

<table>
<thead>
<tr>
<th>Intervention at time</th>
<th>0</th>
<th>+Q1</th>
<th>+Q2</th>
<th>+Q3</th>
<th>+Q4</th>
<th>+Q5</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Q5</td>
<td></td>
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<td></td>
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<td>-Q4</td>
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<td>-Q3</td>
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<td>-Q2</td>
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<td>-Q1</td>
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<td>Q0</td>
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<td>Q1</td>
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<td>Q2</td>
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<td>Q3</td>
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<tr>
<td>Q4</td>
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<tr>
<td>Q5</td>
<td></td>
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</tbody>
</table>

| Growth rate of quarterly money supply at time 0 | 0.38 | 0.41 | 0.18 | 0.21 | 0.19 | 0.18 |
| Nominal money supply | 0.44 | 0.43 | 0.44 | 0.21 | 0.18 | 0.19 |
| Real money supply | 0.32 | 0.37 | 0.32 | 0.13 | 0.12 | 0.13 |

Note: Real money supply is defined as M2 + CDs divided by GNP deflator. Nominal money supply is defined as nominal money supply divided by GNP deflator. Growth rate of quarterly money supply is the annual growth rate of quarterly money supply. Source: Economic Statistics Monthly, Research and Statistics Department of the Bank of Japan, various issues; Annual Report on National Accounts, Economic Planning Agency, various issues.

Figure 11.2. Responses of M2 + CDs to a 1-trillion-yen shock in intervention. Based on the vector autoregression model composed of the amount of intervention, the logarithm of M2 + CDs divided by the implicit deflator for GNP, and constants. It is estimated with quarterly data from the first quarter of 1974 to the first quarter of 1992. The number of lags is set at four quarters.

logarithm of M2 + CDs divided by the implicit GNP deflator, and constants. It is estimated with quarterly data from the period 1974:Q1–1992:Q1. The number of lags is set at four quarters.

Figure 11.2 depicts the dynamic response of M2 + CDs to a 1-trillion-yen shock in intervention. Several points are noteworthy. First, the money supply does not respond at the moment of intervention. In other words, intervention by the Bank of Japan was completely sterilized. This is consistent with the finding of Takagi (1991), who concludes from a regression analysis that there was almost complete sterilization in Japan in the period 1973:Q2–1989:Q2. Second, M2 + CDs monotonically increases in response to a shock in intervention until it deviates 2.2 percent from the original level nine quarters later. This means that the initial

An alternative specification is to use the growth rate of real M2 + CDs instead of the logarithm of real M2 + CDs. In this case, we obtain responses of the growth rate of real M2 + CDs. Taking its integral, we obtain a graph similar to Figure 11.2.
Table 11.3. Historical decomposition of the growth rate of M2 + CDs

<table>
<thead>
<tr>
<th>Year</th>
<th>Forecast errors in growth rate of real M2 + CDs (%)</th>
<th>Explained by innovation in Intervention</th>
<th>Explained by innovation in M2 + CD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>0.48</td>
<td>-0.14</td>
<td>+0.62</td>
</tr>
<tr>
<td>1986</td>
<td>0.56</td>
<td>-0.57</td>
<td>+1.13</td>
</tr>
<tr>
<td>1987</td>
<td>3.89</td>
<td>+1.45</td>
<td>+2.44</td>
</tr>
<tr>
<td>1988</td>
<td>4.33</td>
<td>+4.60</td>
<td>-0.27</td>
</tr>
<tr>
<td>1989</td>
<td>1.64</td>
<td>+1.49</td>
<td>+0.15</td>
</tr>
<tr>
<td>1990</td>
<td>3.00</td>
<td>-2.45</td>
<td>+5.45</td>
</tr>
<tr>
<td>1991</td>
<td>-4.24</td>
<td>-2.61</td>
<td>-1.63</td>
</tr>
</tbody>
</table>

Note: The same quarterly vector autoregression model as in Figure 11.2 is used. The decomposition is based on the following partition of the moving average representation:

\[ z_{t+j} = \sum_{i=1}^{j} A_i u_{t+i} + \sum_{i=0}^{j-1} A_i u_{t+i} \]

where \( z \) is the vector composed of the amount of intervention and the growth rate of real M2 + CD, and \( u \) is the corresponding innovation vector. The left-hand side of the equation represents the forecast error: the actual value of \( z \) at \( T + j \) minus the forecast of \( z_{t+j} \), based on information at time \( T \). It is decomposed into innovations in the two variables. \( T \) is set at 1980:Q1.


The table that (i) the forecast errors in the (positive) growth rate of real M2 + CD from 1987 to 1989 are mostly explained by innovations in intervention; (ii) the negative forecast error in 1991 is also explained by innovations in intervention. Put differently, a market participant observing innovations in intervention could predict a loose monetary policy in the period 1987–9 as well as a tight policy in 1991.\(^{12}\)

11.4 Unexpected component of intervention

The positive correlation between monetary policy and intervention that we found in the preceding section implies that there is a common factor governing both the determination of monetary policy and that of intervention policy. As discussed in Section 11.2, a point to be checked next is whether that common factor is observable to market participants. If the common factor is fully observable, intervention would provide no new information for market participants, so that the current exchange rate would never respond to intervention. Only when the conduct of both intervention policy and monetary policy is based on a common factor that is not observable to market participants does intervention influence the current exchange rate. The purpose of this section is to examine to what extent intervention by the Bank of Japan was anticipated during the sample period. More specifically, we will investigate the type of correlation between intervention and a vector of variables that are observable to market participants, \( Y \), by specifying the Bank of Japan’s policy response function regarding foreign exchange intervention.

\(^{12}\) On the basis of the fact that the Treasury or the Ministry of Finance partly controls foreign exchange intervention in most countries, Humpage (1991) points out the possibility that intervention could signal changes in future fiscal policy. In the case of Japan, the institution in charge of foreign exchange intervention is the Foreign Exchange Funds Special Account of the National Budget. Accordingly, foreign exchange intervention is ultimately controlled by the Japanese Ministry of Finance, which is also responsible for fiscal policy. Therefore, it is plausible that the Japanese Ministry of Finance with a target yen rate higher than the current spot rate urges the Bank of Japan to sell dollars today and controls government expenditures at future dates with a view to maintaining the strong yen. Since typical models used in discussion among economists seem to indicate that an increase in government expenditure causes an appreciation of the domestic currency, the hypothesis that intervention serves as a signal to future fiscal policy predicts a negative correlation between the net purchase of foreign currencies and changes in government expenditure. A tentative examination of the Japanese data, however, shows a strong positive correlation between the two time series, suggesting the possibility that Humpage’s hypothesis does not hold in Japan.
11.4.1 Asymmetric leaning-against-the-wind policy

Hutchison (1984) and Takagi (1991), among others, point out that the Bank of Japan's intervention policy can be characterized as "leaning against the wind," which implies that its intervention is predictable to some extent from the past movement of the exchange rate.

If the Bank of Japan follows a leaning-against-the-wind policy, we should systematically observe that it purchases (sells) foreign currencies when the yen appreciates (depreciates). We call this type of intervention rule a symmetric leaning-against-the-wind policy. In Figure 11.3, such a policy is observed on a monthly basis during the period from 1973 to early 1980.\(^\text{13}\) For the rest of the sample period, however, a close examination of the monthly intervention data in Figure 11.3 indicates that the Bank of Japan's intervention deviated from the above rule. First, a "leaning-against-the-wind" policy was employed from late 1985 to early 1986 in that the Bank of Japan consistently sold dollars while the yen was appreciating.

Second, even when the Bank of Japan intervened in a leaning-against-the-wind fashion, the intervention behavior was not a symmetric leaning-against-the-wind policy as defined above. More specifically, there are two types of periods: (i) periods in which the Bank of Japan purchases foreign currencies during the month when the yen appreciates but does not intervene during the month when the yen depreciates; (ii) periods in which the Bank of Japan sells foreign currencies during the month when the yen depreciates but does not intervene during the month when the yen appreciates. In other words, on a monthly basis, the Bank of Japan responds only to an appreciation of the yen in the first case, while it responds only to a depreciation of the yen in the second case. We call this an "asymmetric leaning-against-the-wind policy."

To look more closely at the asymmetric leaning-against-the-wind policy, we divide the whole sample period into the following six subperiods depending on whether the Bank of Japan responded on a monthly basis mainly to an appreciation of the yen or to a depreciation of the yen: (i) March 1973 to April 1980; (ii) May 1980 to May 1981; (iii) June 1981 to August 1985; (iv) September 1985 to March 1986; (v) April 1986 to March 1989; (vi) April 1989 to May 1992. According to Table 11.4, the Bank of Japan responded evenly both to an appreciation of the yen and to a depreciation of the yen during the first subperiod. But during the second and fifth subperiods, the bank mainly responded only to an appreciation of the yen. For example, during the fifth subperiod, the bank never sold foreign currencies, although its purchase of foreign exchange amounted to more than 8 trillion yen. In contrast, during the third, fourth, and sixth subperiods, the bank responded mainly to a depreciation of the yen.

To characterize types of leaning-against-the-wind policies, we describe the response function of the Bank of Japan as

\[
x_t = a \Delta q_{t-1} + v_t \quad \text{if} \quad \Delta q_{t-1} \geq 0;
\]

\[
x_t = b \Delta q_{t-1} + v_t \quad \text{if} \quad \Delta q_{t-1} < 0,
\]

(11.6)

where \(x_t\) represents the net purchase of foreign currencies, \(\Delta q\) is a change in the real yen-dollar rate, \(a\) and \(b\) are nonpositive parameters, and \(v_t\) is a disturbance term. In words, the amount of intervention, which is determined after observing a change in the real yen-dollar rate, might...
respond differently to an appreciation of the yen and to a depreciation of the yen.

The first type, which is called a symmetric leaning-against-the-wind policy, or SLAW policy, is characterized as

$$a = b < 0.$$  \hspace{1cm} (11.7a)

As seen in Figure 11.4, which plots the monthly amount of intervention against the percent change of the real exchange rate from the previous month, the policy adopted during the first subperiod appeared to be of this type.\textsuperscript{44} In fact, ordinary least squares estimation indicates that\footnote{We must be careful in interpreting this fact, because we are discussing a contemporaneous correlation between intervention and the real exchange rate, so that simultaneity between the two variables might be a serious problem. Causality running from intervention to the real exchange rate implies a negative correlation between the two. Therefore, the observed positive correlation may well be weaker than the true correlation.} a = -0.0636 and b = -0.0465 (see the last two columns of Table 11.4): on average, the Bank of Japan sold 63.6 billion yen of foreign currencies when the yen depreciated by 1 percent, and bought 46.5 billion yen of foreign currencies when the yen appreciated by 1 percent.

The second type, which is called the asymmetric leaning-against-the-wind policy of type 1, or ALAW\textsubscript{1} policy, is characterized as

$$b < a \leq 0.$$  \hspace{1cm} (11.7b)

This policy was adopted in the second and fifth subperiods (see Figure 11.4). More formally, Table 11.4 shows that the estimated values of a are not significantly different from zero in both periods, while the estimated values of b are negative and significantly different from zero.

The third type, which is called the asymmetric leaning-against-the-wind policy of type 2, or ALAW\textsubscript{2} policy, is characterized as

$$a < b \leq 0.$$  \hspace{1cm} (11.7c)

The Bank of Japan's intervention policy in the third and sixth subperiods appears to fall into this category (see Figure 11.4). Indeed, the estimated values of b are not significantly different from zero in both periods, and the estimated values of a are negative and significantly different from zero (Table 11.4).

11.4.2 The target exchange rate hypothesis

Having identified three kinds of leaning-against-the-wind policies based on a careful examination of the monthly intervention data, we must
next ask what elements were important for the Bank of Japan in choosing among the three.

To answer this question, it is important to note that central banks often pay attention to levels of exchange rates as well as changes in exchange rates. On the basis of this understanding, we denote the Bank of Japan's target exchange rate at time $t$ by $T_t$, which is assumed to be time variant. Then our hypothesis is that the Bank of Japan adopts at time $t$ 

$$\text{ALAW}_1 \quad \text{if} \quad q_\tau - 1 < T_\tau - 1;$$

$$\text{ALAW}_2 \quad \text{if} \quad q_\tau - 1 \geq T_\tau - 1.$$  

(11.8)
In words, the Bank of Japan responds only to an appreciation of the yen when the current level of the yen is above the target level; on the other hand, it responds only to a depreciation of the yen when the current level of the yen is below the target level. Put differently, when the deviation of the exchange rate from the target level shrinks in absolute value, the Bank of Japan does not intervene, signaling its judgment that the direction of the movement of the exchange rate is desirable. By contrast, when the deviation of the exchange rate from the target level becomes larger in absolute value, the Bank of Japan sends a message through nonzero intervention that the direction of the movement of the exchange rate is undesirable. In terms of the target exchange rate hypothesis, the levels of the yen were above target levels in the second and fifth subperiods and the opposite held in the third and sixth subperiods.

An important implication of the target exchange rate hypothesis is that the amount of intervention at \( t \) depends on the level of the target exchange rate at \( t - 1 \) as well as the percent change in the real exchange rate at \( t - 1 \). Therefore, market participants need to know the target exchange rate in order to infer the amount of intervention on the next day. If the target exchange rate is observable to market participants, they could know the precise time at which the Bank of Japan switches its intervention policy from one to another. If this is the case, there exists no uncertainty with respect to the timing of policy switching. But if the target exchange rate is unobservable, the timing of policy switching is uncertain for market participants. In this case, even after observing the current level of the exchange rate, market participants do not necessarily know which intervention policy will be adopted on the next day.

This suggests that the observability of target exchange rates is crucial in allowing market participants to compute the unanticipated component of intervention. In what follows, we first compute the unanticipated component of intervention under the assumption that the target exchange rate is observable to market participants, and then discuss the issue of surprise intervention in a more general setting in which the target exchange rate may not be observable.

11.4.3 Estimation of unanticipated intervention: the case of observable target rates

Under the hypothesis described in equation (11.8), if the target exchange rate is observable, the Bank of Japan's intervention can surprise market participants only when the disturbance term \( \nu \) in equation (11.6) becomes significantly different from zero. In order to assess the extent to which intervention was unanticipated, therefore, we need to compute

Note that SLAW policy does not have this signaling function. Intervention policy described by equation (11.8) is quite similar to the target zone model of Lewis (1990), which generalizes the Krugman-type target zone model to allow for intramarginal intervention.
the time series of the disturbance term by estimating equation (11.6) separately in each period. This procedure is equivalent to assuming that market participants knew the sample breakpoints and the Bank of Japan's response function in each subperiod ex ante.16

A problem we encounter in estimating the disturbance term is that, because theleaning-against-the-wind policy was not employed in the fourth subperiod, it is not obvious whether the policy switching in this subperiod had been predicted by market participants who had complete knowledge of the target rate. It should be noticed, however, that since the yen was consistently below the target level during the third and fourth subperiods, market participants believing that the intervention policy was characterized by equation (11.8) had no reason to predict that the Bank of Japan would deviate from \( \text{ALAW}_2 \) throughout the third and fourth subperiods. On the basis of this reasoning, we estimate equation (11.6) over the combined period of the third and fourth subperiods (i.e., June 1981 to March 1986).

Figure 11.5 depicts the time series of actual and anticipated intervention from 1984 to 1992. The difference between the two corresponds to the disturbance term. A casual comparison of the actual and the anticipated intervention shows that there were several instances in which the disturbance term was significantly different from zero, including the fourth quarter of 1985, when the Bank of Japan sold dollars jointly with the central banks of the other G-5 countries.17 However, these were exceptional cases. In fact, we can observe in Figure 11.5 a striking correlation between the actual and the anticipated intervention. Therefore, we may reasonably conclude from this simple regression analysis that the Bank of Japan's intervention was mostly anticipated by market participants during this sample period.18

16 The estimation procedure of the disturbance term is based on the assumption that the Bank of Japan's response function is stable. If its response function were not stable, it would be quite difficult to distinguish changes in the target exchange rate from changes in the reaction function.

17 Other instances in which the disturbance term was significantly different from zero include (i) early 1987, when the massive purchases of foreign currencies were underestimated; (ii) June 1989 and March 1990, when the massive sales of foreign currencies were underpredicted. However, these two cases differ from the intervention that occurred immediately after the Plaza meeting, because the direction of intervention was correctly anticipated in these two cases, whereas the scale of intervention was not correctly predicted.

18 The anticipated component of intervention in other subperiods has been computed in the same way, although the figures are not shown because of space limitations. As the close correlation in each subperiod shown in Figure 11.5 suggests, we have reached the same conclusion in these cases.

11.4.4 Unobservable target rates

Although the assumption that the target rate is observable is crucial in the computation of the anticipated component of intervention, the problem is that the assumption is not necessarily realistic. If the target rate is unobservable to market participants, they do not know whether \( \text{ALAW}_1 \) or \( \text{ALAW}_2 \) will be adopted, so they cannot make a precise inference on the direction and amount of intervention on the next day. In this sense, the extent to which intervention is anticipated crucially depends on the degree of observability of the target exchange rate.
Although it is quite difficult to assess the degree of observability of the Bank of Japan's target exchange rate without any formal analysis, it seems safe to rule out the possibility that the target rate was consistently known to market participants during the sample period. First, the Bank of Japan has never announced explicit target rates or target zones since it adopted the flexible exchange rate system in 1973. Second, there does not seem to have existed a systematic link between the realization of variables observable to the market and the policy switches between ALAW and ALAW, during the sample period. This means that the target rate was determined by the Bank of Japan at least partly depending on inside information.

In sum, we have shown in this section that (i) intervention tended to be highly correlated with percent changes in the exchange rate, but (ii) the functional relationship changed several times in an unpredictable way; accordingly, (iii) the past movements of the exchange rate by themselves were not sufficient to predict future intervention accurately; therefore, (iv) the Bank of Japan could surprise market participants through intervention at least several times during the sample period 1973–92.

11.5 Conclusion

On the basis of a simple theoretical model, we have obtained two intuitive implications of the signaling hypothesis of foreign exchange intervention: intervention policy should be correlated with future monetary policy, and intervention should not be fully anticipated. Otherwise, sterilized intervention would not be effective.

To examine the first implication empirically, we have compared the Bank of Japan's intervention policy with its monetary policy in the period 1973–92. We found that (i) the purchase (sale) of foreign currencies consistently preceded a reduction (increase) in the Bank of Japan discount rate; and (ii) the purchase (sale) of foreign currencies tended to precede an increase (decrease) in the growth rate of broad money. These two findings are consistent with the signaling hypothesis.

The second implication has been investigated by specifying the Bank of Japan's policy response function regarding foreign exchange intervention. As past studies indicated, we have found that the Bank of Japan's intervention policy was dependent to some extent on the past movement of the exchange rate. At the same time, however, we have also found that the functional relationship changed several times during the period 1973–92. Between April 1986 and March 1989, for example, as the yen appreciated, the Bank of Japan intervened by buying foreign currencies in a leaning-against-the-wind fashion but did not intervene when the yen depreciated. In contrast, between April 1989 and May 1992, the Bank of Japan intervened in a leaning-against-the-wind fashion when the yen depreciated, while it did not intervene when the yen appreciated. One possible interpretation of such policy switches is that the Bank of Japan had a target exchange rate that might change over time, and intervention occurred only when the exchange rate tended to deviate greatly from the target level. If this is the case, intervention policy depended not only on the past movement of the exchange rate but also on the movement of the target exchange rate. Because it is only reasonable to assume that the target rate was unobservable to market participants during the sample period, the possibility that interventions were fully anticipated should be ruled out. We may thus conclude that the Bank of Japan's intervention data were consistent with the two implications of the signaling hypothesis.

References


