

Monetary policy, intervention, and exchange rates in Japan

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10.1 Introduction

Until the end of the Bretton Woods system in the early 1970s, Japanese monetary policy was driven by concern about maintaining the international value of the yen fixed. The need to maintain fixed exchange rate parities limited the degree of discretion by the Bank of Japan in its conduct of monetary policy. Balance-of-payments deficits and downward pressure on the yen necessitated contractionary policy and a growth slowdown; surpluses and upward yen pressure required expansionary policy.

With the exchange rate anchor for monetary policy eliminated at the end of the Bretton Woods era, the Bank of Japan (BOJ) switched to domestic price stability as the main target of policy, with the strategic aim of reducing the inflation rate. The BOJ's success in maintaining the lowest rate of price inflation among industrial countries since the late 1970s has been attributed to a so-called money-focused monetary policy (Suzuki, 1985; Fukui, 1986). The conventional wisdom is that this money-focused approach has resulted in the placing of relatively little weight on the state of the economy when determining monetary policy (e.g., Friedman 1985).

However, Hamada and Hayashi (1985), Ito (1989), and Bryant (1991) express doubt that the BOJ places much weight on limiting deviations of any given money aggregate from targeted values and assert that the BOJ does not focus on any single target. A number of recent papers

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have focused on the role of external considerations in the determination of BOJ monetary policy. Hutchison (1988), for example, finds that during the period from August 1978 to September 1985 Japanese monetary policy was sensitive to exchange rate changes. These results support the view that the BOJ has pursued a flexible monetary policy since the mid-1970s and has not attempted rigid short-term control of money aggregates.

The inclusion of exchange rate or balance-of-payments considerations in a central bank's objective function generates the potential for conflict with domestic policy targets. Such a conflict surfaced strikingly in the case of the BOJ when the yen began a sharp appreciation against the dollar in early 1985. Initially welcomed as a long-overdue correction to the overvalued dollar, and sanctioned by the G-5 Plaza Agreement in September 1985, the yen appreciation was aided by dollar sales in the foreign exchange market in late September and October (Figure 10.1). As the yen appreciation accelerated in early 1986, however, a marked shift in Japanese intervention policy led to the rapid accumulation of foreign exchange reserves in support of the dollar. During the period 1986-8 Japan's foreign exchange reserves jumped more than fourfold, from \$22 billion to \$90 billion. The accumulation of reserves was accompanied by an increase in monetary base growth from 5 percent to nearly 15 percent, and a subsequent rise in consumer price inflation from nearly zero between early 1986 and mid-1988 to almost 4 percent by December 1990. The BOJ reacted to these developments by sharply raising money market interest rates and tightening monetary conditions from mid-1988 through 1990.

With this recent experience of Japan in mind, Poole (1992), Tschoegl (1989), and others have argued that exchange rate targeting has tended to exacerbate business cycles in Japan. While on average Japanese monetary policy has successfully constrained inflation, periodic efforts to limit yen appreciations, as in the period after the Plaza Agreement, have resulted in excessive monetary expansions followed by the need for undue monetary contraction. Takagi (1991), by contrast, argues that domestic monetary control in Japan has not been seriously compromised by external considerations.

To shed light on these issues, in this essay we investigate the pattern of official Japanese exchange market intervention and the extent to which the BOJ has been able to insulate domestic monetary control from exchange rate considerations since the early 1970s. The objective is to identify and explain possible sources of conflict between domestic monetary control and exchange rate policy in Japan.

Three broad findings emerge from our study of Japanese monetary

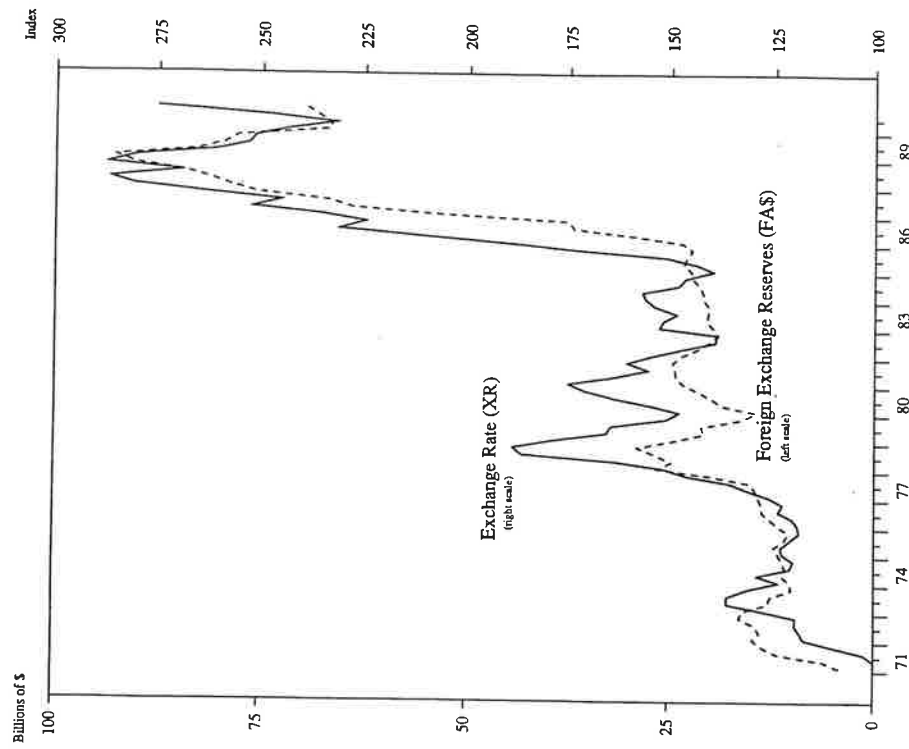


Figure 10.1. Exchange rate and foreign exchange reserves. Reserves in billions of U.S. dollars; exchange rate in \$/Yen (1970:Q1 = 100).

policy. First, we find evidence that the intervention and sterilization policy responses of Japanese monetary authorities have varied across different time periods and particular episodes of strong yen appreciation and depreciation. We attribute this finding to policy preference shifts, external developments, and financial market liberalization in Japan that have influenced the timing and magnitude of foreign exchange intervention, sterilization, and their ultimate impact on monetary conditions.

Second, we identify differences between the contemporaneous and longer-term influence of foreign reserves on money aggregates. This

suggests a possible trade-off in the pursuit of conflicting short-run and long-run policy objectives by Japanese monetary authorities.

Third, we find an asymmetric response pattern in Japanese foreign exchange market intervention policy: Japanese monetary authorities have tended to resist yen depreciations more strongly than yen appreciations. A pattern of asymmetry exists in sterilization behavior as well: foreign currency purchases (sales) in response to yen appreciation (depreciation) have generally been met with greater (less) offsetting domestic credit operations. We argue that this behavior is consistent with monetary control in pursuit of general price stability in the face of a long-term trend appreciation of the yen.

The essay is organized as follows. Section 10.2 presents stylized facts relevant to Japanese monetary and exchange rate policy and looks at monetary developments during episodes of sharp yen appreciation and depreciation. Sections 10.3 and 10.4 present empirical analyses of intervention and sterilization policies, respectively. Section 10.5 considers the linkages between foreign reserves, the monetary base, and the money supply. Section 10.6 draws policy implications. An appendix describes the institutional mechanics of foreign exchange market intervention in Japan.

10.2 Stylized facts

This section presents some stylized facts about movements in Japan's money aggregates, the value of the yen, and Japanese official reserve holdings over the period 1971–90. Attention is also drawn to macroeconomic and monetary developments in several episodes of sharp yen appreciation and depreciation.

10.2.1 General developments

Figure 10.2 plots quarterly growth rates of Japan's broad money supply (BM) and monetary base (MB) over the period 1971–90. Broad money is defined as M2 before May 1979 and as M2 + CDs afterward. Growth rates are calculated as the percent change over four quarters.¹

Movements in broad money and monetary base growth display the

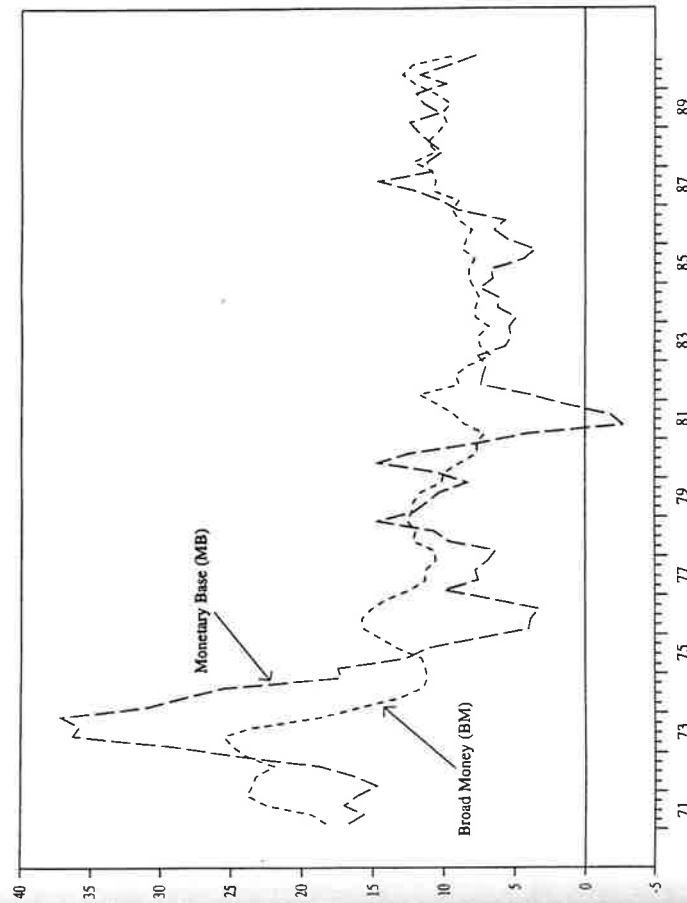


Figure 10.2. Broad money and monetary base aggregates. Percent change over four quarters.

same secular trend, although the contemporaneous covariation between the two series is generally low, particularly through the late 1970s. The BOJ's decisive action in the mid-1970s to reduce trend money growth is the most striking feature of the behavior of both money aggregates. After a decade of trend decline, however, the rate of growth of broad money picked up in late 1983, gradually increased, and then jumped almost 4 percentage points to double-digit levels in 1987.²

Figure 10.3 plots growth rates of the nominal dollar value of the yen (XR) and of the dollar-denominated (FA\$, in the top panel) and yen-denominated (FA, in the bottom panel) value of official net foreign exchange reserve assets held by Japanese monetary authorities over the

¹ Broad money and monetary base stocks each quarter are constructed as the average of end-of-month stock figures. Broad money figures were obtained in seasonally adjusted form from the Bank of Japan, *Economics Statistics Monthly*; monetary base figures are from the International Monetary Fund (IMF), *International Finance Statistics (IFS)*, line 14 ("Monetary Authorities, Reserve Money"), and were seasonally adjusted using the X-11 procedure in SAS.

² The rise in consumer price inflation was preceded by bursts of financial asset and real estate inflation. Broad money and monetary base stocks each quarter are constructed as the average of end-of-month stock figures.

the yen and a yen appreciation. We examine net official assets, since the Japanese authorities do not make gross intervention data public.

Movements in the yen exchange rate and Japanese foreign reserves are positively correlated during most periods in the sample. Yen appreciation (depreciation) tends to be accompanied by increases (decreases) in foreign reserves. This is also clear from Figure 10.1, where dollar-denominated reserves are expressed in level terms (rather than in percent changes). Thus, Japanese monetary authorities have generally sold (bought) yen and bought (sold) foreign reserves when the value of the yen appreciates (depreciates), seeking to dampen or slow exchange rate fluctuations.

Particularly significant increases in reserves can be observed following the periods of sharp yen appreciation accompanying the breakup of Bretton Woods in the early 1970s and the decline of the dollar in the mid-1980s; large declines in the stock of official reserves occurred following the oil price hikes and depreciations of the yen in 1973-4 and 1978-9. The two most evident episodes of high money growth identified in Figure 10.2, one in the early 1970s and the second in the late 1980s, followed periods of rapid yen appreciation, substantial foreign exchange intervention, and the accumulation of international reserves. This suggests a link between rapid money growth during periods of sharp yen appreciation and unsterilized dollar-support foreign exchange market intervention.

Turning to the linkage between intervention and the monetary base, the foreign exchange reserve data most useful in this regard are the yen value of official foreign asset acquisitions by the BOJ. The yen-denominated foreign asset changes presented in Figure 10.3, FA, include, along with changes in BOJ reserve holdings, changes in the net foreign claims of other government agencies that transact in foreign exchange markets through the Foreign Exchange Fund Special Account (FEFSA). In addition, because they value reserve assets at the current exchange rate, FA includes the effects of exchange-rate-induced fluctuations in the yen value of existing foreign reserves as well as reinvested interest earnings on foreign assets.⁴ These valuation changes enter the capital component, rather than the bank reserves component, of the liability side of the consolidated balance sheet of the monetary authorities.

Following the approach of Takagi (1991), we construct an estimate (FABOJ) of the yen value of the BOJ's official foreign assets that is independent of these exchange rate valuation effects. This measure, obtained by subtracting available information on the consolidated credit balance of

⁴ The figures exclude foreign assets other than those classified by the IMF as foreign exchange reserves, such as special drawing rights and the IMF reserve position.

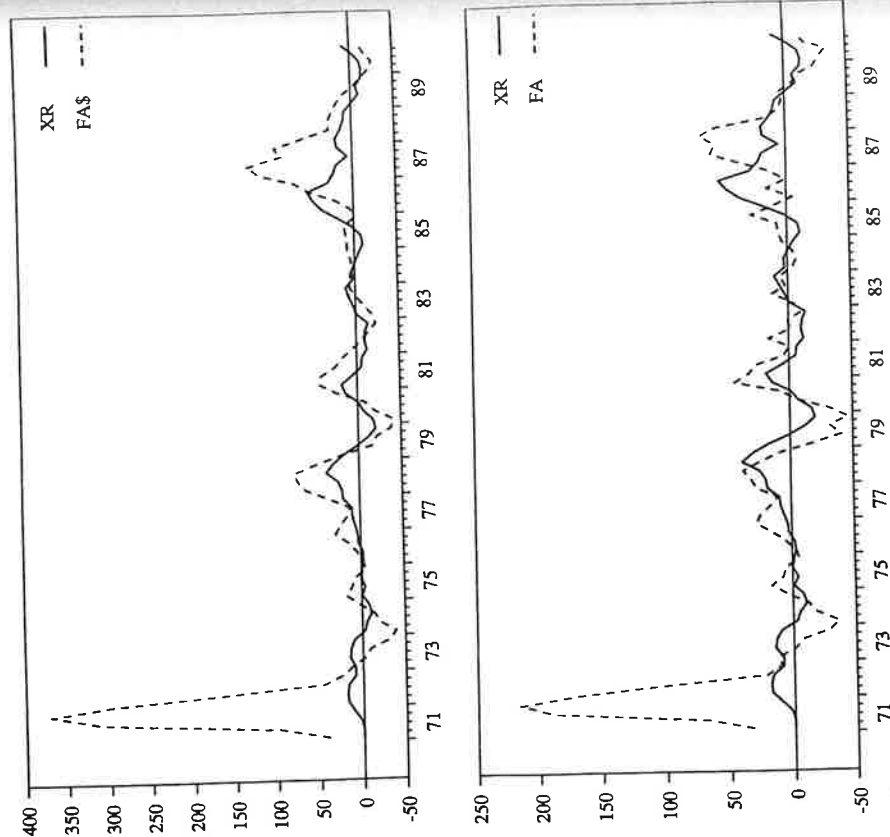


Figure 10.3. Exchange rate and foreign exchange reserves in dollars (top) and yen (bottom). Percent change over four quarters. Exchange rate in \$/yen; positive values imply a yen appreciation.

period 1971-90.³ We focus on the nominal U.S. dollar value of the yen, since the U.S. dollar is dominant in any measure of the effective exchange rate index of the yen. Positive values indicate a rise in the dollar value of

³ The exchange rate series are averages of monthly period average figures, from the *IFS*, line 1f. Foreign exchange reserve stocks each quarter are constructed as the average of end-of-month stock figures. Figures in dollars were obtained from *IFS*, line 1d.d ("Foreign Exchange"); figures in yen are from *IFS*, line 11 ("Monetary Authorities, Foreign Assets"). Both monthly series were seasonally adjusted using the X-11 procedure in SAS.

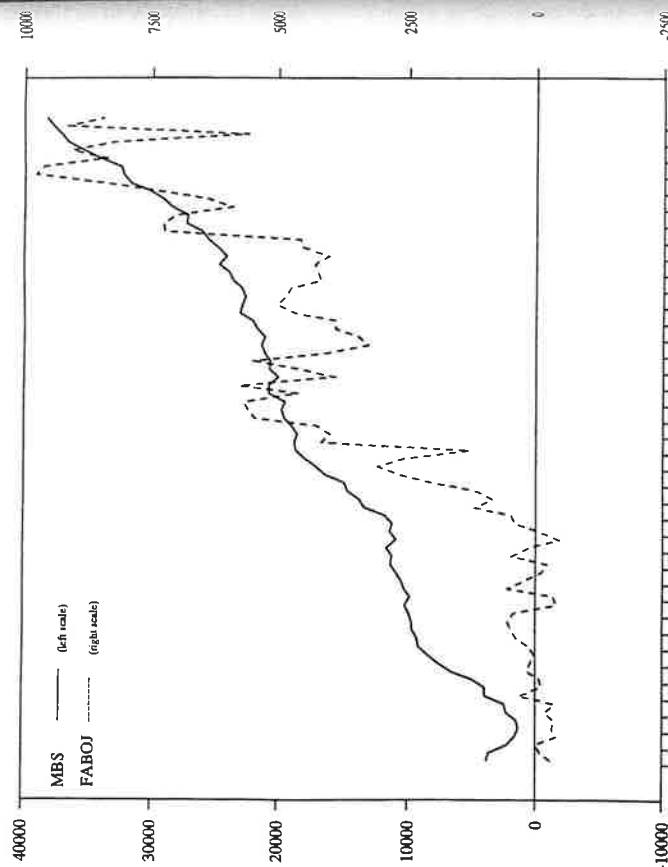


Figure 10.4. Monetary base and Bank of Japan foreign exchange reserves
Billions of yen.

the BOJ and the FEFSA to the central government from the BOJ's outstanding credit to the central government, represents an estimate of the outstanding value of the BOJ's credit to the FEFSA.⁵ It may be interpreted as the cumulative sum of all purchases (and sales) of foreign exchange bills by the BOJ from the FEFSA, valued at *historical* exchange rates. It thus provides a measure of the yen value of official foreign assets that is independent of valuation effects. Changes in FABOJ measure the effect of intervention on the monetary base at the exchange rate prevailing at the time foreign exchange transactions were made.

Figure 10.4 plots FABOJ and a liability sources-side measure of the BOJ's monetary base, MBS, both in yen levels.⁶ The latter is defined

⁵ The balance sheet of Japanese monetary authorities is defined as the consolidated account of the BOJ and the FEFSA. See the Appendix.

⁶ Quarterly observations of both series were constructed as the average of end-of-month stock figures obtained from the BOJ *Economics Statistics Monthly*. The monthly data were seasonally adjusted using the X-11 procedure of SAS.

as the sum of bills discounted, loans, bills purchases, and government bonds held by the BOJ. Other components are excluded because they are relatively minor and/or stable.

Relative to movements in the monetary base, the foreign exchange reserves series exhibits substantial variability. However, in a number of periods, particularly in the early to mid-1970s, some positive covariation in the series is observable. This suggests a shift over time since the 1970s in either the desire or ability of the Bank of Japan to sterilize fully the effects of its intervention operations and consequent reserve movements on the monetary base.

10.2.2 Focal episodes

Clear patterns in the data over the full period since the end of the Bretton Woods era may be difficult to discern if policy responses tend to vary with episodes of sharp movements in the exchange rate. In this case, looking at particular focal episodes may provide more information on the extent to which monetary control has been influenced by external considerations. To this end, we examine the policy response of Japanese monetary authorities during specific episodes of yen appreciation and depreciation. We focus on three periods of appreciation beginning with (i) 1971:Q3, when the yen appreciated with the unraveling of the Bretton Woods system; (ii) 1976:Q1, when the yen strengthened with Japan's recovery from the effects of earlier oil price rises and recession; and (iii) 1985:Q4, following the Plaza Agreement. We also examine two periods of depreciation associated with oil price shocks in 1973:Q4 and 1978:Q4.

Episodes of appreciation. The six panels of Figure 10.5 show various monetary policy indicators before and after the beginning of the three yen appreciation episodes. Time 0 indicates the beginning of each episode. Points to the right (left) refer to variable values in subsequent (preceding) quarters. Indicators of change in the exchange rate, foreign exchange reserves, monetary base, broad money ($M2 + CDs$), and the consumer price index (CPI), as well as the call money rate level, are shown. All variables are measured as four quarter rates of change, except the call money rate, which is in percent levels.⁷

⁷ The series for the exchange rate, foreign exchange reserves denominated in yen, the monetary base, and broad money ($M2 + CDs$) are represented by the variables XR, FA, MB, and BM defined and discussed previously. The CPI is obtained from the *IFS*, line 64.

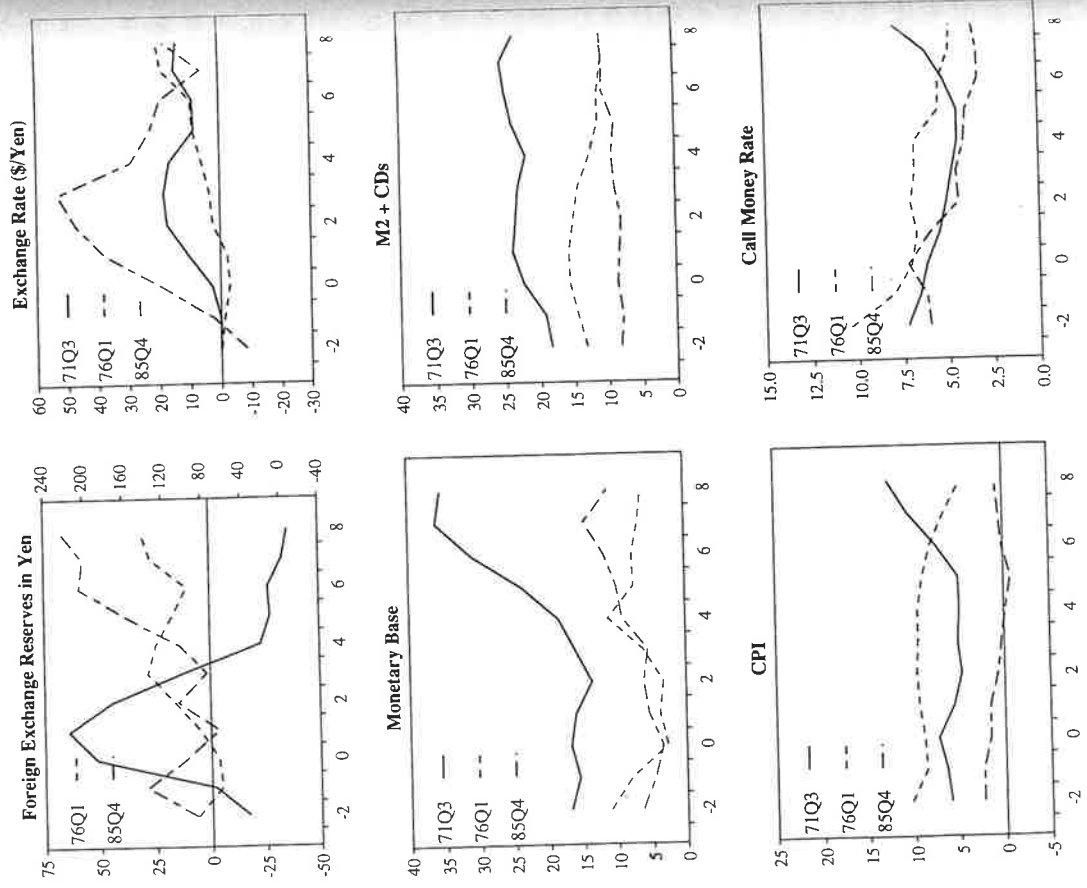


Figure 10.5. Yen appreciation episodes. Percent change over four quarters, except the call money rate, which is in percent levels.

(i) *Breakup of Bretton Woods*: Existing exchange rate parities came under increasing pressure in 1971, with the overvaluation of the dollar at Y/\$ 360 forcing the Japanese authorities to intervene heavily to maintain the exchange rate peg. As a consequence, Japanese foreign ex-

change reserves grew rapidly in the months before August 1971, when the U.S. finally closed the "gold window" and the yen was subsequently revalued. Pressures on the dollar continued in the following months, however, and the yen appreciated further despite large-scale intervention by the Japanese monetary authorities. Even the new realignments sanctioned by the Smithsonian Agreement in December 1971 ceased to halt the rise in the yen against the dollar in early 1972.

Against this background, monetary base growth began to accelerate sharply in 1972 and peaked at more than 35 percent in early 1973. The broad money supply, which had been growing at almost 20 percent per year before the initial appreciation of the yen, rose even faster, at almost 25 percent per year, through the latter part of 1971 and into 1973. Loose monetary conditions were also reflected in call money interest rate declines through most of 1971–2. Japanese inflation rose to double-digit levels at the beginning of 1973, in response to the monetary stimulus. Japan completely abandoned its fixed parity with the dollar in early 1973 and, together with most other industrial countries, moved to the present system of managed floating.

(ii) *Mid-1970s*: Beginning in early 1976, the yen experienced a second period of sustained appreciation. During this episode, the Japanese monetary authorities again engaged in substantial intervention operations designed to moderate yen appreciation by dollar purchases in the foreign exchange market. The authorities intervened particularly heavily when yen appreciation accelerated in late 1977 and early 1978. This intervention was accompanied by increased growth in the monetary base through 1976 and into the first half of 1977. However, money supply growth declined somewhat in 1976–7. Money market interest rates and inflation also fell gradually during this episode.

(iii) *Post-Plaza Agreement*: After a moderate appreciation in early 1985, the yen began a sharp and sustained appreciation following the agreement of the G-5 countries held in September 1985 at the Plaza Hotel in New York. The Japanese monetary authorities joined other central banks in selling dollars in coordinated intervention from late September through the end of October and immediately tightened monetary conditions somewhat by raising interest rates. From the spring of 1986 through the end of 1988, however, the stance of intervention policy abruptly changed to limiting yen appreciation by buying dollars, particularly in 1987 after the February Louvre Accord.

Monetary base growth increased through 1986 and 1987 from 5 percent to nearly 15 percent per year. Japanese broad money supply growth

initially remained steady at around 8 percent, but then rose to around 10 percent by mid-1987. The generally accommodative stance of policy during this time was also marked by successive declines in interest rates. Nonetheless, virtual price stability was maintained during much of this period, as import price declines helped to offset some increases in the domestic component of the overall CPI index. Inflation began to accelerate toward the end of 1988, however, and peaked at almost 4 percent two years later.

A comparison of these three episodes of yen appreciation indicates that all were generally characterized by the accumulation of foreign exchange reserves and rising monetary base growth, indicating less than complete sterilization, at least in the short run. However, only in the first episode, at the time of the breakdown of the Bretton Woods system, was the increase in monetary base growth immediately followed by a sharp rise in the broad money supply. This may indicate that structural shifts in the relationship between the monetary base and the broad money supply since then, perhaps attributable to financial market developments in Japan, have lessened the impact of base money changes on the broad money supply. We discuss this issue in Section 10.5.

Episodes of depreciation. Figure 10.6 illustrates the two episodes of yen depreciation associated with sharp oil price increases.⁸ In both cases the monetary authorities intervened by selling foreign exchange reserves to strengthen the yen.

(i) *First oil price rise:* In the case of the first oil price rise at the end of 1973, monetary base growth fell sharply in response to the monetary tightening already begun early in the year in response to building inflationary pressures. Broad money growth, which had also been declining several quarters before the depreciation of the yen, fell further as well. Money market rates rose again after the oil shock, further tightening monetary conditions. Thus, foreign exchange sales during this episode were unsterilized and contributed to the overall restrictive monetary policy stance.⁹

(ii) *Second oil price rise:* Monetary conditions were quite different before the second oil price shock at the end of 1978. Inflation pressure

⁸ See Hutchison (1991) for an international comparison of macroeconomic developments and policy responses at the time of oil price shocks in the 1970s and 1990.

⁹ Broad money growth declined from more than 25 percent in early 1973 to about 11 percent in mid-1974, and short-term interest rates more than doubled from 6 percent to 13 percent.

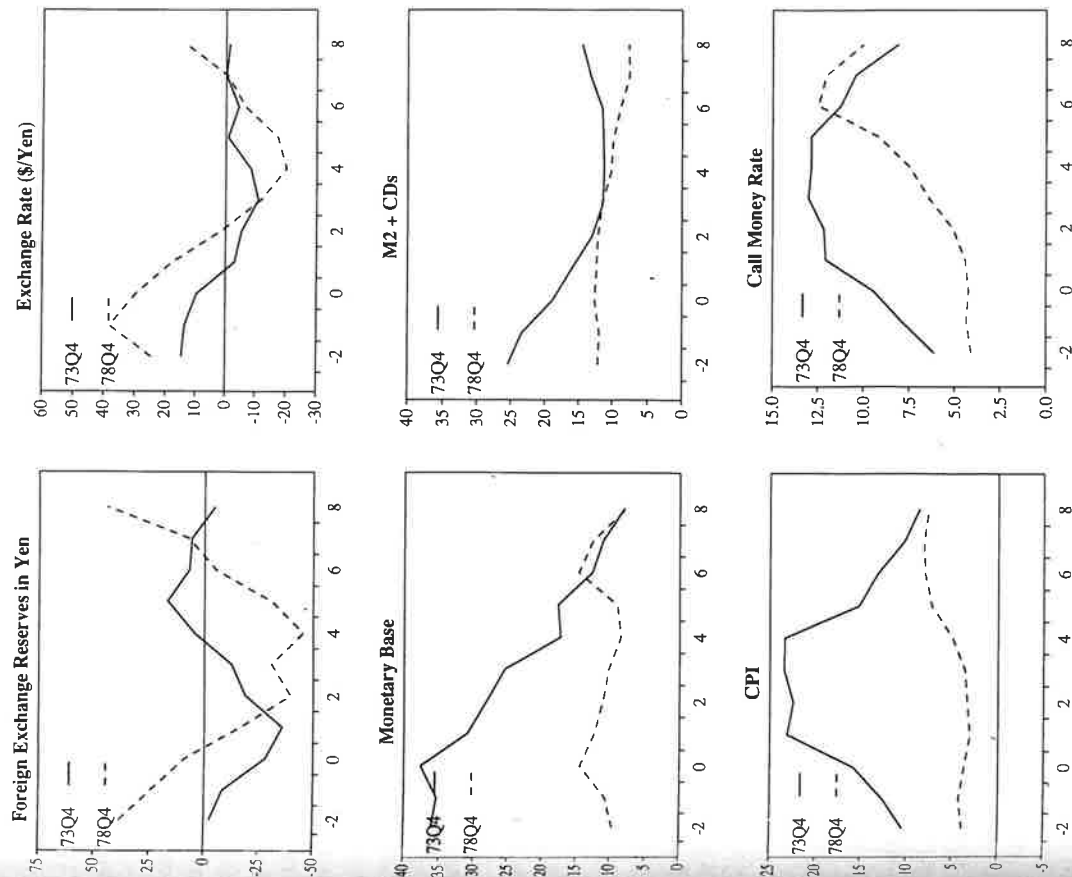


Figure 10.6. Yen depreciation episodes. Percent change over four quarters, except the call money rate, which is in percent levels.

was not evident, money aggregate growth rates were fairly stable, and interest rates had been steady for some time. In the year and a half following the oil shock, the yen depreciated by more than 25 percent against the dollar; substantial foreign exchange market dollar sales to

support the yen led to a sharp drop in international reserves. Base money growth declined substantially as the yen depreciated, reflecting unsterilized intervention operations and a sharp discretionary rise in short-term interest rates. Broad money also declined, albeit gradually, during this episode.

In both cases the depreciation of the yen was accompanied by declining foreign exchange reserves, declining monetary base growth, and monetary policy tightening. Substantial unsterilized foreign exchange market intervention is clearly evident, perhaps more so than in the episodes of yen appreciation in 1976–7 and after the Plaza Agreement. It is not clear, however, how to separate the policy response to yen depreciation from the oil price hikes themselves or, in the 1973 case, from prior concerns and policy actions about inflation. Nevertheless, the comparison of episodes suggests some possible asymmetries in the behavior of Japanese monetary authorities during depreciations and appreciations of the yen.

The preliminary examination of the data in this section indicates some linkage of money growth performance in Japan with foreign exchange intervention activity. Attempting to discern the impact of foreign exchange operations on money growth from simple bivariate relationships may be misleading, however. The linkages between foreign exchange operations and monetary growth are potentially complex. Controlling for other variables that may affect the foreign exchange–money link is also essential. To this end, we now turn to more formal statistical analysis.

10.3 Intervention policy

To assess the extent of the association of foreign exchange intervention by Japanese monetary authorities and movements in the nominal value of the yen, we estimate a standard central bank intervention function, with the magnitude of intervention assumed to be linearly related to the percent change in the exchange rate:¹⁰

$$I_t = \alpha + \beta \Delta XR_t + \epsilon_t, \quad (10.1)$$

where I is the amount of intervention and ΔXR is the (log) percent change in the average monthly exchange rate (with an increase defined as an appreciation of the yen against the dollar). We employ seasonally

¹⁰ Earlier studies of Japanese intervention policy testing a similar equation include Quirk (1977), Hutchison (1984), and Takagi (1991).

adjusted monthly data over the managed floating exchange rate period 1973:3–1990:12.¹¹ We consider three different measures of intervention.

ΔFA denotes the change in the yen-denominated value of (net) official foreign asset holdings of the FEFS; $\Delta FA\$$ denotes the equivalent in dollar terms. Some argue that interest earnings should be excluded from measures of reserve holdings. However, such reinvestment may be properly thought of as intervention, since the Japanese monetary authorities could have used the dollar interest earnings to reduce the flow of yen-denominated assets into private portfolios, simultaneously leaving more dollar assets for the private market to hold. Nevertheless, we consider a third, interest-rate-adjusted measure of intervention defined as

$$\Delta FA\$ADI_t = \Delta FA\$_t - R_t[(FA\$_t + FA\$_{t-1})/2],$$

where R is the average U.S. Treasury bill rate. All intervention measures are expressed in percent change form by means of scaling by the level of foreign asset holdings at the end of time t .

To the extent that intervention affects the contemporaneous level of the exchange rate, estimating equation (10.1) by ordinary least squares (OLS) is subject to simultaneity bias. Estimation results were also obtained by instrumenting out the current exchange rate change with three lags each of the Japanese call money rate, the Federal Reserve funds rate, and logarithmic changes in the Japanese CPI and the exchange rate.

The estimation results for (10.1) with the alternative measures of intervention are reported in the top part of Table 10.1 with a time trend and with and without a lag of the dependent variable. (The constant and trend terms are not reported.) Observe that the sign of the estimated coefficient of the exchange rate variable is positive and generally significant, indicating that the monetary authorities tended to sell (buy) foreign exchange when the yen depreciated (appreciated). This is consistent with an intervention policy of leaning against the wind. The inclusion of lagged dependent variables reduces the degree of serial correlation, but it and the method of estimation do not generally affect the significance of the estimated coefficients.

The dollar-based measures of reserves indicate that during the whole of the post-Bretton Woods period the Japanese authorities have responded to a 1 percent appreciation of the yen by increasing international reserves by about 1/2 to 1 percent on average. The yen-based

¹¹ Data were seasonally adjusted using the X-11 procedure in SAS. The results are unaffected using seasonally unadjusted data with seasonal dummies.

Table 10.1. Response of official foreign exchange reserves, 1973:3–1990:12

Dependent variable	Exchange rate	Lagged dependent variable	Q-msl	Adj. R ²	OLS/INST	
					Q-msl	INST
$\Delta FA/FA$	0.65 (.03)	—	.35	.11	OLS	OLS
	0.60 (.00)	0.13 (.04)	.42	.12	OLS	OLS
	0.51 (.08)	—	.31	.10	INST	INST
	0.30 (.36)	0.16 (.02)	.34	.10	INST	INST
$\Delta FA\$/FA\%$	0.74 (.00)	—	.00	.22	OLS	OLS
	0.61 (.00)	0.28 (.00)	.36	.29	OLS	OLS
	0.96 (.00)	—	.00	.20	INST	INST
	0.52 (.05)	0.30 (.00)	.37	.28	INST	INST
$\Delta FA\$ADJ/FA\%$	0.76 (.00)	—	.00	.22	OLS	OLS
	0.62 (.00)	0.29 (.00)	.36	.30	OLS	OLS
	1.04 (.00)	—	.00	.19	INST	INST
	0.58 (.03)	0.30 (.00)	.36	.30	INST	INST
Dependent variable	Exchange rate appreciation	Exchange rate depreciation	Lagged dependent variable	Q-msl	Adj. R ²	
$\Delta FA/FA$	0.26 (.19)	1.19 (.00)	.12 (.08)	.54	.13	
$\Delta FA\$/FA\%$	0.37 (.01)	1.02 (.00)	.26 (.00)	.20	.30	
$\Delta FA\$ADJ/FA\%$	0.37 (.01)	1.05 (.00)	.27 (.00)	.20	.20	

Note: Dependent variables are defined as the monthly change in the end-of-period stocks scaled by the end-of-period level. The stock series were seasonally adjusted. The exchange rate is defined as the logarithmic change in the average monthly exchange rate of the U.S. dollar against the yen; an increase in the exchange rate denotes an appreciation of the yen. Numbers in parentheses denote marginal significance levels; Q-msl refers to the marginal significance level of the Ljung-Box Q-statistic for serial correlation.

measure of reserves gives a somewhat lower response in the $\frac{1}{3}$ to $\frac{2}{3}$ percent range.¹² The lagged dependent variables are highly significant, ranging from .13 to .30, and indicate that the longer-run intervention response exceeds the initial impact effects. The adjusted R² statistics

¹² The estimated exchange rate coefficients using the yen-denominated measure of intervention tend to be smaller than the dollar-denominated measures. This is because of the valuation effects of exchange rate changes on the yen value of foreign reserve

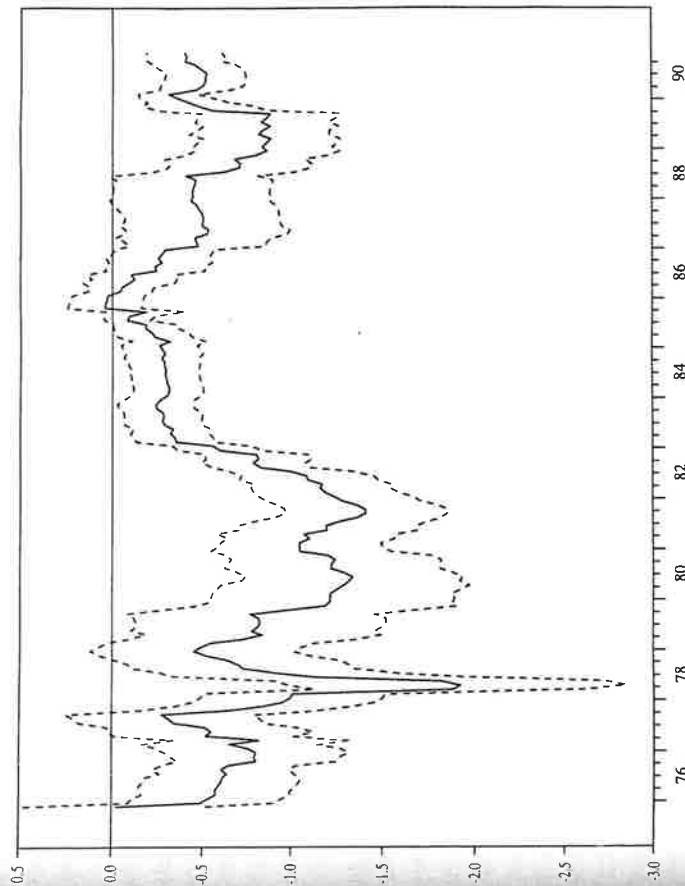


Figure 10.7. Response of foreign exchange reserves to exchange rate. Rolling 33-month sample periods (30 degrees of freedom).

indicate that substantial variation in international reserves remains unexplained by the model (about 90 percent when using the yen-based international reserves measure), reflecting the simplicity of the empirical formulation.

In order to investigate the stability of the degree of intervention, we employ a series of thirty-three-month rolling OLS regressions using the $\Delta FA\%$ measure of intervention and a lagged dependent variable (i.e., the first estimation period covers 1973:3–1975:12, the second covers 1973:4–1976:1, and so on, until the last period, covering 1988:4–1990:12). Each regression has thirty degrees of freedom. The results are summarized in Figure 10.7, where the coefficient on the exchange rate

holdings. As the monetary authorities sell dollar reserves and buy yen in order to limit depreciation of the yen (a rise in the yen price of the dollar), the depreciation of the yen renders the value of remaining dollar reserve holdings larger in yen terms. Hence, yen-denominated reserve holdings decline less in response to a given exchange rate change.

(β) in the rolling regressions is plotted. The identifying date noted in the chart represents the end of the thirty-three-observation sample period for each of the rolling regressions. A 10 percent statistical confidence interval for the point estimates is also plotted.

Observe that the intervention coefficient tended to be highest (in absolute value) for sample periods ending with observations in the late 1970s and early 1980s, when the yen was generally depreciating. This is consistent with a policy of greater sales of dollar reserves (and purchases of yen) in order to support the value of the yen. The intervention coefficient tended to be lowest, indicating less sale of dollars, in the periods ending with observations in the middle to late 1980s, roughly when the yen was appreciating against the dollar.¹³ Thus, when the yen was depreciating, the monetary authorities sold relatively more dollar reserves, while when the yen was appreciating, they sold relatively fewer dollar reserves. This is consistent with a policy of moderating exchange rate movements in both periods – that is, leaning against the wind – but with a stronger response on average attempting to limit yen depreciation.

This finding is confirmed with a regression that reestimates (10.1) with separate variables for $\Delta X R$ when the yen is appreciating and when it is depreciating. (The first variable is constructed by multiplying $\Delta X R$ by a dummy variable that has a value of 1 when $\Delta X R$ is positive and a value of 0 otherwise; the second variable is constructed analogously with a dummy variable that has a value of 1 when $\Delta X R$ is negative.) The results, reported in the bottom panel of Table 10.1, show that the Japanese monetary authorities indeed tended to intervene roughly three times more in response to a depreciation than to an appreciation.¹⁴ They are consistent with Takagi's (1991) estimates of intervention activity by the Japanese authorities.¹⁵

At first glance it appears odd that a bias by policymakers toward foreign exchange sales (against yen depreciation) is consistent with the large accumulation of foreign exchange reserves by Japan over the last two decades, as shown in Figure 10.1. However, given the relatively

¹³ The finding of limited intervention and sales of dollars in 1983 and 1984, even though the value of the yen was then low, indicates that the BOJ was refraining from much active intervention during this period. From late 1985 through mid-1988, as the yen appreciated rapidly, the stance of intervention became more active. The BOJ clearly sought to limit further yen appreciation by buying dollars, particularly in 1987 after the February Louvre Accord and the October stock market crash.

¹⁴ An *F*-test indicates that this difference is statistically significant.

¹⁵ This finding is not consistent with Hutchison (1984), however, perhaps because of the earlier and more limited sample period (March 1973 to November 1981) employed in his study.

high longer-term productivity growth and other factors contributing to rising international competitiveness in Japan, the yen has appreciated against the dollar over most of the managed floating rate period. Under these circumstances, a symmetric leaning-against-the-wind policy would have led to an even greater accumulation of foreign exchange reserves and subsequent problems for monetary control.¹⁶ From this perspective, and greater resistance to currency depreciation than to appreciation may be interpreted as an effort by the BOJ to limit the potentially excessive monetary stimulus associated with the trend accumulation of foreign reserves.

10.4 Sterilization policy

An activist intervention policy does not necessarily impede a central bank's ability to control monetary targets and pursue domestic policy targets. The authorities may sterilize most or all of the effects of foreign exchange reserve changes on money aggregates by systematically adjusting the level of domestic credit. Under this circumstance, monetary control would be insulated from exchange intervention operations, at least in the short run.¹⁷ To explore this aspect of policy, we estimate the degree of sterilization of foreign exchange intervention by the BOJ over the managed floating rate period.

10.4.1 Sterilization regressions

The change in the monetary base, ΔMB , can be expressed as

$$\Delta MB_t = \Delta FA_t + \Delta DC_t, \quad (10.2)$$

where ΔFA and ΔDC denote the change in the official foreign reserve and domestic credit components of the monetary base, respectively, all valued in yen. We assume that domestic credit changes depend on current and lagged interventions ΔFA_{t-j} , as well as autoregressive lags,

$$\Delta DC_t = \sum_{j=0}^m \gamma_j \Delta FA_{t-j} + \sum_{j=1}^n \alpha_j \Delta DC_{t-j} + v_t, \quad (10.3)$$

¹⁶ This assumes that intervention operations per se have not changed the long-term trend in the yen-dollar exchange rate.

¹⁷ The extent to which sterilization is possible, and, more generally, the ability to insulate domestic policy objectives from external considerations, is dependent on the degree of capital mobility and other factors. See Herring and Marston (1977) for an exposition of this point within the context of a portfolio balance model.

where v_t is a random variable that represents other changes. The lag pattern of the individual γ_j coefficients reflects how sterilization is distributed over time. The long-run multiplier response of domestic credit to foreign asset changes is given by $\sum_{j=0}^m \gamma_j / (1 - \sum_{j=1}^n \alpha_j)$. If $\gamma_0 > -1$, intervention is less than fully sterilized in the current period and there is an initial effect on the monetary base. Whether or not foreign exchange interventions are sterilized completely in the long run depends on the lagged pattern of intervention.

The effect of intervention in period t and in earlier periods on base monetary growth in the current period can be expressed as

$$\begin{aligned} \Delta MB_t = & \sum_{j=1}^n \alpha_j \Delta MB_{t-j} + (1 + \gamma_0) \Delta FA_t + \sum_{j=1}^n (\gamma_j - \alpha_j) \Delta FA_{t-j} \\ & + \sum_{j=m}^{m-n} \gamma_j \Delta FA_{t-j} + v_t, \end{aligned} \quad (10.4)$$

assuming $m > n$. Observe that the coefficients on lagged intervention terms are linear combinations of lagged sterilization (γ_j) and lagged adjustment (α_j) coefficients. This points to the difficulty of interpreting coefficients in dynamic monetary base equations.¹⁸ In order to analyze the behavior of Japanese monetary authorities, we estimate equation (10.3) empirically with seasonally adjusted monthly data over the managed floating rate period.

We measure ΔMB by the change in the source side of the monetary base, ΔMB_S , discussed in Section 10.2. ΔFA is measured by changes in FABOJ, also discussed earlier. It reflects the incipient addition to domestic base money resulting from the BOJ's acquisition of foreign exchange and excludes exchange rate valuation effects that should not be reflected as changes in the monetary base. Changes in domestic credit, ΔDC , are defined as the difference between the changes in the monetary base and foreign reserves. All estimates of (10.3) included two lags of domestic credit ($n = 2$), contemporaneous and three lags of foreign assets ($m = 3$), a constant, and a trend term. This specification appeared to capture suitably the dynamics of domestic credit adjustment.

One potential econometric problem with estimating (10.3) (or 10.4)) by OLS arises from the possible simultaneity of ΔMB and ΔDC , on the

¹⁸ Von Hagen (1989), for example, estimates a monetary base equation like (10.4) for Germany over the period 1979–88 and finds that the sum of the coefficients on ΔFA terms is significantly different from zero. He also finds, however, that the sum of coefficients in a regression like (10.3), of domestic credit on contemporaneous and lagged changes of international reserves, is insignificantly different from -1 (see also Obstfeld, 1983).

one hand, and ΔFA , on the other. In the presence of a systematic foreign exchange intervention rule, the change in reserves valued at a constant exchange rate may be correlated with the disturbance to the monetary base and domestic credit equations. If such a correlation exists, then OLS estimates are inconsistent. To take account of this possibility, we estimate (10.3) with instrumental variables (INST) as well as OLS.

Table 10.2 presents results of the estimates for the contemporaneous coefficient (γ_0) as well as the long-run multiplier ($\sum_{j=0}^n \gamma_j / (1 - \sum_{j=1}^n \alpha_j)$) of foreign asset changes on domestic credit. We consider the full managed floating period 1973:5–1990:12, as well as various sub-periods corresponding to possible policy regime shifts by the BOJ in 1978:7 with the announced adoption of official monetary growth targets, and in 1985:9 following the Plaza Agreement by the G-5 countries to coordinate intervention.¹⁹ We also test for asymmetry in the sterilization response between episodes of yen appreciation and depreciation.

Focusing on the OLS results, observe that over the full period the contemporaneous coefficient on foreign exchange reserves of $-.75$ is significantly different from -1 at better than 1 percent; the long-run multiplier of $-.88$ is significantly different from -1 only at the 13 percent level. Thus, in the long run it cannot be rejected that foreign asset changes were fully offset by domestic credit changes, leaving the monetary base unchanged. For the period 1973:5–1978:6, the offset was less than one for one, both in the short run ($-.47$) and in the long run ($-.64$). This implies that, during this period, foreign intervention had some positive effect on the monetary base. A one-for-one long-run offset, leaving the monetary base unchanged, cannot be rejected during either the period 1978:7–1985:8 or the period 1985:9–1990:12.²⁰ The results using instrumental variables suggest a similar shift in the extent of sterilization between the 1973:5–1978:6 period and afterward.

¹⁹ See Takagi (1991) for a characterization of different monetary and exchange rate policy regimes in Japan since 1973.

²⁰ These results contrast somewhat with those of Takagi (1991), who estimates an equation for the monetary base that assumes only contemporaneous intervention, using quarterly data over the period 1973:Q1–1989:Q2. (His specification also includes the call money rate, the percent change in the wholesale price index, and the lagged change in the monetary base.) He finds that the coefficient on contemporaneous foreign asset changes was insignificant for the full period, but was negative and significant for the period 1978:Q3–1973:Q2–1978:Q2 (indicating oversterilization), insignificant for the period 1978:Q3–1985:Q3, and positive and significant for the period 1985:Q4–1989:Q2 (indicating partial sterilization). He interprets this as implying that the BOJ has become more accommodative over time in the sense that it allowed an increasingly larger part of changes in the foreign asset component of the monetary base to affect the overall monetary base.

Note: All equations included contemporaneous and three lags of foreign asset changes, two lags of the dependent variable, a constant, and a time trend. Numbers in parentheses for the contemporaneous effect denote marginal significance levels of F -test statistic against -1; numbers in parentheses for the long-run multiplier effect denote marginal significance levels of F -test against -1; Q -msl refers to the marginal significance level of the Ljung-Box Q -statistic for serial correlation.

Regression technique	Sample period	Exchange rate appreciation			Exchange rate depreciation		
		Contemporaneous	Long-run multiplier	Q -msl	Contemporaneous	Long-run multiplier	Adj. R^2
OLS	1973:5-1990:12	-0.75 (.00)	-0.88 (.13)	.01	.52	.50	.52
	INST	-0.90 (.74)	-1.02 (.95)	.01	.30	.23	.50
OLS	1973:5-1978:6	-0.47 (.00)	-0.64 (.13)	.90	.90	.30	.90
	INST	-0.20 (.03)	-0.35 (.16)	.96	.23	.30	.90
OLS	1978:7-1985:8	-0.85 (.08)	-0.99 (.94)	.02	.53	.53	.02
	INST	-0.80 (.46)	-0.95 (.86)	.01	.53	.53	.01
OLS	1985:9-1990:12	-0.76 (.00)	-0.90 (.27)	.45	.66	.65	.45
	INST	-0.84 (.55)	-0.95 (.79)	.48	.65	.65	.48
OLS	1978:7-1990:12	-0.79 (.00)	-0.90 (.24)	.02	.58	.57	.02
	INST	-0.84 (.55)	-0.95 (.81)	.02	.58	.57	.02
OLS	1973:5-1990:12	-0.74 (.00)	-0.96 (.75)	.53	.53	.53	.53
	INST	-0.78 (.02)	-0.95 (.69)	.58	.53	.53	.58

Table 10.2. Response of domestic credit to foreign asset changes

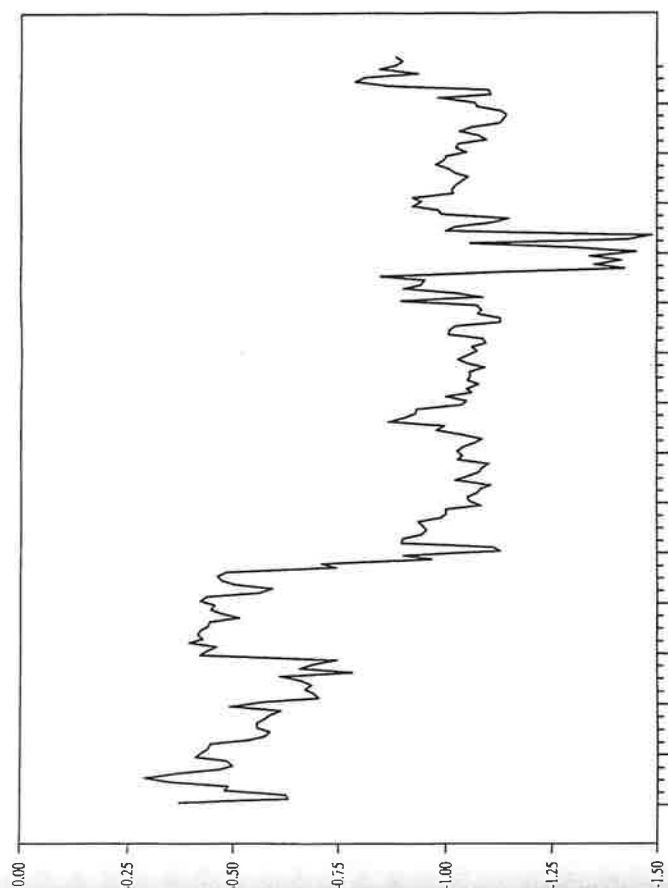


Figure 10.8. Long-run response of domestic credit to foreign exchange reserves. Rolling 33-month sample periods (25 degrees of freedom).

Figure 10.8 reports the rolling OLS regression results for the long-run multiplier response of domestic credit to foreign exchange asset changes, based on thirty-three-month rolling regressions. Each regression has twenty-five degrees of freedom. The identifying date noted in the chart represents the end of the thirty-three-month sample period for each of the rolling regressions. The figure confirms the earlier finding of a less than one-for-one degree of long-run sterilization of foreign asset changes in the mid-1970s to late 1970s, in contrast to nearly complete sterilization in subsequent periods.²¹ This suggests a shift in the ability or desire of Japanese monetary authorities to sterilize the effects of foreign asset changes on the monetary base.

OLS tests of sterilization asymmetry across periods of yen appreciation and depreciation are reported in the lower panel of Table 10.2.

²¹ There is some evidence at the end of 1980 of "oversterilization," i.e., a greater than proportionate change in domestic credit in response to foreign asset changes.

Observe that the initial response appears to be virtually identical irrespective of whether the yen is appreciating or depreciating. The contemporaneous sterilization coefficient estimate for the full sample period 1973:5–1990:12 is $-.74$ for intervention when the yen is appreciating and $-.73$ when it is depreciating. But estimates of subsequent sterilization, indicated by the long-run multipliers in the table, suggest that the BOJ sought more vigorously to insulate the monetary base during intervention episodes associated with yen appreciation. In particular, the estimated long-run sterilization coefficient is $-.96$ for episodes of yen appreciation and $-.78$ for episodes of yen depreciation. Thus, the sterilization coefficient estimates indicate that Japanese policymakers appear more reluctant to allow intervention activity to influence the monetary base during periods of yen appreciation – that is, when it is likely to prove expansionary.

10.4.2 VECM analysis

The sterilization coefficient estimates derived earlier were obtained from estimation of a single “structural” equation – the policy reaction function (10.3) – in the context of a broader, simultaneously determined system of equations representing the macroeconomy. As such, these estimates represent a partial equilibrium effect, as opposed to the full reduced-form effect, of official reserve changes on domestic credit. The full reduced-form effect in principle depends both on the policy response itself and on feedback effects of the private sector – for example, bank portfolio adjustments to sterilization and intervention operations. Hence, the ultimate effects of intervention operations on monetary control are not adequately described by policy reaction function estimates alone. This suggests the desirability of reduced-form estimates from a broader simultaneous equation system.

To address this issue we specify a simultaneous equation time series model using a vector error correction modeling strategy (VECM). This technique allows us to evaluate reduced-form effects without explicitly modeling the structural linkages in the system. It permits evaluation of the full reduced-form effects of a change (“impulse”) in foreign exchange reserves on domestic credit, while controlling for the short-term dynamic interactions of these and other variables in the system.

Our VECM model is specified as

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \cdots + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha(\beta' X_{t-1}) + u + \epsilon_t, \quad (10.5)$$

where X is a four-variable vector consisting of DC, FA, Japanese in-

dustrial production (IP), and Japan's consumer price level (P). DC and FA are specified in trillions of yen, and IP and P are in natural log levels. The vector of error correction terms (with one lag) are denoted by $\beta'X$; α is the parameter vector indicating the speed of adjustment to an eventual equilibrium; $\Gamma_1 \dots \Gamma_{k-1}$ are parameter vectors reflecting short-run dynamics. u is a vector of constants, and ϵ is a vector of Gaussian error terms. IP and P are included in the model to control for other factors that may influence the timing and magnitude of the domestic credit response to foreign asset changes. The model allows for the possibility of (but does not assume) an “equilibrium” (co-integrating) relationship among all of the variables in X – that is, a tendency for the variables to move together over longer periods of time. Such a constant long-run relationship implies that policy reaction functions and other structural features of the economy linking these variables are stable.

We estimate the model over the 1978:7–1990:12 period when the BOJ is generally viewed as having focused more on money aggregate targeting.²² We restrict estimation to a six-month lag autoregressive system ($k = 7$). The empirical analysis proceeds in four steps:²³ (i) estimation of the longer-term relationships (co-integration) in the data using the Johansen methodology (Johansen, 1991); (ii) estimation of the VECM with the error correction terms implied by the co-integrating relationships; (iii) calculation of the moving average representation (MAR) of the model from the VECM estimates (using the Choleski decomposition to identify contemporaneous shocks); and (iv) calculation of the impulse response functions from the MAR.

Omitting details,²⁴ we focus on the impulse response function results,

²² FA and DC are measured, as in the sterilization regressions, by the BOJ foreign asset proxy, FABOJ, and by the difference between the source-side measure of the monetary base, MBS, and FABOJ, respectively. Both of these series were seasonally adjusted using the X-11 procedure of SAS. The CPI is obtained from *IFS*, line 64; the industrial production index is from the *IFS*, line 66 . . . c.

²³ Before testing for co-integrating relationships, we determined the order of integration of each variable individually using augmented Dickey–Fuller tests. We could not reject a unit root in levels, but could reject a unit root in first differences, for all of the variables of interest. The variables were therefore modeled as $I(1)$ processes, i.e., first-difference stationary. For the sake of brevity, these results are not reported in the text, but are available from the authors upon request.

²⁴ Using the two maximum likelihood ratio tests suggested by Johansen (1991) and the critical values tabulated in Johansen and Juselius (1991), we cannot reject the existence of one, and possibly two, co-integrating vectors in our four-variable system. The trace statistic values were 59.18 for $r = 0$, 30.88 for $r \leq 1$, 9.03 for $r \leq 2$, and 2.10 for $r \leq 3$. The maximum eigenvalue statistics were 28.30 for $r = 0$, 21.86 for $r = 1$, 6.93 for $r = 2$, and 2.10 for $r = 3$. At the .05 critical values, the trace statistic suggests at most

Table 10.3. *Effect of one unit foreign asset shock on domestic credit (cumulative impulse response from VECM)*

Months ahead	Response
1	-.80
2	-.72
3	-.68
4	-.48
5	-.39
6	-.36
9	-.45
12	-.45
15	-.38
18	-.41
21	-.38
24	-.37

Note: Results estimated from a VECM containing foreign assets, domestic credit, consumer prices, and industrial production.

reflecting the cumulative effect on domestic credit from a one-unit shock in foreign assets. These results are shown in Table 10.3. The initial impact effect estimated is -0.80 , indicating that the combination of BOJ sterilization operations and private sector portfolio shifts cause domestic credit changes to offset 80 percent of the monetary-base impact of foreign exchange market intervention. This estimate is strikingly similar to the contemporaneous partial equilibrium OLS estimates shown in Table 10.2 for this sample period.

The effect of the initial sterilization operations is apparently offset by private sector portfolio adjustment, however, and the estimated cumulative effect gradually declines (in absolute value) until reaching -0.37 after about twenty-four months. This indicates that more than 60 percent of a rise in foreign assets eventually filters through to an increase in the monetary base. Thus, when the more complicated dy-

one co-integrating vector ($r = 0$ is rejected, but $r \leq 1$ is not rejected), while the maximum eigenvalue statistics indicate either one or two co-integrating vectors; i.e., $r = 0$ is rejected and $r = 1$ is close to rejection. The model is specified more completely with a more comprehensive set of results for Japan and Germany, in Glick and Hutchison (1994).

namic structure of a simultaneous system is taken into account, we find that international reserve changes eventually have affected the growth of Japan's monetary base; foreign exchange intervention is not fully sterilized in the long run.

10.5 Monetary control

Unsterilized intervention directly affects base money and, through this link, influences broader money aggregates and monetary conditions generally. This raises two questions. First, how strong is the link between monetary base and broad money growth in the case of Japan? This is important because unsterilized intervention operations may not materially affect monetary conditions if the broad money-monetary base ratio (or money multiplier) moves in an offsetting direction (e.g., declines concurrently with unsterilized purchases of foreign exchange). Second, are there episodes when particularly rapid money growth can be considered compatible with price stability due, for example, to financial market and regulatory changes that increased money demand? In such circumstances intervention and the unsterilized accumulation of foreign exchange inflows may have limited inflationary impact.

To help us address these questions, Figure 10.9 plots the money multiplier as the ratio of broad money ($M2 + CDs$) to the monetary base over the managed floating exchange rate period.²⁵ Significant short-term swings in the multiplier are evident, suggesting that, at least in the short run, unsterilized intervention operations may not have a predictable influence on broad money growth. Observe, in particular, the significant decline in the ratio during the period 1972-5, attributable in part to the raising of bank reserve requirements and tightening of "window guidance" as instruments of tighter monetary policy during this period.²⁶

Observe also in Figure 10.9 the significant long-term rise in the multiplier from the mid-1970s. The multiplier climbed from roughly 8.5 in early 1975 before leveling off at almost 12 in the late 1980s, a 50 percent increase. It is beyond the scope of this essay to analyze the factors underlying this development. The important point for our purposes is that the rise in the multiplier implies that a given amount of unsterilized

²⁵ The series for broad money and the monetary base are represented by BM and MB, respectively.

²⁶ See Organization for Economic Cooperation and Development, *Economic Surveys* (1975), for a description of how window guidance was extended to cover a range of financial institutions beyond the city banks and how selective credit controls were adopted beginning in 1973.

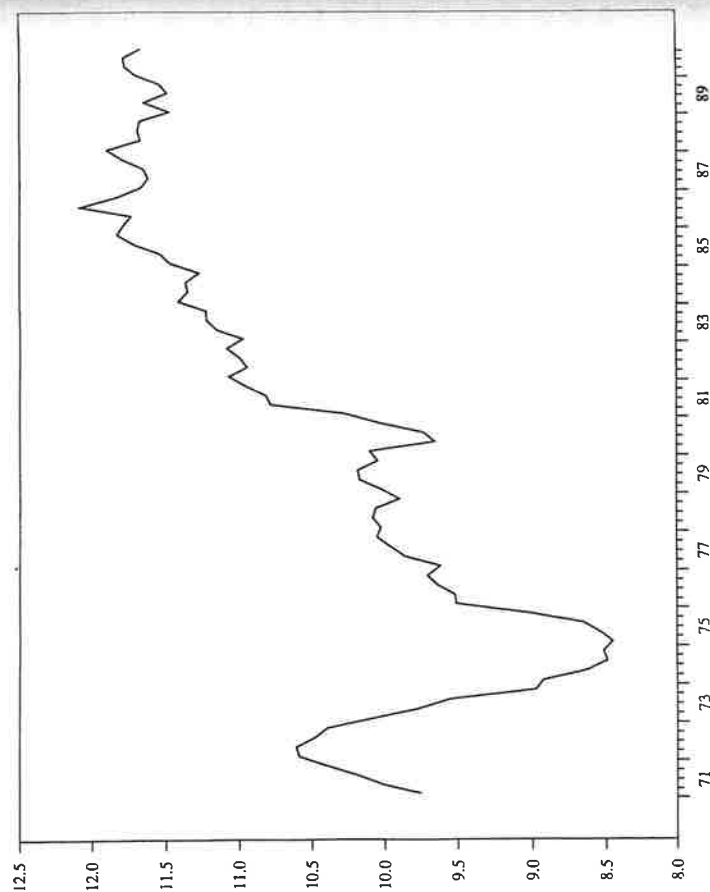


Figure 10.9. Ratio of broad money (M2 + CDs) to monetary base.

intervention operations in the 1980s should have a larger impact on broad money growth and hence greater potential inflationary impact than previously.

Our analysis in Section 10.2 of focal episodes of sharp yen appreciation in 1971–3, during the end of Bretton Woods, and in 1985–7, following the Plaza Agreement, suggested that the accumulation of foreign reserves did, in fact, contribute to rapid monetary base and broad money growth. Was money growth during these periods “excessive”?

Figure 10.10 shows the cumulative percent differences between actual broad money (M2 + CDs) growth and forecasts of broad money growth during these two episodes. The forecasts are derived from out-of-sample dynamic predictions of a simple twenty-four-lag autoregressive money growth equation, with a constant and time trend, estimated over the period 1971:1–1990:12. The horizontal scale in Figure 10.10 measures the number of months after the beginning of each episode – dated as 1971:8 in the first case and 1985:9 in the second. Positive (negative)

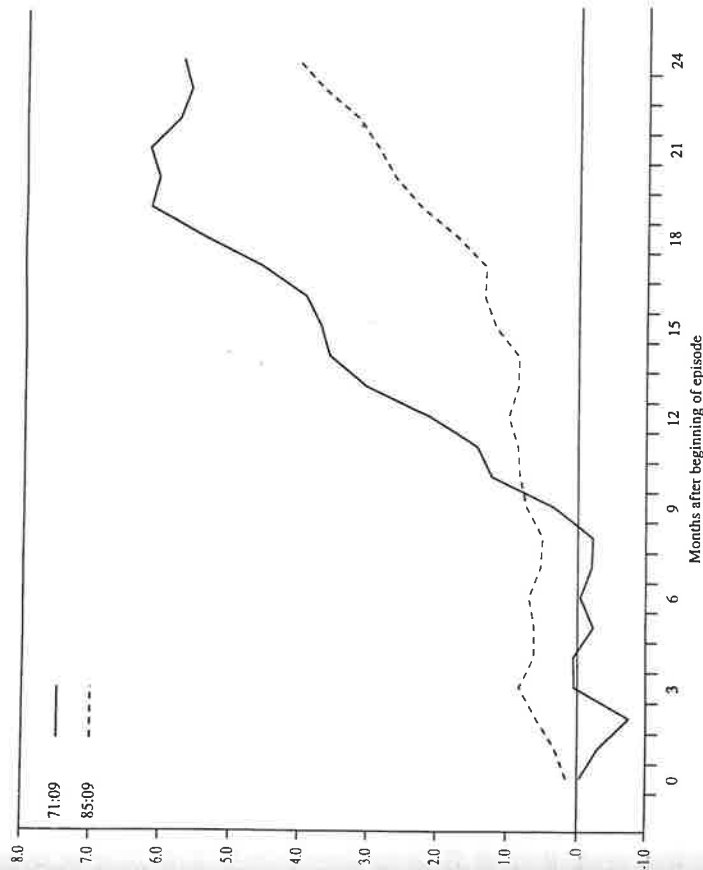


Figure 10.10. Cumulative broad money forecast errors.

values indicate the underprediction (overprediction) of actual money growth.

The figure shows that in both episodes actual money growth was much more rapid than forecast: the cumulative forecast error was more than 6 percent by early 1973 and almost 4 percent in mid-1987. Thus, based on past autoregressive patterns and trends in money growth, growth rates in both episodes of yen appreciation were unusually high. The fact that, in contrast to the experience of the early 1970s, the second episode did not result in immediately explosive consumer price inflation may be attributed in part to a favorable shift of money demand associated with financial liberalization that accommodated the excessive money growth.²⁷ Nonetheless, the intervention efforts and accumulation of foreign reserves to limit yen appreciation after the Plaza Agreement clearly created the potential for additional inflation that eventually

²⁷ Takagi (1991) makes this point as well. He also emphasizes the role of declining interest rates in raising money demand during this period. Also see Yoshida and Rasche (1990).

emerged in the late 1980s. In this case external considerations created problems for domestic monetary control.

10.6 Conclusion

This essay has explored the linkages between foreign exchange market intervention policy and monetary policy in Japan in order to determine whether attempts to influence the exchange rate have forced the Bank of Japan to compromise on its commitment to monetary control. Although the intervention and sterilization policies of the Japanese monetary authorities have varied across time periods and particular episodes of sharp change in the value of the yen, a number of broad findings emerge from our analysis.

Our empirical work indicates that Japan generally has followed an active foreign exchange intervention policy for most of the post-Bretton Woods period, driven in large part by a desire to dampen exchange rate fluctuations against the U.S. dollar ("leaning against the wind"). We find evidence that Japanese intervention policy has been asymmetric in the sense that the magnitude of foreign exchange reserves expended to restrain yen depreciation has generally been larger than that of reserve purchases to limit yen appreciation.

Estimates of the sterilization coefficients of a domestic credit equation indicate that the BOJ has attempted to offset a large part of the monetary effects of foreign exchange intervention operations. We also find, however, that when a more complicated dynamic system structure is taken into account, international reserve changes eventually do influence monetary base growth. Thus, in the long run, foreign exchange intervention in Japan is not fully sterilized.

Consistent with the pattern of intervention policy, we found that sterilization policy has also been asymmetric. Specifically, sterilization has generally been less during episodes of yen depreciation when the BOJ is losing foreign exchange reserves. This has tended to dampen monetary base growth and tighten monetary conditions precisely when the yen weakens. Conversely, Japanese sterilization policy has been more reluctant to allow intervention activity to influence the monetary base during periods of yen appreciation – that is, when it is likely to prove expansionary in nature.

Has domestic monetary control in Japan been affected as a consequence of its activist intervention policy? By international standards, Japan has certainly displayed successful inflation performance. The asymmetric nature of intervention and sterilization in the BOJ's operations, against a background of trend yen appreciation, may have played

a role in this success. Resisting yen depreciation more vigorously than yen appreciation, and allowing foreign exchange sales to have a larger impact than foreign exchange purchases on base money, helps limit the overall accumulation of international reserves and dampens upward pressure on money growth. A symmetric activist policy would have led to a much larger accumulation of foreign exchange reserves and problems for monetary control. By implementing monetary policy in this way, the BOJ has reconciled somewhat the tension in policymaking that often arises when central banks attempt to balance internal and external objectives.

Nevertheless, while on average monetary policy in Japan has worked well, actions to limit sharp appreciations of the yen have resulted in money growth being somewhat higher than it would otherwise have been and have exacerbated the problems of monetary control. This is most apparent with the experience of the early 1970s. However, the more recent 1985–8 episode suggests the same conclusion. Intervention against the rise in the yen undoubtedly contributed to an expansion of the monetary aggregates. It can be argued that only an offsetting increase in the demand for money associated with financial liberalization limited the inflationary impact of this monetary stimulus. Thus, efforts to influence the exchange rate have had an impact on domestic monetary control in Japan.

Appendix: the mechanics of intervention and sterilization in Japan

The link between exchange rate policies and monetary control arises from the central bank's balance sheet. Domestic monetary control is achieved primarily by controlling the growth rate of the monetary base – commercial bank deposits at the central bank plus currency in circulation. The monetary base, on the sources side, consists of domestic assets and international reserves held by the central bank. Exchange rate control requires purchases and sales of foreign assets, which change the international reserves component of the base. Only if such foreign exchange interventions are "sterilized" completely, that is, have no effect on monetary base growth, will exchange rate policies not impede domestic monetary control. Otherwise, foreign exchange market interventions have some impact on the growth of the monetary base and, consequently, on domestic monetary control.

The mechanics of intervention and sterilization in Japan are similar to those in other industrial countries and work as follows. When intervening in the foreign exchange market, the BOJ acts as the agent of the

Ministry of Finance through the FEFSA of the central government. Foreign exchange market intervention involves a funds transfer between the FEFSA and the commercial banking sector and thereby directly affects the monetary base. When the FEFSA buys dollars through the BOJ, the yen funds necessary to finance the transaction are usually raised by issuing foreign exchange bills, all of which are purchased by the BOJ. In the consolidated account of the BOJ and FEFSA, the amount of foreign exchange bills issued by the FEFSA and bought by the BOJ will cancel out. The BOJ therefore needs to sell securities (e.g., government bonds, financing bills, Treasury bills) in order to absorb yen funds if it is to "sterilize" the impact of dollar purchases on the monetary base.

References

- Bryant, Ralph (1991). "Model Representations of Japanese Money Policy," (Bank of Japan) *Monetary and Economic Studies* 9:11-61.
- Friedman, Milton (1985). "Monetarism in Rhetoric and Practice." In A. Ando, H. Eguchi, R. Farmer, and Y. Suzuki, eds., *Monetary Policy in Our Times*, pp. 15-28. Cambridge, MA: MIT Press, 1985.
- Fukui, Toshiko (1986). "The Recent Development of the Short-Term Money Market in Japan and Changes in the Techniques and Procedures of Monetary Control Used by the Bank of Japan." In *Changes in Money Market Instruments and Procedures: Objectives and Implications*, pp. 94-126. Basel: Bank for International Settlements.
- Glick, Reuven, and Michael Hutchison, (1994). "Foreign Exchange Reserves and Money Dynamics in Germany and Japan." Unpublished manuscript, Federal Reserve Bank of San Francisco.
- Hamada, Koichi, and Fumio Hayashi (1985). "Monetary Policy in Postwar Japan." In A. Ando, H. Eguchi, R. Farmer, and Y. Suzuki, eds., *Monetary Policy in Our Times*, pp. 83-121. Cambridge, MA: MIT Press.
- Herring, Richard, and Richard Marston (1977). "Sterilization Policy: The Trade-off between Monetary Autonomy and Control over Foreign Exchange Reserves," *European Economic Review* 10:225-343.
- Hutchison, Michael (1984). "Official Japanese Intervention in the Foreign Exchange Market: Leaning Against the Wind?" *Economics Letters* 15:115-20.
- (1988). "Monetary Control with an Exchange Rate Objective: The Bank of Japan, 1973-86," *Journal of International Money and Finance* 7:261-71.
- (1991). *Aggregate Demand, Uncertainty, and Oil Prices: The 1990 Oil Shock in Comparative Perspective*, BIS Economic Papers no. 31. Basel.
- Ito, Takatoshi (1989). "Is the Bank of Japan a Closet Monetarist? Monetary Targeting in Japan, 1978-1988," NBER Working Paper no. 2874. Cambridge, MA.
- Johansen, Søren (1991). "Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Autoregression Models," *Econometrica* 59:1551-80.
- Johansen, Søren, and Katarina Juselius (1991). "Maximum Likelihood Estimation and Inference on Cointegration with Applications for the Demand for Money," *Oxford Bulletin of Economics and Statistics* 52:169-210.
- Obstfeld, Maurice (1983). "Exchange Rates, Inflation, and the Sterilization Problem: Germany 1975-81," *European Economic Review* 21:161-89.
- Poole, William (1992). "Exchange-Rate Management and Monetary-Policy Mismanagement: A Study of Germany, Japan, United Kingdom, and United States after Plaza," *Carnegie Rochester Conference Series on Public Policy* 36:57-92.
- Quirk, Peter (1977). "Exchange Rate Policy in Japan: Leaning Against the Wind," (International Monetary Fund) *Staff Papers* 24:642-64.
- Suzuki, Yoshio (1985). "Japan's Monetary Policy over the Past 10 Years," (Bank of Japan) *Monetary and Economic Studies* 3:1-18.
- Takagi, Shinji (1991). "Foreign Exchange Market Intervention and Domestic Monetary Control in Japan, 1973-89," *Japan and the World Economy* 3:147-80.
- Tschoegl, Adrian (1989). "Money Supply, Forex Intervention and the Stock Market," SBCI Securities (Asia), Tokyo.
- von Hagen, Jürgen (1989). "Monetary Targeting with Exchange Rate Constraints: The Bundesbank in the 1980s," (Federal Reserve Bank of St. Louis) *Economic Review* (September-October):53-69.
- Yoshida, Tomoo, and Robert Rasche (1990). "The M2 Demand in Japan: Shifted and Unstable?" (Bank of Japan) *Monetary and Economic Studies* 8:9-30.