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Foreign Exchange Market Intervention and Domestic
Monetary Control in Japan, 1973-89

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Abstract

The paper presents an empirical analysis of official foreign exchange market intervention and domestic monetary control in Japan during 1973-89. It shows that: (1) the authorities, a net purchaser of foreign exchange over this period, began to intervene more decisively in 1978; and (2) they began to accommodate a greater portion of the resulting reserve inflows in 1985. This greater reserve accommodation, however, was not the principal cause of the recent surge in broad money growth. Rather, it was lower interest rates and financial market liberalization that precipitated the rapid monetary expansion, which in turn facilitated the greater accommodation of reserve inflows.

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Summary

The paper presents an empirical analysis of official foreign exchange market intervention and domestic control of the monetary base and the broad money supply in Japan during the recent period of flexible exchange rates, 1973-89.

With respect to intervention, the analysis finds that the authorities generally followed a policy of "leaning against the wind" and were thus a net purchaser of foreign exchange during much of this period, corresponding to the secular appreciation of the yen. There is some evidence to suggest that the intervention response of the authorities became more pronounced after 1978.

With respect to the control of the monetary base, the monetary authorities were found to have almost completely sterilized reserve movements for the period taken as a whole. There were, however, important differences across different time periods: while the authorities apparently "over-sterilized" reserve movements during the earlier period, they began to accommodate a greater portion of the movements (particularly inflows) of reserves after 1985.

This increased reserve accommodation since 1985 was, however, a result, rather than the cause, of the recent surge in the growth of the broad money supply. The analysis suggests that lower interest rates and the increasing money multiplier resulting from financial market liberalization probably could account for much of the recent monetary expansion. It was this monetary expansion that in turn allowed the authorities to accommodate a greater portion of reserve inflows.

The Bank of Japan thus faced little conflict between the modest objective of its foreign exchange market intervention and its accommodative control of monetary aggregates: the Bank simply accommodated or sterilized reserve movements based on the residual amount of the monetary base required to support a given level of the money supply.

Introduction

The paper presents an empirical analysis of foreign exchange market intervention and domestic monetary control in Japan during the period of 1973-89. Its major purpose is to analyze (1) how the Japanese authorities intervened in the foreign exchange market in response to exchange rate movements and (2) the extent to which such behavior might have influenced their ability to control the monetary base and the broad money supply. The recent period of flexible exchange rates witnessed a major shift in Japan's monetary regime in July 1978, when the Bank of Japan began to make a public announcement of its quarterly "forecast" of broad money supply growth (Suzuki, 1985). Another important regime shift occurred in September 1985, when the Japanese authorities began their determined effort to encourage and then maintain a sustained rise in the nominal value of the yen against the US dollar. Of particular interest to us, therefore, is to see whether or not these regime shifts had any quantifiable effect on the behavior of the monetary authorities with regard to their conduct of intervention and monetary policies.

Prior to the early 1970s, most economists had argued that the merit of the flexible exchange rate system lied in its ability to allow countries to pursue an independent monetary policy. It is true that, under flexible exchange rates, a country could in principle choose its desired rate of monetary expansion by leaving exchange rate determination completely to market forces. In practice, however, the flexible exchange rate has turned out to be "another parameter to be controlled in managing the domestic economy" (Kindleberger, 1969). Out of their own choosing, therefore, the policy makers of most major countries have created a potential conflict between a desired level of the nominal exchange rate and a desired nominal supply of money.

The Japanese policy makers have been no exception. We know, from both popular press and several analytical studies, that the Bank of Japan has at times intervened in the foreign exchange market and manipulated short-term interest rates in order to influence the movement of the nominal value of the yen (Quirk, 1977; Hutchison, 1984, 1988; Ito, 1987, 1989). At the same time, the Bank of Japan has been quite successful in maintaining price stability with no visible change in the rate of GNP growth. ^{1/} This observation has led Meltzer (1986) to conclude that the Bank of Japan seized the shift to flexible exchange rates as "the opportunity to increase control over the money stock and to reduce variability in prices and output". It remains to be seen how the Japanese authorities handled the potential conflict between exchange rate management and domestic monetary control, if such a conflict existed at all.

^{1/} The rate of both wholesale and consumer price inflation remained well below 5 percent per year after the series of oil price hikes in 1980.

The paper is organized as follows. Section I presents a cursory review and quantitative analysis of Japan's official foreign exchange market intervention taken in response to exchange rate movements during the period of 1973-89. Section II quantifies the response of the overall monetary base to changes in its foreign asset source component. Section III gives some measure of the interaction of monetary base control and money supply control. Section IV presents a summary and concluding remarks. Finally, Appendix I provides a brief summary of other policy measures taken in response to exchange rate movements; Appendix II outlines the essential elements of Japan's monetary control mechanism; and Appendix III documents the sources of data.

II. Official Foreign Exchange Market Intervention, 1973-89

1. Overview of Intervention Policy

As probably the most flexible tool of exchange rate management, the Japanese authorities have frequently resorted to market intervention following the commencement of exchange rate floating on February 14, 1973. ^{1/} In intervening in the foreign exchange market, the Bank of Japan acts as the agent of the Ministry of Finance under the Foreign Exchange Fund Special Account of the National Budget. When it purchases foreign exchange, for example, the balance of foreign assets in the possession of the government initially increases, while the balance of government deposits at the central bank decreases. The counterpart of the decrease in government deposits is a corresponding increase in the deposits of commercial banks at the central bank. Thus, official foreign exchange intervention immediately alters the monetary base at prevailing exchange rates. In order to restore part (or all) of the government deposits, the Bank of Japan purchases foreign exchange bills from the Foreign Exchange Fund Special Account. ^{2/} It is only through this operation that the balance sheet of the central bank is affected by official foreign exchange intervention.

The Japanese authorities do not make intervention data public, making it impossible to study official intervention on a gross basis as well as on a daily or weekly basis. However, on a monthly or quarterly (net) basis, we can obtain a proxy of the amount of foreign exchange market intervention by calculating changes in the end-of-period balance of official foreign exchange reserves (RES) adjusted for estimated interest earnings during the period. Official reserves should preferably be valued in foreign currency in order to avoid attributing exchange rate-induced

^{1/} See Appendix I for a brief outline of other policy measures taken in response to exchange rate movements during 1973-89.

^{2/} Those familiar with the U.S. Federal Reserve System can think of the role of foreign exchange bills as analogous to that of gold certificates in the U.S. system.

valuation changes to the intervention behavior of the authorities. One such proxy can be given by:

$$I_t = RES_t - RES_{t-1} - TBR_t [(RES_t + RES_{t-1})/2] \quad (1)$$

where I_t is the amount of intervention (in dollars) during period t , RES_t is the dollar value of foreign exchange reserves at the end of period t , and TBR_t is the average U.S. Treasury bill rate during period t . The quarterly times-series of I_t for Japan is plotted in Chart 1, along with the movement of the quarterly average exchange rate of the yen against the US dollar.

Before proceeding to a more formal analysis of Japanese intervention policy, it would be useful to present a brief review of representative intervention measures taken during the recent period of flexible exchange rates. For convenience of presentation, the period of flexible exchange rates is somewhat arbitrarily divided into two subperiods, corresponding to the periods before and after 1985, when a major shift in policy took place.

a. From 1973 to 1984

The initial stance of official intervention during 1973-74 was to support the yen in the face of depreciating pressure. Following the initial appreciation of nearly 10 percent in February 1973, the Japanese yen began to depreciate as speculative capital began to flow out of the country (Chart 1). The monetary authorities first exercised a tight management of the exchange rate within a narrow band around the presumed central rate of 265 yen to the dollar by selling dollars in the market (Komiya and Suda, 1983; Fukao, 1989). ^{1/} The authorities abandoned this policy in the middle of October 1973, when the yen reacted sharply to the quadrupling of oil prices, while continuing to sell dollars in the market sporadically throughout 1974 (Quirk, 1977; Komiya, and Suda, 1983). The yen eventually stabilized at around 300 yen to the dollar in the latter half of 1974 and remained there throughout 1975.

The stance of intervention changed in the direction of moderating the appreciation of the yen through purchases of dollars (often on a large scale) in early 1976, when the yen began to show a sign of strengthening (Chart 1). Following the meeting of the Group of Seven (G-7) countries held in San Juan in June 1976; however, the Japanese authorities scaled down the amount of intervention and generally limited intervention to smoothing operations. The authorities, however, intervened heavily when the appreciation was particularly sharp in late

^{1/} The volume of intervention during the 7-month period from March to September 1973 was estimated to be about 50 percent of the total volume of foreign exchange trading in Tokyo (Komiya and Suda, 1983).

1977 and early 1978 (Komiya and Suda, 1983). ^{1/} From November 1978, the Bank of Japan joined the central banks of the United States, Federal Republic of Germany and Switzerland in coordinated intervention by selling yen.

From late 1978, the yen began a sustained depreciation against the U.S. dollar that lasted, except for a brief period in 1980, until the beginning of 1985 (Chart 1). The general stance of the Bank of Japan with regard to foreign exchange market intervention during much of this period was to support the yen. The intervention in support of the yen was reportedly massive in the spring and the fall of 1979 (Ohta, 1982). In the spring of 1980, the Bank of Japan also joined the central banks of other industrial countries in coordinated intervention to sell dollars. After 1981, however, the scale of intervention became much smaller (Komiya and Suda, 1983). In fact, the Japanese authorities generally refrained from active intervention during 1983-85 (Chart 1), although they continued to sell dollars occasionally in coordination with the central banks of other major countries (most notably in the latter part of 1983).

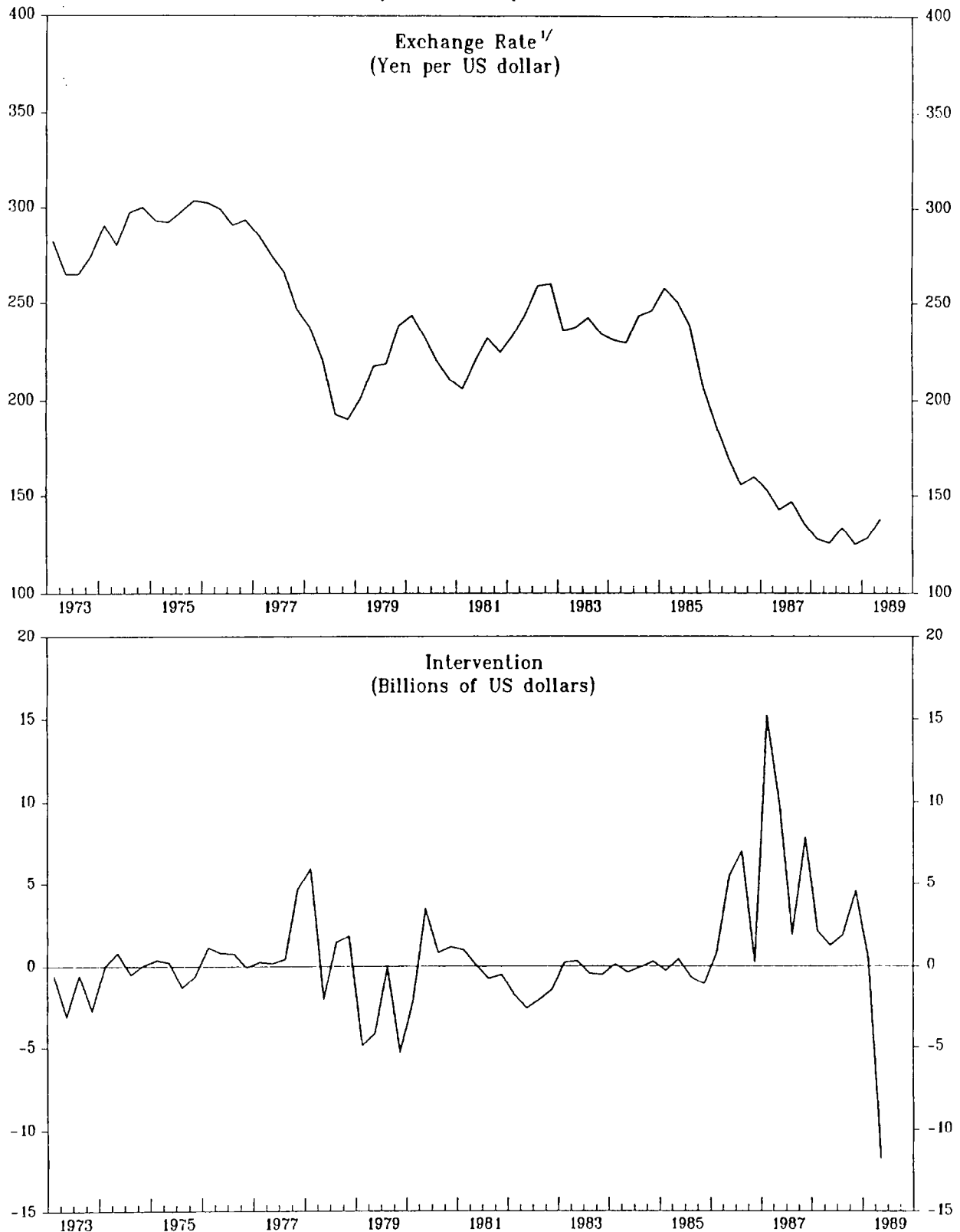
b. From 1985 to 1989

After a moderate appreciation in early 1985, the yen began its sharp and sustained appreciation following the agreement of the Group of Five (G-5) countries held in September 1985 (the Plaza Agreement). The Bank of Japan joined the central banks of other G-5 countries in selling dollars on a massive scale in coordinated intervention from late September through the end of October (Ito, 1987; Funabashi, 1988). When the yen reached around 200 to the dollar in late 1985, however, the stance of intervention changed from appreciating the yen to stabilizing the yen, though with little apparent success (Ito, 1987). Following the further appreciation of the yen in March 1986, the Bank of Japan intervened in the foreign exchange market by purchasing dollars until the summer of 1986.

1987 saw a renewed commitment to exchange rate stability on the part of the authorities of the major countries. In late February, the authorities of the G-5 countries declared their readiness to intervene in order to help stabilize exchange rates at "around current levels" (the Louvre Accord). The Bank of Japan honored the Louvre Accord with a more active intervention policy (Ito, 1989; Funabashi, 1988). The generally massive size of intervention during 1987 is evident in Chart 1. After the dollar began to show signs of weakening in mid-May (it fell below 150 yen to the dollar), the Bank of Japan joined the Federal Reserve in purchasing dollars on a massive scale. Another large scale dollar-purchase intervention was reported from immediately after the stock market crash of October 1987 through December 1987.

^{1/} The volume of intervention in November 1977 and in March 1978 was estimated to be about 32 percent and 44 percent, respectively, of the volume of foreign exchange trading in Tokyo (Komiya and Suda, 1983).

Chart 1. Movements of the Nominal U.S. Dollar/Yen Exchange Rate and
Official Foreign Exchange Market Intervention in Japan
Q1 1973 to Q2 1989



Source: IMF, International Financial Statistics; and the author's estimates.

1/ Quarterly average data.

The meeting of the G-7 countries in December 1987 reaffirmed the commitment of the authorities of the major industrial countries to exchange rate stability. It was against this background that the Bank of Japan reportedly intervened in times of the perceived weakness of the dollar in support of the dollar (e.g., in January, April and November of 1988), and in times of the perceived strength of the dollar in support of the yen (e.g., in June and September of 1988). Concerted intervention to resist upward pressure on the dollar was reported in the early part of 1989, particularly during the months of April and May.

2. Analysis of Intervention Policy

A casual look at the quarterly time-series of the outstanding value of foreign assets (valued in U.S. dollars) held by the Japanese monetary authorities indicates that the level of reserves increased over the period of 1971-89 (Chart 2). We also observe strikingly parallel movements of foreign exchange reserves and the nominal exchange rate of the yen against the U.S. dollar. This indicates that the Japanese monetary authorities were a net seller of domestic currency, corresponding to their stance of intervention to moderate (or smooth out) the secular appreciation of the yen over this period.

The trend increase of foreign exchange reserves along with the trend appreciation of the yen, however, should not mask the presence of quarter-to-quarter fluctuations. For example, significant declines in the balance of official foreign exchange reserves can be observed for the periods immediately following the two oil price hikes in 1973 and 1978-79 as well as during early 1989. It would be of interest to see if there was any systematic relationship between the movement of foreign exchange reserves and that of the nominal exchange rate that cannot be detected by visual inspection.

It should be noted that the analysis here deals with intervention net of reverse intervention that may have taken place within the same quarter; the choice of quarterly data reflects the fact that the authorities use quarterly monetary data to conduct monetary policy. ^{1/} Moreover, emphasis will be placed exclusively on the nominal value of the yen against the U.S. dollar because it is clearly what the monetary authorities have in mind when they intervene in the foreign exchange market. At any rate, the substantive result of our analysis should remain essentially unchanged even if we use other exchange rate measures, such as the real exchange rate of the yen against the U.S. dollar or the effective exchange rate of the yen. It is well known that nominal exchange rate movements dominate price movements in the short run and that the share of the US dollar is dominant in any meaningful measure of the effective exchange rate index of the yen.

^{1/} See Appendix II for the source of data.

Table 1. Response of Official Foreign Exchange Reserves
to Exchange Rate Movements,
1973:Q2 - 1989:Q2 1/

	(1)	(2)
<u>Regression coefficients 2/</u>		
Constant (α)	-0.01(1.03)	-0.01(0.82)
Lagged dependent variable (β)	0.23*(2.17)	0.25*(2.26)
<u>Exchange rate changes 3/</u>		
1973:2-1989:2 (γ_0)	-0.99**(4.43)	--
1973:2-1978:2 (γ_1)	--	-0.64(1.14)
1978:3-1985:3 (γ_2)	--	-1.17**(3.46)
1985:4-1989:2 (γ_3)	--	-0.92**(2.66)
<u>Summary statistics</u>		
Degrees of freedom	62	60
R^2 (\bar{R}^2)	0.33(0.31)	0.34(0.29)
LM(1) <u>4/</u>	0.40	1.64
SEE	0.093	0.094
<u>F-Statistics on coefficient restrictions 5/</u>		
$\gamma_1 = 0$	19.59**(1,62)	6.62**(3,60)
$\gamma_1 = 0$	--	1.30(1,60)
$\gamma_2 = \gamma_3$	--	0.25(1,60)

1/ Estimation of equation (2) in the text; **(*) indicates that the statistic is significant at 1 (5) percent.

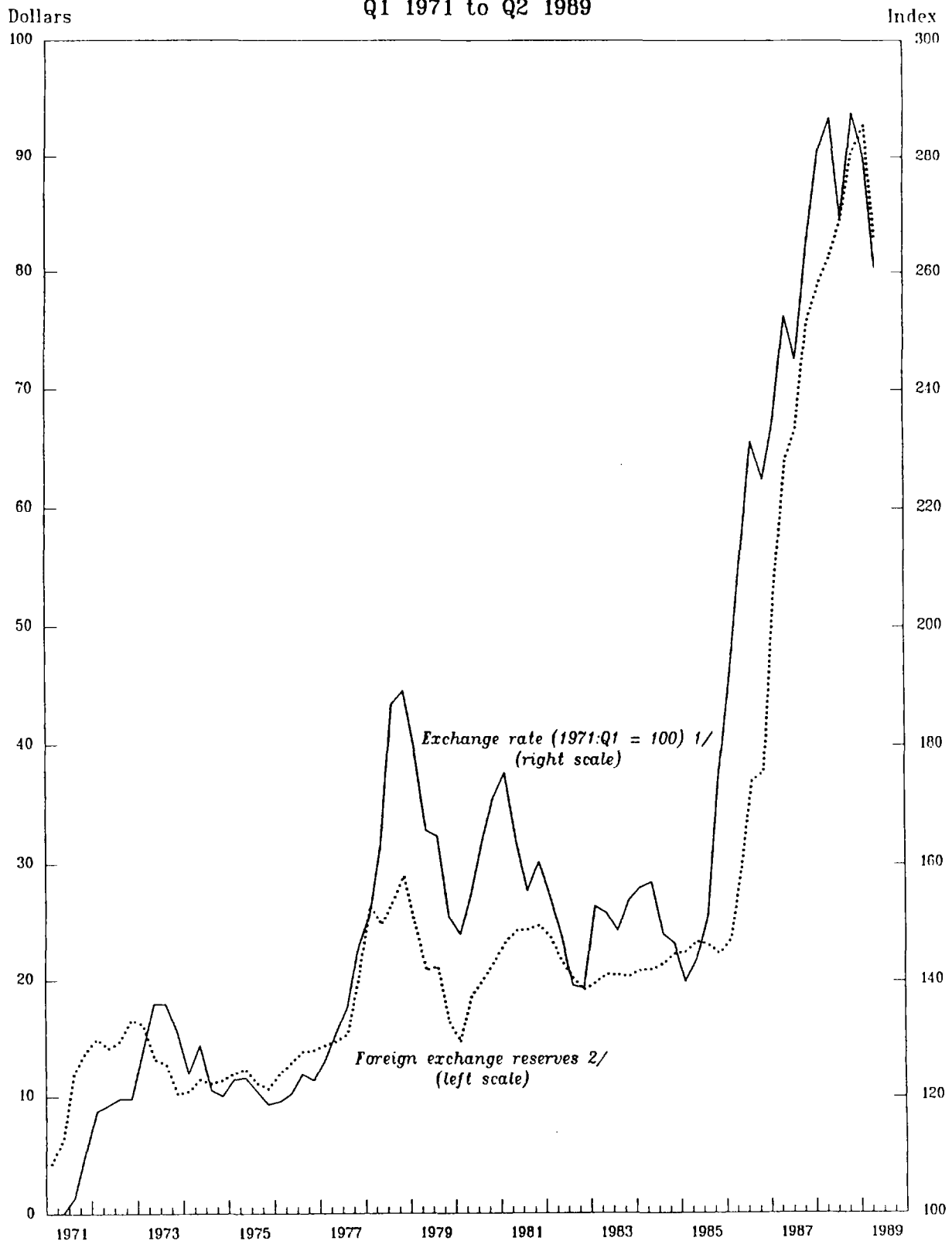
2/ The numbers in parentheses are t-values.

3/ The exchange rate variables are expressed as logarithmic changes in the average quarterly yen/dollar rate; an increase in the value is a depreciation of the yen.

4/ General Lagrange multiplier (χ^2) statistic for first-order serial correlation in residuals.

5/ The numbers in parentheses refer to the relevant degrees of freedom.

Chart 2. Movements of the Nominal U.S. Dollar/Yen Exchange Rate and
Official Foreign Exchange Reserves in Japan,
Q1 1971 to Q2 1989



Source: IMF, International Financial Statistics.

1/ Quarterly average data; an increase is an appreciation of the yen against the U.S. dollar.
2/ End-of-period data in billions of U.S. dollars.

The flow change (net of interest earnings) of foreign exchange reserves in the balance sheet of the Foreign Exchange Fund Special Account can be postulated to respond to exchange rate movements in the following way:

$$DRES_t = \alpha + \beta DRES_{t-1} + \delta EX_t + e_t \quad (2)$$

where $DRES_t$ is the amount of intervention divided by the current level of reserves as a scale variable, i.e., (I_t/RES_t) ; EX_t is the logarithmic change in the average quarterly exchange rate (with an increase in the value defined as a depreciation of the yen against the dollar); α is a constant; β and δ are coefficients; e is a random error term; and t is a time subscript.

One potential econometric problem with estimating equation (2) by ordinary least squares (OLS) arises from the possible simultaneity of $DRES_t$ and EX_t , if the intervention operation of the monetary authorities in turn affects the level of the exchange during the same period. While the possibility is subject to empirical verification, however, we may safely assume that the effect of intervention on the exchange rate was of second-order importance because, for the sample period taken as a whole, net quarterly intervention was almost completely sterilized (see the next section). ^{1/} There is now a broad professional consensus that sterilized intervention does not significantly affect the exchange rate except perhaps in the very short run (Obstfeld, 1988).

The results from estimating equation (2) by OLS are reported in the first column of Table 1. We observe that the sign of the estimated coefficient of the exchange rate variable (γ) is negative and significant, indicating that the monetary authorities sold (purchased) foreign exchange when the yen depreciated (appreciated). This is consistent with the intervention policy of "leaning against the wind" as documented for the early part of the flexible exchange rate period by Quirk (1977), Hutchison (1984), and others. The hypothesis that γ is zero can be rejected at the 1 percent level of significance.

In order to see if the regime changes of 1978 and 1985 had any effect on the response of intervention to exchange rate movements, equation (2) was next estimated by creating separate variables for EX corresponding to the periods 1973:2-1978:2, 1978:3-1985:3, and 1985:4-1989:2. The estimation results (the second column of Table 1) indicate that while the coefficients of all the exchange rate variables were

^{1/} Past attempts to estimate the intervention equation jointly with an exchange rate determination equation by (say) two-stage least squares have not been successful (see, for example, Quirk, 1977). The well-known empirical observation that short-run exchange rate behavior is closely approximated by a random walk process makes it difficult to structurally model exchange rate determination or to justify the use of lagged changes in the exchange rate as an instrumental variable (Takagi, 1988b).

Table 2. Response of Official Foreign Exchange Reserves
to Exchange Rate Movements,
1973:Q2 - 1989:Q2 1/

	(1)	(2)	(3)
<u>Regression coefficients 2/</u>			
Constant (α)	0.02(1.09)	0.01(0.39)	0.01(0.38)
Lagged dependent variable (β)	0.24*(2.25)	0.26*(2.33)	0.23*(1.96)
Exchange rate changes for 1973:2-1978:2 (γ_1)	--	-0.51(0.91)	-0.55(0.97)
Depreciation (δ_0)	-2.00**(3.75)	--	--
1978:3-1989:2 (δ_1)	--	-1.74**(3.38)	--
1978:3-1985:3 (δ_2)	--	--	-1.96**(3.41)
1985:4-1989:2 (δ_3)	--	--	-1.05(1.11)
Appreciation (η_0)	-0.37(0.98)	--	--
1978:3-1989:2 (η_1)	--	-0.66(1.90)	--
1978:3-1985:3 (η_2)	--	--	-0.49(0.94)
1985:4-1989:2 (η_3)	--	--	-0.78*(1.90)
<u>Summary statistics</u>			
Degrees of freedom	61	60	58
R ² (\bar{R}^2)	0.37(0.34)	0.36(0.31)	0.37(0.30)
LM(1) <u>3/</u>	0.43	1.91	2.03
SEE	0.091	0.093	0.094
<u>F-statistics on coefficient restrictions 4/</u>			
$\gamma_i = \delta_i = \eta_i = 0$	--	7.52**(3,60)	4.64**(5,58)
$\delta_i = \eta_i = 0$	12.46**(2,61)	--	--
$\delta_1 = 0$	--	0.82(1,60)	0.94(1,58)
$\delta_1 = \eta_1$	4.29*(1,61)	2.28(1,60)	1.08(2,58)
$\delta_2 = \eta_2$	--	--	2.95(1,58)
$\delta_3 = \eta_3$	--	--	0.06(1,58)

1/ Estimation of equation (2) in the text; **(*) indicates that the statistic is significant at 1 (5) percent.

2/ The exchange rate variables are expressed as logarithmic changes in the average quarterly yen/dollar rate; an increase in the value is a depreciation of the yen. The numbers in parentheses are t-values.

3/ General Lagrange multiplier (χ^2) statistic for first-order serial correlation in residuals.

4/ The numbers in parentheses refer to the relevant degrees of freedom.

negative, the scale of intervention became more pronounced after the monetary regime change of 1978. The coefficient of the exchange rate variable for the first period (γ_1) was not significantly different from zero; however, those for the next two periods were both significant at 1 percent. The restriction that the coefficients of the exchange rate variable for the second period (γ_2) and that for the last period (γ_3) were identical could not be rejected.

Was the behavior of the monetary authorities symmetric with respect to depreciation and appreciation? In order to answer this question, equation (2) was then reestimated with separate variables for EX corresponding to depreciation and appreciation (the first column of Table 2). The estimation results indicate that the coefficient of the depreciation variable was significant at the 1 percent level, while the coefficient of the appreciation variable was not significant. This may suggest the greater commitment of the monetary authorities to price stability after the monetary regime change of 1978. Essentially the same results were obtained when the separate (depreciation and appreciation) variables were created only for the period after the third quarter of 1978 (the second column of Table 2). This confirms the results reported in Table 1 that the scale of intervention became more pronounced after the third quarter of 1978.

Finally, the depreciation and appreciation variables were further divided into those corresponding to the periods before and after the regime change of September 1985 (the third column of Table 2). The estimation results indicate that the coefficient of the depreciation variable was significant (at 1 percent) for the 1978:3-1985:3 period, and that the coefficient of the appreciation variable was significant (at 5 percent) for the 1985:4-1989:2 period. This probably reflects the different environments under which the monetary authorities were operating. The 1978:3-1985:3 period roughly corresponded to the period when the yen was generally depreciating against the U.S. dollar, while the 1985:4-1989:2 period roughly corresponded to the period when the yen was largely appreciating. At any rate, the stance of intervention policy during both of these periods was in the direction of moderating exchange rate fluctuations.

III. Behavior of the Monetary Base

1. Mechanism of monetary base control

Foreign exchange market intervention reallocates the liabilities of the Bank of Japan between the Foreign Exchange Fund Special Account of the Central Government and the banking sector. Purchases of foreign exchange result in an increase in the central bank deposits of the banking sector, while sales of foreign exchange lead to a decrease. This means that the monetary base (the deposits of the banking sector at the central bank plus currency in circulation) is immediately altered by foreign exchange market intervention.

Table 3. Response of the Monetary Base to
Changes in Foreign Assets, 1973:Q2 - 1989:Q2 1/

	(1)	(2)
<u>Regression coefficients</u> <u>2/</u>		
Constant (θ)	-420(1.18)	-522 (1.55)
Foreign Assets (ϕ_0)	0.16(1.58)	--
1973:2-1978:2 (ϕ_1)	--	-0.62*(2.12)
1978:3-1985:3 (ϕ_2)	--	0.15(1.41)
1985:4-1989:2 (ϕ_3)		0.50*(2.31)
<u>Dummies</u>		
Q1 (σ_1)	1311*(2.56)	1250**(2.60)
Q4 (σ_2)	4127**(14.20)	4406**(15.23)
Lagged monetary base (λ)	-0.57**(6.29)	-0.56**(6.58)
Whole sale price inflation (μ)	15434**(3.24)	17741**(3.91)
Call money rate (ρ)	-57(1.18)	-55(1.21)
<u>Summary statistics</u>		
Degrees of freedom	58	56
R^2 (\bar{R}^2)	0.86(0.85)	0.88(0.86)
LM(1) <u>3/</u>	2.36	2.43
SEE	919	862
<u>F-statistics on coefficient restrictions</u> <u>4/</u>		
$\phi_1 = 0$	2.50(1,58)	4.25**(3,56)
$\phi_1 = \bar{\phi}$	--	4.95*(2,56)

1/ Estimation of equation (4) in the text; **(*) indicates that the statistic is significant at 1 (5) percent.

2/ The numbers in parentheses are t-values.

3/ General Lagrange multiplier (χ^2) statistic for first-order serial correlation in residuals.

4/ The numbers in parentheses refer to the relevant degrees of freedom.

The simplified flow identity (valued in yen), relating the monetary base to its source side, is given by:

$$\Delta MB_t \equiv \Delta FA_t + \Delta DC_t \quad (3)$$

where MB is the monetary base; FA is the foreign asset source component; and DC the domestic source component (domestic credit); and Δ is a first difference operator. Suppose, for example, that the authorities purchase foreign exchange in response to currency appreciation. The flow identity suggests that, they can then (1) "sterilize" the increase in FA by reducing DC if they have a target growth of MB for the period; (2) accommodate the increase in FA by allowing MB to increase by the same amount; or (3) choose some combination of the two. What we want to know is how ΔMB responds to ΔFA .

In analyzing the response of the monetary base to changes in the yen value of foreign assets, it is important that the latter does not reflect valuation change induced by exchange rate movements, in so far as intervention affects the monetary base at the prevailing exchange rate at which the transaction in foreign exchange is made. In contrast, the yen value of official foreign assets published in the monetary survey is valued at the current exchange rate (and not historically prevailing rates) and thus includes the capital gain (or loss) component, which is reflected in the capital account (and not the reserves) of the liability side of the consolidated balance sheet of the monetary authorities.

One way to obtain an estimate of the yen value of official foreign assets that is independent of capital gains from published sources is to obtain an estimate of the outstanding value of central bank credit to the Foreign Exchange Fund Special Account. Such an estimate, which roughly corresponds to the balance of central bank holdings of foreign exchange bills, can be obtained by subtracting the balance of the monetary authorities' outstanding credit to the central government in the monetary survey from the balance of the Bank of Japan's outstanding credit to the central government. ^{1/} Chart 3 depicts the quarterly time-series of the balance of foreign assets in the Foreign Exchange Fund Special Account (Monetary Survey) and the value of central bank credit to the Special Account so estimated (Bank of Japan). The chart indicates that, while both have shown broadly similar movements over the period of 1973-89, the latter series has shown a somewhat delayed response pattern over a relatively shorter period.

^{1/} This follows from the fact that the balance sheet of the monetary authorities in the monetary survey is the consolidated account of the Bank of Japan and the Foreign Exchange Fund Special Account of the central government.

Table 4. Response of the Monetary Base Changes
in Foreign Assets, 1973:Q2 - 1989:Q2 1/

	(1)	(2)
<u>Regression coefficients</u> <u>2/</u>		
Constant (θ)	-398(1.08)	-590(1.65)
Increases in foreign assets (ψ_0)	0.13(0.81)	--
1973:2-1978:2 (ψ_1)	--	-1.32** (3.05)
1978:3-1989:3 (ψ_2)	--	0.04(0.27)
1985:4-1989:2 (ψ_3)	--	0.56* (1.96)
Decreases in foreign assets (ω_0)	0.20(1.11)	--
1973:2-1978:2 (ω_1)	--	0.10(0.22)
1978:3-1985:3 (ω_2)	--	0.26(1.48)
1985:4-1989:2 (ω_3)	--	0.32(0.80)
Dummies		
Q ₁ (σ_1)	1319* (2.55)	1185* (2.50)
Q ₄ (σ_2)	4141** (13.90)	4523** (15.48)
Lagged monetary base (λ)	-0.57** (6.24)	-0.54** (6.26)
Wholesale price inflation (μ)	15456** (3.21)	17974** (4.04)
Call money rate (ρ)	-56(1.16)	-23(0.50)
<u>Summary statistics</u>		
Degrees of freedom	57	53
R ² (\bar{R}^2)	0.86(0.84)	0.89(0.87)
LM(1) <u>3/</u>	2.49	4.33*
SEE	926	843
<u>F-statistics on coefficient restrictions</u> <u>4/</u>		
$\psi_1 = \omega_1 = 0$	1.26(2,57)	3.15** (6,53)
$\psi_0 = \omega_0$	0.07(1,57)	--
$\psi_1 = \omega_1$	--	4.69* (1,53)
$\psi_2 = \omega_2$	--	0.74(1,53)
$\psi_3 = \omega_3$	--	0.20(1,53)

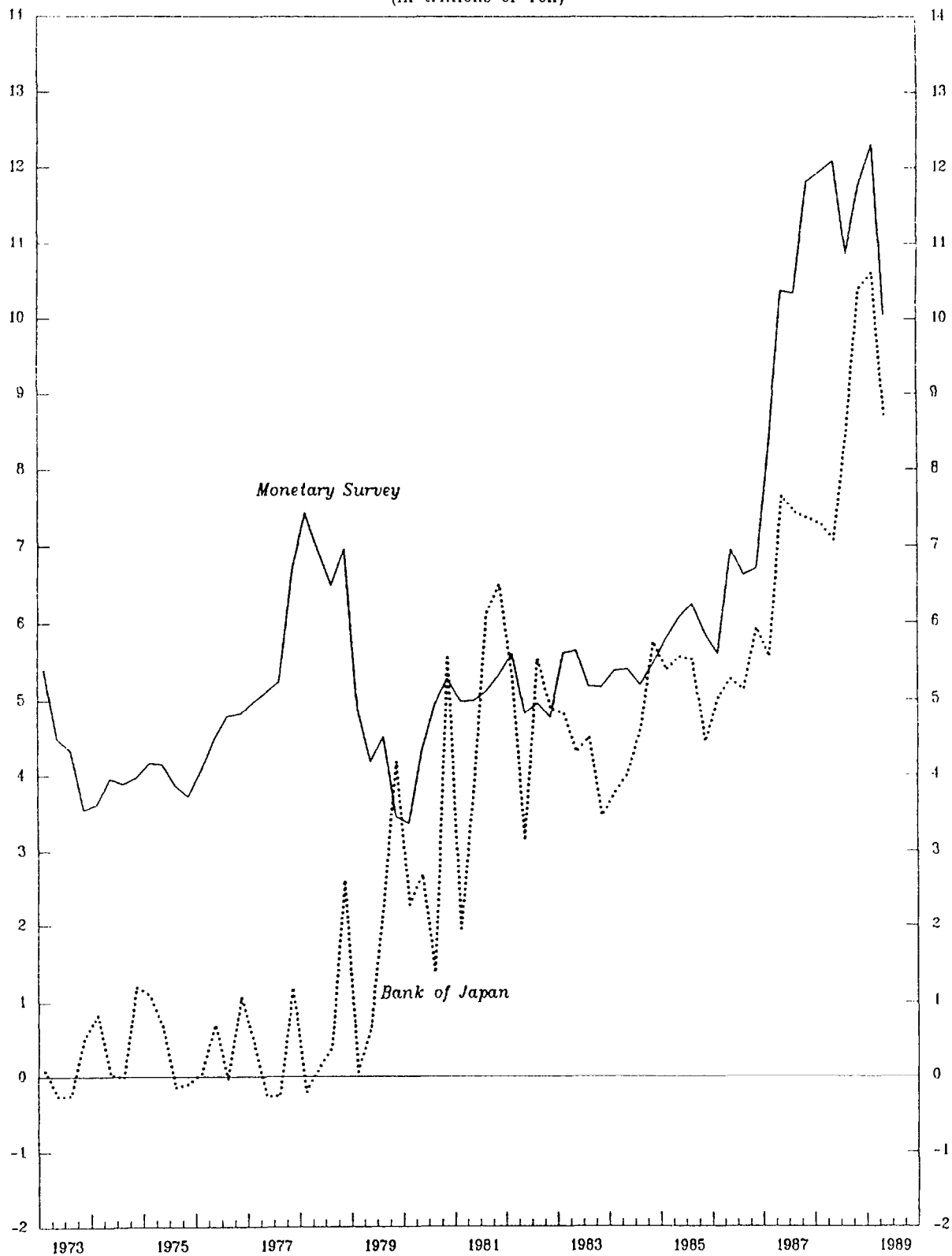
1/ Estimation of equation (4) in the text; **(*) indicates that the statistics is significant at 1 (5) percent.

2/ The numbers in parentheses are t-values.

3/ General Lagrange multiplier (χ^2) statistic for first-order serial correlation in residuals.

4/ The numbers in parentheses refer to the relevant degrees of freedom.

Chart 3. Two Alternative Measures of Official Foreign Assets
in Japan, Q1 1973 to Q2 1989^{1/}
(In trillions of Yen)



Source: Bank of Japan, Economic Statistics Monthly; and the author's estimates.

1/ End-of-quarter data.

2. Analysis of the Behavior of the monetary base

In order to analyze the behavior of the monetary authorities with respect to their control of the monetary base, we will concentrate on the source side of the monetary base. ^{1/} The flow identity (3) can be translated into the response function of the source side of the monetary base as follows:

$$\Delta MBS_t = \theta + \phi \Delta FOA_t + \sigma Q_t + \lambda \Delta MBS_{t-1} + \mu DWP_t + \rho CMR_t + u_t \quad (4)$$

where θ is a constant; FA is now replaced by its proxy FOA; ΔMBS is a quarterly change in the source side of the monetary base; Q is a column vector of seasonal dummy variables for the first and fourth quarters of each year (mostly capturing the influences of the seasonal movements of Treasury funds and of currency in circulation); DWP is the quarterly logarithmic change in the wholesale price index as a measure of inflation; and CMR is the level of the call money rate as a measure of the stance of monetary policy; ϕ is the coefficient of ΔFOA , σ a row vector of the coefficients of Q , λ is the coefficient of lagged ΔMBS ; μ is the coefficient of DWP ; ρ is the coefficient of CMR ; and u is a random error term.

Normally, estimation of equation (4) by OLS would involve a potential econometric problem, because ΔMBS would affect the exchange rate, thus affecting the intervention behavior of the monetary authorities in the same period. This potential simultaneity problem, however, is not present in our specification in which FA is replaced by its proxy FOA. What ΔMBS_t (or ΔMB_t) affects through the exchange rate is ΔFA_t or ΔRES_t , and not ΔFOA_t . The results from estimating equation (4) by OLS are reported in Table 3. ^{2/}

We observe that, for the entire sample period, the coefficient of ΔFOA_t was not significantly different from zero, indicating that there was almost complete sterilization (the first column of Table 3). That is to say, a change in the foreign asset source component of the monetary base was not allowed to affect the overall monetary base. In order to see

^{1/} The major components included in the analysis are bills discounted, loans, bills purchased and government bonds (see Appendix III for the source of data). The other components are not explicitly included, because they are generally minor and stable. The seasonal variation (corresponding to tax receipts) of government deposits--also minor in absolute magnitude--is captured in the seasonal dummies.

^{2/} See Appendix III for the source and description of data.

Table 5. Test of Granger Causality of Money Supply,
1975:Q2-1989:Q1 1/

(F-Statistics)

	Monetary Base(LMB) → Money Supply(LMS)	Call Money Rate(CMR) → Money Supply(LMS)
2-variable <u>2/</u> case	1.66	5.49**
3-variable <u>3/</u> case	3.81**	7.99**

1/ The number of lags is set at four quarters; ** indicates that the F-statistic is significant at one percent.

2/ Only the lagged values of either LMB or CMR are included along with the seasonal dummies.

3/ The lagged values of both LMB and CMR are included along with the seasonal dummies.

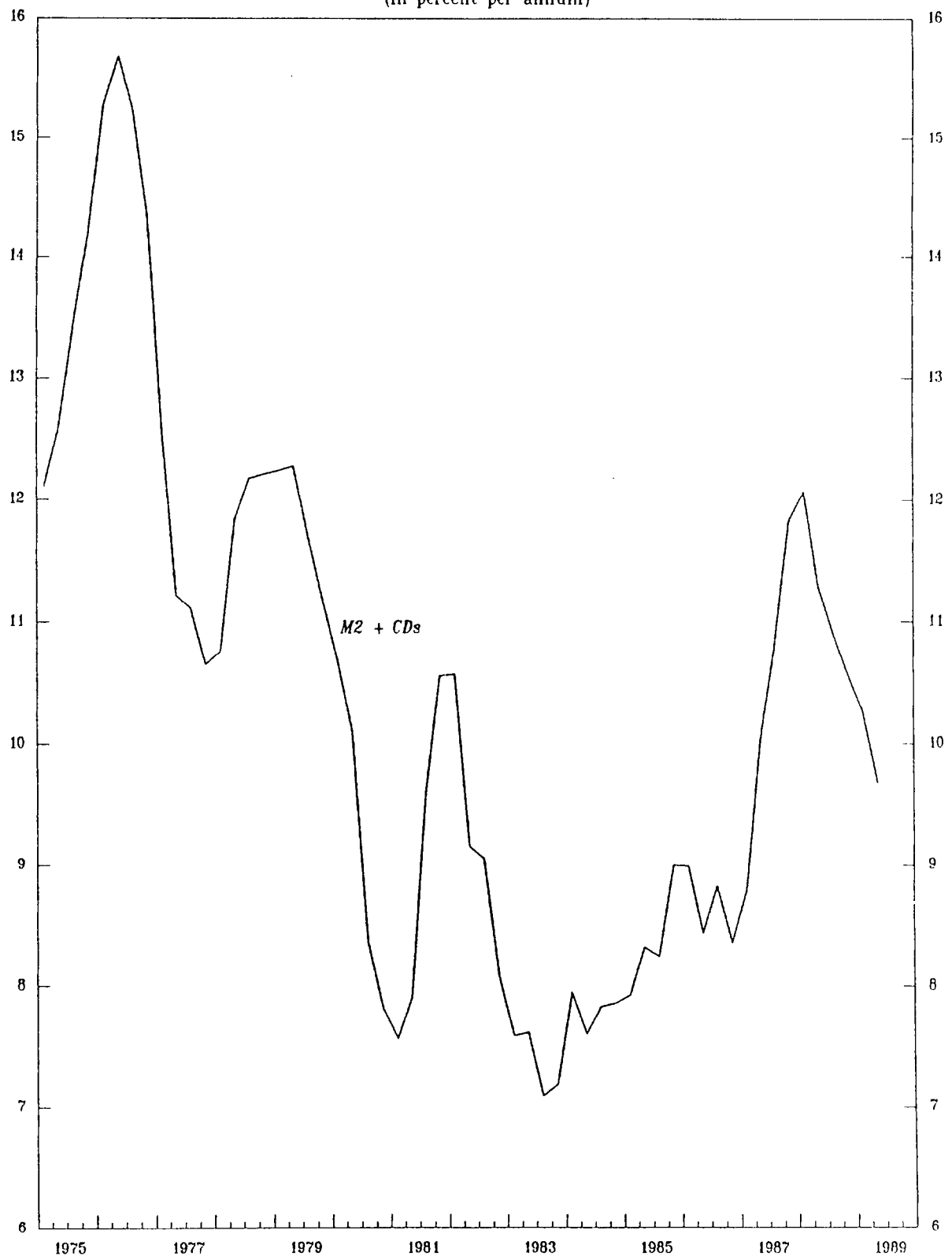
Table 6. Variance Decomposition of Money Supply 1/
Forecast Errors, 1975:Q2-1989:Q1

(In percent)

Quarter	(1)			(2)		
	LMB	CMR	LMS	CMR	LMS	LMB
1	0.9	4.6	94.5	3.8	96.2	0.0
2	1.0	12.0	87.0	11.4	88.6	0.0
3	6.6	34.1	59.3	28.6	57.5	13.9
4	6.5	43.6	49.9	37.2	47.5	15.3
5	6.3	41.6	52.1	35.4	49.2	15.4
6	7.1	42.2	50.7	35.7	47.8	16.5
7	9.7	42.1	48.2	35.0	44.9	20.1
8	10.8	41.9	47.3	34.6	43.9	21.5

1/ Based on standard Choleski decomposition. The ordering is as given (from left to right).

Chart 4. Rate of Growth of Broad Money in Japan
Q1 1975 to Q2 1989^{1/}
(In percent per annum)



Source: Bank of Japan, Economic Statistics Monthly.

^{1/} Growth rate of the quarterly average balance of M2 + CDs over four quarters.

the possible impacts of the regime changes on the behavior of the monetary base, equation (4) was next estimated with separate variables for FOA corresponding to the periods 1973:2-1978:2, 1978:3-1985:3, and 1985:4-1989:2 (the second column of Table 3). We note that: for the first period, the coefficient of ΔFOA was negative and significant; for the second period, the coefficient was not significantly different from zero; and for the last period, the coefficient was positive and significant. One possible interpretation of these results is that, along with the secular increase in the monetary base, it became easier to accommodate reserve movements over time.

Equation (4) was next reestimated with separate variables for FOA corresponding to whether or not there was an increase or decrease in foreign assets during the quarter (the first column of Table 4). We find the coefficients of both the increase variable and the decrease variable were not significant, indicating almost complete sterilization. If we divide each of the FOA variables (increases and decreases) into the three subperiods, we find that only the coefficients of the increase variable were significant for the first and the last periods (the second column of Table 4). This probably reflects the fact that Japan was a net purchaser of foreign exchange during this period, and that the behavior of the monetary authorities with respect to the control of the monetary base was largely confined to their reaction to reserve inflows.

The crucial result of the empirical analysis in this section is the observation that the apparent attitude of the monetary authorities became more accommodative over time, in the sense that they allowed an increasingly greater part of changes in the foreign asset component of the monetary base to affect the overall monetary base. One possible interpretation of this result, as mentioned earlier, is that the increasing balance of the monetary base over time allowed a greater portion of reserve movements to be accommodated with greater ease. We will return to this point in the concluding section of the paper, after we evaluate the behavior of the broad money supply in the next section.

IV. Domestic Monetary Control

After several years of trend deceleration, the rate of growth of broad money (M2 plus CDs) in Japan began to pick up in late 1983 and surged in early 1987 (Chart 4), somewhat coinciding with the beginning of the rapid appreciation of the yen. A popular explanation of this recent surge in the growth of money supply (particularly in 1987) rests on the rapid appreciation of the yen and the presumed unsterilized foreign exchange market intervention of the monetary authorities to help arrest it (see, for example, SBCI Securities, 1989). A closer examination of actual data, however, suggests caution in accepting this seemingly plausible explanation on two levels. First, despite the increase in the balance of foreign assets, its share in the source side of the monetary base remained relatively small, increasing from about 22 percent in 1984 to about

35 percent in 1987. In contrast, the share was as high as 70 percent in 1971 (at the peak) and 50 percent in 1973.

Second, perhaps more importantly, the monetary base is only a secondary determinant of the money supply in Japan. The Bank of Japan does not control monetary aggregates by controlling the monetary base through the money multiplier relationship (Suzuki, Kuroda and Shirakawa, 1988). Instead, the Bank influences bank lending, by which deposits are created; the central bank then residually supplies high-powered money to help commercial banks secure the required reserves. ^{1/} It is thus more plausible to think that the rapid monetary expansion allowed greater accommodation of reserve inflows, rather than to think that the greater reserve accommodation caused that greater monetary expansion. The relevant question then becomes what accounted for this rapid monetary growth.

In accounting for the recent behavior of the money supply (M2 plus CDs), two factors seem to stand out. First, the recent period was characterized by historically low interest rates (Chart 5). ^{2/} Granger causality tests, in fact, suggest that the short-term interest rate was a more important determinant of the behavior of the money supply than the monetary base. According to the results reported in Table 5, the null hypothesis that the first differences in log of the monetary base (LMB) did not help predict the first difference in log of M2 plus CDs (LMS) could not be rejected when the lagged values of only LMB (and the seasonal dummies) were included, although the hypothesis was rejected when the lagged values of the first difference of the call money rate (CMR) were also included. In contrast, the null hypothesis that CMR did not help predict LMS was rejected in both specifications and at lower levels of statistical significance.

Essentially the same conclusion about the relative importance of LMB and CMR would emerge even if we took account of the possible joint endogeneity of all the three variables. For example, we can think of the following simple vector autoregression (VAR), consisting of LMB, CMR and LMS (all in first difference form), as characterizing the relationship between the three variables:

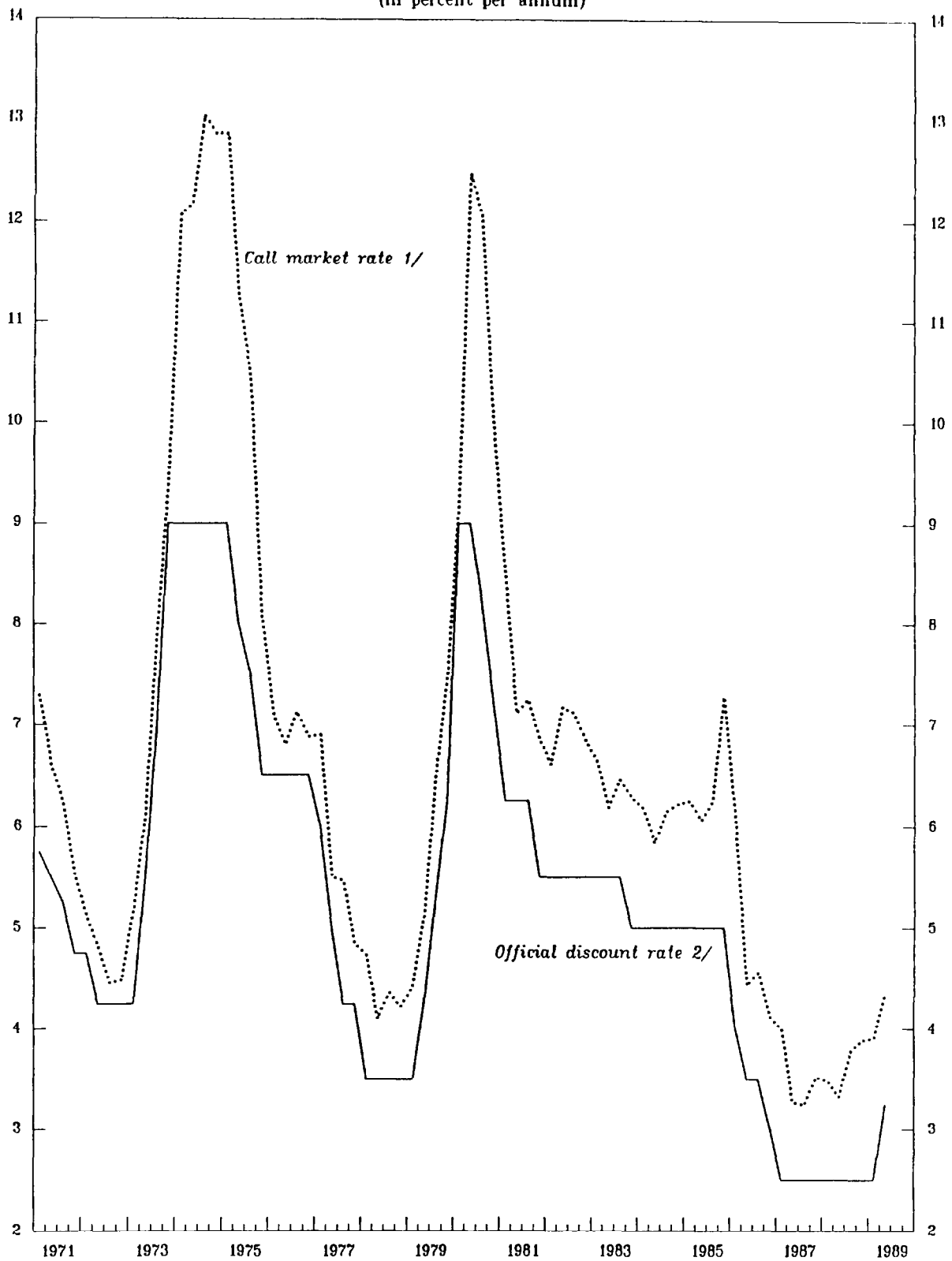
$$X_t = C + \sum_{j=1}^4 F_j X_{t-j} + G Y_t + v_t \quad (5)$$

where X is a column vector of the three endogenous variables, C is a column vector of constants, F is a 3 by 3 matrix of the coefficients of X , Y is a column vector of three seasonal dummy variables with G a 3 by 3

^{1/} See Appendix II for a brief outline of the monetary control mechanism in Japan.

^{2/} See Appendix I for a brief review of recent interest rate policy in Japan.

Chart 5. Short-term Interest Rates in Japan, Q1 1971 to Q2 1989
(In percent per annum)



Source: IMF, International Financial Statistics.

1/ Quarterly average data.

2/ End-of-quarter data.

matrix of coefficients, and v is a column vector of random error terms. The number of lags is set at four quarters.

Based on variance decomposition analysis reported in Table 6, we find that the variance of innovations to the monetary base accounted for less than one percent of the variance of the forecast errors of the money supply for the first and second quarters. In contrast, the variance of innovations to the call money rate accounted for around 4 percent (for the first quarter) and around 12 percent (for the second quarter) of the money supply forecast error variance. Together with the results of the Granger causality tests, these results seem to provide some evidence of the relatively greater influence of the short-term interest rates on the behavior of the money supply in Japan.

Second, another important factor accounting for the recent behavior of the money supply is the behavior of the money multiplier (Chart 6). Japan has witnessed a trend increase in the money multiplier for M2 (or M2 plus CDs) since 1975, corresponding to the acceleration of financial market liberalization that have allowed commercial banks to offer competitive interest rates on an increasingly greater portion of bank deposits (Takagi, 1988a). This has resulted in increased intermediation as well as in a shift of funds out of narrow money within the banking system (the share of M1 in M2 plus CDs declined below 40 percent in the late 1970s to a little above 25 percent currently). It is believed that financial market liberalization raised the level of the money supply consistent with desired price stability, and has allowed the monetary authorities to tolerate the pace of monetary expansion observed in recent years.

V. Conclusion

This paper has presented a review and an empirical analysis of official foreign exchange market intervention and domestic monetary control in Japan during the period of 1973-89. Concerning intervention, the analysis of the paper has found that the monetary authorities generally followed a "leaning against the wind" policy and were thus a net purchaser of foreign exchange during much of this period, corresponding to the secular appreciation of the yen. There is some evidence to suggest that, from the third quarter of 1978 through the third quarter of 1985 (when the yen was generally depreciating against the U.S. dollar), the authorities responded particularly sharply against currency appreciation. This may mean that, since the monetary regime change of 1978, the monetary authorities became particularly committed to price stability and adjustment of trade imbalances.

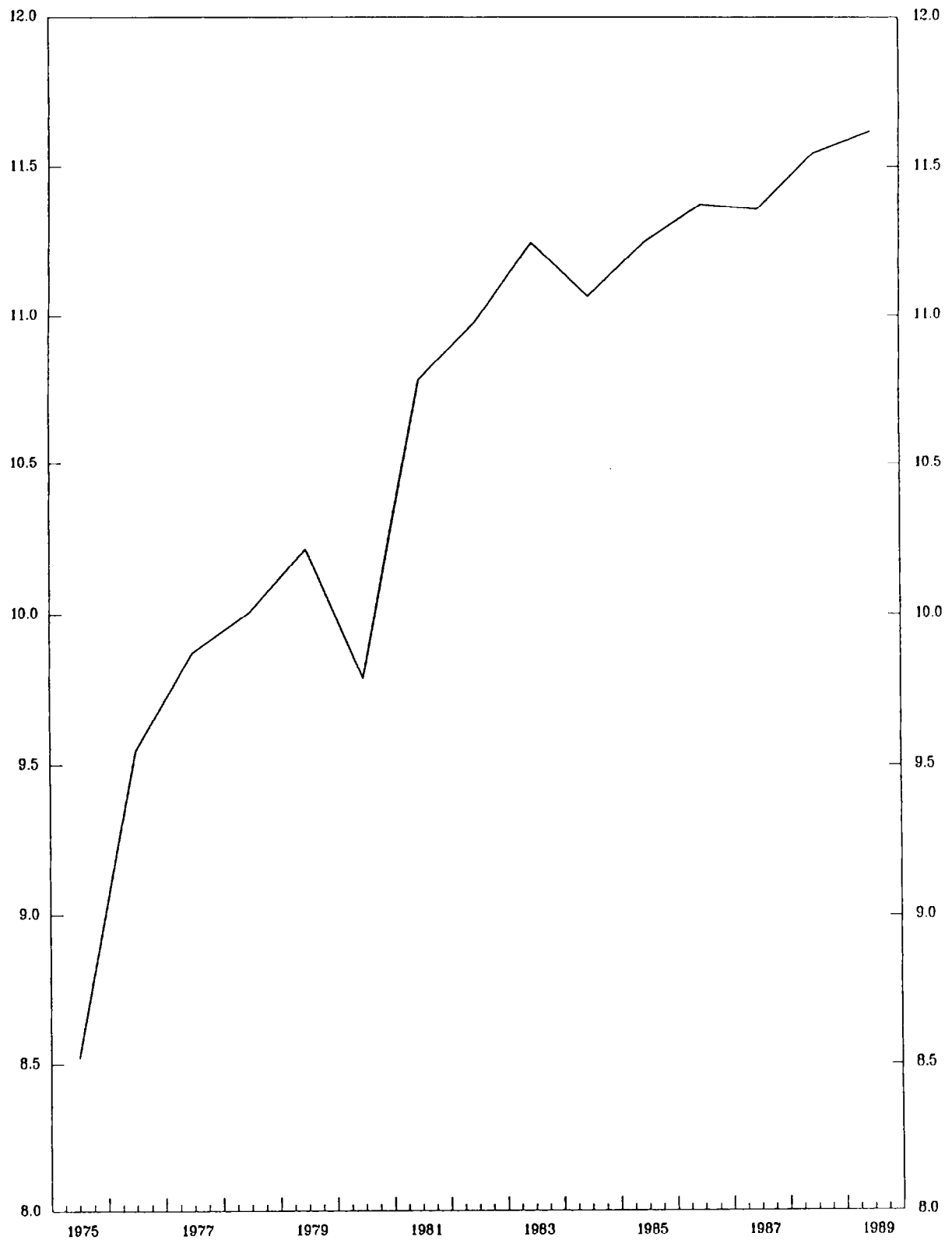
As to the behavior of the monetary base, the monetary authorities were found to have almost completely sterilized reserve movements for the period taken as a whole. Important differences, however, were found across different time periods. During the early period, reserve movements were apparently "oversterilized," (e.g., the monetary base was decreased

by reserve inflows). Over time, the monetary authorities came to sterilize a smaller portion of the movements (particularly inflows) of foreign exchange reserves. For the period after the fourth quarter of 1985, only about 50 percent of reserve inflows was sterilized. 1/

This increased reserve accommodation, however, should not be taken to be the principal cause of the recent surge in the growth of the money supply. The Bank of Japan controls the money supply through control of commercial bank credit, passively supplying high-powered money so as to meet the reserve needs of the banking sector in the short run. Our analysis has suggested that much of the recent increase in the money supply can be accounted for by the lower interest rates and the rising money multiplier in recent years. Domestic considerations (fear of a recession resulting from the yen appreciation) probably was an important factor in the decision of the monetary authorities to lower interest rates from early 1986; financial market liberalization allowed them to tolerate the rapid monetary expansion without sacrificing price stability. It was this monetary expansion that has allowed them to accommodate reserve inflows with greater ease. The Bank of Japan thus faced little conflict between the modest objective of its foreign exchange market intervention and its accommodate control of monetary aggregates; the Bank simply "accommodated" or "sterilized" reserve movements based on the residual amount of the monetary base that is required to support a given level of the money supply.

1/ The figure would be about 30 percent if we used the unadjusted value of official foreign assets (i.e., FA in the text).

Chart 6. Annual Movement of the Money Multiplier in Japan, 1975-89 ^{1/}



Source: IMF, International Financial Statistics.

^{1/} Calculated as the ratio of M2 + CDs over the monetary base at the end of June.

Summary of Policy Measures Taken in response to
Exchange Rate Developments

The Japanese authorities have used measures other than foreign exchange market intervention as a tool of exchange rate policy. This appendix will present major episodes in which the Japanese authorities (1) changed the official discount rate, and (2) used capital control measures, in response to exchange rate movements. The discussion here, however, does not address the issue of whether these policy measures had their intended effects on the exchange rate.

1. Discount rate adjustments

The Japanese authorities have made adjustments in the official discount rate. In addition to domestic considerations, a decision to adjust the discount rate has responded to exchange rate movements (Hutchison 1988), often in coordination with the authorities of the other major industrial countries.

a. From 1973 to 1984

When the yen began to float, the economy faced mounting inflationary pressures, and later downward pressure on the yen. The monetary authorities thus raised the official discount rate five times during 1973, bringing the rate from 4.25 percent to 9 percent in December (Chart 5). However, with the stabilization of the yen and weak domestic demand in early 1975, the Bank of Japan began to ease interest rates by reducing the discount rate in four steps from 9 percent to 6.5 percent during 1975. The period of yen appreciation from 1976 to 1978 saw four more discount rate cuts until the rate of 3.5 percent was reached in March 1978.

In late 1979, the Bank of Japan began to attempt to control the inflationary pressures arising from the increase in oil prices by pursuing a tighter monetary policy. It raised the discount rate in three steps from 5.25 percent in November 1979 to 9 percent in March 1980. During the ensuing period of yen depreciation, however, the Bank of Japan gradually reduced the discount rate, reflecting the successful control of inflationary pressures. The only notable interest rate action the Bank of Japan took in response to the weakening yen during this period was the tightening of monetary conditions in the spring of 1982. As a result of this action, the call money rate, for example, rose temporarily from 6.5 percent in mid-March to 7.1 percent in mid-April. ^{1/}

^{1/} This high interest rate policy was eased in late August and completely terminated in late November, in response mainly to domestic considerations (Komiya and Suda, 1983).

b. From 1985 to 1989

During the months that immediately followed the Plaza Agreement in September 1985, the Bank of Japan sharply raised short-term interest rates to strengthen the yen. The call money rate, for example, increased sharply from 6.2 percent in mid-October to 8.5 percent in mid-December (Ito, 1987). Once the appreciation of the yen was secured in January 1986, however, the Japanese authorities shifted attention from the exchange rate to the domestic economy. The Bank of Japan lowered the discount rate from 5 to 4.5 percent in late January, further to 4 percent in March in coordination with the Federal Reserve and the Bundesbank, and again to 3.5 percent in April in harmony with the Federal Reserve. In November, the Bank of Japan further reduced the discount rate to 3 percent, because it wanted to prevent a further appreciation of the yen following a series of discount rate cuts by the Federal Reserve during the summer of 1986 (Funabashi, 1988).

On February 20, 1987, immediately preceding the G-5 meeting at the Louvre, the Bank of Japan again lowered the discount rate to 2.5 percent, the lowest in post war history (Chart 5). Following the Louvre Accord, the Bank of Japan further eased monetary conditions: the call money rate, for example, fell from 3.9 percent in mid-March to 3.1 percent in mid-May. Monetary policy remained generally easy during the period of relative strength of the yen in 1987 and 1988. The policy of easy money was reversed in response to the sharp depreciation of the yen in early 1989. The Bank responded by raising the discount rate to 3.25 percent in May and further to 3.75 percent in October.

2. Capital controls

As perhaps the least flexible tool of exchange rate management, the Japanese authorities have occasionally resorted to capital controls. The importance of capital controls, however, declined over time and particularly after the December 1980 revision of the Foreign Exchange and Foreign Trade Control Law, which in principle liberalized all foreign exchange transactions (Takagi, 1988a). Since 1981, the ability of the authorities to exercise control on international capital flows has been limited to moral suasion over the portfolio behavior of institutional investors (Fukao and Okina, 1989).

a. From 1973 to 1980

Following the commencement of exchange rate floating, the authorities first used capital controls to mitigate the depreciation of the yen. As measures to encourage capital inflows, for example, they removed restrictions on foreign acquisition of Japanese securities in November 1973 and completely liberalized the acquisition of Japanese government securities by foreigners in August 1974. As a measure to discourage capital outflows, they placed restrictions on acquisition of

short-term foreign securities by Japanese institutional investors and foreign currency deposits by residents (Komiya and Suda, 1983; Fukao, 1989).

Once the strength of the yen became more apparent in 1977, however, the Japanese authorities began to implement measures to encourage capital outflows and discourage capital inflows (Fukao, 1989). In June 1977, they removed ceilings on the amount of foreign currency deposits owned by residents and the restrictions on the acquisition of foreign securities by residents. In November 1977, they set a 50 percent reserve requirement (increased to 100 percent in March 1978) on net increases in non residents' free yen accounts and effectively disallowed non residents to purchase short-term government securities. In March 1978, they restricted the acquisition of Japanese securities by foreigners.

As the yen began to show a trend depreciation from late 1978, the stance of the authorities was again reversed. In February 1979, the authorities lifted the earlier restrictions on acquisition of Japanese securities by foreigners and free yen accounts owned by foreigners. In May 1979, the government completely liberalized participation of non-residents in the short-term gensaki (bond repurchase) market. ^{1/} In March 1980, the authorities allowed Japanese banks to raise funds in London and transfer them to their head offices and removed the interest ceiling on non-residents' free yen accounts. This trend toward greater capital liberalization was codified in the revised Foreign Exchange and Foreign Trade Control Law enacted in December 1980.

b. From 1981 to 1989

Along with the enactment of the revised Foreign Exchange Law, the authorities also decided to liberalize acquisition of foreign assets by such institutional investors as insurance companies and trust banks. ^{2/} This move toward less regulation was in a sense contrary to the exchange rate objective of the authorities, because the resulting accumulation of foreign assets by institutional investors was obviously in the direction of supporting the continued weakness of the yen in the early 1980s. However, as the trend depreciation of the yen became more evident in April 1982, the authorities reacted by implementing a temporary measure to restrict net foreign investments by institutional investors (Fukao, 1989). ^{3/}

^{1/} See Takagi (1988a; 1989) for a general survey of Japan's financial markets.

^{2/} Financial institutions are subject not only to the Foreign Exchange Law but also to the prudential regulation of the Ministry of Finance.

^{3/} The Japanese authorities emphasize that these temporary restrictions represented only the "voluntary compliance" of the financial institutions.

Once the yen began to appreciate in 1985, however, the authorities removed all temporary capital control measures placed on institutional investors, and then eliminated all flow restrictions on their portfolio behavior in August 1986. In the area of stock restrictions, they raised the ceiling on the maximum authorized share of foreign assets in total assets for insurance companies from 10 percent to 25 percent in March 1986, and further to 30 percent in August 1986 (Fukao and Okina, 1989). It is now believed that the authorized ceiling on the stock of foreign assets is no longer binding on their behavior (Fukao, 1989).

Outline of the Monetary Control Mechanism 1/

As in any other central banking system, the Bank of Japan derives its ability to influence nominal interest rates from its ability to influence the supply of and demand for high-powered money (or base money). The Bank of Japan does not practice rigid high-powered money control, however, because it believes that the demand function for high-powered money is highly unstable in the short run. Instead, the Bank of Japan remains the residual supplier of base money in the short run and indirectly controls the long-run balance of base money by influencing the lending behavior of commercial banks through interest rates.

The Law Concerning the Reserve Deposit Requirement System of May 1957 mandates that the financial institutions under the system maintain a certain average balance of reserves (ABR) with the Bank of Japan during a given maintenance period (from the 16th day of each month through the 15th day of the next), determined by the legal reserve requirement ratio (r) times the average outstanding balance of deposits during the calendar month that ends at the midpoint of the reserve maintenance period, i.e., 2/

$$ABR \equiv \frac{\sum_{t=1}^T RR_t/T}{\sum_{i=1}^I D_i/I} = r \quad (6)$$

where t ($=1, T$) refers to the reserve maintenance period, i ($=1, I$) refers to the calendar month, RR is the daily reserve held at the central bank, and D is the amount of deposits.

The unique feature of the Japanese banking system is that the central bank implicitly guarantees that the relationship (6) holds for each bank on the 15th day of each month. As a result, Japanese banks hold virtually no excess reserves: the average amount of excess reserves in the banking system during a typical month is no more than 0.1 percent of total reserves held at the central bank. However, each bank has some discretion as to how to allocate the average balance of required reserves over the maintenance period. This constitutes the key mechanism by which the central bank influences nominal interest rates on a daily basis.

This mechanism consists of two tools. The first is the accounting concept called the "reserve progress ratio (RPR)" defined as:

1/ For a more detailed exposition, see Suzuki, Kuroda, and Shirakawa 1988.

2/ Here, I am abstracting from the fact that there are different types of deposits that are subject to different reserve requirements.

$$RPR_t = \left(\sum_{j=1}^t RR_j \right) / ABR * T \quad (7)$$

where j ($=1, t$) is the portion (up to the t -th day) of the reserve maintenance period. The reserve progress ratio at time t shows the proportion of actual reserves accumulated up to that time in the aggregate balance of total required reserves for the reserve maintenance period (for which the projected value is used before the end of the calendar month). On the last day of the reserve maintenance period ($j=T$), the Bank of Japan guarantees that $RPR_T = 1$ for each bank, by extending or recalling loans.

The second tool is the use of the discount window. In Japan, the central bank maintains the official discount rate below interbank interest rates, allowing it to ration credit at its discretion. In calculating the effective rate of discount, the Bank of Japan counts the day on which the credit is extended as one full day under the "method of counting both ends". If, for example, a bank receives credit from the discount window at 4 percent for one day, the effective rate becomes 8 percent. In this manner, the Bank creates incentives for commercial banks to smooth out their discount window borrowing over a longer period by discouraging extremely short-term borrowing.

In controlling interest rates, the Bank of Japan defines the "path of reserve accumulation" in which the required reserves are maintained equally every day as the standard path (i.e., RPR increases by $1/T$ a day during the maintenance period). If the Bank desires to tighten monetary conditions, it will reduce the RPR of the banking system relative to the standard path by reducing direct lending or selling securities. The increased RPR will in turn raise interbank interest rates through two channels. First, given the penal rate system for short-term discount borrowing, it will induce some banks to begin to borrow in the call market. Second, it will provide a signal of the tighter stance of monetary policy, causing expectations of higher interest rates.

It is believed that an increase in the interbank rates limits the expansion of the money supply through three channels (Suzuki 1986). First, it tends to reduce the expansion of bank loans by lowering the profitability of bank lending. Second, it reduces corporate investment demand by increasing market interest rates through arbitrage (Takagi 1987, 1988c). Third, with some deposit rates still fixed, it will result in disintermediation. If this type of monetary control mechanism is strictly in operation, then, the direction of causality should run, not from the monetary base to $M2$ plus CDs, but from interbank interest rates to $M2$ plus CDs and then, through the residual supply of high-powered money, to the monetary base. In practice, however, the monetary base does seem to cause (in the sense of Granger) the money supply at least in quarterly average data, as reported in the text.

Sources of Data

1. Data for Section I

The quarterly time-series of the average exchange rate of the yen against the U.S. dollar, the end-of-period balance of foreign assets (valued in millions of U.S. dollars), and the average U.S. Treasury bill rate were obtained from IMF, International Financial Statistics, various issues.

2. Data for Section II

The quarterly time-series of the end-of-period balances of bills discounted, loans extended, bills purchased, and government bonds (all valued in billions of yen) held by the central bank were obtained from the Bank of Japan, Economic Statistics Monthly, various issues; and the quarterly time-series of the average call money rate, the wholesale price index and the end-of-period balances of official foreign assets and claims on the government (both valued in billions of yen) were obtained from IMF, International Financial Statistics, various issues.

3. Data for Section III

The quarterly time-series of the average call money rate, the end-of-period official discount rate, and the end-of-period monetary base (commercial bank reserves at the central bank plus currency in circulation) were obtained from IMF, International Financial Statistics, various issues; the quarterly time-series of the average balance of M2 (M2 plus CDs after 1979) was obtained from the Bank of Japan, Economic Statistics Monthly, various issues.

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