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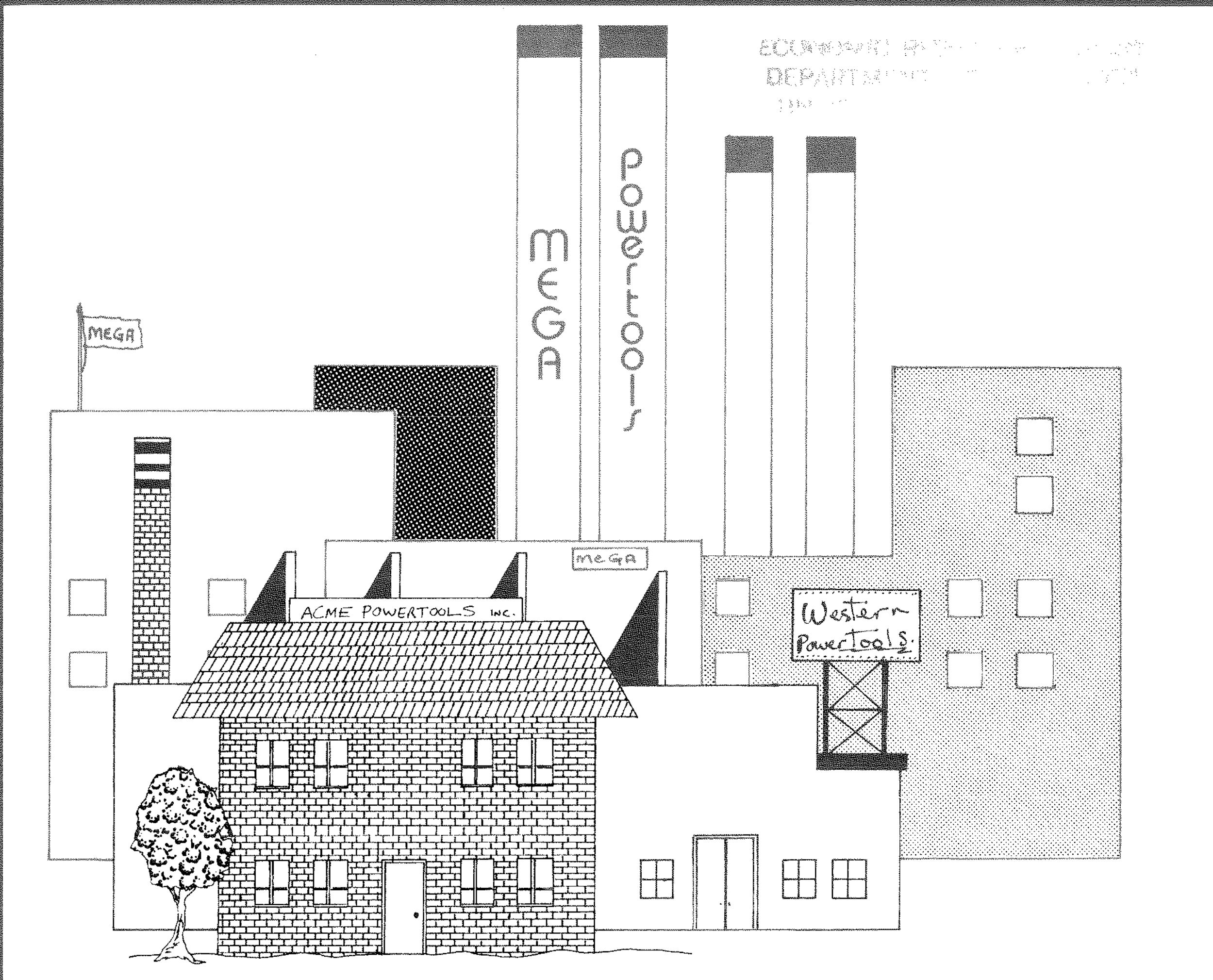

Firm Size, Exchange Rates, and Interest Rates

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Intervention, Deficit Finance and Real Exchange Rates: The Case of Japan

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How official sterilized (non-monetary) foreign exchange market intervention may influence the exchange rate by changing the relative supply of government bonds denominated in domestic and foreign currencies is shown in this paper. Recent Japanese experience is investigated in the context of a simple asset market model of exchange rate determination. The empirical estimates suggest that Japanese official intervention has had only a small influence on the real value of the yen-dollar exchange rate largely because its impact was dwarfed by the role of large fiscal deficits in changing the relative supply of government bonds.

The Williamsburg economic summit took place last Spring amidst great concern over the general strength and dramatic volatility of the dollar in world currency markets. A major issue on the agenda was whether central banks should increase their intervention in the foreign exchange market and attempt both to hinder the dollar's climb and to reduce its fluctuations. As a basis for discussion, summit participants used the Report of the Working Group on Exchange Market Intervention (the Jurgensen report) commissioned at the 1982 Versailles summit. Although the report gave few policy recommendations, it did help to identify the important issues and to clarify the meaning of intervention. In particular, the Jurgensen report distinguished between "monetary" intervention and "sterilized" intervention, and emphasized that the effectiveness of central bank foreign exchange market operations will largely depend upon the distinction.

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Official foreign exchange market intervention may be viewed as a process through which the central bank shifts the composition of its portfolio between foreign and domestic assets. In the case of monetary intervention, the central bank changes its net foreign asset holdings through purchases and sales of foreign exchange and allows a corresponding change in its monetary liabilities, that is, the monetary base (total reserves plus currency held by the non-bank public). Sterilized intervention, on the other hand, means that the central bank allows the change in its net foreign asset holdings to be offset by a corresponding change in its net domestic assets. Monetary liabilities of the central bank remain unchanged in this case, and the monetary base is "sterilized" from foreign exchange market intervention operations. In both instances, foreign assets held by the public will change. Monetized intervention, however, will change the public's holdings of base money, while sterilized intervention will change the public's holdings of domestic bonds.

Table 1 illustrates the effect of intervention on asset supplies in more concrete terms. The table shows a stylized central bank balance sheet and the consolidated private sector claims on foreign and domestic governments. The domestic central bank holds two assets, domestic government bonds and foreign government bonds, and has one liability, domestic base money. (For the sake of simplicity, we assume that central bank domestic credit equals domestic bond holdings and that central bank net foreign asset holdings equal net foreign bond holdings). The consolidated private sector aggregates the foreign private sector and the domestic private sector and focuses on total claims on government, that is, ''outside'' assets. Consolidated private sector claims on foreign and domestic governments are distributed between domestic base money, foreign base money, domestic government bonds and foreign government bonds.

Monetary foreign currency support intervention occurs when the central bank purchases foreign currency from the private sector with domestic currency, and in turn purchases a foreign bond with its foreign exchange receipts.[1] The net effect on the central bank balance sheet and private asset holdings from this operation is indicated by (1) in Table 1. The central bank increases its holdings of foreign bonds and increases domestic base money. Reflecting the new composition of the central bank portfolio, the private sector holds more domestic base money and fewer domestic bonds.

Table 1

(A)

Domestic Central Bank Balance Sheet

Assets		Liabilities	
Foreign Bonds	1 + 2 +	Domestic Base Money	1 + 2 nc
Domestic Bonds	1 nc 2 –		

(B)

Consolidated Private Sector Claims on Governments (Foreign and Domestic)

Domestic Base Money	1 + 2 nc
Foreign Base Money	1 nc 2 nc
Domestic Bonds	1 nc 2 +
Foreign Bonds	1 – 2 –

Notes: +: increase
–: decrease
nc: no change

With a stylized case of sterilized foreign currency support intervention, the domestic central bank follows all of the steps outlined above for monetary intervention and then takes one additional step—it sells a domestic bond in order to hold domestic base money unchanged. The net effect, shown by (2) in Table 1, is that the central bank holds more foreign bonds and fewer domestic bonds, leaving base money unchanged, while the private sector holds fewer foreign bonds and more domestic bonds.

The Jurgensen report emphasized the distinction between monetary and sterilized intervention because the form intervention takes will largely determine its effectiveness. Few disagree that monetary intervention may have a significant influence on the exchange rate. By changing base money, monetary intervention will influence the broader money aggregates, interest rates, and prices in the economy. These variables are important determinants of exchange rates. Sterilized intervention, on the other hand, amounts to a switch of a domestic (foreign) bond for a foreign (domestic) bond held in private portfolios. This form of intervention will only be effective if investors view the bonds as less than perfect substitutes, and relative yields adjust as a consequence of the change in their relative supply. The change in relative yields is the channel through which sterilized intervention may exert an influence on the exchange rate. The debate surrounding the efficacy of intervention thus largely concerns sterilized intervention, and the degree to which changes in the distribution of foreign and domestic bonds in private portfolios will influence relative yields.

A major difficulty facing the central bank, however, is that sterilized intervention is but one source of change in the public's bond holdings. The sale of government bonds to finance government budget deficits will likely play a larger role than intervention in determining the bond mix in private portfolios. The public's domestic government bond holdings (B) is determined by the interaction of monetary policy, government budget deficits, and official exchange market intervention. A government budget deficit over any given period, for example, must be financed by the private sector. The government bond can be sold either to the public or to the central bank. In the former case, B will increase; in the latter case, base money will increase. On the other hand, B will also be influenced by the central bank when it purchases or sells domestic bonds in conducting monetary policy through open market operations, even in the absence of current government budget deficits. In short, the public's domestic bond holdings equal the cumulative domestic budget deficit ($\int$DEF) minus cumulative open market purchases of government bonds in exchange for domestic base money (MB^d)[2] plus cumulative sales of home-country domestic bonds by official foreign-exchange intervention authorities ($\int$INT), that is, sterilized intervention in both the home and foreign countries combined:[3]

$$B = \int DEF - MB^d + \int INT \qquad (1)$$

From equation (1), it is apparent that a domestic bond sale either to finance a home-country budget deficit, or to finance exchange market intervention in support of the foreign currency will increase the supply of domestic currency denominated bonds in private portfolios. The ability of the central bank to influence the relative supply of bonds through sterilized foreign exchange operations alone during any given period will therefore be complicated by these other sources of supply.

Purpose

This paper investigates the Japanese experience with sterilized intervention in the foreign exchange market over the 1973–82 floating rate period. The Japanese case is particularly interesting both because the Bank of Japan pursues an active foreign exchange market intervention policy—it is among the most active of central bank participants in the foreign exchange market—and because large central government budget deficits have increased the stock of yen-denominated government bonds in private portfolios at a rate far surpassing that of most other major industrial nations since the mid-seventies. An empirical study of the Japanese case therefore provides some interesting insights into the complications central banks face in their attempts to manage exchange rates.

Section I presents a model of real (price-adjusted) exchange rate determination that is later employed to measure the effectiveness of Japanese sterilized intervention operations. The model is a variant of the "asset market approach" which views the exchange rate as an asset price whose value is largely determined by the relative demand and supply of asset stocks denominated in various national currencies and which is prone to large fluctuations as asset risk-return characteristics are perceived to change. The foreign exchange market is viewed as an asset market in this model, with exchange rates determined not by the balancing of flow demands and supplies of currencies, but rather by the values at which the market as a whole is willing to hold the outstanding stocks of assets.[4] Sterilized intervention can be conveniently analyzed within this framework because of its influence on relative bond supplies.

Section II discusses Japanese foreign exchange market intervention policy and describes the growth of fiscal deficits in Japan. This provides the background for an account of the growth of Japanese government bonds in private portfolios in comparison to the United States. An empirical test of the model using Japanese-U.S. data from 1973 through 1982 is the subject of the third section. The paper concludes with a short summary and discussion of several policy implications.

I. Real Exchange Rate Model

The basic formulation of the real exchange rate model follows Isard (1980a, 1980b) and may be viewed as a simplification of Hooper and Morton's (1982) extension of the sticky-price monetary model of exchange rate determination developed by Dornbusch (1976).[5] The focus dependent variable is the real (price-adjusted) value of the exchange rate. Because the real exchange rate is a measure of domestic and foreign relative prices, it is an important factor in determining a country's position in international competition, and its determinants are of special policy significance.

The exchange rate equation is derived initially from the covered interest parity condition. This condition states that the return on domestic securities must equal the return available on (equally risky) foreign securities once investors have covered their open positions (and hedged against exchange risk) by forward market purchases or sales:[6]

$$(1 + R) = (F/S)(1 + R^*) \tag{2}$$

where: R = domestic nominal interest rate over maturity t
R* = foreign nominal interest rate over maturity t
S = spot exchange rate (domestic price of foreign currency)
F = forward exchange rate

In log form, (2) may be expressed as (3)

$$r = f - s + r^* \quad \text{or} \tag{3}$$

$$f - s = r - r^* \tag{3'}$$

where $r = \log(1 + R)$, $r^* = \log(1 + R^*)$, $s = \log S$ and $f = \log F$

The expected yield differential between domestic and foreign bonds is the difference between the forward rate and the future spot rate,[7] $\phi^e = f - s^e$. To see this, we may substitute $f = \phi^e + s^e$ into (3) and solve for the expected yield differential: $\phi^e = r - [r^* + (s^e - s)]$. The return on domestic bonds is given by the domestic interest rate (r) and the return on foreign bonds is given by the foreign interest rate (r^*) plus the expected percent appreciation of the foreign currency, $s^e - s$. The forward rate will generally not equal the expected future spot rate $\phi^e \neq 0$ (and expected yields on government bonds denominated in different national currencies will generally not be equal), if investors view the bonds as imperfect substitutes. A simple model relating the yield differential to government bond supply and demand is developed below.

Rearranging and substituting the yield differential and expected future spot exchange rate for the forward rate gives:

$$s^e - s = r - r^* - \phi^e \tag{4}$$

or

$$s = (r^* - r) + \phi^e + s^e \tag{4'}$$

Equation (4) is a condition which will hold in internationally integrated financial markets with rational behavior on the part of investors. It simply states that the market expectation of domestic currency depreciation over a given period will be equal to the interest differential between domestic and foreign securities over a similar holding period, less any expected yield differential.

It is convenient to think of the future expected exchange rate as linked to the current spot exchange rate through the interest differential. Equation (4′) illustrates this relationship. A given interest differential (including ϕ^e) is consistent with any given spot exchange rate level, and only indicates the expected change in the (log) level of the exchange rate over the maturity of the bonds in question. Once expectations about the expected future spot rate are identified, however, the spot rate is determined at a given level. The link between the current (spot) price of a currency and its expected future price is hence quite strong, as it is in the case of any asset price.

To show that (4′) holds in real (price-adjusted) terms as well as nominal, we define the real exchange rate (q) and expected future real exchange rate (q^e) as the difference between the nominal exchange rate and current and expected future relative prices expressed in logs, respectively:

$$q = s - (p - p^*) \tag{5}$$

$$q^e = s^e - (p^e - p^{*e}). \tag{5'}$$

where: q = real exchange rate (log)
q^e = expected future real exchange rate (log)
p = domestic price level (log)
p* = foreign price level (log)
p^e = expected future domestic price level (log)
p^{*e} = expected future foreign price level (log)

Equations (5) and (5′) are both identities and differ only in that (5′) is an *ex ante* relationship based on market expectations of future spot exchange rates and of future domestic and foreign price levels. The real exchange rate measures deviations from purchasing power parity, that is, the extent to which the nominal exchange rate moves beyond simple adjustment to relative price shifts.

Expected future price levels may now be disaggregated into their current price and expected inflation components,

$$p^e = p + \pi \tag{6}$$

$$p^{e*} = p^* + \pi^* \tag{6'}$$

where $\pi = \ln(1 + \dot{p})$, $\pi^* = \ln(1 + \dot{p}^*)$, and $\dot{p}$, $\dot{p}^*$ equal the expected percent change in the domestic and foreign price levels, respectively. Substituting (5) – (6′) into (4′) then gives the basic real exchange rate identity:

$$q = (r^* - \pi^*) - (r - \pi) + \phi^e + q^e \tag{7}$$

This equation expresses the real exchange rate as a function of domestic and foreign real interest rates, the yield differential, and the expected future real exchange rate. Up to this point, we have made no behavioral assumptions about the way expectations are formed, and have derived (7) by manipulating the covered interest arbitrage condition, introducing the definition of the real exchange rate and disaggregating the expected future price level into its current price and expected inflation components. The formation of expectations regarding the future real exchange rate and the yield differential need to be identified, however, before the model can be implemented.

Expected Equilibrium Real Rate

Among the more important influences of expectations about future real exchange rates (q^e), is the market's perception of a sustainable balance of payments. The current account of the balance of payments is perhaps the most logical choice as a measure of external equilibrium from an asset market view of exchange rate determination. This is because the current account equals the difference between the sale of domestic goods and services (and net transfers) to foreigners and the purchase of foreign goods and services by domestic residents. Whenever the current account does not equal zero, a nation exports more or less than it imports. In the absence of official reserve flows, the current account imbalance reflects the net accumulation (current account surplus) or decumulation (current account deficit) of private domestic resident claims on foreigners. It is in this sense that a sustainable long-run current account must be consistent with the rate of foreign asset accumulation or decumulation desired by private investors (both foreign and domestic) in the long-run. If an unexpected current account surplus or deficit arises, some adjustment may be necessary to restore the current account to a path moving towards its long-run sustainable value. The real exchange rate is a major component in the current account adjustment process because it reflects the relative price between domestic and foreign goods and services. An unexpected current account surplus or deficit, to the extent that it is considered permanent, is therefore assumed to indicate to market participants that a real exchange rate shift may be necessary to return the current account back to its sustainable level or path.[8]

This process may be formalized by stating the change in the expected long-run future real exchange rate (dq^e) as a function of unexpected current account movements or "surprises" (CA^s) over period t:

$$dq^e = g[CA^s(t)]\, dt \tag{8}$$

This relationship assumes that all changes over period t in the expected future long-run real exchange rate are unexpected, and that no time trend, and hence predictable element, is discernable during the period under investigation. Market participants thus employ all available current account information in their formation of expectations about the future real exchange rate, and only additional information imbedded in the unexpected component of the contemporaneous current account will cause them to revise their expectations. We are, in effect, assuming that market participants form their expectations "rationally," but we limit the set of relevant information upon which they base their expectations to the current account.

Integrating (8) from an initial period to the present gives the level of the expected long-run future real exchange rate at a point in time t as a function of unexpected cumulative current account developments:

$$q^e = \int g[CA^s(t)]\, dt \tag{9}$$

It is assumed that the (log) level of the expected future real exchange rate, q^e, may be expressed as a simple linear function of the cumulative sum of unexpected current account developments:[9]

$$q^e = \alpha_0 + \alpha_1 \Sigma CA^s \tag{10}$$

Yield Differential Determinants

The expected yield differential is of particular importance because it is through this channel that foreign exchange market intervention influences the exchange rate. The yield differential is determined by the interaction of demand and supply for assets in both home and foreign countries. Under certain assumptions, it may be expressed as a function of the relative supply of government bonds, relative wealth, the perceived exchange rate risk associated with holding foreign bonds, the degree of investor risk aversion and the currency "habitat" preferences of investors (Dornbusch, 1980).

For the purpose of empirical estimation, we assume a simple bond demand function similar to Frankel (1982) to derive the yield differential determinants.[10] Total private demand for domestic government bonds (B) is the sum of domestic private demand (B_d) and foreign private demand (B_f). The domestic and foreign demand functions, in turn, may be expressed as a proportion (β) of domestic and foreign wealth invested in domestic government bonds:

$$B_d = \beta_d W_d \tag{11}$$

$$B_f = \beta_f W_f \tag{12}$$

where $W_d(W_f)$ is domestic (foreign) wealth and $\beta_d(\beta_f)$ is the proportion of domestic (foreign) wealth devoted to domestic government bonds. By assuming that β_d and β_f are simple linear functions of the expected yield differential, that is,

$\beta_d = a_d + b\,\phi^e$ and $\beta_f = a_f + b\,\phi^e$, we may write (11) and (12) as:

$$B_d = (a_d + b\,\phi^e)\,W_d \tag{13}$$

$$B_f = (a_f + b\,\phi^e)\,W_f \tag{14}$$

where a_d, a_f are the desired percentages of total domestic and foreign wealth, respectively, held in domestic government bonds independently of expected relative yields, and $b\phi^e$ measures the proportion of wealth devoted to domestic bonds in response to differential yields. This formulation assumes that domestic and foreign demand for domestic government bonds, measured as a percentage of total wealth, differs only by a constant term which is presumably higher in the domestic country because domestic investors prefer the home currency "habitat."

To close the model we need to introduce the foreign bond market and develop demand functions analogous to (13) and (14). We do so by defining wealth as total holdings of bonds, both foreign and domestic. Domestic wealth (foreign wealth) relevant for portfolio choice in this model thus consists of domestic resident (foreign resident) holdings of both domestic and foreign bonds. This implicitly assumes that investors first allocate a portion of their total wealth to total bond holdings, and then decide between foreign and domestic bonds. This assumption, though restrictive, allows us to drop the foreign bond demand functions explicitly, and to infer the percentage of domestic and foreign residents' wealth devoted to foreign bonds directly from β_d and β_f. For example, the percentage of total domestic wealth, so defined, invested in foreign bonds equals one minus the percentage of domestic wealth invested in domestic bonds, $(1-\beta_d)$.

W can now define total "world" wealth as $W = W_d + W_f$; sum (13) and (14) to get total domestic bond demand ($B = B_d + B_f$); and solve for the yield differential:

$$\phi^e = \frac{1}{b}\left\{\frac{(B)}{W}\right\} - \frac{(a_d - a_f)}{b}\left\{\frac{(W_d)}{W}\right\} - \frac{a_f}{b} \tag{15}$$

From (1) and (15), it is apparent that a domestic bond sale either to finance a home-country budget deficit, or to finance foreign-currency support exchange market intervention, will increase the supply of domestic currency denominated bonds in private portfolios and, consequently, increase their expected relative return (that is, increase the yield differential), if investors view the bonds as less than perfect substitutes ($b \neq \infty$). This will immediately depreciate the exchange rate through (7) in our model. The larger the degree of substitutability between foreign and domestic bonds, that is, the larger the value of b, the smaller will be the increase in the yield differential, and hence, the effect on the exchange rate, of any given change in relative bond supply. An increase in domestic wealth relative to total wealth, on the other hand, will increase the relative demand for domestic bonds (assuming that domestic investors display a greater preference for home securities than do foreign investors, that is, $a_d > a_f$) and lower the yield differential. This will appreciate the value of the domestic currency.

Real Exchange Rate Equation

Substituting the expected equilibrium real exchange rate determinants (10) and yield differential determinants (15) into the basic real exchange rate equation (7), and rearranging, gives the model to be estimated in Section III of this article:

$$q = b_o + b_1 (r^* - \pi^*) + b_2 (r - \pi) + b_3 (B/W) + b_4 (W^d/W) + b_5 (\Sigma CA^s) \qquad (16)$$

where: $b_o = \alpha_o - (a_f/b)$;
$b_1 > 0$
$b_2 < 0$
$b_3 = 1/b > 0$
$b_4 = [-(a_d - a_f)/b] < 0$
$b_5 = \alpha_1 < 0$

Equation (16) expresses the real exchange rate as a function of foreign and domestic real interest rates, the proportion of domestic government bonds in total wealth, the proportion of domestic wealth in total wealth and the cumulative sum of current account surprises. The real exchange rate will depreciate (that is, increase) with a rise in the foreign real interest rate, and appreciate with a rise in the home real interest rate. The size of the real interest rate coefficients (b_1 and b_2) equal, in theory, the term to maturity (in years) of the foreign and domestic bonds whose interest rates are included in the equation. For example, a one percentage point increase in the five-year domestic bond rate (expressed at annual rates), *ceterius paribus*, should immediately appreciate the real exchange rate by five percent. The exchange rate appreciation keeps expected relative yields unchanged by creating an expected home currency depreciation of approximately one percent annually over the five-year maturity of the domestic bond. Unexpected current account surpluses in the home country (b_5), on the other hand, will appreciate the domestic currency, as market participants perceive a shift in the terms of trade necessary to return the current account to a sustainable long-run equilibrium position.

An increase in the share of domestic government bonds in total wealth, other things being equal, will depreciate the home currency as investors demand a higher yield to absorb the bonds into their portfolios. Holding interest rates and the future expected real exchange rate constant, the increased yield may come about through an exchange rate depreciation. An increase in the share of domestic wealth in total wealth, on the other hand, will increase the relative demand for domestic bonds and appreciate the exchange rate, *ceteris paribus*.

This process can be explained in intuitive terms as the macro-economic adjustment process set in motion from domestic disturbances that work partially through the foreign exchange market. In this case, the disturbance is an increase in domestic government bonds which necessitates an increase in their expected relative return. Part of this adjustment may be reflected in higher relative interest rates in the home country, and part may come about through an increase in the expected appreciation of the domestic currency. The increase in the expected appreciation of the currency may come about by an immediate spot depreciation beyond any drop in expectation regarding the future equilibrium rate (which is determined by the long-run current account equilibrium condition). This then sets up a greater appreciation of the home currency, or less of a depreciation, than was expected before the sale of a domestic bond, either to finance a domestic budget deficit or to finance foreign-currency support intervention (purchases of foreign bonds with domestic bonds).[12]

II. Exchange Market Intervention and Budget Deficit Finance in Japan

The real exchange rate model outlined above, with its focus on the influence of privately held government bonds and financial wealth on the exchange rate, is particularly appropriate for an analysis of the Japanese experience since the mid-1970s. On the one hand, Japan's large fiscal deficits and active exchange market intervention policy have combined to increase greatly the supply of Japanese government bonds in private portfolios[13] relative to other major industrial nations. On the other hand, the surplus of Japanese private savings over investment during the last decade has meant that financial wealth in Japan available for portfolio investment has also grown at a more rapid rate than most other industrial nations.

Table 2 gives two measures of the Bank of Japan's foreign exchange market intervention in relation to changes in the yen-dollar exchange rate over the course of the floating rate period. The intervention proxies are gross changes in official Japanese reserves (less gold) and changes in the Japanese foreign exchange funds account.[14] By either measure, Japanese intervention in foreign exchange markets is significant and the Bank of Japan is generally recognized as among the most active of the central bank participants in the foreign exchange markets. During 1982, for instance, Japan lost almost $5 billion in foreign exchange reserves in an attempt to slow the slide of the yen against the dollar. The foreign exchange funds measure suggests that the Bank of Japan sold $8.9 billion (net) foreign exchange during 1982. Furthermore, Japan in the past has gained or lost similar amounts of international reserves in a single quarter in its foreign exchange operations. The sharp drop of the yen following the oil price shock in the fourth quarter of 1979, for instance, was met with strong yen-support operations by the Bank of Japan and a $5 billion decline in official reserves. The foreign exchange funds account indicates that the Japanese sold $6.2 billion in foreign exchange during the quarter.

The Bank of Japan has generally followed a "leaning against the wind" intervention policy, that is, it usually sells yen when it appreciates and buys yen when it depreciates. This is indicated by the figures in the table. Japanese reserves generally fall when the yen is depreciating and rise when it is appreciating, and the Bank of Japan both buys and sells large amounts of foreign exchange over a period of several quarters. Empirical evidence derived from estimating the Bank of Japan's foreign exchange market intervention functions also supports this conclusion. Quirk (1977) estimates that the

Table 2
Official Japanese Foreign Exchange Market Intervention: Reserve Change, Foreign Exchange Funds and Exchange Rate Change

	Gross Change in[1] Official Reserves (less gold) (Billion Dollars)	Foreign Exchange[2] Funds Account (Billion Dollars)	Percent Change in[3] Yen-Dollar Exchange Rate (Yen Depreciation (+))
1974	U.S. $ 1.3	U.S. $−1.3	7.5%
1975	−0.6	−2.1	1.6%
1976	3.8	2.6	0.0%
1977	6.6	6.2	− 9.4%
1978 I	6.3	7.7	− 3.8%
II	−1.9	1.1	− 7.0%
III	1.9	2.9	−12.7%
IV	3.8	3.1	− 1.1%
1979 I	−4.2	−3.9	5.7%
II	−4.1	−4.1	8.0%
III	0.4	0.8	0.5%
IV	−5.0	−6.2	9.0%
1980 I	−1.8	−3.7	2.0%
II	4.1	2.4	− 4.5%
III	1.1	0.9	− 5.4%
IV	1.6	1.2	− 4.2%
1981 I	1.9	1.5	− 2.4%
II	1.0	0.3	7.0%
III	0.2	−1.1	5.4%
IV	0.6	−0.6	− 3.1%
1982 I	−1.1	−1.9	3.9%
II	−1.7	−2.6	4.6%
III	−1.4	−2.5	6.0%
IV	−0.7	−1.9	0.3%

Notes: (1) Source: IMF, *International Financial Statistics*
(2) Bank of Japan, *Economic Statistics Monthly*; converted to dollars with period average yen-dollar exchange rate.
(3) Period average yen-dollar exchange rate.

Bank of Japan bought (sold) U.S. $160 million in foreign currency in the current month in response to a one-percent appreciation (depreciation) of the yen against the dollar during the March 1973–October 1976 period. Argy (1982) calculates a somewhat stronger response (U.S. $210 million) for a given percent change in the effective (trade-weighted) value of the yen over the March 1973–December 1979 period. Policy statements by Japanese central bank officials do not refute these findings.[15]

One implication of the Japanese leaning-against-the-wind intervention policy, however, is that, while it may influence relative government bond supplies in the short-term, it will have little effect over extended periods as intervention on either side of the market is eventually reversed. This suggests that month-to-month and perhaps, quarter-to-quarter, changes in the yen exchange rate may be influenced by Japanese intervention policy through this channel, but that longer-term effects are probably small. This is, of course, the intent of a leaning-against-the-wind policy—to slow, but not to reverse, exchange rate movements in the hopes of reducing exchange volatility, while not hindering longer-term trends.

Table 3 illustrates the development of Japanese general government budget deficits, as a percent of GNP, in comparison to the U.S. and Germany. The rapid growth of these deficits and their large size, both by historical standards in Japan and relative to the U.S., Germany and other major industrial countries, is a fairly recent phenomenon.

Japanese government budget deficits surged in the mid-1970s, as Table 3 demonstrates. The rising fiscal deficits are attributable to both cyclical and structural developments in the pattern of revenues and expenditures. On the revenue side, the 1974–1975 recession in Japan brought on a cyclical shortfall in government revenues, more so than in most industrial countries, because Japan is highly dependent on corporate taxes, and consequently highly variable corporate profits, for its tax revenue. The structural problem on the revenue side is that the Japanese income growth rate, and hence, the growth of tax receipts, has slowed substantially since 1973.

Table 3
International Comparison of General Government Fiscal Balance, 1972–81
(In percent of GNP)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Japan[1]										
Receipts	22.1	24.0	25.1	23.1	24.0	24.7	26.5	27.2	28.7	30.0
Disbursements	21.8	21.9	25.0	26.7	27.5	28.8	30.7	31.7	32.7	33.7
Balance	0.3	2.1	0.1	− 3.6	− 3.5	− 4.1	− 4.1	− 4.4	− 4.0	− 3.7
United States[2]										
Receipts	31.4	31.5	32.2	30.6	31.3	31.6	31.5	31.6	31.8	32.6
Disbursements	31.7	31.0	32.5	34.9	33.5	32.5	31.5	31.1	33.1	33.5
Balance	− 0.3	0.5	− 0.3	− 4.2	− 2.1	− 0.9	–	0.6	− 1.3	− 1.0
Germany[2]										
Receipts	38.7	41.2	41.5	40.8	42.3	43.5	43.3	42.9	42.8	–
Disbursements	39.2	40.0	42.9	46.6	45.9	45.9	46.0	45.8	46.3	–
Balance	− 0.5	1.2	− 1.4	− 5.8	− 3.6	− 2.4	− 2.7	− 2.9	− 3.5	–

[1] Fiscal year.
[2] Calendar year.

Chart 1
Relative Japanese/U.S. Government Debt

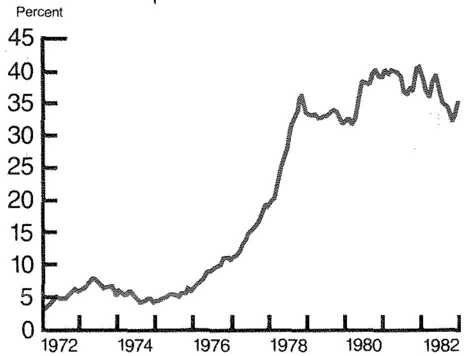


Table 4
International Comparison of Gross Private Savings Less General Government Fiscal Deficit, 1972–80 (percent of GNP)

	1972	1975	1978	1980
Japan	31.7	25.7	24.9	24.9
United States	15.1	12.8	17.3	15.3
Germany	21.0	16.0	18.1	17.3

Notes: Calculated as gross private savings less general budget deficit, as percent of GNP. Japan data is for fiscal year; U.S. and German data cover calendar years.

On the expenditure side, the government sector in Japan has grown rapidly in recent years, led by increases in social security benefits, social assistance grants, and interest on the public debt. These developments have increased the size of general government expenditures from its historically small percentage of GNP to a ratio approximately equal to that of the U.S. in 1981—33 percent.

The net result of these developments is that the government began issuing "deficit finance" bonds in 1975 to cover the shortfall in revenues over *current* expenditures. The amount of deficit-financing bonds issued by the government increased rapidly from 1975 through the remainder of the decade. Total government bond issues as a percent of both general account expenditure and GNP peaked in fiscal 1979-80. These developments have correspondingly spurred the growth of Japanese government bonds held privately. The ratio of outstanding government bonds to GNP increased in Japan from 6% to 36% from the end of fiscal 1974/75 to the end of 1982/83. In less than a decade, Japan moved from having a ratio of (central government) outstanding bonds to GNP that was among the lowest in industrial countries to one that was among the highest. Chart 1 illustrates the growth of Japanese national government debt held in private portfolios in comparison to the U.S. over the last decade.

Another reason the model developed above is particularly relevant for the Japanese case is that it explicitly accounts for the influence of relative financial wealth on the exchange rate. Japanese financial wealth, similar to government debt, has grown at a rapid pace over the last decade, and at a rate much faster than that of other major industrial nations.[16] This phenomenon is due both to the high private savings rate in Japan, which has continued unabated over the decade, and the sharp drop in the growth of Japanese private domestic investment since the 1973 oil-price shock. The combination of the two factors has resulted in a large increase in Japanese financial wealth that has been available to finance domestic government budget deficits (see Table 4) as well as to export capital (through current account surpluses) to the rest of the world over the greater part of the period. One advantage of the present model is that it allows us to identify the separate influences of relative wealth from relative bond supply on the real exchange rate.

While it is true that the rapid growth of financial wealth in Japan has largely "filled in" the financing requirements of government budget deficits, it is nevertheless useful to look at the partial influence of each variable on the exchange rate.[17]

III. Empirical Results

This section presents the empirical results from testing the two-country real exchange rate model given by equation (16) with monthly data for Japan and the U.S., over the 1973-82 period of floating exchange rates. Long-term real interest rates are used as the interest rate variable in the model because expectations of the future real exchange rate, q^e, are based on an equilibrium current account condition that will hold only in the long run.[18]

The real value of the yen/dollar in log form (q) is calculated as the log of the spot yen/dollar exchange rate less the log of the Japanese wholesale price index plus the log of the U.S. wholesale price index. Long-term real interest rates (r_{lt}) are constructed from the nominal interest rate on long-term governmental securities less a two-year centered moving average of the monthly percent change in the consumer price index.[19]. Japanese government bonds held privately (B^j) is measured by total Japanese national government debt, net of Bank of Japan and government agency holdings.

"World" financial wealth (W) is calculated as the sum of U.S. base money, U.S. national government debt privately held, Japanese base money and Japanese national government debt privately held.[20] Japanese financial wealth (W_j) is calculated as the sum of Japanese national government debt privately held, Japanese base money, and the cumulative sum of Japanese current account surplus from March 1973, the beginning of the floating rate period in Japan. B^j/W and W^j/W state total Japanese privately held bonds and financial wealth, respectively, as a percent of total financial wealth.[21]

The current account surprise variable is the cumulative sum of the residuals from the equation regressing the difference in the Japanese and U.S. current account (JCA-USCA) on six of its lagged values and three lagged values of the real exchange rate.

Estimation results are given in Table 5. Column (4) of the table shows the fully specified model given by equation (16), and columns (1)-(3) show the sensitivity of the coefficient estimates to dropping particular variables from the regressions. Turning to column (4), all of the signs of the variable coefficients conform to theoretical predictions, and are significant at the 90% level of confidence or higher with the exception of the current account surprise variable. A one percentage point increase in the Japanese long-term real interest rate is estimated to appreciate the real value of the yen by 0.77 percent, *ceterius paribus*. The U.S. real interest rate estimate is significantly higher than its Japanese counterpart, however, and suggests that a one percentage point increase will depreciate the yen by 1.35 percent.

The estimates for the yield differential determinants, relative Japanese debt (B^j/W) and relative

Table 5
Regression Estimates of the Real Yen/Dollar Exchange Rate
(Monthly, March 1973–December 1982)

Explanatory Variables	(1)	(2)	(3)	(4)
Intercept	5.46	5.66	5.44	5.62
	(145.80)	(130.90)	(164.27)	(110.90)
r^j_{lt}	– 0.08	– 0.79	– 0.09	– 0.77
	(– 0.13)	(– 1.91)	(– 0.15)	(– 1.81)
r^{us}_{lt}	0.99	1.42	0.97	1.35
	– (1.96)	(3.20)	(2.02)	(2.96)
B^j/W		1.14		1.17
		(1.83)		(1.86)
W^j/W		– 1.47		– 1.39
		(– 3.34)		(– 3.19)
ΣCA^s			– 0.004	– 0.003
			(– 1.83)	(– 1.18)
R^2	.86	.86	.87	.86
Rho	.91	.81	.89	.82
OBS	118	118	118	118

Notes: (1) r^j_{lt} (r^{us}_{lt}) is constructed from nominal long-term rates less a twelve month centered moving average of monthly percentage change in the Consumer Price Index. B^j/W is the ratio of Japanese national government securities to "world" private financial wealth, proxied by the sum of Japanese and U.S. private financial wealth. W^j/W is the ratio of Japanese private financial wealth to world private financial wealth. CA^s is the cumulative current account surprise variable. The real yen/dollar rate in log form is constructed as the log of the nominal yen/dollar rate less the log of the Japanese Wholesale Price Index (WPI) plus the log of the U.S. WPI index. See statistical appendix for data sources and complete variable definitions.

(2) All equations are estimated with the Fair technique, with correction for first-order autocorrelation ($\hat{\rho}$) and instruments for r^j and B^j/W. The t-statistics are in parentheses below each coefficient.

wealth (W^j/W), suggest that these factors also exert an important influence on the yen rate. A one percentage point increase in the ratio of Japanese national government debt to total financial wealth depreciates the real value of the yen 1.17 percent. A one percentage point increase in the ratio of Japanese financial wealth to total financial wealth, on the other hand, appreciates the yen 1.39 percent. A one billion dollar unexpected increase in the net Japanese-U.S. current account is estimated to appreciate the yen by 0.3 percent. This coefficient is not statistically significant, however.

The first three columns in the table show the results from regressing the real exchange rate on Japanese and U.S. real interest rates alone (Column 1), real interest rates together with relative debt and relative wealth (Column 2), and real interest rates with the cumulative current account surprise variable (Column 3). All of the coefficient signs in the regressions again conform to theory and, in addition, long-term U.S. interest rates, relative Japanese debt, and relative Japanese wealth are significant at the 90% level of confidence or higher. The long-term Japanese real interest rate, however, only becomes significant when relative debt and relative wealth are included in the regression. The cumulative current account surprise variable, in contrast, is only significant when these variables are excluded.

Overall, the regressions lend some support to the real exchange rate model. Considering the length of the period under investigation, and the great deal of volatility the real yen-dollar rate has experienced, the results may be viewed in a favorable light. Of particular interest for our purposes is that relative debt and relative wealth both enter significantly in the regressions, and that the Japanese real interest rate only becomes significant with the yield differential determinants included. This indicates that the Japanese real interest rate is an important determinant of the real exchange rate, but that its influence can only be measured when the model is fully specified and other factors (relative debt and relative wealth) are held constant.

To get a rough idea of the policy significance of the B^j/W coefficient estimate, consider the size of the coefficient in relation to the total stocks of Japanese government debt and total financial wealth. For December 1982 values, a one percentage point increase in the ratio of Japanese debt to total wealth would entail a U.S. $13.28 billion increase in Japanese government bonds outstanding in private portfolios (assuming financial wealth remains unchanged). This increase causes an estimated 1.1 percent depreciation in the real value of the yen.

A comparison of this figure to the recent Japanese budget deficit was 10,853 billion yen in 1982, or approximately U.S. $43 billion calculated at the period average yen/dollar exchange rate. At given financial wealth and Japanese real interest rates, the floatation of these additional government bonds to finance this revenue shortfall would have caused the real value of the yen to depreciate by an estimated 3½ percent over the course of the year.

Turning to Japanese intervention, the yen was generally weak in comparison to the dollar through most of 1982 and, in response, the Bank of Japan bought yen and sold dollars in the Tokyo foreign exchange market. Assuming that the Bank of Japan sold between $5-$9 billion in foreign exchange over the year, the estimates suggest that this would have appreciated the yen during the year by less than one percent in real terms holding other factors unchanged.

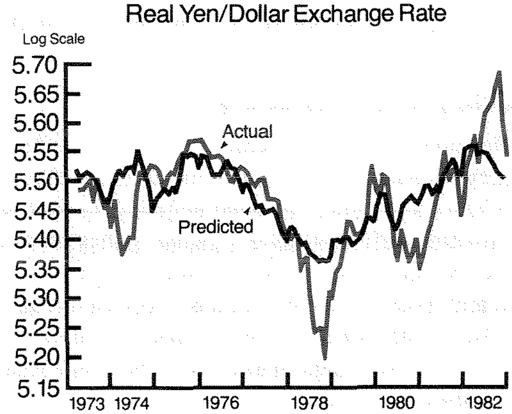
These examples serve to illustrate the large sums involved if Japan wishes to influence the real value of the yen through sterilized intervention operations. The sums are large because existing stocks of government bonds in private portfolios are large, and very large purchases or sales of these assets are involved in bringing about a significant change in their relative supply. The examples also point out that the large financial requirements of the central government have caused new bond issues to dominate the limited domestic bond purchases by the Bank of Japan needed to finance yen-support intervention operations in 1982. More generally, in the Japanese case, it appears that the influence of sterilized intervention on the movements in the yen-dollar real exchange rate since the mid-seventies has probably been small. In addition, sterilized intervention may become even less effective as an independent policy instrument. In the face of large, and rapidly growing, privately held stocks of government bonds, it may take an enormous amount of sterilized intervention to influence the exchange rate.

Some words of caution regarding the interpretation of these results are in order. First, while the model appears to perform well overall by standard goodness-of-fit (R^2) measures, it has only moderate success in tracking some of the more dramatic swings in the real value of the yen. This is illustrated in Chart 2 which shows actual and predicted values of the real yen value (log) from the fourth regression (Column 4) in Table 5.[22]

A second point concerns the coefficient estimates on the real interest rate variables. Both coefficients are substantially less (in absolute value) than theory suggests should be the case for long-term interest rates. In addition, the Japanese real interest rate coefficient is significantly less than that of the U.S., whereas theory predicts coefficient values roughly equal in absolute value. These shortcomings in the empirical estimates are important because interest rates play a central role in our model of exchange rate determination. Both the generally low coefficient values and the asymmetry between Japanese and U.S. variables shed some doubt on the plausibility of the underlying model. On the other hand, the inherent difficulties in measuring expected long-term inflation in both Japan and the U.S. may explain these apparent inconsistencies.

Third, and perhaps most important, the model's estimates only measure the direct or partial influence of relative debt on the exchange rate. To the extent that additional bond issues increase domestic real interest rates, the exchange rate will tend to appreciate in value, and, thereby, offset some of the initial downward pressure on the currency. That is, budget deficits may cause real interest rates to rise and appreciate the domestic currency. This constitutes an indirect channel through which government

Chart 2
Real Yen/Dollar Exchange Rate



bond issues may influence the exchange rate, and it will work against the direct effect channeled through the risk premium.

But, while the link between real interest rates and real exchange rates is well-documented, there is only scant evidence of a predictable link between government bond supplies and real interest rates. In the Japanese case, a recent empirical study by Fukao and Okubo (1982) appears to refute the hypothesized positive link indirectly when it found no evidence of such a link between government bonds outstanding and *nominal* long-term interest rates. One explanation for their finding may be, as the theory presented here suggests, that the foreign exchange market absorbs some of the initial impact resulting from government bond issues in Japan. In the short run, the yen exchange rate is clearly more flexible than Japanese long-term interest rates, a reason being that Japanese long-term interest rates have been subject to fairly rigid government controls until recent years. Because of this rigidity, the exchange rate may be the channel through which relative yields adjust to reach a new equilibrium following a shift in relative government bond supplies. The empirical results do not refute this hypothesis.

Parameter Shift

The Japanese financial system has undergone a process of rapid liberalization in recent years[23] that has included the deregulation of interest rates and relaxation of capital controls. These developments suggest that Japanese and U.S. government securities have probably been viewed by investors as better substitutes during the latter part of the sample period than previously, making the yield differential variable less pronounced and its determinants less important in our exchange rate equation. To investigate this proposition, we include a test to see if the slope parameters on relative debt and relative wealth have significantly changed from the 1973:03-1978:12 period to the 1979:01-1982:12 period. The *a priori* expectation is that both coefficients are significantly less in absolute value in the latter period than in the earlier period.

Test results are given in Table 6. Column (2) presents estimates of the full model with the shift dummy variables and, for purposes of comparison, column (1) restates previous model coefficient estimates. Neither parameter shift is significant at the 90% level of confidence. However, the estimated coefficients for the earlier period do increase substantially in absolute value—from 1.17 to 1.78 for relative debt and from -1.39 to -1.69 for relative wealth—and the estimated coefficients in the latter period approach zero. Both results are consistent with our expectations. The estimated coefficients in the latter period equal -0.48 [1.78 + (-2.26)] for relative debt and -0.32 (-1.69 + 1.37) for relative wealth.

These results suggest that the yield differential variable may have become less important because of the ongoing liberalization of the Japanese financial system. This implies that the relative supply of government securities and relative financial wealth will probably have less of an impact on the yen exchange rate in the future than it had in the past. In practical terms, this means that the *direct* influence of Japanese government budget deficits on the real exchange rate may be less currently than what the model estimates suggest was the case during the greater part of the seventies. It also means, however, that sterilized intervention as a separate policy instrument may be even less effective now than it was during the earlier period.

Table 6
Regression Estimates of the Real Yen/Dollar Exchange Rate with Parameter Shift Dummy between 1973:03–1978:12 and 1979:01–1982:12

Explanatory Variables	(1)	(2)
Intercept	5.62	5.62
	(109.57)	(108.59)
r^j_{lt}	– 0.77	– 0.95
	(– 1.81)	(– 2.01)
r^{us}_{lt}	1.35	1.61
	(2.96)	(3.39)
B^j/W	1.17	1.78
	(1.86)	(1.77)
W^j/W	– 1.39	– 1.69
	(– 3.19)	(– 2.94)
ΣCA^s	– .003	– .003
	(– 1.18)	(– 1.35)
$D^*(B^j/W)$		– 2.26
		(– 1.54)
$D^*(W^j/W)$		1.37
		(1.58)
R^2	.86	.86
Rho	.82	.81
OBS	118	118

Note: See Notes for Table 4. Dummy variable equals zero for 1973:03–1978:12 period and unity for 1979:01–1982:12.

From this viewpoint, a loss in effectiveness of the sterilized intervention policy instrument may have been a necessary cost associated with the increased internationalization of the Japanese financial system. The results are inconclusive, but they do suggest that even the limited effectiveness of this policy instrument may overstate its importance.

West Germany also has generally unregulated capital flows. Consistent with the results presented above, a recent study of the German case by Obstfeld (1982) also found that sterilized intervention has only a small effect on the exchange rate. Through a series of experiments simulating a structural model of German asset markets and prices, he concluded that the German central bank's "...ability to influence the exchange rate without altering monetary conditions is very limited. It is accurate to assert that the sterilized intervention considered above has essentially no effect on the exchange rate." (p. 24). This conclusion for Germany is consistent with the empirical results obtained in the case of Japanese sterilized intervention in this study.

VI. Conclusions and Policy Implications

This paper has analyzed how sterilized foreign exchange market intervention works within a simple model of real exchange rate determination. We demonstrated that this form of intervention changes the relative supply of bonds denominated in domestic and foreign currency. It will only influence the exchange rate when investors view the bonds as imperfect substitutes and relative yields adjust as a consequence.

Because the central bank does not allow base money to change in response to its foreign exchange purchases and sales, sterilized intervention may be of limited usefulness as a separate policy instrument. Nevertheless, the distinction between sterilized and monetary intervention is important because it isolates the direct effects of intervention operations on the exchange market from those of monetary policy operations.

Sterilized intervention has two important limitations in particular. First, while sterilized intervention may influence the relative supply of government bonds at the margin, bond issues floated to finance government budget deficits have played a predominant role in changing relative bond supplies. In theory, the shift in the relative supply of bonds is what influences the exchange rate, not whether the source of the change is due to foreign exchange operations or to finance budget deficits. Sterilized intervention will shift relative bond supplies to a greater extent than bond issues to finance deficits for a given purchase or sale of domestic bonds (because foreign bonds privately held will correspondingly increase or decrease with central bank domestic bond purchases or sales in the intervention case). For a given shift, however, the simple asset model predicts an equal influence on the exchange rate.

Second, is the related point that the central bank's ability to use sterilized intervention as an effective policy instrument will be smaller the larger the outstanding stocks of government liabilities. Quite simply, the rapid growth of government bonds since the mid-seventies has correspondingly increased the amount of sterilized intervention necessary to bring about a given exchange rate change (assuming the elasticity of substitution between foreign and domestic bonds remains unchanged) in Japan. In this sense, the central bank must be willing to commit ever growing resources in pursuit of their exchange rate objectives.

A simple model of real exchange rate determination, applied to Japanese-U.S. data over the 1973-82 floating rate period, provided some interesting results. The empirical results generally support the theoretical model and suggest that the relative supply of government bonds has influenced the yen-dollar real exchange rate. However, the coefficient estimates also suggest that a very substantial amount of sterilized intervention may be necessary to bring about a noticeable exchange rate movement. This result is primarily due to the large existing stocks of Japanese and U.S. government bonds outstanding. Another complication is that the Bank of Japan's intervention operations since the mid-seventies, though sizable by international standards, have been small relative to Japanese government bond issues financing budget deficits. In addition, some tentative evidence indicates that the effectiveness of sterilized intervention in Japan is further limited by the financial market liberalization measures implemented in recent years. These measures have tended to increase the substitutability between Japanese and U.S. bonds, and reduces the effectiveness of sterilized intervention.

It is difficult to draw strong policy conclusions about the overall usefulness of sterilized intervention from these results, however. We have used a very simple model in the analysis, and have identified only one channel through which sterilized intervention may influence the exchange rate. Sterilized intervention may influence the exchange rate through other channels as well. For example, sterilized intervention may have a "demonstration" effect, that is, it may influence expectations about underlying economic conditions or policies. This in turn might directly shift the expected future real exchange rate, q^e, and the current rate. In addition, the results presented here are based on monthly data while central bank intervention objectives may be of a shorter duration. Japanese intervention, even when sterilized, may have a considerable influence on short-term exchange rates (for example, daily) that is not picked up by monthly data.

Nevertheless, these results do support the simple asset market model of exchange rate determination presented here and suggest that the Bank of Japan's sterilized intervention operations have had only a small influence on the yen-dollar real exchange rate. However, it appears likely that sterilized intervention will become an even less potent policy instrument as the Japanese financial system becomes more closely integrated with its western counterparts.

Data Appendix

Data Sources: International Monetary Fund, *International Financial Statistics (IFS)*; Bank of Japan, *Economic Statistics Monthly (EMS)*; U.S. Treasury Department, *Treasury Bulletin*.

q = real yen-dollar exchange rate (log) = $\log(s) - \log(P) + \log(P^*)$;

P = Japanese Wholesale Price Index, (*IFS*, line 63);

P^* = U.S. Wholesale Price Index, (*IFS*, line 63);

r^j_{lt} = Japanese long-term real interest rate; weighted average of 5-10 year bond rates in Japan (Source: FRB Macrodata library); less expected inflation (see text for construction of expected inflation)

r^{us}_{lt} = U.S. long-term real interest rate; 10-year U.S. treasury bonds (Source: FRB macrolibrary); less expected inflation (see text for definition)

B^j = Japanese national government debt held privately; equal to total national government debt less government and Bank of Japan holdings. Converted to billion U.S. dollars with period average exchange rate. Source: *ESM* Table: "National Government Debt."

W = U.S. and Japanese financial wealth proxy; $W = B^j + B^{US} + M^j + M^{US}$

B^{US} = U.S. central government debt held privately; calculated as (1) "Estimated Ownership of Public Debt Securities by private investors—total privately held" (Table OFS-2) less (2) "selected U.S. liabilities to foreigners—total, official institutions" (Table IFS-2) less (3) "nonmarketable U.S. Treasury bonds and notes issued to official institutions and other residents of foreign countries" (Table IFS-3). *Treasury Bulletin*

M^j = Bank of Japan Reserve Money, (*IFS* line 14); (converted to billion U.S. dollars with period average exchange rate).

M^{US} = U.S. Federal Reserve, Reserve Money, (*IFS* line 14);

W^j = Japanese financial wealth; $W^j = M^j + B^j + JCASUM$

JCASUM = cumulative sum of Japanese current account from 1973:03 (billion U.S. dollars) (*ESM*) plus $11.5 billion (U.S. liabilities to Japan, 1973:03, *IFS* line 9a.d.)

ΣCA^s = cumulative current account surprise; cumulative sum of residuals from regressing Japanese current account less U.S. current account on six own lag values and three q lag values (from 1973:03).

FOOTNOTES

1. Central banks generally hold their foreign reserve assets which are used for intervention operations in the form of government interest-bearing securities, primarily U.S. Treasury securities, as the dollar is the predominant intervention currency.

2. Note that MB^d created through open market purchases of government securities does not necessarily equal the total monetary base. Base money may be supplied through central bank loans to commercial banks or through open market operations using commercial bills, for instance.

3. See Dooley and Isard (1979), p. 5, for a discussion of this issue.

4. See Mussa (1979) and J. A. Frankel (1981) for convincing arguments in support of an asset market approach as opposed to the more traditional "flow" models of exchange rate determination.

5. Isard (1980a, 1980b, 1982) derives this model in a similar fashion (in both nominal and real values) and terms his an "accounting identity" approach because it is based on an arbitrage condition and several identities. It is also derived and tested for a weighted average of the dollar's real value by Hooper (1983). Hooper ignores the risk premium in his empirical tests, however.

6. The covered interest rate parity condition, equation (2), generally holds in Japan once transactions costs are taken into account. See Seo (1981).

7. The yield differential is usually called the risk premium in the exchange rate literature. This is because risk adverse speculators must expect some profit if they are to hold an uncovered futures contract (and bear the risk associated with unexpected exchange rate fluctuations) which the interest rate arbitragers have purchased or sold to hedge their portfolios against exchange rate risk.

8. This condition also implicitly sets the condition for goods market equilibrium and has been introduced in this context by Kouri (1976) and Hooper (1983), amongst others. Note also that the sustainable long-run current account is assumed constant in this model.

9. A more complicated function is derived in Hooper and Morton (1982). They attempt to distinguish between transitory and permanent elements in the current account.

10. The asset demand function employed here is a simplification of Frankel's (1982) general approach. Frankel

extends the single foreign demand for domestic securities function developed here into two components: a "focus" foreign country demand function and a third-country investor demand function.

11. The few studies that have embedded exchange risk determinants into empirical exchange rate models have generally employed "abbreviated specifications" (e.g. Hooper and Morton (1982), p. 45) because of data considerations. These attempts have met with limited success in modeling the risk premium, however. Misspecification of the model may be one reason for the generally poor results heretofore. This model derives the determinants of the risk premium along the lines of Dornbusch (1980), Dooley and Isard (1979) and Frankel (1982), and employs this more complete specification in the exchange rate equation estimates. This formulation presents the risk premium as a function of both the relative supply of government bonds demonimated in domestic anf foreign currency and the international distribution of wealth among investors.

12. Another explanation of the adjustment process given changes in relative asset supplies or relative wealth considers the role of private capital flows. An increase in domestic assets at unchanged interest rates, for instance, will increase the proportion of home securities in private portfolios beyond the ratio desired by investors. As investors begin to sell home securities in favor of foreign securities in an attempt to bring portfolios back into balance, the resulting capital outflows from the domestic country puts downward pressure on the exchange rate. Increases in relative domestic wealth, on the other hand, will shift upward the demand for home securities, cause an incipient capital inflow and appreciate the domestic currency. If assets are considered perfect substitutes, i.e., investors do not differentiate between securities donominated in the home and foreign securities, then neither relative asset supplies nor relative wealth should influence the exchange rate through this channel (i.e., through the risk premium or "differential return" channel).

13. This measures Japanese government securities not held by the Bank of Japan or other Japanese government agencies (e.g., Trust Fund Bureau, Industrial Investment Special Account, Postal Life Insurance and Annuity). Of the total government debt held privately in December 1982, 99% was held in long-term instruments (internal bonds—consisting of construction bonds and deficit-finance bonds).

14. Quirk (1977) argues that the foreign exchange funds is the most appropriate proxy for Japanese official intervention because it includes "hidden intervention," i.e., Bank of Japan foreign exchange deposits with its member commercial banks, and excludes certain transactions with the U.S. military in Japan which are included in official reserve figures.

15. See, for instance, "A Japanese View of Exchange Rate Policy" written in 1982 by Shijuro Ogata, Bank of Japan Executive Director, for **Aussenwirtsehalf** of the University of St. Gallen.

16. By the national income accounting identity, it can be shown that the excess of private savings (S) over private domestic investment (I) equals the current account surplus (X-M) plus the government budget deficit (G-T): $S-I=(X-M)+(G-T)$. Beyond running large government budget deficits (measured either by the central or consolidated general government accounts), Japan has run a current account surplus over the greater part of the last decade and has generally been a net exporter of capital to the rest of the world.

17. See Hang-Sheng Cheng, "Crowding-Out: Japanese Experience," Federal Reserve Bank of San Francisco **Weekly Letter**, March 19, 1982, for an engaging discussion of the "crowding out" versus "filling-in" issue in the Japanese context. The common opinion expressed by government publications in Japan is that there is no evidence of government credit demands crowding out private investment thus far, but it is feared that it may become a problem in the future if budget deficits are not reduced. See **Economic Survey of Japan 1979/1980**.

18. The Fair estimation procedure is employed in all regressions. This is a statistical technique designed to provide consistent coefficient estimates of an equation with both autocorrelated error terms and endogenous explanatory variables. Which variables are assumed endogenous is particularly important because the empirical results are sensitive to this choice. Japanese relative bond supplies and Japanese real interest rates are treated as endogenous variables in the short-run. To the extent that Bank of Japan reacts to real exchange rate movements in its intervention operations, Japanese bond supply will be correlated with the error term in the exchange rate equation. Interest rates in Japan, both nominal and real, may also be systematically influenced by real exchange movements and are treated as an endogenous variable in the model estimation. The instruments for both endogenous explanatory variables are formed from the predicted values of a reduced form equation which includes contemporaneous and lagged exogenous variables in the system (r^{us}, W^{i}/W, CA^{s}), the lagged endogenous variables (q, B/W, r^{j}) and a time trend. See Fair (1970).

19. This measure is similar to Hooper (1983) and Shafer and Loopesko (1983).

20. The financial wealth measure has been broadened from that defined in the theoretical section. To private bond holdings have been added (U.S. and Japanese) base money. This adjustment has been made to help distinguish better empirically between domestic bond supply and domestic financial wealth.

21. All Japanese data used in computing B^{j}, W and W^{j} are converted from yen to U.S. dollars at the average month-to-month yen/dollar exchange rate.

22. A related point concerns the structural stability of the exchange rate equation and estimated coefficients to different sample periods, changes in variable definitions, and the choice of estimation technique. Exchange rate models

have generally had poor out of sample forecasting performance in recent years, and have demonstrated significant structural instability. The results here should therefore be interpreted with this important qualification in mind.

23. See Charles Pigott's "Financial Reform in Japan," in Federal Reserve Bank of San Francisco **Economic Review**, Winter 1983, for a comprehensive review of the process of liberalization in Japanese financial markets.

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