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To: Members of the Executive Board
From: The Secretary
Subject: Interest Rate Differentials and the Exchange Rate of the Yen

The attached paper on interest rate differentials and the exchange rate of the yen is circulated for the information of the Executive Directors.

If Executive Directors have technical or factual questions relating to this paper, they should contact Ms. Susan Schadler, ext. (5)7317.

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INTERNATIONAL MONETARY FUND

Interest Rate Differentials and the Exchange Rate of the Yen

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The question of the role of interest rate developments in sustaining the current configuration of exchange rates has been the focus of considerable interest in recent months. In examining developments in the dollar/yen exchange rate during the last several years, a generally strong link is evident between movements in the exchange rate and in interest rate differentials between the United States and Japan. More specifically, the following view of exchange rate determination emerges. Over long periods of time, the exchange rate tends to move to maintain purchasing power parity (PPP) between currencies. In the short to medium term, however, the far more volatile conditions in asset markets, which reflect a variety of influences, including interest rates and exchange rate expectations, tend to dominate exchange rate movements. Actual and expected current account developments also appear to play an important role in determining short- and medium-term exchange rate movements through their effect on exchange rate expectations.

While there is considerable agreement on the effect of asset market conditions, particularly of interest rate differentials on exchange rates, developments during 1982 have led to some questioning of the link. One problem with much of the discussion on the relationship between interest rates and exchange rates has been a tendency to base arguments on simple two-variable correlations rather than on analyses which incorporate the effects of a number of influences. Once the effects of other variables on exchange rates is accounted for, the relationship between interest rates and the exchange rate seems quite robust.

1. Exchange rates in the long run

Chart 1, which shows bilateral and effective exchange rates adjusted for relative prices and costs between Japan and trading partners, suggests that over very long periods, exchange rates of the yen have tended to adjust to maintain PPP. Nevertheless, while there is no indication of a pronounced secular movement away from PPP, deviations from the mean of relative prices have been as large as 40 per cent. These short- to medium-term deviations from PPP appear to reflect changes in factors affecting trade in assets rather than in factors affecting trade in goods.

2. Asset markets and the exchange rate

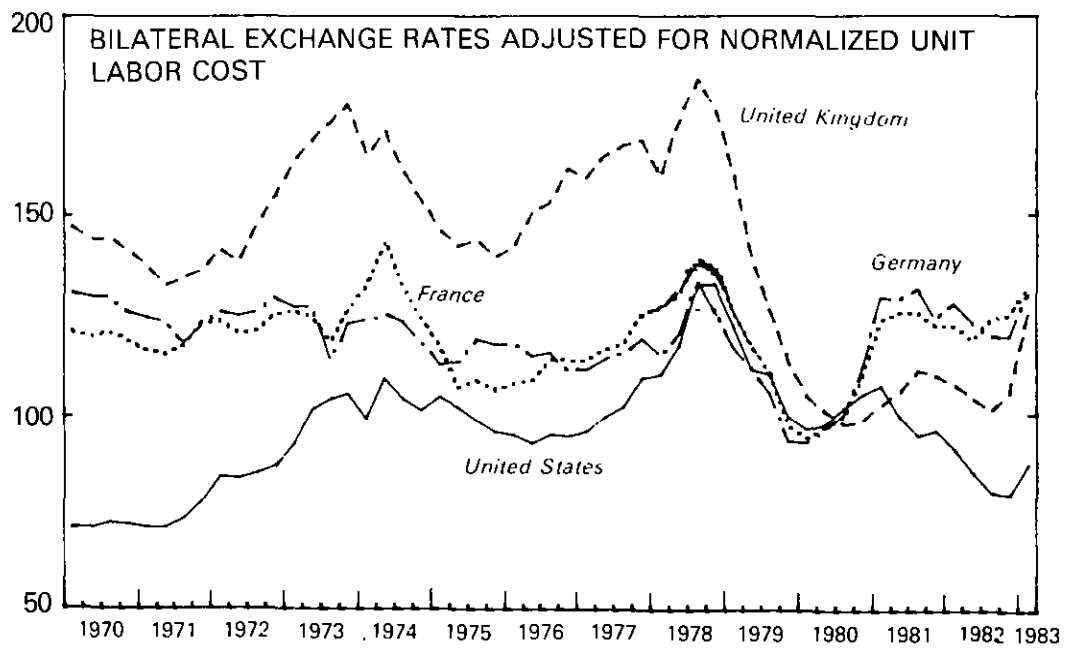
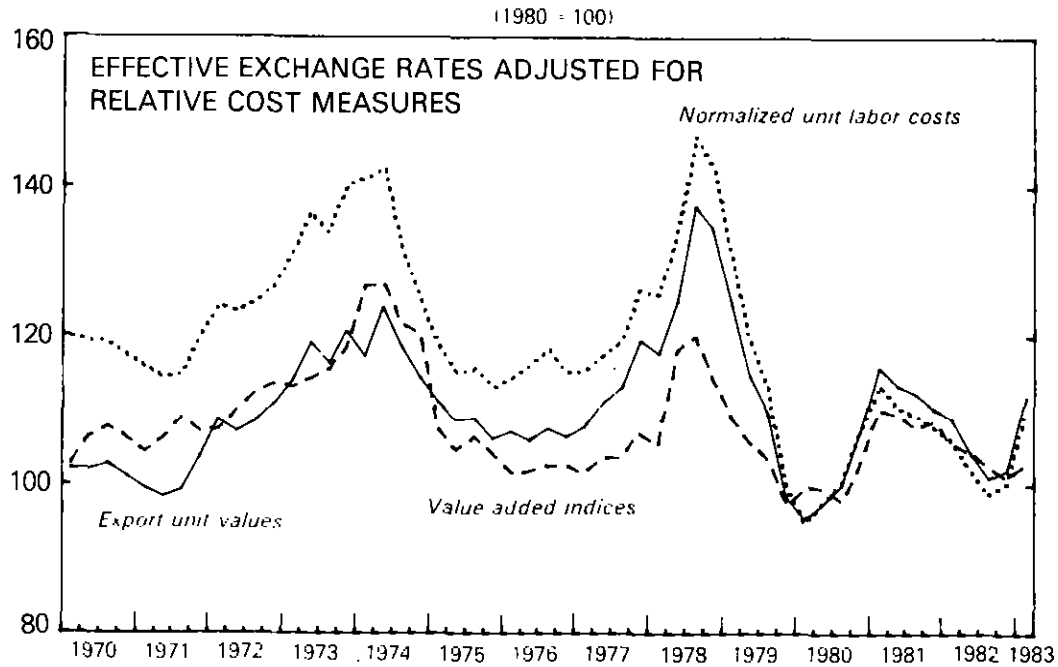
The central role of asset markets in exchange rate determination arises both because an exchange rate can be viewed as the relative price of two assets and because capital flows are capable of responding much more rapidly than flows of goods to perceived changes in conditions. The primary factors in asset markets that affect actual or potential capital flows are changes in actual and expected relative rates of return arising from, among other factors, changes in actual or expected interest rate differentials, in expected movements of the exchange rate, and in the relative riskiness of holding various assets.

a. Interest rate differentials

To the extent that exchange rates are expected to move in line with inflation rate differentials, relative real interest rates, rather than nominal interest rates, provide the best measure of relative rates of return. In fact, nominal interest rate differentials may give a misleading indication of relative rates of return since, like expected exchange rate changes, they are often related to expected rates of inflation. For example, an increase in the nominal interest rate differential in favor of, say, the United States, may reflect an increase in expected U.S. inflation and a corresponding expected depreciation of the dollar. In such a situation, the higher nominal U.S. interest rate would not represent an enhancement of the attractiveness of holding dollar assets relative to assets denominated in another currency. Alternatively, an increase in the nominal interest differential in favor of the United States could occur with no increase in inflationary expectations. There would then be no change in the expected equilibrium exchange rate and, indeed, with a higher expected return on dollar assets, the immediate impact would be to strengthen the dollar. By examining the response of the real exchange rate to the real interest rate differential, the ambiguity between these two cases is avoided. In the first case, one would expect no change in either the real interest rate differential or the real exchange rate. In the second case, the real interest rate differential in favor of the United States would increase, and the real value of the dollar would appreciate.

It is difficult to choose the asset maturity for which interest rates should be compared to exchange rate developments since, strictly speaking, interest rates on the whole maturity spectrum of assets should affect exchange rate behavior. Relating exchange rate movements to changes in interest differentials on two different maturities of assets may give quite different results when the term structure of interest rates in either country is not stable. Generally, however, a given change in long-term interest rate differentials should evoke a larger change in exchange rates than the same change in the short-term differential. This results from the fact that an interest rate provides an indication of expectations about interest rate developments during its asset maturity period. An equal change in the long-term and short-term interest rate differentials, therefore, indicates expectations that the new level of the differential

CHART 1
MEASURES OF THE REAL EXCHANGE RATE, 1970-83¹



¹Rising indices imply falling competitiveness



will persist beyond the short-term asset maturity. For given expectations about the future level of the exchange rate, the longer any given change in the interest rate differential between two countries is expected to last, the larger the immediate change in the exchange rate. This occurs because the immediate exchange rate change must be just large enough to make room for an expected change in the exchange rate during the holding period which will offset the interest rate differential and equilibrate relative rates of return over the entire period. Thus, to the extent that a change in the long-term interest rate differential reflects expectations that the differential will persist beyond a shorter term asset maturity period, it should have a larger effect on exchange rate movements. Nevertheless, most empirical analyses relate short-term real interest rate differentials to exchange rate behavior. This is because comparable short-term interest rates for a variety of countries are relatively easy to identify and the use of proxies for expected inflation rates for short periods in the future is generally more plausible.

Chart 2 shows real short-term interest rates for the United States and Japan, the real short-term interest rate differential, and the real dollar/yen exchange rate. The relationship between the real exchange rate and the real interest rate differential must be examined with two caveats in mind. First, the chart shows only one dimension of the relationship--that between current interest rates and the exchange rate. Since expectations of future interest rate developments are probably even more volatile than actual interest rates, an important element explaining exchange rate variability is missing from the chart. Second, as mentioned above, myriad other factors at times overwhelm and obscure the influence of interest rates on the exchange rate. Nevertheless, with the exception of periods when other factors obviously dominated exchange rate behavior, there is a reasonably clear, positive relationship between the two. For presentational purposes, it is useful to divide the chart into subperiods for closer examination.

(i) From early 1977 through mid-1978 (subperiod I), the real exchange rate and the real interest differential were positively related--the interest differential moved in favor of Japan by 3.8 percentage points and the yen appreciated by 27 per cent. ^{1/}

(ii) This relationship dissolved almost completely during the latter half of 1978 and the first half of 1979 (subperiod II) when the real value of the yen appreciated to a peak in late 1978 before depreciating sharply, while the interest differential moved slightly more in favor of Japan. In Chart 3, it will be seen that the large current account

^{1/} A highly simplified equation quantifying the relationship between the real short-term interest rate differential and the real exchange rate between the yen and the U.S. dollar, which incorporates the influence of other factors, is presented in an appendix. This equation indicates that a 1 percentage point increase in the interest differential (Japan-United States) gives rise, on average, to a 1.9 percentage appreciation of the yen.

imbalances of both Japan and the United States were reversed quite suddenly during this period--a factor which probably altered exchange rate expectations and therefore dominated the interest rate/exchange rate relationship.

(iii) Between the third quarter of 1979 and mid-1980 (subperiod III) a positive relationship re-emerged. Between August 1979 and March 1980 the real interest differential edged downward by 1.3 percentage points, while the yen depreciated by 15 per cent in real terms. In the period from March-June 1980, a 4.5 percentage point increase in the real interest differential is indicated to have been a major factor behind the dramatic 13 per cent rebound in the real value of the yen.

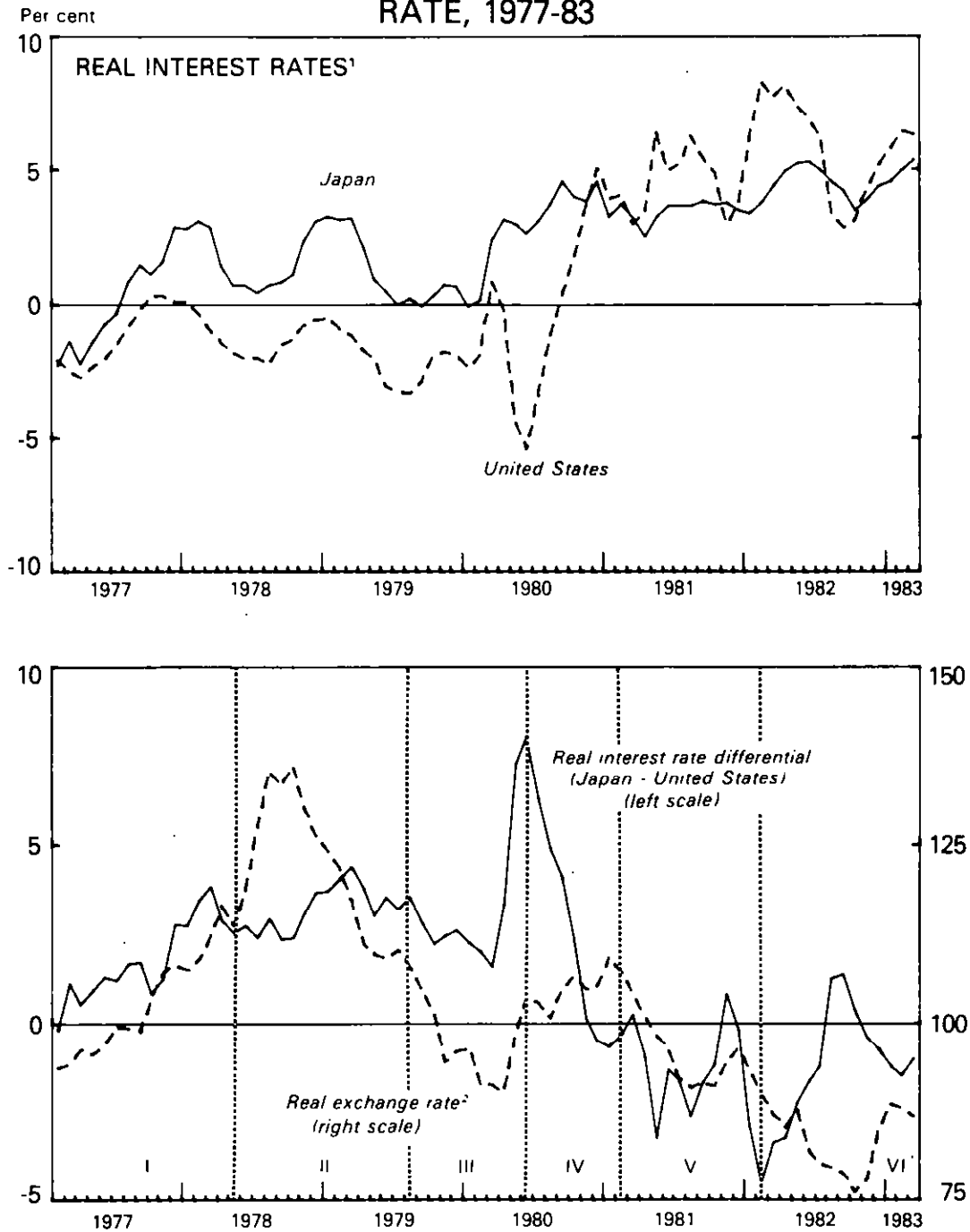
(iv) During the latter half of 1980 (subperiod IV), real interest rates in the United States increased sharply in relation to those in Japan, yet the yen appreciated strongly. This negative relationship appears to have been related at least to some extent to a sharp improvement in economic fundamentals in Japan--the relatively favorable wage settlement for major corporations in April 1980, the sharp turnaround in Japan's current account deficit in the second quarter of the year, and the emerging evidence that Japan had more successfully dealt with the inflationary impact of the oil price increase than other major industrial countries.

(v) During 1981 and the first two months of 1982 (subperiod V), a positive relationship again became apparent. Considerable variability of the real interest rate differential between January and August 1981 coincided with a 17 per cent depreciation of the real value of the yen. Then, between August and November, a 2.7 percentage point increase in the interest differential was accompanied by a 4 per cent appreciation of the yen. The reversal of the interest differential in December, associated with a further sharp rise in interest rates in the United States, closely coincided with the renewed weakness of the yen.

(vi) Developments since February 1982 (subperiod VI) are often cited as evidence that the relationship between the exchange rate and interest rate differentials is tenuous at best. Between February and September, the differential moved in favor of Japan by 6.5 percentage points, while the yen, interrupted only by a brief show of strength in May, depreciated by more than 12 per cent in real terms. During the last two months of the year, the interest differential again moved in favor of the United States by 1.7 percentage points, while the yen staged a dramatic recovery against the dollar, appreciating by almost 12 per cent.

The apparent suspension of the conventional link between the interest differential and the exchange rate during this period, however, may, for a number of reasons, more accurately be interpreted as an example of the ability of other factors to overpower that link. First, during the first half of the year, it became evident that the widely expected strengthening of Japan's current account during 1982 would not materialize owing to an unanticipated weakening of export growth. Second, during the middle of the year, there appears to have been a marked deterioration in public perceptions of the strength of the emerging recovery in Japan and of the

CHART 2
**REAL INTEREST RATES AND THE REAL EXCHANGE
 RATE, 1977-83**



¹ The real interest rate at time t is calculated as the nominal interest rate at time t less the annualized percentage change between t and $t+6$ in a 6-month centered moving average of the consumer price index. The nominal interest rate used for Japan is the 3 month Gensai rate and that for the United States is the 3 month Treasury bill rate.

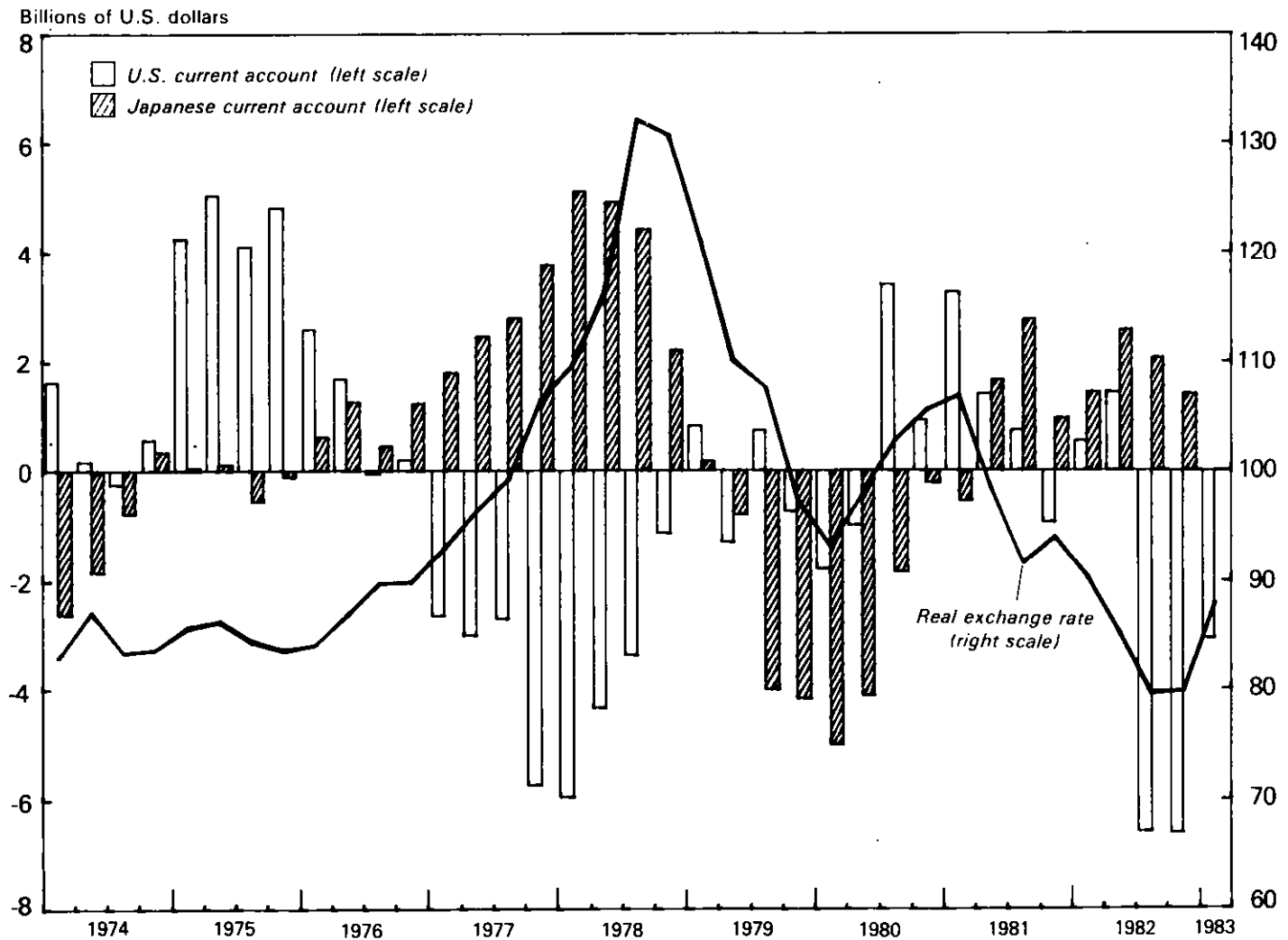
² The real exchange rate is an index of the nominal exchange rate (US\$ yen) multiplied by the ratio of the consumer price index in Japan to that in the United States. The average value in 1980 equals 1.

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CHART 3
CURRENT ACCOUNTS OF JAPAN AND THE UNITED STATES
AND THE REAL EXCHANGE RATE, 1974-83



ability of the authorities to reverse the growing fiscal imbalance. A substantial shortfall in the outcome of budgetary revenues for FY 1981 (March-to-March) was announced in May, while the previous acceleration of private consumption expenditures was reversed during the third quarter of the year. These factors may have created some uncertainty among market participants as to the future course of economic policies in general, and interest rates and financial market conditions in particular. It also seems likely that this uncertainty was aggravated both by the highly publicized official statements made in mid-September that the country was suffering from a "financial crisis" in connection with the fiscal situation and by events surrounding the change in leadership of the country during October and November. The fact that, throughout the year until November, the yen weakened not only against the dollar, but also against virtually all major currencies, suggests that uncertainty owing to these developments had a depressing effect on expectations of the yen's future value which dominated the effect of the movement of interest differentials in favor of Japan. Finally, during much of 1982, other major currencies were also considerably weaker against the dollar than developments in interest rate differentials would have indicated. The generality of this weakness suggests that some change in the attractiveness of dollar assets may have occurred during this period as a result, for example, of the decline in inflationary expectations in the United States and of a change in the perception of the relative safety of U.S. assets in the face of uncertainties in international financial markets.

b. Exchange rate expectations

While neither exchange rate expectations nor the market's views on prospective developments in variables affecting such expectations are observable, it is commonly believed that expectations about future exchange rates are continuously subject to revision on the basis of "news" concerning virtually every facet of the economy. This process of continuous revision makes exchange rate expectations and, in turn, actual exchange rates more volatile than the actual behavior of many of the variables that affect them. As discussed above, these movements often obscure, but should not be misinterpreted as removing, the more easily observable relationship between interest rate differentials and the exchange rate.

The previous section mentioned a variety of factors that affect exchange rate expectations, many of which are political in nature and extremely difficult to identify with confidence. Among the more obvious factors for which proxies, at least, can be observed are expected inflation differentials, as captured in calculations of real interest rate differentials, and current account developments which indicate the need for exchange rate adjustments to alter competitiveness in order to return

to external balance. ^{1/} Chart 3 shows the U.S. current account, the Japanese current account, and the real exchange rate. Between 1974 and early 1981, a strong positive relationship existed between the Japanese current account and the real value of the yen vis-a-vis the dollar. A factor contributing to the strength of this relationship was the generally negative correlation between the Japanese and U.S. current accounts which helped provide unambiguous signals on needed changes in competitiveness. Since early 1981, however, the relationship between the Japanese current account and the value of the yen has weakened considerably. During the second and third quarters of 1981, the sharp increase in the Japanese current account surplus and some weakening of the U.S. current account coincided with a depreciation of the yen. Since then, though the Japanese current account has generally remained in surplus and shown no trend, the real value of the yen has generally declined. Nevertheless, the sharp deterioration in the U.S. current account in the third quarter of 1982 preceded by only several months the rebound in the value of the yen.

Three factors may be responsible for some apparent weakening of the current account/exchange rate link. First, since late 1980, U.S. and Japanese current account developments have shown far more similarity than during the 1970s, and, therefore, jointly have indicated less of a need for changes in competitiveness. Second, as pointed out above, the actual current account surplus for Japan in 1982 was substantially lower than original forecasts. Despite its relative strength, the current account outcome probably, therefore, had a depressing effect on the exchange rate. Finally, the threat that current account imbalances may be corrected through the intensification of protectionist measures against Japanese goods rather than through exchange rate adjustments as in the past, may be eroding the influence of current account developments on expectations about exchange rates.

To summarize, movements of the yen/dollar exchange rate appear to be linked to changes in the real interest rate differential between the United States and Japan. However, because of the important influence of highly volatile expectations on exchange rate movements, there have been lengthy periods during which the link between the exchange rate and interest rate differentials has been obscured. In particular, current account developments, which have indicated the need for substantial changes in competitiveness, appear at times to have led to large changes in exchange rate expectations, the effects of which have dominated the interest differential/exchange rate relationship. The sustained depreciation

^{1/} The link between the current account and exchange rate expectations is based on the premise that unexpected changes in the current account alter the market's view of the level of the real exchange rate that would be compatible with a sustainable current account. On a highly simplified level, it is assumed that expectations about the current account are based on the present level of the current account, so that actual changes in the current account affect changes in the exchange rate or, alternatively, the level of the current account affects the level of the exchange rate.

of the yen during much of 1982, despite a substantial movement of the interest differential in favor of Japan, may also have been the result of a series of changes in public perceptions about the strength of the Japanese economy and related uncertainty about the future course of the economic policies and financial market conditions.

A Simple Attempt at Quantification

While explanatory equations for exchange rates are notoriously poor at explaining short-run variations and subject to all the caveats mentioned above concerning the difficulty of measuring expectations, they are useful in indicating the relative importance of various factors affecting exchange rates. The equation reported in this appendix is not an attempt to produce an exhaustive description of the determinants of the dollar/yen exchange rate, but rather an attempt to relate the real dollar/yen exchange rate (S) to the major quantifiable explanatory variables described in the preceding pages--the real short-term interest differential between Japan and the United States ($RJ-RUS$), lagged unexpected developments in the Japanese and U.S. current account balances (DCA), and last period's value of the real exchange rate (S_{t-1}).

More concretely, the specification of the equation is based on the interest parity condition.

$$(1) \quad x_t - x_t^e = i_j - i_{us}$$

where x is the nominal dollar/yen exchange rate, i indicates a nominal interest rate and superscript e indicates expected levels of the attached variable. Lower case letters indicate logarithms of variables except for nominal interest rates. Tautologically,

$$(2) \quad x^e = p_{us}^e - p_j^e + s^e$$

$$(3) \quad s^e = p_j^e - p_{us}^e + x^e$$

where p is the price level of the indicated country and s is the real dollar/yen exchange rate. Expectations of future relative prices and the future real exchange rate are assumed to be determined as follows:

$$(4) \quad p_{us}^e - p_j^e = p_{(us)t} + e_{us} - p_{(j)t} - e_j$$

$$(5) \quad s_t^e - s_{t-1}^e = (s_t^* - s_{t-1}^e)$$

$$(6) \quad s_t^* = a (DCAS)_{t-1}$$

where indicates the rate of change of prices and $DCAS$ is unexpected changes in the difference between the current account in Japan and that in the United States, which are assumed to indicate changes in the equilibrium exchange rate, s^* . Combining (1) - (6) gives the estimation equation:

$$\begin{aligned} \ln(s)_t = & (i_j - e_j) - (i_{us} - e_{us}) + a (DCAS)_{t-1} \\ & - (1 -) [(i_j - e_j)_{t-1} - (i_{us} - e_{us})_{t-1}] \\ & + (1 -) \ln(s)_{t-1} \end{aligned}$$

The equation is estimated with data from the first quarter of 1978 to the first quarter of 1983. 1/

$$\ln(S) = -0.582 + 0.019 (RJ-RUS) + 0.017 DCA (-1) - 0.844 (RJ-RUS)_{t-1} \\ (1.15) \quad (3.53) \quad (2.98) \quad (7.97) \\ + 0.844 \ln(S(-1)) \\ (7.97)$$

$$\overline{R}^2 = .8462 \quad H = 1.452 \quad SEE = 0.056$$

The results of the equation suggest the following conclusions:

1. There is a positive and empirically significant relationship between the real short-term interest rate differential and the exchange rate. A 1 percentage point increase in real interest rates in Japan relative to those in the United States leads, on average, to a 1.9 per cent appreciation of the yen vis-a-vis the U.S. dollar. 2/

1/ The real exchange rate and the real interest differential are defined in footnotes 1 and 2 of Chart 2. The variable DCA represents cumulated unexpected changes in the difference between the current account balances of Japan and the United States. A slightly more sophisticated measure of these unexpected changes than used in Chart 3 is calculated for the equation. Specifically, the expected difference between the current account balance in Japan and in the United States is estimated by regressing the actual difference on its lagged values and on lagged values of the real exchange rate. The variable DCA is the cumulated divergence of the actual from the expected difference between the Japanese and U.S. current account balances. That is:

$$DCA = (DCAS) \\ \text{where } DCAS = DCA^e - DCAB \\ \text{and } DCA^e = \text{expected divergence between the current account} \\ \text{balances of Japan and the United States} \\ DCAB = \text{actual divergence between the current account} \\ \text{balances of Japan and the United States.}$$

The variable is lagged because it is assumed that market participants receive current account data with a one-period lag. Numbers in parentheses below coefficients are t-statistics. H is Durbin's statistic to test for first order serial correlation in the presence of lagged dependent variables. It indicates that the hypothesis that there is no first order autocorrelation cannot be rejected at a high level of confidence. In an effort to avoid multicollinearity, the coefficient on the lagged real interest rate differential was constrained to be equivalent to that on the lagged real exchange rate as indicated in the theoretical specification.

2/ The magnitude of this effect is consistent with results obtained in a similar equation of the real effective value of the dollar as reported in SM/83/152.

2. The current account variable also bears a positive and empirically significant relationship to the value of the yen. An unexpected 1 billion dollar increase in the difference between the current account surplus in Japan and the United States leads on average to a 1.7 per cent appreciation of the yen.

3. The coefficient on the lagged exchange rate (0.844) is quite robust statistically. This is consistent with many other equations explaining exchange rates between major currencies and the dollar and may be interpreted as indicating the importance of past values of the exchange rate in expectations of future exchange rates.

4. Although the relationship of the exchange rate to both the interest rate differential and current account developments is statistically robust, the behavior of these two explanatory variables alone cannot fully explain the recent weakness of the yen. For example, during the period of very rapid depreciation of the yen, between the first quarter of 1981 and the second quarter of 1982, movements in the real interest differential and in current account developments account for only about 10 per cent of the approximately 22.5 per cent depreciation of the real exchange rate. Clearly, therefore, there are other variables of importance that have affected the exchange rate during the recent period.