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Exchange Rate Fluctuations, Balance of Payments Imbalances and Internationalization of Financial Markets

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This paper tries to explain large exchange rate swings and persistent balance of payments imbalances among major countries in the 1980s. With a simple two-country model, we illustrate that the behavior of the real exchange rate and the current account depends importantly on the degree of internationalization of financial markets. As internationalization progresses, an expansionary fiscal policy in one country induces a larger appreciation of its currency and a larger and more persistent current account imbalance. In order to test our theory, we estimated regression equations of yen-dollar and DM-dollar exchange rates using a Kalman filter method, taking account of the structural shifts in the foreign exchange market due to internationalization.

I. Introduction

Large exchange rate fluctuations and persistent balance of payments imbalances among major industrial countries have become serious problems in the world economy in the 1980s. With respect to balance of payments imbalances, the divergent fiscal policy of the United States, Japan and West Germany has often been pointed out as the most important factor (see Branson 1985, Ueda 1985, and Turner 1986), and which can be summarized as follows.

The large budget deficits of the United States, which emerged in the first half of the 1980s, pushed up real interest rates and attracted capital from abroad. This incipient capital inflow to the United States induced the appreciation of the dollar against the yen and the DM. The consequent overvaluation of the dollar weakened the competitiveness of U.S. industry and generated current account deficits. While the United States was running large budget deficits, Japan and Germany were cutting their budget deficits.

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Because of this, their real interest rates were relatively low and the yen and the DM remained weak. The weak exchange rates of Japan and Germany, in turn, helped to expand their current account surpluses.

This is a fairly persuasive story and it appears that it has become the standard explanation given by macroeconomists for external imbalances among the major countries. However, the size and the persistence of imbalances must depend not only on divergent fiscal policy but also on the condition of international financial markets. This is because current account imbalances cannot persist without corresponding capital movements. The relaxation of foreign exchange controls, the declining cost of financial transactions due to technological progress in the field of telecommunications and improved know-how with respect to international portfolio management have enhanced international capital mobility. Therefore, in recent years, we have had to pay due attention to the internationalization of financial markets in order to analyze the behavior of exchange rates, real interest rates, and balance of payments.

Section II of this paper examines the behavior of real exchange rates, real interest rates, and the balance of payments under the floating exchange rate regime since 1973. It shows that the effects of real interest rate differentials on the yen-dollar and DM-dollar real exchange rates have become stronger, while effects of balance of payments disequilibria have weakened.

Section III presents a simple two-country model to analyze the international transmission of fiscal policy. The model shows that an increase in the U.S. budget deficit tends to raise U.S. real interest rates and the real exchange rate of the dollar against the yen. This fiscal shock also raises the real interest rate of Japan by increasing Japanese exports and worsens the U.S. current account.

In Section IV, the model shows that the behavior of these macroeconomic variables depends importantly on the degree of internationalization of financial markets. In particular, the internationalization of financial markets changes the relative importance of exchange rate determinants. In other words, the section theoretically shows that the larger international financial markets become, the smaller the required risk premium to finance balance of payments disequilibria by international investors becomes. Because of this, the impact of the balance of payments disequilibria on exchange rates decreases. The model also shows that the effects of the real interest rate differential on exchange rates increases. Consequently, as the internationalization of financial markets progresses, an expansionary fiscal policy in one of the two countries induces:

(1) a larger appreciation of its currency,
(2) a stronger convergence of real interest rates between the two countries, and
(3) a larger and more persistent current account imbalance between the two countries.

On the other hand, the increased integration of goods markets through international trade tends to reduce exchange rate fluctuations occasioned by changes in fiscal policy.

Accordingly, when international financial markets expand at a more rapid pace than international trade increases, changes in fiscal policy are likely to cause larger fluctuations in exchange rates.

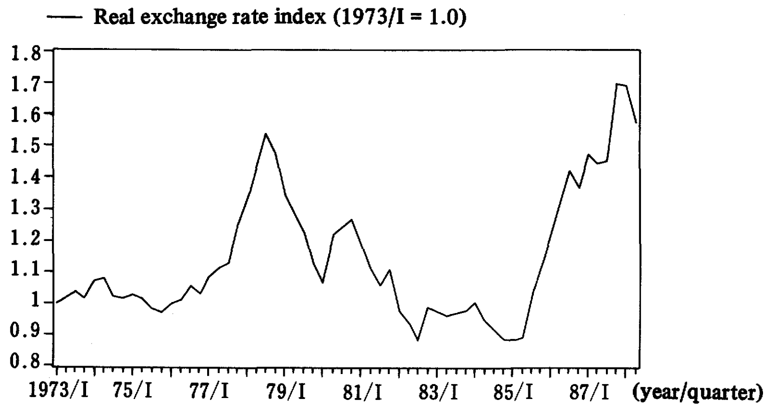
Based on the above theory, Section V empirically analyzes actual movements in the real yen-dollar and DM-dollar exchange rates under the floating exchange regime since 1973. Regression equations are estimated to explain the movements of real exchange rates with real interest rate differentials and accumulated current account balances. In order to measure changes in the relative importance of real exchange rate determinants over time, an estimation procedure which allows changes in parameter values in the estimation period (Kalman filter method) was used. This method differs from ordinary regression equation estimation methods in which parameter values are assumed fixed during the estimation period. The results of the estimation were consistent with the above theory: showing that the importance of the real interest rate differential has increased while that of the accumulated current balance has declined.

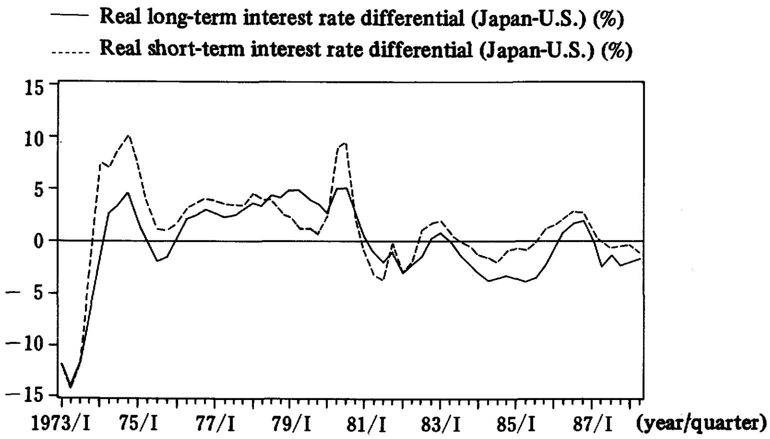
Finally, Section VI discusses policy implications of the findings of this paper. Since large changes in fiscal policy tend to generate serious exchange-rate misalignment and current account imbalances under the current international financial environment of high capital mobility, each government is required to manage its fiscal policy with due consideration to the international spillover effects. When a major country like the United States increases its budget deficit, thereby creating current account deficits, such deficits can easily be financed by the inflow of private capital attracted by a high real interest rate for a while. However, the downward pressure on its exchange rate due to a balance of payment deficit is merely postponed. Therefore, higher capital mobility does not solve balance-of-payment problems. If corrective policy action is also postponed, the imbalance becomes larger and more difficult to rectify. Eventually, market forces will significantly change exchange rates and interest rates, thereby forcing each country to rectify imbalances. Although the balance-of-payment imbalances of major countries can nowadays be financed by private capital movements nowadays, it is necessary to avoid excessive balance of payments imbalances in order to attain stable exchange rates.

II. Yen-Dollar and DM-Dollar Exchange Rate Movements Since 1973

Exchange rates among the yen, the dollar, and the DM have shown large swings since the floating rate regime began in 1973. Real yen-dollar and DM-dollar exchange rate indices and their presumed determinants are shown in Figures 1 and 2. Real exchange rates are calculated by using GNP/GDP deflators. Real interest rate differentials are estimated by using ex post GNP/GDP inflation rates and indicate relative yields on financial instruments denominated in the yen, the DM, and the dollar as measured in own currency terms. The accumulated current balance indicates portfolio pressures generated by cumulative balance of payments imbalances since 1973. Taking account of

Figure 1. Yen-Dollar Real Exchange Rate and Its Presumed Determinants





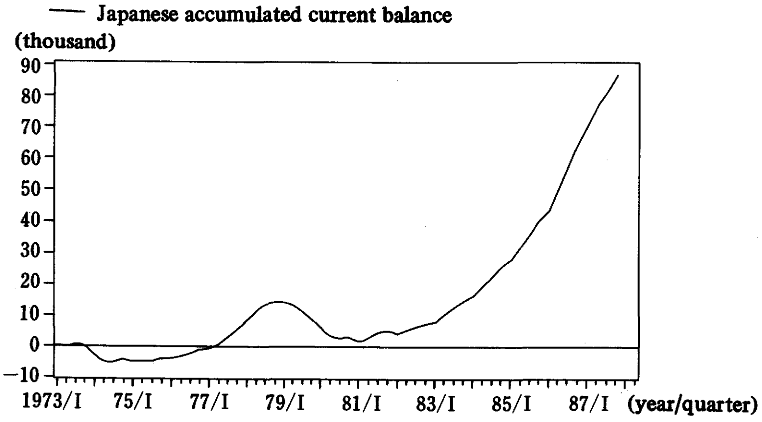
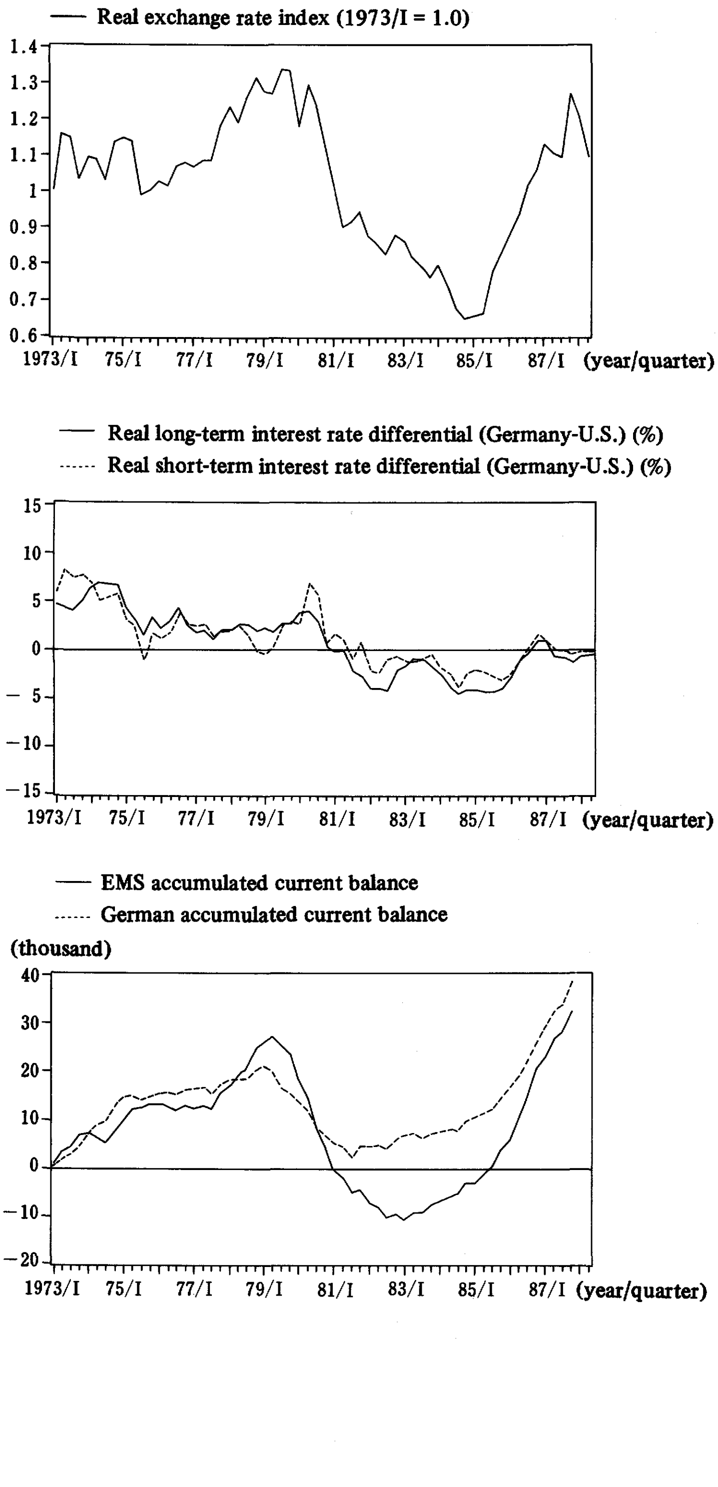


Figure 2. DM-Dollar Real Exchange Rate and Its Presumed Determinants



Notes to Figures 1 and 2

1. Real exchange rate: End of the quarter nominal yen-dollar and DM-dollar exchange rates were adjusted by the GNP/GDP deflators of the United States, Japan and Germany.
2. Real interest rate differential: Nominal interest rates were first adjusted by the ex-post one-year inflation rate of the respective country and then the real interest rate differentials between Japan/Germany and the U.S. were derived.

   ⟨Short-term rates⟩ United States: 3-month Treasury bills; Japan: 3-month gensaki rate; Germany: 3-month interbank rate.

   ⟨Long-term rates⟩ United States: 10-month Treasury securities; Japan: 10-year government bonds; Germany: public sector bonds.

   ex post inflation rate = $100 \times [(P_{t+4}/P_t) - 1]$

   P_t = GNP/GDP deflator at quarter t.

   OECD forecasts are used for the recent period.
3. Accumulated current balance: Current balances were accumulated from 1973/I and divided by the nominal GNP index of the United States, Japan, Germany and the United Kindgom. In calculating the nominal GNP index, we used the following variable weight formula in order to avoid the effects of exchange rate movements.

$$W_i(t) = E_i(t) \times Y_i(t)/[\Sigma_i E_i(t) \times Y_i(t)]$$

$$I(t)/I(t-1) = \Sigma_i W_i(t) \times [Y_i(t)/Y_i(t-1)]$$

where

$I(t)$ = nominal GNP index at time t

$W_i(t)$ = weight of i^{th} country's GNP/GDP at time t

$Y_i(t)$ = nominal GNP/GDP of i^{th} country at time t

$E_i(t)$ = nominal exchange rate of i^{th} currency to the dollar at time t (the price of i^{th} currency in terms of the dollar)

From the second equation, we can get the growth rate of the nominal GNP index. By multiplying this growth rate,we can get the level of the index.

the declining importance of the dollar (in nominal terms) as the world economy has grown, these accumulated balances are divided by a nominal GNP index of the major four countries (the United States, Japan, Germany and the United Kingdom). In the case of the DM-dollar exchange rate the accumulated balance of major EMS countries (West Germany, France, Italy, The Netherlands and Belgium) are shown in addition to the German balance. This is because real exchange rates among EMS countries have been fairly steady compared with yen-dollar or DM-dollar real exchange rates and, consequently, it is possible to regard this region as a DM currency area.

Until the early 1980s, accumulated current balances were reasonably well correlated with the real exchange rates of Japan and Germany. The timing of the sharp appreciation of the yen in 1978 and the depreciation the next year correspond to the swing of the accumulated current balance. The high DM period of 1978 to 1980 also coincides with the peak of the EMS balance, with the EMS balance being more closely correlated with the DM-dollar real exchange rate than the German current balance. These observations are consistent with the fact that the internationalization of financial markets was less important in the 1970s.

However, these correlations of exchange rates and accumulated balances changed after 1981: while Japan has rapidly accumulated current account surpluses since, the real value of the yen did not increase before mid-1985; and the DM depreciated further while the accumulated current balance remained relatively stable. A different relationship seemed to emerge in the first half of the 1980s: real long-term interest rate differentials were closely correlated with real exchange rates, with real short-term interest rates being less closely correlated. Finally, with respect to the most recent period since 1985, the sharp appreciation of the yen and the DM corresponds to the swing in real long-term interest rate differentials and continued current balance surpluses.

This seems to indicate that there has been a shift in the relative importance of the balance-of-payments factor and the real interest factor as determinants of real exchange rates. In the earlier period, the balance-of-payment factor was dominant, while in the more recent period the real interest rate differential has become more important.

A possible cause of this structural change in the determinants of exchange rates is the increasing internationalization of financial markets. Especially after the advent of the current floating rate regime, the United States, West Germany, Japan, the United Kingdom and some other major countries significantly liberalized exchange controls on international capital movements partly due to the fact that their monetary authorities no longer had to defend the par value of their respective currency. In 1974, the United States abolished the Interest Equalization Tax which was introduced in 1963 to defend the dollar. In the same year, West Germany also abolished its Bardepot system which required that a percentage of German residents' foreign borrowings be deposited in cash with the Bundesbank in a non-interest bearing account.[1] The United Kingdom abolished all exchange controls in late 1979. Japan gradually lifted exchange controls in the 1970s and 1980s. In 1980, Japan introduced the New Foreign Exchange Control Law, making foreign investment much less restricted. At about the same time, the attitude of the monetary authorities became more lenient concerning foreign investment by institutional investors (Japan's New Foreign Exchange Control Law is not concerned with regulating institutional investor portfolios).[2]

In addition to this trend of deregulating international financial transactions, declining transaction costs due to technological progress in the area of telecommunications have increased capital mobility. These developments have increased the depth of the foreign exchange market by increasing the number of participants and transactions—a greater number of participants means more funds are committed to the market, thereby raising its overall effective risk tolerance. Theoretically, this increased depth makes it possible for the market to absorb substantial portfolio pressure created by balance of

[1]See Walmsley (1979, p. 23).

[2]Fukao and Hanazaki (1987) present some aspects of exchange decontrol and consequent increases in international financial transactions.

payments imbalances with less exchange rate movement (see M. Fukao 1983a, p. 108).

Regarding the effects of these structural changes in international financial markets on the relative importance of the determinants of exchange rates, Kyoji Fukao (1983) made a detailed study using a rational expectations model. In the following, we present a similar analysis in a more accessible and general manner and apply it to the international transmission of fiscal policy under increasingly integrated financial markets.

III. Fiscal Policy, Real Exchange Rates and Real Interest Rates

This section presents a simple textbook two-country model which is an extension of a small country model by Branson (1985). Using this model, we analyze the effect of divergent fiscal policy in the 1980s. All variables are expressed in real terms in order to simplify analysis. Because of this formulation, the model cannot analyze inflation explicitly. A diagrammatic solution was first developed by Okina (1986).

A. Model

Suppose there are only two countries in the world. In order to simplify the explanation, we call them the United States and Japan. For the United States, the national income identity is written as

$$Y = C + I + G + X = C + S + T$$

where

Y = GNP
C = consumer expenditures
I = gross private investment
G = government purchases of goods and services
X = net exports of goods and services
S = gross private savings
T = tax revenue minus transfers from the government to the private sector.

Here, we have to note that X stands for the net export of goods and services (i.e. the current account balance). By rearranging terms within the right-hand equality, we obtain get the following identity:

$$(G-T) = S - I - X.$$

If we abstract cyclical movements of income and tax, we can take the budget deficit (G−T) as being exogenous. Also, we can exclude income, Y, from the determinants of savings, S, investment, I, and current balance, X. Consequently, we can rewrite the above equation as follows by indicating the dependence of S and I on the real interest rate, r, and the dependence of X on the logarithm of the real exchange rate, e (the price of one yen in terms of the dollar)[3]:

$$(G-T) = S(r) - I(r) - X(e) \tag{1}$$

$$dS/dr > 0 \quad dI/dr < 0 \quad dX/de > 0.$$

This is the I-S equation for the United States. Similarly, we can write the I-S equation for Japan.

$$(G^* - T^*) = S^*(r^*) - I^*(r^*) - X^*(e) \tag{2}$$

Since the net exports of the United States are the net imports of Japan, we have the following identity:

$$X(e) = -E\,X^*(e)$$

where E is the exponent of e (log E = e).

From the above two I-S equations, we can draw the U.S. I-S curve which shows the relationship between the U.S. real interest rate, r, and the real exchange rate, e, and the Japanese I-S curve does likewise for Japan's real interest rate, r*, and the real exchange rate, e. The upper panel of Figure 3 shows these two I-S curves with the vertical axis indicating different real interest rates for the two curves. The U.S. I-S curve is upward sloping since a higher e (i.e. a weaker dollar) requires a higher U.S. real interest rate, r, to clear the goods market. The Japanese I- S curve is downward sloping since a higher e (i.e. a stronger yen) requires a lower Japanese real interest rate, r*. From these two curves, we can derive the two real interest rates and the differential which satisfies the two I-S equations for a given real exchange rate. This relationship between the real interest rate differential and the real exchange rate is shown as the DD curve in the lower panel of Figure 3.

In this model, we effectively assumed that the flow balance of savings and investment determines the real interest rate of each country for a given real exchange rate (and a given current balance which depends only on the real exchange rate). It is perhaps natural to think that the adjustment speed of the stock of physical capital is much slower

[3]It is usually assumed that consumption depends on disposable income (Y-T) and the real interest rate, r. Therefore, even if we abstract the cyclical movement of income, Y, savings, S, depends not only on the real interest rate but also on the amount of tax, T. Therefore equation (1) becomes:

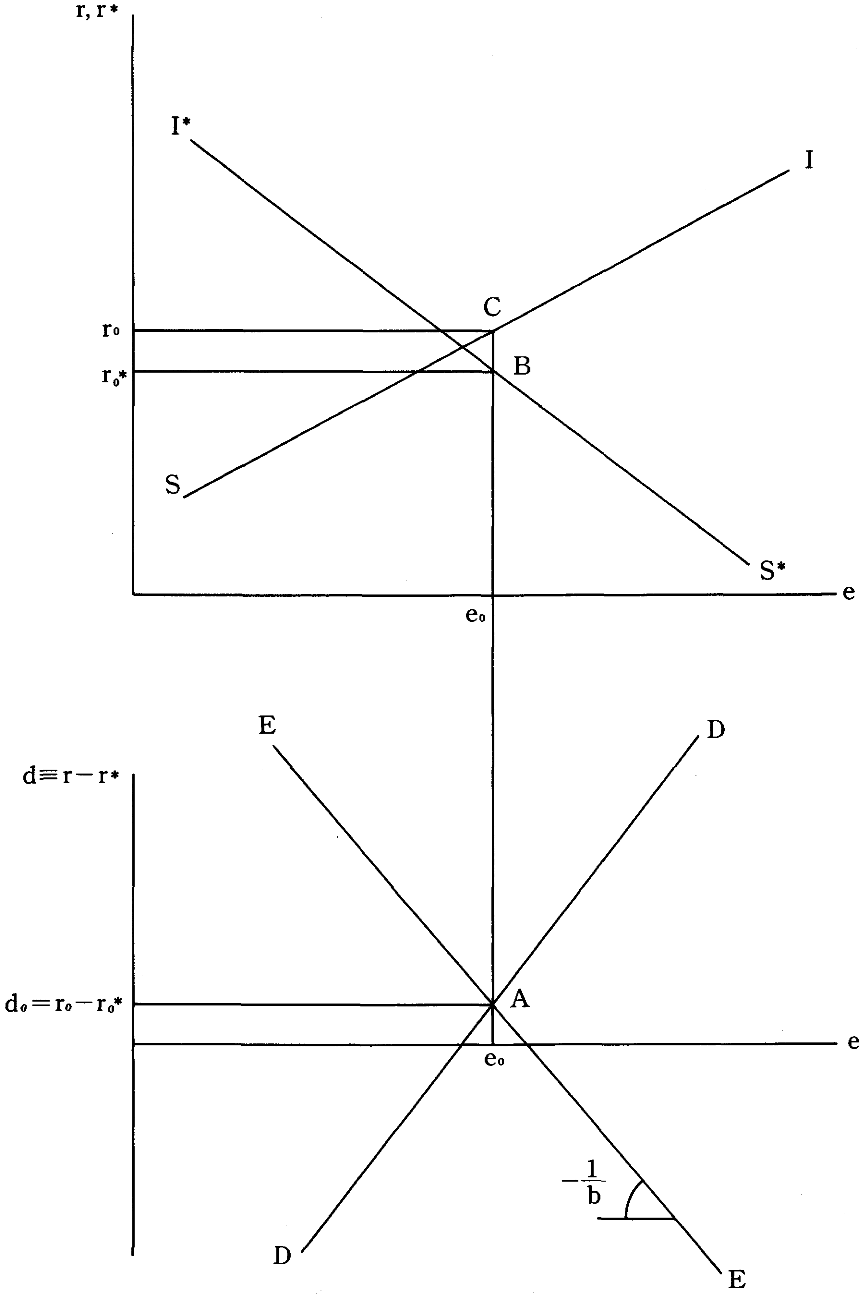
$$(G-T) = S(r,T) - I(r) - X(e)$$

and the impact of fiscal policy depends on the following variable:

$$G - (1 + S_T)T$$

where S_T is the partial derivative of S with respect to T and $0 > S_T > -1$. However, in the following analysis, we drop the dependence of S on T to simplify our exposition and measure the impact of fiscal policy by the budget deficits.

Figure 3. Basic Model



than the adjustment speed of the financial market in which the real exchange rate is determined in the short run. Therefore, while the real interest rates of the two countries are assumed to be determined by the flow equilibrium of goods markets, the real exchange rate is assumed to be determined by stock equilibrium of the financial market. In the following, we specify the financial market of the model.

We can obtain another relationship between the U.S.-Japan real interest rate differential, $(r - r^*)$, and the real exchange rate, e, that is imposed by financial market equilibrium. We assume that yen and dollar bonds are not perfect substitutes and that expectations regarding future movements of the real exchange rate are regressive. Under these assumptions, the uncovered arbitrage in yen and dollar financial markets requires the following condition:

$$r^* = r - 1/b\,(e^e - e) - RP \tag{3}$$

where

e^e = logarithm of the expected long-term equilibrium real exchange rate between the dollar and the yen

b = time period within which the real exchange rate is expected to converge with its long-term equilibrium rate

RP = risk premium.

This equation indicates that Janan's real interest rate r^* has to be equal to the U.S. real interest rate r adjusted for the expected change in real exchange rate (the second term on the right-hand side) and for the risk premium term (the third term) which compensate for the risk stemming from future fluctuations in the real exchange rate.[4]

If investors in each country regard their respective domestic-currency bonds to be risk free and foreign-currency ones risky, then foreign currency assets or liabilities will

[4]When there is no inflation, it is obvious that equation (3) has to hold. When there is some inflation we have to take account of the difference between nominal and real interest rates. In nominal terms, we have the following arbitrage condition:

$$i^* = i + x - RP.$$

where

i^* = Japan's nominal interest rate.

i = U.S. nominal interest rate.

x = expected rate of appreciation of the dollar against the yen in nominal terms.

Since nominal interest rates are equal to the sum of real interest rates and inflation rates, we can rewrite the above equation as follows:

$$r^* = r + (x + p - p^*) - RP$$

where

p, p^* = inflation rates in the United States and Japan, respectively.

Since the second term of the right-hand side of the above equation is the inflation adjusted rate of expected change in the nominal exchange rate, it is equal to the expected change in the real exchange rate. Therefore, the above equation is equivalent to equation (3) in the text.

not be held unless there is some real return differential. This return differential is the risk premium, RP. In the framework of standard mean-variance analysis, the risk premium can be expressed as follows[5]:

$$RP = s^2/c\,B^* \tag{4}$$

where

s^2 = volatility of the real exchange rate

c = a positive constant which is proportional to the aggregate risk tolerance of investors in the financial market

B^* = Japan's accumulated current account surplus.

As we can observe from equations (3) and (4), when Japan has an accumulated current account surplus (i.e. $B^* > 0$), Japan's real interest, r^*, has to be lower than the U.S. real interest rate adjusted by the expected change in the real yen-dollar exchange rate by the amount of the risk premium factor, RP. Risk premium goes up when anticipated volatility s^2 increases and smaller when risk tolerance c increases.

Since s^2 indicates investor anticipation of the volatility of the exchange rate, when the exchange rate is unstable, s^2 will be large. On the other hand, c indicates the aggregate risk tolerance of all investors who participate in international financial transactions. When there is a given expected yield differential between yen and dollar assets, the larger c is, the larger the amount of risky investments to assets which have the higher expected return. Therefore, when there are restrictions on foreign investments such as exchange controls, c will be small because some investors cannot participate in such investments. On the other hand, the liberalization of exchange controls and lower transaction and information costs for international financial transactions tend to promote the internationalization of financial markets and increase c. Therefore, in the framework of our model, the internationalization of financial markets is expressed as an increase in parameter c. Although parameters s^2 and c depend on conditions in international financial markets, we conducted the following analysis assuming that they were given.

By substituting RP in equation (3) with the right-hand side of equation (4), we get the following real exchange rate equation:

$$e = e^e + b^*(r^* - r) + [b\,s^2/c]\,B. \tag{5}$$

This equation indicates that an increase in Japan's (U.S.) real interest rate induces an appreciation of the yen (the dollar). Also, an increase in the accumulated current account surplus of Japan induces an appreciation of the yen. In the short run, we can

[5]When s^2 is the anticipated variance of the real exchange rate, this is a standard result. See, for example, M. Fukao (1987), Branson and Henderson (1985), and Frankel (1985). In this model, we do not introduce uncertainty explicitly. Therefore, s^2 is an exogenous parameter which indicates the volatility of the real exchange rate. Regarding attempts to make the anticipated variance endogenous, see K. Fukao (1983) and Ohtaki et al. (1987).

regard the stock of assets as given and the above equation gives the relationship between the real interest rate differential, $(r^* - r)$, and the real exchange rate, e. This relationship is expressed by the EE curve in the lower panel of Figure 3. The slope of this curve is given by $(-1/b)$ which depends on the expected speed of adjustment of the real exchange rate, e, towards its long-term equilibrium rate, e^e. When investors expect a speedy adjustment, b is small and the slope of the EE curve is steep.

In the short run, simultaneous equilibrium in goods and financial markets is reached at the intersection of the DD curve and the EE curve, A. In this equilibrium, the real exchange rate is e_0, and the real interest rate differential is $r_0 - r^*_0$ which corresponds to the distance between points B and C in the upper panel.

The above equation (5) was derived under the rather arbitrary assumption of regressive expectations. But it is consistent with rational expectations over a long-term horizon. When the current real exchange rate is above the equilibrium rate, the country with the overvalued currency tends to run current account deficits. This reduces its external assets and induces a fall in its real exchange rate. Therefore, expectations that the real exchange rate will move towards its equilibrium rate will be realized in the long run. The appendix to this paper develops a rational expectations version of this model and proves this point.

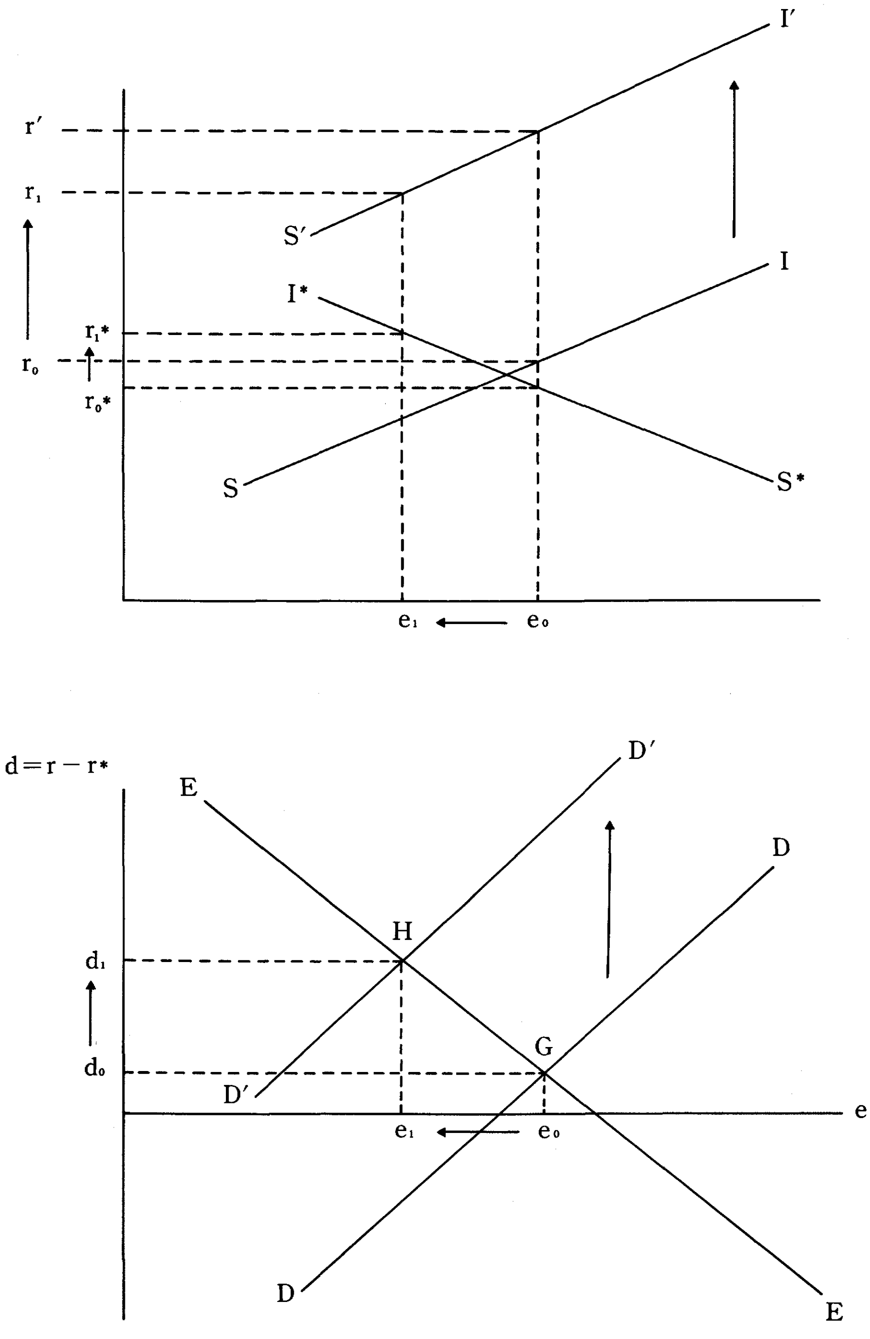
B. The effects of fiscal policy

The most often cited cause of balance of payment imbalances is the divergent stance of fiscal policy between the United States on the one hand and Japan and West Germany on the other. From a longer perspective, all three countries experienced an increase in total government expenditures relative to GNP. For the United States and Japan, the increases in government expenditures come mainly from the rapid expansion of social security transfers. Japan experienced the fastest growth in terms of the size of government. However, Japan and West Germany could raise tax revenues and thus avoid an increase in budget deficits. On the other hand, the current receipts of the U.S. government stayed flat in the 1980s and could not meet growing expenditures.

The effects of divergent fiscal policy with respect to real interest rates, the real exchange rate and the current balance can be analyzed by our simple model. In order to simplify the following exposition, we analyzed the effect of an increase in the U.S. budget deficit although Japan and Germany actually reduced their budget deficits.

In the framework of our analysis, an increase in the U.S. budget deficit shifts the U.S. I-S curve upwards from IS to I′S′ in Figure 4. Consequently, the U.S. real interest rate rises from r_0 to r' at the initial real exchange rate, e_0. As indicated in Figure 4, this shift of the I-S curve also shifts the DD curve to D′D′. Equilibrium moves from G to H in the lower panel of the chart. The dollar appreciates against the yen in real terms from e_0 to e_1 and the real interest rate differential widens from d_0 to d_1. We can decompose this change in the real interest rate differential into individual movements of the two real interest rates in the upper panel. As the dollar appreciates, Japan's real interest rate rises

Figure 4. Fiscal Policy Shock



from r^*_0 to r^*_1 due to larger net exports. On the other hand, the U.S. real interest rate rises from r_0 to r_1 which is less than the upward shift of its I-S curve due to reduced net exports under a higher dollar. This transmission mechanism of fiscal policy can be interpreted as an international crowding out process.

In this model, monetary policy is not treated explicitly. However, in the short run, monetary policy has a considerable effect on the real interest rate and on the real exchange rate. In fact, in the early 1980s, in addition to expansionary fiscal policy, the United States took a tight monetary policy—a mix which generated a very high real interest rate.[6] This high U.S. real interest rate was transmitted to Japan and Germany although the two adopted tight fiscal policy. In addition to the transmission mechanism described above, Japanese and German monetary authorities tried to support their currencies by raising short-term interest rates when their currencies came under heavy downward pressure. This operation also narrowed real interest rate differentials.

Because of these factors, the world economy experienced a very high real interest rate. Figure 5 shows the behavior of interest rates in both nominal and real terms for the three major countries. Two measures of real interest rates are presented. The conventional measure adjusts nominal interest rates by the percentage change in GNP/GDP deflators during the past twelve months; this measure implicitly assumes static expectations about future rates of inflation. The other measure of real interest rates (ex-post rate) uses the actual one-year ahead inflation rate (for the most recent period, OECD forecasts are used). As we can clearly observe, both measures were much higher in the first half of the 1980s than in the 1970s.[7]

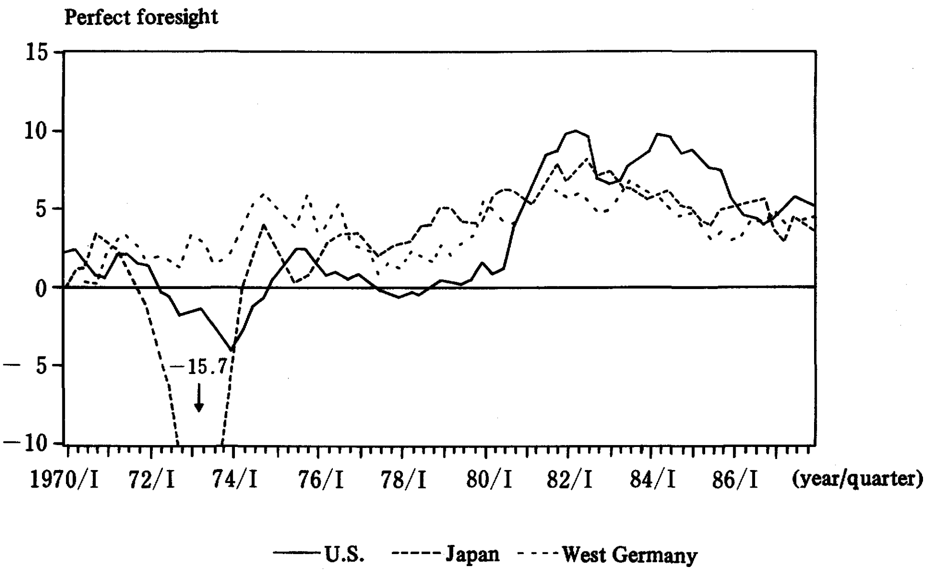
In our model, a higher real interest rate tends to depress domestic absorption by increasing the cost of financing investment in both countries. However, this contractionary effect depends not only on the level of real market interest rates but also on the tax system. Even if the level of real interest rates and the cost-of-capital elasticity of investment were the same in the United States and Japan, the contractionary effects of high real interest rates depend on the tax wedge between the market rate and the cost of capital. Therefore, corporate and personal tax plays an important role in determining the effect of high real interest rates on current account imbalances.

According to estimates of the cost of capital obtained through debt financing by Fukao and Hanazaki (1986, 1987), which used the estimation method of King and Fullerton (1984), the cost for business and housing investment in the United States was much lower than real market interest rates in the first half of the 1980s because of large negative

[6]There are many articles on the relationship between the high real interest rate and the policy mix of the United States. See, for example, Krugman (1983), Blanchard and Summers (1984), Frenkel (1985) and Tanzi (1985).

[7]Regarding the convergence of real interest rates among major OECD countries, see Section I of Fukao and Hanazaki (1987). Annex A of this article also provides a survey of the literature on the convergence of real interest rates.

Figure 5. Long-term Real Interest Rates of Major Countries



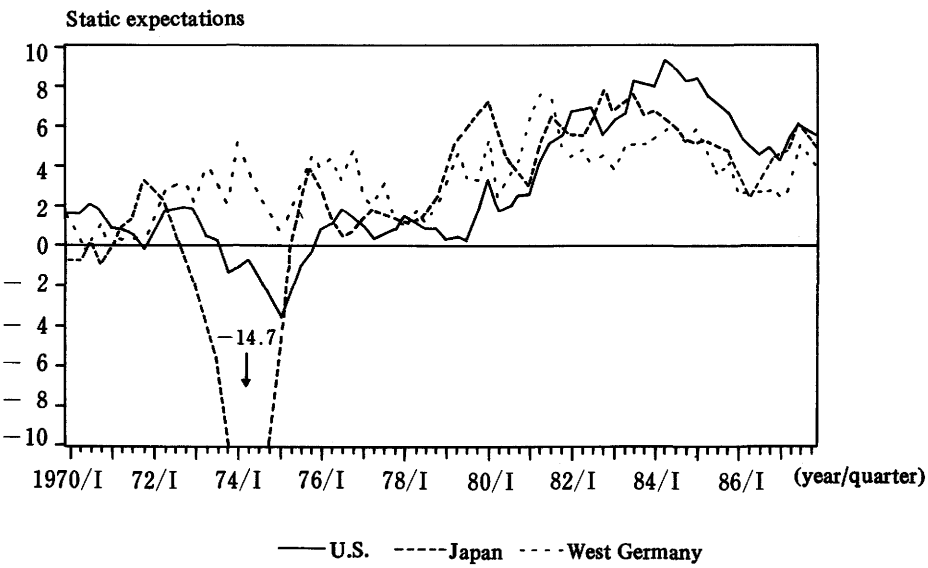
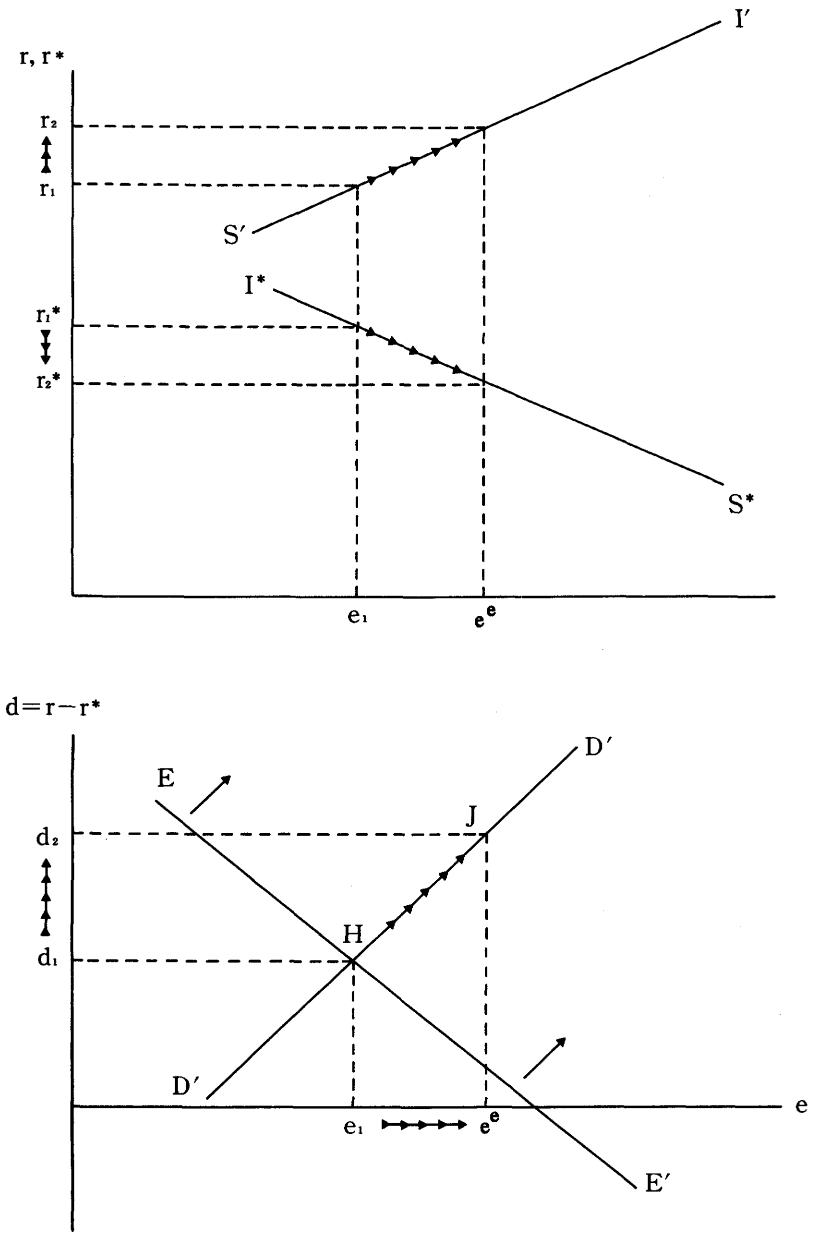


Figure 6. Dynamic Adjustment



tax wedges. These large negative tax wedges were due to a relatively high inflation rate which made it possible to deduct larger nominal interest payments from taxable income and the existence of investment tax credits. On the other hand, Japan and Germany had much smaller negative tax wedges because of their low inflation rates and the absence of any general investment tax credit programs. Consequently, the contractionary effects of high real interest rates must have been larger in Japan and in Germany than in the United States.

Our model also gives a prediction for the long-term adjustment process. Figure 4 shows only short-run equilibrium and the stock variables are given. Since the current account balances are not zero, the accumulated current account surplus of Japan, B*, in equation (5) increases over time. As Figure 6 shows, this will shift the EE curve upwards. During this process, the dollar depreciates against the yen in real terms and the real interest rate differential widens. As the upper panel indicates, the U.S. real interest rate rises while that for Japanese falls. This adjustment process is quite different from Dornbusch (1976) well-known rational expectations model. In his model, the real interest rate differential narrows when the real exchange rate adjusts towards its long-term equilibrium level. In our model, the real interest rate differential widens when the exchange rate moves towards its equilibrium level. This adjustment of the real exchange rate towards equilibrium level is induced by the changing accumulated current balance. Even for long-term equilibrium, the real interest rate differential is not zero. This interest rate differential corresponds to the risk premium which is required to induce private investors to hold risky foreign assets.

With our model, it is possible to explain why the dollar started to fall in 1985 while the U.S. budget deficit did not fall until 1987. Although the real interest rate differential remained favorable to dollar assets in 1985, Japan and Germany started to run huge current account surpluses by then. This portfolio pressure began to push the dollar downwards in 1985. In 1987, the drop in the U.S. budget deficit and smaller negative tax wedges for investment due to the tax reform bill of 1986 together worked to reduce the U.S. real interest rate. The declining U.S. real interest rate and accumulating current account surpluses in Japan and Germany induced a sharp fall of the dollar in 1986 and 1987 (see next section for more details).

IV. Internationalization of Financial Markets as a Cause of Persistent Balance of Payments Imbalances

The analysis of the overvaluation of the dollar and high real interest rates in the previous section is fairly standard in the sense that the divergent fiscal policy is identified as the major cause in the first half of the 1980s. Although the difference in fiscal policy is indeed the most fundamental background of existing balance of payments imbalances among major countries, the imbalances could not persist without corresponding capital movements. Therefore, we have to pay attention to structural changes in international financial markets.[8] In this section, we analyze the effect of internationalization of financial markets on the behavior of real interest rates and real exchange rates.

A. The effects of internationalization of financial markets

In the framework of the model developed in Section III, the effects of the internationalization of financial markets can be analyzed as an increase in the risk tolerance parameter, c, in equation (5) which is reproduced below:

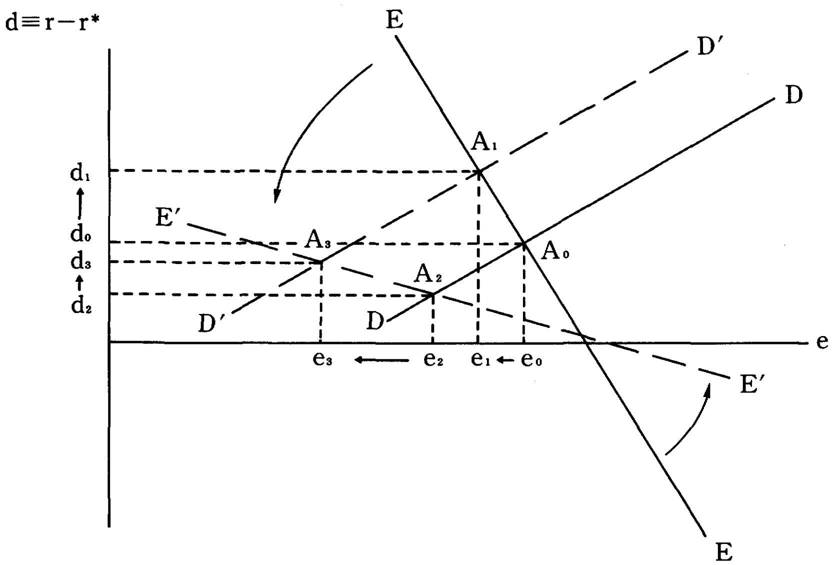
$$e = e^e + b(r^* - r) + [b\, s^2/c]\, B^*. \tag{5}$$

While this change in c reduces the size of the coefficient of the accumulated current balance, B^*, it is expected to strengthen the extent to which changes in real interest rate differentials affect the exchange rate, given that investor expectations are formed rationally. Because the current balance now has less effect on the exchange rate, the overvaluation of a currency occasioned by an increase in the domestic real interest rate is rectified less quickly by exchange rate adjustment induced by deficits in the current balance. As the rectifying effect of the current balance weakens, the period of exchange-rate misalignment becomes more persistent. This weakens regressive expectations, making the expectations parameter, b, larger. The combined effect is a larger c and a larger b but smaller (b/c) which determines the effect of the current balance on the real exchange rate. The reason for a smaller (b/c) is as follows: the first-round effect of an increase in c has to dominate the second-round effect of an increase in b; otherwise, an increase in c tends to strengthen the effect of the current balance on the exchange rate and the expectations parameter, b, does not increase to begin with. Thus, with the greater internationalization of financial markets, the relative effect of real interest rate differentials becomes more important while the effect of the current balance becomes less important (see Appendix for proof).

This structural change in the international financial market changes the international transmission of fiscal policy. The changes in the parameters in equation (5) reduce the slope of the EE curve in Figure 4. As indicated in Figure 7, this will rotate the EE curve counter-clockwise to E′E′. An expansionary U.S. fiscal policy, which is expressed as an upward shift of the DD curve to D′D′, will induce a larger appreciation of the dollar and a smaller widening of the real interest rate differential after such rotation of the EE curve. Before rotation, the dollar appreciates from e_0 to e_1 and the real interest rate differential widens from d_0 to d_1. After rotation, the dollar appreciates from e_2 to e_3 and the real interest rate differential widens from d_2 to d_3.

[8]At the Bank of Japan Conference held in 1987, many participants expressed their opinion that large exchange rate misalignment and current account imbalances are caused by the combination of divergent fiscal policy and the internationalization of financial markets. See Suzuki and Okabe (1987, p. vii).

Figure 7. Internationalization of Financial Markets



This structural change will also affect the dynamic adjustment process shown in Figure 6. If net exports, X, are proportional to the exchange rate misalignment, $(e^e - e)$, the speed of adjustment of the real exchange rate, e, to its equilibrium rate, e^e, through the change in B^* would be slower for a given misalignment because of a smaller (b/c) in equation (5).

Although the parameter (b/c) on the accumulated current balance, B^*, becomes smaller, it does not necessarily mean that the total effect of the risk premium term on the real exchange rate becomes smaller (the last term of equation 5). This is because the initial effect of fiscal policy on the real exchange rate and the current balance becomes larger as financial markets become more integrated internationally. Increased current account imbalance tends to strengthen the total effect of risk premium on the exchange rate which is determined by the product of (bs^2/c) and B^*.

B. Difference between the integration of financial markets and goods markets

In the above analysis, we showed that the increasing depth of international financial markets tends to change the relative importance of exchange rate determinants. It tends to increase the importance of the real interest rate differential while decreasing the effect of a given current account imbalance. In the following, we consider how increasing the integration of goods markets through international trade affects the relative importance of exchange rate determinants.

Suppose that there are only two countries in the world—Japan and the United States. As the goods markets of the two countries becomes more integrated through trade, the size of current account imbalances due to a given degree of misalignment in the yen-dollar real exchange rate becomes greater. Therefore, for a given degree of exchange rate misalignment from its equilibrium level, the change in the accumulated current balance of Japan, B^*, quickens. For example, when the United States adopts an expansionary fiscal policy, the resulting high U.S. real interest rate generates an overvaluation of the dollar. This overvaluation of the dollar tends to generate a bigger current account imbalance between Japan and the United States when goods markets are more integrated through international trade. As a result, the adjustment speed depicted in Figure 6 will be faster than otherwise. If this speedy adjustment process is correctly foreseen by market participants (i.e. rational expectations), then the parameter of the time expected for adjustment, b, becomes smaller. As we can see from equation (5), this tends to reduce the effect of real interest differentials on the real exchange rate. Furthermore, this decline in parameter b also reduces the effect of the accumulated current balance because its effect depends on bs^2/c. Under given risk tolerance, c, and anticipated volatility s^2, the size of this parameter will decline.

Thus, increasing economic integration through international trade tends to reduce the importance of both real interest rate differentials and accumulated current balances as exchange rate determinants. Some economists point out that the increasing globalization of financial markets compared with the sluggish integration of goods markets might be the cause of excessive exchange rate misalignments. Our analysis gives a theoretical foundation to this view.

V. Empirical Analysis of Yen-Dollar and DM-Dollar Floating Exchange Rates

Although the exchange rate is one of the most important economic variables, it has proved to be difficult to explain its movement empirically.[9] Most theoretical models predict that real exchange rates are determined by real interest rate differentials, balance of payments, and other variables which affect market expectations. One of the difficulties of going from theoretical models to empirical estimation is apparently attributable to changes in the relative importance of various exchange rate determinants over time.

As we saw in the second section, the sharp appreciation of the yen and the DM against the dollar in the 1970s corresponded to the current account surpluses of Japan and West Germany. However, the appreciation of the dollar in the first half of the 1980s occurred while Japan's current account surplus was steadily increasing. When the dollar appreciated, market participants paid much attention to the movement of U.S. interest rates. Regarding the sharp depreciation of the dollar after 1985, it is difficult to explain it only by interest rate developments. When the dollar fell sharply, market participants

[9]Meese and Rogoff (1983) showed that the random walk model predicts better than some structural models outside of the sample period. Isard (1986) provides a survey on exchange rate models.

again paid considerable attention to the U.S. balance of payments.

As is shown in the theoretical analyses, it is natural to consider that these changes in the relative importance of exchange rate determinants are caused by the increasing internationalization of financial markets. A higher capital mobility tends to strengthen the real interest factor while weakening the balance of payments factor. In the 1970s, Japan's exchange controls were relatively tight and the yen foreign exchange market relatively thin. As Japan accumulated a large current account surplus in relation to the depth of the foreign exchange market, strong upward pressure on the yen was generated in 1977 and 1978. However, in December 1980, the New Foreign Exchange Control Law was enacted, making foreign investment much easier. At about the same time, the attitude of the monetary authorities also became more lenient with respect to foreign investment by institutional investors. Financial institutions and nonfinancial corporations had also accumulated foreign investment know-how by this time. This period of liberalization coincided with that of high U.S. real interest rates, creating pent-up demand for foreign securities. Partly due to this capital outflow pressure, the yen remained weak until 1985.[10] Finally, concerning the correction of the overvaluation of the dollar after 1985, in addition to the fall of U.S. real interest rates we have to take account of the huge current account imbalances among major countries. While the size of international financial markets increased significantly, deepening the depth of the foreign exchange market, the enormous current account imbalances inundated the market, precipitating the rapid correction of the overvalued dollar. (In the Appendix, we analyze how increasing risk tolerance affects the importance of the balance of payments factor as a determinant of real exchange rates.)

Based on these considerations, we analyze the behavior of yen-dollar and DM-dollar real exchange rates under the current floating rate regime. Real interest rate differentials and accumulated current balances are used as explanatory variables of real exchange rates. In order to capture changes in the relative importance of these two real exchange rate determinants, we will use a Kalman filter method which allows gradual changes in the parameter values.

A. Specifications of estimated equations

We will re-estimate an exchange rate equation with an explicit foreign exchange risk premium term, which the author has estimated elsewhere (M. Fukao 1981, 1983a, 1985 and 1987). The estimated equation is basically the same as equation (5) in Section III of this paper. Since the theory was in the framework of the two-country model, the exchange rate equation featured only one accumulated current balance as the risk premium term. However, for an empirical estimation, we have to take account of the existence of a

[10]Concerning the trend in foreign securities investment by Japanese institutional investors and deregulation by the monetary authorities in Japan in the 1980s, see Fukao and Okina (1988).

third country. In the following analysis, we will introduce the accumulated current balance of a third country in the risk premium term. Specifically, the following yen-dollar and DM-dollar equations are estimated:

$$e^j_t = a^j + b^j_t(r^j_t - r^u_t) + c^j_t(M^{jj}B^j_t + M^{jg}B^g_t) + w^j_t$$

$$e^g_t = a^g + b^g_t(r^g_t - r^u_t) + c^g_t(M^{jg}B^j_t + M^{gg}B^g_t) + w^g_t$$

where

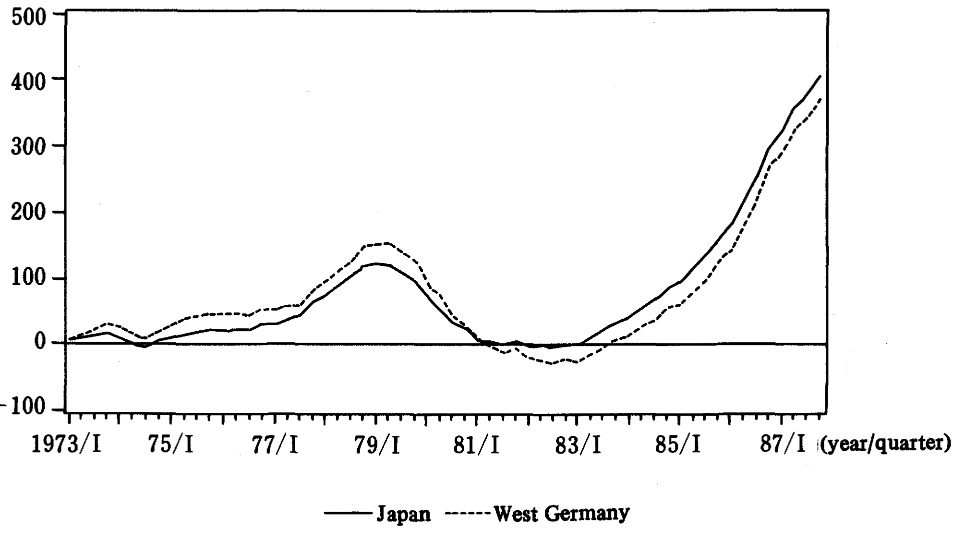
- e^j_t, e^g_t: indices of the yen-dollar and the DM-dollar exchange rate (first quarter of 1973= 1.0)
- r^j_t, r^g_t, r^u_t: real long-term interest rates of Japan, West Germany and the U.S. (an annual rate of 5% is expressed as 0.05)
- M^{jj}, M^{gg}, M^{jg}: variance of the rate of change in the yen-dollar and DM-dollar real exchange rates and covariance between them
- B^j_t, B^g_t: the accumulated current balance (in billion dollars) of Japan and the EMS divided by a composite index of GNP of major countries (1.0 in the first quarter of 1973)
- a^j, a^g: constant term for the yen-dollar and DM-dollar equations
- b^j_t, b^g_t: variable coefficients of real interest rates for the yen-dollar and DM-dollar equations
- c^j_t, b^g_t: variable coefficients of risk premium for the yen-dollar and DM-dollar equations
- w^j_t, w^g_t: error term for the yen-dollar and DM-dollar equations.

The first terms on the right hand side of these estimated equations are constants, which correspond to the equilibrium real exchange rates in equation (5). However, because of the bias of the accumulated current balance variables used in the equations, which we will discuss later, equilibrium exchange rates cannot be obtained from estimated constants. The second terms are real interest rate differentials between Japan and the United States and between West Germany and the United States. They are multiplied by variable coefficients. The third terms are risk premia also with variable coefficients. Unlike the theoretical equation (5), they include the accumulated current balance of a third country. The yen-dollar equation has a term which is the weighted sum of Japan and EMS accumulated current balances with the variance of the yen-dollar real exchange rate and covariance between the yen-dollar and DM-dollar exchange rates as weights. In the theoretical model, only two countries, Japan and the United States, and only two currencies, the yen and the dollar, are considered in order to simplify the explanation. In reality, there is an important third country (EC) whose economic conditions have a great impact on the yen-dollar exchange rate. It is thus necessary to take account of the movement of the EC balance of payments in order to explain the yen-dollar exchange rate. Specifically, we assumed that the world consists of three currency areas, the yen, the dollar and the DM. The magnitude of this third-country effect is estimated by the covariance term. (For a theoretical explanation of this formulation, see M. Fukao 1983b and 1987.)

As data for our estimation, the real exchange rates, long-term real interest rate differentials and accumulated current balances shown in Figures 1 and 2 are used (for details, see notes to these figures). The risk premium variables and the variance-covariance matrix of real exchange rates (the third term of the above equation) are shown in Figure 8.

Strictly speaking, in order to measure portfolio pressure stemming from balance of payments imbalances, it is necessary to obtain the net external asset position of each currency area by accumulating respective current account from the beginning of history. Because of the limitation of data available, however, accumulated current balances since 1973 were used. (Because of this, the accumulated current balance does not correspond to net external assets. Therefore, the constant term in the estimated equation has a bias.)

Figure 8. Risk Premium Variable of West Germany and Japan (Normalized by nominal GNP index of major countries)



Variance-covariance Matrix of Yen/Dollar and DM/Dollar Real Exchange Rates

Estimation period 1973/I ~ 87/IV

	Yen/Dollar	DM/Dollar
Yen/Dollar	0.003721	0.002719
DM/Dollar	0.002719	0.004370

If intervention by the monetary authorities were exogenous to the foreign exchange market, it would be appropriate to subtract that portion of portfolio pressure borne by the authorities. However, the composition of foreign currency assets and liabilities of monetary authorities, which are necessary to make adjustments for estimation, are not available.[11] Moreover, while intervention affects exchange rates by changing the supply of assets denominated in different currencies, exchange rate movements also affect the degree of intervention. When the second relationship is very strong, it is not possible to measure the effect of intervention on exchange rates using estimated equations. Since reserves are usually highly correlated with exchange rates due to "leaning-against-the-wind" intervention policy, it is difficult to take account of the effect of intervention in the risk premium term. Accordingly, in this paper, we abstract intervention by the monetary authorities.[12]

As for the variance-covariance matrix in the risk premium term, the variance-covariance matrix of changes in real exchange rates during the entire estimation period (from the first quarter of 1973 to the fourth quarter of 1987) is used, assuming that the anticipated matrix did not change during the estimation period.[13]

Regarding changes in variable parameters b and c during the estimation period, the following two formulations were made.

<u>Random Walk</u>

$$b_t = b_{t-1} + \text{(white noise)}$$
$$c_t = c_{t-1} + \text{(white noise)}$$

[11]When the author previously conducted a similar empirical analysis by adjusting the accumulated current balance by foreign exchange reserves and disregarding the currency composition of foreign exchange reserves, satisfactory results could not be obtained. See Fukao (1987).

[12]If the amount of intervention is strictly proportionate to exchange rate movements, it is not possible to identify the effect of intervention.

Theoretically, it is possible to abstract official intervention from the estimation of exchange rate equations. Consider the following conditions:

i) The authorities are accommodating a constant portion of portfolio pressure created by balance of payments imbalances;

ii) The private sector thinks that the reserves held by the monetary authorities are, in fact, its own assets (Ricardian hypothesis).

In the first case, the authorities asset-liability structure is always similar to that of the private sector. In the second case, the private sector takes account of the official portfolio structure in its investment decisions. In these cases, we can abstract official intervention.

[13]This variance-covariance matrix is the anticipated future variability of real exchange rates by investors participating in the foreign exchange market. Therefore, it is natural to suppose that the structure of the matrix will change during the estimation period. Okina and Suzuki estimated a similar equation to the one estimated here, in which the variance-covariance matrix is assumed to change during the estimation period, based on the actual variance-covariance of exchange rate movements. However, according to empirical analysis by the author (M. Fukao 1987), when this variance and covariance matrix is assumed to change during the estimation period, the variance and covariance matrix becomes too unstable and the results unsatisfactory. Accordingly, we did not allow changes in this matrix during the estimation period.

In this formulation, the first difference of the parameter is equal to a random error term. In other words, we assume that the coefficients follow random-walk processes.

Random Trend

$$b_t = 2\ b_{t-1} - b_{t-2} + \text{(white noise)}$$
$$c_t = 2\ c_{t-1} - c_{t-2} + \text{(white noise)}$$

In this formulation, the second difference of the parameter is equal to a random error term. Here, we assume that the two parameters follow random trends.

B. Estimation results

We estimated the exchange rate equations with a Kalman filter method.[14] Although we used data from the first quarter of 1973 to the fourth quarter of 1987, initial values for the variable parameters were determined by data from the beginning of 1973 to the fourth quarter of 1974 according to the maximum likelihood method. By so doing, two sets of estimated values were obtained for each parameter (two time series of parameter value during the estimation period). One of them is a filtered series while the other is a smoothed series. The difference between the two is that while the parameter value from the filtered series at one period uses information up to this period, the parameter value obtained from the smoothed series at one period uses all information from the entire sample period.[15] In this paper, we take the parameter values from the smoothed series, from the viewpoint that we analyze the functioning of the floating rate regime with the advantage of hindsight.

1. Yen-dollar rate

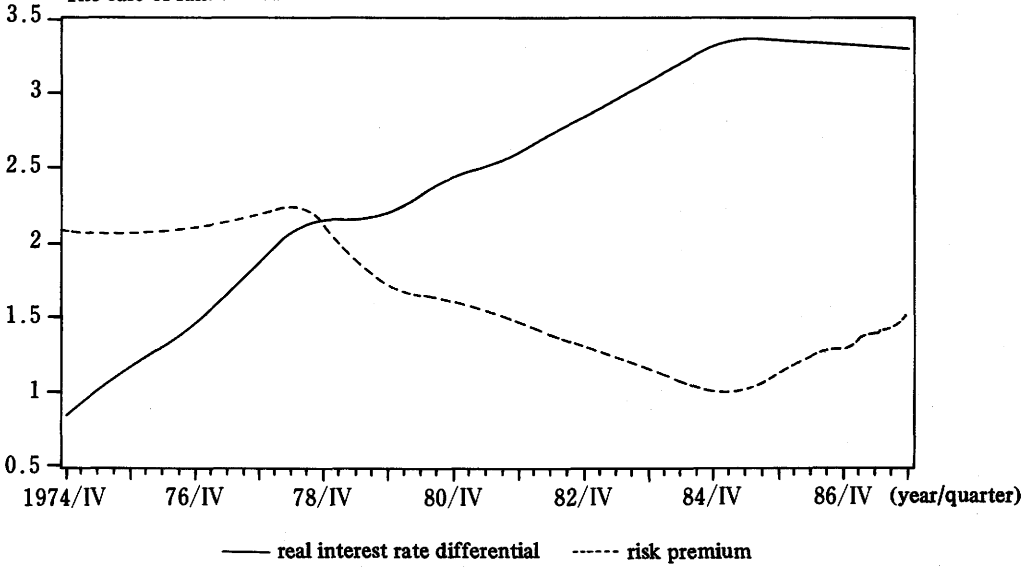
Figure 9 shows the movements of the parameter of the real interest rate differential, b^j, and that of the risk premium, c^j of the yen-dollar real exchange rate equation during the estimation period. The upper panel shows estimated parameters under the assumption that parameters follow random walk, while the lower panel shows estimated parameters under the assumption that parameters follow random trend. As we can observe from the figures, while the coefficient of the real interest rate differential traces a considerable upward trend, the coefficient of the risk premium fell slightly. This movement is consistent with the predicted behavior of parameters in our theory in the case of the

[14]In this estimation, I used a program called Kalman, developed by the Econometrics Section of the Research and Statistics Department of the Bank of Japan. As for the Kalman filter method, see Chow (1983, Chap. 10).

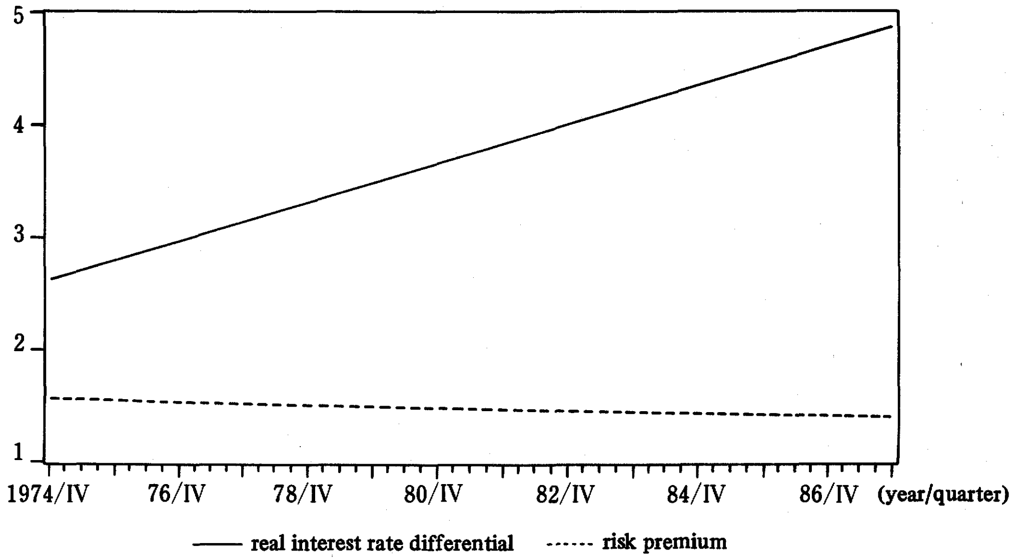
[15]This difference between the filtered series and the smoothed series can be intuitively understood by the following example. Suppose that we are interested in the seasonally-adjusted movements of an economic time series two years ago. Then there is a choice between two alternative strategies; whether the seasonal adjustment is made by using only the data available two years ago or by using all data available until the most recent period. The former method corresponds to the filtering method, while the latter corresponds to the smoothing method.

Figure 9. Parameter of Yen/Dollar Equation
(Estimation results by Kalman filter method)

The case of random walk



The case of random trend



internationalization of financial markets in the fourth section. (See upper panel of Figure A-2 in the Appendix and explanation).

a. Random-walk parameters

We first explain the estimation results of the yen-dollar equation under the assumption that parameters follow random walk. From Figure 9 and the upper panel of Table 1, we notice that the parameter of the real interest rate differential rose significantly from 0.8 at the end of 1974 to 3.3 at the end of 1987. On the other hand, the parameter of risk premium initially stayed flat at around 2.1, but declined to 1.0 by 1984. In the most recent period, it rose slightly again.[16] From the estimated behavior of parameters, we can detect changes in the relative importance of real exchange rate determinants.

The size of the parameter of the real interest rate differential indicates the estimated change in the yen-dollar real exchange rate in percent when the Japan-U.S. real interest rate differential changed by 1 percent. At the end of 1974, the real exchange rate changed only by 0.83 percent against a 1-percent change of the real interest rate differential. On the other hand, at the end of 1987, the real exchange rate changed as much as 3.3 percent.

Next, let us look at the effects of the accumulated current account balance on the yen-dollar real exchange rate. The upper panel of Table 2 shows the estimated change in the yen-dollar real exchange rate when the accumulated current account balance of Japan and EMS countries increased by $10 billion in nominal terms. These figures were estimated from the above estimation results and variance and covariance matrix. As the table shows, the impact of changes in nominal accumulated current account balances on the yen-dollar real exchange rate declined significantly by the end of 1987 compared with the end of 1974. A Japanese current account surplus of $10 billion raised the yen against the dollar by 7.7 percent in 1974. However, in 1987, it raised the yen by only 1.68 percent. This significant fall in the impact of the current account factor can be attributed to the gradual decline of the parameter value of the risk premium term of the estimated equation and the declining significance of the nominal $10 billion against the scale of the world economy due to U.S. inflation and world economic growth during the period. The nominal GNP index of the four major countries, which is taken as 1.0 at the beginning of 1973, reached 2.2 at the end of 1980, and 3.4 at the end of 1987. The significance of nominal one dollar relative to world GNP at the end of 1987 is less than one third that at the beginning of 1973. The current account surplus of EMS countries also raises the yen

[16]The reason why the parameter of the risk premium began to rise since 1984 in the yen-dollar equation and leveled off in the DM-dollar equation may be attributable to the sharp depreciation of the dollar which began in 1985. In face of sharp exchange rate movements, market participants may have adjusted anticipated volatility upwards. This volatility is treated as a fixed variance and covariance matrix in the estimated equation. However, if the anticipated volatility did rise, it would show up as an increase in the risk-premium parameter.

Empirical analysis showing similar results with this was conducted by the Research and Statistics Department of the Bank of Japan (1987,p.31).

Table 1. Estimated Parameters of Yen/Dollar Real Exchange Rate Equation
(Estimation results of real exchange rate equation by Kalman filter method)

The case of random walk — Estimation period 1973/I ~ 87/IV

Period	Real interest differential	Risk premium
1974/IV	0.832	2.069
1980/IV	2.445	1.608
1987/IV	3.295	1.540

The case of random trend

Period	Real interest differential	Risk premium
1974/IV	2.624	1.578
1980/IV	3.665	1.476
1987/IV	4.881	1.414

Note: The parameter of real interest rate differential shows the change of real exchange rate when the real interest differential moves by one percentage point.

Table 2. Effects of Current Account Imbalances on Real Exchange Rates
(Estimation results of the case of random walk)

Effects on Yen/Dollar Exchange Rate (Figures are appreciation of the yen against the dollar in percent)

Period	$10 billion Japan surplus	$10 billion EMS surplus
1974/IV	7.70%	5.63%
1980/IV	2.73	1.99
1987/IV	1.68	1.23

Effects on DM/Dollar Exchange Rates (Figures are appreciation of the DM against the dollar in percent)

Period	$10 billion Japan surplus	$10 billion EMS surplus
1974/IV	3.97%	6.39%
1980/IV	1.84	2.96
1987/IV	0.62	0.99

against the dollar due to the third country effect because the yen and the DM are substitute assets (see Fukao 1983).

From the estimated parameter values, we can calculate the risk premium which is necessary to induce private investors to finance the accumulated current account imbalances by bearing the risk of exchange rate movements. Here, we will calculate the risk premium necessary to finance an accumulated current account surplus of 1 percent of Japan's GNP. Japan's GNP in 1987 was about \$2.6 trillion and hence 1 percent was \$26 billion. According to Table 2, a \$26 billion current account imbalance leads to a real yen-dollar rate change of 4.4 percent ($1.68 \times 260/100$). From comparing equations (4) and (5) in the third section, we can show that the risk premium, RP, is obtained by dividing the above figure by the value b^j (estimated value of the parameter of the real interest differential). Accordingly, the required risk premium is 1.3 percent at an annual rate (4.4/3.3).[17] In other words, in order to induce investors to finance current account imbalance of \$26 billion, the expected real return differential has to be 1.3 percent at an annual rate.

b. Random trend

Figure 9 and the lower panel of Table 1 show that while the parameter of the real interest rate differential rose continuously from 2.6 at the end of 1974 to 4.9 at the end of the estimation period, the parameter of risk premium declined slightly from 1.6 to 1.4. Except for the estimated parameter of the real interest rate differential which is slightly bigger than in the case of random walk, the estimated parameters under random trend are fairly similar to those under the random walk.

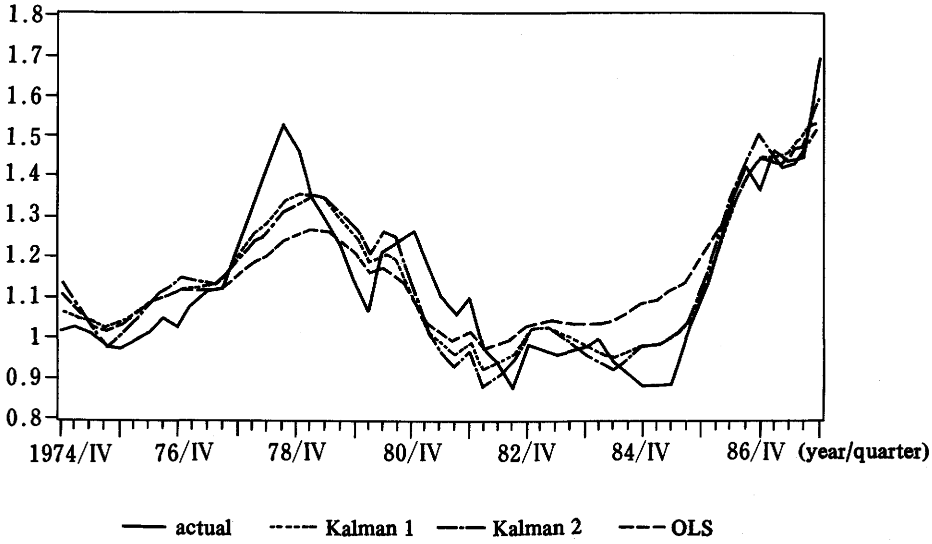
c. Comparison of the estimated equation by a Kalman filter method with an ordinary regression equation

In order to evaluate the estimated equation using a Kalman filter method, the predicted values of the real exchange rate based on the above two cases of parameters and the predicted value of the yen-dollar real exchange rate based on an ordinary least squares method are compared with the actual value of the yen-dollar real exchange rate (see upper panel of Figure 10). In this chart, Kalman 1, Kalman 2 and OLS correspond to the random walk case, the random trend case, and the ordinary least squares method, respectively. As we can observe, compared with OLS, the predicted values of the real exchange rate using Kalman filter methods are much improved. The difference between the predicted values of the real exchange rate in the two Kalman filter methods (random

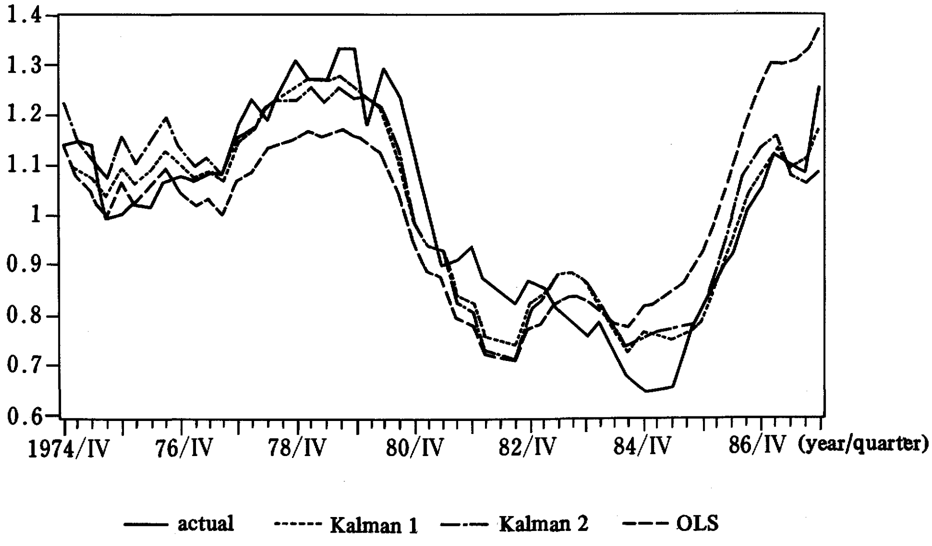
[17]Krugman (1981) and Frankel (1985) argued that given the empirical estimate of relative risk aversion (about 2), the risk premium required to induce investors to finance balance-of-payments imbalances is of negligible magnitude theoretically. Krugman (1981) also argued that the economic gain from portfolio diversification is so small that a relatively minor transaction cost prevents international diversification. However, these two *a priori* calculations are self-contradictory. If the gain from international diversification is small compared with transaction costs, many small investors would not participate in the foreign exchange market. This would reduce the effective size of the market and increase the risk premium by making effective relative risk aversion larger.

Figure 10. Comparison of Estimated Equations

Comparison of Yen/Dollar exchange rate equations



Comparison of DM/Dollar exchange rate equations



walk and random trend) is relatively small. Therefore, it seems difficult to decide which one of the two results is superior.

2. *DM-dollar rate*

Figure 11 shows movements in the estimated parameters of the real interest rate differential and risk premium (b^g and c^g respectively) of the DM-dollar real exchange rate equation. Similar to Figure 9, the upper panel shows the estimation results assuming that parameters follow random walk, while the lower panel shows estimation results assuming parameters follow random trend. Table 3 shows the values of parameters of the DM-dollar equation. As in the yen-dollar equation, the parameter of the real interest rate differential rose throughout the estimation period, while that for risk premium term was on a downward trend. Judging from the result of the random walk case, a 1 percent change in the real interest rate differential brought about a 2.5 percent change in the exchange rate at the end of 1974, but a 4.8 percent change at the end of 1987. On the contrary, a $10 billion increase in the accumulated current account balance of EMS countries raised the value of the DM against the dollar by 6.4 percent at the end of 1974, but only by 1.0 percent at the end of 1987.

Comparing the two DM-dollar equations under variable parameter methods with a simple regression equation (lower panel of Figure 10), we observe that the former is considerably improved in terms of fitting actual data.[18]

[18]In the empirical analysis of this section, we applied the Kalman filter assuming that the constant term is truly fixed while the other two parameters are not. Since we used GNP deflators in calculating real exchange rates, this assumption means that these real exchange rates defined by GNP deflators tend to converge to certain long-term equilibrium levels. However, since the estimation period is rather long (15 years), it may not be appropriate to assume that these real exchange rates converge at certain levels.

Therefore, we also estimated on the assumption that the constant term is also a variable parameter. That is, assuming that the constant term followed random walk, the two sets of estimations described in the main text were conducted for the yen-dollar and the DM-dollar exchange rates.

According to the estimation which assumes that all three parameters, a, b and c follow random walk, b and c barely changed in either the yen-dollar or the DM-dollar equations and only the constant term, a, changed. This constant term moved to the direction of the appreciation of the dollar vis-à-vis the yen and the DM in the yen-dollar and the DM-dollar equations, respectively.

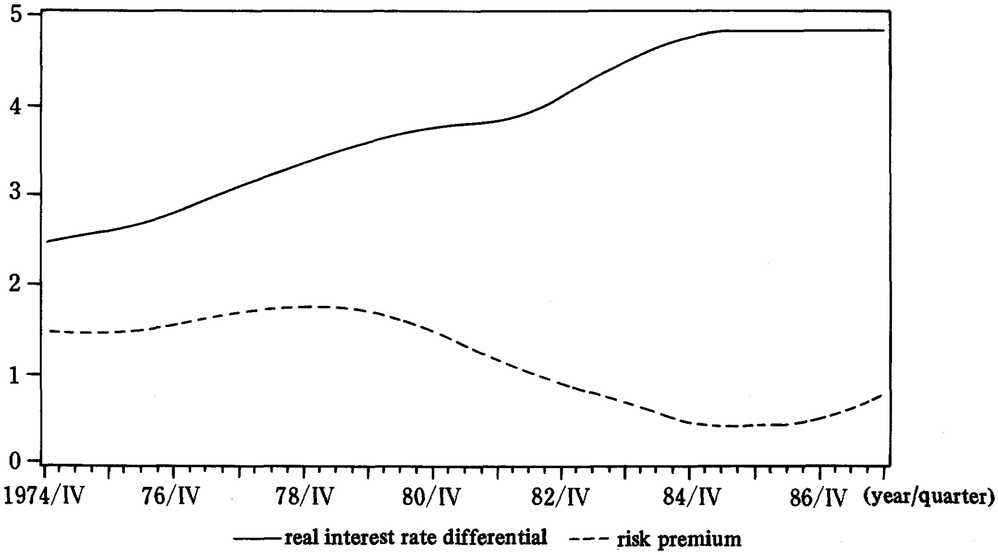
According to the estimation which assume that the constat term, a, follows random walk and b and c follow random trend, the constant term, a, barely changed, while the other two parameters, b and c were very close to the results in the main text of this paper.

These results are contradictory and it is difficult to interpret them. However, the first estimation seems to indicate that when all three parameters are assumed to follow random walk, the change in each parameter cannot be decomposed. As a result, the coefficient of the real interest rate differential, b, and that of risk premium, c, barely moves and only the constant term, a, changes. The estimation result that the constant term, a, moves to the direction of the depreciation of the yen and the DM is contrary to the conventional view that the yen will appreciate gradually in real terms, reflecting the improving competitive position of Japanese industry.

Judging from these considerations, the data seems to support the hypothesis that the relative importance of exchange rate determinants changes due to the internationalization of financial markets rather than the hypothesis that the constant term changes.

Figure 11. Parameter of DM/Dollar Equation
(Estimation result by Kalman filter method)

The case of random walk



The case of random trend

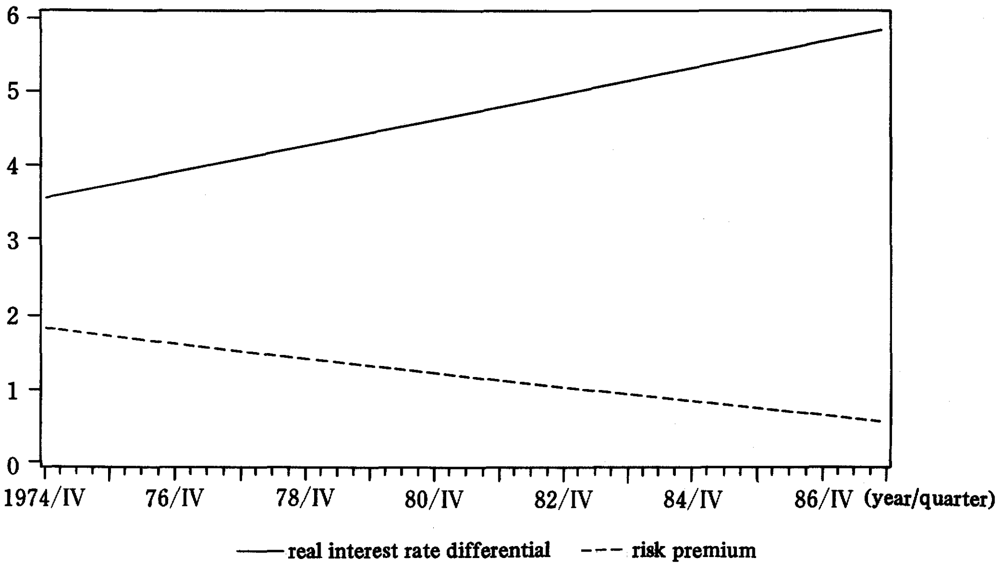


Table 3. Estimated Parameters of DM/Dollar Real Exchange Rate Equation
(Estimation results of real exchange rate equation by Kalman filter method)

The case of random walk — Estimation period 1973/I ~ 87/IV

Period	Real interest differential	Risk premium
1974/IV	2.454	1.463
1980/IV	3.768	1.486
1987/IV	4.835	0.778

The case of random trend

Period	Real interest differential	Risk premium
1974/IV	3.578	1.809
1980/IV	4.608	1.231
1987/IV	5.811	0.559

Note: The parameter of real interest rate differential shows the change of real exchange rate when the real interest differential moves by one percentage point.

VI. Conclusion

From experience under the current floating exchange rate regime, we have observed that while the impact of the real interest rate differential on the exchange rate has increased, that of the accumulated current balance has decreased. These changes in the relative importance of real exchange rate determinants conform with the theoretical analysis developed in this paper. The over-valuation of the dollar and the persistent balance of payments imbalances in the first half of the 1980s can be attributable to divergent fiscal policy among major countries and the rapid internationalization of financial markets. The latter factor contributed to the increased impact U.S. fiscal expansion had on the dollar and made it possible to finance the huge balance of payments imbalances.

It has sometimes been argued that higher capital mobility would make it easier to finance large balance of payments imbalances because of the increased depth of the foreign exchange market.[19] However, as we have seen, higher capital mobility makes real exchange rates more sensitive to divergent fiscal policy among major countries. Bigger exchange rate misalignments due to divergent fiscal policy generate larger balance of payments imbalances. These, in turn, tend to create portfolio pressure and exchange rate misalignments. Therefore, higher capital mobility does not solve balance of payments

[19]See McKinnon (1976) for an example.

problems. It merely postpones the emergence of these pressures. From this viewpoint, it is fairly easy to see how the United States had been able to postpone its policy action for so long by relying on private investors to finance its current account deficits. At the same time, Japan has also been able to offset its current account surplus by massive private capital outflows. Such large-scale private capital movements have only been possible because of the greater integration of world financial markets in recent years.

Another long-term problem connected with such exchange rate misalignments is the long cycle of exchange-rate swings. Since the *accumulated* current balance affects the *level* of the exchange rate, a country with an accumulated surplus tends to have an overvalued currency for a long time until that surplus is consumed by a flow of deficits. However, when the exchange rate approaches its presumed equilibrium level, the country concerned would still have flow deficits due to the weakened competitive position of its industries (the so-called hysteresis effect). This, in turn, pushes its exchange rate lower, beyond the equilibrium level for a period. Thus, stock-flow interaction can generate a long cycle of exchange rate swings characterized by overshooting, disturbing resource allocation among countries.

After fifteen years of experience with the floating rate regime, it has become clear that market forces alone cannot create stable exchange rates. Given that some of the large swings in real exchange rates are explained by real interest rate differentials and balance of payments imbalances, it is necessary to avoid large swings in these variables to avoid exchange rate misalignments. It is essential, therefore, for major countries to manage macroeconomic policy with due attention to international spill-over effects in order to avoid serious exchange rate misalignment and to achieve a more stable economic environment.

Appendix: Two-Country Rational Expectations Model

In this appendix, we develop a rational expectations version of the two country model shown in Section III of the text. The analysis shows that the expectations specification in the model in the text is rational under certain conditions. Moreover, this appendix supplies mathematical proof of the propositions in the text.

A. Solution of rational expectations model

The equations of the model in Section III are as follows:

$$(G-T) = S(r_t) - I(r_t) - X(e_t) \tag{A-1}$$

$$(G^*-T^*) = S^*(r^*) - I^*(r^*_t) - X^*(e_t) \tag{A-2}$$

$$r^*_t = r_t - (1/b)(e^e - e_t) - (s^2/c)\, B^*_t. \tag{A-3}$$

The first two equations are I-S equations for the United States and Japan, respectively. The third equation is uncovered interest parity (derived from equations 3 and 4 in the text). In equation (A-3), the change in the real exchange rate is expected regressively and assumed to be proportional to the difference in the log of the actual real exchange rate, e_t, from its long-term equilibrium rate, e^e. Also note that the accumulated current balance of Japan, B^*, is measured as a ratio of annual GNP. In this appendix, we assume that expectations are formed rationally and have thus reformulated equation (A-3) as follows:

$$r^*_t = r_t - \dot{e}_t - (s^2/c)\, B^*_t. \tag{A-4}$$

In the above equation, the dot over the real exchange rate indicates the time derivative of the actual real exchange rate. In order to introduce dynamics to the model, we assume that the current account surplus of Japan is proportional to the difference in the real exchange rate from its long-term equilibrium level. Hence the following equation:

$$\dot{B}^*_t = -\varphi(e_t - e^e) \tag{A-5}$$

φ= a positive constant which indicates the sensitivity of the current balance to a change in the real exchange rate.

From the above equation, we abstracted interest income on external assets and capital gains or losses from exchange rate movements. However, if the real interest rate is close to the real growth rate trend and the accumulated current balance, B^*, is expressed as a ratio of GNP, the interest income can be dropped from equation (A-5). This is because part of the increase in the accumulated current balance due to interest income is offset by the increase in GNP which is used for normalization.

By linearizing equations (A-1), (A-2), (A-4) and (A-5), we can easily solve the system. However, by introducing new notations, we can simplify the solutions. Equations (A-1) and (A-2) define the relationship between the real exchange rate and the real interest rate under given budget deficits. For a given level of budget deficits, we can define the long-term equilibrium real interest rate for each country, by solving equations (A-1) and (A-2) for real interest rates when the real exchange rate is equal to its long-term equilibrium level. For example, we can derive the long-term equilibrium real interest rate of the U.S., r^e, by solving the equation (A-1) for r at $e=e^e$. This r^e depends only on U.S. budget deficits. An increase in the U.S. budget deficits tends to raise the long-term equilibrium real interest rate of the U.S. However, budget deficits of Japan do not affect it. Because of this property, we can use r^e as an indicator of U.S. fiscal policy. Similarly, we can use the long-term equilibrium real interest rate of Japan, r^e, as an indicator of Japan's fiscal policy.

By linearlizing equations (A-1) and (A-2) and using the definition of these long-term equilibrium real interest rates, we can derive the following relationships:

$$(r_t - r^e) = \alpha(e_t - e^e) \tag{A-6}$$

$$(r^*_t - r^{*e}) = -\beta(e_t - e^e) \tag{A-7}$$

α, β= positive constants.

By eliminating r_t and r^*_t in (A-4) with equations (A-6) and (A-7), we have the following equation:

$$\dot{e}_t = (\alpha+\beta)(e_t-e^e) - (s^2/c)(B^*_t-B^{*e}) \tag{A-8}$$

where

$$B^{*e} = c(r^e - r^{*e})/s^2. \tag{A-9}$$

Thus, equations (A-5) and (A-8) form a system of differential equations which defines the dynamics of the model. By solving the characteristic equation of the system, we get two roots.

$$\lambda_1 = [(\alpha+\beta) + \sqrt{(\alpha+\beta)^2+4\varphi s^2/c}]/2 > 0 \tag{A-10}$$

$$\lambda_2 = [(\alpha+\beta) - \sqrt{(\alpha+\beta)^2+4\varphi s^2/c}]/2 > 0 \tag{A-11}$$

Out of these two roots, λ_1 corresponds to the unstable solution. Therefore, in the following analysis, we use only the negative root, λ_2. From the form of equation (A-11), we can observe that an increase in the risk tolerance parameter, c, reduces the absolute value of λ_2.

From the form of equations (A-5) and (A-8), we can easily see that the system has the following solutions:

$$e_t = C_1 \exp(\lambda_2 t) + e^e \tag{A-12}$$

$$B^*_t = C_2 \exp(\lambda_2 t) + B^{*e} \tag{A-13}$$

where C_1 and C_2 are the constants determined by the initial condition of the state variable B^* and the requirement that the solution path has to be on the saddle path. Assuming that the accumulated surplus of Japan at time t=0 is equal to B^*_0, then we obtain

$$C_2 = B^*_0 - B^{*e}. \tag{A-14}$$

By substituting solutions (A-12) and (A-13) into equation (A-5), we also obtain the initial position of the real exchange rate

$$C_1 = -(\lambda_2/\varphi)(B^*_0-B^{*e}). \tag{A-15}$$

By substituting C_1 and C_2 in equations (A-12) and (A-13), we can obtain the solution of this rational expectations model.

B. Implications of the model

From the above solutions, we can derive some important implications. First, the long-term behavior of the solution. Equations (A-12) and (A-13) indicate that e_t converges with e^e and B^*_t converges with B^{*e}. Therefore, in the long run, the real exchange rate moves to the equilibrium real exchange rate e^e and the accumulated current balance of Japan moves to its long-run equilibrium level B^{*e}. The expression of B^{*e} in equation (A-9) shows that the equilibrium surplus depends on risk tolerance, c, the long-term equilibrium real interest differential, $(r^e - r^{*e})$, and the volatility of the real exchange rate, s^2. If risk tolerance or the equilibrium real interest rate differential increase, B^{*e} increases. Therefore, an increase in U.S. budget deficits tends to raise r^e and raise the equilibrium accumulated surplus of Japan. On the other hand, if s^2 increases, making yen and dollar assets less substitutable, B^{*e} decreases.

In this long-term equilibrium, the accumulated surplus of Japan is non zero in general. Therefore, Japan either receives interest income from its external assets or pays interest on its external liabilities. As we have mentioned in the explanation of equation (A-5), if the real interest rate is equal to the real growth rate, the rate of increase in external assets from interest income or the rate of increase in external liabilities is exactly equal to this real growth rate of the economy. Thus, when the real interest rate is close to the growth rate, this long-term equilibrium is sustainable in the sense that the accumulated surplus-GNP ratio of Japan converges at a stable level.

Secondly, lets consider the short-run behavior of the solution. An increase in U.S. budget deficits immediately appreciates the real exchange rate of the dollar against the yen. By differentiating the solution of the model (A-12) with respect to r^e and using equations (A-9) and (A-15), we get

$$de_t/dr^e = \lambda_2 c/\varphi s^2 = 1/[\lambda_2 - (\alpha+\beta)] < 0 \qquad \text{(A-16)}$$

where the right-hand equality can be proved from the expression of λ_2 in equation (A-11). From the above equation we can observe that an increase in U.S. budget deficits tends to depreciate the yen against the dollar by raising r^e in the short run. Also, an increase in risk tolerance, c, tends to increase the absolute size of the above derivative by reducing the absolute size of λ_2. In other words, the short-run effect of fiscal policy on the real exchange rate becomes bigger as risk tolerance gets larger.

However, this appreciation of the dollar is temporary. The short-run depreciation of the yen generates a current account surplus for Japan. As Japan's accumulated current account surplus increases, the yen appreciates against the dollar as a result of increased risk premium (see equation A-4).

In the framework of this rational expectations model, the regressive expectations used in equation (3) of the text are also rational. Since the solution for the real exchange rate can be written as:

$$e_t = C_1 \exp(\lambda_2 t) + e^e,$$

its time derivative can be expressed as:

$$\dot{e}_t = \lambda_2 C_1 \exp(\lambda_2 t) = \lambda_2 (e_t - e^e). \tag{A-17}$$

Therefore, the expected rate of change in the real yen-dollar rate is proportional to the deviation in the real exchange rate of the yen from its equilibrium rate. Since λ_2 is negative, when the yen is overvalued (i.e. $e_t > e^e$) it is expected to depreciate, and vice versa.

C. Numerical analysis of the solution path

In order to understand the properties of the solution path of this rational expectations model more concretely, we will give some numerical examples.[20]

This section utilizes the following units of measurement.

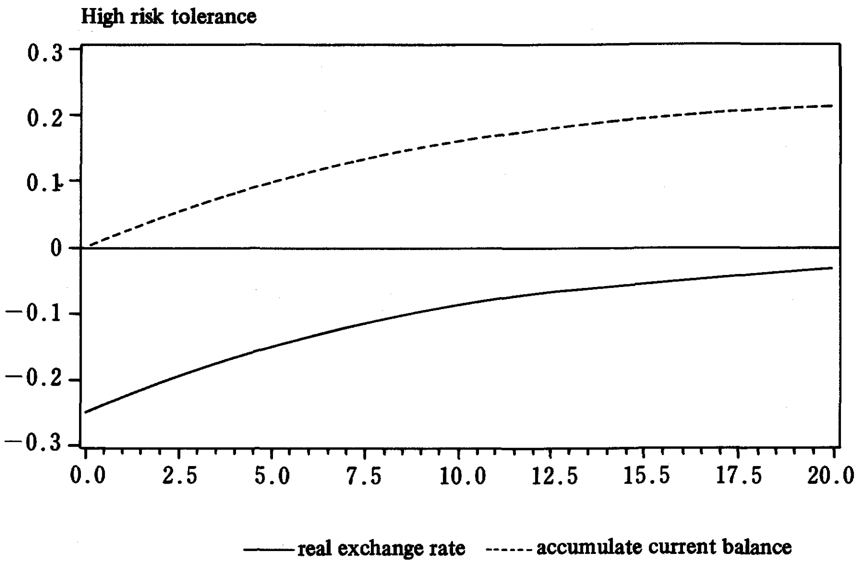
time:	year
real exchange rate:	natural logarithm of the ratio to long-term equilibrium level
current account:	ratio of GNP
accumulated current account:	ratio of annual GNP
real interest differential:	natural log of one plus annual rate of interest in fractions (ln(1+r)).

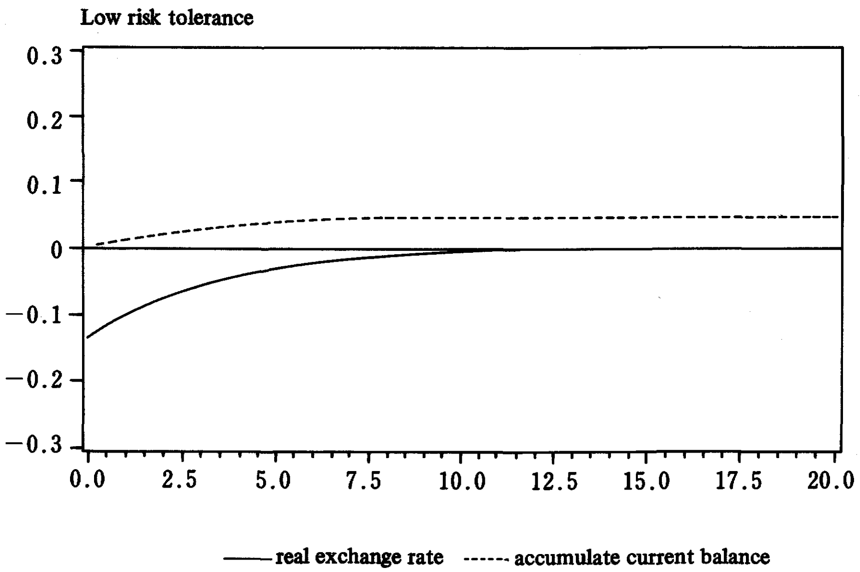
An interesting question is the behavior of the solution path when the risk tolerance parameter, c, increases. Figure A-1 shows the two solution paths for two different risk tolerance parameters. We assumed the following parameter values and initial shock. We also assume that the accumulated current balance is zero and the real exchange rate is equal to its long-term equilibrium rate initially.

$\alpha+\beta = 0.1$:	When two countries are completely symmetric, $\alpha=\beta=0.05$. This means that when the real exchange rate depreciates by 10 percent, the real interest rate increases by 0.5 percentage points.
$\varphi = 0.1$:	When the real exchange rate depreciates by 10 percent, the current account balance improves by 1 percent of GNP.
$\Delta(r^e - r^{*e}) = 0.05$:	Initial shock: The United States initiates a fiscal expansion which raises the U.S. long-term equilibrium real interest rate by 5 percentage points compared with Japan.
$s^2/c = 0.2$:	High risk tolerance: To induce investors of the two countries to finance the accumulated current account surplus equal to 10 percent of Japan's annual GNP, the expected return on dollar

[20] Amano (1985) and Ishii, et. al. (1985) made simulation analyses of the effect of the internationalization of financial markets on exchange rates, real interest rates, and current balances from a similar viewpoint as ours.

Figure A-1. Effect of Fiscal Policy





assets has to exceed that of yen assets by 2 percentage points.

$s^2/c = 1.0$: Low risk tolerance: To finance the same surplus as above, a 10-percentage-point return differential is required.

Two solution paths of the model under these parameters and initial conditions are shown in Figure A-1. The horizontal axis indicates time from the initial shock in years. The vertical axis indicates both the accumulated current account of Japan relative to its GNP and the difference in the real exchange rate from its equilibrium level. The upper panel shows the case of high risk tolerance in which only a small risk premium is required to finance imbalances in the accumulated current account. In this case, after initial fiscal expansion in the United States, the yen immediately depreciates 25 percent and gradually appreciates towards its equilibrium level thereafter. Japan's accumulated current account surplus approaches 25 percent of GNP.

The lower panel shows the case of low risk tolerance. When risk tolerance is low, the yen depreciates only 14 percent in face of the same fiscal shock. The speed of convergence of the real exchange rate in this case is faster than the case above. The accumulated current balance approaches 5 percent of Japan's GNP. Thus, the variability of the exchange rate and the accumulated current balance under low risk tolerance is smaller than that under high risk tolerance.

D. Relative importance of exchange rate determinants

In the above, we analyzed the effect of fiscal policy on the exchange rate and the current balance using a rational expectations model. In this framework, the solution path of the exchange rate is completely determined by ultimate exogenous variables such as long-term equilibrium real interest rates and the initial condition of the accumulated current balance (see equations A-12 and A-13). However, immediate exchange rate determinants are the real interest rate differential and the accumulated current balance (see equation 5 in the text). Therefore, in this section, we theoretically analyze the relationship between the exchange rate and these immediate determinants.

The solution paths of the exchange rate and the accumulated current balance certainly satisfy the exchange rate equation (A-4). From this equation and the equation on the formation of exchange-rate expectations, we obtain the following equation, which corresponds to equation (5) in the text.

$$e = e^e - (1/\lambda_2)(r^* - r) - [s^2/(c\lambda_2)]\, B^* \qquad \text{(A-18)}$$

The internationalization of financial markets tends to increase risk tolerance, c. By comparing equations (A-18) and (5) in the text, we find the following correspondence between the risk tolerance parameter and the importance of the real interest rate differential on exchange rate determination:

$$b = -1/\lambda_2. \qquad \text{(A-19)}$$

As the parameter of risk tolerance, c, increases, the absolute value of λ_2 decreases, making b larger. This increase in b tends to increase the effect of real interest rate differentials on the real exchange rate.

From equation (A-11), we can see that as c gets bigger, λ_2 declines and b becomes larger. This increase in b tends to increase the impact of the real interest rate on the real exchange rate. As c goes to infinity, λ_2 approaches zero and b goes to infinity. Although this means that the coefficient of the real interest term of the exchange rate equation (5) in the text goes to infinity, it does not imply that the variability of the exchange rate becomes boundless. This is because, as the sensitivity of the exchange rate to the real interest rate increases, the convergence of real interest rates across countries gets stronger, making the real interest rate differential smaller. When the U.S. adopts an expansionary fiscal policy, the U.S. real interest rate rises and the yen depreciates against the dollar sharply. This depreciation of the yen improves the current balance of Japan and pushes up Japan's real interest rate, making the real interest rate differential narrower.

We can also show that the responsiveness of the real exchange rate to a change in the accumulated current balance becomes smaller as risk tolerance gets bigger. As we have seen in equation (5), this responsiveness depends on the size of $[-s^2/(c\lambda_2)]$. From equations (A-19) and (A-16), we have

$$-s^2/(c\lambda_2) = -[\lambda_2-(\alpha+\beta)]/\varphi. \qquad \text{(A-20)}$$

On the right-hand side of the above equation, all parameters are positive except for λ_2 and only this parameter depends on risk tolerance, c (see equation A-11). Since an increase in the risk tolerance tends to reduce the absolute size of λ_2, the absolute size of the left-hand side of the equation becomes smaller. This will reduce the effect of the accumulated current balance on the real exchange rate.

However, even if risk tolerance gets bigger, the effect of the accumulated current balance does not approach zero. We can show that the value of equation (A-20) converges to a non-zero finite value as c increases.

$$\lim_{c\to\infty} [-s^2/(c\lambda_2)] = (\alpha+\beta)/\varphi. \qquad \text{(A-21)}$$

This is because, as c increases, λ_2 decreases, offsetting the effect of the initial increase in c on $[-s^2/(c\lambda_2)]$. This can be explained intuitively as follows. As risk tolerance of the market increases, the required risk premium to finance the given amount of the accumulated current balance (annual rate of return differential) will decline (see equation 4 in the text). However, at the same time, the effect of the accumulated current account balance on the real exchange rate, which tends to push the real exchange rate, e_t, towards its equilibrium rate, e^e, also becomes smaller (a smaller λ_2). Under our assumption of rational expectations, this change in the adjustment speed is correctly perceived by investors. Under (e_t-e^e), the expected rate of change in the real exchange rate becomes smaller. Therefore, the divergence of the real exchange rate, e_t, from its equilibrium level, e^e, which is required to generate a given expected rate of change in the real exchange rate, has to be larger. Thus, while an increase in c reduces the risk premium in terms of the annual rate of return differential, the effect of risk premium on the level of the real exchange rate does not become smaller than the above limit.

On the other hand, an increase in the sensitivity of the current account to a change in the real exchange rate, φ, tends to increase the absolute value of λ_2, making b smaller. This tends to reduce the effect of the real interest rate differential on the real exchange rate (see equation A-19). The smaller b also reduces the effect of the accumulated current balance (see equation A-20). An increase in φ also reduces the effect of the current balance on the exchange rate. This is because an increased speed of adjustment in the current account balance tends to reduce b, making the required difference between the real exchange rate and the long-term equilibrium real exchange rate smaller (see equation A-18).

E. Numerical analysis of the relative importance of exchange rate determinants

In this section, we numerically analyze the effects of structural changes in international financial markets and trade structure on the relative importance of exchange rate determinants.

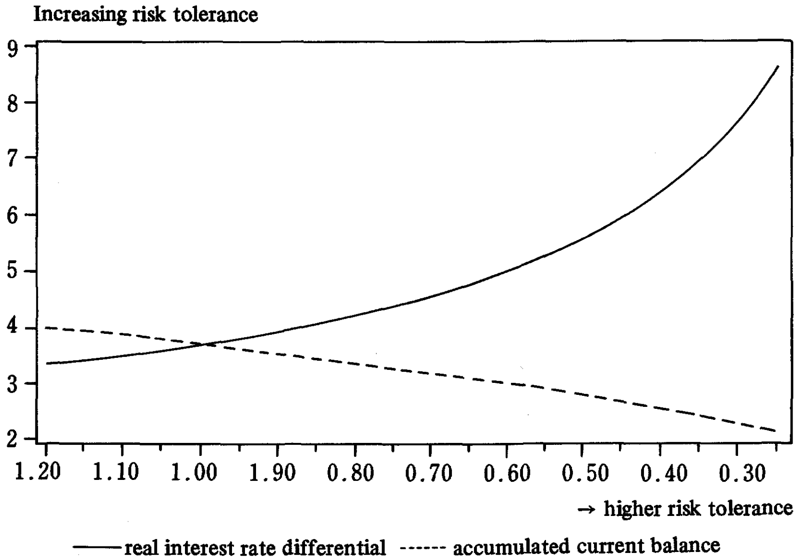
The upper panel of Figure A-2 shows the change in the relative importance of the real interest differential and the accumulated current balance as real exchange rate determinants when risk tolerance changes. The horizontal axis measures the risk tolerance parameter by s^2/c. In this figure, this risk tolerance parameter is varied between 0.3 to 1.2 and as we move to the right, s^2/c becomes small (i.e. risk tolerance, c, increases). All other parameters are the same as in Figure A-1.

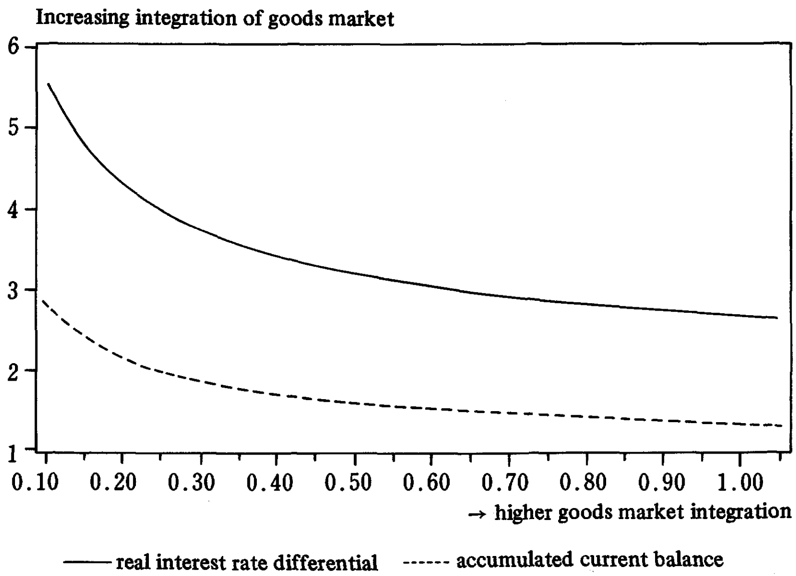
As we can clearly see from the figure, as risk tolerance gets bigger, the importance of the real interest rate differential sharply increases. When risk tolerance is small, e.g. s^2/c is equal to 1.0, a one-percentage-point change in the real interest rate differential moves the real exchange rate by 3.7 percent. On the other hand, when the risk tolerance is large, e.g. s^2/c is equal to 0.3, the same change in the real interest rate moves the real exchange rate by 7.7 percent.

The importance of the accumulated current balance gradually falls as risk tolerance increases. When s^2/c is equal to 1.0, a one percent change in the accumulated current balance relative to GNP moves the real exchange rate by 3.7 percent. On the other hand, when s^2/c becomes 0.3 and risk tolerance is large, the same change in the current balance moves the real exchange rate by 2.3 percent. However, the effect of the accumulated current balance does not decline less than 1.0 percent which is the smallest possible effect of the 1 percent change in the accumulated current balance given by equation (A-21).[21]

Finally, let's consider the change in the relative importance of exchange rate determinants when integration of goods markets progresses. The lower panel of Figure A-2 shows the change in the relative importance of the real interest differential factor and the

Figure A-2. Relative Importance of Determinants of Exchange Rate





accumulated current account balance factor when the sensitivity of the current balance against a change in the real exchange rate, φ, shifts. The horizontal axis stands for this parameter, φ, with a range between 0.1 to 1.0. On the other hand, risk tolerance is fixed to be equal to 0.5 in terms of s^2/c. Here, we have to pay attention to the fact that the values of α and β are not independent from the movements of φ. As the current balance becomes more sensitive to a change in the real exchange rate, the real interest rate also becomes more susceptible to a change in the real exchange rate (see equations A-1, 2, 6, 7). Therefore, in this diagram, α and β are assumed to be proportional to φ(actually we set $\alpha+\beta=\varphi$). Also, other parameters are assumed to be the same as in Figure A-1.

As integration of goods markets progresses (as φ increases), the impact of changes in the real interest rate differential and the accumulated current balance declines. When integration of goods markets is low (e.g. φ is equal to 0.1), a one-percentage-point change in the real interest rate differential moves the real exchange rate by 5.6 percent. However, when integration of goods markets is high (e.g. φ is equal to 1.0), the same change in the real interest rate differential moves the real exchange rate 2.7 percent. Regarding the effect of the accumulated current balance, the impact of one percent change in the balance declines from 2.8 percent to 1.4 percent as φ increases from 0.1 to 1.0.

Thus, integration of goods markets tends to reduce the variability of real exchange rates.

[21]Analysis in this Appendix shows that the effect of an accumulated current balance as an immediate real exchange rate determinant does not converge to zero as risk tolerance goes to infinity (see equation A-21). However, the full solution of the model, (A-12) and (A-5), indicates that the effect of the initial value of the accumulated current balance, B^*_0, on the real exchange rate at the beginning of the simulation is determined by $(-\lambda_2/\varphi)$. As risk tolerance c increases, this converges to zero. This is because, at the limit of $c \to \infty$, the non-zero effect of the initial value of B^*_0 on the exchange rate is exactly offset by the change in the real interest rate differential induced by the change in the initial value of the accumulated current balance.

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