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Effects of Changes in Monetary Policy under Managed Dual Exchange Rates

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Abstract

This paper analyzes how the commercial and financial exchange rates adjust over time under the regime of managed dual rates, following an unanticipated increase in the money supply. It is shown that if the official intervention is light, the commercial rates will first rise, then fall either directly or cyclically to its long-run equilibrium. The financial rates will first overshoot, then deviate further from its long-run equilibrium before it finally returns to the equilibrium either directly or cyclically. These two patterns of adjustment are very different from those under the "pure" dual exchange rates.

Introduction

In order to insulate the current account foreign exchange market from the erratic movement of international capital movements, many countries have adopted a dual exchange rates system under which the ccurrent and capital account foreign exchange

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transactions are separated, each having its own market and its own price. It is interesting to know how the exchange rates in the two markets adjust over time following a disturbance in the market, such as an unanticipated increase in money supply.

The literature on the dynamic adjustment path of the exchange rates under such a circumstance is fruitful. Cumby(1984), Aizenman(1985), Gardner(1985), Bhandari(1985), and Lai and Chu(1986a)(1986b), for examples, can all be considered to have made important contributions in analyzing the problem. However, to date it seems that there has not been anything done on the dynamic paths of the exchange rates under a "managed" dual exchange rates system under which the financial rate in the capital account market floats freely while a managed floating regime is adopted for the commercial rate in the current account market. The importance of such an arrangement should not be overlooked. According to the 1984 issue of *IMF Annual Report*, five countries have joined this club of managed dual rates as of June 1984.[1] This paper is therefore written to analyze the problem of the dynamic adjustment of the exchange rates for a small open economy that adopts the regime of managed dual exchange rates.

In what follows, we will present the basic model and its long-run equilibrium configurations in section II. Section III then discusses the short-run properties of the solutions, and section IV describes the dynamic adjustment paths of the exchange rates over time. Finally, section V summarizes the findings of entire paper.

I. The Theoretical Framework and Long-Run Equilibrium

The model to be presented below is a simple extension of the Frenkel and Rodriquez (1982) model. It assumes that : (i) the open economy is small in the sense that it cannot affect foreign interest rate and foreign price of imports ; (ii) the domestic output is exogenously fixed at its full-employment level, given freely flexible wage in the labor market ; (iii) domestic price responses to excess demand in the goods market sluggishly ; (iv) expectations are formed regressively[2] ; (v) the authorities intervening in the commercial exchange market adopt the policy of "leaning against the wind ;" (vi) the residents regard the domestic and foreign bonds as perfect substitutes.

Throughout this paper, the following notations will be used : k=positive speed adjustment in the goods market ; p=domestic price level ; I=investment expenditure ; r=nominal interest rate ; S=saving ; y=full-employment output ; G=government

1.They are Costa Rica, Mexico, Ecuador, Uganda, and Afghanistan.

2.For an empirical justification of this expectation form, see Frankel and Froot (1987).

expenditure ; B=current account balance ; e_c=commercial exchange rate (the domestic currency price of foreign exchange) ; L=real demand for money ; D=domestic credit ; R=foreign exchange reserves ; K=capital account balance ; e_f=financial exchange rate (the domestic currency price of foreign exchange) ; t=time ; i=real interest rate ; and $q(=e_c p^*/p)$=terms of trade where an "*" indicates a foreign variable. In addition, we will use "Λ" to indicate the long-run equilibrium value, and " · " to indicate the rate of change with respect to time.

As in Dornbusch (1976) et al., the domestic price adjusts sluggishly according to goods market excess demand, i.e.,

$$\dot{p}=k\{I[r-\theta_P(\hat{p}-p)/p]-s(y)+G+B(y,\ e_c p^*/p)\} \tag{1}$$

where $I_i=\frac{dI}{di}<0$ and $B_q=\frac{\partial B}{\partial q}>0$ by assuming that the Marshall-Lerner condition is satisfied. Given reqressive expectations, the expected price level, p^e, is given by

$$p^e=\theta_P\hat{p}+(1-\theta_P)p$$

it follows that the real interest rate is $r-\frac{\theta_P(\hat{P}-P)}{P}$.

Equilibrium in the money market obtains when the demand for money balances equals the supply of money balances:

$$L(y,\ r)=\frac{D}{P}+R \tag{2}$$

where $L_r=\frac{\partial L}{\partial r}<0.$

In the current account foreign exchange market, since e_c is not allowed to be completely flexible, however much imbalance that arises there will be reflected in the changes in official foreign reserves:

$$\dot{R}=B(y,\ \frac{e_c P^*}{P}\ ) \tag{3}$$

In the capital account market, assuming domestic and foreign bonds are perfect substitutes, the following interest rae parity will hold

$$r=\frac{r^*(\theta_C\hat{e}_C+(1-\theta_C)e_C)}{e_f}+\frac{\theta_f(\hat{e}_f-e_f)}{e_f} \tag{4}$$

where the expressions on the LHS and the RHS measure the yields on domestic bonds and foreign bonds respectively.[3]

Finally, in the commercial foreign exchange market where official intervention is taking place, we have assumed that the authorities will lean against the wind, that is, they will purchase (sell) foreign reserves whenever the domestic currency tends to appreciate (depreciate) :

$$\dot{R}=E(e_C-\bar{e}_C) \tag{5}$$

where $E'=\dfrac{dE}{d(e_C-\bar{e}_C)}<0$ and $\bar{e}_C$ is the publicly known and exogenously determined target commercial exchange rate that the authorities attempt to defend.[4]

It is worth noting that if $E'\to-\infty$, i.e., the government is determined to intervene in the commercial foreign exchange market to maintain the officially announced commercial exchange rate, the commercial exchange rate becomes fixed in effect.[5] If, on the other hand, E' is finite, the model becomes what we call a "managed dual exchange rates" system where there is active but not complete official intervention in the commercial foreign exchange market. This is the case to be considered in this paper.

Equations (1)$-$(5) thus define the macroeconomic structure of our small open economy, and they contain five endogenous variables : p, r, R, e_C and e_f. At long-run equilibrium, since $\dot{p}=\dot{R}=0$, $p=\hat{p}$, $r=\hat{r}$, $R=\hat{R}$, $e_C=\hat{e}_C$, and $e_f=\hat{e}_f$, differentiating totally equations (1)$-$(5), with $p=e_C=e_f=1$ and $B=0$ as the initial values, we have

3.See, e.g., Flood (1978), Marion (1981), Gardner (1985), and Lai and Chu (1986b) for detailed derivation. A point that is worthwhile mentioning here is that, under the (pure) dual rates system, e_C is fixed, so the first term of this expression becomes $r^*\bar{e}_C/e_f$, while in the current model, e_C is allowed to float under management, so $\theta_C\hat{e}_C+(1-\theta_C)e_C$ becomes the expected commercial exchange rate in the current market.

4.This kind of behavior equation is also used by Galbis (1975), Roper and Turnovsky (1980), Bhandari (1982, ch. 13), Frenkel and Aizenman (1982), and Turnovsky (1983a) (1983b).

5.The other extreme is that the government does not intervene at all in the commercial foreign exchange market, so both the commercial and financial exchange rates become flexible. See Lai and Chu (1986b) for the dynamic adjustment of the exchange rates in this case.

$$\begin{bmatrix} -B_q & I_1 & 0 & B_q & 0 \\ D & L_r & -1 & 0 & 0 \\ -B_q & 0 & 0 & B_q & 0 \\ 0 & 1 & 0 & -r^* & r^* \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} d\hat{p} \\ d\hat{r} \\ d\hat{R} \\ d\hat{e}_c \\ d\hat{e}_f \end{bmatrix} = \begin{bmatrix} 0 \\ dD \\ 0 \\ 0 \\ de_c \end{bmatrix} \tag{6}$$

By Cramer's rule, it follows that

$$\frac{\partial \hat{P}}{\partial D} = \frac{\partial \hat{r}}{\partial D} = \frac{\partial \hat{e}_c}{\partial D} = \frac{\partial \hat{e}_f}{\partial D} = 0 \tag{7}$$

$$\frac{\partial \hat{R}}{\partial D} = -1 \tag{8}$$

Equations (7) and (8) state that an expansion in domestic credit will only reduce the foreign reserves by an equal amount and leave all other variables intact in the long run. These results are similar to those of Cumby (1984), Aizenman (1985), Gardner (1985) and Lai and Chu (1986a) under the regime of "pure" dual exchange rates, which means that e_c is fixed completely while e_f floats freely in the market. Evidently, the real consequences of our introducing official intervention in the commerical foreign exchange market do not show up at all at long-run equilibrium. They are, however, very important in affecting the dynamic adjustment paths of the exchange rates over time, to be explained below.

Ⅱ. Short-Run Effects

For the short-(and intermediate-)run effects of expansionary monetary policy, first combine equations (3) and (5) to get :

$$B(y, \ \frac{e_c P^*}{P}) = E(e_c - \bar{e}_c) \tag{9}$$

which means however much the current account may be imbalanced in the short-or intermediate-run, the amount of this imbalance, B, must be equal to the amount purchased or sold by the authorities, E, at any point in time. Then, since equations (2) and (4) will also hold at any point in time, totally differentiating these two equations and equation (9) while treating p and R as exogenous variables, we have

$$\begin{bmatrix} L_r & 0 & 0 \\ 0 & B_q-E' & 0 \\ 1 & -r^*(1-\theta_c) & (r^*+\theta_f) \end{bmatrix} \begin{bmatrix} dr \\ de_c \\ de_g \end{bmatrix} = \begin{bmatrix} dD+dR-Ddp \\ B_q dp \\ r^*\theta_c d\hat{e}_c+\theta_f de_f \end{bmatrix} \tag{10}$$

Using $\frac{\partial \hat{e}_c}{\partial D}=\frac{\partial \hat{e}_f}{\partial D}=0$ from equation (7), the following three short-run reduced equations can be obtained from equation (10):

$$r=r(\underset{+}{P},\ \underset{-}{R},\ \underset{-}{D}) \tag{11}$$

$$e_c=e_c(\underset{+}{P},\ \underset{0}{R},\ \underset{0}{D}) \tag{12}$$

$$e_f=e_f(\underset{\pm}{P},\ \underset{+}{R},\ \underset{+}{D}) \tag{13}$$

where the signs of the partial derivatives of the functions are indicated under the respective variables. The explicit forms of these partial derivatives are

$$r_P=\frac{\partial r}{\partial p}=\frac{-D}{L_r}>0 \tag{11a}$$

$$r_R=\frac{\partial r}{\partial R}=r_D=\frac{\partial r}{\partial D}=\frac{1}{L_r}<0 \tag{11b}$$

$$(e_c)_P=\frac{\partial e_c}{\partial p}=\frac{B_q}{B_q-E'}>0 \tag{12a}$$

$$(e_f)_P=\frac{\partial e_c}{\partial p}=\frac{D(B_q-E')+r^*B_qL_r}{L_r(B_q-E')(r^*+\theta_f)}<0 \tag{13a}$$

$$(e_f)=\frac{\partial e_f}{\partial R}=(e_f)_D=\frac{\partial e_f}{\partial D}=\frac{-1}{L_r(r^*+\theta_f)}>0 \tag{13b}$$

Comparing $\frac{\partial e_c}{\partial D}$ with $\frac{\partial \hat{e}_c}{\partial D}$ and $\frac{\partial e_f}{\partial D}$ with $\frac{\partial \hat{e}_f}{\partial D}$, the relationship between the short- and the long-run exchange rates corresponding to an expansion in

money supply are

$$\frac{\partial e_c}{\partial D}-\frac{\partial \hat{e}_c}{\partial D}=0 \tag{14}$$

$$\frac{\partial e_f}{\partial D}-\frac{\partial \hat{e}_f}{\partial D}=\frac{-1}{L_r(r^*+\theta_f)}>0 \tag{15}$$

Equation (14) says that the commercial exchange rate will display no undershooting or overshooting phenomenon following an expansion in money supply with both short- and long-run effects being identical to zero. On the contrary, the financial exchange rate will definitely exhibit an overshooting phenomenon, as clearly indicated by the positive difference between $\frac{\partial e_f}{\partial D}$ and $\frac{\partial \hat{e_f}}{\partial D}$ in equation (15).

Ⅲ. Dynamic Adjustment

In this section we will investigate the adjustment process of the commercial and the financial exchange rate following an unanticipated increase in the money supply. Substituting equations (7)-(8) and (11)-(13) into (1) and (3), we obtain

$$\dot{P}=J(\underset{-}{P},\ \underset{+}{R},\ \underset{+}{D}) \tag{16}$$

$$\dot{R}=H(\underset{-}{P},\ \underset{0}{R},\ \underset{0}{D}) \tag{17}$$

where

$$J_P=k[I_i(r_P+\theta_P)+B_q((e_c)_P-1)]<0 \tag{16a}$$

$$J_R=J_D=k(I_ir_R+B_q(e_c)_R)>0 \tag{16b}$$

$$H_P=B_q((e_c)_P-1)<0 \tag{17a}$$

The dynamic system of equations (16) and (17) is described in Figure 1. The slopes of the $\dot{P}=0$ and $\dot{R}=0$ curves are

$$\frac{\partial_P}{\partial_R}/\dot{P}=0 = \frac{-J_R}{J_P} >0 \tag{18}$$

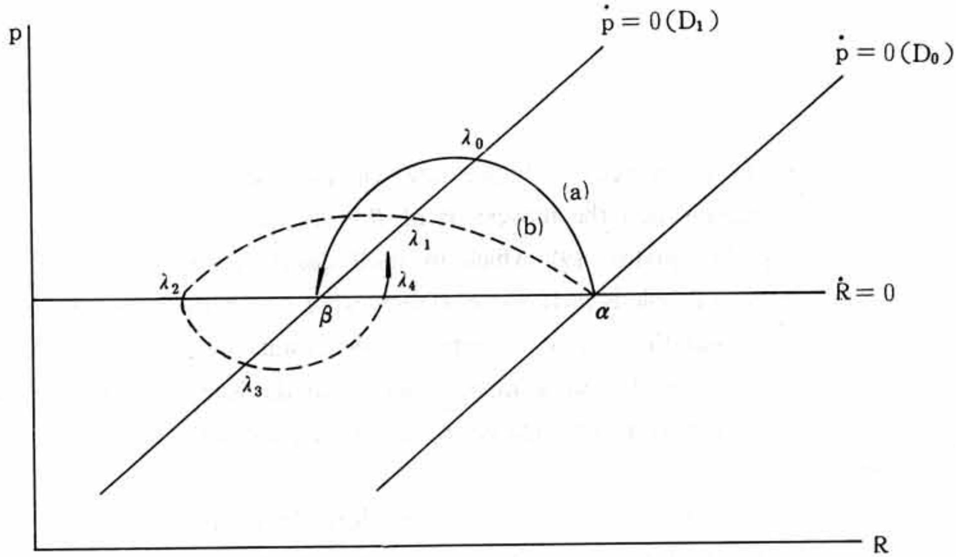
$$\frac{\partial_P}{\partial_R}/\dot{R}=0 = \frac{-H_R}{H_P} =0 \tag{19}$$

respectively. The charateristic equation corresponding to the system is

$$\delta^2-J_P\delta-H_PJ_R=0 \tag{20}$$

where δ is the characteristic root. Given the signs reported in (16) and (17), it is clear that the system is definitely stable.

(Figure 1)



In Figure 1, suppose initially the economy is at α. Following an increase in money supply, the $\dot{p}=0(D_0)$ curve will shift leftwards to $\dot{p}=0(D_1)$ while the $\dot{R}=0$ curve will remain intact. The new steadystate equilibrium point, β, must therefore lie horizontally to the west of point α on the $\dot{R}=0$ curve. Between α and β, there are two possible patterns of adjustment in p and R. If in equation (20),

$$J^2_P > -4H_P J_R \tag{21a}$$

the adjustment path would be non-cyclical, as indicated by path (a) in Figure 1. If on the other hand

$$J^2_P < -4H_P J_R \tag{21b}$$

path (b) in Figure 1 will prevail.

Given the adjustment path of (p, R) in Figure 1, we can now discuss the focal point of this paper, that is, how the commercial and the financial exchange rates change according to how the domestic price and the level of foreign reserves adjust over time.

Consider first the commercial exchange rate.

1. The Commercial Exchange Rate

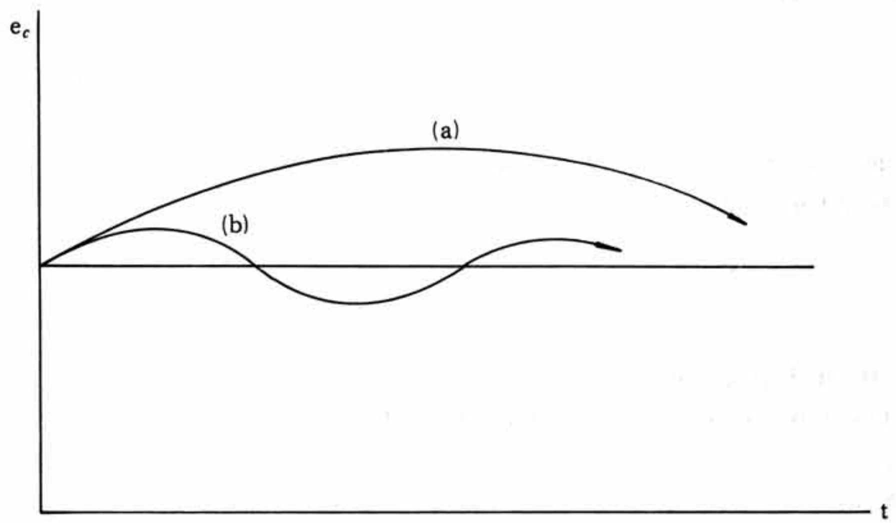
Differentiate equation (12) with respect to t,

$$\dot{e}_C = \underset{+}{(e_C)_P}\dot{p} \tag{22}$$

which means that the commercial exchange rate will increase (decrease) as domestic price increases (decreases), and the movement of R will have no effects on e_C. This is hardly surprising. In equation (9), which by itself determines the level of e_C, the only other endogenous variable is p. If p rises (falls), exports of domestic goods become more (less) expensive and the current account will deteriorate (improve), causing the commercial exchange rate to depreciate (appreciate), given the leaning-against-the-wind ($E' < 0$) pattern of official intervention, and given the unchanged official target commercial exchange rate, $\bar{e}_C$.

The movement in e_C over time should now be clear. As (p, R) moves along path (a) from α to the point of interesection between path (a) and $\dot{p}=0(D_1)$ in Figure 1, p rises, and e_C too will rise. Once (p, R) moves beyond that point, however, p starts to fall and so does e_C. The movement in e_C as (p, R) moves along path (a) in Figure 1 can therefore be represented by path (a) in Figure 2.

(Figure 2)



If (the dotted) path (b) in Figure 1 prevails, p must move cyclically. In this case, path (b) in Figure 2 describes the corresponding movement in e_C.

Thus, there are two possible patterns of movements is e_C, given by paths (a) and (b) in Figure 2. These movements are necessary to maintain the current account equation (9) as the terms of trade changes as a result of the movements in the domestic price level. In contrast, under a "pure" dual rates system referred to above, whatever the amount of current account imbalance may be as the terms of trade changes, it is totally absorbed by changes in the foreign reserves, so e_C remains intact.

2. The Financial Exchange Rate

Differentiating equation (13) with respect to time yields

$$\begin{aligned}\dot{e}_f &= \underset{\pm}{(e_f)_P}\dot{p} + \underset{+}{(e_f)_R}\dot{R} \\ &= \underset{+}{(\dot{e}_f)_R\dot{R}}[1+(\frac{(\dot{e}_f)_P}{(\dot{e}_f)_R})\ (\frac{\dot{P}}{\dot{R}})] \end{aligned} \tag{23}$$

where $(\dot{p}/\dot{R})$ is the slope of the dynamic path from α to β in Figure 1.

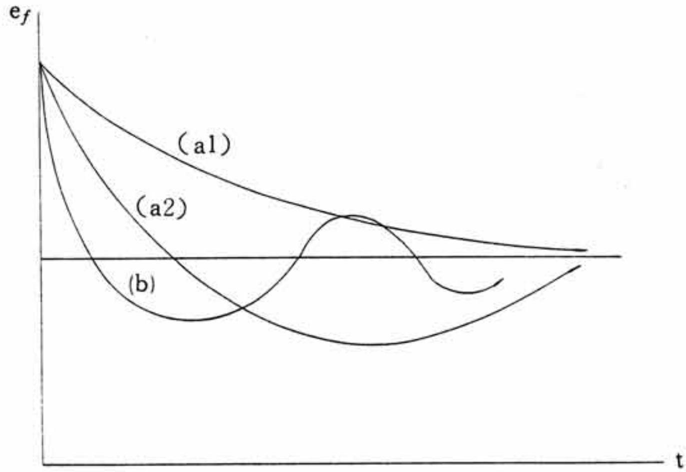
The sign of equation (23) depends on the signs of $(e_f)_P$ and $(e_f)_R$, given the signs of $\dot{p}$ and $\dot{R}$ in Figure 1. We know $(e_f)_R$ is positive but $(e_f)_P$ is ambiguous in sign, so we have to consider both of its possible cases.

(i) $(e_f)_P<0$

Consider now path (a) in Figure 1. Before (p, R) hits the intersection of path (a) and $\dot{p}=0$ (D_1) (point λ_0), p rises and R falls, equation (23) is negative so e_f falls. Beyond the intersection, since $\dot{R}$ is still negative but $\dot{p}$ becomes negatives as well, the sign of e_f is undetermined.There are, however, only two possibilities. One possibility is that nowhere on the positively sloped portion of the path (a) is its slope greater than $(\dot{p}/\dot{R})_{ca1}(>0)$, the critical value of $\dot{p}/\dot{R}$ at which $\dot{e}_f=0$ in equation (23), when $(e_f)_P<0$ and path (a) in Figure 1 prevails. If this is the case, e_f will continue falling throughout the entire path (a) in Figure 1 as (p, R) moves from α to β, and path $(a1)$ in Figure 3 represents the e_f path over time.

The other possibility is that as (p, R) moves towards β on the positively sloped portion of path (a) in Figure 1, the slope of path (a), which continues increasing in value, at one point becomes equal to (and subsequently greater than)$(\dot{p}/\dot{R})_{ca1}$. Should this be the case, $\dot{e}_f$ will become positive after this critical point is passed, so the time path of e_f will look like path (a2) in Figure 3.

(Figure 3)



Turn now to path (b) in Figure 1. Before (p, R) reaches the point of intersection between this path and $\dot{p}=0$ (D_1) in the figure (point λ_1), the story is the same as for path (a), and e_f falls. Beyond point λ_1, we can again obtain for equation (23) a critical value, $(p/\dot{R})_{cb1}$, at which $\dot{e}_f=0$, when $(e_f)_P<0$ and path (b) in Figure 1 prevails. This time, however, there has to be a slope between points λ_1 and λ_2 on path (b) in Figure 1 that is equal to $(\dot{p}/\dot{R})_{cb1}$ because the slope of path (b) is zero at λ_1 and approaches positive infinity as (p, R) approaches λ_2, while $(\dot{p}/\dot{R})_{cb1}$ is positive and finite. In other words, there has to be a point on path (b) between λ_1 and λ_2, such that before (p, R) reaches this point, $\dot{e}_f$ remains negative, but after (p, R) passes it, $\dot{e}_f$ becomes positive.

By analogous reasoning, it can be shown that on path (b) between points λ_2 and λ_3, $\dot{e}_f$ is positive, and that between points λ_3 and λ_4, there exists a critical point at which the sign of equation (23) changes from being positive to negative, as (p, R) moves on.

So far path (b) in Figure 1, the entire dynamic path of e_f can now be summarized in Figure 3 by path (b).

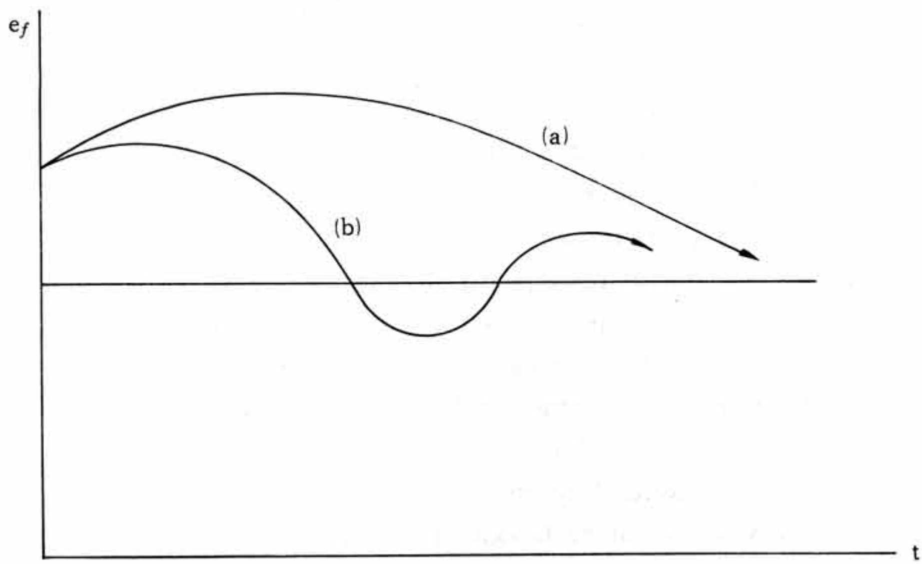
The three different patterns of adjustment in e_f that we have identified so far are the same as those in Lai and Chu (1986a), which models the dynamic path of e_f under a "pure" dual exchange rates system. This is not surprising. In equation

(13a), the sign of $(e_f)_P$ or $\frac{\partial e_f}{\partial P}$ depends on E´. The larger the absolute value of E´ is, the more likely it is for $(e_f)_P$ to be negative. Under a "pure" dual rates system, E´ approaches $-\infty$, so $(e_f)_P$ has to be negative. However, even if E´ does not approach negative infinity under a managed dual rates system, $(e_f)_P$ is negative if the absolute value of E´ is large enough. In other words, if the official intervention in the current account foreign exchange market is sufficiently heavy, the patterns of changes in e_f over time would be similar to those patterns under a fixed commericial exchange rate system. This explains the similarity between Figure 3 and the findings in Lai and Chu (1986a).

(ii) $(e_f)_P>0$

If the official intervention is sufficiently light so that e_C becomes relatively quite flexible, $(e_f)_P$ in equation (23) may become positive (see equation (13a)). In this case, again one has to consider paths (a) and (b) in Figure 1 separately. Assume path (a) is the case. As (p, R) moves from α to λ_0, p rises and R falls, so the sign of equation (23) is ambiguous. But it can be shown that the critical value of $(\dot{p}/\dot{R})$ at which $\dot{e}_f=0$ in equation (23), call it $(\dot{p}/\dot{R})_{ca2}$ in this case, has to be (in absolute value) smaller

(Figure 4)



6.This is so because the slope of path (a) at α is infinite. See the Appendix for details.

than the slope of path (a) at α but greater than zero or the slope of path (a) at λ_0.[6] In oher words, $(\dot{p}/\dot{R})_{ca2}$ must be equal to the slope of some point on path (a) between α and λ_0. This implies that as (p, R) initially moves away from α, $\dot{p}/\dot{R}$ of path (a) is smaller than $(\dot{p}/\dot{R})_{ca2}$, so $\dot{e}_f$ is positive. Over time, (p, R) will pass the critical point and $\dot{e}_f$ become negative. So in this case, the movement in e_f should look like path (a) in Figure 4.

Next consider path (b) in Figure 1. Here, too, it can be shown that the critical slope of the time path at which $\dot{e}_f=0$ is somewhere between α and λ_1 on path (b), reappears somewhere between λ_2 and λ_3 on the same cyclical path, and so on so forth. So now the time path of e_f should be path (b) in Figure 4, applying analogous reasoning to what was discussed above.

The two patterns of movement in e_f in Figure 4 are the most important findings of this paper. Here we show that if the commercial exchange rate in the current account market is not completely fixed but rather allowed to be floating under official intervention, under certain circumstances, in particular if intervention is rather light, the financial exchange rate will first overshoot following an unantipated expansion in money supply, then *deviate further* from its long-run eqilibrium, before it finally returns.

Why this is the case is not hard to understand. Recall equation (4) where

$$\frac{r^*(\theta_C\hat{e}_C+(1-\theta_C)e_C)}{e_f}+\frac{\theta_f(\hat{e}_f-e_f)}{e_f}$$

is the yield on foreign bonds, and r is the yield on domestic bonds. Following an expansionary monetary policy, e_C will initially rise substantially in Figure 2 if intervention is light (E' is small). The higher e_C becomes, the higher is market participants' expectation of e_C in the next period, given regressive expectations, and given the unchanged long-run equilibrium $\hat{e}_C$. This causes the expected yield on the interest income of foreign bonds to rise, resulting in more capital outflow than otherwise, so the financial exchange rate will depreciate to bring back equilibrium. This explains the deviation of e_f from its long-run level during the early period of its adjustment in Figure 4.

If, on the other hand, official intervention is heavy so that e_C does not move by any large amount, the expected increase in the (domestic currency value of) interest income on foreign bonds would be limited, the economy would then approach the "pure" dual rates system. Under that system, the domestic interest rate starts rising after it initially falls as a result of the impact effect of expansionary monetary policy, attracting capital inflow, so e_f has to fall to bring equation (4) back to equilibrium. In this case, the patterns of adjustment in e_f look like the time paths in Figure 3.

Ⅳ. Conclusion

Based on an extension of the Frenkel and Rodriguez (1982) type of foreign exchange rates models, this paper analyzes how the commercial and financial rates adjust over time under the regime of managed dual rates, following an unanticipated increase in the money supply. It assumes that the domestic price level is sluggish but will gradually adjust to close the gap between supply and demand in the goods market, and that people form their expectations regressively.

We find that if the official intervention in the current account foreign exchange market is heavy, the nature of the economy will approach that of a pure dual rates system, under which the commercial rate is completely fixed while the financial rate is completely flexible. The adjustment in the financial exchange rate can then follow three different patterns, as pointed out in Lai and Chu (1986a).

If on the other hand the official intervention is light, we have shown that the commercial rate will first rise, then fall either directly or cyclically to its long-run equilibrium following a money supply increase. The financial exchange rate will first overshoot, then *deviate further* from its long-run equilibrium before it finally returns to the equilibrium either directly or cyclically. These two patterns of adjustment are very different from those under the "pure" dual rates system, and they offer a plausible explanation of the volatility of the financial rate under the regime of managed dual exchange rates.

Appendix

The purpose of this appendix is to show that the slope of path (a) at α in Figure 1 is infinite. Linearizing equations (16) and (17) in the text by using Taylor expansions, we have

$$\dot{p}=J_P(p-\hat{p})+J_R(R-\hat{p})$$
$$\dot{R}=H_P(p-\hat{p})$$

the solutions to which are [see Gandalfo (1971, pp.254-261)]

$$P(t)=\hat{P}+A_1e^{\delta_1 t}+A_2e^{\delta_2 t} \tag{Ala}$$

$$R(t)=\hat{R}+\frac{\delta_1-J_P}{J_R}\quad A_1e^{\delta_1 t}+\frac{\delta_2-J_P}{J_R}A_2e^{\delta_2 t} \tag{A1b}$$

where δ_1 and δ_2 are the characteristic roots. We know from equation (20) in the text that

$$\delta_1+\delta_2=J_P \tag{A2a}$$

$$\delta_1\delta_2=-H_PJ_R \tag{A2b}$$

Let $t=0$ be the time when domestic credit expansion takes place, one obtains from (A1) that

$$P(0)=\hat{P}+A_1+A_2 \tag{A3a}$$

$$R(0)=\hat{R}+\frac{\delta_1-J_P}{J_R}A_1+\frac{\delta_2-J_P}{J_R}A_2 \tag{A3b}$$

Knowing that $P(0)=\hat{P}$ and $R(0)>\hat{R}$ from equation (7) and (8) in the text, (A3) can be rewritten as

$$\begin{bmatrix} 1 & 1 \\ \frac{\delta_1-J_R}{J_R} & \frac{\delta_2-J_R}{J_P} \end{bmatrix} \begin{bmatrix} A_1 \\ A^2 \end{bmatrix} = \begin{bmatrix} 0 \\ R(0)-\hat{R} \end{bmatrix} \tag{A4}$$

the solutions to which are

$$A_1=-A_2=\frac{J_R(R(0)-\hat{R})}{\delta_1-\delta_2} \tag{A5}$$

Now differentiate (A1) with respect to t:

$$\dot{P}(t)=\delta_1A_1e^{\delta_1 t}+\delta_2A_2e^{\delta_2 t} \tag{A6a}$$

$$\dot{R}(t)=\frac{\delta_1-J_R}{J_R}\quad \delta_1A_1e^{\delta_1 t}+\frac{\delta_2-J_P}{J_R}\quad \delta_2A_2e^{\delta_2 t} \tag{A6b}$$

At $t=0$, equation (A6) gives

$$\dot{P}(0)=\delta_1 A_1+\delta_2 A_2 \tag{A7a}$$

$$\dot{R}(0)=\frac{\delta_1-J_P}{J_R}\,\delta_1 A_1+\frac{\delta_2-J_P}{J_R}\,\delta_2 A_2 \tag{A7b}$$

Using (A5) and (A2a), equation (A7) implies that

$$\dot{p}(0)=J_R[R(0)-\hat{R}]>0 \tag{A8a}$$

$$\dot{R}(0)=0 \tag{A8b}$$

which in turn imply that

$$\frac{\dot{p}(0)}{\dot{R}(0)}=\infty$$

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