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Neutral Intervention Operations, Non-Neutral Monetary Disturbances, and Exchange Rate Dynamics under Two-Tier Exchange Regime: a comparison between Alternative Expectations

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Abstract

Based on the Frenkel and Rodriguez(1982) model, this paper utilizes the regressive and the intraequilibrium expectation structure respectively to discuss how the economy will respond in the presence of permanent monetary policy, and compares the difference of the dynamic process generated under different expectation formulations. It is shown that, as the public make an overestimation in future long-run financial exchange rate, two kinds of expectations can produce sharply different adjustment paths of the financial exchange rate if capital mobility is relatively immobile. However, both expectations will contribute the same adjustment behavior if capital mobility is highly mobile.

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Ⅰ. Introduction

Many developing countries have recently adopted the dual exchange rate regime to prevent speculative movements of capital from disturbing their economies. Under such an arrangement, all current account transactions are settled at a pegged commercial rate, while all capital account transactions are settled at a freely floating financial rate. In this regime, to prevent current account imbalances from spreading to the domestic economy, the authorities may intervene in the financial foreign exchange market. The type of intervention operations can be called "neutral" if, as defined by Lanyi (1975, p. 716), "the monetary authority sells (buys) foreign exchange in the financial exchange market equal to the net increase (loss) in official reserves arising from a current account surplus (deficit)." The consequence of such a neutral intervention policy is that "[it]ensures overall balance of payments equilibrium, with the imbalance on current account exactly offset by an equal imbalance of opposite sign on capital accout" [Lanyi (1975, p. 716)]. [1] A salient feature of the dual regime characterized by a neutral intervention operation undertaken by the government is that money is non-neutral, since the system suffers from a form of money illusion, i. e., the exchange-rate rigidity emerging from the current account transactions. [2]

It is widely accepted that one must know the process by which exchange rate expectations are formed before he investigates the actual movement of the exchange rate. Recently, the existing studies on exchange rate dynamics almost asume that market participants form their expectations either with regressive expectations or with perfect foresight [for example, Dornbusch (1976), Kouri (1976), Dornbusch and Fischer (1980), Frenkel and Rodriguez (1982)]. The hypothesis of regressive expectations assumes that economic agents know how the long-run state will change in response to a domestic or foreign disturbance. More specifically, as Bhandari (1982) and Kawai (1985) argued, regressive expectations imply that the asset holders possess perfect foresight in the long run. On the other hand, perfect foresight assumes that market participants not only have the knowledge about the steady-state values of the economic variables but also know the exact adjustment process. In effect, it is well known that

1. This is the reason why Swoboda(1974, p.260) argues that, "such [neutral intervention] operations maintain the stock of international reserves constant, so that current-account imbalances do not affect the monetary base."

2. A detailed explanation is provided in section Ⅰ.

these two expectation structures will be consistent with each other by setting a specific value of the expectational parameter under regressive expectations [see, for example, Dornbusch(1976)].

For a neutral disturbance, it may be reasonable to assume that market participants can correctly compute the future long-run exchange rate through using past experience. The most famous example is the Dornbusch (1976) elegant paper, in which the exchange rate will increase equiproportionately with the increased money stocks. The participants thus can make their expectations without collecting any macroeconomic parameters. However, if an economy experiences a non-neutral disturbance, the computation of the new steady-state value now requires possessing the relevant information of the structural parameters; therefore the regressive expectations are not suitable if the precise knowledge of the macroeconomic parameters is not available to them.

A more reasonable expectation formulation proposed by Bhandari (1981) (1982) is the intraequilibrium expectations.[3] It hypothesizes that the public may have a misestimation of the steady-state value in the short run; however, as time passes, they will revise their estimation of the long-run value in each period according to the degree of error in their previous expectations, since more new information and experience are available to them. Consequently, equipped with these new information and experience, the error associated with the previous forecast of the long-run level will diminish over time, and finally expectations about the location of the long-run equilibrium are fulfilled [Bhandari(1982, p.34)].

The purpose of this paper is to examine the dynamic adjustment of the financial exchange rate following an expansionary monetary policy under a two-tier exchange regime characterized by the authorities being engaged in a neutral intervention operation. Although there is an extensive literature that tells the similar story as this paper does, previous efforts in the literature unanimously focus themselves on either the regime of ordinary dual exchange rates without neutral intervention [Cumby(1984), Aizenman (1985), Dornbusch(1986), and Lai and Chu(1986a)] or the regime of dual floating exchange rates [Bhandari(1985) and Lai and Chu(1986b)]. It seems that very few efforts have been made to analyze the case of the two-tier regime in which neutral intervention operations are adopted by the authorities. As stated above, money is non-neu-

3. Frenkel(1975) offers an expectation schedule that is very similar to the intraequilibrium expectations.

tral in the context of the dual exchange regime with neutral intervention policy, it gives us an inspiration that we can use the intraequilitbium expectation formulations to trace out dynamic adjustment paths of the monetary disturbances. Consequently, this paper will utilize the regressive and the intraequilibrium expectation structure respectively to discuss how the economy will respond in the presence of monetary policy, and compare the difference of the dynamic process generated under different expectation formulations. It is shown that, as the market participants make an overestimation in the future long-run financial exchange rate, two kinds of expectations can produce sharply different adjustment paths if international capital is relatively immobile. However, the same pattern of adjustment paths can be observed if capital is highly mobile.

The rest of the paper is organized as follows. In section I below, we will present our model and describe its long-run equilibrium. Then in section Ⅱ, the dynamic adjustment paths of the financial exchange rate over time under alternative expectation formulations are identified. Finally, section Ⅲ summarizes the findings of the entire paper.

Ⅱ. The Theoretical Model and Its Long-run Equilibrium

The framework we shall develop can be viewed as an extension of the Dornbusch (1976) and the Frenkel and Rodriguez(1982) model from a flexible regime to a two-tier regime with neutral intervention policy. Following Dornbusch(1976) and Frenkel and Rodriguez(1982), we assume that: (i) the domestic economy is specified to be small in the sense that it cannot influence foreign interest rate and foreign price of its imports: (ii) the supply of domestic output is fixed: [4] (iii) the domestic price adjusts with a lag, not instantaneously. [5]

The amended model can then be expressed by the following log-linear relationships: [6]

$$\dot{p}=k\{u+(\gamma-1)\bar{y}-\sigma r+\mu\delta(\bar{e}_c+p^*-\dot{p})\},\ 0<\gamma<1,\ k, \sigma, \mu, \delta>0 \qquad (1)$$

4. In the last part of his paper, Dornbusch(1976) extends the model to allow for short-run adjustments in output. In effect, our analysis can be easily exteded to investigate the situation where the domestic output is permitted to vary. The mathematical derivations which introduce variable income assumption are available upon request from the authors.

5. Recent papers by Rotemberg(1982), Meese(1984), and Carlton(1986) present evidences that support the existence of price stickiness.

6. For a full derivation of the equations, see Appendix 1.

$$m-p=-\lambda r+\phi\bar{y}, \quad \lambda, \phi>0 \tag{2}$$

$$\delta(\bar{e}_c+p^*-p)+\beta[r-r^*-r^*(\bar{e}_c-e_f)-(e_f^e-e_f)]=0, \quad \beta>0 \tag{3}$$

where k=speed of adjustment; $\bar{y}$=the logarithm of the fixed supply of domestic output; μ =the logarithm of the autonomous component of aggregate demand; r=the domestic nominal interest rate; $\dot{p}$=the logarithm of the domestic price; p^*=the logarithm of the foreign price in terms of foreign currency; $\bar{e}_c$=the logarithm of the fixed commercial exchange rate (the domestic currency price of foreign exchange); e_f=the logatithm of the financial exchange rate (the domestic currency price of foreign exchange); e_f^e=the logarithm of the expected financial exchange rate; m=the logarithm of the nominal money supply; r^*=the foreign nominal interest rate; and an overdot denotes the rate of change with respect to time (t).

Equation (1) describes that the domestic price adjusts sluggishly to excess demand in the goods market. It states that domestic aggregate demand is determined by the level of domestic output, the interest rate, and the terms of rade.[7,8] Equation (2) is the equilibrium condition for the money market. Note that the neutral intervention operations adopted by the monetary authorities ensure overall balance of payments equilibrium, so that the money supply remains constant even if the current account (hence the capital account) is not balanced. Equation (3) then describes the condition in which balance of payments is in equilibrium, i. e., the trade balance and the net capital inflow must sum to zero. It is worth mentioning that in equation (3), the capital movement is a function of the difference between the return on domestic bonds, r, and the net return on foregn bonds, $r^*+r^*(\bar{e}_c-e_f)+(e_f^e-e_f)$.[9,10] As noted in Frenkel and Rodriguez (1982), the coefficient β denotes the degree of capital mobility. $\beta=0$ and $\beta\rightarrow\infty$ correspond to zero capital mobility and perfect capital mobility, respectively. It will be

7. To avoid the need for specifying price expectations, it is assumed, as in Dornbusch(1976) and Frenkel and Rodriguez(1982), that absorption depends upon the nominal interest rate.

8. $\mu=1/\bar{y}$, where $\bar{y}$ is the fixed supply of output measured in natural units. Appendix 1 provides a detailed explanation.

9. For a detailed derivation, see Flood(1978), Marion(1981), Gardner(1985), and Lai and Chu (1986b).

10. Following Frenkel and Rodriguez(1982), this paper adopts the flow approach to international capital movements. On the other hand, Lai and Chang(1987) and Lai, Chu and Chang(1989) adopt the stock specification of capital movements. Though the latter approach seems more reasonable, this paper still utilizes the former approach for minimizing the number of differential equations and for avoiding the complexity of the analysis.

shown below that the extent of β is a key factor determining the dynamic behavior of the financial exchange rate.

Equations (1)–(3) thus define the macroeconomic structure of our small open economy, and they contain three endogeneous variables: p, r, and e_f. Let swung dashes denote long-run equilibrium values of the relevant variables, then putting the following steady-state characteristics: $\dot{p}=0$, $p=\tilde{p}$ $r=\tilde{r}$, and $e_f=e_f^e=\tilde{e}_f$ into equations (1)–(3),[11] we have

$$-\mu\delta\tilde{p}-\sigma\tilde{r}=-u+(1-\gamma)\bar{y}-\mu\delta(\bar{e}_c+p^*) \tag{4a}$$

$$\tilde{p}-\lambda\tilde{r}=m-\phi\bar{y} \tag{4b}$$

$$-\delta\tilde{p}+\beta\tilde{r}+\beta r^*\tilde{e}_f=\beta r^*+\beta r^*\bar{e}_c-\delta(\bar{e}_c+p^*) \tag{4c}$$

By Cramer's rule, it follows from equations (4a), (4b), and (4c) that

$$\frac{\partial\tilde{p}}{\partial m}=\frac{\sigma}{\lambda\mu\delta+\sigma}>0 \tag{5}$$

$$\frac{\partial\tilde{r}}{\partial m}=\frac{-\mu\delta}{\lambda\mu\delta+\sigma}<0 \tag{6}$$

$$\frac{\partial\tilde{e}_f}{\partial m}=\frac{\delta(\beta\mu+\sigma)}{\beta r^*(\lambda\mu\delta+\sigma)}>0 \tag{7}$$

Equations (5)–(7) tell us that, under the two-tier exchange rate regime with neutral intervention operations, a monetary expansion will increase the domestic price and the financial exchange rate, and decrease the interest rate, in the stationary state. These results run in sharp contrast to those under two-tier exchange rates with non-intervention policy.[12] The non-neutral property revealed in the above equations follows from the fact that the two-tier regime suffers from a form of money illusion, i. e., the exchange-rate rigidity in the current account.

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11. In the long run, there is no forecasting error. It follows that $e^e_f=\tilde{e}_f$.

12. In a dual regime with non-intervention policy, an increase in money supply will not have any effect on the domestic price and financial exchange rate but will decrease the foreign reserves by an equal quantity. See Aizenman(1985), Gardner(1985), and Lai and Chu(1986a).

Ⅲ. Dynamic Adjustment

Since the asset markets are cleared instantaneously by assumption, equations (2) and (3) must hold at any point of time. In the short run, the impact effect can be determined by solving equations (2) and (3) with sticky domestic price since we assume that the domestic price adjusts sluggishly in response to excess demand in the goods market. It follows that

$$\begin{bmatrix} -\lambda & 0 \\ \beta & \beta(r^{*}+1) \end{bmatrix} \begin{bmatrix} r \\ e_f \end{bmatrix} = \begin{bmatrix} m-p-\phi\bar{y} \\ \beta r^{*}+\beta r^{*}\bar{e}_c+\beta e_f^{e}-\delta(\bar{e}_c+p^{*}-p) \end{bmatrix} \tag{8}$$

By Cramer's rule, it gives that

$$r=\frac{-m+p+\phi\bar{y}}{\lambda} \tag{9}$$

$$e_f=\frac{\lambda[\beta r^{*}+\beta r^{*}\bar{e}_c^{e}+\beta e_f^{e}-\delta(\bar{e}_c+p^{*}-p)]+\beta(m-p-\phi\bar{y})}{\lambda\beta(r^{*}+1)} \tag{10}$$

It is clear from equation (10) that the short-run financial exchange rate has mutually dependent relationship with the expected financial exchange rate. Consequently, in the short run the spot financial exchange rate will have different values, and hence in the intermediate run the financial rate will have different dynamic patterns in response to alternative expectation schemes. In what follows, we will discuss two expectation formulations: regressive expectations and intraequilibrium expectations, and compare the exchange rate dynamics between these two expectation schemes.

A. Regressive Expectations

One of the popular expectation formulations used in the existing literature is regressive expectations [see, for example, Dornbusch (1976), Bhandari (1982), Frenkel and Rodriguez (1982)]. The main characteristic of the regressive expectations is that it assumes the expected finanacial exchange rate to be a multiplicatively weighted average of the long-run and the current financial exchange rate,[13] i. e.,

13. Williamson(1983, p.227) offers a detailed statement.

$$e_f^e = \theta\tilde{e}_f + (1-\theta)e_f, \;\; 1>\theta>0 \tag{11}$$

Substituting equation (11) into (10) and using equation (7) then the impact effect of monetary expansion on the financial exchange rate is

$$\frac{\partial e_f(0+)}{\partial m} = \frac{\lambda\delta\theta(\beta\mu+\sigma)+\beta r^*(\lambda\mu\delta+\sigma)}{\lambda\beta r^*(r+\theta)(\lambda\mu\delta+\sigma)} \tag{12}$$

where we specify that the time immediately after the increase in money stock is 0+. The economic reasoning for equation (12) is as follows. At the time of increased money supply, owing to the presumption that the domestic price is sluggish, the interest rate must immediately decrease to maintain continuous money market equilibrium. Moreover, given $\bar{e}_c$ and p being fixed in the short run, it follows that the current account remains intact in the short run, and hence the return on both bonds is required to be equalized to maintain the balance-of-payments equilibuium (equation (3)).
Subsequently, the spot financial exchange rate must increase to equalize the yield on both bonds, given the fact that the interest rate decreases and stationary financial exchange rate increases.

A comparison of (12) with (7) indicates that

$$\frac{\partial e_f(0+)}{\partial m} - \frac{\partial \tilde{e}_f}{\partial m} = \frac{\sigma(\beta-\lambda\delta)}{\lambda\beta(r^*+\theta)(\lambda\mu\delta+\sigma)} \gtreqless 0 \quad \text{as } \beta \gtreqless \lambda\delta \tag{13}$$

It is clear from equation (13) that the short-run financial exchange rate will overshoot or undershoot its long-run equilibrium level depending on the relative size of β and $\lambda\delta$. Obviously, an expansion in money supply will exhibit an overshooting phenomenon if the capital mobility is relatively high (i. e., $\beta>\lambda\delta$), while undershooting will prevail if capital mobility is relatively low (i. e., $\beta<\lambda\delta$).[14]

Turn next to the adjustment process. Substituting equation (9) into (1), we have

$$\dot{p} = k[u+(\gamma-1)\bar{y} - \sigma\,\frac{(-m+p+\bar{\phi}y)}{\lambda} + \mu\delta(\bar{e}+p^*-p)] \tag{14}$$

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14 . In the context of the flexible exchange regime, Frenkel and Rodriguez(1982, p.17) also reach the similar conclusions, i.e., "when capital is highly mobile the exchange rate must overshoot its long-run value, but when capital is relatively immobile the exchange rate undershoots its long-run value."

This equation allows us to derive the $\dot{p}=0$ curve, i. e., the combinations of e_f and p that will clear the goods market. From (14) the slope of the $\dot{p}=0$ curve is

$$\left.\frac{\partial p}{\partial e_f}\right|_{\dot{p}=0}=0 \tag{15}$$

Also, call the combinations of e_f and p that will keep the asset markets in equilibrium the AA curve. Given $e_f^e=\theta\tilde{e}_f+(1-\theta)e_f$, from equation (10) the slope of the AA curve is

$$\left.\frac{\partial p}{\partial e_f}\right|_{AA}=\frac{\lambda\beta(r^*+\theta)}{\lambda\delta-\beta} \gtrless 0 \text{ if } \beta\gtrless\lambda\delta \tag{16}$$

Since the asset markets are cleared instantaneously, at no time will the economy be allowed to deviate from the AA locus. On the other hand, since the goods market may be in disequilibrium in the short to intermediate run, points off the $\dot{p}=0$ curve are acceptable.

Figure 1 describes the case of high mobility of capital (i. e., $\beta>\lambda\delta$).
Suppose that initially the economy is at poing E^0 and inital financial exchange rate is $\tilde{e}_f^0$. Now following an increase in money supply, AA (m_0) will shift rightwards to AA (m_1) while $\dot{p}=0$ (m_0) will shift upwards to $\dot{p}=0$ (m_1).[15] The financial exchange rate e_f must rise to $e_f(0+)$ on impact to clear the asset markets in the short run. Thereafter the economy will move gradually from point E^1 to the long-run equilibrium E^* anlong AA (m_1). Thus, the financial exchange rate will first overshoot and them decrease to its long-run level.

Figure 2 shows what happens when capital is relatively immobile. Again, the economy is at E_0 and financial exchange rate is e_f^0 initially. In response to an increase in money supply, AA (m_0) will shift rightwards to AA (m_1) and $\dot{p}=0$ (m_0) will shift upwards to $\dot{p}=0$ (m_1). In the short run, the economy will instantaneously jump to E^1, meaning that e_f will increase to $e_f(0+)$ on impact. Then, over time, E^1 will gradually

15. Given $e_f^e=\theta\tilde{e}_f+(1-\theta)e_f$, from equations(10) and (14)we have

$$\left.\frac{\partial e_f}{\partial m}\right|_{AA}=\frac{\partial e_f(0+)}{\partial m}=\frac{\lambda\delta\theta(\beta\mu+\sigma)+\beta r^*(\lambda\mu\delta+\sigma)}{\lambda\beta r^*(r^*+\theta)(\lambda\mu\delta+\sigma)}$$

$$\left.\frac{\partial p}{\partial m}\right|_{\dot{p}=0}=\frac{\partial\tilde{p}}{\partial m}=\frac{\sigma}{\lambda\mu\delta+\sigma}$$

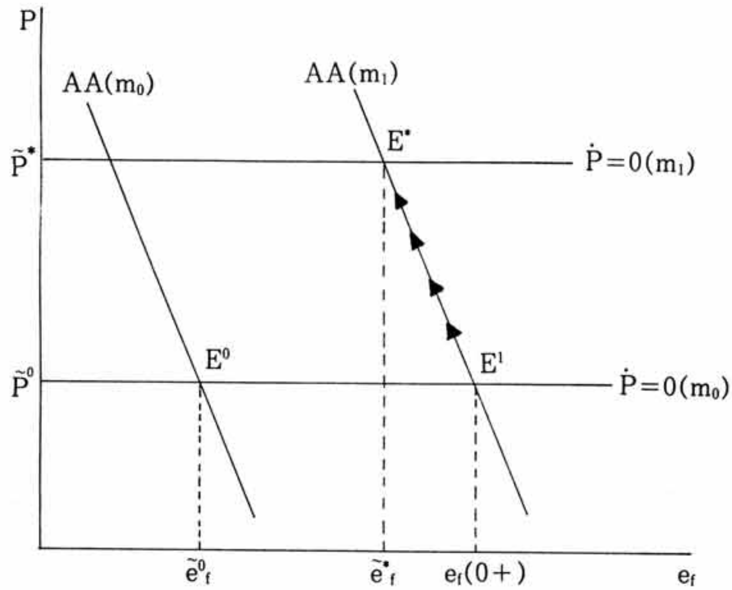

Figure 1

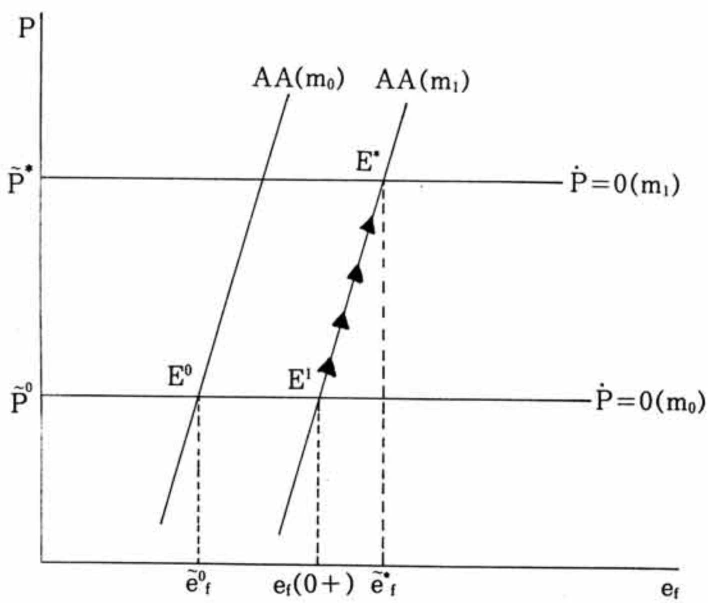

Figure 2

move to E^*, implying that e_f and p are rising at the same time. This is the case where the financial exchange rate undershoots its long-run equilibrium level and is consistent with equation (13).

Finally, we want to point out that the dynamic adjustment path of the fianacial exchange rate under regressive expectations is consistent with the perfect foresight trajectory if we choose a specific value of the expectational parameter θ. This result implies that the same behavior of e_f will be observed regardless of whether the public are equipped with regressive expectations or with perfect foresight.

Rewriting equations (1)−(3) in deviation form and recalling $e_f^e=\theta\tilde{e}_f+(1-\theta)e_f$, we

$$\dot{p}=-k[\sigma(r-\tilde{r})+\mu\delta(p-\tilde{p})] \tag{1'}$$

$$(p-\tilde{p})=\lambda(r-\tilde{r}) \tag{2'}$$

$$-\delta(p-\tilde{p})+\beta[(r-\tilde{r})+(r^*+\theta)(e_f-\tilde{e}_f)]=0 \tag{3'}$$

Thus, it can readily be shown from equations (1)′ and (2)′ that the price adjustment equation may be written as

$$\dot{p}=-k(\frac{\sigma}{\lambda}+\mu\delta)(p-\tilde{p}) \tag{17}$$

Corresponding to (17), the actual financial exchange rate adjustment equation is of an identical form:[16]

$$\dot{e}_f=-k(\frac{\sigma}{\lambda}+\mu\delta)(e_f-\tilde{e}_f) \tag{18}$$

Then, subtracting e_f from both sides in (11) and recalling the definition $\dot{e}_f^e=e_f^e-e_f$, we obtain the path of expected depreciation

16. Substituting (2)′ into (3)′ to solve for the financial exchange rate deviation, we obtain

$$(e_f-\tilde{e}_f)=\frac{\lambda\delta-\beta}{\lambda\beta(r^*+\theta)}(p-\tilde{p})$$

Differentiating the above equation with respect to time and substituting equation(17)into the resulting equation give

$$\dot{e}_f=\frac{\lambda\delta-\beta}{\lambda\beta(r^*+\theta)}\dot{p}=-k[\frac{\lambda\delta-\beta}{\lambda\beta(r^*+\theta)}(\frac{\sigma}{\lambda}+\mu\delta)(p-\tilde{p})$$

Finally, recalling $(e_f-\tilde{e}_f)=\frac{\lambda\delta-\beta}{\lambda\beta(r^*+\theta)}(p-\tilde{p})$, the above equation can further reduce to equation (18) in the text.

$$\dot{e}_f^e = -\theta(e_f - \tilde{e}_f) \tag{19}$$

Perfect foresight requires that the paths of actual and expected depreciation as given in equations (18) and (19), respectively, be coincident. Hence, the perfect foresight value of the expectational parameter is defined by

$$\theta^* = k(\frac{\sigma}{\lambda} + \mu\delta) \tag{20}$$

Obviously, similar to regressive expectation formulations, perfect foresight involves some macro parameters of the economy.

B. Intraequilibrium Expectations

It is clear from the above analysis that economic agents with regressive expectations are assumed to know the long-run equilibrium value of the relevant variables. Thus, from equation (7) we know that, in a dual regime with neutral intervention operations, unless economic agents possess precise knowledge of structural parameters: δ, β, μ, λ, and r^*, they cannot correctly compute the expected financial exchange rate. However, these structural parameters may not be completely known to the economic agents either because the cost of getting information is too high or because the relevant information is not available at the time of prediction. Under this situation, market participants of course cannot make correct prediction of the long-run financial exchange rate, and therefore the regressive expectations are not suitable for analyzing the dynamic adjustment of the financial exchange rate.

Rather than assuming that the long-run financial exchange rate is correctly forecasted, we now propose a more reasonable expectation formulation: the intraequilibrium expectations. Its main characteristic is that the public may have misestimation of the long-run financial rate in the short run; however, as time goes by, market participants will acquire more information and experience, so that the error associated with the initial forecast of the long-run equilibrium diminishes, and eventually expectations about the location of the long-run equilibrium are fulfilled.

In contrast with the regressive expectations, we now specify that, under the intraequilibrium expectations, the expected financial rate, e_f^e, is a weighted average of the expected long-run financial rate, $\tilde{e}_f^e$, and the current financial rate, e_f, i. e.,

$$e_f^e = \theta\tilde{e}_f^e + (1-\theta)e_f, \quad 1 > \theta > 0 \tag{21}$$

Comparing (11) with (21), it is clear that the only difference between the two expectations, $\tilde{e}_f$, is replaced by $\tilde{e}_f^e$, since the economic agents who form their expectations with intraequilibrium are allowed to misestimate their long-run level of the financial rate in the short and intermediate run. Based on this specific feature, we assume that, in response to an increase in money supply, the public have the following estimation of the long-run financial rate immediately

$$\frac{\partial \tilde{e}_f^e(0+)}{\partial m} = \alpha(0+)\frac{\partial \tilde{e}_f}{\partial m}, \alpha(0+)>0 \tag{22}$$

where $\tilde{e}_f^e(0+)$ is the initial forecast of the equilibrium financial exchange rate after monetary disturbance m occurs at time 0. Obviously, market participants have an overestimation if $\alpha(0+)>1$ and an underestimation if $\alpha(0+)<1$. On the other hand, market participants have a correct estimation if $\alpha(0+)=1$, and this situation is parallel to the regressive expectations.

Differentiating equations (10) and (21) with respect to m and putting them together, and then substituting (7) and (22) into the resulting equation, we have

$$\frac{\partial e_f(0+)}{\partial m} = \frac{\alpha(0+)\theta\lambda\delta(\beta\mu+\sigma)+\beta r^*(\lambda\mu\delta+\sigma)}{\lambda\beta r^*(r^*+\theta)(\lambda\mu\delta+\sigma)} \tag{23}$$

A comparison between (7) and (23) indicates that

$$\frac{\partial e_f(0+)}{\partial m} - \frac{\partial \tilde{e}_f}{\partial m} = \frac{[\alpha(0+)-1]\theta\delta(\beta\mu+\sigma)}{\beta r^*(r^*+\theta)(\lambda\mu\delta+\sigma)} + \frac{\sigma(\beta-\lambda\delta)}{\lambda\beta(r^*+\theta)(\lambda\mu\delta+\sigma)} \tag{24}$$

Obviously, under intraequilibrium expectations, whether the spot financial rate overshoots or undershoots its steady-state value depends not only on the relative mobility of the international capital but also on whether the public have an overestimation or underestimation of the future long-run financial rate.

A comparison of (13) with (24) reveals some interesting results: (i) when capital mobility is relatively high ($\beta>\lambda\delta$), there must be a short-run overshooting under regressive expectations; while a short-run undershooting may arise under intraequilibrium expectations if the public make an underestimation of the future steady-state financial rate, and (ii) when capital is relatively immobile ($\beta<\lambda\delta$), the financial exchange rate must undershoot its long-run value under regressive expectations; while the short-run movement of the financial rate may exceed its long-run total adjustment under intraequilibrium expectations if the public make an overestimation of the future stationary financial rate.

We now turn to discuss the adjustment process. Since equation (9) indicates that the short-run interest rate is independent of the expected financial rate, the price adjustment equation under intraequilibrium expectations is the same as that under regressive expectations, i. e.,

$$\dot{p}=k[u+(\gamma-1)\bar{y}-\sigma\frac{(-m+p+\phi\bar{y})}{\lambda}+\mu\delta(\bar{e}_c+p^*-p)] \tag{25}$$

Furthermore, under intraequilibrium expectations, the public will correct their expectations as they make a forecasting error. We then specify an additional dynamic mechanism, i. e., the public expectation—revision function

$$\alpha(t)=1+[\alpha(0+)-1]\exp(-\pi t),\ \pi>0 \tag{26}$$

It indicates that the error associated with the initial forecast, $\alpha(0+)-1$, will diminish exponentially at the rate π as time goes by. As is evident in equation (26), the intraequilibrium expectations formulation can generate an automatic mechanism to make the forecasted stationary value of the financial rate gradually converge to its long-run level as economic agents accumulate more information. Though, as Bhandari (1982, p. 35) claimed, the intraequilibrium expectations formulation does not explain why the initial error decays exponentially at a common rate π for all times as information is accumulated smoothly and continuously, it seems that the intraequilibrium expectations are more realistic as well as more general than the regressive expectations, which require that the long-run financial rate corresponding to every level of all exogenous variables be correctly computed. Possessing the property embodied in (26), a dynamic equation then can be derived (see Appendix 2)

$$\dot{\tilde{e}}_f^e=\frac{d\tilde{e}_f^e}{dt}=\pi(\tilde{e}_f-\tilde{e}_f^e) \tag{27}$$

Equations (25) and (27) allow us to derive the $\dot{p}=0$ and the $\dot{\tilde{e}}_f^e=0$ curve which respectively traces the locus of p and $\tilde{e}_f^e$ that will keep the goods market and the expected long-run financial exchange rate in equilibrium. The slopes of the $\dot{p}=0$ and $\tilde{e}_f^e=0$ curves are

$$\left.\frac{\partial p}{\partial \tilde{e}_f^e}\right|_{\dot{p}=0}=0 \tag{28}$$

$$\left.\frac{\partial p}{\partial \tilde{e}_f^e}\right|_{\dot{\tilde{e}}_f^e=0} = \infty \tag{29}$$

These two equations give rise to the shape of the two curves $\dot{p}=0$ and $e_f^e=0$ in figures 3a, 4a, and 5a.

Let S be the characteristic root, then the characteristic equation corresponding to the system is

$$S^2+[k(\frac{\sigma}{\lambda}+\mu\delta)+\pi]S+k\pi(\frac{\sigma}{\lambda}+\mu\delta)=0 \tag{30}$$

Since $k(\frac{\sigma}{\lambda}+\mu\delta)+\pi>0$ and $k\pi(\frac{\sigma}{\lambda}+\mu\delta)>0$, the system is always stable. In addition, it is straightforward that the adjustment path must be non-cyclical since

$$\begin{aligned} \Omega &= [k(\frac{\sigma}{\lambda}+\mu\delta)+\pi]^2-4k\pi(\frac{\sigma}{\lambda}+\mu\delta) \\ &= [\lambda(\frac{\sigma}{\lambda}+\mu\delta)-\pi]^2>0 \end{aligned} \tag{31}$$

Next, we will discuss the dynamic adjustment patterns of the financial exchange rate. As indicated above, the public may either overestimate or underestimate the long-run financial exchange rate initially following a monetary shock. In what follows, however, we only discuss the case of overestimation for saving space and leave the case of underestimation to the interested reader as an exercise.

The adjustment process corresponding to the market participants overestimating the long-run level of e_f can again be classified by the following two cases.

(i) Capital Is Relatively Immobile($\beta<\lambda\delta$)

In figures 3a, 4a, and 5a, suppose that initially the economy is at E_0 and inital money supply is m_0. Now given that money supply increases from m_0 to m_1, the $\dot{p}=0(m_0)$ curve will shift upwards to $\dot{p}=0(m_1)$ and the $e_f^e=0(m_0)$ curve will shift rightwards to $e_f^e=0(m_1)$. [17] The new steady state is established at point E^*.

17. It follows from equations (25) and (27) that

$$\left.\frac{\partial p}{\partial m}\right|_{\dot{p}=0} = \frac{\partial \tilde{p}}{\partial m} = \frac{\sigma}{\lambda\mu\delta+\sigma}$$

$$\left.\frac{\partial \tilde{e}_f^e}{\partial m}\right|_{\dot{\tilde{e}}_f^e=0} = \frac{\partial \tilde{e}_f}{\partial m} = \frac{\delta(\beta+\sigma)}{\beta r^*(\lambda\mu\delta+\sigma)}$$

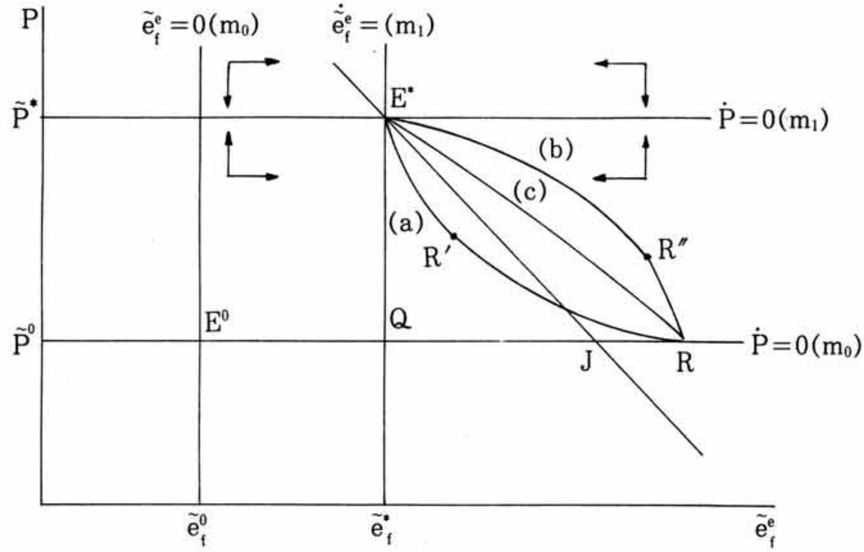

Figure 3a

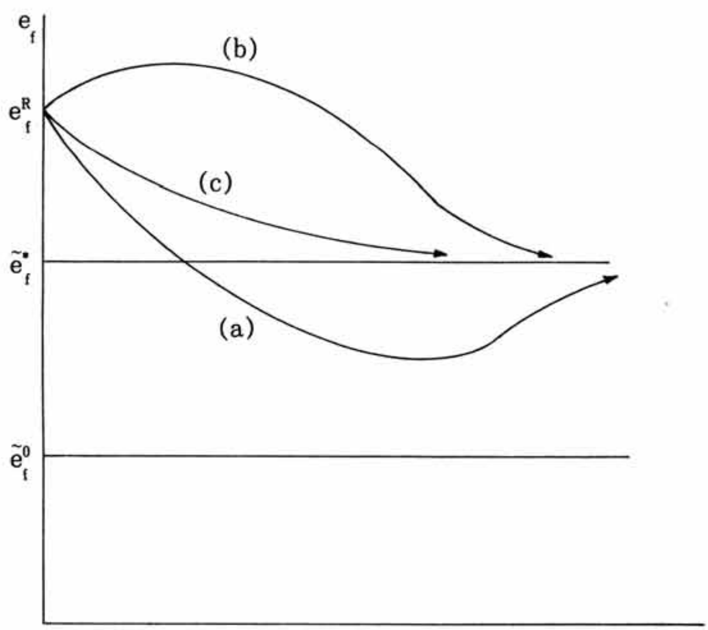

Figure 3b

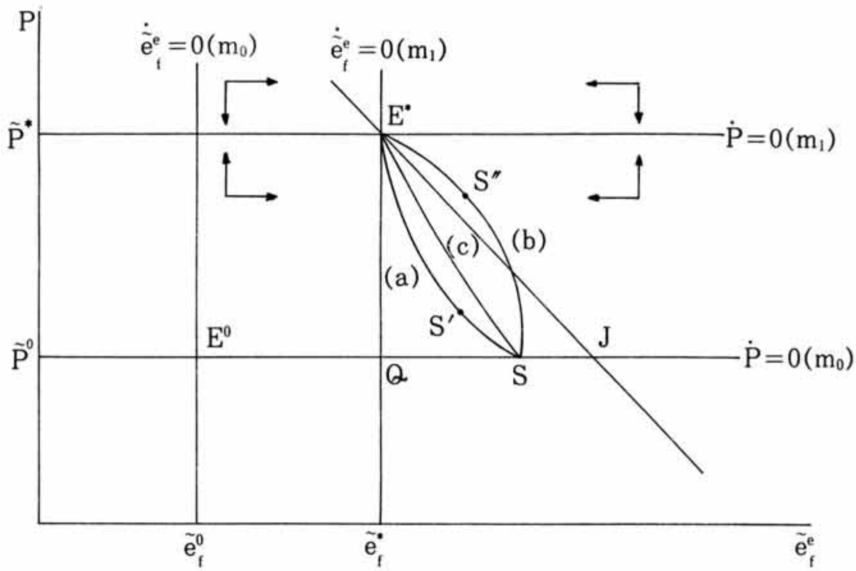

Figure 4a

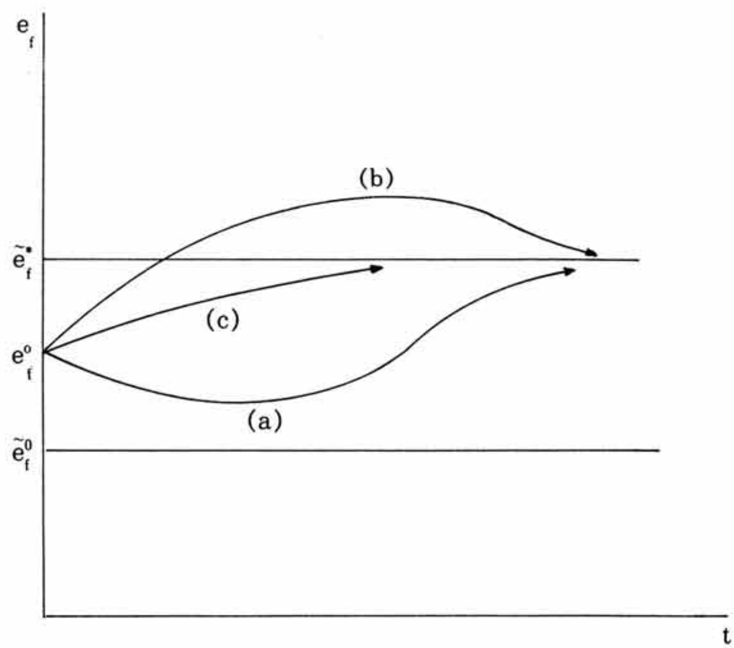

Figure 4b

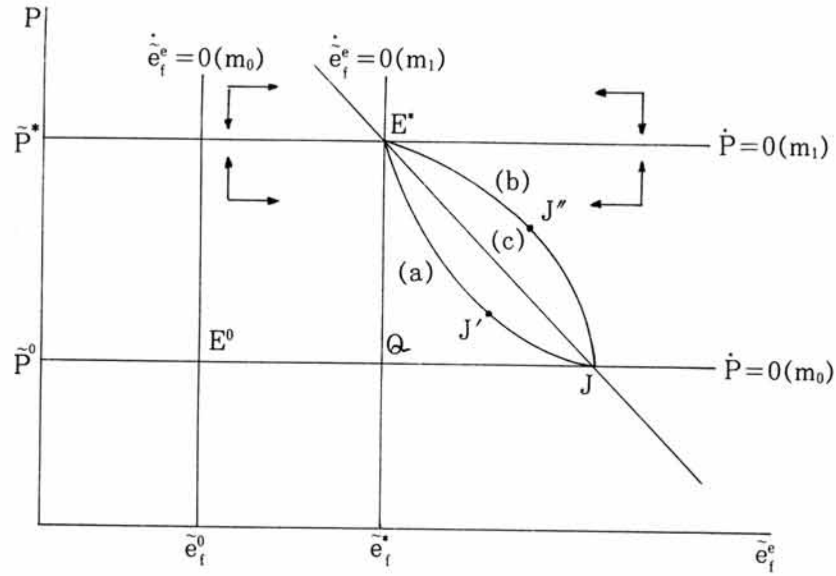

Figure 5a

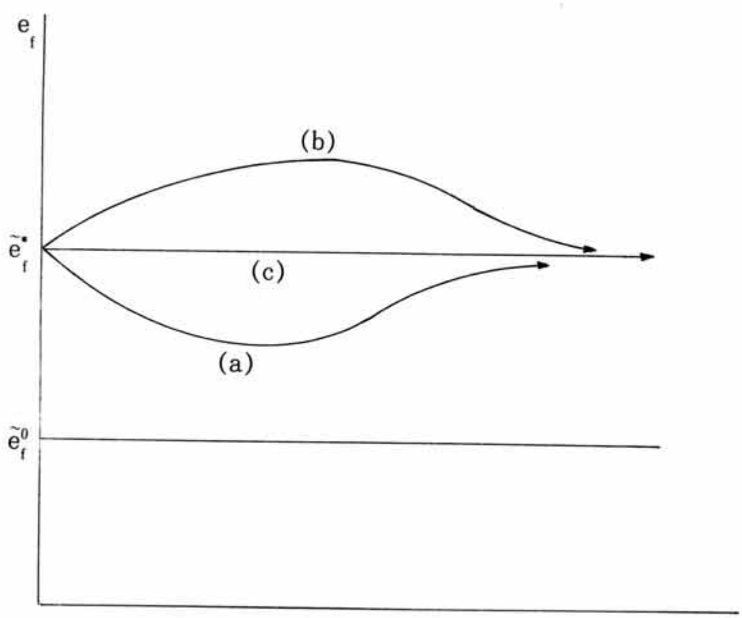

Figure 5b

Equation (24) tells us that, under the situation $\alpha(0+)>1$ and $\beta<\lambda\delta$, the spot financial exchange rate may be greater than, equal to, or less than the long-run financial rate, thus from (24) we can obtain a critical value of $\alpha(0+)$ where the short-run and the long-run financial rate are equalized. Denoting this critical value of $\alpha(0+)$ as α^*, then

$$\alpha^*=1+\frac{\sigma r^*(\lambda\delta-\beta)}{\theta\lambda\delta(\beta\mu+\sigma)} \tag{32}$$

Letting point J in figures 3a, 4a, and 5a indicate the point which $\alpha(0+)$ is equal to α^*. Obviously, point J must lie rightwards to point Q, since the public overestimate the long-run financial rate. Furthermore, upon the shock of an increase in money supply the economy may instantaneously jump to the point which lies horizontally to the west, east, or exactitude of point J on the $\dot{p}=0(m_0)$ curve depending on whether $\alpha(0+)$ is less than, greater than, or equal to α^*. In what follows, we will in turn discuss each of these three cases. Finally, one point should be noted here is that it can be easily derived that the slope of the ray E^*J is $\frac{\lambda\beta\theta}{\beta-\lambda\delta}$ [18]

Case 1. $\alpha(0+)>\alpha^*$

The situation is illustrated in figure 3a. It indicates that the economy will immediately jump to R in response to a monetary expansion and the financial exchange rate will overshoot its steady-state value because the point R lies horizontally to the east of the point J. As arrows indicate in figure 3a, between short-run equilibrium point R and new steady-state point E^*, there are three possible patterns of adjustment in p and $\tilde{e}_f^e$, i.e., path (a), path(b), and path(c).

Given these dynamic paths of (p, e_f^e)in figure 3a, we can now discuss the focal point of this paper, that is, how the actual financial exchange rate changes according to how the domestic price and the expected long-run financial rate adjust over time.

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18. Equation (5) indicates that the distance of E^*Q is equal to

$$\frac{\partial\tilde{p}}{\partial m}=\frac{\sigma}{\lambda\mu\delta+\sigma}$$

On the other hand, it is clear from equations (7), (22) and (32) that the length of QJ equals

$$\left.\frac{\partial\tilde{e}_f^e(0+)}{\partial m}\right|_{\alpha(0+)=\alpha^*}-\frac{\partial\tilde{e}_f}{\partial m}=(\alpha^*-1)\frac{\partial\tilde{e}_f}{\partial m}$$

$$=\frac{\sigma r^*(\lambda\delta-\beta)}{\lambda\delta\theta(\beta\mu+\sigma)}\cdot\frac{\delta(\beta\mu+\sigma)}{\beta r^*(\lambda\mu\delta+\sigma)}=\frac{\sigma(\lambda\delta-\beta)}{\lambda\beta\theta(\lambda\mu\delta+\sigma)}$$

To answer this, differentiate equations (10) and (21) with respect to time and put them together, we have [19]

$$\dot{e}_f=\frac{1}{r^*+1}\dot{e}_f^e+\frac{(\lambda\delta-\beta)}{\lambda\beta(r^*+1)}\dot{p}=\frac{\theta}{r^*+\theta}\dot{\tilde{e}}_f^e+\frac{(\lambda\delta-\beta)}{\lambda\beta(r^*+\theta)}\dot{p} \tag{33a}$$

$$=\frac{\theta}{r^*+\theta}\dot{\tilde{e}}_f^e[1+\frac{(\lambda\delta-\beta)}{\lambda\beta\theta}\frac{\dot{p}}{\dot{\tilde{e}}_f^e}] \tag{33b}$$

where $\dot{p}/\dot{\tilde{e}}_f^e$ is the slope of the dynamic path from R to E^* in figure 3a.

Given the assumption that capital is realtively immobile ($\lambda\delta>\beta$) and $\dot{\tilde{e}}_f^e<0$ and $\dot{p}>0$ when the economy moves from R to E^*, from equation (33b) we then have

$$\dot{e}_f \gtreqless 0 \text{ if } \frac{\dot{p}}{\dot{\tilde{e}}_f^e} \gtreqless \frac{\lambda\beta\theta}{\beta-\lambda\delta} \tag{34}$$

Consider first path (a) in figure 3a. It is obvious that there exists one and only one point (call it R´) such that the algebraic value of the slope is greater then $\frac{\lambda\beta\theta}{\beta-\lambda\delta}$ (the slope of the ray E^* J) between R and R´, and less than it between R´ and E^*, implying that first $e_f<0$ than $e_f>0$ as the economy moves from R, passing R´, towards E^*. The movement of e_f corresponding to the movements of p and $\tilde{e}_f^e$ along the entire adjustment path would therefore look like path (a) in figure 3b.

Next, let us turn to examine path (b) in figure 3a. As (p, $\tilde{e}_f^e$) moves from R to E^*, there has to be a point R" such that $\frac{\dot{p}}{\dot{\tilde{e}}_f^e} < \frac{\lambda\beta\theta}{\beta-\lambda\delta}$ between RR" and $\frac{\dot{p}}{\dot{\tilde{e}}_f^e} > \frac{\lambda\beta\theta}{\beta-\lambda\delta}$ between R"E^*. Thus, the time path of e_f will look lide path (b) in figure 3b.

The other possible time path we shall examine is path (c) in figure 3a. This is a special situation where $\frac{\dot{p}}{\dot{\tilde{e}}_f^e} > \frac{\lambda\beta\theta}{\beta-\lambda\delta}$ (=slope of the ray E^* J), so in this case, $\dot{e}_f<0$ throughout the adjustment process, and path (c) in figure 3b prevails.

Case 2. $\alpha(0+)<\alpha^*$

This case is depicted in figure 4a. Following an increase in money stock, the economy will move from E^0 to S on impact and the financial exchange rate will undershoot its long-run value (as indicated in figure 4b that $\tilde{e}_f^0$ jumps to e_f^s) since point S is locat-

19. In the adjustment process, m=0 is specified since monetary expansion is permanent.

ed horizontally to the west of the point J. The same as the case of $\alpha(0+)>\alpha^{*}$, $(p, \tilde{e}_f^e)$ can follow three different patterns of dynamic adjustment: namely path (a), path (b) and path (c) in figure 4a.

By the analogous inference, we can easily find that: (i) corresponding to the path (a), $\dot{e}_f$ is first negative then positive, giving rise to the path (a) in figure 4b; (ii) corresponding to the path (b), $\dot{e}_f>0$ between SS" and $\dot{e}_f<0$ between S"E*, the path (b) in figure 4b then prevails; (iii) corresponding to the path (c), $\dot{e}_f>0$ throughout the adjustment process, meaning that e_f increases monotonically towards its new long-run value, as indicated by path (c) in figure 4b.

Case 3 $\quad \alpha(0+)=\alpha^{*}$

Figure 5a describes the case of $\alpha(0+)=\alpha^{*}$. As the authorities undertake an expansionary monetary policy, the economy will immediately shift from E^0 to J and the financial exchange rate will rise to their long-run level on impact, displaying no overshooting or undershooting phenomenon. Obviously, three distinct patterns can be also recognized, i. e., path (a), path (b), and path (c) in figure 5a. Since the economic reasoning for the movement of e_f over time is not different from that of the above two cases, we thus can conclude that: (i) path (a) indicates that e_f will first fall then rise; (ii) path (b) describes that e_f will first increase then decrease; (iii) path (c) indicates that e_f will stay at its long-run level at all times. These dynamic paths are illustrated in figure 5b.

Alternatively, we can use figures 3a, 4a, and 5a to illustrate the adjustment behavior of e_f under regressive expectations. As stated above, the regressive expectation formulation indicates that market participants can correctly calculate the long-run equilibrium value of e_f. It implies that both $\alpha(0+)=1$ and $\dot{\tilde{e}}_f^e=0$ will result at all times. Consequently, following that the money stock increases from m_0 to m_1, the economic agents will immediately revise their expectation and raise their expected long-run financial rate, $\tilde{e}_f^e$, from $\tilde{e}_f^0$ to $\tilde{e}_f^{*}$, and then the economy will shift from E^0 to Q on impact. Since point Q lies horizontally leftwards to point J, it follows that the financial exchange rate will undershoot its steady-state value on impact. Thereafter, $(p, \tilde{e}_f^e)$ will move along the $\dot{\tilde{e}}_f^e=0$ (m_1) curve from Q to the new steady-state point E^* because $\dot{\tilde{e}}_f^e=0$ must be held under the hypothesis of regressive expectations. Given $\dot{\tilde{e}}_f^e=0$, from equation (33a) we have

$$\dot{e}_f=\frac{(\lambda\delta-\beta)}{\lambda\beta(r^{*}+\theta)}\,\dot{p} \tag{35}$$

under the situation $\lambda\delta>\beta$, over time e_f will monotonically rise to its long-run level as p continues to rise in the adjustment process. Therefore, in response to an increased money supply, e_f will increase but undershoot on impact, and then rise monotonically to its long-run level. This dynamic pattern is the same as that presented in figure 2.

Having completed the discussion on the behavior of e_f under the situation that the international capital is relatively immobile, it is the time to see how the behavior of e_f will result under the opposite situation, i. e., capital is relatively mobile.

(ii) Capital Is Relatively Mobile ($\beta>\lambda\delta$)

Throughout this paper, the public are assumed to make an overestimation in future long-run financial exchange rate, thus, under the situation $\beta>\lambda\delta$, from (24) it follows that

$$\frac{\partial e_f(0+)}{\partial m} > \frac{\partial \tilde{e}_f}{\partial m} \tag{36}$$

Obviously, given that the capital flow is highly mobile and the agents make an overprediction about future stationary financial exchange rate, an expansionary monetary policy definitely results in an overshooting of the financial rate, This result runs in sharp contrast with the situation where the capital mobility is relatively low. From the other viewpoint to examine this conclusion, given $\beta>\lambda\delta$ and $\alpha(0+)>1$, it can be obtained from equation (32) that $\alpha^{*}<1<\alpha(0+)$ will always hold, this is the reason why the economy will experience a short-run overshooting of the financial rate.[20]

Let us now show what an exact picture of e_f will display as the economy moves from the point R to the final destination E^{*}. Apparently, the dynamic path of p and $\tilde{e}_f^e$ is characterized by $\dot{p}>0$ and $\dot{\tilde{e}}_f^e<0$, putting these knowledge into equation (33a) and given $\beta>\lambda\delta$, it implies that, after an initial overshooting, e_f will decline monotonically to its long-run level. This dynamic pattern is the same as that of regressive expectations, which is illustrated in figure 1.

Before ending this section, it is worth noting that we can also infer the dynamic adjustment of e_f involving regressive expectations by utilizing figures 3a, 4a, and 5a. This task can be taken by using the similar reasoning stated in the case of $\beta<\lambda\beta$. We thus do not repeat it here.

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20. It implies that, in the case of $\beta>\lambda\delta$, the critical point J in figures 3a, 4a, and 5a now shift to a point which lies horizontally to the west of the point Q

Ⅳ. Concluding Remarks

This paper 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 the pubilc are equipped with regressive expectations or with intraequilibrium expectations. Based on the Frenkel and Rodriguez(1982) model, which is extended from the pioneering Dornbusch(1976) work, this paper analyzes how different adjustment patterns of the financial exchange rate will follow if the public adopt alternative expectation formulations under a two-tier regime with neutral intervention operations, following an unanticipated and permanent increase in the money stock.

In summary, we have established the following findings from the analysis in the previous sections.

Finding 1. As the public form their expectations regressively, a short-run overshooting of the financial exchange rate will definitely result if the economy experiences a relatively high mobility of capital. However, a short-run undershooting is always observed if capital is relatively immobile.

Finding 2. As the public follow the intraequilibrium expectation formulation and simultaneously make an over estimation in future long-run exchange rate, the financial exchange rate may overshoot, undershoot, or jump exactly to its new long-run level on impact if capital mobility is relatively low. Over time the financial exchange rate will display a number of dynamic adjustment patterns which are very different from that of regressive expectations. On the contrary, if capital is highly mobile, the adjustment path of the financial exchange rate is completely the same as that of regressive expectations.

Appendix 1

Since the equilibrium condition for the money market(equation(2)) is standard, in this Appendix we will only derive how equations (1) and (3) are obtained by using the method offered by Bhandari(1982, ch.13) and Lai and Chang(1989).

Levels of the relevant variables in terms of *natural* units are denoted by upper-case letters. The aggregate demand for domestic goods, D, is defined as

$$D=C+I+G+B \tag{A1}$$

where C, I, G, and B denote consumption, investment, government expenditure, and balance of trade, respectively. (A1) can be rewritten as

$$D=\exp(\ln C)+\exp(\ln I)+\exp(\ln G)+B \tag{A2}$$

Since B may be negative, it is clear that in (A2), B cannot be expressed in logarithmic form. But all the other variables can.

Taking logarithms of(A2) gives

$$\ln D=\ln[\exp(\ln C)+\exp(\ln I)+\exp(\ln G)+B] \tag{A3}$$

A first-order logarithmic Taylor approximation to (A3) yields

$$\ln D=(C^0/D^0)(\ln C-\ln C^0)+(I^0/D^0)(\ln I-\ln I^0)+(G^0/D^0)(\ln G^0-\ln G^0) \\ +(1/D^0)(B-B^0)+\ln D^0 \tag{A4}$$

where C^0, I^0, G^0, B^0, and D^0 are initial values of C, I, G, B and D. Letting $\overline{Y}$ denote the fixed supply of output measured in natural units and assuming that the goods market is in equilibrium initially, i.e., $D^0=\overline{Y}$, and then collecting constant terms, (A4) then becomes

$$d=\mu_1 c+\mu_2 i+\mu_3 g+\mu B+k \tag{A5}$$

where $\mu_1=C^0/\overline{Y}$, $\mu_2=I^0/\overline{Y}$, $\mu_3=G^0/\overline{Y}$, $\mu=1/\overline{Y}$, $d=\ln D$, $c=\ln C$, $i=\ln I$, $g=\ln G$, and k is the aggregate constant term.

We assume that the function forms of the logarithmic consumption and investment functions are

$$c=\gamma_0+\gamma_1\overline{y} \tag{A6}$$

$$i=\sigma_0-\sigma_1 r \tag{A7}$$

Moreover, we also assume the trade balance(in natural units) is given by

$$B=\delta(\overline{e}_c+p^*-p) \tag{A8}$$

Substituting(A6), (A7), (A8) into (A5) and collecting the constant terms, we have

$$d=\mu_1\gamma_1\overline{y}-\mu_2\sigma_1 r+\mu_3 g+\mu\delta(\overline{e}_c+p^*-p)+[k+\mu_1\gamma_0+\mu_2\sigma_0] \tag{A9}$$

Letting $\mu_1\gamma_1=\gamma, \mu_2\sigma_1, =\sigma$, and $u=\mu_3 g+k+\mu_1\gamma_0+\mu_2\sigma_0$, (A9) becomes

$$d=u+\gamma\overline{y}-\sigma r+\mu\delta(\overline{e}_c+p^*-p) \tag{A10}$$

Finally, as in Dornbusch(1976), the rate of increase in the domestic price is assumed to be proportional to excess demand in the domestic goods market :

$$\dot{p}=k(d-\bar{y})$$
$$=k\{u+(\gamma-1)\bar{y}-\sigma r+\mu\delta(\bar{e}_c+p^*-p)\} \tag{A11}$$

This last equation is the equation (1) in the text.

The next stage is to drive the equilibrium condition for the balance of payments. Following Frenkel and Rodriguez(1982) and Kiguel(1987), assume that capital flows respond only to the difference between the yield on domestic bonds and the yield on foreign bonds, that is

$$K=\beta[r-r^*-r^*(\bar{e}_c-e_f)-(e^e_f-e_f)] \tag{A12}$$

where K is net capital inflows. It is worth mentioning that K cannot be measured in logarithms since its value may be negative. From(A8) and (A12) it is clear that the balance-of-payments equilibrium condition in the context of the two-tier regime with neutral intervention operations is

$$\delta(\bar{e}_c+p^*-p)+\beta[r-r^*-r^*(\bar{e}_c-e_f)-(e^e_f-e_f)]=0 \tag{A13}$$

As is evident, (A13) is identical to (3) in the text.

Appendix 2

This Appendix will provide a detailed derivation for equation(27).

Assuming that the economy is at its steady state initially. In response to an increase in money stock from m_0 to m_1, from equations(7) and (22) we can obtain the forecast error at the instant of monetary shock(as defined the time 0+in the text) as follows

$$\tilde{e}^e_f(0+)-\tilde{e}_f=[\alpha(0+)-1]\ [\frac{\delta(\beta\mu+\sigma)}{\beta r^*(\lambda\mu\delta+\sigma)}]\ [m_1-m_0] \tag{A14}$$

Similarly, the forecast error associated with the time t can be exprssed as

$$\tilde{e}^e_f(t)-\tilde{e}_f=[\alpha(t)-1]\ [\frac{\delta(\beta\mu+\sigma)}{\beta r^*(\lambda\mu\delta+\sigma)}]\ [m_1-m_0] \tag{A15}$$

Putting equation(26) in the text into equation(A15) gives

$$\tilde{e}^e_f(t)-\tilde{e}_f=[\alpha(0+)-1]\exp(-\pi t)[\frac{\delta(\beta\mu+\sigma)}{\beta r^*(\lambda\mu\delta+\sigma)}][m_1-m_0] \tag{A16}$$

Differentiation equation (A16) with respect to time, it follows that

$$\dot{\tilde{e}}^e_f(t)=[\alpha(0+)-1](-\pi)\exp(-\pi t)[\frac{\delta(\beta\mu+\sigma)}{\beta r^*(\lambda\mu\delta+\sigma)}][m_1-m_0] \tag{A17}$$

Finally, substituting (A16) into (A17), we have

$$\dot{\tilde{e}}^e_f(t)=-\pi[\tilde{e}^e_f(t)-\tilde{e}_f]=\pi[\tilde{e}_f-\tilde{e}^e_f(t)] \tag{A18}$$

Equation (A18) is exactly the same as equation(27) in the text except that we explicitly contain the time indicator in the former equation.

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