<*Articles*>

Currency Crises and Exchange Rate Expectations

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In this paper, we explore how the expected future increase in the money supply leads to the collapse of the fixed exchange rate regime given some sluggish adjustment in outputs, consumption, and prices with negative real shocks over the economy. The crucial role of this expected money supply increase is its effect of lowering the shadow value of the currency (or the shadow equilibrium exchange rate) in the fixed exchange rate regime.

1. Introduction

Since the final demise of the Bretton Woods System in the early 1970 s, many countries have tried to stabilize their currency in foreign exchange markets. In practice, however, they eventually gave up to maintain their fixed exchange rate, after a convulsive speculative attack. Such currency crises fell on Europe in 1992, Mexico in 1994, and Asia in 1997.

The conventional theories about the currency crisis is largely classified into the following two groups.

First, Krugman (1979) extended the analysis of Salant and Henderson (1978) to attacks on fixed exchange rate regimes, which is later simplified by Flood and Garber (1984 a). They showed that if a government with persistent money-financed fiscal deficits is assumed to use a limited stock of foreign reserves to peg its exchange rate, rational speculators would attack on the currency when reserves fell below some critical level. The view that deteriorating fundamentals lead to currency crises is often called the "first-generation model".

The second, alternative view of currency crises model is often called the "second-generation model". The representative papers are Obstfeld (1986), Ofstfeld (1994), and Obstfeld (1996). They show that a government chooses whether or not to defend a pegged exchange rate by making a trade-off between short-run macroeconomics flexibility and longer-term credibility, and the crises arise when the defense of the exchange rate is more costly because speculators suspect that defense will ultimately fail. As a result, a speculative attack would occur either as result of

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a predicted future deterioration in fundamentals, or through self-fulfilling prophecy even if a government follows the right monetary policies.

These models made clear the nature of speculation in fixed exchange rate regimes and the timing of attack. But they did not show the performance of the real sector when fixed exchange rate regimes collapse.

In this paper, we try to show the relation between the collapse of the fixed exchange rate regime and its effects over the real domestic economy by several alternative small open macro economic models à la Mundell-Fleming and Dornbusch. The paper shows another factor of the currency crisis, i.e., the expected future increase in the money supply, which has not been explored in the previous studies. The paper is constructed as follows.

In section 2, we summarize the basic notation and assumptions. In section 3, we build a standard small open macro economy model under the flexible exchange rate system à la Mundell-Fleming and Dornbusch with sluggish output adjustment. In section 4, we employ this basic model to show that the expected future increase in the money supply leads to a collapse of the fixed exchange rate system before the money supply increase and the negative real shock on the economy. In section 5, we allow instantaneous output adjustment but allow some demand inertia against the changes in the real exchange rate. This causes the J-curve effect, which leads to qualitatively the same results on the role of the expected future increase in the money supply. In section 6, we further show that our results also hold even when we take account of the supply side of the economy with sluggish price adjustment. And section 7 concludes the paper.

2. The Model

We employ a standard small-open macro-economy model à la Mundell and Fleming with constant prices and sluggish output adjustment. We also assume for simplicity of exposition that the foreign prices are also constant. The model consists of the following set of equations.

$$h(y, \rho_r, g, e) = a(y, \rho_r) + g + z(y, e) \qquad (1)$$

$$\dot{y} = \kappa\{h(y, \rho_r, g, e) - y\} \qquad (2)$$

$$m = L(y, \rho_r) \qquad (3)$$

$$\rho_r = \rho_r^* + \epsilon\left\{\frac{\dot{e}}{e}\right\} \qquad (4)$$

$$\epsilon\left\{\frac{\dot{e}}{e}\right\} = \frac{\dot{e}}{e} \qquad (5)$$

$$m = \begin{cases} ef + d & \text{for the fixed exchange rate regime} \\ d & \text{for the flexible exchange rate regime} \end{cases} \qquad (6)$$

where the notations without an asterisk (*) refers to the home country's variables, those without an asterisk to the foreign ones, and they are defined as below.

y	the real produced national income
$a(\cdot)$	the real aggregate private expenditure function
g	the real government expenditure
$z(\cdot)$	the real current account or net export function
$h(\cdot)$	the real aggregate demand function
ρ_r	the real interest rate

e	the real exchange rate
κ	a positive constant showing the adjustment speed for outputs
m	the real money supply
$L(\cdot)$	the real money demand function
$\epsilon(\cdot)$	the expectation operator
f	the real foreign reserves held by the domestic central bank
d	the real domestic credit created by the domestic central bank
$\bar{e}$	the initial real exchange rate

As in the standard analysis, we assume:

Assumption 1. *The macro-economy of the home country satisfies:*

(A-1) $a_y(y, \rho_r) \in (0, 1)$, *and* $a_\rho(y, \rho) < 0$.

(A-2) $z_y(y, e) < 0$, *and* $z_e(y, e) > 0$.

(A-3) $L_y(y, \rho_r) > 0$, *and* $L_\rho(y, \rho_r) < 0$.

(A-4) *All investors, both domestic and foreign, share the common rational expectations on each and every variable of the economy.*

(A-1) and (A-3) may not require any explanation. (A-2) represents that the import demand increases in the national income and that the Marshall-Lerner condition holds to ensure that the depreciation in the exchange rate improves the country's current account. (A-4) shows that every investor has the same rational expectation over the financial investment opportunities.

Let us briefly explain the system of equations above. (1) defines the real aggregate demand as the sum of the private expenditure, the government expenditure and the net exports. (2) represents the short-run dynamics of output adjustment process, and (3) the money market equilibrium condition for the home country. (4) means that the interest parity always holds.[1] (5) means that the private sector rationally anticipates the path generated by the changes in the real exchange rate. (6) shows the balance sheet of the domestic central bank where we assume that the central bank holds no foreign currency reserves in the flexible exchange rate regime.

Let us now delineate equilibria for both the fixed and flexible exchange rate regimes as a preliminary analysis for currency crises.

3. Fixed Exchange Rate Regime and Currency Crises

We first consider the case in which our country employs the fixed exchange rate regime and explore into the potential factors to trigger currency crises. There are two remarks in order here.

First, the domestic central bank is obliged to sustain the exchange rate parity. We denote by $\bar{e}_0$ the real exchange rate associated with the parity.

Second, since the prices are fixed and the market rationally expects it, the interest arbitrage condition 4 requires equality of the domestic interest rate with the foreign one, i.e.,

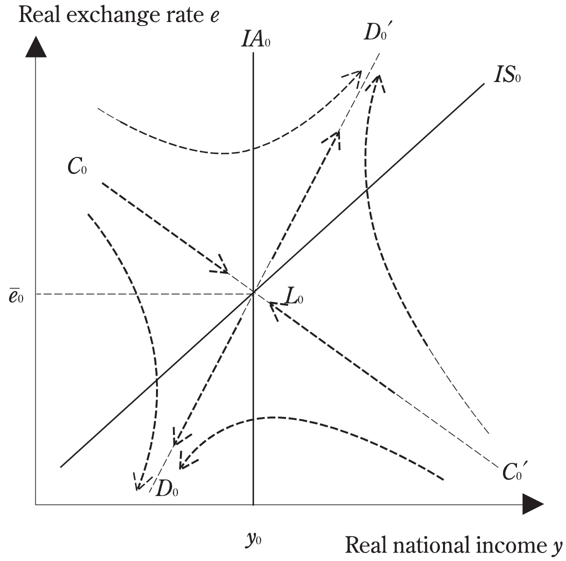
$$\rho_r = \rho_r^*. \tag{7}$$

Third, by virtue of (7), the domestic money market equilibrium condition (3) is rewritten as below:

$$m = L(y, \rho_r^*), \tag{8}$$

which implies that the money supply is endogenously determined given the real national income. In view of (6), (8) determines the equilibrium foreign currency

Figure 1. Short-run Equilibria for Fixed and Flexible Exchange Rate Regimes



reserve f as below:

$$f = \frac{1}{\bar{e}_0}\{m - d\}. \tag{9}$$

3.1. Short-run Equilibria for the Fixed Exchange Rate Regime

With the remarks above in our mind, let us explore into the dynamics working in the fixed exchange rate regime. The dynamics is governed by

$$\dot{y} = \varkappa\{h(y, \rho_r^*, e, g) - y\} \tag{10}$$

The phase diagram for the above dynamics is depicted over the (y, e)—plane as in Figure 1.

The curve IS_0 shows the real national income y to clear the commodity market given the real exchange rate e. It is upward sloping, for depreciation in the real exchange rate raises the net export demand and boosts the aggregate demand. As implied by the short-run adjustment process (10), given the real exchange rate e the real national income is increasing (or decreasing) over (or below) the curve IS_0.

Since the real exchange rate is given at $\bar{e}_0$, the economy must reach a stationary equilibrium at point L_0. Let y_0 denote the associated level of the real national income, m_0 the associated equilibrium money supply given by (8), and f_0 the equilibrium foreign currency reserve determined by (9).

There is one remark in order here. That is, the country can maintain the fixed exchange rate regime at the given exchange rate parity only when the equilibrium volume of the foreign currency reserve f_0 given by (9) is non-negative. Otherwise, the fixed exchange rate regime collapses away.

Of course, there is a problem when talking of the collapse of the fixed exchange rate regime. That is, possibility of the collapse hinges on the assumed exchange rate parity. When the country devaluates the exchange rate, it may prolong the expectancy of the fixed exchange rate system. However throughout the present paper, we focus our attention to the possibility of collapse only at the given exchange rate parity. And for discussing the problem of collapse, we impose

Assumption 2. *Given the initial parity of the foreign exchange rate and the volume of domestic credit, the country can sustain the fixed exchange rate regime.*

The assumption is equivalent to

$$f_0 > 0,$$

where f_0 is determined by (9).

3.2. Potential Factors of Currency Crises

Let us return to the fixed exchange rate and explore into what hinders the domestic government from sustaining the fixed exchange rate regime. By our definition, the country can sustain the fixed exchange rate regime if and only if the equilibrium foreign currency reserve is strictly positive given the initial foreign exchange rate parity. Thus any factors boosting the domestic money demand leads to currency crises. They are listed as below:

(i) An increase in the domestic credit supply d

(ii) An increase in the government expenditure g

Although the traditional theoretical literature focuses on the first monetary factor, we must note that the second fiscal factor, or more generally real factors, could trigger currency crises.

Hereafter we let d_c, the critical volume of the domestic credit letting the equilibrium foreign currency reserve equal to zero given the initial exchange rate parity, i.e., $d_c = m_0$. We also let g_c the critical level of the government expenditure leading to zero foreign currency reserve. Thus either when $d > d_c$ or when $g > g_c$ the country cannot sustain the fixed exchange rate regime and is forced to move into the flexible exchange rate regime. We focus our attention on the monetary factor, i.e., an increase in the domestic credit throughout the rest of the paper. The fiscal factor will be discussed rather briefly in the conclusion.

4. Currency Crises and Expectations on Exchange Rates

Before inquiring into the situation after collapse of the fixed exchange rate regime, we first delineate the equilibrium before the currency crises as a preliminary analysis.

4.1. Equivalent Flexible Exchange Rate Regime

For this purpose, we first note that given the initial exchange rate parity $\bar{e}_0$ and the initial domestic credit supply d_0, the country can move to the flexible exchange rate regime without any changes in the economic performance. That is, even in the flexible exchange rate regime the parity $\bar{e}_0$ is sustained as an equilibrium foreign exchange rate given the money supply $m_0 = \bar{e}_0 f_0 + d_0$.

This initial situation is depicted as a stationary state to the following set of dynamic equations:

$$\dot{y} = \kappa\{D(y, m, g, e) - y\} \qquad (11)$$

$$R(m, y)=\rho_r^*+\frac{\dot{e}}{e} \tag{12}$$

The above equations are derived as follows. First, we derive the domestic equilibrium interest rate function, denoted by $R(m, y)$. Since the money market is instantaneously cleared throughout the time, we may express the equilibrium real interest rate in the home country by

$$\rho_r=R(m, y), \tag{13}$$

which is derived by solving (3) for r. Obviously, an increase in the money supply leads to a drop in the interest rate ($R_m(m, y)<0$), while an increase in the national income pushes it up ($R_y(m, y)>0$).

Second, we express the aggregate demand function with the domestic interest being endogenously determined, which is expressed by $D(y, m, g, e)$. This is obtained by substitution of the above equilibrium interest rate function $R(m, y)$ into the real aggregate demand function $h(y, \rho_r, g, e)$ as below:

$$D(y, m, g, e)=h(y, R(m, y), g, e) \tag{14}$$

It shows the aggregate demand with the domestic money market being at equilibrium. One can show immediately [2]

$$D_y(y, m, g, e)\in(0, 1) \tag{15}$$
$$D_m(y, m, g, e)>0 \tag{16}$$
$$D_g(y, m, g, e)>0 \tag{17}$$
$$D_e(y, m, g, e)>0 \tag{18}$$

The set of equations governing the present dynamics is given below:

$$\dot{y}=\kappa\{D(y, m, g, e)-y\} \tag{19}$$
$$\dot{e}=\{R(m, y)-\rho_r^*\}e \tag{20}$$

The dynamics generated by (19) and (20) is depicted over the (y, e)—plane as before in Figure 1.

First, the upward-sloping curve named IS_0 gives the relation between the real exchange rate e and the real national income y clearing the commodity market.[3]

Second, the vertically straight line named IA_0 depicts the stationary values of the real exchange rates equating the domestic interest rate with the foreign one, i.e., $R(m, y)=\rho_r^*$. Since this condition is independent of the exchange rate, the associated equilibrium locus is given by a vertically straight line as IA_0. Left to IA_0, the domestic interest rate becomes lower than the foreign one, which requires appreciation of the foreign exchange rate for international interest arbitrage. Right to IA_0, the reverse holds true, i.e., the exchange rate should depreciates.

The (y, e)—plane is divided into four regions by the two saddle point paths; one is given by curve C_0C_0' showing a convergent path and the other by curve D_0D_0' showing a divergent path. Since the real national income is sluggish in adjustment and the exchange rate is instantaneously adjusted over time, given any real national income level the exchange rate is first adjusted to locate itself on the convergent path C_0C_0', after which the economy adjusts itself along the path C_0C_0' towards the stationary point L_0. The figure is drawn so that given the equilibrium money supply in the fixed exchange rate regime m_0, the country can switch to the flexible exchange rate regime with the given exchange rate parity $\bar{e}_0$.

4.2. Unexpected Monetary Expansion and Currency Crises

Now suppose that the domestic central bank decides to increase the domestic credit up to $d_1(>d_c)$ in the fixed exchange rate system, which has not been expected by the private sector. Note that the country can no longer sustain the fixed exchange rate regime. For the present domestic credit expansion gives an downward pressure to the domestic interest rate, triggers massive capital outflow, leading to depletion of the foreign currency reserve. Since the country is forced to move to the flexible exchange rate regime and its foreign currency reserve is depleted, the money supply in the resulting flexible exchange rate regime is given by $m_1=d_1$. This money supply volume is larger than the initial one but smaller than the one when the foreign currency reserve is kept constant at the initial equilibrium level. That is, m_v should satisfy:

$$m_0<m_1=d_1<m_0+(d_1-d_0)\{=\bar{e}_0 f_0+d_1\}$$

This money supply volume is larger than the initial one, for the foreign currency will not be depleted unless $d_1>\bar{e}_0 f_0+d_0(=m_0)$.

The new set of dynamic equations is:

$$\dot{y}=\kappa\{D(y,\ m_v,\ g,\ e)-y\} \tag{21}$$

$$R(m_v,\ y)=\rho_r^*+\frac{\dot{e}}{e} \tag{22}$$

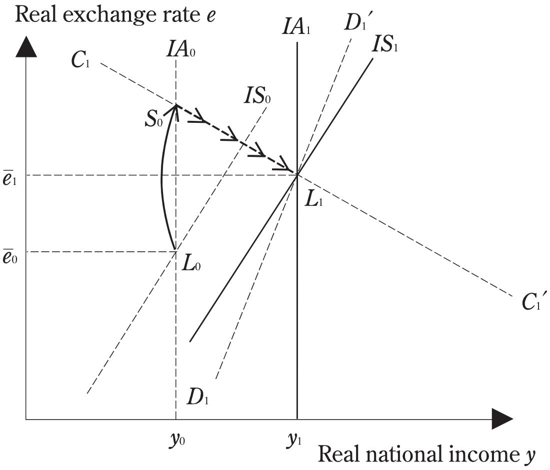
The stationary state is governed by the following set of equations:

$$D(y,\ m_v,\ g,\ e)=y \tag{23}$$

$$R(m_v,\ y)=\rho_r^* \tag{24}$$

An increase in the money supply shifts rightward the commodity market equilibrium locus from IS_0 to, say IS_1, for given the real exchange rate it lowers the domestic interest rate and thus boosts the private expenditure. It also shifts rightward the interest arbitrage locus from IA_0 to, say IA_1, for the resulting drop in the domestic rate of interest requires an increase in the transaction demand for money so as to be equated again with the foreign interest rate. The new short-run stationary state, given by point L_1, entails greater national income y_1 and depreciated exchange rate e_1 as the standard Mundell-Fleming model shows.

Figure 2. Unexpected Monetary Expansion and Currency Crisis



The adjustment towards the new stationary state goes as follows. The economy first jumps to a point named S_0 on the new convergent saddle point path C_1C_1', after which it adjusts itself along C_1C_1' towards L_1.

There are a couple of remarks in order here. First, an expected monetary expansion leads to a sudden collapse of the fixed exchange rate system. The foreign capital outflows from the home country at an instant, which forces the domestic central bank to give up maintaining the fixed exchange rate system.

Second, the collapse of the fixed exchange rate system requires exchange rate overshooting; the new equilibrium exchange rate e_1 should be depreciated compared with the initial exchange rate parity $\bar{e}_0$, but the exchange rate just after the collapse of the system overshoots the new equilibrium level.

Third, the collapse of the fixed exchange rate regime does not give any effects on the real national income. The succeeding macroeconomic adjustment rather produces its expansion!

Thus insofar as monetary expansion is unexpected for the private sector, the succeeding currency crisis should be rather welcome by the home country, for it boosts the real national income particularly when it suffers from massive unemployment.

4.3. Expected Monetary Expansion and Currency Crisis

What if the monetary expansion is expected in advance by the private sector? This is the next question which we tackle here. To make the difference clear, we assume that the monetary expansion in question is planned in the enough distant future. Hereafter the current point in time is denoted by time 0, and the time of monetary expansion is by time $T(>0)$.

What does this imply? We know that in the distant future the fixed exchange rate system collapses. At the collapsing time, the exchange rate depreciates. Since the market anticipates such depreciation, it should not happen abruptly, for there arises an opportunity for interest arbitrage to raise an enormous amount of profit. This in turn implies that the system should have collapsed even before the planned monetary expansion is put into force. That is, the foreign currency reserve must be depleted long before the monetary expansion. Let T_C denote the time when the fixed exchange rate system collapses.

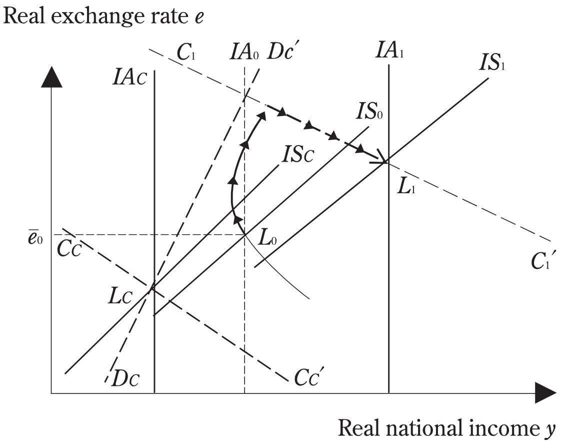
As discussed in Obstfeld (1996), there must not be any profit-raising interest arbitrage opportunities over the adjustment period. It implies that at time T_C when the country switches to the flexible exchange rate system the equilibrium exchange rate should be equal to the exchange rate parity in the fixed exchange rate regime.

Let us summarize the preceding discussion. We have the following three adjustment phases. In Phase I, the economy sustains the fixed exchange rate regime with the initial money supply m_0, i.e., the initial foreign currency reserve f_0 and the domestic credit d_0 at the parity $\bar{e}_0$. In Phase II, the foreign currency reserve is depleted and the economy is forced to abandon the fixed exchange rate regime. Since the domestic credit is not increased yet, the money supply decreases up to $m_C = d_0$. And in Phase III, the domestic credit is expanded up to d_1, which gives the new volume of the money supply.

Let us describe the adjustment process more in detail by using Figure 3. We may not need any explanation for Phase I. The economy stays at point L_0.

Now move to Phase II. The fixed exchange rate system collapses at time T_C,

Figure 3. Expected Monetary Expansion and Currency Crisis



when the equilibrium exchange rate in the flexible exchange rate system should be equal to the exchange rate parity $\bar{e}_0$. Since the real national income is sluggish in adjustment, the economy at time T_C must be located at point L_0, the initial stationary level. But the forces of the dynamics follows those under the flexible exchange rate regime with the smaller money supply $m_C = d_0$ after depletion of the foreign currency reserve. And those forces are created by the two stationary loci, curves IS_C and IA_C, which are associated with the money supply m_C. Since the money supply decreases after the collapse of the fixed exchange rate regime, the two loci are located left to the initial ones with the new stationary state L_C involving the appreciated exchange rate.

Since the new commodity market equilibrium locus IS_C is located left to the initial one IS_0, it is straightforward to see that at the initial stationary state L_0 the exchange rate starts to depreciate while the real national income begins to decrease. Although the national income starts to increase after an interval, the exchange rate keeps to depreciate until at time T domestic credit is actually expanded and the economy moves to Phase III.

In Phase III, domestic credit is expanded as well as the money supply from d_0 to d_1. The force of dynamics is now governed by the new commodity market equilibrium locus IS_1 and the interest arbitrage locus IA_1 which are associated with the new larger money supply $m_1 = d_1$. Since the inrestors expected the money supply increase at time T in advance, the economy is adjusted to land at the associated convergent path C_1C_1' at time T. It adjusts itself along C_1C_1' afterwards over time towards the new stationary state L_1. We have again an overshooting phenomenon

Figure 4. Adjustment in the Real National Income

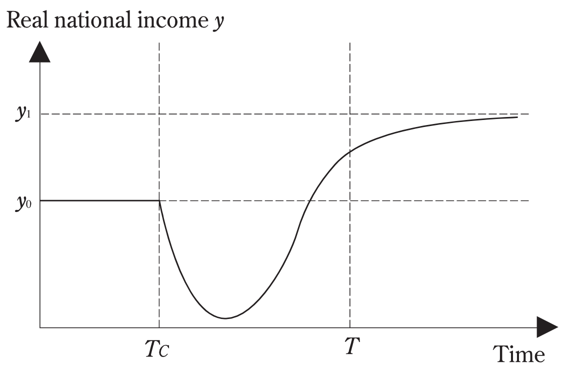
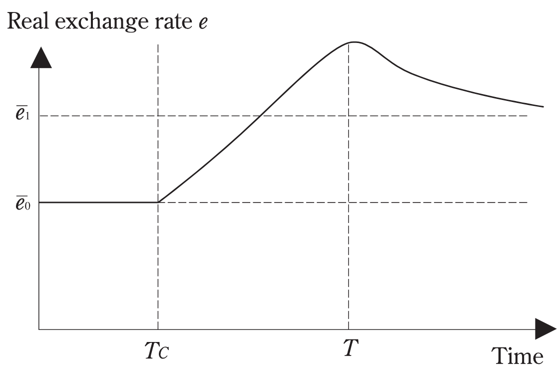


Figure 5. Adjustment in the Real Exchange Rate



in the exchange rate.

The following diagrams summarize the performance of the economy over the adjustment path.

Proposition 1. *When the domestic credit is expected to expand enough to collapse the fixed exchange rate system in the distant future and it is rationally expected by the private sector, then the following adjustment occurs even before the monetary expansion.*

(i) *The fixed exchange rate system collapses before the monetary expansion.*
(ii) *Collapse of the fixed exchange rate system has real effects; it first decreases the real national income for the time being after the collapse but reaches the greater level ultimately.*
(iii) *Collapse of the fixed exchange rate system yields overshooting in the exchange rates.*

The adjustment path has slightly different properties when the monetary expansion is expected in the near future. The fixed exchange rate system collapses even at this juncture when the expectation of the monetary expansion is held by the private sector. The resulting exchange rate jumps to a certain level higher than the initial parity. When the time of the monetary expansion is near enough to the present, then the real national income may keep increasing over time.

More generally, we can prove the following concerning the timing of the collapse in the fixed exchange rate system.[4]

Proposition 2. *The time of collapse in the fixed exchange rate system is nearer to the present as the size of the domestic credit expansion becomes greater.*

5. Demand Inertia in Trade and J-curve Effects

In the previous section, we have shown that currency crises triggered by expected monetary expansion affects the real side of the economy when the real output adjusts sluggishly. However, even when the real output instantaneously adjusts to clear the commodity market, similar effects work if the foreign trade transactions adjusts sluggishly. This is the case in which the so-called "J-curve effect" sets into the model. We amend the model to take account of this demand inertia effect in trade in the present section.

For incorporating the J-curve effect into the model, we assume that the trade transaction entails some sluggishness in the sense that its volume depends on the average real exchange rate from the past to the present. More specifically, we assume that the net exports function is now given by

$$z(y, e, \zeta),$$

where

$$\zeta_t = \frac{1}{\delta}\int_{-\infty}^{t} e(\tau)\exp\{-\delta(t-\tau)\}d\tau \tag{25}$$

$$\delta > 0 \text{ (a positive constant)} \tag{26}$$

$$z_e(\cdot) < 0 \tag{27}$$

$$z_\zeta(\cdot) > 0 \tag{28}$$

$$z_e(\cdot) + z_\zeta(\cdot) > 0 \tag{29}$$

ζ_t represents the real exchange rate averaged over the past, which we call simply the average exchange real exchange rate. Here the parameter δ represents the speed of adjustment in trade transactions. Condition (27) represents that in the short run depreciation of the exchange rate worsens the current account while condition (29) coupled with (28) implies that the it improves the current account in the long run. That is, (27) and (29) mean that the Marshall-Lerner condition does not hold in the short-run but in the long-run.

Since the commodity market is instantaneously adjusted to clear, the real national income at time t, denoted by $y(t)$, is given as a solution to:

$$y(t)=a(y(t), \rho_r(t))+g + z(y(t)), e(t), \zeta(t)), \quad (30)$$
$$m(t)=L(y(t), \rho_r(t)), \quad (31)$$
$$\dot{e}(t)=\{\rho_r(t)-\rho_r^*\}e(t) \quad (32)$$

We first characterize the domestic equilibrium, i.e., the solution $(y(t), \rho_r(t))$ for the first two dynamic equations above, (30) and (31).

As the standard comparative analysis implies, they depend on $(\zeta(t), g, e(t))$, the relation of which we express by $\tilde{y}(\zeta(t), m(t), e(t), g)$ and $\tilde{\rho}_r(\zeta(t), m(t), e(t), g)$. In view of (27)-(29), the following results are immediate to obtain:

$$\frac{\partial\rho_r(\zeta, m, e, g)}{\partial\zeta}>0 \quad (33)$$
$$\frac{\partial\rho_r(\zeta, m, e, g)}{\partial m}<0 \quad (34)$$
$$\frac{\partial\rho_r(\zeta, m, e, g)}{\partial e}<0 \quad (35)$$

Thus the dynamics in the flexible exchange rate system is governed by:

$$\dot{\zeta}(t)=\delta\{e(t)-\zeta(t)\} \quad (36)$$
$$\dot{e}(t)=\rho_r(\zeta(t), m(t), e(t), g)-\rho_r^* \quad (37)$$

A stationary state is defined to be given by a pair (ζ, e) satisfying:

$$e=\zeta$$
$$\rho_r(\zeta, m, e, g)=\rho_r^*$$

The associated phase diagram is shown in Figure 6. The 45° line labelled $e=\zeta$ shows the locus for stationary levels of the average exchange rate for each real exchange rate. We call this locus the stationary average exchange rate locus. Clearly, in the stationary state, the average exchange rate must be equal to the current exchange rate.

On the other hand, the upward-sloping curve IA_0 shows (ζ, e) pairs giving rise to equality between the domestic and foreign interest rates. This interest arbitrage locus IA_0 is steeper than the 45° line, for a proportional increase in e and ζ raises the real national income by virtue of the Marshall-Lerner condition (29), leading to the domestic interest rate higher than abroad.

The (ζ, e)—plane is divided into four regions with two saddle pint paths, named C_0C_0' (a convergent path) and D_0D_0' (a divergent one). Since the average exchange rate adjusts itself sluggishly, given any average exchange rate ζ the exchange rate jumps to the level associated ζ on the convergent saddle-point path C_0C_0', and then the economy moves toward the stationary point, which is an intersection of the 45° line and IA_0.

Figure 6. Medium-run Exchange Rate Dynamics

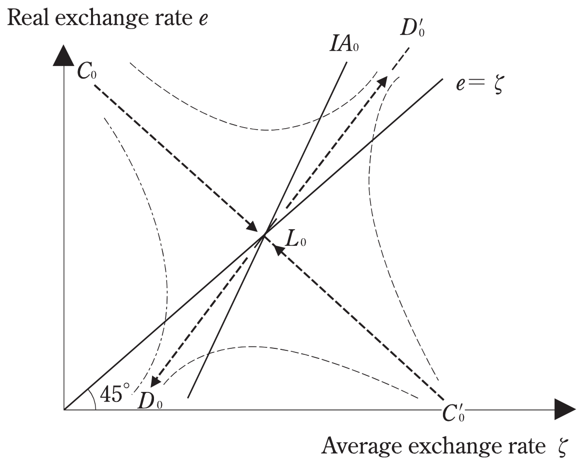
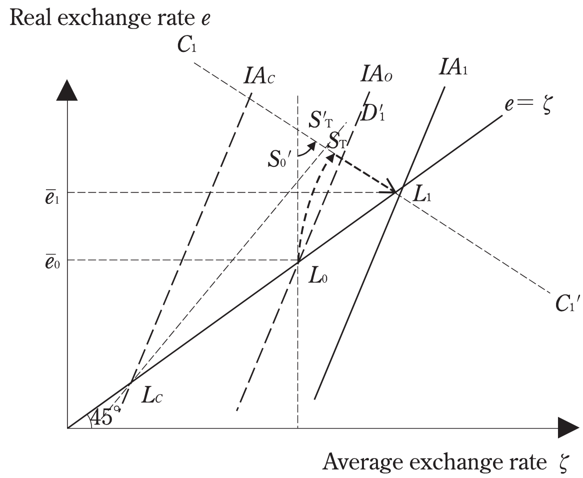


Figure 7. Currency Crises and J-curve Effects



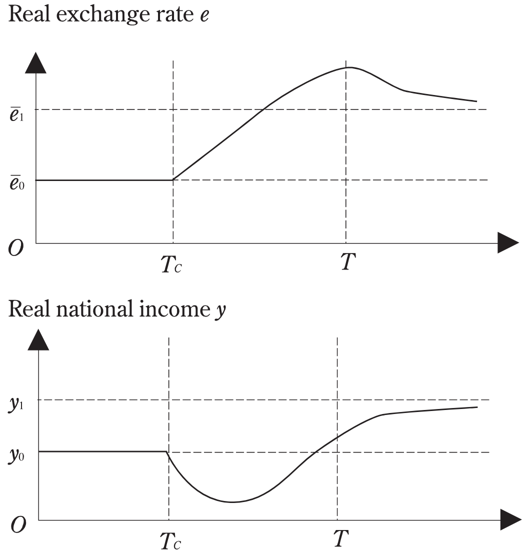
As in the previous section, we suppose that the country employs initially the fixed exchange rate regime. Given the initial exchange rate parity $\bar{e}_0$ and the initial domestic credit volume d_0, the country is assumed to sustain the fixed exchange rate system. The stationary state in the equivalent flexible exchange rate regime is shown by point L_0 in Figure 6.

Suppose then that the domestic central bank plans to expand the domestic credit up to d_1 at time T in the future distant enough, which makes the country unable to sustain the fixed exchange rate regime. The situation is depicted by Figure 7. The new stationary state in the flexile exchange rate regime given the money supply $m_1=d_1$ is given by an intersection of the new interest arbitrage locus IA_1 and the 45° line, shown by point L_1. The adjustment path from the initial stationary state L_0 to the new one L_1 is derived as below.

Let T_C denote the time when the fixed exchange rate regime collapses. For the time being, we assume $T_C>0$. When the fixed exchange rate regime collapses at time T_C, the foreign currency reserve will be depleted instantaneously, so that the money supply shrinks suddenly from $m_0(=\bar{e}_0 f_0+d_0)$ to $m_C(=d_0)$. The interest arbitrage locus associated with m_C, denoted by IA_C, will be located left to the initial one IA_0 as shown in Figure 7. This is because given the average exchange rate a decrease in the domestic money supply raises the domestic interest rate and thus appreciation of the exchange rate is required to restore equality between the domestic and foreign interest rates, for exchange rate appreciation lowers the real national income and the domestic interest rate in the short run.

By the time T when domestic credit expands, the economy is governed by the dynamics expressed by IA_C and the 45° locus. More specifically, since the exchange rate cannot jump at time T_C the economy starts adjustment at point L_0 with depreciation in the exchange rate. The resulting adjustment path from time T_C to T is given by a curve L_0S_T. After time T when domestic credit expands, the economy adjusts itself along the new convergent path C_1C_1' with appreciation in the

Figure 8. Adjustment Paths under the J-curve Effect



real exchange rate but with depreciation in the average exchange rate. Along the adjustment path $L_0S_TL_1$, the real output first declines for a while but it should increase up to the level greater than the initial stationary value y_0 before reaching L_1, for the Marahsll-Lerner condition holds in the long run. The results are summarized in Figure 8.

When domestic credit expansion is expected sooner enough, then the fixed exchange rate regime instantaneously collapses at present with a jump in the exchange rate. The adjustment path in such a case is depicted by, for example, a path $S'_0S'_TL_1$ in Figure 7.

6. Sluggish Price Adjustment and Currency Crises

It is essential in the proceeding section for the collapse of the fixed exchange rate regime to affect the real output that the real national income should depend on the real exchange rate in some way or other. A crucial assumption in the previous sections is that the economy is in a under-employment equilibria over the time.

Once we allow for the response in the supply side, the real effects of the collapse in the fixed exchange rate regime should vanish unless the aggregate supply also depends on the real exchange rate. We will demonstrate this in the present section.

Consider the following aggregate supply function.

$$y_s = y_s(e), \tag{38}$$

where $y'_s(e) < 0$ is assumed to hold. This type of aggregate supply is often employed, particularly when we consider an open macro-economy with imported consumables and rigidity in the real wage in terms of the consumer price indices.

Unlike in the previous sections, we assume:

Assumption 3. *The economy now satisfies the following conditions.*

(A 3-1) *The domestic prices changes when the commodity market is in disequilibrium.*

(A 3-2) *The price changes only sluggishly in the short run.*

(A 3-3) *The aggregate supply is decreasing in the real exchange rate.*

(A 3-4) *The aggregate supply is instantaneously adjusted given the real exchange rate, so that the real national income is always equal to the aggregate supply.*

(A 3-5) *The net export demand increases along with depreciation in the real exchange rate, i.e., the Marshall-Lerner condition holds even in the short run.*

Given the above anumption, the dynamics of the economy employing the flexible exchange rate regime is now governed by the following set of equations.

$$\frac{\dot{p}}{p}=\mu\{h(y,\rho_r,g,e)-y\} \tag{39}$$

$$y=y_s(e) \tag{40}$$

$$m=L(y,\rho_r) \tag{41}$$

$$\frac{\dot{e}}{e}=\rho_r-\rho_r^* \tag{42}$$

where μ is a positive constant representing the adjustment speed in the domestic price and (40) represents the aggregate supply function satisfying $y_s'(e)<0$ by virtue of A 3.

For inquiry into the dynamics, we first put (40) into (41), and solve it for the domestic interest rate, which we express by

$$\rho_r=\hat{R}(m,e). \tag{43}$$

This equilibrium domestic interest function satisfies:

$$\hat{R}_m(m,e)<0$$
$$\hat{R}_e(m,e)<0$$

The first relation needs no explanation. The second relation holds, for depreciation in the real exchange rate decreases the aggregate supply and thus the real national income, which depresses the transaction demand for money.

Put (43) as well as the aggregate supply function (40) into the aggregate demand function, and obtain

$$\phi^d(m,e,g)=h(y_s(e),\hat{R}(m,e),g,e)-y_s(e), \tag{44}$$

which represents the excess demand in the commodity market. This function satisfies:

$$\phi_m^d(m,e,g)=h_r(\cdot)\hat{R}_m(\cdot)>0$$
$$\phi_e^d(m,e,g)=(h_y(\cdot)-1)y_s'(e)+h_r(\cdot)\hat{R}_e(\cdot)+h_e(\cdot)>0$$
$$\phi_g^d(m,e,g)=h_g(\cdot)>0$$

Thus the standard properties of the excess commodity demand hold.

Using (43) and (44), we may rewrite the above dynamical system in terms of (m, e) as below:

$$\frac{\dot{m}}{m}=-\mu\phi^d(m,e,g) \tag{45}$$

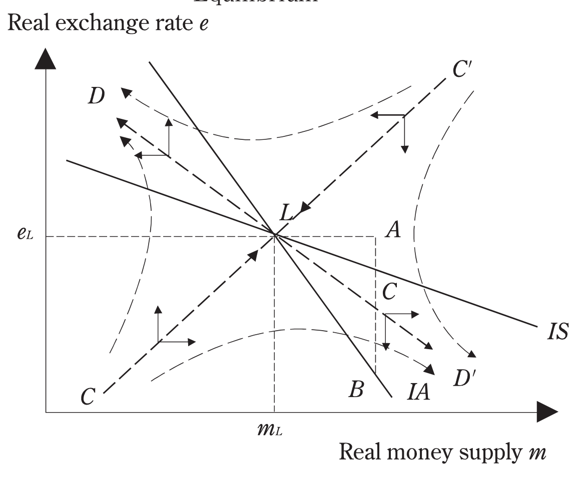
$$\frac{\dot{e}}{e}=\hat{R}(m,e)-\rho_r^* \tag{46}$$

where use was made of the relation

$$\frac{\dot{m}}{m}=-\frac{\dot{p}}{p}, \tag{47}$$

given the nominal money supply. The associated phase diagram is shown by Figure

Figure 9. Flexible Prices and Long-run Equilibrium



9. The curve IS shows (m, e) leading to the commodity market equilibrium, and the curve IA shows (m, e) equating the domestic interest rate withe the foreign counterpart.

There are three remarks in order here. First, the long-run stationary state represented by the intersection of the two curves IS and IA, denoted by point L in the figure, is independent of the nominal money supply. That is, the so-called money neutrality proposition holds here also in the present model. We express the associated real exchange rate by e_L, the real money supply by m_L, and the real national income by y_L.

Second, the two curves are both downward sloping. As with the curve IS, the excess commodity demand increases both in the real money supply and the real exchange rate. And as with the curve IA, the domestic interest rate decreases both in the real money supply and the real exchange rate.

Lastly, the curve IS is steeper than the curve IA. To confirm this property, consider an increase in the money supply associated with the movement from point L to point A in Figure 9. This produces a positive excess demand in the commodity market and lowers the domestic interest rate below the foreign counterpart. To recover the equality between the domestic and foreign interest rates, the real exchange rate should decrease up to the level associated with point B. But when we compare points L and B, the domestic interest rates are the same but the real exchange rate depreciates, so that there is still positive excess demand in the commodity market. To make this excess demand vanish, we need appreciation in the real exchange rate, say up to the level associated with point C in the figure. Thus the desired property is proven to hold.

As in the previous sections, let us suppose that our country initially employs the fixed exchange rate regime and sustains a long-run stationary state. This means that given the initial domestic credit volume, the real exchange rate associated with the parity $\bar{e}_0$ should be equal to e_L and the real money supply m_0 to m_L.

Now suppose further that the domestic central bank now plans to expand the domestic credit supply at time T in the future as in the previous sections. This future monetary expansion is assumed to be rationally expected in the market, so that the fixed exchange rate regime should collapse even before time T. Let us depict the adjustment required using Figure 10 first.

At time T_C when the fixed exchange rate regime collapses, the nominal money supply decreases as much as the initial holding of the foreign currency reserve, which are lost due to capital outflow. Since the price cannot jump, the real money supply shrinks as much as the rate of the decrease in the nominal money supply. The real money supply just after the collapse is represented by m_C in the figure. Since the real exchange rate cannot jump either by virtue of international interest arbitrage, the economy jumps from the initial long-run equilibrium L to point S_C. The succeeding adjustment before the monetary expansion goes along the path denoted by AA'. And at the time just before T it reaches point S_C^-, and then jumps to point S_C^+ on the convergent saddle-point path

Figure 10. Flexible Prices and Currency Crises — Case 1

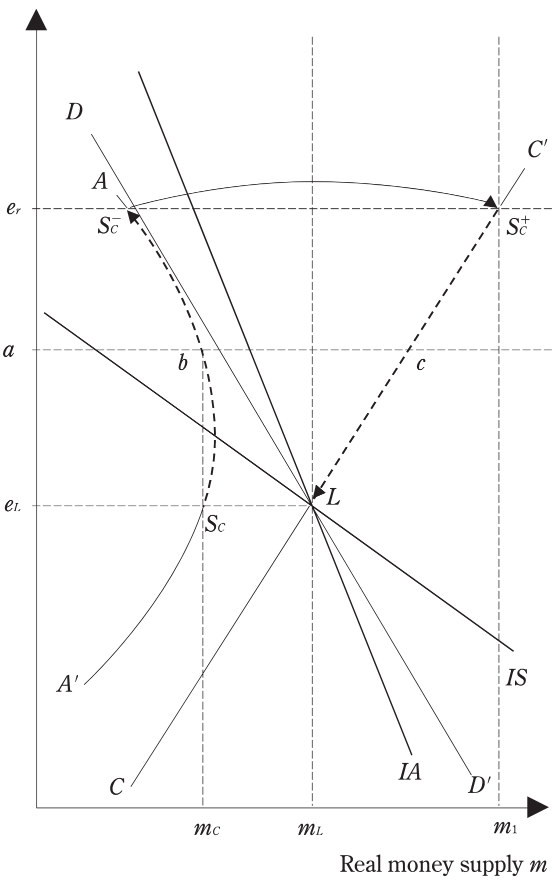
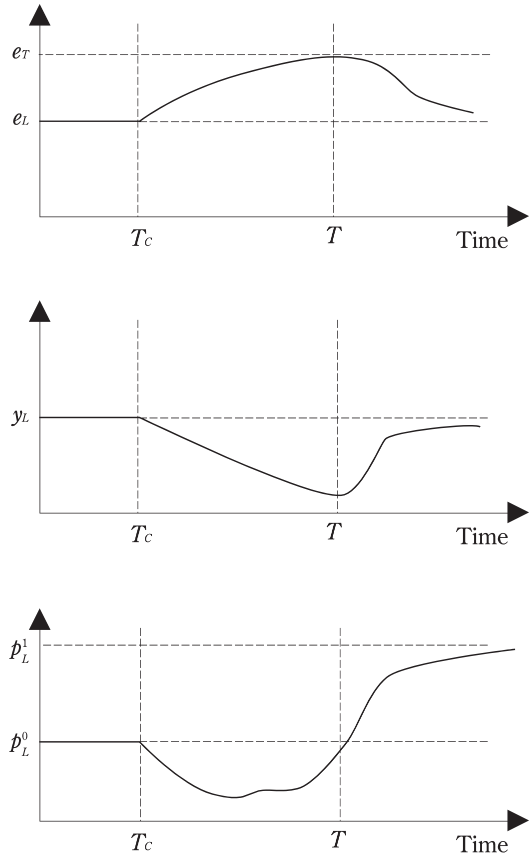


Figure 11. Adjustments for Case 1



CC' by virtue of domestic credit expansion.

The adjustments in the real exchange rate, the real national income and the domestic price level are depicted in Figure 11. The real exchange rate first depreciates till T, the time of monetary expansion, after which it appreciates and returns to the long-run equilibrium value e_L. The real national income moves in the opposite direction. Of interest is the adjustment in the domestic price level. Before the time of monetary expansion, it first decreases for a while but then begins to increase.

Similar results hold for Figure 12. The difference between Cases 1 and 2 is that the domestic price level before T may be higher than the initial long-run equilibrium price level.

Another possibility is described in Figure 13. Unlike the previous cases, the real exchange rate keeps appreciation before time T, after which it depreciates up to the new long-run equilibrium level. Thus the collapse of the fixed exchange rate regime first increases the real national income for a while before the domestic central bank expands domestic credit. The price level also behaves in a way completely different from the one in the previous cases. It keeps rising before T, after which it begins to become lower. These are shown in Figure

Figure 12. Flexible Prices and Currency Crises — Case 2

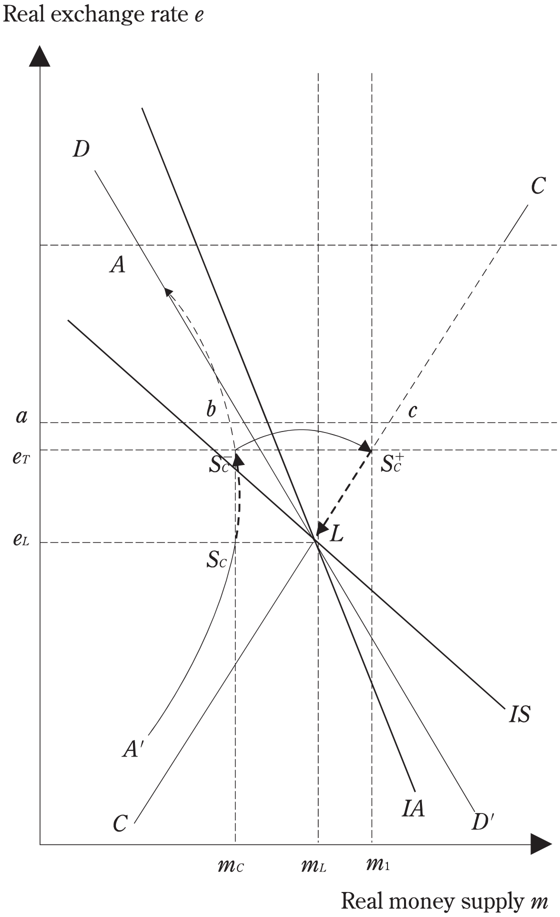
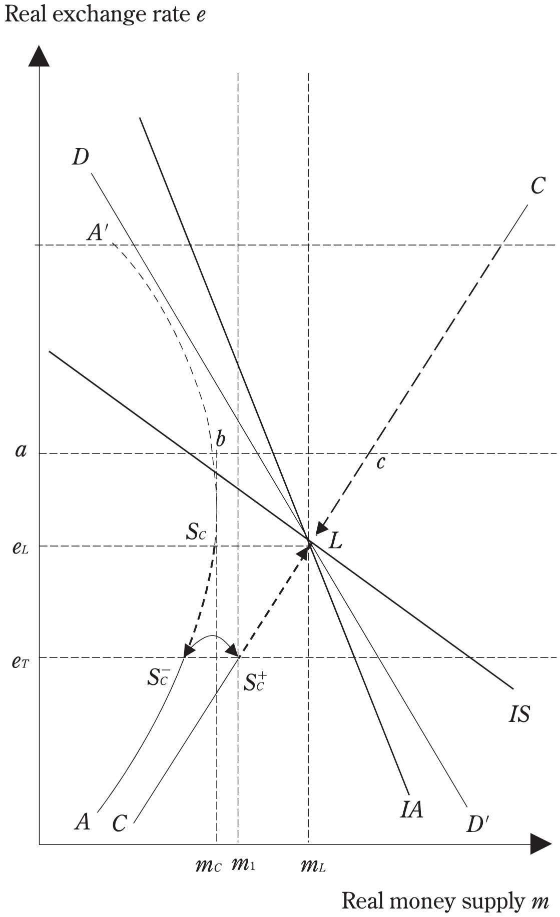


Figure 13. Flexible Prices and Currency Crises — Case 3



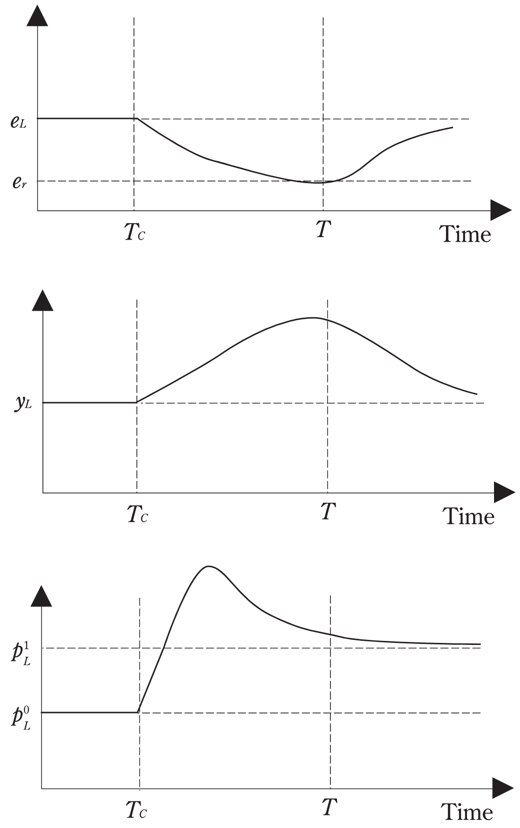
14.

7. Conclusion

In this paper, we have explored how the expected future increase in the money supply leads to the collapse of the exchange rate regime given some sluggish adjustment in outputs, consumption, and prices with negative real shock over the economy. The crucial role of this expected money supply increase is its effect of lowering the shadow value of the currency (or the shadow equilibrium exchange rate) in the fixed exchange rate regime.

There is a shortcoming of the present model based on the Mundell-Fleming model. That is, unlike what we expect, the expected future fiscal reforms reducing the government expenditure also causes the currency crisis. But it is due to the shortcoming of the Mundell-Fleming model based on the perfect substitution between domestic and foreign government bonds. Once we allow for their imperfect substitution, we may obtain the more persuasive results. But it is our future task.

Figure 14. Flexible Prices and Currency Crises



Appendix: Anticipated Monetary Expansion and the Timing of the Collapse in the Fixed Exchange Rate System

Let T denote the time when the domestic credit is expanded by the domestic central bank, and T_C the time when the fixed exchange rate regime collapses given the initial exchange rate parity. We also let $S = T - T_C$.

The economy employs the flexible exchange rate regime over the period $[T_C, T]$ given the money supply $m_C = d_0$, i.e., the initial money supply m_0 minus the depleted foreign currency reserve $\bar{e}_0 f_0$, and the dynamics obeys

$$\dot{y} = \varkappa\{D(y, m_C, g, e) - y\} \quad (48)$$

$$\dot{e} = \{R(m_C, y) - \rho_T^*\}e \quad (49)$$

There are two initial conditions and one terminal one for the above dynamic system. First, the real national income cannot jump at any time over adjustment, y_0 should be equal to the initial stationary value. Second, for the moment, assume that the exchange rate does not jump at the collapsing time of the fixed exchange rate regime. This imposes an initial condition

$$e_0 = \bar{e}_0. \quad (50)$$

Lastly, since the economy should be governed by the dynamics given the above set of dynamic equations with m_C being replaced with $m_T = d_1$ from time T and should converge to a new stationary state, the terminal values for (48) and (49), i.e., (y_T, e_T) should be on the convergent saddle-point path. Let

$$y_T = \psi(e_T) \quad (51)$$

represent the relation of (y, e) over this convergent path.

Then the following relation should hold:

$$\psi(e_T) - y_0 = \int_{T_C}^{T} \varkappa\{D(y_\tau, m_C, g, e_\tau) - y\tau \quad (52)$$

$$e_T - \bar{e}_0 = \int_{T_C}^{T} \{R(m_C, y_\tau) - \rho_T^*\}e_\tau d\tau \quad (53)$$

This set of equations involves T_C (the time when the fixed exchange rate regime collapses) and e_T (the equilibrium exchange rate at time T of domestic credit expansion) as endogenous variables which are determined by $(T, y_0, \bar{e}_0, m_C, g, \rho_r^*)$. Total differentiation of the above equations yields:

$$\begin{aligned}&\psi'(e_T)+\varkappa\{D(y_0, m_C, g, \bar{e}_0)-y_0\}dT_C\\ &=dy_0+\varkappa\{D\psi(e_T), m_C, g, e_T)-y_T\}dT\\ &\quad+\varkappa\int_{T_C}^{T}D_m(y_\tau, m_C, g, e_\tau)d\tau dm_C\\ &\quad+\varkappa\int_{T_C}^{T}D_g(y\tau, m_C, g, e\tau)d\tau dg \qquad (54)\end{aligned}$$

$$\begin{aligned}&de_T+\{R(m_C, y_0)-\rho_r^*\}\bar{e}_0dT_C\\ &=d\bar{e}_0+\{R(m_C, \psi(e_T))-\rho_r^*\}dT\\ &\quad+\int_{T_C}^{T}R_m(m_C, y_\tau)e_t aud\tau dm_C\\ &\quad-\int_{T_C}^{T}e_\tau d\tau d\rho_r^* \qquad (55)\end{aligned}$$

Or alternatively in a matrix form,

$$\begin{pmatrix}\psi' & \varkappa\{D(y_0, m_C, g, \bar{e}_0)-y_0\}\\ 1 & R(m_C, y_0)-\rho_r^*\end{pmatrix}\begin{pmatrix}de_T\\ dT_C\end{pmatrix}$$
$$=\begin{pmatrix}dy_0+\varkappa\int_{T_C}^{T}D_g(\cdot)d\tau dg\\ d\bar{e}_0-\int_{T_C}^{T}e_\tau d\tau d\rho_r^*\end{pmatrix}+\begin{pmatrix}\varkappa\{D(\psi(e_T), m_C, g, e_T)-y_T\}\\ \{R(m_C, \psi(e_T))-\rho_r^*\}\end{pmatrix}dT+\begin{pmatrix}\varkappa\int_{T_C}^{T}D_m(\cdot)d\tau\\ \int_{T_C}^{T}R_m(\cdot)e_t aud\tau\end{pmatrix}dm_C \qquad (56)$$

The determinant Δ associated with the coefficient matrix is given by

$$\begin{aligned}\Delta=&\psi'(e_T)\{R(m_C, y_0)-\rho_r^*\}\\ &-\varkappa\{D(y_0, m_C, g, \bar{e}_0)-y_0\}, \qquad (57)\end{aligned}$$

which is negative for sufficiently small $\varkappa$.

Then the following comparative statics results hold:

$$\frac{1}{\Delta}\frac{\partial T_C}{\partial T}>0 \qquad (58)$$

$$\frac{1}{\Delta}\frac{\partial T_C}{\partial m_C}>0 \qquad (59)$$

where $\varkappa$ is assumed to be sufficiently small and use was made of $R(m_C, \psi(e_T))-\rho_r^*<0$. Note that the greater m_C implies the smaller volume of the initial holdings of the foreign currency reserve. With this in our mind, we have established:

Proposition 3. *Assume that the adjustment in the real national income is sufficiently sluggish. Then (i) the later domestic credit expansion leads to later collapsing of the fixed exchange rate regime, and (ii) the greater initial holdings of the foreign currency reserve leads to sooner collapsing of the fixed exchange rate regime.*

Notes

1 Since we assume constant prices, the expected rate of inflation is also zero all the time. Thus the standard interest parity condition for nominal interest rates and expected rate of depreciation in the nominal exchange rate holds also for the associated real values.

2 The results other than the first are straightforward from the assumptions. The first result holds because (i) an increase in the income leads to a less than proportionate increase in the aggregate private expenditure, and (ii) an increase in the national income raises the domestic interest rate, leading to a decrease in the private expenditure.

3 Rigorously speaking, the commodity-market equilibrium locus in the flexible exchange rate regime has a steeper slope than the one in the fixed exchange rate regime. This is because an increase in the real national income raises the domestic rate of interest through a boost in the transaction demand for money, which dampens the increase in the effective demand dues to depreciation in the exchange rate. However we ignore this property in drawing the picture in Figure 1 for simplicity of exposition.

4 In the appendix, we further explore the determinants of the timing of the collapse in the fixed exchange rate system.

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