Fiscal Policy and Exchange Rates in the Dornbush-Rogoff Model

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abstract

In this paper we examine the effects of an expansionary fiscal policy on the real and nominal exchange rates in a variant of the Dornbush-Rogoff model of a small open economy. We show that an unanticipated permanent increase in government spending may generate the nominal exchange rate's undershooting, overshooting, and instantaneous adjustment, depending on the structural parameters of the economy.

Keywords: Fiscal Policy; Exchange Rates; Small Open Economy; Overshooting; Undershooting

JEL Classification: F31; F41

1. Introduction

In a recent paper, Rogoff (2002) reevaluated the contributions of the "overshooting" model of Dornbusch (1976) in the field of international macroeconomics and finance.[1] As Rogoff (2002) stated, the Dornbusch (1976) model is still a workhorse model for policy analysis and has a remarkable influence on various aspects of policy-making process.

Rogoff (2002) presented an elegant and sophisticated variant of the Dornbusch (1976) model to show the celebrated overshooting result of an expansionary monetary policy. It may be appropriate to call it *the Dornbush-Rogoff model*.[2]

Reformulated in a refined manner, however, the effects of a fiscal policy are seldom referred in the literature. The Dornbusch-Rogoff model is formulated to emphasize the effects of monetary policy on the exchange rate, and seems to pay little attention to those of fiscal policy. As we show in the following sections, the Dornbusch-Rogoff model has many implications of the effects of a fiscal policy on the real and nominal exchange rates. Thus, in this paper we examine the effects of an expansionary fiscal policy in a variant of the Dornbusch-Rogoff model of a small open economy.[3)]

The rest of the paper is organized as follows. In section 2 we present the model, which is a variant of the Dornbusch-Rogoff model of a small open economy. In our analytical framework, government spending is explicitly introduced in a very simple manner. In section 3 the steady-state of the economy and its dynamic properties are examined. In section 4 the effects of an expansionary fiscal policy on the real and nominal exchange rates are investigated. Finally, in section 5, concluding remarks are given.

2. The Model

A simple extension of Rogoff (2002) is used to examine the effects of an expansionary fiscal policy in a small open economy with price stickiness. Two extensions are introduced. (i) Government spending is explicitly introduced in a very simple manner. (ii) Real money balance is given by nominal money supply deflated by the general price index, which reflects the exchange rate effects.

Consider a small open economy with flexible exchange rates and perfect capital mobility. Following Rogoff (2002) and Obstfeld and Rogoff (1996), we formulate the continuous-time model of the economy under the perfect foresight in equations (1)-(6) below. All variables except for domestic and world interest rates are expressed in natural logarithm.

$$i = i^* + \dot{e} \ . \tag{1}$$

Equation (1) is the uncovered interest rate parity condition with perfect foresight. In a small open economy with flexible exchange rates and perfect capital mobility, the domestic nominal interest rate i is equal to the world nominal interest rate i^* plus the expected rate of depreciation of the nominal exchange rate. Under the assumption of perfect foresight, the expected rate of depreciation of the exchange rate is equivalent to the actual rate of depreciation $\dot{e}$.

$$m - \eta = -\lambda i + \phi y \ , \tag{2}$$

where $\lambda > 0$ and $\phi > 0$. Equation (2) states the money market equilibrium. The right-hand side is the real money demand which depends negatively on the domestic nominal interest rate and positively on the real income (output) y. On the other hand, the left-hand side is the real money supply where nominal money m is deflated by the general price index η.

$$y^d = \bar{y} + \delta(e + p^* - p) + g \,, \tag{3}$$

where $\delta > 0$. $\bar{y}$ is the potential output level consistent with full employment. g is government spending. Equation (3) expresses that the aggregate demand depends positively on the potential output, the real exchange rate, and government spending. Note that the aggregate demand does not depend on the domestic interest rate. Following Rogoff (2002), for simplicity, we consider the case where the aggregate demand of the economy is insensitive to the interest fluctuation.[4)]

$$\dot{p} = \psi(y^d - \bar{y}) + \dot{e} \,, \tag{4}$$

where $\psi > 0$. Equation (4) is the dynamic price adjustment equation *à la* Mussa (1982). The presence of $\dot{e}$ in the price adjustment equation (4) reflects the forward-looking property in response to expected future exchange rate fluctuations.

$$\eta \equiv \theta(e + p^*) + (1 - \theta)p \,, \tag{5}$$

where $0 < \theta < 1$. Equation (5) is the definition of the general price index. The general price index is a weighted average of foreign goods prices evaluated by domestic currencies and home goods prices. θ is a weight for the foreign goods prices evaluated by domestic currencies.

$$q \equiv e + p^* - p \,. \tag{6}$$

Equation (6) is the definition of the real exchange rate. As expressed in natural logarithm, if purchasing power parity (PPP) is established, then the real exchange rate becomes zero. Following Rogoff (2002), we do not suppose PPP at any time. So even in the long run the real exchange rate does not necessarily becomes zero. Finally, we assume $i^* = p^* = \bar{y} = 0$ for simplicity and without loss of generality.

3. The Steady-State

In this section we investigate the steady-state of the economy and its dynamic properties. Substituting equations (1), (3) and (6) into equation (4), we have

$$\dot{q} = -\psi\delta q - \psi g \ . \tag{7}$$

Equation (7) describes the behavior of the real exchange rate. On the other hand, substituting equations (1), (3), (5) and (6) into equation (2), we obtain

$$\dot{e} = -\frac{1-(\theta+\phi\delta)}{\lambda}q + \frac{1}{\lambda}e - \frac{1}{\lambda}m + \frac{\phi}{\lambda}g \ . \tag{8}$$

Equation (8) expresses the movement of the nominal exchange rate.

Combining equation (7) with equation (8), the dynamics of the economy is described in the (q, e) space. The $\dot{q} = 0$ locus is

$$q = -g/\delta \ . \tag{9}$$

The $\dot{q} = 0$ locus is vertical and exclusively determines the steady-state level of the real exchange rate. On the other hand, the $\dot{e} = 0$ locus is

$$e = [1-(\theta+\phi\delta)]q + m - \phi g \ . \tag{10}$$

As easily recognized, the sign of the coefficient on q in equation (10) determines the slope of the $\dot{e} = 0$ locus in the (q, e) space. If $1 > \theta+\phi\delta$, then the $\dot{e} = 0$ locus is upward sloping. If, on the other hand, $1 < \theta+\phi\delta$, then the $\dot{e} = 0$ locus is downward sloping. Further, if $1 = \theta+\phi\delta$, then the $\dot{e} = 0$ locus is horizontal. The situations are described in the (q, e) space of Figures 1, 2 and 3, respectively.

The steady-state values of the real exchange rate $\bar{q}$ and the nominal exchange rate $\bar{e}$ can be calculated from equations (9) and (10).

$$\bar{q} = -g/\delta \ , \tag{11}$$

$$\bar{e} = m - (1-\theta)g/\delta \ . \tag{12}$$

Note that the real exchange rate is expressed in natural logarithm. Thus, it is possible that $\bar{q}$ is negative in the current analysis. Also note that $\bar{q} \to 0$ and $\bar{e} \to m$ as $\delta \to \infty$.

This implies that if the aggregate demand of the economy is extremely sensitive to the real exchange rate, then the purchasing power parity is established in the steady-state and the nominal exchange rate is independent of government spending. As the real exchange rate in the steady-state is free from the level of government spending, the $\dot{q}=0$ locus remains unchanged in response to a permanent fiscal expansion.

To examine the dynamic properties of the steady-state, representing equations (7) and (8) in matrix form, we have

$$\begin{bmatrix} \dot{q} \\ \dot{e} \end{bmatrix} = J \begin{bmatrix} q \\ e \end{bmatrix} + \begin{bmatrix} -\psi g \\ -m/\lambda + \phi g/\lambda \end{bmatrix} , \tag{13}$$

where

$$J \equiv \begin{bmatrix} -\psi\delta & 0 \\ -[1-(\theta+\phi\delta)]/\lambda & 1/\lambda \end{bmatrix} .$$

The coefficient matrix J of the dynamic system has the negative determinant as follows.

$$\det J \equiv -\psi\delta/\lambda < 0 . \tag{14}$$

This implies that the steady-state of the economy is saddle-point stable and there exists a convergent saddle-point path.

Depending on the sign of $1-(\theta+\phi\delta)$, we have three different phase diagrams of the economy. The case for $1 > \theta+\phi\delta$ is described in Figure 1. In this case, the $\dot{e}=0$ locus is upward sloping. The slope of the $\dot{e}=0$ locus is less than unity in the (q, e) space. The steady-state is the intersection of the $\dot{q}=0$ and $\dot{e}=0$ loci in the (q, e) space. There exists a saddle-point path SS convergent to point E. The slope of the saddle-point path SS is less than that of the $\dot{e}=0$ locus.

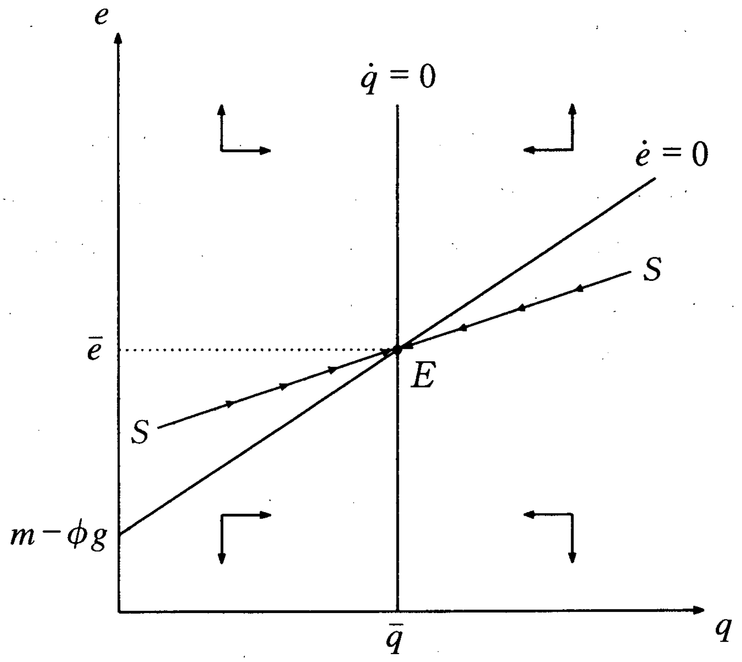

Figure 1. The Dornbush-Rogoff Model for $1>\theta+\phi\delta$.

The case for $1<\theta+\phi\delta$ is described in Figure 2. In this case, the $\dot{e}=0$ locus is downward sloping. The steady-state is the intersection of the $\dot{q}=0$ and the $\dot{e}=0$ loci in the (q, e) plane. There exists a saddle-point path SS convergent to point E. The slope of the saddle-point path SS is larger than that of the $\dot{e}=0$ locus.

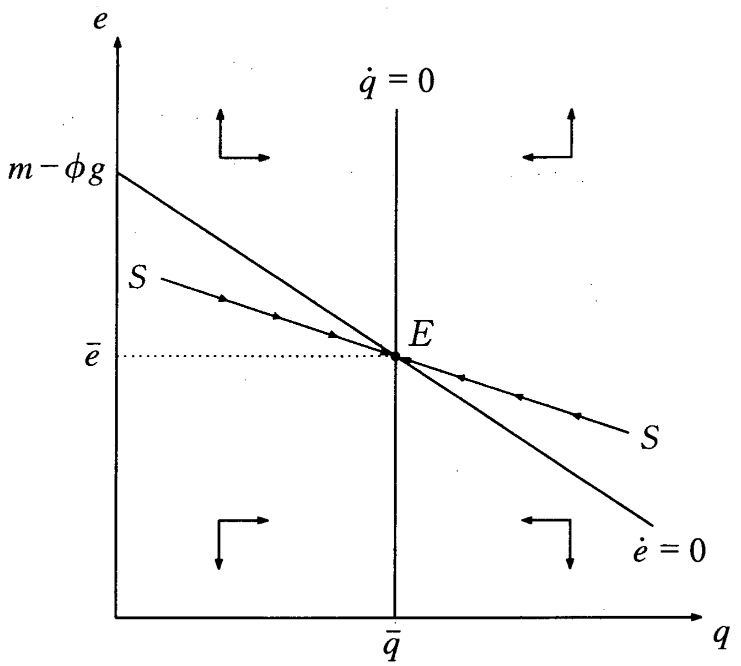

Figure 2. The Dornbush-Rogoff Model for $1<\theta+\phi\delta$.

The case for $1=\theta+\phi\delta$ is described in Figure 3. In this case, the $\dot{e}=0$ locus is horizontal. The steady-state is the intersection of the $\dot{q}=0$ and $\dot{e}=0$ loci in the (q, e) space. A saddle-point path SS convergent to point E coincides with the $\dot{e}=0$ locus in this case.

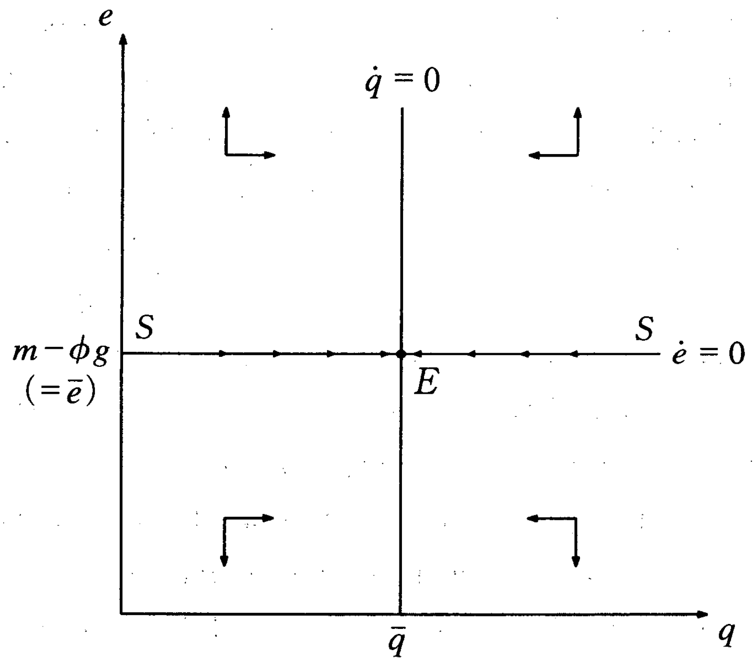

Figure 3. The Dornbush-Rogoff Model for $1=\theta+\phi\delta$.

4. The Effects of Fiscal Policy

In this section we examine the effects of fiscal policy on the real and nominal exchange rates. Especially, the case of once-and-for-all unanticipated permanent fiscal expansion is studied.

As shown in the previous section, we have three different phase diagrams of the economy depending on the structural parameters. Thus, the dynamic adjustmet processes in response to fiscal expansion may differ in each case.

Before proceeding the analysis, however, we can easily obtain the comparative statics results of a permanent fiscal expansion on the real and nominal exchange rates at the steady-state. From equations (11) and (12), we have

$$\partial\bar{q}/\partial g=-1/\delta<0\ , \tag{15}$$

$$\partial\bar{e}/\partial g=-(1-\theta)/\delta<0\ . \tag{16}$$

The above results show the real and nominal appreciation of the exchange rates at the steady-state. And also the real exchange rate appreciates more than the nominal exchange rate as θ is between zero and unity.

Case 1: $1 > \theta + \phi\delta$

Consider first the case for $1 > \theta + \phi\delta$. Suppose that the economy is initially at the steady-state point E in Figure 4. When we have a permanent increase in government spending, both $\dot{q} = 0$ and $\dot{e} = 0$ loci are affected. The $\dot{q} = 0$ locus shifts leftward while the $\dot{e} = 0$ locus shifts downward. Note that the old and new $\dot{e} = 0$ loci are not depicted in Figure 4 to avoid complexity. When we have a fiscal expansion, the steady-state of the economy moves from point E to point E' in Figure 4. Comparing the new steady-state with the old one, both real and nominal exchange rates appreciate.

On the transitional process from the old steady-state to the new one, the economy shows the following dynamics. When an expansionary fiscal policy is conducted, the economy, initially at point E, jumps immediately toward point E_0 along the 45-degree line. As the price is sticky and remains unchanged in the short run, such an adjustment process emerges. The adjustment speeds of both real and nominal exchange rates are the same in the short run. Point E_0 is located on the new saddle-point path $S'S'$ through the new steady-state point E'. Then, the economy moves from point E_0 to point E' over time along the new saddle-point path $S'S'$.

Let us consider each movement of real and nominal exchange rates. The real exchange rate jumps downward from the initial level $\bar{q}$ to q_0 immediately following a permanent fiscal expansion. After an initial appreciation, the real exchange rate appreciates further toward the new steady-state level $\bar{q}'$ over time. In the case of $1 > \theta + \phi\delta$, the real exchange rate shows undershooting in response to an expansionary fiscal policy.

The nominal exchange rate, on the other hand, jumps downward immediately from the initial level $\bar{e}$ to e_0 after an expansionary government spending. Following an immediate appreciation, the nominal exchange rate gradually appreciates toward the steady-state level $\bar{e}'$ over time. In the case of $1 > \theta + \phi\delta$, similar to the real exchange rate, the nominal exchange rate shows undershooting in response to a permanent increase in government spending.

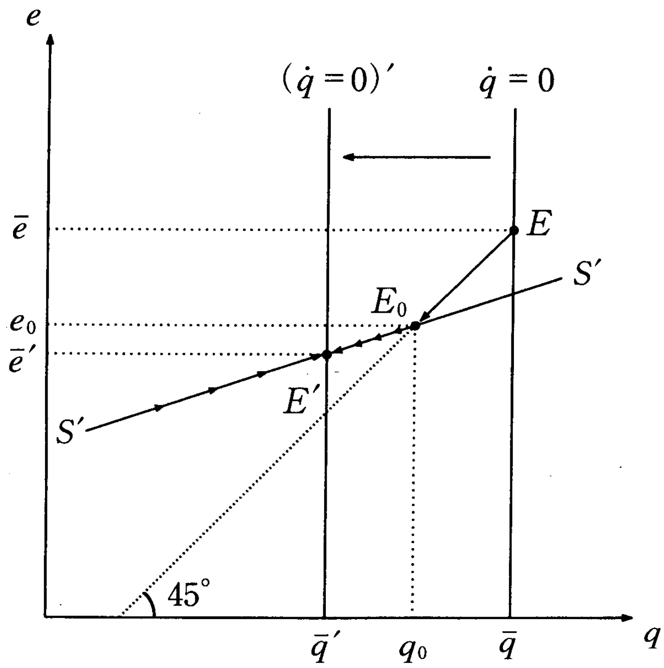

Figure 4. Fiscal Policy for $1 > \theta + \phi\delta$.

Case 2: $1 < \theta + \phi\delta$

Consider next the case for $1 < \theta + \phi\delta$. Suppose that the economy is initially at the steady-state point E in Figure 5. When we have a permanent increase in government spending, both $\dot{q}=0$ and $\dot{e}=0$ loci are affected similar to the previous case. The $\dot{q}=0$ locus shifts leftward and the $\dot{e}=0$ locus shifts downward. As in the previous case, we omit the description of a shift in the $\dot{e}=0$ locus to avoid complexity. When we have a fiscal expansion, the steady-state of the economy moves from point E to point E' in Figure 5. Comparing the new steady-state and the old one, both real and nominal exchange rates appreciate.

On the adjustment process, from the old steady-state to the new one, the economy shows the following dynamics. When a permanent increase in government spending is conducted, the economy jumps immediately from the initial point E to E_0 along the 45-degree line. Price stickiness in the short run generates such an adjustment process. Point E_0 is located on the new saddle-point path $S'S'$ through the new steady-state point E'. Then, the economy moves from point E_0 to point E' over time along the new saddle-point path $S'S'$.

Let us examine each movement of real and nominal exchange rates. The real exchange rate jumps immediately downward from the initial level $\bar{q}$ to q_0 after a permanent fiscal expansion. Following an initial appreciation, the real exchange rate appreciates further toward the new steady-state level $\bar{q}'$ over time. In the case of $1 < \theta + \phi\delta$, similar to the previous case, the real exchange rate shows undershooting in response to a fiscal expansion.

The nominal exchange rate, on the other hand, immediately jumps downward from the initial level $\bar{e}$ to e_0 after a fiscal expansion. Following an immediate appreciation, the nominal exchange rate gradually depreciates toward the new steady-state level $\bar{e}'$ over time. In the case of $1 < \theta + \phi\delta$, contrary to the previous case, the nominal exchange rate shows overshooting in response to a permanent increase in government spending.

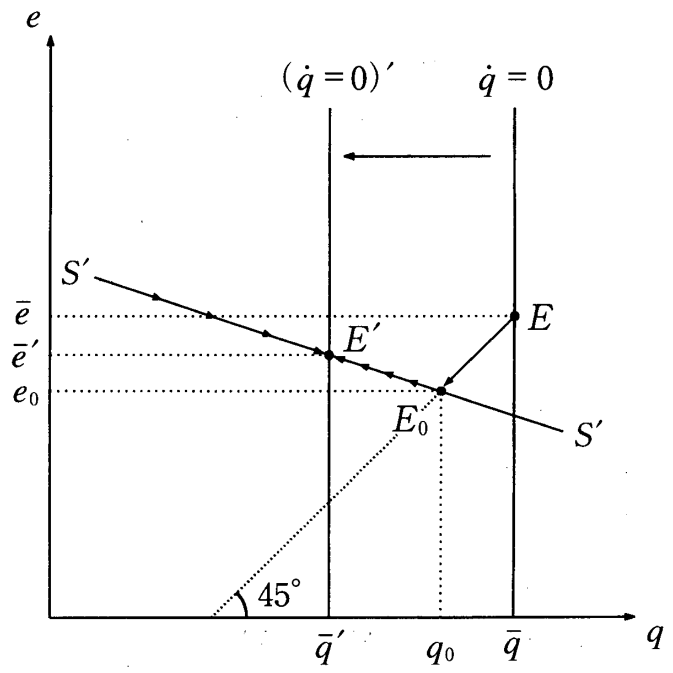

Figure 5. Fiscal Policy for $1 < \theta + \phi\delta$.

Case 3: $1 = \theta + \phi\delta$

Finally, consider the case for $1 = \theta + \phi\delta$. Suppose that the economy is initially at the steady-state, point E in Figure 6. When we have a permanent increase in government spending, both $\dot{q} = 0$ and $\dot{e} = 0$ loci are affected. The $\dot{q} = 0$ locus shifts leftward while the $\dot{e} = 0$ locus shifts downward. As in the previous cases, the old and new $\dot{e} = 0$ loci are not described in Figure 6 to avoid complexity. Note that, however, the saddle-point path coincides with the $\dot{e} = 0$ locus in the case of $1 = \theta + \phi\delta$ as shown in the previous section. Thus, the new saddle-point path $S'S'$ depicted in Figure 6 implies the new $\dot{e}=0$ locus. When we have an expansionary fiscal policy, the steady-state of the economy moves from point E to point E' in Figure 6. Comparing the new steady-state with the old one, both real and nominal exchange rates appreciate.

On the transitional process from the old steady-state to the new one, the economy shows the following dynamics. When an expansionary fiscal policy is conducted, the economy, initially at point E, jumps immediately toward point E_0 along the 45-degree line. Similar to the previous cases, the price stickiness of the economy generates such an adjustment. Point E_0 is located on the new saddle-point path $S'S'$ which is also the new $\dot{e}=0$ locus. Then, the economy moves from point E_0 to point E' over time along the new, convergent saddle-point path $S'S'$.

Let us consider each movement of real and nominal exchange rates. The real exchange rate jumps downward from the initial level $\bar{q}$ to q_0 immediately following a permanent fiscal expansion. After an initial appreciation, the real exchange rate appreciates further toward the new steady-state level $\bar{q}'$ over time. As in the previous cases, the real exchange rate shows undershooting in response to an expansionary fiscal policy.

The nominal exchange rate, on the other hand, jumps downward immediately from the initial level $\bar{e}$ to the new steady-state level $\bar{e}'$ after an expansionary government spending. The nominal exchange rate shows an instantaneous adjustment and there

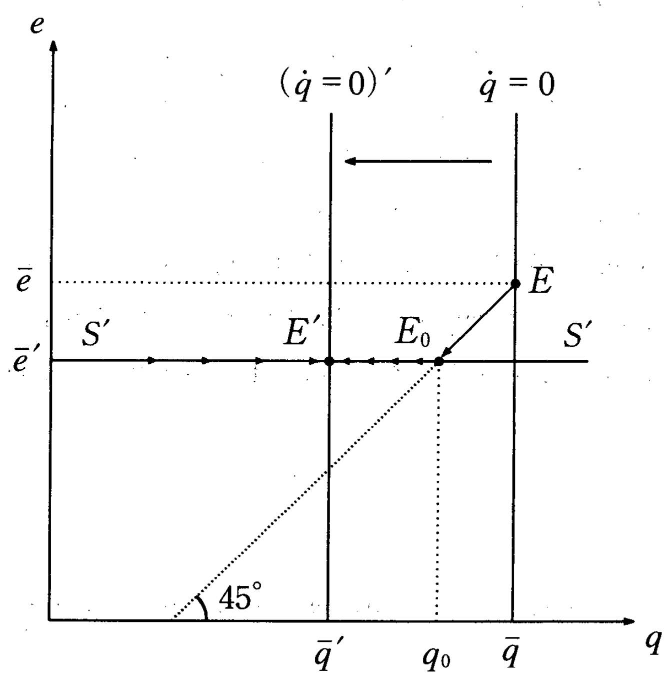

Figure 6. Fiscal Policy for $1=\theta+\phi\delta$.

is no transitional period in this case. Contrary to the previous cases, the nominal exchange rate does not show undershooting or overshooting phenomenon. In the case of $1=\theta+\phi\delta$, the nominal exchange rate shows an instantaneous adjustment in response to a permanent increase in government spending.

5. Concluding Remarks

In this paper we have examined the effects of an expansionary fiscal policy on the real and nominal exchange rates in a variant of the Dornbush-Rogoff model of a small open economy. In the long-run, an expansionary fiscal policy generates real and nominal appreciation of the exchange rates. On the transitional process, the real exchange rate always exhibits the undershooting phenomenon in a small open economy with price stickiness. On the other hand, the nominal exchange rate shows the possibilities of undershooting, overshooting, and instantaneous adjustment, depending on the structural parameters of the economy. This implies that *fiscal policy* as well as *monetary policy* is responsible for the excess volatility of the nominal exchange rate.

Notes

1) Rogoff (2002) was originally presented as the Mundell-Fleming Lecture at the Second Annual Research Conference of International Monetary Fund in 2001.
2) The details of the model were already explained in Obstfeld and Rogoff (1996). Thus, it might be more appropriate to call it *the Dornbusch-Obstfeld-Rogoff Model.*
3) The model we present here includes the Rogoff (2002) as a special case. Setting $\theta=0$ in our model, we have the Rogoff (2002) model with $\bar{q}=0$ (exogenously fixed).
4) Even if we include the interest rate effect in the aggregate demand equation, the essential messages of the model remains unchanged except for complex calculations and expressions.

References

De Grauwe, P. (1996) *International Money: Postwar Trends and Theories*, Second Edition, Oxford University Press.

Dornbusch, R. (1976) "Expectations and Exchange Rate Dynamics," *Journal of Political Economy*, Vol. 84, No. 6, pp. 1161-1176.

Mark, N. C. (2002) *International Macroeconomics and Finance: Theory and Econometric Methods*, Blackwell Publishers.

Mussa, M. (1982) "A Model of Exchange Rate Dynamics," *Journal of Political Economy*, Vol. 90, No. 1, pp. 74-104.

Kawai, M. (1994) *International Finance* (in Japanese), University of Tokyo Press.

Obstfeld, M., and A. C. Stockman (1985) "Exchange-Rate Dynamics," in R. W. Jones and P. B. Kenen (eds.) *Handbook of International Economics*, Vol. 2, North-Holland, pp. 917-977.

Obstfeld, M., and K. Rogoff (1996) *Foundations of International Macroeconomics*, The MIT Press.

Rogoff, K. (2002) "Dornbusch's Overshooting Model After Twenty-Five Years," *IMF Staff Papers*, Vol. 47, Special Issue, pp. 215-227.

Sarno, L., and M. P. Taylor (2002) *The Economics of Exchange Rates*, Cambridge University Press.