Policy-making in an Open Economy: The Mundell-Fleming and Dornbusch Models*

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Abstract

This seminar paper covers the basics of two key international macroeconomic models: the Mundell (1963) & Fleming (1962) model and Dornbusch (1976) model. I first build the framework and intuition of the Mundell-Fleming Model, then cover monetary and fiscal policy outcomes under flexible and fixed exchange rate regimes. Then, I go through the intuition and mechanics of the Dornbusch model. As an extension, I examine the Frenkel and Rodriguez (1982) model that incorporates capital mobility and balance of payment identities into the Dornbusch model.

JEL Classification:

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1 Introduction

The primary building blocks of Macroeconomic theory tend to work with closed economies, where output is measured by

$$Y = C + I + G \tag{1}$$

In this paper, we will work with an open economy, which includes the exports and imports (or current account NX). Thus, we now consider that the output of the open economy is measured by

$$Y = C + I + G + NX \tag{2}$$

With the addition of the open economy, we now include how exports and imports flows impact output. Mundell (1963), Fleming (1962), and Dornbusch (1976) all provide models that shed some light in this channel, particularly through how the interest rate and the exchange rate move in relation with each other. This relationship suggests that domestic monetary and fiscal policy have consequences in impacting international transactions in both the current and capital accounts.

This paper is organized as follows. Section 2 will cover the Mundell-Fleming approach to modelling how exchange rates impact output using a static model. Secion 3 will similarly model how exchange rates impact output using a dynamic model. Section 4 concludes.

2 Mundell-Fleming Model

In the Mundell (1963) and Fleming (1962) framework, we first assume that exchange rates are flexible. These models will give the intuition of how enacting monetary or fiscal policies within an open economy impacts exchange rates and domestic output. Furthermore, we address how the changes in the economy differ given differences in capital mobility regimes (e.g. if a country uses capital controls or not). We will first build the framework, then look at monetary and or fiscal policy outcomes under IS-LM.

2.1 Building the Framework

Because we are working in the open economy, we introduce Balance of Payments (BOP), which represents the sum of the current account NX, which depends on next exports and the exchange rate, and capital account KA, which depends on the capital net inflows (or outflows) and the domestic and foreign interest rates. Formally, BOP is defined as

$$BOP = X(Y, E) + KI(r - r^*) \tag{3}$$

where $X(Y, Q)$ is the exports as a function of output Y and exchange rate E, KI is the net capital inflows, and r and r^* is the real interest rate of the country and the rest of the world respectively.[1] The capital mobility of the country is determined by the slope of the BOP. Mathematically, this is found by taking the derivative of the BOP equation:

$$\left(\frac{dr}{dY}\right)_{B=0} = -\frac{X_Y}{KI_R} \geq 0 \tag{4}$$

This presents three cases of capital mobility:

1. There is infinite capital mobility if we assume $r = r^*$, which satisfies arbitrage conditions in the capital markets. Thus, $KI \to \infty$, so $\frac{dr}{dY} \to 0$.

2. There is some capital mobility where $r \neq r^*$, which suggests that capital flows into $(r > r^*)$ or out of $(r < r^*)$ the country due to arbitrage in capital markets.

3. There is no capital mobility, such that $KI_r \to 0$, so $\frac{dr}{dY} \to \infty$.

Now, we consider the IS-LM framework. The IS curve is given by

$$Y = A(r, Y) + G + X(Y, E) \tag{5}$$

where $A(r, Y) \equiv C(Y) + I(r)$ and the LM curve is given by

$$M = M^S = M^D \tag{6}$$

Thus, we have the basic components of the model: the IS-LM components govern the exogenous shocks in fiscal and monetary policy, and the BOP governs the balance between the capital account and current account. Furthermore, the BOP governs the mobility of capital.

In the following subsections, we explore the impacts of expansionary monetary and fiscal policy in an open economy. While there are many possibilities, we limit the discussion to: (1) expansionary monetary or fiscal policy and (2) perfect vs. imperfect capital mobility. Furthermore, we make the assumption that in all cases, exchange rates are flexible, such that E is able to move.

2.2 Monetary and Fiscal Policies under a Flexible Exchange Rate Regime and Perfect Capital Mobility

With the framework, we can now consider how fiscal and monetary policy impact interest rates and exchange rates, and thus output. In this section, we assume that exchange rates in the domestic

[1] Here, we express E as domestic currency per one unit of foreign currency. Thus, an increase/decrease in E is a depreciation/appreciation of the domestic currency.

country are are flexible. Furthermore, assume that capital is perfectly mobile, where there are no barriers to movement of capital or investment between the domestic country and the rest of the world.

2.2.1 Monetary Policy

Suppose the domestic country enacts expansionary monetary policy, an exogenous shock to the increase in the money supply. In response, the domestic interest rate, r, decreases, so the domestic interest rate is lower than that of the rest of the world, r^*. Since $r < r^*$, it is more attractive for domestic investors to invest abroad, so there is an increased demand for foreign currency. The increased demand of foreign currency leads to a depreciation in the domestic currency. Domestic goods are now cheaper and more attractive to the rest of the world, so the rest of the world buys more domestic goods, boosting the net exports of the domestic country. As a result, the output of the domestic country increased, while r returns r^*.

We illustrate this scenario with the IS-LM-BP model, shown in Figure 1. Overall, the domestic currency depreciates and domestic output increases as a result of expansionary monetary policy and perfect capital mobility.

2.2.2 Fiscal Policy

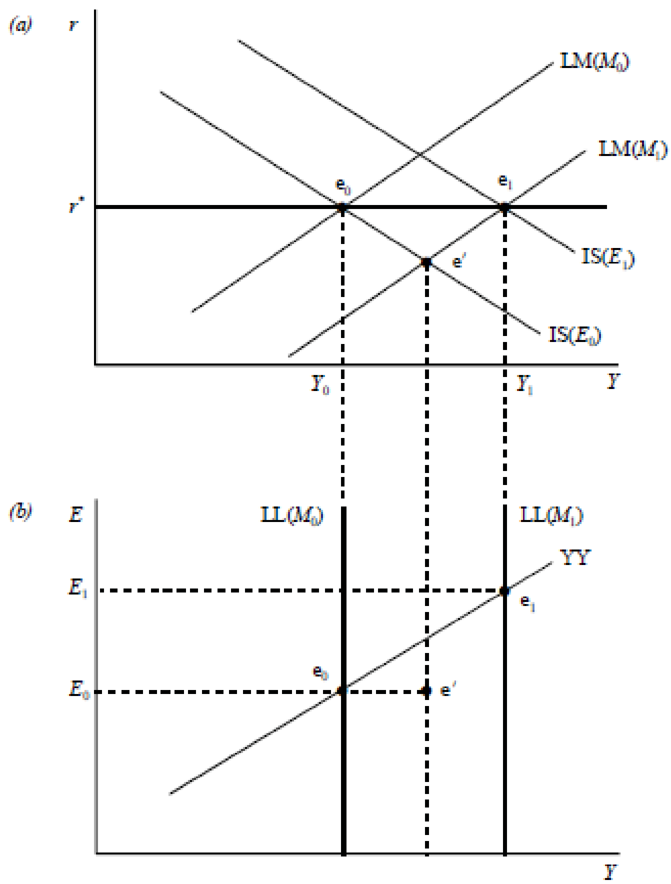
Suppose now that the domestic country enacts expansionary fiscal policy. In response to an exogenous change in government spending, the domestic interest rate increases. This pushes the r upwards, such that $r > r^*$. As a result of the increase in the interest rate relative to the rest of the world, the domestic currency appreciates, which causes domestic goods to be more expensive relative to the rest of the world. This decreases the capital account, so domestic output decreases.

We can also illustrate this scenario using the IS-LM-BP model, shown in Figure 2. Overall, while the domestic currency appreciated, domestic output remains unchanged as a result of expansionary fiscal policy and perfect capital mobility.

2.3 Monetary and Fiscal Policies under a Flexible Exchange Rate Regime and Imperfect Capital Mobility

Under these scenarios, the movement of capital between the country and the rest of the world is not perfect, as there are barriers that impact the flow of capital. An example of these barriers is capital controls, where capital flows are either taxed or capped. Under these circumstances, the movement of the exchange rate is lessened. Once again, we consider two scenarios: expansionary monetary policy vs. expansionary fiscal policy.

Figure 1: Expansionary Monetary Policy with Infinite Capital Mobility (and Flexible Exchange Rates)



2.3.1 Monetary Policy

The beginning of this scenario is the same as before, where an increase in the money supply causes r to decrease. Once again, since $r < r^*$, the domestic currency depreciates, causing goods in the domestic country to be cheaper relative to the rest of the world, causing the current account of the domestic country to increase. However, in this instance, since capital does not move freely like before, the balance of payments shifts. Mathematically, this is because $r - r^* \neq 0$ in our balance of payments equation. As a result, domestic currency depreciates and domestic output increases, like before, but r declines. We illustrate this scenario using the IS-LM-BP model in Figure 3.

2.3.2 Fiscal Policy

The beginning of this scenario is the same as before, where an increase in fiscal spending causes r to increase. Once again, since $r > r^*$, the domestic currency appreciates, causing goods in the

Figure 2: Expansionary Fiscal Policy with Infinite Capital Mobility (and Flexible Exchange Rates)

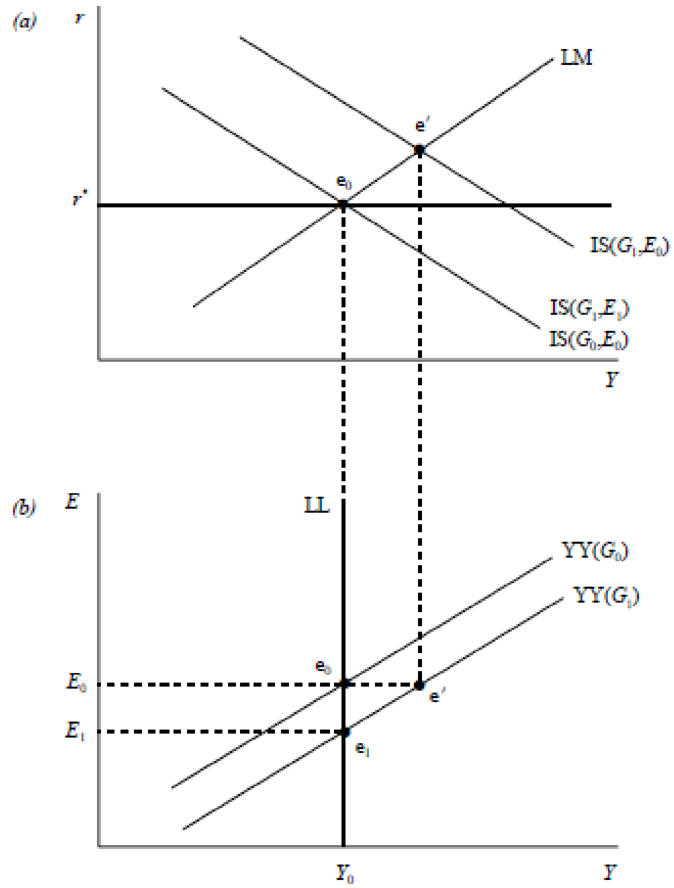
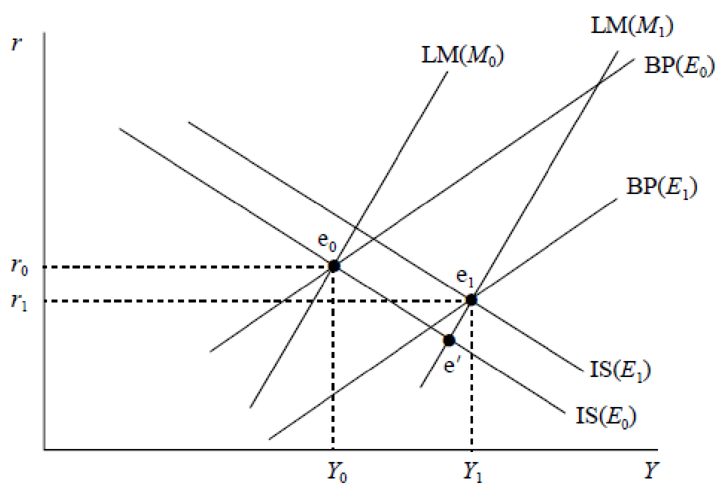


Figure 3: Expansionary Monetary Policy with Imperfect Capital Mobility (and Flexible Exchange Rates)



domestic country to be more expensive relative to the rest of the world, causing the current account of the domestic country to decrease. Once again, since capital is not perfectly mobile, changes in the exchange rate also causes the balance of payments to shift. As a result, contrary to the perfect capital mobility scenario, while domestic currency appreciates, domestic output increases slightly, while r also increases.

3 Dornbusch Model

The Dornbusch model is a dynamic version of the Mundell and Fleming models, where we incorporate the assumption that investors form some expectation regarding how the exchange rate will change. Mathematically, we express this new equilibrium as a saddle-path stable point. The Dornbusch model also assumes that capital mobility is perfect. To start, we begin with equations that govern the output, money markets, and price, as expressed by the IS (equation 7), LM (equation 8), and Phillips Curves (equation 9). Because we deal with an open economy, we also include uncovered interest parity (equation 10). Finally, we add a perfect foresight assumption as to how the exchange rate will move (equation 11). The equations are expressed

$$y = -\epsilon_{YR} r + \epsilon_{YQ}(p^* + e - p) + \epsilon_{YG} g \tag{7}$$

$$m - p = -\epsilon_{MR} r + \epsilon_{MY} y \tag{8}$$

$$\dot{p} = \phi(y - \bar{y}) \tag{9}$$

$$r = r^* + \dot{e}^e \tag{10}$$

$$\dot{e}^e = \dot{e} \tag{11}$$

where $\dot{p} = dp/dt$ and $\dot{e} = de/dt$. In the long run, we assume that $\dot{p} = 0$, so $\bar{y} = y$, $dote = 0$, and $r = r^*$. We solve the model for $\dot{p}$ and $\dot{e}$ as a function of e and p. To do this, we set equation 7 equal to 8, and substitute some of the terms from equations 9, 10, and 11.[2] The solution is expressed

[2]Solving for $\dot{e}$ and $\dot{p}$ are left up to the reader.

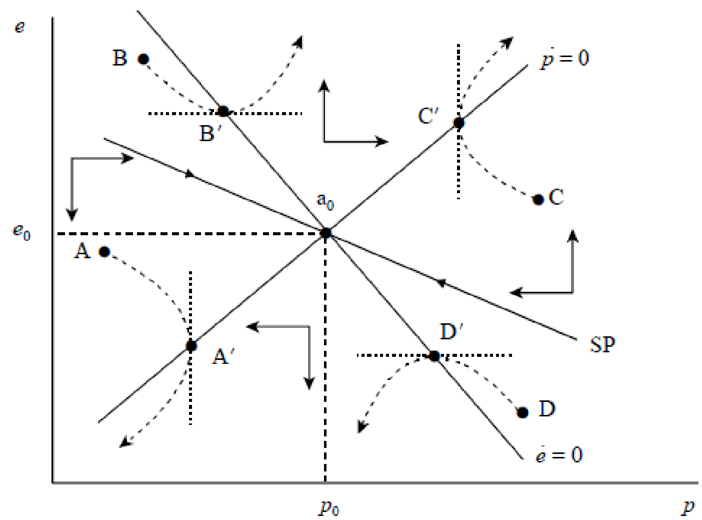
$$\begin{bmatrix} \dot{e} \\ \dot{p} \end{bmatrix} = \begin{bmatrix} \dfrac{\varepsilon_{MY}\varepsilon_{YQ}}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} & \dfrac{1-\varepsilon_{MY}\varepsilon_{YQ}}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} \\ \dfrac{\phi\varepsilon_{MR}\varepsilon_{YQ}}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} & -\dfrac{\phi\left[\varepsilon_{YR}+\varepsilon_{MR}\varepsilon_{YQ}\right]}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} \end{bmatrix} \begin{bmatrix} e \\ p \end{bmatrix} + \begin{bmatrix} \dfrac{\varepsilon_{MY}\varepsilon_{YQ}p^{*}+\varepsilon_{MY}\varepsilon_{YG}g-m}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} - r^{*} \\ \dfrac{\phi[\varepsilon_{MR}\varepsilon_{YQ}p^{*}+\varepsilon_{MR}\varepsilon_{YG}g+\varepsilon_{YR}m]}{\varepsilon_{MR}+\varepsilon_{MY}\varepsilon_{YR}} - \phi\bar{y} \end{bmatrix}. \tag{12}$$

Using the equation, we can graphically express $\dot{e} = 0$ and $\dot{p} = 0$, which govern the equilibrium on the dimension of e and p. The $\dot{e} = 0$ line is downward sloping and $\dot{p} = 0$ is upward sloping. For $\dot{e} = 0$ we assumed that money supply effect dominates the money demand effect. For $\dot{p} = 0$, increasing domestic price p reduces output y, so to restore the level of y such that $y = \bar{y}$, e must increase (currency must depreciate).

Now that we have both $\dot{e} = 0$ and $\dot{p}$ lines, we want to identify the short-run dynamics. First, consider the $\dot{e} = 0$ line where $r = r^*$. If we are at a point above the $\dot{e} = 0$ line (i.e. $r > r^*$), the nominal exchange rate, output, and domestic interest are all too high. The uncovered interest parity will predict exchange rate depreciation ($\dot{e}^e > 0$) and the arrow should point up (away from the $\dot{e} = 0$ line). The opposite is true for points below the $\dot{e} = 0$ line: these points are where $r < r^*$, so nominal exchange rate, output, and domestic interest are all too low. The uncovered interest parity will predict exchange rate appreciation ($\dot{e}^e < 0$) and the arrow will point down (away from the $\dot{e} = 0$ line). Second, consider the $\dot{p} = 0$ line. If we are at a point to the right of $\dot{p} = 0$, $y < \bar{y}$ so the domestic prices are falling, so the arrow should point left (towards the $\dot{p} = 0$ line). The opposite holds true for points to the left of the $\dot{p} = 0$ line: $y > \bar{y}$, so domestic prices will rise and the arrow will point right (towards the $\dot{p} = 0$ line).

Figure 4 presents the phase diagram for the Dornbusch Model. In terms of speed for adjustment, e jumps instantaneously and p adjusts slower due to our assumption of sticky prices. In the long run, we come to a saddle path solution. The economy goes back to equilibrium only if it lands on the saddle path. Because the agents of this model have perfect foresight, they will adjust e or p such that the economy return to saddle path stability. The saddle path equilibrium in Dornbusch (1976) comes with an overshooting feature, such that policy shocks will cause the exchange rate to overshoot before declining to its equilibrium levels.

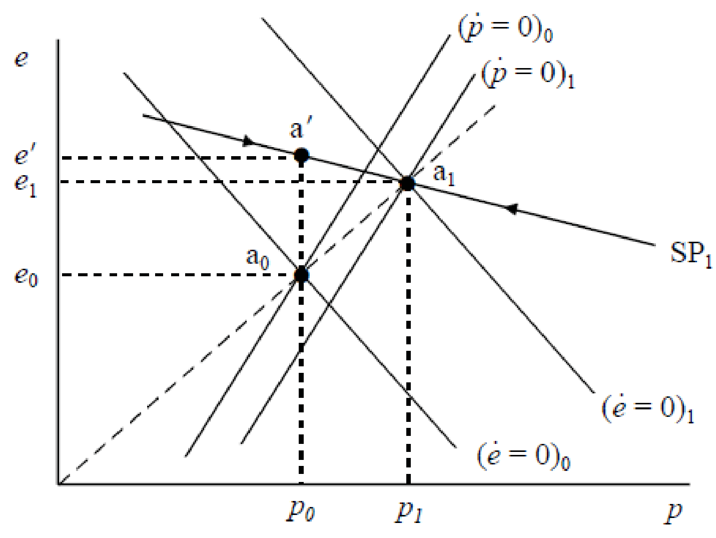
Figure 4: Dynamic representation of Dornbusch Model



3.1 Monetary Policy

We consider expansionary monetary policy under two cases: unanticipated vs anticipated shocks. We use Figure 5 to aid our discussion.

Figure 5: Expansionary Monetary Policy with the Dornbusch Model



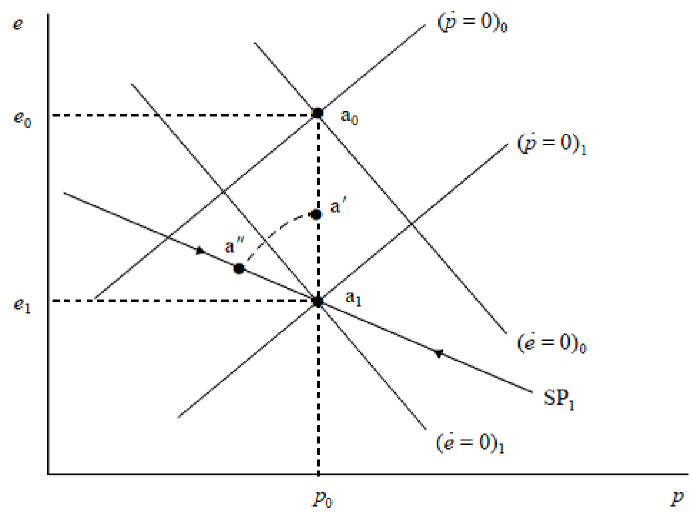
Consider an unanticipated monetary policy shock. When m increases, we push down $r < r^*$, which causes the currency to depreciate (e increases). Here, we assume that m increases at the right amount such that the economy lands on the saddle path to return to equilibrium (using Figure 5, we need to make the jump from a_0 to a'). Since the currency depreciated, the demand for domestic goods increases, so y increases where $y > \bar{y}$, so p starts to rise. Assuming we hit the SP, in the long run, the economy will reach the new equilibrium point with currency appreciating (in Figure 5 from a' to a_1). As a result, p increases and currency depreciates (e increases).

Next, we consider an anticipated monetary policy shock...

3.2 Fiscal Policy

Once again, we consider an unanticipated and anticipated policy shock expansionary fiscal policy shock. We use Figure 6 to aid our discussion.

Figure 6: Expansionary Fiscal Policy with the Dornbusch Model



With unanticipated expansionary fiscal policy, an increase in g shifts the $\dot{p} = 0$ line to the right and the $\dot{e} = 0$ line to the left. Using Figure 6, the equilibrium will fall from point a_0 to a_1. Thus, we are left with appreciation of the exchange rate while the price level is stays the same. As an added wrinkle, if the $\dot{e} = 0$ and $\dot{p} = 0$ lines shifted to different degrees, the economy still needs to jump to the saddle path line in order to reach equilibrium.

Next, let's consider the case that the expansionary fiscal policy is anticipated, that is, the government announces that g will go up. Since we have g increase, the $\dot{e} = 0$ and $\dot{p} = 0$ curves will shift the same way as before, but only when the policy is implemented. Now, when the government announces g will increase, the agents of the economy will react since they know that the currency will appreciate, so e decreases at the time of announcement. Between announcement and implementation, the exchange rate will further appreciate, and since g hasn't increased yet, p will fall since output would be below full employment (the economy is at a point to the left of the $\dot{p} = 0$ line). When the policy is implemented, the price level will start to rise once again, and exchange rate will appreciate further. In the long run, the price level returns to its previous level while the exchange rate appreciates. Using Figure 6, the trajectory of the economy goes from a_0 to a' upon announcement of g increase, the a' to a'' between announcement and implementation, and then from a'' to a_1 along the saddle path in the long run.

3.3 Assuming Imperfect Capital Mobility

In this section, we assume that capital mobility is imperfect. The model by Frenkel and Rodriguez (1982) incorporates the KI and Balance of Payments identity along with the framework laid out by Dornbusch (1976).

$$y^d = \bar{y} + \epsilon_{DQ}(p^* + e - p) \tag{13}$$

$$r = \epsilon_{RY}\bar{y} - \epsilon_{RM}(m - p) \tag{14}$$

$$\dot{p} = \phi(y^d - \bar{y}) \tag{15}$$

$$X = \epsilon_{XQ}(p^* + e - p) \tag{16}$$

$$KI = \xi(r - [r^* + \dot{e}]) \tag{17}$$

$$KI + X = 0 \tag{18}$$

The balance of payments identity are given by equations 16-18. Capital mobility is mathematically expressed as ξ. Once again, we solve for $\dot{p}$ and $\dot{e}$ by setting equation 13 equal to equation 14. We derive $\dot{p} = 0$ and $\dot{e} = 0$:

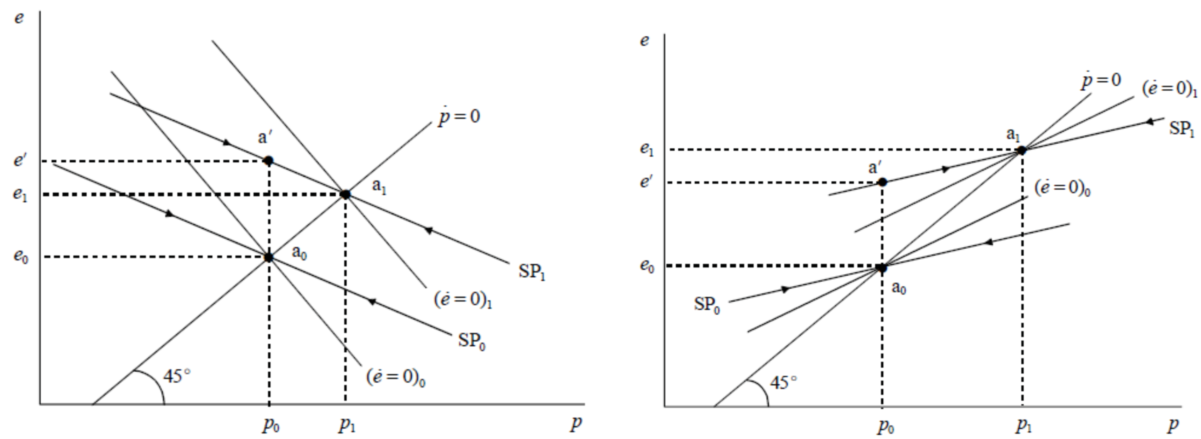
$$e + p^* = p \tag{19}$$

$$e + p^* = \left(1 - \frac{\xi\epsilon_{RM}}{\epsilon_{XQ}}\right)p + \frac{\xi}{\epsilon_{XQ}}(\epsilon_{RM}m - \epsilon_{RY}\bar{y} + r^*) \tag{20}$$

The $\dot{p} = 0$ line remains upward sloping, but the slope of $\dot{e} = 0$ is ambiguous depending on how mobile capital is. $\dot{e} = 0$ is upward sloping when capital mobility is low and downward sloping when capital mobility is high.

Consider expansionary monetary policy under the cases of low capital mobility and high capital mobility. Here, the effects of expansionary monetary policy is decomposed into two effects: the capital outflows (i.e. KI) effect and trade account effect (i.e. NX). When low capital mobility, the trade account effect dominates the capital outflows effect. When we look at the balance of payments equilibrium $X + KI = 0$, when KI decreases, X must increase, which requires a depreciation in the currency (making domestic goods cheaper for foreigners). Thus, the result is the currency will continually depreciate as price rises. The opposite is true under high capital mobility: the capital outflows effect dominates the trade account effect. Here, once again using $X + KI = 0$, KI increases, so X must decrease, which requires appreciation in the currency, making domestic goods more expensive for foreigners. The result is that the currency will overshoot depreciating before appreciating to the new equilibrium point. Figures 7 depict changes in e and p as a result of expansionary policy under the perfect and imperfect capital mobility regime.

Figure 7: Expansionary Fiscal Policy with the Frenkel-Rodriguez Model



(a) High Capital Mobility

(b) Low Capital Mobility

4 Conclusion

In conclusion, working in an open economy offers much of the same analyses as before in a closed economy. However, now we deal with exchange rates, which has the ability to net out the implementation of monetary and fiscal policy. We use the Mundell-Fleming and Dornbusch models to study what happens to output, interest rates, and exchange rates both in a static and dynamic environment respectively. It is not surprising to find that the Mundell-Fleming and Dornbusch models offer similar results, but the inclusion of expectations is the main difference. In Mundell-Fleming, we only see interest rate and output changes from upon the implementation of monetary of fiscal policy. In the Dornbusch model, we see how exchange rate overshoots or undershoots upon implementation of monetary and fiscal policy. The exchange rate moves more realistically because of the inclusion of the uncovered interest parity, where investors make some expectation how the interest rate will move the next period.

Within the model, we assume that exchange rates are flexible. With infinite capital mobility, our equilibrium conditions always require $r = r^*$ from one equilibrium point to the next. With imperfect capital mobility, equilibrium can exist when $r \neq r^*$. These two scenarios can model the outcomes of monetary and fiscal policy given a capital control policy regime.

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