

## 14.02 Macroeconomics

May 18, 2006

### Practice Question: Mundell-Fleming Model

#### Managing Vermont's Economy

Vermont has been an independently minded state for some time. It finally decides to introduce its own currency, VT\$. You are lucky and get the job as Vermont's first central bank president. In order to determine the best economic policy, you write down the following open economy model for Vermont:

$$\text{IS: } Y = A + \alpha Y - \beta T - \gamma i + \delta Y^{US} - \phi E$$

$$\text{LM: } M = Y - \lambda i$$

$$\text{UIP: } i = i^{US} - \frac{E^e - E}{E}$$

With the following notation:

$Y$  : Vermont's Real GDP

$Y^{US}$  : Real GDP of the US

$T$  : Vermont's Taxes

$i$  : Vermont's nominal interest rate

$i^{US}$  : Nominal interest rate of the US

$E$  : VT\$ in terms of US\$

$E^e$  : Expected future VT\$ in terms of US\$

$M$  : Vermont's stock of money in circulation

The only trading partner of Vermont is the US. Please note that the level of prices is normalized to 1 in both Vermont and the US, and there is no inflation. All of the coefficients  $\alpha, \beta, \gamma, \delta, \phi$  and  $\lambda$  as well as the constant  $A$  are assumed to be positive, and  $\alpha, \beta < 1$ . Capital is perfectly mobile.

1. Interpret each of the coefficients ( $\alpha, \beta, \gamma, \delta$  and  $\phi$ ) in the IS relation. (Hint: relate your answer to the marginal propensity to consume, invest, export, and import).

Ans:

$\alpha$  is the sum of the marginal propensity to consume and the marginal propensity to invest, minus the marginal propensity to import, with respect to domestic GDP.

$\beta$  is the marginal propensity to consume with respect to domestic GDP.

$\gamma$  is the sensitivity of investment with respect to the interest rate.

$\delta$  is the marginal propensity to export with respect to US GDP.

$\phi$  is the sensitivity of net exports with respect to the exchange rate.

Assume that you start with a fixed exchange rate regime such that VT\$ 1 is US\$ 0.5, i.e., the fixed exchange rate  $\bar{E} = 0.5$ . Financial markets expect the exchange rate regime to prevail in the future ( $E^e = \bar{E}$ ).

2. Suppose that the level of taxes in Vermont is changed from  $T$  to  $T' > T$ . How do you as the central banker need to adjust your money supply? Explain why, relating your answer to the interest parity condition.

Ans:

By the UIP condition and the fact that the exchange rate is fixed, Vermont's interest rate is equal to the US interest rate. Replacing this in the IS relation and solving for  $Y$  gives:

$$Y = (1 - \alpha)^{-1} (A - \beta T - \gamma i^{US} + \delta Y^{US} - \phi \bar{E})$$

Replacing into the LM relation gives:

$$M = (1 - \alpha)^{-1} (A - \beta T - \gamma i^{US} + \delta Y^{US} - \phi \bar{E}) - \lambda i^{US}$$

Now we can see how the central bank has to change money supply in response to an increase in taxes in order to keep the exchange rate fixed:

$$M' - M = -\frac{\beta}{1 - \alpha} (T' - T)$$

The reasoning is the following: an increase in taxes from  $T$  to  $T'$  decreases GDP by  $\frac{\beta}{1 - \alpha} (T' - T)$ ; this is the usual goods market multiplier with fixed interest rates. Because GDP decreases, money demand decreases. Vermont's households reduce their money holdings by exchanging VT\$ for bonds. Increasing demand for VT\$-denominated bonds tends to increase bond prices and thus reduces the interest rate. By the UIP, the interest rate cannot change under fixed exchange rates. The central bank therefore has to increase the supply of bonds to offset the increasing demand, so as to decrease the amount of money in circulation.

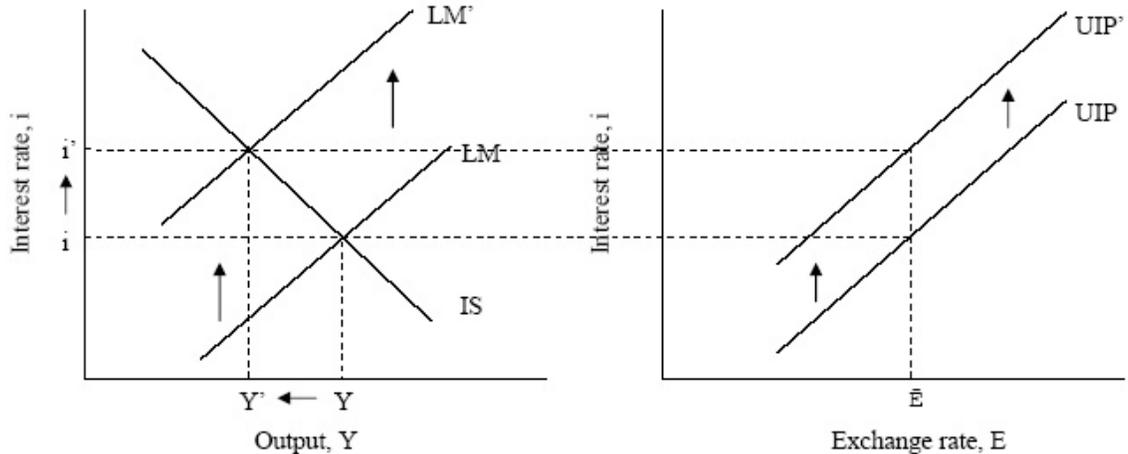
Things start to go wrong in Vermont's economy. The exchange rate is still fixed at the level  $\bar{E}$ , but financial markets now expect that this exchange rate will be abandoned in the future for a lower exchange rate  $E' < \bar{E}$  (i.e., financial markets expect a devaluation of VT\$).

3. If the initial exchange rate  $\bar{E}$  is maintained, how is Vermont's interest rate affected by the anticipation of a future devaluation? What is the appropriate central bank policy that you need to undertake in order to maintain the fixed exchange rate? Draw the IS-LM diagram for the open economy. Show the effects graphically, and explain your answer in words.

Ans:

The current exchange rate is  $\bar{E}$ , the expected future exchange rate is  $E' < \bar{E}$ . By the interest rate parity, this implies  $i > i^{US}$ . The intuition is that investors must be compensated for the expected devaluation; the interest rate in Vermont must therefore be higher than the US interest rate. In the diagram, the shift in expectations shifts the UIP upwards. Because the exchange rate is fixed at  $\bar{E}$ , this implies that Vermont's interest rate moves up from  $i$  to  $i'$ . To defend its currency, the central bank must reduce money supply and thus shift up the

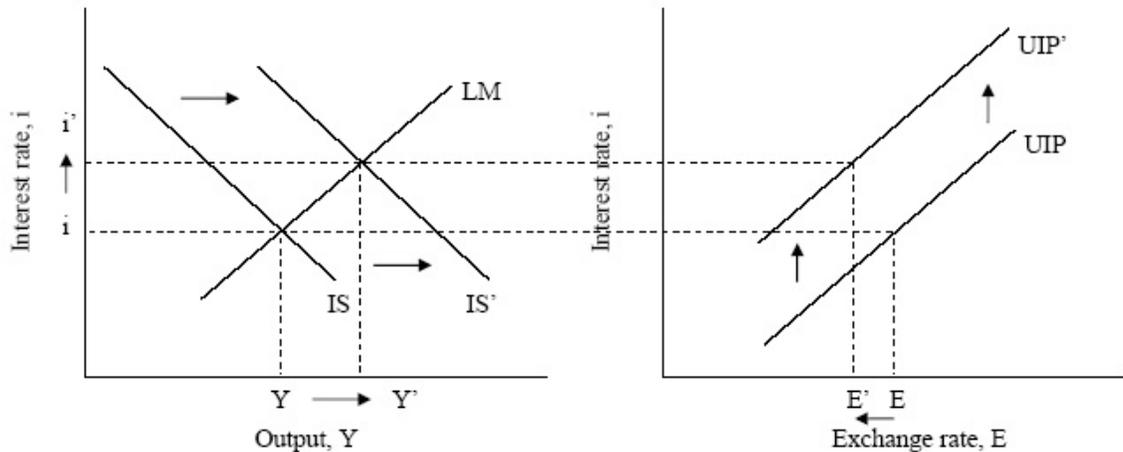
LM curve. This corresponds to a move along the IS curve that increases  $i$  and decreases  $Y$ .



After a few months of financial turmoil, you decide to abandon the fixed exchange rate regime and let the VT\$ float.

4. What is the impact on Vermont's economy (output, interest rates, exchange rate, trade balance) of an increase in  $i^{US}$  given a fixed money supply and fixed exchange rate expectations? Draw the IS-LM diagram for the open economy. Show the effects graphically, and explain your answer in words.

Ans:



The increase in the US interest rate leads to an upward shift of the UIP curve, and an outward shift of the IS curve. Output increases from  $Y$  to  $Y' > Y$ , the interest rate increases from  $i$  to  $i' > i$ , and the exchange rate decreases (i.e., VT\$ depreciates). Holding everything else constant, the depreciation of VT\$ improves the trade balance if the Marshall-Lerner condition holds. However, in addition to the change in exchange rate,  $Y$  also goes up, which tends to increase imports in general, so the net effect on net exports is ambiguous.

The intuition is the following: at a given Vermont interest rate, the increase in the US interest rate must compensate investors with an expected appreciation

of VT\$, thus implying an immediate depreciation. This depreciation leads to a shift of the IS curve to the right. The LM curve does not shift, as money supply is held constant. The depreciation thus leads to an increase in output and the domestic interest rate. The increase in Vermont's interest rate is less than the increase in the US interest rate due to the expected appreciation of VT\$.

5. Can the Central Bank of Vermont use monetary policy to offset the impact of the increase in  $i^{US}$  on Vermont's GDP? What does this imply for the exchange rate?

Ans:

The Central Bank should lower the money supply, shifting the LM curve to the left. This leads to a further increase in the interest rate and a reduction in GDP, and thus offsets the impact of the increase in  $i^{US}$  on Vermont's GDP. The further increase in  $i$  reduces the interest rate differential and thus weakens the immediate depreciation of VT\$. However, VT\$ still needs to depreciate immediately to offset the adverse effect of the increase in  $i$  on  $Y$ , i.e.,  $E$  goes down.