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**14.02 Principles of Macroeconomics**  
**Problem Set 5**  
**Fall 2005**

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Posted: Wednesday, November 16, 2005  
Due: Wednesday, November 23, 2005

Please write your name AND your TA's name on your problem set. Thanks!

**Exercise I. True/False? Explain**

- 1) Depending on expectations, a contractionary fiscal policy can reduce the budget deficit without a decrease of the output level.

*True. If the situation is such that the announcement of a contractionary fiscal policy today makes people improve their expectations in the future substantially (higher  $Y_{future}^e$ , lower  $r_{future}^e$ ), it could be that the IS curve shifts to the right instead of to the left.*

- 2) Tradable goods prices are a better measure of the degree of openness of an economy than trade volume.

*True. The volume of trade takes into account the size of exports and imports. However, it does not fully take into account the change in behavior of the domestic market (producers and consumers) implied by a higher degree of openness of the economy. The change in prices of tradable goods (net of transportation costs) is a better indicator. For example, domestic producers may be forced to sell at a lower price once they are challenged by foreigner competitors. It could be that domestic consumers still buy products from domestic producers, but at a much lower price. This effect is not captured by a change in the volume of trade.*

- 3) In the medium run equilibrium, the current account has to be balanced.

*False. Even if running a big trade deficit can be problematic, the natural level of output does not prevent it from happening.  $Y_n$  is determined in the labor market and is independent of trade budget considerations. The degree of openness, however, could affect  $Y_n$  through several other channels: changing the markup, the labor market structure (the variable  $z$ ), or maybe even the size of the labor force.*

- 4) If the uncovered interest parity does not hold, it surely means that there is an arbitrage opportunity.

*False. The uncovered interest parity does not take in account several factors that can justify differences in returns: risk and transaction costs, for example.*

- 5) The higher the degree of openness of an economy, the less of an effect a domestic expansionary fiscal policy has on the output level.

*True. In an open economy the Keynesian multiplier is smaller. Part of the effect of an expansionary fiscal policy is absorbed by an increase in imports.*

## Exercise II. Exchange Rates and the Interest Parity Condition

Assume that the uncovered interest parity holds.

European bonds		Us-bonds	
maturity	$i^*$	maturity	$i$
1-y	0.02	1-y	0.036
2-y	0.02	2-y	0.04
3-y	0.0225	3-y	0.0425
4-y	0.035	4-y	0.044
5-y	0.025	5-y	0.045

- 1) Knowing that the current exchange rate between dollar and euro  $E_t$  is 0.85 (euros per 1 dollar), calculate the market expectation about the nominal exchange rate for the next 5 years ( $E_{t+1}^e, E_{t+2}^e, E_{t+3}^e, E_{t+4}^e, E_{t+5}^e$ ). HINT: You may want to use a spreadsheet to do the calculations.

*The uncovered interest parity is*

$$(1 + i_t) = (1 + i_t^*) \left( \frac{E_t}{E_{t+1}^e} \right).$$

*From it we get*

$$E_{t+1} = 0.836873$$

*In order to calculate the expected nominal exchange rate from  $t+2$  on, we can properly adapt the uncovered interest parity, remembering that it is a no arbitrage condition.*

*Remember that the yield to maturity on an  $n$ -year bond or, equivalently, the  $n$ -year interest rate, is defined as that constant **annual** interest rate that makes the bond price today equal to the present value of future payments on the bond.*

*Now compare, for example, the returns on a European bond and the one on a US-bond, both bonds with maturity of 2 years.*

The expected present value of the return on the American bond is

$$\frac{(1+i_{2t})^2}{(1+i_{1t})(1+i_{1t+1}^e)}$$

The expected present value of the return on an European bond purchased today is

$$\frac{(1+i_{2t}^*)^2}{(1+i_{1t})(1+i_{1t+1}^e)} \frac{E_t}{E_{t+2}^e}$$

Note that the real exchange rate takes into account the moment in which euros are bought in order to purchase the European bond (today) and the moment in which the return in euros on the bond, once matured, is converted back to dollars. The no arbitrage condition impose that the two expected returns have to be equal. Given that the discount factor is the same for both expected present values, we can simplify the expression.

$$(1+i_{2t})^2 = (1+i_{2t}^*)^2 \frac{E_t}{E_{t+2}^e}$$

Proceeding in this way for the remaining expected exchange we get

Eet+1	0.836873
Eet+2	0.817622
Eet+3	0.802012
Eet+4	0.821066
Eet+5	0.771715

You may say that assuming that the bonds are bought today is an ad hoc assumption.

Instead the no arbitrage condition should hold also for trade strategies that require buying the asset in the future.

Go back to the example. Assume that we want to buy the European bond next year.

In this case the no arbitrage condition is

$$(1+i_{1,t+1}^e) = (1+i_{1,t+1}^{*e}) \frac{E_{t+1}^e}{E_{t+2}^e}$$

where  $i_{1,t+1}^e$  is the next year's expected 1-year nominal interest rate.

Remember from the structure of the yield curve that  $(1+i_{2t})^2 = (1+i_{1t})(1+i_{1t+1}^e)$ .

This is another equivalent way to pin down  $E_{t+2}^e, E_{t+3}^e, E_{t+4}^e, E_{t+5}^e$ .

- 2) Assume that the price indexes are  $P_t^* = 0.99$  for Europe and  $P_t = 1.32$  for the US. Calculate the current bilateral real exchange rate between the US and Europe,  $\varepsilon_t$ .

The real exchange rate is defined as  $\varepsilon = \frac{EP}{P^*}$

$$\varepsilon = 1.133.$$

Note that even though the nominal exchange rate is low, American goods are valued more than 1:1 versus European goods since the price level in the US is higher.

- 3) Suppose that in the next 5 years inflation rates are expected to be fixed at  $\pi^* = 2\%$  in Europe and at  $\pi = 3\%$  in the US. Calculate the market expectations for the real exchange rate for the next 5 years.

Remember that  $\pi_{t+1}^e = \frac{P_{t+1}^e - P_t}{P_t}$ .

Given that  $\pi_{t+i}^e = 3\%$  for  $i=1,2,3,4,5$ ; we can calculate the future expected US-price levels

P <sub>t</sub>	1.32
P <sub>t+1</sub>	1.3596
P <sub>t+2</sub>	1.400388
P <sub>t+3</sub>	1.4424
P <sub>t+4</sub>	1.485672
P <sub>t+5</sub>	1.530242

Similarly for Europe

P* <sub>t</sub>	0.99
P* <sub>t+1</sub>	1.0098
P* <sub>t+2</sub>	1.029996
P* <sub>t+3</sub>	1.050596
P* <sub>t+4</sub>	1.071608
P* <sub>t+5</sub>	1.09304

Combining all the data about expected price levels and expected nominal exchange rates, we can compute the expected real exchange rate.

epsilon <sub>t</sub>	1.133333
epsilon <sub>t+1</sub>	1.12677
epsilon <sub>t+2</sub>	1.111643
epsilon <sub>t+3</sub>	1.10111
epsilon <sub>t+4</sub>	1.138322
epsilon <sub>t+5</sub>	1.080391

- 4) Keeping everything else constant, how does your answer change if the market expects  $\pi^* = 3\%$  and  $\pi = 2\%$  instead? Is the assumption to keep everything else constant plausible? Explain.

Keeping everything else constant we get

epsilon <sub>t</sub>	1.133333
epsilon <sub>t+1</sub>	1.104997
epsilon <sub>t+2</sub>	1.069097
epsilon <sub>t+3</sub>	1.038504
epsilon <sub>t+4</sub>	1.052856
epsilon <sub>t+5</sub>	0.979964

The assumption of keeping everything else constant is not plausible. A change in the expected inflation rates changes the structure of the yield curve. This implies a change in the expected nominal exchange rate. Taking in account of this fact can lead to a different pattern for the expected real exchange rate.

### Exercise III. Open Economy IS-LM

Consider the following open economy:

$$C = 100 + 0.2(Y - T)$$

$$I = 100 + 0.2Y - 240r$$

$$IM = 0.1Y\varepsilon + 24\varepsilon^2$$

$$X = 0.02Y^* - 24\varepsilon$$

$$T = 50$$

$$G = 50$$

$$Y^* = 5000 \text{ (GDP of the rest of the world)}$$

$$M^s = 200$$

$$M^d = PY - 3600i$$

Suppose that  $P = P^* = 1$  and that there is no inflation  $\pi^* = \pi = 0$ .

- 1) Assume the economy commits to having a trade balance (net exports) equal to zero (TB=0). Calculate the equilibrium ( $Y$ ,  $r$ ,  $\varepsilon$ ).

$$\text{IS relation: } Y = C + I + G + NX$$

$$\text{where } NX = X - \frac{IM}{\varepsilon}$$

$$\text{Trade Balance equal to zero: } NX = 0$$

$$Y = 100 + 0.2(Y - 50) + 100 + 0.2Y - 240r + 50$$

$$Y = 0.4Y + 240 - 240r$$

$$Y = 400 - 400r$$

$$\text{LM relation: } M^s = M^d$$

$$\text{Given } i = r + \pi, \text{ and } \pi = 0, i = r.$$

$$200 = Y - 3600r$$

$$Y = 200 + 3600r$$

$$\text{IS-LM equilibrium}$$

$$200 + 3600r = 400 - 400r$$

$$4000r = 200$$

$$i = r = 0.05$$

$$Y = 380$$

From the TB=0 condition we get

$$0.02Y^* - 24\varepsilon = \frac{(0.1Y + 24\varepsilon)\varepsilon}{\varepsilon}$$

Plugging in the values for  $Y$  and  $Y^*$ .

$$62 = 48\varepsilon$$

$$\varepsilon = 1.29$$

- 2) If  $r^* = 0.02$  and the uncovered interest parity holds, what is the expected change in the real exchange rate for the next period?

Note that  $\varepsilon = \frac{EP}{P^*} = E$  at any period ( $t$ ), given the

assumptions  $P = P^* = 1$  and  $\pi^* = \pi = 0$ .

We noted before that  $i = r$  (because of the same assumptions).

The uncovered interest parity states  $(1 + i_t) = (1 + i_t^*) \left( \frac{E_t}{E_{t+1}^e} \right)$ .

Given our assumptions it becomes  $(1 + r_t) = (1 + r_t^*) \left( \frac{\varepsilon_t}{\varepsilon_{t+1}^e} \right)$

Thus  $\varepsilon_{t+1}^e = \frac{(1 + r_t^*)}{(1 + r_t)} \varepsilon_t$

$$\varepsilon_{t+1}^e = 1.25$$

- 3) Keep  $TB=0$  and imagine that  $G$  increases by 48. Calculate the new equilibrium. How does your answer to part 2) change?

$$Y = 100 + 0.2(Y - 50) + 100 + 0.2Y - 240r + 98$$

$$Y = 0.4Y + 288 - 240r$$

$$Y = 480 - 400r$$

*IS-LM equilibrium*

$$200 + 3600r = 480 - 400r$$

$$4000r = 280$$

$$r = 0.07$$

$$Y = 452$$

*From the  $TB=0$  condition we get*

$$100 - 0.1Y = 48\varepsilon$$

$$\varepsilon = 1.14$$

$$\varepsilon_{t+1}^e = 1.09$$

- 4) Assume  $G=50$  as in the beginning of this question. Imagine the economy commits to having a fixed real exchange rate  $\varepsilon_t = \varepsilon_{t+1} = \varepsilon$  and allows the trade balance to vary. Calculate the equilibrium.

*From the uncovered interest parity we get  $r^* = r = 0.02$ .*

*From the LM relation we get*

$$Y = 200 + 3600r$$

$$Y = 272$$

*From the IS relation we get*

$$Y = 100 + 0.2(Y - 50) + 100 + 0.2Y - 240r + 50 + 0.02Y * -24\varepsilon - \frac{(0.1Y + 24\varepsilon)\varepsilon}{\varepsilon}$$

$$48\varepsilon = 144.8$$

$$\varepsilon = 3.02$$

$$X = 27.6$$

$$\frac{IM}{\varepsilon} = 99.6$$

$$TB = X - \frac{IM}{\varepsilon} = -72$$

- 5) Imagine that G increases by 48. Assume that the Central Bank does not accommodate this policy, (i.e. they do nothing). Calculate the new equilibrium. How does the TB change? Comment. (HINT: The government still wants to keep  $\varepsilon_t = \varepsilon_{t+1} = \varepsilon$ , but they could change the value of  $\varepsilon$ ).

*Still  $r^* = r = 0.02$  and  $Y = 272$  hold.*

$$Y = 100 + 0.2(Y - 50) + 100 + 0.2Y - 240r + 98 + 0.02Y^* - 24\varepsilon - \frac{(0.1Y + 24\varepsilon)\varepsilon}{\varepsilon}$$

$$48\varepsilon = 192.8$$

$$\varepsilon = 4.02$$

$$X = 3.6$$

$$\frac{IM}{\varepsilon} = 123.6$$

$$TB = X - \frac{IM}{\varepsilon} = -120$$

*The Trade Deficit increases by 48.*

*Note that the real exchange rate is changed forcing the government to devalue: a fiscal policy as the one we described and the commitment to keep a fixed exchange rate are inconsistent.*

- 6) Assume  $G=50$  again. How does a decrease in  $Y^*$  by 2400 affect the equilibriums you calculated in part 1) and part 3), respectively? Comment.

*In the  $TB=0$  policy rule scenario, a negative shock to  $Y^*$  does not change the equilibrium  $Y=380$  and  $r=0.05$ . The real exchange rate drops from 1.29 to 0.29. The change in the real exchange rate neutralizes the effects of the foreign income shocks. The government can thus maintain its commitment to  $TB=0$  by letting the exchange rate vary freely.*

*Also in the  $\varepsilon_t = \varepsilon_{t+1} = \varepsilon$  policy rule scenario, a decrease in  $Y^*$  does not change neither equilibrium  $Y=272$  nor equilibrium  $r=0.02$ , but the real exchange rate goes under pressure. If nothing changes,  $\varepsilon$  has to be devaluated from 3.02 to 1.93. In this case an expansionary fiscal policy  $\Delta G = +48$  helps the government to keep  $\varepsilon$ . Economic policy has to be used in order to neutralize the effects of a foreign income shock and keep the commitment.*