14.02 Principles of Macroeconomics

Solution for Problem Set 5

Posted: Wednesday, March 21, 2001

Due: Wednesday, April 4, 2001

Please remember to write your TA's name and section time on the front page or your PS.

Part 1: True/False Questions: Decide whether each statement is true or false and justify your answer with a short argument. (2 points each, 18 points total)

1. **A country cannot reduce its trade deficit through a depreciation. Examining the equality NX= Sp + Sg – I shows that the trade deficit is solely determined through local private saving, government saving and investment, and none of these are affected by the exchange rate.**

False. The argument may sound convincing, but we know it is wrong. We showed that a depreciation leads (if the Marshall-Lerner condition holds) to an increase in output and an improvement in the trade position. So what is wrong with it? A depreciation actually affects saving and investment: it does so by affecting the domestic goods market, thereby increasing output. Higher output leads to an increase in saving over investment, or, equivalently, to a decrease in the trade deficit.

2. **An expansionary fiscal policy will eventually reduce the trade deficit.**

False. An increase in government spending (which leads also to an increase in the government deficit) leads to an increase in output, and, therefore, to an increase in the trade deficit: $\uparrow G \rightarrow (\uparrow Y) \rightarrow \downarrow M(e,Y)$, $=X(e,Y^W) \rightarrow \downarrow NX \equiv X-M$. Consequently, the government deficit and the trade deficit are called the **twin deficits** (both come hand in hand).

3. **A real depreciation would lead to an immediate improvement in the nominal trade balance.**

False. The real depreciation leads initially to a deterioration, then to an improvement of the trade balance. This is because the quantities of exports and imports adjust more slowly relative to the immediate change in their value due to the change in the exchange rate (the price change). In the short run, $NX = \approx X(e,Y^W) - \uparrow e * \approx Q(e,Y) \rightarrow \downarrow NX$, while in the medium run $NX = \uparrow X(e,Y^W) - \uparrow e * \downarrow Q(e,Y) \rightarrow \uparrow NX$ (assuming the Marshall-Lerner condition holds). This is what is called the "**J-curve**".

4. **Due to the nominal appreciation of the US Dollar, I was able to do more things during my trip to Israel.**

False. A nominal appreciation does not *necessarily* lead to real appreciation. In order to be able to buy more products from Israel, I need to have a real appreciation. Put another way, I need that the US inflation is not greater than the Israeli inflation by more than the nominal appreciation, in order to get a real appreciation; $\downarrow e=(\downarrow E \uparrow P^*/\uparrow P) \Rightarrow |\downarrow E| > |\uparrow P^*/\uparrow P|$.

5. **Technology improvement shifts the AS curve, and leads to a lower prices and higher GNP.**

True. When firms have better technology, they can produce more output at any price level. Therefore, technology improvement shifts the AS curve down and to the left, and leads to lower prices and higher GNP.

6. **Under perfect capital mobility, when a country joins a system of fixed exchange rates, it gives up the freedom to choose its interest rate.**

True. In a credible fixed exchange rate regime, by definition, the expected change in the exchange rate is zero: $(E^e - E)/E\ E = 0$. Therefore, by the Interest Rate Parity condition, $i = i^* + (E^e - E)/E\ E \Rightarrow i = i^*$, no matter what the monetary policy is. In fact, the central bank should adjust the money supply in order to keep the domestic interest rate equal to the international interest rate. Therefore, monetary policy is no longer independent.

7. **The increasing productivity and output of another country is a threat to the prosperity of the US.**

False. Since exports are a positive function of the world's output, an increase in the world's output increases our exports and thereby increases our own GDP.

8. **The twin deficits refer to the government's budget deficit and the international trade deficit.**

True. Refer to T/F #2 above.

9. **Similar to consumption, changes in the growth rate of capital spending are smoother than changes in the growth rate of GNP.**

False. The growth rate of investment is more volatile than the GDP's growth or consumption's growth rate. In fact, it accelerates relative to the GDP growth (second derivative of the GDP with respect to time).

Part 2: Open Economy IS-LM (6 points each, 36 points total)

Consider the following open economy:

C=20+0.8*(Y-T)

I=30+0.3*Y-20*i

G=T=10

NX (Net Exports)=40-0.3*Y-30/E

M^D=Y-50*i

M^S=295

P=P^*=1, where P is the domestic and P* is the foreign price level

Expected exchange rates, E^e , =1, the foreign interest rate, i^* , = 0.1, and the exchange rate is flexible.

1. **Write down and graph the LM relation. Explain what it represents and whether there are any differences relative to the closed economy.**

LM: 295=Y-50*i; this is an upward-sloping line in the Y-i space. The interpretation of this equation is that it represents equilibrium in the money market. There are no differences r/e the closed economy; equilibrium is driven by liquidity need for transactions. Since you only need domestic currency for liquidity, openness should not (significantly) affect the money market.

2. **Write down and interpret in words the equilibrium condition of the goods market. Are there any differences relative to the closed economy?**

Goods market equilibrium is Y=C+I+G+NX, where demand is equal to supply of goods. The difference between the closed and open economy is that you have to add net exports, which introduces the real exchange rate and foreign output as other variables that influence demand. Net exports are decreasing in output, which decreases the feedback (multiplier) effect (smaller multiplier).

Note: "solving" this model for the closed economy (with the same numbers) gives a "negative" multiplier; doing this alone is not a complete answer to the question of the difference between the closed and open systems.

3. **Derive and graph the open economy IS curve (in the Y-i space). Interpret, and explain any differences relative to the closed economy IS curve.**

A complete answer to this question must begin with stating the returns on domestic bond investment, $(1 + i)$, and foreign bond investment, $(1/E_t)(1 + i^*)(E_{t+1})$. Answers should equate the two, get the precise formula; then state the convenient (approximate) form: $i = i^* + (E^e_{t+1} - E_t)/E_t$. The graph is a downward-sloping curve in the i-E space.

Next step is to get the IS curve by combining the goods market and interest parity relations: $Y=0.8*Y+92-20*i-30/E=0.8*Y+92-20*i-30-30*i=30*i^{*}=0.8*Y+65-50*i$, so $Y=325-250*i$. The graph is downward sloping in the Y-i space. The interpretation is that the equation shows output for a given interest rate, consistent with both interest parity and goods market equilibrium. Higher interest rates depress investment, and appreciate the currency and thus depress net exports. Both effects generate a decrease in demand, which then gets multiplied and translates into smaller output. The distinctions between open and closed are the different multiplier (smaller in the open economy) and a second interest rate channel (through the exchange rate and net exports.)

4. **Explain the effects of a fiscal expansion using words and graphs (no algebra): what happens to output, the interest rate and the exchange rate? What happens to investment and net exports? Answer the same questions for a monetary expansion as well.**

With a fiscal expansion, higher G means increased demand for any level of the interest rate, so the IS shifts out. This means higher output, higher interest rates (because the money supply is fixed, so interest rates must increase to make people happy with their existing cash holdings but more income), thus an appreciation (higher interest rates here, so the country must have a depreciation by tomorrow – this implies an appreciation today). The effect on investment is ambiguous, since higher output increases I but higher interest rates decrease I. For net exports, higher Y decreases NX, higher i (via lower E) also has a negative effect, so NX goes down.

For a monetary expansion, higher M implies lower interest rates for any level of output. The LM curve shifts out. Lower interest rates boost I and NX (moving along the IS curve), so we have higher Y, lower i and thus higher E (depreciation) eventually. Investment is higher, NX is unclear (Y effect vs. E effect).

5. **How can the government decrease interest rates without changing output? What will happen to the exchange rate and net exports?**

The government can accomplish this goal with a policy mix of fiscal contraction and monetary expansion. In this case, the LM shifts out and the IS shifts in, keeping Y fixed. This increases E, so the only effect on NX is due to higher E: NX increases.

6. **Can the government achieve lower interest rates without changing output and net exports in our model? In reality?**

In our model, the government has M, G and T as policy tools. However, G and T have the same effect on everything (but C), so it is as if in fact we have only two instruments. To achieve three targets, this is not, in general, enough. In reality (and this can be incorporated into the model), you can influence net exports through export subsidies, import tariffs, etc. – any third policy tool that has a direct effect on NX would do.

Part 3: Exchange Rates And Expectations (8 points each, 24 points total)

Consider an open IS-LM economy with fixed exchange rates E = 1, and the domestic interest rate (i) and the foreign interest rate (i*) given below:

i=0.15, i*=0.06.

1. **What's the exchange rate people expect (E^e) in this market?**

People expect a devaluation to a level where E is equal to 1.09.

2. **What will happen if people are right and the Central Bank devalues the currency to the level people think is correct? In particular, what happens to interest rates and output?**

If the country devalues, E will rise. This will put pressure on the interest parity equation – at the moment of devaluation (before i has had a chance to adjust), domestic bonds look more attractive than foreign bonds. This makes foreign investors want to buy domestic bonds – they trade foreign currency for domestic at the central bank at the new exchange rate (1.09), driving up domestic money supply. This shifts out the LM, lowering i until i = i* = 0.6. This drop in interest rates will push investment up (moving along the IS curve) and therefore output will increase.

There is also be a second order effect on NX – the new, higher E means that NX rises. This shifts out the IS curve, puts upward pressure on interest rates, and leads to further expansionary monetary accommodation. This has an additional boost on output.

3. **How does your answer change if, after the devaluation, people start thinking that the Central Bank is 'weak' and believe that it will start printing lots of money?**

People will expect an even higher E for the future (E^e goes way up.) This shifts out the interest parity curve. The moment that these expectations change, the return on foreign bonds looks more attractive than domestic bonds – see this in the arbitrage equation. This means that investors will want to move their currency out of the country, putting lots of pressure on the central bank to pay out its foreign reserves to support the exchange rate. In turn, this reduces the money supply, shifts in the LM curve, and pushes interests rates very high. Output will decrease from its levels in (b).

Note that as long as the country is defending its exchange rate, there is no effect on NX or the IS: NX moves when E moves, and E is still fixed here. It is possible to imagine a scenario where the central bank runs out of reserves if E^e keeps rising, and abandons its fixed E all together.

If you assumed that the conditions in (b) and (c) were happening at the same time (instead of sequentially, as above) then the 2 changes – the devaluation and the rise in E^e – would be pulling output in different directions. The ultimate effect on output would depend on the magnitude of the change in E^e.

Part 4: Volatility of Investment (8 points each, 24 points total)

Consider an economy with N firms, each of them composed of one entrepreneur and capital. All firms have the same production function: $y_{n,t} = A_t k_{n,t}^{\alpha}$ (no labor is used).

The real interest rate (r) and the depreciation rate (d) are given as constant. Firms can adjust (either up or down) their stock every period.

1. **What are the:**

(a) GNP of the economy (Yt);

$$Y_t = \sum_{n=1}^{N} y_{n,t} = A_t \sum_{n=1}^{N} k_{n,t}^{\alpha}$$

(b) Per-period profit function;

Note that no labor is used in production, therefore, the per-period profit function is: the cost of having capital includes the interest rate r and the capital lost due to depreciation δ.

$$[y_{n,t} - (r + \delta)\ k_{n,t}] = [A_t k_{n,t}^{\alpha} - (r + \delta)\ k_{n,t}]$$

(c) Optimal capital of the economy (K*);

Taking the derivative of the profit function w.r.t. capital and equating to zero, we obtain:

$$\partial[A_t k_{n,t}^{\alpha} - (r + \delta)\ k_{n,t}]/ \partial k_{n,t} = \alpha A_t k_{n,t}^{(\alpha-1)} - (r + \delta) = 0$$

$$\Rightarrow k_{n,t} = [\alpha A_t /(r + \delta)]^{1/(1-\alpha)}$$

Therefore, all firms will have the same identical capital level, and the aggregate level of capital stock is:

$$K_t^{*} = N\,[\alpha A_t /(r + \delta)]^{1/(1-\alpha)}$$

(d) Capital/Output ratio (K/Y).

$$Y_t = \sum_{n=1}^{N} y_{n,t} = A_t \sum_{n=1}^{N} k_{n,t}^{\alpha} = A_t \sum_{n=1}^{N} [\alpha A_t /(r + \delta)]^{\alpha/(1-\alpha)}$$

$$\Rightarrow Y_t = N\, A_t\, [\alpha A_t /(r + \delta)]^{\alpha/(1-\alpha)} =$$

$$K_t = N\,[\alpha A_t /(r + \delta)]^{1/(1-\alpha)}$$

$\Rightarrow K_t / Y_t = N [\alpha A_t / (r + \delta)]^{1/(1-\alpha)} / N A_t [\alpha A_t / (r + \delta)]^{\alpha/(\alpha-1)} =$

$\Rightarrow K_t / Y_t = \alpha/(r + \delta)$

the capital/output ratio is decreasing in r & δ because the higher the cost of capital the less capital firms will want to use.

2. If $A_t = A_{t-1}$, find gross and net investment at time t (I_N).

It's given that $A_t = A_{t-1} = A \ \forall t$

Gross investment is:

$I_t = K_t - (1-\delta) K_{t-1} = \delta K_t \ \forall t$

$\Rightarrow \mathbf{I_t} = \delta K_t = \delta N [\alpha A_t / (r + \delta)]^{1/(1-\alpha)} = \delta N [\alpha A / (r + \delta)]^{1/(1-\alpha)} \ \forall \mathbf{t}$

Net investment is:

$I^N_t = I_t - \delta K_t = 0$

Or $I^N_t = K_t - K_{t-1} = 0$

3. Assume d=0.6, r=4%, d=10%, $A_1=A_2=A_3=1.0$, $A_4=A_5=A_6=1.2$, $K_0=K_1$*, $I_{N0}=0$.Find and plot the path of GNP, K and I.

$Y_1 = Y_2 = Y_3 = 8N$

$Y_4 = Y_5 = Y_6 = 12.62N$

$K_1 = K_2 = K_3 = 32N$

$K_4 = K_5 = K_6 = 50.48N$

$K_1 = K_2 = K_3 = 3.2N$

$K_4 = 21.68$

$K_5 = K_6 = 5.05N$