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Solutions to written exam for the M.Sc. in Economics International Monetary Economics

January 9, 2013

Number of questions: This exam consists of 3 questions.

1. This question only requires short answers. The questions relate to the following learning objectives: explain and describe the main characteristics of the European Monetary Union; describe the main models of exchange rate determination (the Monetary approach to the exchange rate, Dornbusch overshooting model and Lucas asset pricing model) and use these models to analyze the effects of monetary and fiscal policy on the exchange rate, and summarize the empirical evidence on these models; describe the institutional features of the foreign exchange market products (spot and forward contracts) and be able to distinguish between speculation and arbitrage; and describe and explain Covered Interest Rate Parity (CIP), Uncovered Interest Rate Parity (UIP), and Purchasing Power Parity (PPP) and be able to summarize the empirical evidence on these parity conditions.
   (a) Wrong. The Governing Council consists of the Executive Board and governors of the 17 national central banks in the Eurozone. Non-members of the Eurozone only participate in the European System of Central Banks.
   (b) Correct. Central bank bond purchases will increase the price of bonds and thereby lower the interest rate. The central bank both provides liquidity and reduces the interest rate.
   (c) Correct. The channel works through the Fisher equation and an underlying assumption that the real interest rate is equal across countries. An increase in the domestic interest rate, holding the real interest rate constant, leads to higher inflation and therefore a depreciation of the currency (using PPP).
   (d) Correct. Note, however, that this holds only under the assumption of risk neutrality and rational expectations. If agents are not risk neutral (or agents cannot form rational expectations), there is a wedge between the current forward exchange rate and the future spot rate.

2. This question relates to the learning objective: describe the main models of exchange rate determination (the Monetary approach to the exchange rate, Dornbusch overshooting model and Lucas asset pricing model) and use these models to analyze the

effects of monetary and fiscal policy on the exchange rate, and summarize the empirical evidence on these models.

The Dornbusch model presented in the question is a version of the standard model where we now have assumed that the interest rate cannot affect aggregate demand. The consequence of this new assumption is that the goods market equilibrium curve is a 45-degree line and therefore coincides with the PPP assumption. It is essential that the answer includes a discussion about the slope of this curve and that it has been shown that the curve is a 45-degree line. The second new feature of the model is that the expression for the expectations coefficient θ is shown. This expression can be used when answering the last question about the size of the overshooting effect. If $\pi \to \infty$ then $\theta \to \infty$ and the overshooting effect disappears. The intuition is that prices become less sticky (inflation reacts immediately to demand) and therefore the real exchange rate does not deviate in the short-run from its long-run value and consequently there can be no overshooting effect.

The following equations are given in the question

$$r - r^* = \Delta s^e \tag{1}$$

$$\Delta s^e = \theta\left(\bar{s} - s\right) \tag{2}$$

$$m - p = ky - lr \tag{3}$$

$$y^d = h\left(s - p\right) \tag{4}$$

$$\dot{p} = \pi\left(y^d - \bar{y}\right) \tag{5}$$

where the expectations coefficient θ which is consistent with perfect foresight is given by

$$\theta = -\pi h\left[1 + \frac{1}{l\theta}\right].$$

(a) The main underlying assumptions and explanations to the equations of the model should include the following.

- A small open economy, foreign prices and interest rates are constant.
- All variables are in logs except interest rates.
- PPP holds in the long-run but not in the short-run because prices are sticky.
- UIP holds under risk neutrality (equation (1)). The expected change in the exchange rate is equal to the interest rate differential.
- Equation (3) is a standard money demand function.
- Equation (4) is the aggregate demand function where we have normalized the foreign price level to be equal to 1 (such that p=0) and we have assumed that the interest rate cannot affect aggregate demand.

- Equation (5) is the price adjustment relation which says that the wider the gap between aggregate demand and the constant full employment output, the higher rate of inflation.This is a Keynesian type of model and it is assumed that output is fixed.
- Equation (2) is the most important equation in the model. It says that the expected change in the exchange rate depends on the deviation of the nominal exchange rate from its equilibrium value where $\theta > 0$ is the speed of adjustment.

(b) Money market equilibrium:

Combine equations (1), (2) and (3) such that we can write

$$p - m = -ky + lr^* + l\theta\left(\bar{s} - s\right). \tag{6}$$

Long–run equilibrium implies that $s = \bar{s}$ which will then give us the long–run equilibrium price level

$$\bar{p} = m + lr^* - k\bar{y}. \tag{7}$$

Insert this solution into equation (6) and rearrange

$$s = \bar{s} - \frac{1}{l\theta}\left(p - \bar{p}\right) \tag{8}$$

This is the key equation of the model. It states that deviations from the equilibrium spot exchange rate can be explained by deviations from the long–run equilibrium price level. If we insert equation (7) into (8) we obtain the money market equilibrium curve (the MM-curve in the graphs below).

$$s = \bar{s} - \frac{1}{l\theta}\left(p - m + lr^* - k\bar{y}\right)$$

with slope equal to

$$-\frac{1}{l\theta}$$

To derive the goods market equilibrium curve we insert the aggregate demand function (4) into the price adjustment equation (5) to obtain

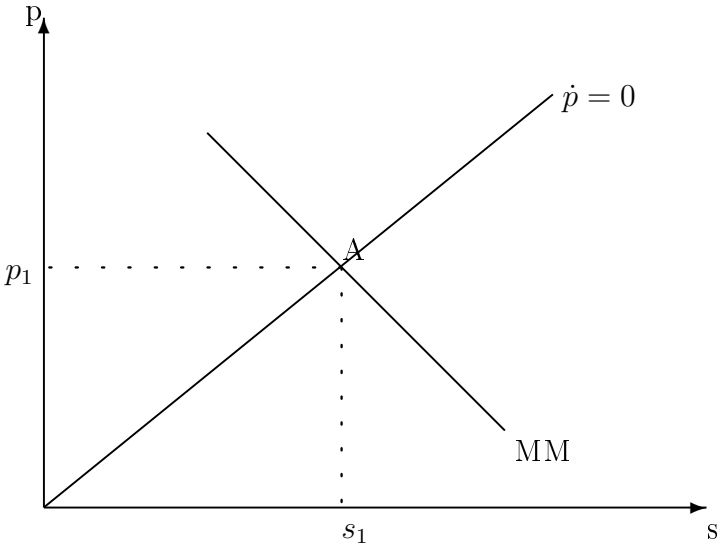
$$\dot{p} = \pi\left(h\left(s - p\right) - \bar{y}\right) \tag{9}$$

and in equilibrium $\dot{p} = 0$ implying that

$$s = p + \frac{\bar{y}}{h}$$

with slope equal to 1 (a 45-degree line). This is an important result that must be reflected in the graph below. The goods market equilibrium curve coincides

with the 45-degree line (the PPP assumption). Initial equilibrium at point A. Points above the $\dot{p} = 0$–curve correspond to excess supply whereas points below correspond to excess demand the reason being that for a given price level, an exchange rate appreciation reduces demand.



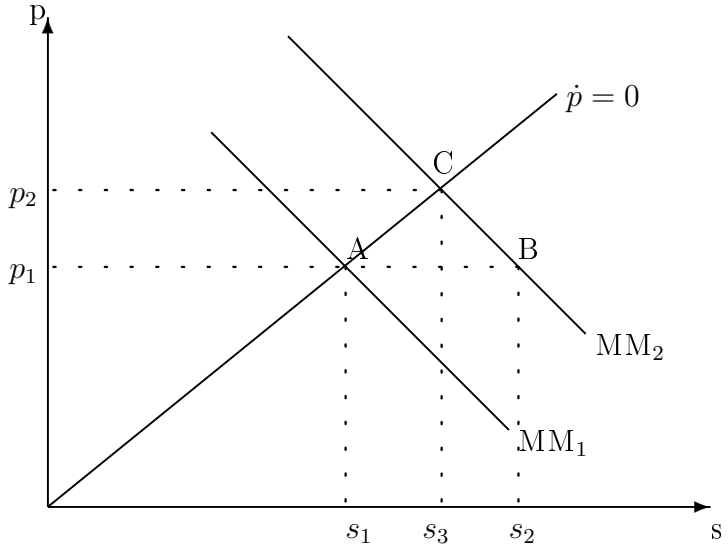
(c) Show how an unanticipated money shock affects both the nominal and the real exchange rate in the short– and long–run. Explain carefully.

Adjustments as in the original Dornbusch model with an overshooting effect. In the graph below we start in equilibrium (at point A). We know from the formal model above that an unanticipated increase in the money supply will raise both the price level and the nominal exhcange rate. Furthermore, if the money supply increases by 10%, then both the price level and the nominal exchange rate must also increase by 10% (the new long-term equilibrium must be located on the goods market equilibrium curve which in this particular version of the model coincides with the PPP line).

An important assumption in the model is that prices are sticky whereas the nominal exchange rate adjusts immediately. With a larger money supply, any given price level must imply a higher s, i.e., a depreciated currency. The MM-curve therefore shifts out to the right. In the short-run the price level is fixed at p_1 and the nominal exchange rate increases to s_2 since we must always be on the MM-curve depicting monetary equilibrium. The economy jumps from point A to point B. If p is given and constant in the short-run, the money supply expansion creates an excess of real money balance ($m/p \uparrow$) which implies a lower domestic interest rate, the domestic interest rate falls. According to UIP, a lower domestic interest rate holding the foreign interest rate constant require an expected appreciation of the exchange rate. Such an appreciation can only happen if the short–run depreciation exceeds the long–run depreciation. At point B, we are below the goods market

equilibrium curve and there is therefore excess demand which eventually will drive up the price level. There are also two other forces that will contribute to the excess demand. The reduced interest rate will have a positive effect on aggregate demand and the undervalued currency implies that domestic goods become cheap compared to foreign goods, foreign demand for domestic goods increase. As the price level increases, the economy moves along the new MM-curve up to point C which is th enew long-run equilibrium.

The analysis shows that the nominal exchange rate first depreciates (jumps from point A to point B) and then appreciates (movement from point B to point C), there is an overshooting effect.



(d) To show that there is overshooting in the model we proceed as usual by total differentiating equation (6) and remembering that in the short-run $dp = 0$ and that $d\bar{s} = dm$ which gives

$$\frac{d\dot{s}}{dm} = 1 + \frac{1}{l\theta} > 1$$

The factors determining the size of the overshooting effect are l and θ.

The question then is how the size of the overshooting effect is affected when $\pi \to \infty$. We can see directly from the relation between the deep parameters and the expectations coefficient that if $\pi \to \infty$ then $\theta \to \infty$ and the overshooting effect disappears.

3. This question relates to the learning objective: describe, explain and compare first, second and third-generation models of currency crises and apply these models to analyze actual currency crises. The question is about the ABB model where the credit multiplier is a function of the real interest rate. The two main relations are stated as well as the slope of the Wealth-curve which is needed to illustrate the model in a graph.

The reason why the slope is needed is that the slope is ambiguous. All other aspects are as in the original ABB model where the credit multiplier is constant.

The ABB model

Consider the ABB model of currency crisis where the credit multiplier is a function of the real interest rate. The model consists of the following two main equations: The IPLM-curve

$$E_1 = \frac{1+i^*}{1+i_1}\frac{M_2^s}{m^d\left(y_2, i_2\right)} \tag{10}$$

and the Wealth-curve

$$y_2 = \sigma f\left((1+\mu_2)(1-\alpha)\left[y_1 - (1+r_0)d_1^c - (1+i^*)\frac{E_1}{P_1}d_1^f\right]\right). \tag{11}$$

It can be shown that the slope of the Wealth-curve is given by

$$\frac{dE_1}{dy_2} = \frac{P_1}{\sigma f'\left(k_2\right)(1-\alpha)(1+\mu)\left[\frac{\mu'}{1+\mu}\Pi_1 - (1+i^*)\,d_1^f\right]}.$$

All these equations are given in the question.

(a) Explain the main underlying assumptions of this model including how currency crises are generated.

Main underlying assumptions:

- PPP holds *ex ante* but not necessarily *ex post*.
- There is an exogenous supply shock affecting the economy in period 1 and the central bank can respond by altering the interest rate.
- Prices are sticky implying that a shock to PPP leads to a change in nominal exchange rates (P_t is preset at time $t-1$).
- UIP holds
$$(1+i_t) = (1+i_t^*)\,\frac{E_{t+1}^e}{E_t}.$$
- Central Bank credibly targets inflation from period 2 but not in period 1 if there is a supply shock implying that i_t for $t \geq 2$ is predetermined.
- Standard production function but the capital stock depends on borrowing and the cash flows from earlier period. This implies that the capital stock and thus production are predetermined.
- Imperfect credit markets: firms are credit constrained, they can only borrow a fixed share of their current wealth or cash flow and they are forced to borrow abroad.
- In period 1 there is an unanticipated shock and potential monetary policy response in period 1.

- Since there are no shocks other than in period 1 and the central bank targets inflation, monetary policy and thus the interest rate is constant from period 2 onwards. $P_t = E_t \, \forall \, t \neq 1$ and inflation is constant and equal to the rate of change in the exchange rate since PPP holds.

In this model it is the weakness in the financial health of private firms that is causing the crisis. Credit constraints ⇒ foreign debt ⇒a depreciation increases debt repayments ⇒ reduced profits ⇒ reduces firms borrowing capacity ⇒ reduces future output when there is a negative supply shock (or productivity shock).

(b) Illustrate the model in the y_2-E_1-plane.

To illustrate the model graphically we have to consider the slope of the Wealth-curve in detail. The slope of the W–curve is

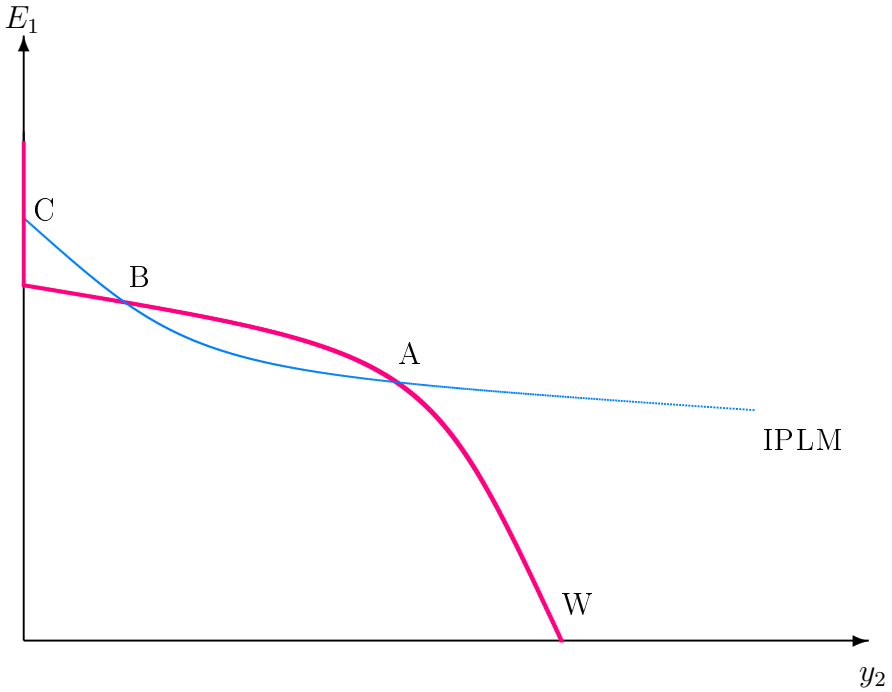
$$\frac{dE_1}{dy_2} = \frac{P_1}{\sigma f'(k_2)(1-\alpha)(1+\mu)\left[\frac{\mu'}{1+\mu}\Pi_1 - (1+i^*)\, d_1^f\right]}$$

where we find that

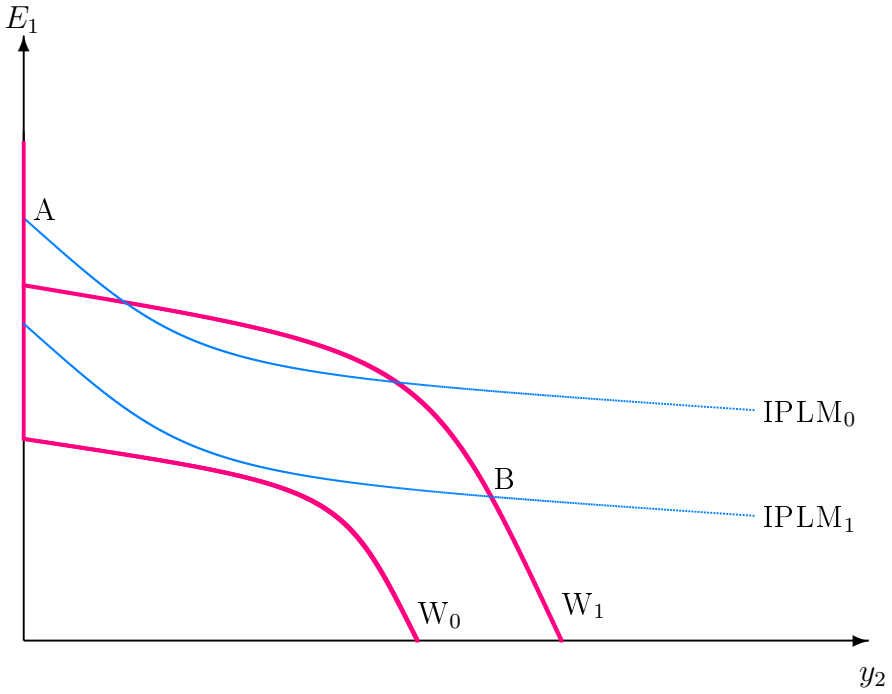
- If the credit multiplier is constant or if foreign debt dominates $\frac{\mu'}{1+\mu} < (1+i^*)\, d_1^f$, then the slope is negative.
- If the credit constraint is not binding (or credit markets are absent), μ is very large, then the curve is vertical.
- If there is no foreign debt, $d_1^f = 0$, then the slope is positive.
- The slope is positive for small values of E and negative for large values of E.

There are only two cases relevant to study, the case when the slope of the W–curve is negative and the case when it is both positive and negative. Currency crises cannot occur in the other two cases. We assume that foreign debt dominates $\frac{\mu'}{1+\mu} < (1+i^*)\, d_1^f$, such that the slope of the W–curve is negative. The W–curve is, by the way, concave if we assume constant returns to scale (or increasing returns to scale).

The graph below illustrates the model. Note that this graph only holds if there is a shock to the economy, otherwise the W-curve is vertical. The position of the W-curve determines whether there are multiple equilibria or not. In the illustration below we have three equilibria, point A (a non-crisis equilibrium), point B and point C (crisis equilibrium).



(c) What is the appropriate monetary policy response to prevent a currency crisis? From the expression for the IPLM–curve we find that a restrictive (expansionary) monetary policy ($i_1 \uparrow$) shifts the IPLM–curve down (up). The W–curve is also affected since changes in the exchange rate affects the credit multiplier. Since $\mu' > 0$ (something we find using the expression for the credit multiplier), an increase in the exchange rate leads to a shift in the W–curve up. Together with the downward shift in the IPLM–curve, we find that restrictive monetary policy is optimal. This is illustrated in the graph below. After the shock, the W-curve is given by W_0 and the initial IPLM-curve is $IPLM_0$ and there will be a currency crisis (only one possible equilibrium at zero output, point A). The appropriate response is to use restrictive monetary policy which will lead to a shift down in the IPLM-curve (to $IPLM_1$) and a shift up in the W-curve (to W_1). In the graph this implies that there is only one possible equilibrium, a non-crisis equilibrium (point B).


E_1
A
IPLM$_0$
B
IPLM$_1$
W$_0$
W$_1$
y_2