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Solution to written Exam at the Department of Economics summer 2021

Economics of Exchange Rates

August 18, 2021

Number of questions: This exam consists of 2 questions.

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1. **Portfolio Balance Model**

   This question covers the portfolio balance model and is related to the learning objective: describe and use the portfolio balance and the signaling models to analyze the effects of policy interventions (central bank interventions, monetary and fiscal policy) on the exchange rate.

   Consider the standard Portfolio Balance Model comprised of the following functions

$$W \equiv M + B_p + SF_p \tag{1}$$

$$M = m\left(r, E\dot{s}, Y, W\right) \quad m_r < 0, m_{E\dot{s}} < 0, m_y > 0, m_w > 0 \tag{2}$$

$$B_p = b\left(r, E\dot{s}, Y, W\right) \quad b_r > 0, b_{E\dot{s}} < 0, b_y < 0, b_w > 0 \tag{3}$$

$$SF_p = f\left(r, E\dot{s}, Y, W\right) \quad f_r < 0, f_{E\dot{s}} > 0, f_y < 0, f_w > 0 \tag{4}$$

   Notation is standard.

   (a) Derive the three asset market equilibrium schedules, illustrate the model in the exchange rate-interest rate plane and explain why the following condition must hold

$$\frac{1 - f_w}{f_r} > -\frac{b_w}{b_r}.$$

   Answer: To derive the asset market schedules we take the total differential of the wealth equation (1) and the asset demand functions (2), (3) and (4) with respect to i, W and S. We also not that in equilibrium $d\mathrm{E}\dot{s} = 0$ and $\mathrm{d}M = \mathrm{d}B_p = \mathrm{d}F_p = 0$.

   Take the total differential of the wealth equation

$$dW = dM + dB_p + F_p dS + S dF_p$$

   To derive the money market schedule we first take the total differential of the money demand function with respect to r, W and $E\dot{s}$. We obtain

$$dM = \frac{dm}{dr}dr + \frac{dm}{dW}dW + \frac{dm}{dE\dot{s}}dE\dot{s} + \frac{dm}{dY}dY$$

but in equilibrium $E\dot{s} = dM = 0$ and we have assumed that $dY = 0$. This implies that the total differential reduces to

$$0 = m_r dr + m_W dW$$

In equilibrium we also know that $dM = dB_p = dF_p = 0$ implying that the total differential of the wealth equation is

$$dW = F_p dS$$

Insert this into the total differential of the money demand function

$$0 = m_r dr + m_W F_p dS$$

and find that the slope of the money market curve is

$$\frac{dr}{dS} = -\frac{m_W}{m_r} F_p > 0$$

since $m_W > 0$ and $m_r < 0$.

To derive the bond market schedule we take the total differential of the bond demand function with respect to r, W and $E\dot{s}$

$$dB_p = \frac{db}{dr} dr + \frac{db}{dE\dot{s}} dE\dot{s} + \frac{db}{dW} dW$$

which, in equilibrium, reduces to

$$0 = b_r dr + b_W dW$$

Use that $dW = F_p dS$ such that

$$0 = b_r dr + b_W F_p dS$$

We then find that the slope of the bond demand equilibrium curve is

$$\frac{dr}{dS} = -\frac{b_W}{b_r} F_p < 0$$

since $b_W > 0$ and $b_r > 0$.

To derive the foreign bond demand schedule we take the total differential of the foreign demand function

$$\overbrace{\frac{dSF_p}{dS} dS + \frac{dSF_p}{dF_p} dF_p}^{\text{use product rule}} = \frac{df}{dr} dr + \frac{df}{dE\dot{s}} dE\dot{s} + \frac{df}{dW} dW$$

which in equilibrium reduces to

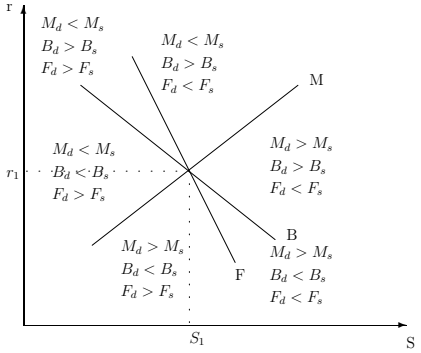
$$F_p dS = f_r dr + f_W dW = f_r dr + f_W F_p dS$$

Rewrite this relation to find the slope of the foreign bond demand schedule

$$\frac{dr}{dS} = \frac{1 - f_W}{f_r} F_p < 0$$

since $0 < f_W < 1$ and $f_r < 0$.

We can now illustrate the model in the graph below.



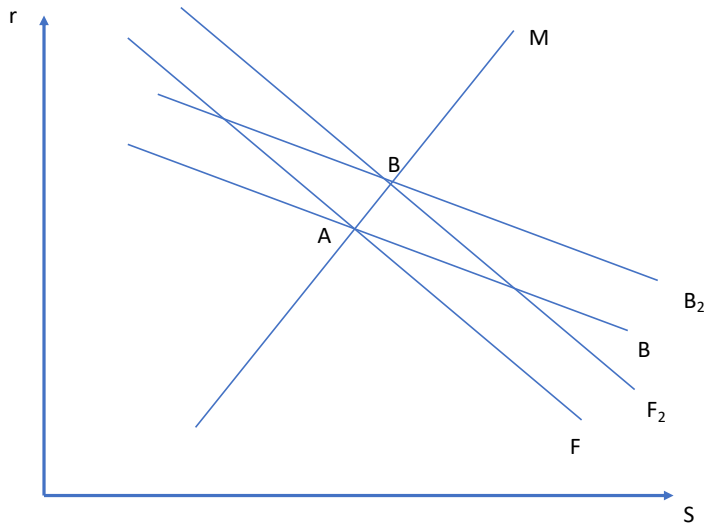
Finally, we assume that the FF curve is steeper than the BB curve

$$\frac{(1 - f_w) F_p}{f_r} > \frac{-b_w F_p}{b_r}$$

implying that changes in the domestic interest rate affect demand for domestic bonds more than they affect the demand for foreign bonds. The reason for this is that the model is not stable unless we add this assumption. It is not necessary to provide a formal motivation or derivations to support this claim. But, it is necessary to mention this and provide some intuition based on market conditions identified in the graph above.

(b) On January 15, 2015 the Swiss central bank decided to abandon the cap on the Swiss Franc against the euro. Investors viewed this policy change as a change in the relative riskiness of domestic and foreign assets and they started buying "safe haven" (Euro) assets. Use the portfolio balance model to show the effects of a change in risk perceptions where domestic (Swiss) assets are viewed as more risky than foreign (Euro) assets.

Answer: In this case Swiss is the domestic economy and Euro area the foreign country. Domestic bonds are viewed as more risky compared to domestic bonds. This will increase the demand for foreign bonds, there will be excess demand, and a reduced demand for domestic bonds, excess supply. This implies that both the B and the F schedules will shift, the M curve is unaffected since there is no change in the supply of money, only a change in bond portfolio holdings. There is excess demand for foreign bonds implying that the F schedule shifts up to the right. There is excess supply of domestic bonds such that the B curve also shifts up to the right. The total effect then is a movement from the initial equilibrium at poit A to the new equilibrium at point B. The exchange rate S will increase (depreciate) and the interest rate will increase, see the graph below.



(c) The change in the demand for domestic and foreign assets caused by the Swiss central bank also affected the foreign country (Euro). Explain how and design a Euro central bank policy response to mitigate the effects on the exchange rate.

Answer: Now, we switch places of the domestic and foreign economies such that Euro area is the domestic economy and Switzerland is the foreign country. From the perspective of the Euro area, the exchange rate has appreciated to an unwanted level. There is excess demand on Euro area bonds. To reduce the exchange rate (depreciate the exchange rate), the Euro central bank may use a sterilized foreign exchange operation buying (selling) foreign bonds (domestic bonds) in the first stage and then sell domestic bonds to the public leaving the money supply unchanged.

(d) How effective is this central bank intervention policy likely to be? Summarize the empirical evidence on central bank interventions.

Answer: The empirical literature suggests that central bank interventions are effective. However, central bankers seem to view interventions through the signaling channel as more effective than interventions through the portfolio channel, the channel we focus on in this question. Therefore, one could draw the conclusion that it is less likely that the sterilized intervention described above should be effective. On the other hand, there are strong empirical evidence supporting the view that interventions could push the exchange rate in the desired direction. This holds for both Danish interventions as well as for the major currencies.

2. **Evaluation of fixed and flexible exchange–rate regimes and monetary unions**

This question relates to the following learning objective: Describe the main models of exchange rate determination (the Mundell-Fleming mode, the Monetary approach to the exchange rate, Dornbusch overshooting model, the portfolio balance model and Lucas asset pricing model) and summarize the empirical evidence on these models.

Consider the following open–economy model:

$$Md_t = Pi_t + \eta Y_t - \sigma r_t + U_t^1$$

$$Pi_t = \alpha P_t + (1-\alpha)\left(S_t + P_t^*\right)$$

$$Yd_t = \theta\left(s_t + P_t^* - P_t\right) - \beta\left(r_t + P_t - P_{t+1|t}\right) + \pi Yn + U_t^2$$

$$Ys_t = \phi\left(P_t - W_t\right) + U_t^3$$

$$O(P, y) = \omega(Y - Yn)^2 + (1-\omega)(P - Pn)^2$$

where notation is standard. Assume that $\eta\left(\theta + \beta\right) > \alpha$.

(a) Provide an explanation of the main assumptions and economic mechanisms underlying this model.

Answer: This is an open economy AD-AS model used to evaluate the choice between fixed and flexible exchange rates comparing these two corner solutions. The main underlying assumption is that the economy is affected by three different types of shocks, a money demand shock, an aggregate demand shock and an aggregate supply shock.

The first equation is a standard money demand function where the real balance is a function of output and the interest rate and U_t^1 is the money demand shock. Here we note that the price level in the demand function reflects both domestic prices and prices on imports as given by the third equation. Higher output levels and lower interest rates tend to increase the money demand, higher output increases the transaction demand whereas a lower interest rate reduces the return on bonds making it less attractive to hold bonds. The money demand shock is a white noise sequence implying that the shock has mean zero, a constant variance and is not autocorrelated.

The expression for the aggregate price level includes the parameter α which is the weight of the domestic price level in the aggregate price level and is a measure of openness, a small α implies a more open economy.

Aggregate domestic demand is given in the next equation. As can be seen in the equation, an appreciation tends to reduce aggregate demand (reduced foreign demand for domestic goods). A higher real interest rate also tends to reduce aggregate demand. A higher natural level of output implies a higher aggregate demand, higher potential output implies higher income. The supply shock is, as the demand shock, a white noise sequence.

The aggregate supply function is also standard, aggregate supply is inversely related to the real wage. A higher real wage reduces aggregate supply. The supply shock is a white noise sequence, i.e., has the same properties as the other two shocks.

If we in addition assume that $\eta\left(\theta + \beta\right) > \alpha$ then this implies that the money demand curve is steeper than the aggregate demand curve and we then implicitly assume a

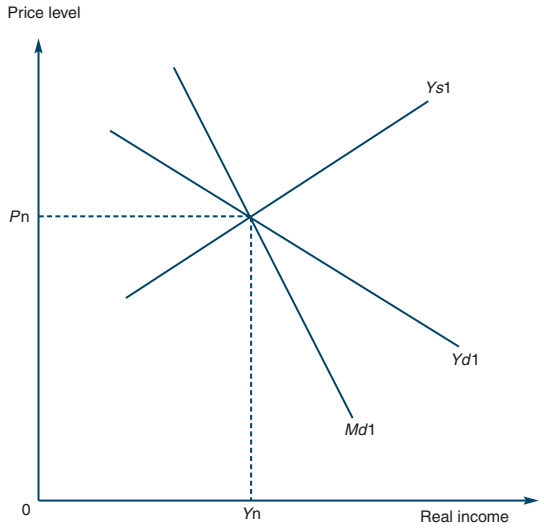
small open economy. The elasticity of domestic demand with respect to the real exchange rate and the real interest rate are relatively large compared to α in this case.

In the objective function, the last equation, we assume that the authority cares about both the price and output levels where ω is the weight attached to output stability. The authority aims at minimizing the objective function.

In addition to the equations, we also assume that capital is perfectly mobile and abstract from risk aversion such that UIP holds (and the risk premium is zero). Labor contracts imply that the wage rate is set in the absence of shocks, they are set such that the expected output is equal to the natural level of output (the full employment output). Then the shocks affect the economy leading to short–run deviations of the price level from its target.

(b) Illustrate the model in the price–output plane and explain intuitively the implied slopes of the curves.

Answer: The model is illustrated in the graph below.



Intuitive explanation:

- A positive money demand shock shifts the Md–curve down, for given Y, P must fall to restore equilibrium.
- There is excess demand for money above the Md–curve.
- Increases in Yd and Ys causes shifts up and to the right.
- If $\eta(\Theta + \beta) > \alpha$ then the Yd–curve is flatter than the Md–curve.
- This implies that we assume a small open economy. If α is small, foreign prices determine the general price level to a larger extent which implies a small open economy.
- If α is large, then it is likely that $\eta(\Theta + \beta) < \alpha$ such that the Yd–curve is steeper than the Md–curve. This is the case of a large relatively closed economy.

The shocks:

- The three shocks are transitory, i.e., they give only short–run effects on the economy. Therefore, the economy will adjust to the shocks and will eventually return to the initial equilibrium in the long–run. What we are interested in here is the short–term fluctuations in output and prices.

(c) Denmark and Sweden, both being small open economies, have chosen different exchange rate policies. Denmark has a fixed exchange rate versus the euro whereas Sweden has a freely floating exchange rate. Use the model above to analyze the effects of supply shocks under both fixed and floating exchange rate regimes. Does the model unambiguously support the choices made by Denmark or Sweden?

Answer: The first step when analyzing the model under fixed and flexible exchange rates is to define equilibrium: $Ms_t = Md_t$ and $Ys_t = Yd_t$. Then, under fixed exchange rates

- $s_{t+1|t} = s_t$ implying that $r_t = r_{t^*}$, and
- money supply is endogenous (the money stock adjusts passively to shifts in Yd and Ys),

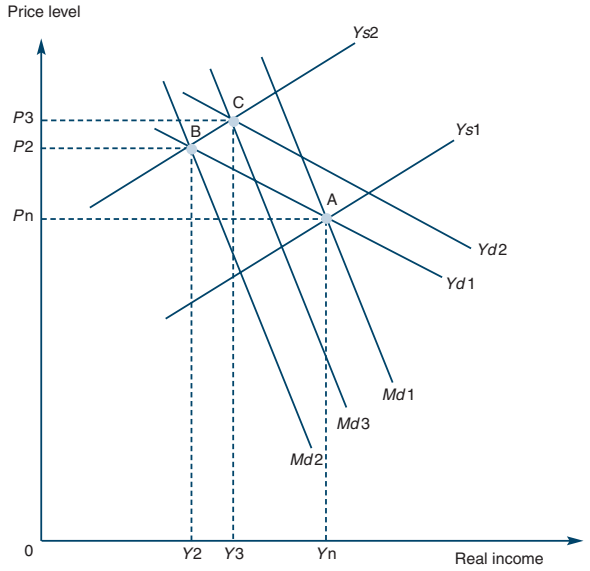
whereas under floating exchange rates

- the exchange rate and the interest rate are both exogenous but tied together through UIP (the exchange rate and the interest rate adjust to restore equilibrium), and
- money supply is exogenous.

Consider next the effects of a negative aggregate supply shock. Assume that there is an unanticipated decrease in aggregate supply, a shift in the Ys–curve to the left. There will be excess supply of money (lower Y for given P leads to lower Md such that there will be excess supply of Md) and the exchange rate will depreciate.

What happens next depends on the exchange rate regime. If the exchange rate is fixed the central bank is selling foreign bonds and buying domestic money in order to defend the fixed exchange rate. Ms will fall. The Md–curve will shift down to the left from Md_1 to Md_2 and there will be a new short–run equilibrium at point B, see the graph below.

Under floating exchange rate, the exchange rate will depreciate. This stimulates aggregate demand and the Yd–curve shifts up to Yd_2. There is also an increase in Md so the Md–curve shifts down from Md_1 to Md_3. The depreciation leads to an expected appreciation and therefore falling interest rate which causes a fall in Md through UIP. The Md–curve will always shift down and to the left implying that point C (the new short–run equilibrium) always is to the left of point A.



Compare the two cases. There is a potential problem. Fixed exchange rates leads to more fluctuations in P whereas Y is more stable. Floating exchange rates leads to more stability in P but less in Y. Thus, the relative weight ω is important in this case. If ω is small (less weight on output stability), then fixed exchange rate is optimal. But, if ω is large (less weight on price stability), then floating exchange rate is optimal.

Note: The results above are dependent on our assumption of a small open economy. For a large relatively close economy, α is large and the Yd–curve is steeper than the Md–curve. It is not necessary to look at this case since we focus on small open economies.

(d) From the empirical literature we know that the supply shocks are more important than other shocks in the Swedish economy whereas supply shocks are relatively less important in Denmark than in Sweden. Does this affect the evaluation of exchange rate regimes in the two countries? If so, explain how!

Answer: The problem is that the choice of exchange rate regime is not clearcut even when assuming that one type of shock dominates. If supply shocks dominate, the choice depends on the weight on price stability in the objective function, as shown above. If supply shocks dominate in Sweden and the Riksbank puts less weight on price stability, then the choice of floating seems to be valid. But, casual evidence would suggest that the Riksbank is very focused on price stability as they have been criticized of keeping the interest rate unnecessarily high even though inflation has been far below the target. If supply shocks are not unimportant in the Danish economy and the focus is on price stability, then the fixed exchange rate policy can be explained. This also holds if aggregate demand shocks are unimportant. A fixed exchange rate regime is optimal when money demand shocks dominate whereas a floating exchange rate is optimal when aggregate demand shocks dominate.

The model does imply that the choice of exchange rate regimes is not straightforward or simple, it depends on the size of the economy, the weight attached to price stability and the types of shocks affecting the economy. It could be that the Danish and the Swedish central banks value price and output stability differently and that they differ in their view of what types of shocks dominate. On this background, it doesn't seem surprising that they would choose different exchange rate regimes.

(e) When comparing the economic development of Denmark and Sweden since the early 1990's we find only minor differences. Can these findings be explained? What are the main results in the literature evaluating the macroeconomic consequences of exchange rate regimes?

Answer: There is no consensus in the literature concerning the macroeconomic consequences of exchange rate regimes. Some researchers find that inflation is significantly lower under fixed exchange rates than in countries having floating or intermediate floating exchange rates. This result is often motivated or explained by increased credibility of the central bank, a less credible central bank commits to a fixed exchange rate versus a country with where the central bank is credible and therefore lower inflation. Economic growth, on the other hand, seems to be higher in countries having floating exchange rates and the volatility of growth tends to be higher under fixed exchange rates. These and other results are heavily dependent on the classification of exchange rate regimes, whether they use de facto or de jure regimes. The sample is also important, both the sample of countries and the time period examined. For example, the textbook presents a table showing that both inflation and economic growth tend to be lower under floating exchange rates but the differences are small. For Denmark and Sweden it seems as if the choice of exchange rate regimes doesn't matter that much in practice, it's more important that all policy makers, the public and other decision makers act in accordance with the prevailing exchange rate regime.