MACROECONOMICS II (ECO00002I)

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OPEN ECONOMY MACROECONOMICS: An Eclectic Approach

Introduction

- So far, we have only considered closed economies. However, the open economy approach is very important for some countries, such as the UK.

- We are going to focus on one aspect of open economy macroeconomics: exchange rate fluctuations.

- Since the collapse of the Bretton Woods system in 1973, most countries allowed their exchange rates to float.

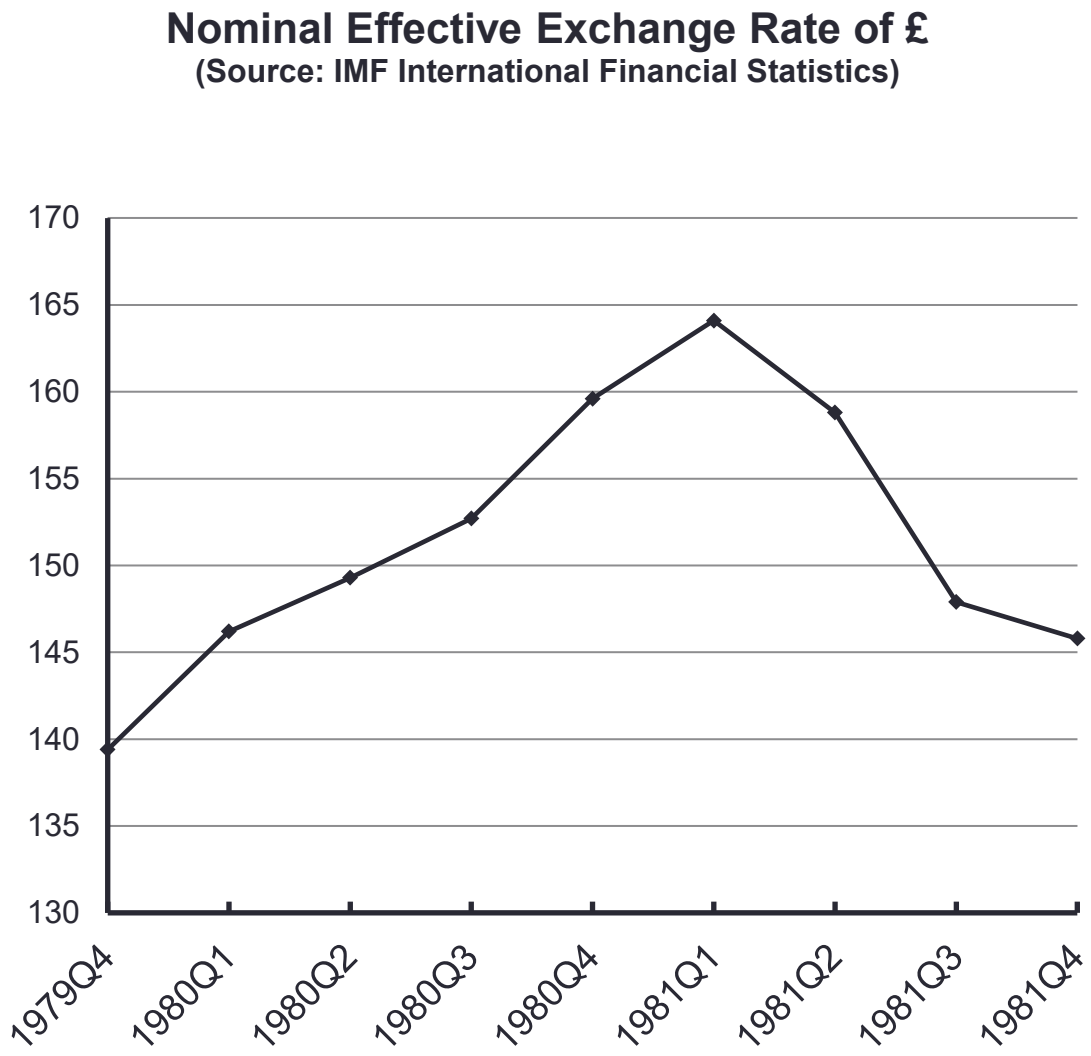
Learning Objectives

Under this topic, we will learn about:

- Exchange rate swings
- The Dornbusch (Exchange rate overshooting) model
- The effect of an increase in the money supply in the Dornbusch model
- Implications of the Dornbusch model

Exchange Rate Swings

- The era of flexible exchange rates has been characterised by major exchange rate swings.
- An exchange rate swing refers to a change in the exchange rate by 20% or more over a period of 1-2 years.



Exchange Rate Swings

- Economists wanted to find out whether these big swings
  - were due to “irrational” speculative behaviour by exchange rate traders or
  - whether they could be explained by systematic macroeconomic forces in which expectations remained “rational”

- This question surfaced in the 1970s as the idea of “rational expectations” was being introduced into macroeconomics by the New Classical School then, as we have seen.

- An answer to this question was proposed by Rudiger Dornbusch.

- Remark: the well-known Mundell-Fleming open-economy macro model not only takes no account of expectations, but it also assumes a fixed price level, which limits its relevance to only short horizons.

The Dornbusch Model

- Dornbusch suggested that big exchange rate swings can be consistent with rational expectations.
- His analysis became to be known as the exchange rate overshooting model.
- The model is eclectic, since it combines the New Classical assumption of rational expectations with the New Keynesian assumption of sticky prices.
- It is, however, not New Keynesian as it does not provide micro foundations for the structural macroeconomic relationships.

Source: Dornbusch Rüdiger (1942-2002) – The Ideas of Economists

The Dornbusch Model

- The originality of Dornbusch's work lies in his exploration of the outcome of an important observation.
- While product markets adjust only slowly, financial markets appear to adjust far more rapidly.
- The consequence of allowing for this feature of the real world turns out to be that financial markets have to over adjust to disturbances, in order to compensate for the stickiness of prices in goods markets.

The Dornbusch Model

- Notations:
  - Lower case symbols denote natural logs (except for the domestic and foreign real interest rate).
  - The country is small, and hence, takes foreign variables denoted by a * as given.
- Definitions:
  - S: nominal exchange rate (price of 1 unit of foreign currency in terms of domestic currency)
  - $\mathrm{Q} = \frac{SP^*}{P}$: real exchange rate (price of 1 unit of foreign goods in terms of home goods)
    with P: domestic price level and P^*: foreign price level

The Dornbusch Model

- Time is a continuous variable so proportional rates of change over time are measured as:
  - $\frac{dp}{dt} = \dot{p} \left(= \frac{\dot{P}}{P}\right)$: rate of inflation
  - $\frac{ds}{dt} = \dot{s} \left(= \frac{\dot{S}}{S}\right)$: rate of exchange rate depreciation

- *Assumption 1: Perfect international capital mobility*
  - $\boldsymbol{r = r^* + \dot{s}^e}$ **(uncovered interest parity - UIP)**

  where $\dot{s}^e$ denotes expected exchange rate depreciation, r and r^* denote domestic and foreign nominal interest rate, respectively.

  - No-arbitrage condition

The Dornbusch Model

- *Assumption 2: expectations, $\dot{s}^e$ are formed rationally*
  - $\boldsymbol{\dot{s}^e = \theta(\bar{s} - s)}$

    where $\bar{s}$ denotes the long-run equilibrium exchange rate and θ is a speed of adjustment parameter.

  - This implies that when the exchange rate is below its long-run equilibrium level in the short-run, there will be a natural expectation that its future path will carry it upward in the direction of equilibrium, rather than away from equilibrium, and vice versa.

  - Moreover, the further the exchange rate, s from its long-run equilibrium value, $\bar{s}$ the faster it will adjust towards it.

  - Dornbusch shows how we can solve for θ as a function of the other parameters of the model.

The Dornbusch Model

- The Money Market:
  - Equilibrium in the money market is given by

    $$\boldsymbol{m - p = k\bar{y} - lr} \qquad \textbf{(LM)}$$

    where m denotes money supply (in logs) and $\bar{y}$ denotes the long-run output (in logs), with $k, l > 0$.
  - Money supply is treated as the exogenous instrument of monetary policy.
  - Money demand is given by a standard looking function, but Dornbusch simplifies it by assuming the income variable is not given by current income, y.
  - Instead, it is given by $\bar{y}$, the long-run or full-employment level of income.

The Dornbusch Model

- The goods market:
  - The demand for goods is given by:
    $\boldsymbol{y^d = h(s - p)}$ **(IS)**
    where $\boldsymbol{y^d}$ denotes demand for home output and $h > 0$.
  - A reduced-form IS equation, where $s - p$ is equal to the real exchange rate, q, with p^* normalized to zero.
  - An increase in $(s - p)$ corresponds to a depreciation of the domestic currency, making home goods cheaper. This results in an increase in net exports, raising total demand for home output ($h > 0$).
  - This is also a simplified IS equation, which omits r with a negative coefficient and any exogenous component of demand on the RHS.

The Dornbusch Model

- The goods market (cont'd):
  - Supply of output is assumed to be given by the long-run level of output, $\bar{y}$.
  - Price adjustment is then given by
    $\dot{\boldsymbol{p}} = \boldsymbol{\pi}(\boldsymbol{y^d} - \bar{\boldsymbol{y}})$ **(Phillips Curve)**
    with $\pi > 0$.
  - This is the Keynesian element in Dornbusch's model, as it shows that the price level only adjusts gradually in response to excess demand for goods, i.e. outside the long-run $\boldsymbol{y^d}$ is not equal to $\bar{\boldsymbol{y}}$.
  - Note that Dornbusch does not include inflation expectations in the Phillips Curve.
  - Dornbusch also assumes actual output, y is always equal to $\bar{y}$.

The Dornbusch Model

- To summarise, the model consists of the following five equations:

$r = r^* + \dot{s}^e$	**UIP**
$\dot{s}^e = \theta(\bar{s} - s)$	**exchange rate expectations**
$m - p = k\bar{y} - lr$	**LM**
$y^d = h(s - p)$	**IS**
$\dot{p} = \pi(y^d - \bar{y})$	**Phillips Curve**

The Dornbusch Model

- We can reduce these 5 equations into equation (1) and (2) below in $(s, p, \dot{p})$.

- Substitute exchange rate expectations in the UIP and then the UIP equation into LM and rearrange to obtain

$$\boldsymbol{p = L + l\theta(\bar{s} - s)} \qquad \textbf{(1)}$$

where $\boldsymbol{L \equiv m - k\bar{y} + lr^{*}}$.

- Then, substitute the IS equation, $y^{d} = h(s - p)$ into the Phillips Curve equation, $\dot{p} = \pi(y^{d} - \bar{y})$ to get

$$\boldsymbol{\dot{p} = \pi[h(s - p) - \bar{y}]} \qquad \textbf{(2)}$$

The Long-run Equilibrium in the Dornbusch Model

- It is easiest to understand how the model works by starting at the long-run equilibrium (or the steady-state). The long-run is defined as where $\dot{p} = 0$ and $\dot{s}^e = 0$.

- Setting $\dot{p} = 0$ in equation (2), and then setting $\dot{s}^e = 0$ in equation (1), we have

  $$\bar{\boldsymbol{p}} = \boldsymbol{L} \ (\equiv \boldsymbol{m} - \boldsymbol{k}\bar{\boldsymbol{y}} + \boldsymbol{l}\boldsymbol{r}^*)$$

- Lastly, substituting $\bar{p}$ from above into the equation obtained by setting $\dot{p} = 0$ in equation (2), yields:

  $$\bar{\boldsymbol{s}} = \boldsymbol{m} + (\boldsymbol{1}/\boldsymbol{h} - \boldsymbol{k})\bar{\boldsymbol{y}} + \boldsymbol{l}\boldsymbol{r}^*$$

- Looking at these two equations, we can see that an increase in the level of the money supply, m produces an equal proportional increase in the price level, p and in the nominal exchange rate, s.

The Long-run Equilibrium in the Dornbusch Model

- In other words, money is neutral in the long-run: it does not affect the real variables in the economy.
- The long-run gives enough time for the price level to fully adjust.
- Hence, the economy has “classical” properties in the long-run.

Dynamic Adjustment in the Dornbusch Model

- To study the dynamics of the model when it is not at the steady-state, first, we rewrite equations (1) and (2) for p and $\dot{p}$ in 'deviation' forms.

- Equation (1) shows the 'static' equation linking p and s:
  $p = L + l\theta(\bar{s} - s)$

- In the steady state, $\bar{s} = s$. Hence, this becomes:
  $\bar{p} = L$

- Subtracting this from the equation above:
  $\boldsymbol{p - \bar{p} = -l\theta(s - \bar{s})}$

- This is the equation for p in deviation form.

Dynamic Adjustment in the Dornbusch Model

- Remember also the equation for $\dot{p}$, equation (2):

$$\dot{p} \quad = \quad \pi[h(s-p) \quad - \quad \bar{y}]$$

- In the steady state, $\dot{p} = 0$. Hence, this becomes:

$$0 \quad = \quad \pi[h(\bar{s}-\bar{p}) \quad - \quad \bar{y}]$$

- Subtract this from the equation above:

$$\dot{\boldsymbol{p}} \quad = \quad \boldsymbol{\pi h}[\underbrace{(\boldsymbol{s}-\boldsymbol{p})}_{\boldsymbol{q}} \quad - \quad \underbrace{(\bar{\boldsymbol{s}}-\bar{\boldsymbol{p}})}_{\bar{\boldsymbol{q}}}]$$

- This is the equation for $\dot{p}$ in deviation form.

Dynamic Adjustment in the Dornbusch Model

- To study the dynamics of the model when it is not at the steady-state, we will use a diagram.

- To draw the diagram showing the adjustment dynamics, we use the deviation equation for $\dot{p}$ to find the locus points, where $\dot{p} = 0$:

  $$\dot{\boldsymbol{p}} = \mathbf{0}\mathbf{:}\ \boldsymbol{s} = \boldsymbol{p} + \bar{\boldsymbol{q}}$$

- In addition, we use the equation for p in deviation form and call it the MM line,

  $$\boldsymbol{MM}\mathbf{:}\ \boldsymbol{p} - \bar{\boldsymbol{p}} = -\boldsymbol{l\theta}(\boldsymbol{s} - \bar{\boldsymbol{s}})$$

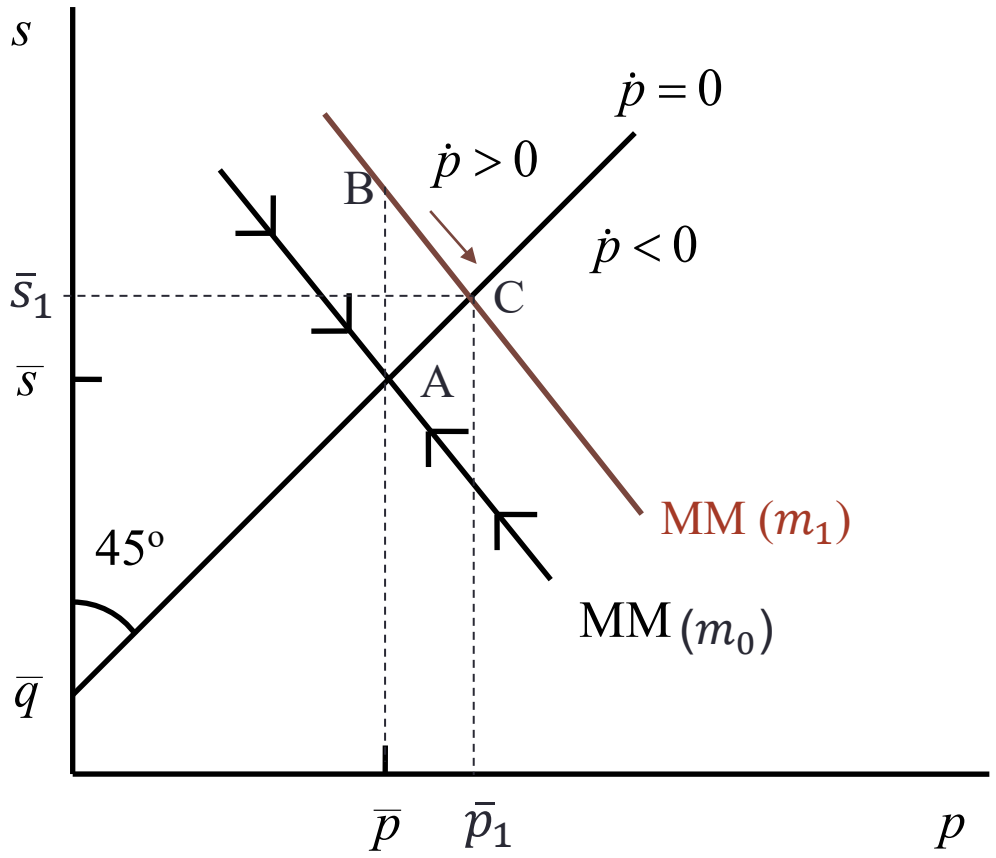
Dynamic Adjustment in the Dornbusch Model

- Note that the economy must be on the MM line even in the short-run, but it is only on the $\dot{p} = 0$ line in the long-run.
- This implies when $\dot{p} \neq 0$, the economy converges to the steady-state on the MM line.
- Note that p is a pre-determined variable, i.e. it cannot jump, whereas s can jump, as it is not pre-determined.

A permanent increase in the money supply

- Suppose the money supply increases from m_0 to m_1.
- We already know that in the long-run, an increase in the level of the money supply, m produces an equal proportional increase in the price level and in the nominal exchange rate.
- How about the short-run?
  - The increase in the money supply does not shift $\dot{p} = 0$ locus, as m does not enter the equation ($s = p + \bar{q}$) obtained using $\dot{p} = 0$.
  - On the other hand, since higher m increases the values for $\bar{p}$ and $\bar{s}$, we know the MM line must pass through the new ($\bar{p}_1$,$\bar{s}_1$) with an unchanged slope: MM line shifts up.

A permanent increase in the money supply



- Remember p can only change gradually as prices are sticky.
- However, the economy must be on the MM line even in the short-run.
- Conclusion: the economy needs to jump from point A to B the moment the money supply increases, and then gradually converge to point C along the new MM line.
- Hence, the exchange rate “overshoots”: it goes beyond its long-run value in the short – run and then tends back towards it.

Comment: rationality of exchange rate expectations

- The Dornbusch model assumes on an ad-hoc basis that exchange rate expectations are given by: $\dot{s}^e = \theta(\bar{s} - s)$
- Is the expected exchange rate depreciation implied by this, $\dot{s}^e$ equal to the actual rate of depreciation, $\dot{s}$?
- Using the equation above, on impact (when the money supply increases) we have $s > \bar{s}$, and hence $\dot{s}^e < 0$.
- Looking at the time path of the exchange rate, we can see $\dot{s} < 0$.
- Hence, the expectations assumption does correctly forecast the sign of $\dot{s}$.
- However, for an arbitrary value of θ, it won't be the case that $\dot{s}^e = \dot{s}$ exactly. Dornbusch shows that there is a particular value of θ for which $\dot{s}^e = \dot{s}$ all the way along the adjustment path.

Implication of the Dornbusch model

- The model demonstrates how we can have large exchange rate swings, even with rational expectations.
- Hence, large exchange rate swings are not necessarily a sign of traders in the forex market having irrational expectations about the future of exchange rates.
- Their expectations are linked to fundamentals of the economy.

Intuitive Explanation of Overshooting

- The increased money supply leads to excess supply in the money market. Prices are sticky so the real interest rate must fall to restore equilibrium:

$$\boldsymbol{m - p = k\bar{y} - lr}$$
$$\uparrow \qquad\qquad \downarrow$$

- The decrease in the domestic real interest rate results in a negative interest rate differential. Hence, $\dot{s}^e$ must become negative to maintain the UIP condition:

$$\boldsymbol{r = r^* + \dot{s}^e}$$
$$\downarrow \qquad \downarrow$$

- In other words, investors expect the home currency to appreciate.

- In the long-run, we know s will be higher (i.e. depreciate) in proportion to the rise in m.

- The only way for s to be higher in the long-run but be falling (as correctly expected) along the transition path is for s to jump beyond the new long-run value, i.e. initially depreciate more.

Comments on the overshooting

- The “intuitive” explanation shows that rational expectations play a key role in causing overshooting, as the logic of why the exchange rate overshoots would break down if we don’t have $\dot{s}^e = \dot{s}$.

- This explanation also shows that sticky prices play a key role in causing overshooting, as p would immediately increase in proportion to m if prices were flexible and r would not decrease.

- $\dot{s}^e$ would then remain constant and s would immediately jump to its higher long-run value without overshooting.

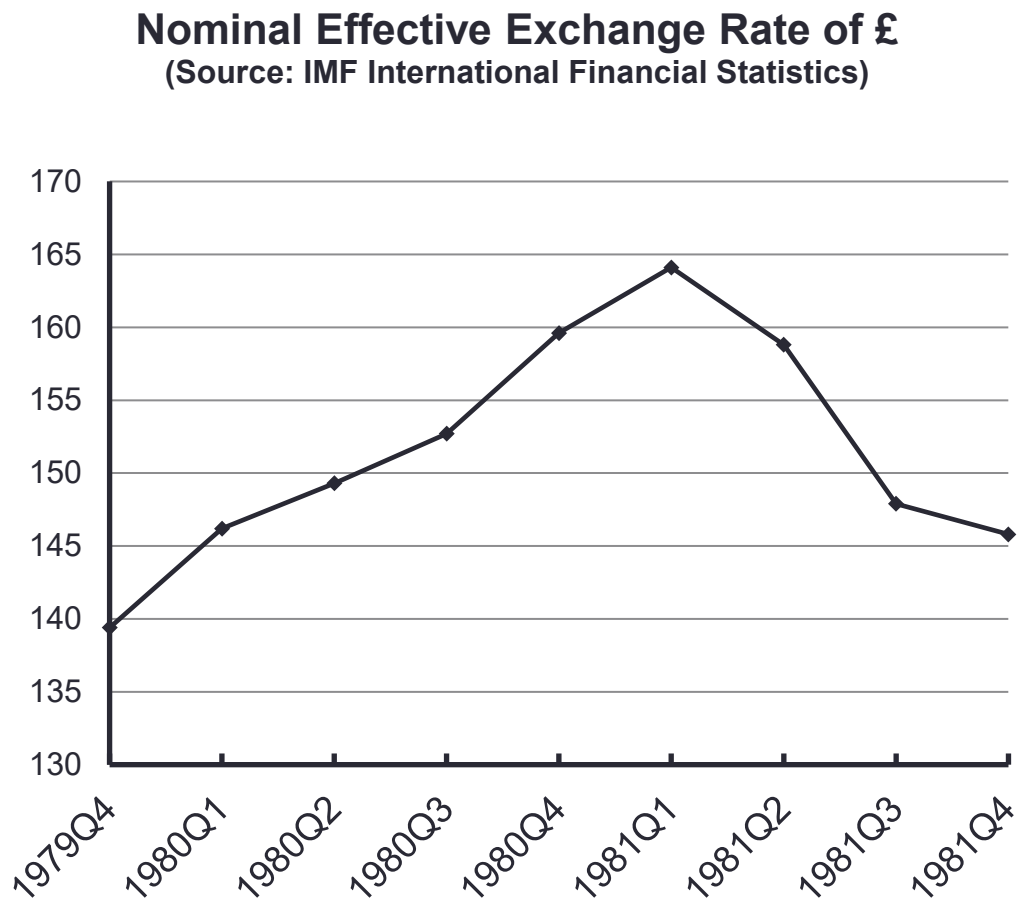
Comments on the overshooting

- Notice that since p does not change on impact, the real exchange rate ($s - p$) also depreciates on impact.
- Through the IS ($y^d = h(s - p)$), we know that the depreciation of the real exchange rate results in an increase in real output, i.e. causes a boom if we assume $y^d = y$.
- In this case, the overshooting of the exchange rate can be thought to result in a boom in the short-run by departing real output from its long-run level.
- However, recall that Dornbusch assumes $y = \bar{y}$, in which case real output does not change.

Comments on the overshooting

- In our analysis here, we assumed that the change in the money supply by policy-makers was unexpected.
- In an important extension of the Dornbusch model where the money supply change is anticipated, it has been shown that the overshooting in this case would be lower.
- Intuitively, the reason is that, from the moment the markets become aware that the money supply is going to increase, they would change their judgement about the long-run equilibrium.
- The result is then for the whole process of adjustment to start immediately, thereby smoothing somewhat the impact of the money supply increase, when it actually takes place.
- It is important to note that this approach assumes that the market is correct in anticipating a money supply increase.
- In practice, the markets may often anticipate monetary policy changes that fail to materialize, causing exchange rate movements that cannot be rationalized.

Application of the Dornbusch model to the UK example



- The marked appreciation of the £ coincided with the election of the Conservative government of Margaret Thatcher and a regime of lowering monetary growth to tackle high inflation.
- Although the shape of the time path of the £ is not given by a jump as implied by the Dornbusch model, this could be due to the monetary growth being lowered progressively.
- Note, however, how the appreciation of the £ was initially higher than the level it later converged to, as demonstrated by the model.

References

- Copeland, L., *Exchange Rates and International Finance* (2005, 4th edition, Pearson), Ch. 7 “Sticky Prices: The Dornbusch Model” [Reading advice: **Essential**].