IFM 2014 Lecture 4

Sticky-price monetary models of the exchange rate

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Outline of lecture

Lecture 4

- Introducing sticky prices
- The Dornbusch model: theory and equations
- Importance of the Dornbusch model
- Frankel's real interest rate differential model
- Monetary exchange rate models: a summary

Introducing sticky prices

- In the flex-price monetary model of the exchange rate, prices are perfectly flexible. As a result, PPP holds continuously – ie in the short and long run.
- This is at odds with the PPP puzzle – there are large and persistent deviations from PPP in the short run, though PPP does appear to be a long run relationship to which real exchange rates revert
- Dornbusch proposed a monetary model that could produce short term PPP deviations and has the feature that PPP holds in the long run
- To do so, he introduced 'sticky prices' into the monetary model

Introducing sticky prices

- It is tempting to think of sticky prices as fixed prices, but there is an important difference
- Fixed prices literally remain fixed, whereas sticky prices are fixed for only a short period of time and then gradually adjust as time goes on
- In the long run, sticky prices have the same implications as flexible prices, but the short run implications can be very different
- See Copeland Ch 4.2 for a more detailed discussion of the difference between fixed and sticky prices

Motivating sticky prices

- Average frequency of price changes

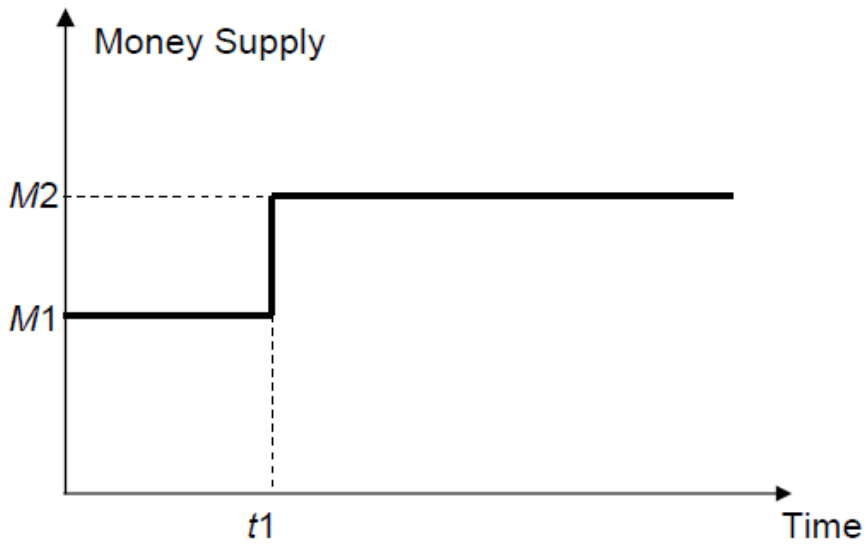
Country	**Duration**	**Study**	**Notes**
US	3-4 months	BK (2004)	Includes sales prices
US	7-11 months	NS (2008)	Excludes sales prices
Euro Area	10-13 months	D etc. (2006)	10 EA countries

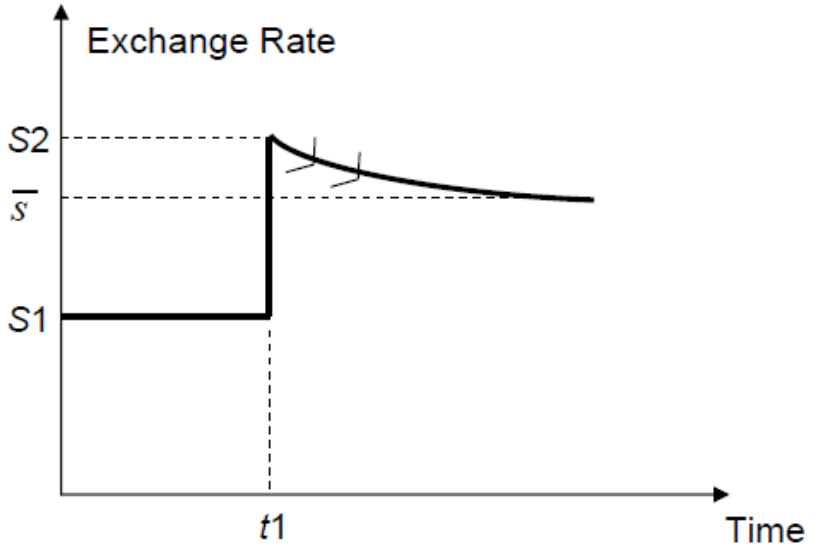
Source: Bils and Klenow (2004), Nakamura and Steinsson (2008), Dhyne et al. (2006)

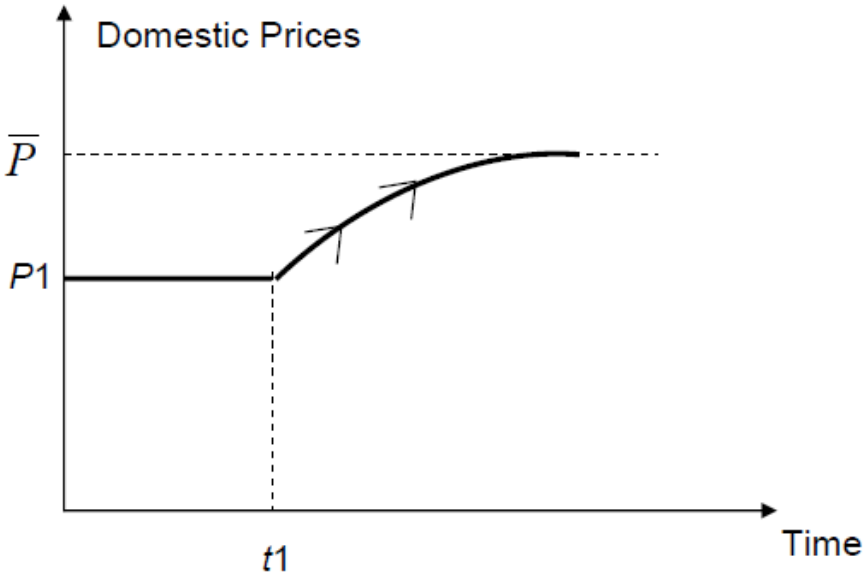
The Dornbusch model: theory

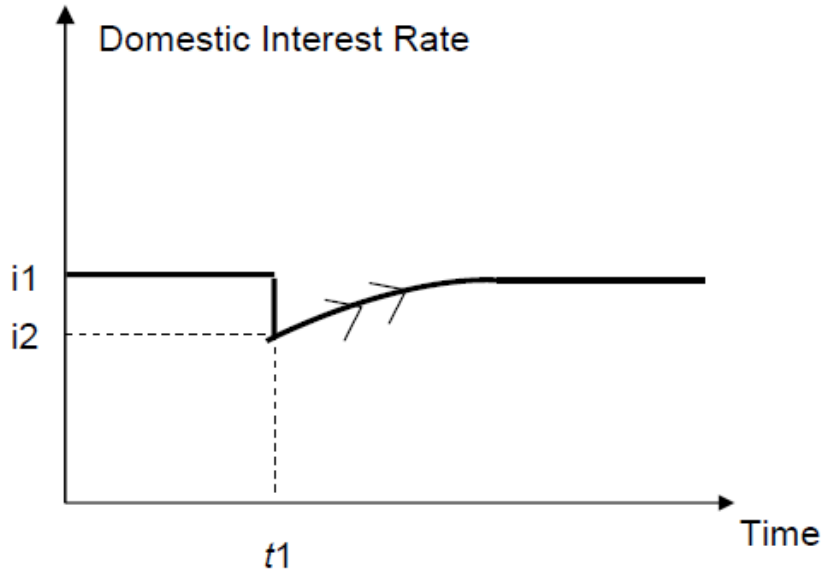
- The Dornbusch model takes as its starting point the realistic assumption that goods prices are sticky
- Financial prices, on the other hand, are assumed to be perfectly flexible, so uncovered interest parity holds
- The main prediction of the model is **exchange rate overshooting**
- The basic idea is that if prices are sticky, then an unexpected increase in the money supply will keep interest rates low for several years
- The cumulative effect on exchange rates through UIP can be quite large – in fact the exchange rate will initially 'overshoot' its long run equilibrium level by some distance

The Dornbusch model: dynamics









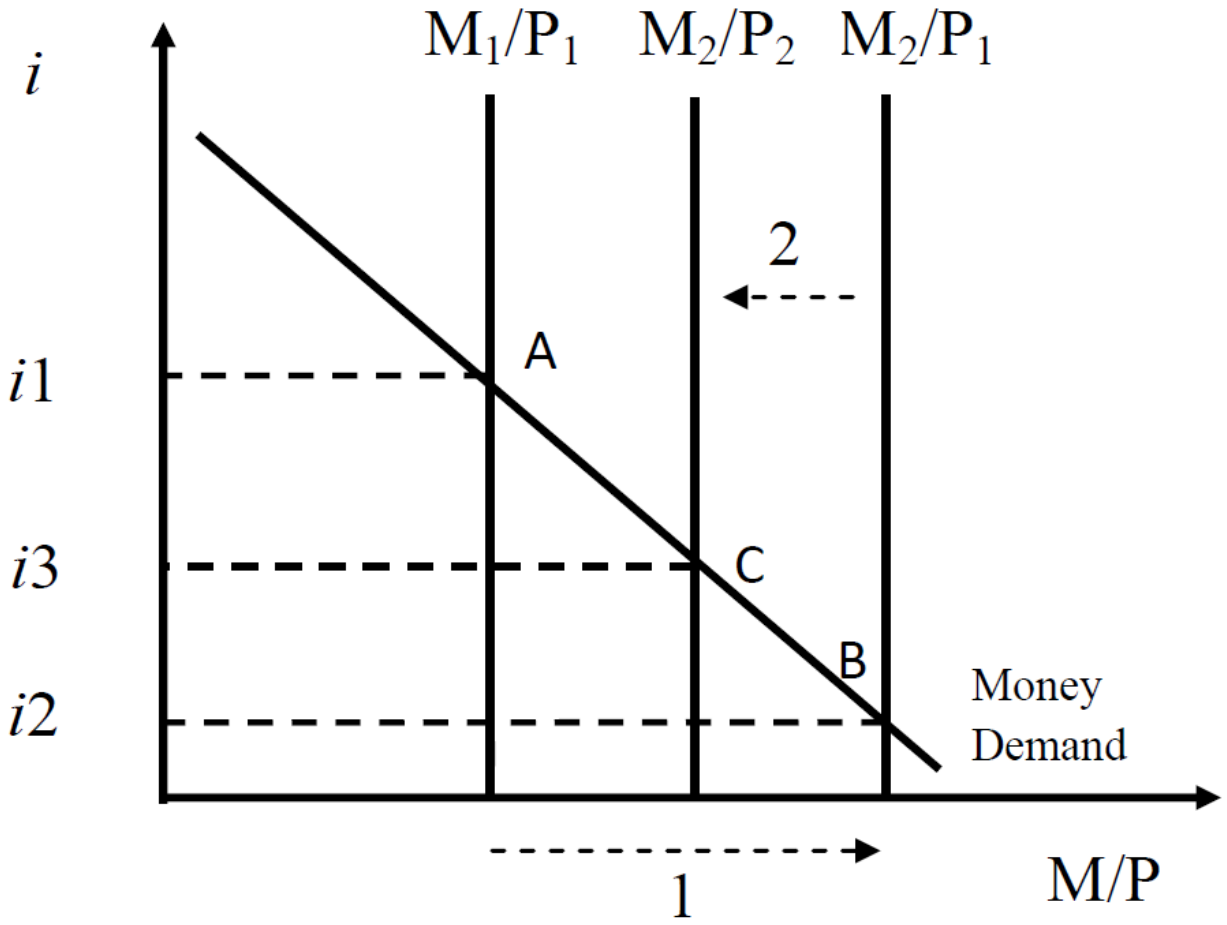
The Dornbusch model: theory

- The initial impact at time $t1$ is similar to the flex-price model, except that the exchange rate does not stop at $\overline{S}$ but overshoots to S_2
- After $t1$ things look very different, but the exchange rate must eventually end up at $\overline{S}$
- UIP is key for understanding what happens:
  1. The domestic interest rate remains lower, so for UIP to hold there must be an **expected future appreciation** of the home currency **after t1**
  2. Consequently, there will also be an **actual appreciation** of the currency **after t1**
  3. The only way this can happen while we are converging on $\overline{S}$ is if the exchange rate initially overshoots

The Dornbusch model: money market

- The money market is crucial for 'overshooting' since it determines the response of the interest rate to an unexpected money supply shock
- The diagram on the next page shows why the interest rate falls and then gradually returns to its pre-shock level
- Sticky prices are vital – if prices were flexible, the interest rate would fall at $t1$ but would be at its pre-shock level in all later years
- The gradual increase in interest rates after the shock reflects the gradual rate at which prices increase over time

The Dornbusch model: money market



- Interest rate initially falls from $i1$ to $i2$, but prices rise, pushing the real money supply back. The economy moves from A to B to C.

The Dornbusch model: equations

- Money demand is exactly the same as in the flex-price model:

$$m^d - p = \eta y - \sigma i$$

- Money market equilibrium:

$$m^d = m$$

- The UIP condition holds at all times:

$$i - i^* = \Delta s^e$$

- Purchasing power parity (PPP) does not hold in the short run, but the long run exchange rate is consistent with PPP

The Dornbusch model: equations

- The long run exchange rate $\overline{s}$ is given by

$$\boxed{\textbf{LPPP:} \quad \overline{s} = \overline{p} - \overline{p}^*}$$

where

$$\overline{p} = \text{long run domestic price level (in logs)}$$
$$\overline{p}^* = \text{long run foreign price level (in logs)}$$

- Domestic inflation π depends positively on the gap between aggregate demand d and domestic income y (both in logs):

$$\pi = \kappa(d - y)$$

- Aggregate demand is positively related to short run deviations from PPP and income, and negatively related to interest rates:

$$d = \beta + \alpha(s - p + p^*) + \phi y - \lambda i$$

The Dornbusch model: overshooting with equations

- An unexpected increase in money supply lowers interest rates and so boosts aggregate demand
- That is, $m \uparrow \implies i \downarrow \implies d \uparrow$
- The rise in demand leads to gradual inflation, with the exact amount determined by the 'speed of adjustment' parameter κ
- As in the flex-price model, $m \uparrow$ leads to an initial depreciation. But the amount of depreciation depends on UIP.
- Since future interest rates remain lower, s^e is lower than s – expected appreciation. This expectation lowers s towards $\overline{s}$.

Importance of the Dornbusch model

- The Dornbusch model is viewed as a significant improvement over the flex-price model for several reasons
- The exchange rate overshooting result is important because it may help to explain why exchange rates are so volatile
- This model emphasises the importance of financial market arbitrage over goods market arbitrage. This is intuitively appealing because financial prices – exchange rates and interest rates – change quite rapidly relative to retail prices for goods.
- The Dornbusch model gives an explanation for short run deviations from PPP, and it does so with reference to economic fundamentals rather than irrational speculation

Frankel's real interest rate differential model

- Up to this point, we have not said anything about inflation expectations
- Frankel's model includes an explicit role for inflation expectations and real interest rates
- It incorporates the flex-price and sticky-price monetary models as special cases and so is suitable for exchange rate analysis both inside and outside hyperinflationary periods
- The model also makes a clear distinction between short run and long run exchange rates

Frankel's real interest rate differential model

Assumptions of the Frankel model

- The home and foreign country have identical money demand functions
- Money supply and money demand are equal
- Uncovered interest parity (UIP) holds and prices are sticky
- Exchange rate expectations depend on:
  1. Gap between the long run exchange rate $\bar{s}$ and the spot rate s
  2. Long run expected inflation differential, $\pi^e - \pi^{e*}$

Frankel's real interest rate differential model

Equations in the Frankel model

- The home and foreign money demand functions are

$$m^d - p = \eta y - \sigma i \qquad \text{and} \qquad m^{d*} - p^* = \eta y^* - \sigma i^*$$

- Money market equilibrium: $m^d = m$ and $m^{d*} = m^*$
- UIP: $i - i^* = \Delta s^e$
- The expected rate of depreciation of the home currency is

$$\Delta s^e = \Theta(\overline{s} - s) + \pi^e - \pi^{e*}$$

where Θ is the speed of adjustment to equilibrium

Frankel's real interest rate differential model

- Subtracting foreign money demand from home money demand:

$$m - m^* - (p - p^*) = \eta(y - y^*) - \sigma(i - i^*)$$

- Rearranging this equation for prices

$$p - p^* = m - m^* - \eta(y - y^*) + \sigma(i - i^*)$$

- So the long run price level differential is

$$\overline{p} - \overline{p}^* = m - m^* - \eta(y - y^*) + \sigma(i^{LR} - i^{LR*})$$

- PPP holds in the long run, so

$$\overline{s} = m - m^* - \eta(y - y^*) + \sigma(i^{LR} - i^{LR*}) \qquad (1)$$

Frankel's real interest rate differential model

- Combining the Δs^e equation and the UIP equation implies that

$$i - i^* = \Theta(\bar{s} - s) + \pi^e - \pi^{e*}$$

- Rearranging this equation for $s - \bar{s}$ gives

$$s - \bar{s} = -\frac{1}{\Theta}(r - r^*) \qquad (2)$$

where $r = i - \pi^e$ and $r^* = i^* - \pi^{e*}$

- **Deviation from $\bar{s}$ = $-\frac{1}{\Theta} \times$ real interest rate differential**

- If real interest rates are higher in the home country, the domestic currency will depreciate until real interest rates are equalised

Frankel's real interest rate differential model

- In the long run, real interest rates are equalised and $s = \bar{s}$
- Therefore, the long run nominal interest rate differential is

$$¡^{LR} - ¡^{LR*} = \pi^e - \pi^{e*}$$

- **LR interest rate differential = Expected inflation differential**
- Substituting for the long run nominal interest differential in (1):

$$\bar{s} = m - m^* - \eta(y - y^*) + \sigma(\pi^e - \pi^{e*}) \qquad (3)$$

- This is the **long run nominal exchange rate equation**

Frankel's real interest rate differential model

- Knowing $\bar{s}$ allows us to solve for the short run nominal exchange rate
- In particular, (2) tells us that

$$s = \bar{s} - \frac{1}{\Theta}(r - r^*)$$

- Substituting for the RHS of (3) in place of $\bar{s}$:

$$s = m - m^* - \eta(y - y^*) + \sigma(\pi^e - \pi^{e*}) - \frac{1}{\Theta}(r - r^*) \qquad (4)$$

- This is the **short run nominal exchange rate equation**

Implications of the Frankel model

- The Frankel model tells us that the exchange rate will deviate from its long run value if real interest rates differ across countries
- The long run nominal exchange rate solution is the same as in the flex-price model, but Frankel emphasises **inflation expectations**
- If long run inflation expectations rise in the home country, then the home currency will depreciate
- The Frankel model suggests that monetary policy can affect exchange rates through **several channels**:
  1. Money supplies
  2. Inflation expectations
  3. Real interest rates

Importance of the Frankel model

- The Frankel model is important because it links exchange rates to inflation expectations
- It also gives us a general model where the flex-price and Dornbusch models arise as special cases
- It is therefore suitable for analysis both inside and outside hyperinflations, and for both short run and long run analysis. This is an advantage it has over the flex-price and Dornbusch models.
- The model also shows us that managing inflation expectations can be as important for exchange rates as money supply management. Therefore, monetary policy credibility is crucial.

Monetary exchange rate models: a summary

- Monetary models of exchange rates explain exchange rate movements in terms of **economic fundamentals** – money supplies, GDPs, interest rates
- The main implication of these models is that monetary policy is crucial for understanding exchange rates
- The possibility of **exchange rate overshooting** suggests that changes in monetary policy could have surprisingly large effects on exchange rates in the short run
- Expectations about future monetary policy are also important in these models due to the **inflation expectations channel**

Next time...

- We will look at the empirical evidence regarding both flex-price and sticky-price monetary models of the exchange rate
- The main question is: can these models help us to understand and predict real-world exchange rate movements?
- **Advance reading:**

1. MacDonald Ch. 6.1 to 6.2 or Pilbeam Ch. 9.6 to 9.10
2. MacDonald Ch. 6.3 to 6.5 (harder)