Lectures 24 & 25: Determination of exchange rates

• Building blocs
  - Interest rate parity
  - Money demand equation
  - Goods markets

• Flexible-price version: monetarist/Lucas model
  - derivation
  - hyperinflation & other applications

• Sticky-price version: Dornbusch overshooting model

• Forecasting
Motivations of the monetary approach

Because $S$ is the price of foreign money (in terms of domestic), it is determined by the supply & demand for money (foreign vs. domestic).

Key assumption: Expected returns are equalized internationally.

- Perfect capital mobility => speculators are able to adjust their portfolios quickly to reflect their desires;
- And there is no exchange risk premium.

$\Rightarrow$ UIP holds: $i - i^* = \Delta s^e$.

Key results:

- $S$ is highly variable, like other asset prices.
- Expectations are central.
Building blocks

Interest rate parity
+ Money demand equation

  + Flexible goods prices => PPP
    => monetarist or Lucas models.

or

  + Slow goods adjustment => sticky prices
    => Dornbusch overshooting model.
Interest Rate Parity Conditions

Covered interest parity across countries

\[ i - i^* = fd \]

holds to the extent capital controls & other barriers are low.

Uncovered interest parity

\[ i - i^* = \Delta s^e \]

holds if risk is unimportant, which is hard to tell in practice.

Real interest parity

\[ i - \pi^e = i^* - \pi^{*e} \]

may hold in the long run but not in the short run.
Monetarist/Lucas Model

PPP: \[ S = \frac{P}{P^*} \]

+ Money market equilibrium
\[ \frac{M}{P} = \frac{L(i, Y)}{1} \quad \Rightarrow \quad P = \frac{M}{L(i, Y)} \]
\[ P^* = \frac{M^*}{L^*} \]

Experiment 1a:
\[ \frac{\textcolor{red}{M}}{\textcolor{blue}{L}(\textcolor{red}{i}, \textcolor{blue}{Y})} \uparrow \Rightarrow \frac{\textcolor{red}{S}}{\textcolor{blue}{L}(\textcolor{red}{i}, \textcolor{blue}{Y})} \uparrow \text{ in proportion} \]

1b:
\[ \frac{\textcolor{blue}{M}^*}{\textcolor{blue}{L}^*} \uparrow \Rightarrow \frac{\textcolor{red}{S}}{\textcolor{blue}{L}^*} \downarrow \text{ in proportion} \]

Why? Increase in supply of foreign money reduces its price.

1/ The Lucas version derives \( L \) from optimizing behavior, rather than just assuming it.
Experiment 2a:
\[ Y \uparrow \Rightarrow L \uparrow \Rightarrow S \downarrow. \]

2b:
\[ Y^* \uparrow \Rightarrow L^* \uparrow \Rightarrow S \uparrow. \]

Why? Increase in demand for foreign money raises its price.

Experiment 3:
\[ \pi^e \uparrow \Rightarrow L \downarrow \Rightarrow S \uparrow \]

Why?

\( i - i^* \) reflects expectation of future depreciation \( \Delta s^e \) (\( \leq \) UIP), which is in turn due (in this model) to expected inflation \( \pi^e \).

So investors seek to protect themselves: shift out of domestic money.
Illustrations of the importance of expectations ($\Delta s^e$):

• **Effect of “News”**: In theory, $S$ jumps when, and only when, there is new information, e.g., re: growth or monetary fundamentals.

• **Hyperinflation**: 
  Expectation of rapid money growth and loss in the value of currency => $L\downarrow$ => $S\uparrow$, even ahead of the actual money growth

• **Speculative bubbles**: 
  Occasionally a shift in expectations, even if not based in fundamentals, can cause a self-justifying movement in $S$.

• **Target zone**: If the band is credible, speculation can stabilize $S$, pushing it away from the edges even ahead of intervention.
An example of the importance of expectations, Nov. 9, 2016: Mexico’s peso fell immediately on news of the US election, even though no economic fundamentals had yet changed.

“The peso was the biggest victim of ... Mr Trump’s triumph, sliding as much as 13.4 % to a record low of 20.8 against the dollar before moderating its fall to 9.2 % on Wednesday,” Financial Times, “Mexican peso hit as Trump takes US presidency,” Nov. 9, 2016.
The world’s most recent hyperinflation: Zimbabwe, 2007-08

Inflation peaked at 2,600% per month.
The central bank monetized government debt. The driving force?
Increase in the money supply:
The exchange rate $S$ increased along with the price level $P$ (PPP).

Both $P$ & $S$ rose far more than the money supply. Why?

When the ongoing inflation rate is high, the demand for money is low in response. For $M/P$ to fall, $P$ must go up more than $M$. 

Zimbabwe Dollar Depreciates Sharply During Hyperinflation Era
PPP in a sense holds well in hyperinflations:
The cumulative change in $E$ corresponds to the cumulative change in $CPI$. 
Where $\pi$ went the highest, 
$P$ went up the most even relative to $M$: $M/P \downarrow$. 

Real money holdings fall in hyperinflations, because the demand for money depends on expected rates of return. The larger the increase in the inflation rate, the bigger the fall in real money.
Limitations of the monetarist/Lucas model of exchange rate determination

No allowance for SR variation in:

the real exchange rate \( Q \)

the real interest rate \( r \).

One approach: International versions of Real Business Cycle models assume all observed variation in \( Q \) is due to variation in LR equilibrium \( \bar{Q} \) (and \( r \) is due to \( \bar{r} \)), in turn due to shifts in tastes, productivity.

But we want to be able to talk about transitory deviations of \( Q \) from \( \bar{Q} \) (and \( r \) from \( \bar{r} \)), arising for monetary reasons.

\[ \Rightarrow \text{Dornbusch overshooting model.} \]
Recap: TWO KINDS OF MONETARY MODELS

(1) Goods prices perfectly flexible
   => Monetarist/ Lucas model

(2) Goods prices sticky
   => Dornbusch overshooting model
Sticky goods prices => autoregressive pattern in real exchange rate
(though you need 100 or 200 years of data to see it)

Estimated adjustment $\approx 25\%$ or $30\%$ per year.
DORNBUSCH OVERSHOOTING MODEL
DORNBUSCH OVERSHOOTING MODEL

PPP holds only in the Long Run, for $\bar{S}$.
In the SR, $S$ can be pulled away from $\bar{S}$.

Consider an increase in real interest rate $r = i - \pi^e$

$\Rightarrow$ Domestic assets more attractive

$\Rightarrow$ Appreciation: $S \downarrow$
until currency “overvalued” relative to $\bar{S}$;
$\Rightarrow$ investors expect future depreciation.

When $\Delta s^e$ is large enough to offset $i - i^*$,
that is the overshooting equilibrium.
Then, **dynamic path:**

high $r$ and high currency  
=> low demand for goods  
(as in Mundell-Fleming model)  
=> deflation, or low inflation  
=> gradually rising $M/P$  
=> gradually falling $i$ & $r$  
=> gradually depreciating currency.

**In LR, neutrality:**

$P$ and $S$ have changed in same proportion as $M$  
=> $M/P$, $S/P$, $r$ and $Y$ back to LR equilibria.
The experiment in the original Dornbusch article: a permanent monetary \textit{expansion}.

\[ r \equiv i - \Delta p^e \]

\[ \text{=> fall in real interest rate, } r \equiv i - \Delta p^e \]

\[ \text{=> domestic assets less attractive } \Rightarrow \text{ depreciation: } S \uparrow, \]

until currency “undervalued” relative to \( \bar{S} \).

\[ \text{=> investors expect future appreciation.} \]

\begin{itemize}
  \item When \(-\Delta s^e \) offsets \(i-i^*\), that is \textbf{the overshooting equilibrium}.
  \item Then, \textbf{dynamic path}: low \(r\) and low currency
    \begin{itemize}
      \item \( \Rightarrow \) high demand for goods \( \Rightarrow \) high inflation
      \item \( \Rightarrow \) gradually falling \(M/P\) \( \Rightarrow \) gradually rising \(i \& r\)
      \item \( \Rightarrow \) gradually appreciating currency.
    \end{itemize}
  \item Until back to LR equilibrium.
\end{itemize}
The Dornbusch model ties it all together:

• In the short run, it is the same as the Mundell-Fleming model,
  • except that $\Delta s^e$ is what allows interest rates to differ,
  • rather than barriers to the flow of capital.

• In the long run, it is the same as the monetarist/Lucas model

• The path from the short run to the long run
  is driven by the speed of adjustment of goods prices,
  • which also drives the path from flat to steep AS curves.
  • Estimated adjustment from the PPP tests $\approx 25\%$ or $30\%$ per year.
Summary of factors determining the exchange rate

(1) LR monetary equilibrium:

\[ S = (P/P^*) \bar{Q} = \frac{M/M^*}{L,(,) / L^*,(,)} \bar{Q} \]

(2) Dornbusch overshooting:
SR monetary fundamentals pull S away from \( \bar{S} \),
in proportion to the real interest differential).

(3) LR real exchange rate \( \bar{Q} \) can change,
e.g., Balassa-Samuelson effect or oil shock.

(4) Speculative bubbles.
TECHNIQUES FOR PREDICTING THE EXCHANGE RATE

Models based on fundamentals
- Monetary Models
  - Monetarist/Lucas model
  - Dornbusch overshooting model
- Other models based on economic fundamentals
  - Portfolio-balance model...

Models based on pure time series properties
- “Technical analysis” (used by many traders)
- ARIMA or other time series techniques (used by econometricians)

Other strategies
- Use the forward rate; or interest differential;
- random walk (“the best guess as to future spot rate is today’s spot rate”)
Appendices

- Appendix 1: The Dornbusch overshooting graph
- Appendix 2: Example: The dollar
- Appendix 3: Is the forward rate an optimal predictor?
Excess Demand (at C) causes $P$ to rise over time until reaching LR equilibrium (at B).

In the instantaneous overshooting equilibrium (at C), $S$ rises more-than-proportionately to $M$ to equalize expected returns.

$M \uparrow \Rightarrow i \downarrow \Rightarrow S \uparrow$ while $P$ is tied down.

Appendix 1

**THE DORNBUSCH OVERSHOOTING DIAGRAM**

An increase in the money supply, $M$, raises the price level, $P$, and spot rate, $S$, proportionately in the long run by PPP (at B). In the short run, however, $P$ is tied down. As a result, $S$ increases more than proportionately in the short run at C; that is, it overshoots its long-run equilibrium.
Appendix 2:
The example of the $ (trade-weighted, 1974-2006)

• Compute real interest rate in US & abroad (Fig. a)
• Differential was
  – negative in 1979,  
  – rose sharply through 1984, and  
  – then came back down toward zero.

• Real value of the dollar followed suit (Fig. b)
  – But many fluctuations cannot be explained, even year-long
    • Strongest deviation: 1984-85 $ appreciation, & 2001-02.
    • Speculative bubble?
US real interest rate < 0 in late 70s (due to high inflation$^e$).

Real $ rose with monetary fundamentals. & then beyond, in 1984-85. & again 2001-02 (esp. vs. €).

Real interest differential peaked in 1984.

¥ in 1995 may have been another bubble.
Appendix 3: The forward rate $F_t$ as a predictor of $S_{t+1}$

• We know that $F_t$ is a terrible predictor of $S_{t+1}$
  – just like any other predictor.
  – I.e., the prediction errors $S_{t+1} - F_t$, positive & negative, are large.
  – Reason: new information (news) comes out between $t$ and $t+1$.

• The question is whether the predictor is unbiased,
  • i.e., are the errors mean-zero & uncorrelated with information known at $t$?
  • If so, then it incorporates all available information.

• But we will see that the answer is “no:”
  – $F_t$ is a biased predictor.
Is the forward market an unbiased forecaster for the future spot exchange rate?

Regression equation: \[ \Delta s_{t+1} = \alpha + \beta (fd_t) + \varepsilon_{t+1} \]

Unbiasedness hypothesis: \( \beta = 1 \)

Random walk hypothesis: \( \beta = 0 \)

Usual finding: \( \beta << 1 \). (Sometimes \( \approx 0 \), or even \( <0 \).)

\[ \Rightarrow fd \text{ is biased} \]

Possible interpretations of finding:

1) Expectations are biased (investors do not determine \( \Delta s^e \) optimally), or else

2) there is an exchange risk premium \( (fd - \Delta s^e \neq 0) \)