Topics for Today

1.) Real Interest Parity

2.) The FX Market

3.) The Monetary Model of Ex. Rates

4.) Testing the Monetary Model
- Excess Volatility + Bubbles

Real Interest Parity

1. $$q = \frac{EP^*}{P}$$

$$\Rightarrow \frac{q^e - q}{q} = \frac{E^e - E}{E} - (\pi^e - \pi^{*e})$$

2. UIP $\Rightarrow \dfrac{E^e - E}{E} = R - R^*$

3. Fisher $\Rightarrow R - R^* = (\pi^e - \pi^{*e}) + (r^e - r^{*e})$

Put them all together,

$$\frac{q^e - q}{q} = r^e - r^{*e}$$

or,

$$\boxed{r^e = r^{*e} + \frac{q^e - q}{q}} \quad > \text{Real Interest Parity}$$

The Foreign Exchange Market

- The FX market is by far the world's largest financial market
- On a typical day, roughly $2.0 trillion changes hands

$\Longrightarrow$ in less than a week fx transactions exceed the annual value of world trade

- The FX market is a decentralized multiple-dealer market. It never closes!
- Most trading is between dealers (about 60-70%).
- About ½ of inter-dealer trades go through fx brokers.

Major Participants

1.) Commercial Banks
2.) other financial institutions
3.) Corporations
4.) Central Banks

Leading Trading Centers

1.) London
2.) New York
3.) Tokyo
4.) Frankfurt, Hong Kong, Singapore ...

Major Instruments

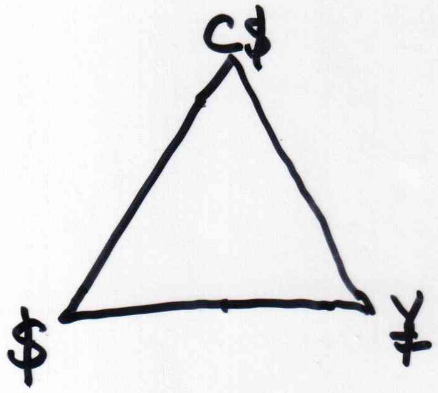
1.) Spot (1-2 day settlement lag)
2.) Forwards } "over-the-counter" mkts.
3.) Swap }

- Futures & options also exist, but they are less important
- Most volume is in forwards & swaps (~60%), with swaps being more important than forwards.

- Most fx trading takes place in and through the U.S. dollar

- Cross rates are determined by "triangular arbitrage".

$$\frac{C\$}{¥} = \frac{C\$}{\$} \cdot \frac{\$}{¥}$$



The Monetary Model of Exchange Rates

3 ingredients

1.) Reduced form money demand + Exog. monetary policy

- $m_t - p_t = \alpha y_t - \eta i_t$

  $m_t^* - p_t^* = \alpha y_t^* - \eta i_t^*$

2.) PPP / Flexible Prices

- $p_t = s_t + p_t^*$

3.) Uncovered Interest Parity (Risk-Neutrality)

- $i_t = i_t^* + E_t(s_{t+1} - s_t)$

These 3 ingredients can be interpreted as expressing equil. in the money market, the goods market, and the bond market.

Note: This is a partial equilibrium model

Although each of these 3 ingredients rests on shakey empirical ground, let's begin by studying their implications.

Differencing money demands yields,

$$p_t - p_t^* = m_t - m_t^* - \alpha(y_t - y_t^*) + \eta(i_t - i_t^*)$$

Using PPP + UIP we can write this as,

$$\boxed{s_t = f_t + \eta\left[E_t s_{t+1} - s_t\right]}$$

where $f_t = m_t - m_t^* - \alpha(y_t - y_t^*)$ defines the so-called monetary model fundamentals.

We can write this as,

$$\boxed{s_t = (1-\beta)f_t + \beta E_t s_{t+1}} \qquad \beta = \frac{\eta}{1+\eta}$$

so that s_t is a convex combo. of current fundamentals and next period's expected ex. rate.

What is a reasonable value for β?

$\eta = \left|\frac{dm}{di}\right|\frac{1}{m} \Rightarrow i \cdot \eta$ = interest elast. of money demand $\approx (.3 - .5)$

$\Rightarrow \eta \approx (30, 50)$ when $i = .01$ (quarterly data)

$\Rightarrow \beta > .95 \Rightarrow$ Ex. Rate mainly determined by expectations!

$$S_t = (1-\beta) f_t + \beta E_t S_{t+1}$$

Iterate forward, using "law of iterated expectations" [caveat: Heterogeneous Expectations!]

$$S_t = (1-\beta) E_t \sum_{j=0}^{T} \beta^j f_{t+j} + \beta^{T+1} E_t S_{t+T+1}$$

$$= (1-\beta) E_t \sum_{j=0}^{\infty} \beta^j f_{t+j} \quad \text{if } \lim_{T\to\infty} \beta^T E_t S_{t+T} = 0$$

No Bubbles Condition

<u>Example</u>

Suppose $f_t = \rho f_{t-1} + \varepsilon_t$, $|\rho| < 1$. Then,

$S_t = \left(\frac{1-\beta}{1-\rho\beta}\right) f_t$. This implies,

$$\text{var}(s_t) = \left(\frac{1-\beta}{1-\rho\beta}\right)^2 \text{var}(f_t) < \text{var}(f_t) \quad [\beta\rho < \rho]$$

More generally, define

$$PV_t = \sum_{j=0}^{\infty} \beta^j f_{t+j}$$

Using this we have the orthogonal decomposition,

$$PV_t = E_t(PV_t) + u_t$$

$$\Longrightarrow \text{var}(PV_t) = \text{var}(E_t PV_t) + \text{var}(u)$$

Applying this to our ex. rate equation,

$$\text{var}(s_t) = \text{var}(E_t PV) < \text{var}(PV) \quad \left.\right\} \text{Shiller Bound}$$

That is, ex. rates should be "smoother" than their ex post realized future fundamentals.

This inequality is strongly rejected by the data.

One response is to consider the possibility of bubbles. Note, with fiat currency, standard TVC doesn't apply to rule out explosive bubbles.

$$s_t = \underbrace{s_t^f}_{\text{fundamentals solution}} + \underbrace{B_t}_{\text{Bubble solution}}, \text{ where } B_{t+1} = \tfrac{1}{\beta} B_t + \varepsilon_{t+1}$$

Bubbles usually ruled out on empirical grounds, since a bubble path is explosive.

However, consider the following process,

$$B_{t+1} = \begin{cases} \frac{1}{\beta\pi} B_t + \varepsilon_{t+1} & \text{w.p. } \pi \\ \varepsilon_{t+1} & \text{w.p. } (1-\pi) \end{cases}$$

"collapsing Bubble" Blanchard (1979)

Note that $E_t B_{t+1} = \tfrac{1}{\beta} B_t$

Testing for Bubbles [Hausman (1978), West (1987), Meese (1986)]

Basic idea : Compare estimates from Euler eq. and PV model. Should be the same under the null of no bubbles. [PV model imposes no bubbles cond., Euler eq. doesn't]

Euler

$$E_t s_{t+1} = \frac{1}{\beta_1} s_t - \frac{1-\beta_1}{\beta_1} f_t$$

RE orth. decomposition $\quad s_{t+1} = E_t s_{t+1} + \underbrace{v_{t+1}}_{\text{orth. forecast error}}$

This gives,

$$s_{t+1} = \frac{1}{\beta_1} s_t - \frac{1-\beta_1}{\beta_1} f_t + v_{t+1}$$

PV

$$s_t = \frac{1-\beta_2}{1-\rho\beta_2} f_t + \text{"Shiller Error"}$$

info used to forecast f_t not contained in history of f_t

$H_0 : \beta_1 = \beta_2$ (No Bubbles)

$H_1 : \beta_1 \neq \beta_2$ (Bubbles)

Mixed Results

Basic Problem : $\hat{\beta}_1 \neq \hat{\beta}_2$ might differ for other reasons, e.g., model misspecification.

Campbell-Shiller Tests

Consider the no-bubbles solution,

$$s_t = (1-\beta) E_t \sum_{j=0}^{\infty} \beta^j f_{t+j}$$

2 Possibilities

1.) Agents & Econometrician have same info. set
$\Longrightarrow$ s_t is an exact function of the variables used to forecast f_t.

2.) Agents have more info.
$\Longrightarrow$ s_t Granger causes f_t

But if (2) is true, how do we test?

Answer: Include s_t in the VAR used to forecast f_t.

2 Cases

1. f_t is stationary, $I(0)$

$$\begin{pmatrix} f_t \\ s_t \end{pmatrix} = \Psi \begin{pmatrix} f_{t-1} \\ s_{t-1} \end{pmatrix} + \varepsilon_t$$

$$(0 \quad 1) = (1 \quad 0)(1-\beta)\left[I - \beta\Psi\right]^{-1}$$

or in linear form,

$$(0, \ 1)\left[I - \beta\Psi\right] = (1-\beta, \ 0)$$

2. f_t has a unit, $I(1)$, and is cointegrated with s_t

Can re-write ex. rate eq. as follows,

$$s_t - f_t = \eta E_t(s_{t+1} - s_t)$$

Using the PV model + law of iterated expectations,

$$\eta E_t(s_{t+1} - s_t) = \eta\left[(1-\beta)E_t\sum_{j=0}^{\infty}\beta^j f_{t+1+j} - (1-\beta)E_t\sum_{j=0}^{\infty}\beta^j f_{t+j}\right]$$

since $\eta = \frac{\beta}{1-\beta}$, we then have

$$\boxed{s_t - f_t = E_t\sum_{j=1}^{\infty}\beta^j \Delta f_{t+j}}$$

Define $\phi_t = s_t - f_t$ as the "spread".

<u>Interpretation</u>

$\phi_t > 0 \Longrightarrow f_t$ expected to rise in future

Now have a VAR in "Error Correction" form (VECM).

$$\begin{pmatrix} \Delta f_t \\ \phi_t \end{pmatrix} = \Psi \begin{pmatrix} \Delta f_{t-1} \\ \phi_{t-1} \end{pmatrix} + \varepsilon_t$$

Therefore, the model implies the following 2 cross-equation restrictions,

$$\boxed{(0 \quad 1) = (1 \quad 0)\beta\Psi[I - \beta\Psi]^{-1}}$$

And the predicted spread is,

$$\boxed{\hat{\phi}_t = (1 \quad 0)\beta\Psi[I - \beta\Psi]^{-1}\begin{pmatrix} \Delta f_t \\ \phi_t \end{pmatrix}}$$

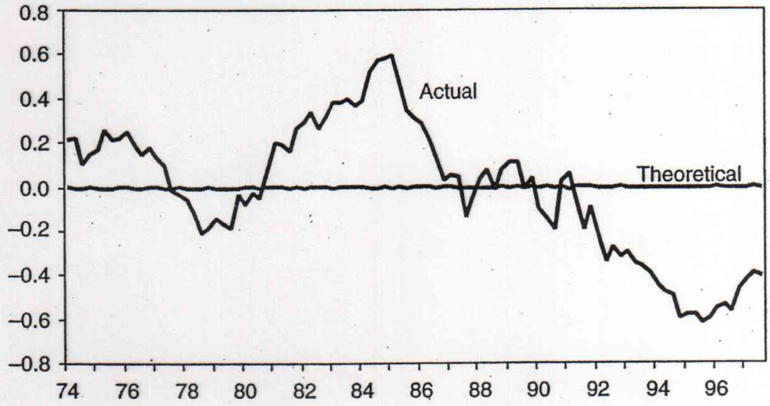


Figure 3.5 Theoretical and actual spreads, $s_t - f_t$.

Long-Run Implications

There are many reasons why the monetary model might not hold at short horizons (e.g., failure of PPP).

A less demanding implication is that s_t and f_t should be cointegrated.

Mark + Sul (JIE, 2001)

Engel, Mark & West (NBER Macro Annual, 2008)

This implies an Error-Correction Model,

Mark (1995, AER)

$$\boxed{\Delta s_{t+k} = \alpha + \beta(f_t - s_t) + v_{t+k} \qquad \beta > 0}$$

Caveats

1.) s_t + f_t may not be cointegrated

2.) In principle, Δf_{t+k} may do the adjusting

3.) Need to correct for small sample bias. Results sensitive to Monte Carlo assumptions. Killian (1997)

4.) Results seem dependent on currency + sample.

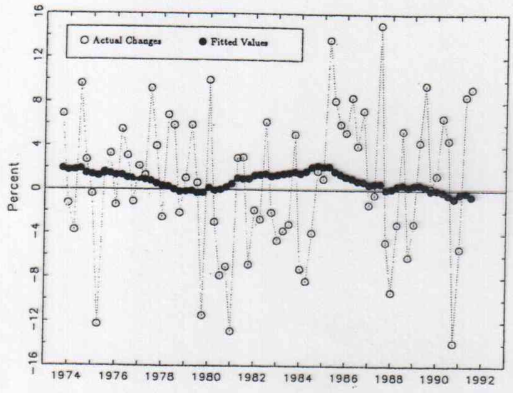


FIGURE 1. ONE-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

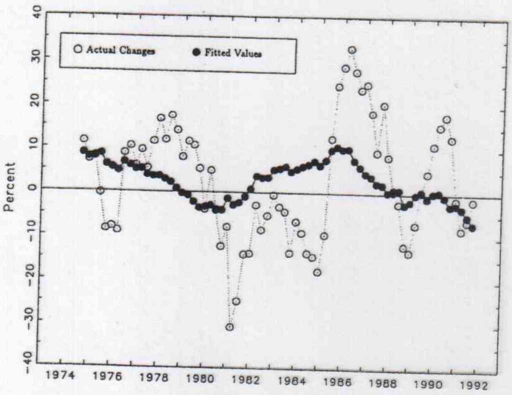


FIGURE 2. FOUR-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

$\Delta e_{t+k} = \alpha + \beta(f_t - e_t)$

$f_t = (m_t - m_t^*) - (y_t - y_t^*)$

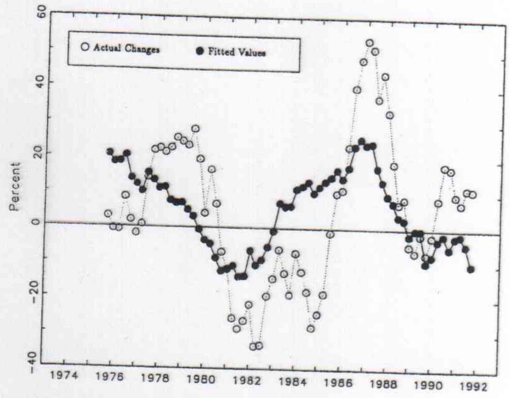


FIGURE 3. EIGHT-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

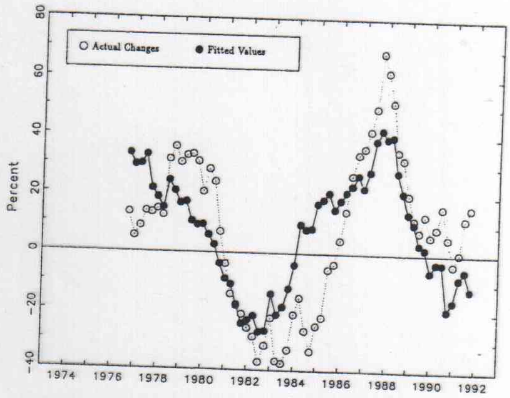


FIGURE 4. TWELVE-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

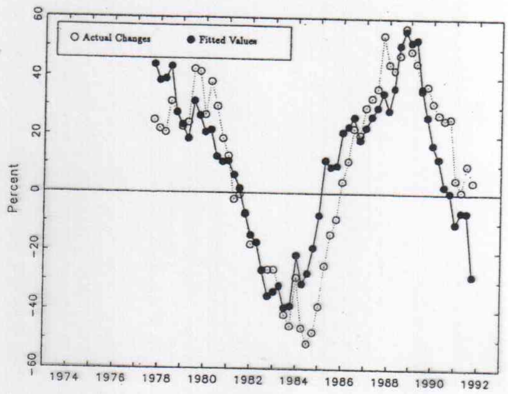


FIGURE 5. SIXTEEN-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE