Exchange Rate Determination and Forecasting

Econ 730
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10.1 Parity Conditions and Exchange Rate Forecasts

• The Fisher Hypothesis
  • Interest rates and inflation
  • Real rates of return – measures how much your purchasing power has increased over time
• The ex post real interest rate
  • \( 1 + r^{ep} = \frac{1+i}{1+\pi} \). Here, \( ep \) stands for “ex post”

• Approximated by: \( r^{ep} = i - \pi \)
10.1 Parity Conditions and Exchange Rate Forecasts

• The ex ante real interest rate – investors must form expectations of inflation

• Expected real interest rate \( E_t r_{t+1} = i_t - E_t \pi_{t+1} \)

• Fisher hypothesis – decomposition of nominal int. rates
  \( i_t = E_t r_{t+1} + E_t \pi_{t+1} \)

• One version of the Fisher hypothesis says \( E_t r_{t+1} \) is constant over time
• Even if not, many claim in the international context that
  \( E_t r_{t+1} = E_t r_{t+1}^* \)
Exhibit 10.1 Average Long-Term Government Bond Yields and Inflation Rates

\[ y = 1.670 + 1.641 \pi \]

\( (0.477) \) \( (0.218) \)

Adj. \( R^2 = 0.788 \)
10.1 Parity Conditions and Exchange Rate Forecasts

- The International Parity Conditions
  - CIRP – Covered Interest Rate Parity
    - Links forward rates, spot rates, and interest rate differentials
  - UIRP or Unbiasedness – Uncovered Interest Rate Parity
    - Sometimes called International Fisher Effect / Relationship
    - Links expected exchange rate changes and interest rate differentials
  - PPP
    - Links inflation rates and rates of changes in forex rates
10.1 Parity Conditions and Exchange Rate Forecasts

- UIP says \( i_t - i_t^* = E_t s_{t+1} - s_t \), using the log approximation

- Relative PPP says \( q_{t+1} - q_t = s_{t+1} - s_t + \pi_{t+1}^* - \pi_{t+1} = 0 \), where \( q_t \) is the log of the real exchange rate

- Take expectations: \( E_t q_{t+1} - q_t = E_t s_{t+1} - s_t + E_t \pi_{t+1}^* - E_t \pi_{t+1} = 0 \)

- Combine with UIP: \( E_t q_{t+1} - q_t = i_t - i_t^* + E_t \pi_{t+1}^* - E_t \pi_{t+1} = E_t r_{t+1} - E_t r_{t+1}^* = 0 \)

- If UIP and Relative PPP hold then \( E_t r_{t+1} = E_t r_{t+1}^* \) and \( E_t s_{t+1} - s_t = i_t - i_t^* = E_t \pi_{t+1}^* - E_t \pi_{t+1} \)
10.1 Parity Conditions and Exchange Rate Forecasts

• If UIP and relative PPP held, the world would be simple
  • The forecasted change in the log of the exchange rate would equal the nominal interest differential
  • That would equal the difference between expected home and foreign inflation
  • Ex ante real interest rates would be equal
• But UIP and PPP do not hold.
  • Relative PPP fails badly. Even if UIP held, we would have
    \[ E_t q_{t+1} - q_t = i_t - i^*_t + E_t \pi^*_t - E_t \pi_{t+1} = E_t r_{t+1} - E_t r^*_{t+1} \neq 0 \]
  • But UIP also does not hold, so we cannot forecast exchange rates with nominal interest rate differentials:
    \[ E_t s_{t+1} - s_t \neq i_t - i^*_t \]
10.2 Currency Forecasting Techniques

- Fundamental exchange rate forecasting
  - Uses fundamentals in econometric models (e.g., money supply, inflation, productivity growth rates, current account)

- Technical analysis
  - Using historical data to find patterns
  - Academics criticize it, but a survey suggests this is used often by traders
    - This suggests that there might be something to it, especially since other models also have shortcomings
    - Fundamental analysis is flawed as well
    - Forward rate may not be an unbiased predictor of the future spot rate, even in an efficient market
    - If enough of the trading world uses it, it will matter through trade pressure
Exhibit 10.3 Categories of Exchange Rate Forecasting Techniques

- Market-based forecasts
  - Forward rate
- Fundamental analysis
  - Judgmental
- Econometric model
- Technical analysis
  - Statistical analysis
    - Filter rules
  - Chartism
    - Regression analysis
    - Nonlinear analysis
10.2 Currency Forecasting Techniques

• Evaluating forecasts
  • Accuracy

\[ e(t + k) = s(t + k) - \hat{s}(t + k) \]

• Mean absolute error (MAE)

\[ MAE = \frac{1}{T} \sum_{t=1}^{T} |e(t + k)| \]

• Root mean squared error (RMSE)

\[ RMSE = \sqrt{\frac{1}{T} \sum_{t=1}^{T} (e(t + k))^2} \]
10.2 Currency Forecasting Techniques

- Being on the right side of the forward rate
  - Making right decision as to whether to go long or short on currency could be sufficient
  - Percentage correct – beat probability and statistics, i.e., 50% chance of being right

- Profitability
  - How often can be you be wrong if you lose small when you are wrong and win big when you are right?
10.2 Currency Forecasting Techniques

• Fancy Foods can seek the advice of two forecasting companies to help it predict future forex rates: Forexia and Trompe Le Monde. Which forecast is more accurate?

<table>
<thead>
<tr>
<th></th>
<th>Forexia</th>
<th>Trompe Le Monde</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast</td>
<td>$1.65/£</td>
<td>$1.51/£</td>
</tr>
<tr>
<td>Forecast relative to forward rate (forward rate: £1.53/$)</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Decision</td>
<td>Hedge</td>
<td>Do not hedge</td>
</tr>
<tr>
<td>Forecast error</td>
<td>−$0.10/£</td>
<td>$0.04/£</td>
</tr>
<tr>
<td>Ex post cost relative to forward rate</td>
<td>Zero</td>
<td>Positive</td>
</tr>
</tbody>
</table>

More inaccurate but suggests hedging, which proves to be less costly.

Technically more accurate but suggests no hedging, which proves to be costly:

\[ £1M \times (\$1.55 - \$1.53)/£ = £20,000 \]
10.3 Fundamental Exchange Rate Forecasting

• Many exchange rate models take the form of:

\[ s_t = b(x_t - s_t) + E_t s_{t+1}, \quad 0 < b < 1 \]

• \( x_t \) represents some economic “fundamental” variables that determine the exchange rate in the long run, such as from monetary policy.

• The equation says that the exchange rate at time \( t \) partially adjusts toward the fundamental value, but is also determined by expectations.

• We can rewrite this equation as:

\[
\begin{align*}
s_t &= \frac{b}{1+b} x_t + \frac{1}{1+b} E_t s_{t+1} \\
&= (1-a) x_t + a E_t s_{t+1} \\
a &\equiv \frac{1}{1+b} \\
0 &< a < 1
\end{align*}
\]
10.3 Fundamental Exchange Rate Forecasting

• This equation shows that the exchange rate is “forward looking”

• Now note that

$$ s_t = (1-a) x_t + a E_t s_{t+1} $$

• Take expectations:

$$ s_{t+1} = (1-a) x_{t+1} + a E_{t+1} s_{t+2} $$

• Substitute into the first equation:

$$ E_t s_{t+1} = (1-a) E_t x_{t+1} + a E_t (E_{t+1} s_{t+2}) = (1-a) E_t x_{t+1} + a E_t s_{t+2} $$

• Continue to iterate, and we get:

$$ s_t = (1-a) x_t + a ((1-a) E_t x_{t+1} + a E_t s_{t+2}) = (1-a) (x_t + a E_t x_{t+1}) + a^2 E_t s_{t+2} $$

$$ s_t = (1-a) \sum_{j=0}^{\infty} a^j E_t x_{t+j} $$
10.3 Fundamental Exchange Rate Forecasting

- The asset market approach to exchange rate determination
  - The exchange rate as an asset price – based on current fundamentals and expectations of future exchange rates
    - Just like stocks – linked to current / future fundamentals
    - Even a small change in current fundamentals can cause a large change in the forex rate if it also changes expectations
  - Conversely, news about the future matters a lot
10.3 Fundamental Exchange Rate Forecasting

- News and exchange rates
  - The performance of the monetary exchange rate model is that exchange rate changes are unpredictable but they still reflect news about fundamentals
  - News is incorporated into exchange rates very quickly (typically less than 15 minutes)
    - Strange reaction to news about inflation/increases in money supply: the dollar appreciates when the money supply increases or inflation increases – one interpretation is that this reaction anticipates central bank responses of aggressive monetary policies (i.e., higher interest rates)
10.3 Fundamental Exchange Rate Forecasting

• Monetary model:

\[ x_t = m_t - m_t^* - (y_t - y_t^*) \]

• The “fundamental” is relative money supplies less relative income (all of these are in logs).
  • A greater supply of money will work to depreciate the currency
  • If income is higher, people demand more money, which will work to appreciate the currency
10.3 Fundamental Exchange Rate Forecasting

• In some models (which assume nominal price stickiness), we have
  \[ x_t = m_t - m^*_t - \left( y_t - y^*_t \right) + q_t \]

• The nominal exchange rate will tend to be high when the real exchange rate is high. But what factors drive the real exchange rate?

• Slow adjustment of prices leads to slow adjustment of the real exchange rate:
  \[ E_t q_{t+1} - q_t = -\kappa q_t \]

• We saw earlier that if UIP holds, \[ E_t q_{t+1} - q_t = E_t r_{t+1} - E_t r^*_{t+1} \]

• These equations then imply:
  \[ q_t = -\frac{1}{\kappa} \left( E_t r_{t+1} - E_t r^*_{t+1} \right) \]
Exhibit 10.4 The Real Exchange Rate and the Real Interest Differential
10.3 Fundamental Exchange Rate Forecasting

• We can put these ideas together:

\[ s_t = (1 - a) \sum_{j=0}^{\infty} a^j E_t x_{t+j} \]

\[ x_t = m_t - m^*_t - (y_t - y^*_t) + q_t \]

\[ q_t = -\frac{1}{\kappa} (E_t r_{t+1} - E_t r^*_{t+1}) \]

• We find

\[ s_t = (1 - a) \sum_{j=0}^{\infty} a^j E_t \left( m_{t+j} - m^*_{t+j} - (y_{t+j} - y^*_{t+j}) - \frac{1}{\kappa} (r_{t+j+1} - r^*_{t+j+1}) \right) \]
10.3 Fundamental Exchange Rate Forecasting

• In that model, then, factors that raise the real interest rate in the home country (such as tighter monetary policy) will raise real interest rates, which in turn will lead to a real depreciation
  • In turn that feeds into a nominal depreciation

• But none of these models turn out to be helpful in forecasting exchange rates
  • For one thing, they require forecasting the economic fundamentals

• Why the random walk works
  • But the models actually imply the exchange rate is not forecastable!
  • Current exchange rates adequately reflect the expected value of future fundamental values
    • In order for this to be true exchange rate should also predict future fundamental values (Engel, Mark and West, 2007 show this to be true)
10.3 Fundamental Exchange Rate Forecasting

- PPP-based forecasts
  - Most popular fundamental exchange rate models
  - “Fair value” exchange rate models used by most brokers / banks
    - They adjust PPP for various effects, such as productivity trends, which is particularly important for developing countries
    - They use the deviation between current value and fair value of the exchange rate to predict the direction of change
  - Academic studies suggest there is some predictive power, though it is limited to medium-to-long horizons
    - For example, the Big Mac index
10.4 Technical Analysis

- “Pure” technical analysis: Chartism
  - Support level – level price has trouble falling below
  - Resistance level – level price has trouble rising above
  - Breakout – a sudden break of a trading range
  - Potentially spurious patterns
  - Trading on a random walk
  - Does charting work?
Exhibit 10.5  Exchange Rate Patterns Described by Chartists
10.4 Technical Analysis

• Filter rules
  • x% rules
    • Buy (go “long”) the currency if it appreciates by x% above its most recent trough (or support level)
    • Sell (go “short”) the currency when it falls x% below its most recent peak (or resistance level)
  • Moving-average crossover rules
    • Go long (short) in the foreign currency when the short-term moving average crosses the long-term moving average from below (above)
    • 1 and 5 days; 1 and 20 days; 5 and 20 days
• Filter rule profitability
  • Used to be profitable (i.e., 6.2%/year for Swiss franc and 13.94% for yen before 1994) but not so much any more
  • Since 2000, studies suggest using simple moving average rules works better
10.4 Technical Analysis

• Regression analysis
  • This framework is used each trading period to find the expected forward market return
  • If the expected return is positive (negative), the strategy is to long (short) the foreign currency

• Non-linear models
  • More sophisticated models which take non-linearity into consideration
    • Use computer techniques such as algorithms to search for optimal trading rules
    • Apply Darwinian-like, natural-selection process to filter rules on past data to breed the “best” trading rules
10.5 Predicting Devaluations (Pegged Regimes)

- What causes a currency crisis?
  - Macroeconomic conditions
    - Government follows policies inconsistent with its currency peg – speculative attack is unavoidable
      - Government will exhaust reserves defending peg
    - Events that should precede devaluations
      - Growing budget deficits
      - Fast money growth
      - Rising wages and prices
      - Currency overvaluation
      - Current account deficits (caused by budget deficits combined with currency overvaluation)
10.5 Predicting Devaluations

- Self-fulfilling expectations
  - Group of investors begin speculative attack
  - Other investors see this and think that the currency will collapse so they convert out of currency

- Contagion
  - If group successfully attacks one currency, they might as well try another
  - If one currency is attacked, other currencies will appreciate relative to that currency and their domestic firms suffer a loss of competitiveness
  - Other countries in similar position – obvious targets (e.g., Asian crisis)