Interest Rate Parity
Example

Suppose that 1-year interest rates on similar assets are 4% in the US and 5 % in the UK. Where will you put your money? Do you have sufficient information to make an informed decision?
The Rate of Return on Foreign Investment

For domestic investment with \( i^\$ \)

\[ $1 \Rightarrow $(1 + i^\$) \]

For covered foreign investment

\[ $1 \Rightarrow £(1/S) \text{ sell } $ \text{ for } £ \]

\[ \Rightarrow £(1/S)(1+i^£) \text{ earning } i^£ \]

\[ \Rightarrow $ F(1/S)(1+i^£) \text{ selling } £ \text{ forward} \]

The rate of return on foreign investment

\[ F(1/S)(1+i^£) - 1 \approx i^£ + (F-S)/S \]
Example

1-year interest rates on similar assets:
   4% in the US and 5 % in the UK
the spot $/£ rate = 1.500
the 1-year $/£ forward rate = 1.470

The effective return on £ assets is
   \[(1.470/1.500)(1+0.05) = 1.029\]
or 2.9% per annum.
In approximation, it is 5% + (-2%) = 3%
Investment Decision

If $1 + i_\$ > (F/S)(1+i_\£)$, invest in $\$ assets.

If $1 + i_\$ < (F/S)(1+i_\£)$, invest in £ assets

Subtract 1 from each side. Using approximation on RHS:

If $i_\$ > i_\£ + (F-S)/S$, invest in $\$ assets.

If $i_\$ < i_\£ + (F-S)/S$, invest in £ assets
Covered Interest Parity (CIP)

Covered interest arbitrage leads to CIP:

\[ 1 + i_\$ = \frac{F}{S}(1+i_£). \]

Using approximation,
\[ i_\$ = i_£ + \frac{F-S}{S} \]

or \[ i_\$ - i_£ = \frac{F-S}{S} \]

The RHS is the forward premium on £.
CIP

• Assumptions
  – No barriers to arbitrage across international financial markets
  – Two assets are identical in every relevant respect except currency of denomination: comparable in terms of default and political risk (such as risk of capital controls)

• CIP: arbitrage should ensure that the interest rate differential on two assets, adjusted to cover the movement of currencies at the maturity of the underlying assets in the forward market, be continuously equal to zero.
Exercises

Q: What would happen in the above case when CIP does not hold? Assume the domestic return is initially lower.

Q: The euro is traded at a forward premium against the dollar. Between \( i^\$, \) and \( i^\€ \), which is higher?
Deviations from CIP

- Transactions costs
- Differential taxation
- Government controls (Political risk)

In the presence of taxation, CIP is modified:

\[(1-t^\$) \cdot i^\$ = (1-t^\£) \cdot i^\£ + (F-S)/S\]
Uncovered Interest Parity

Uncovered interest parity holds if
\[ i^\$ - i^\£ = (S^e-S)/S. \]

\( S^e \) is the expected future exchange rate.
\( i^\£ + (S^e-S)/S \) is the expected return from uncovered investment in foreign assets.
The \((S^e-S)/S\) is called the expected rate of depreciation of the domestic currency.
Exercises

1. The 1-year $ interest rate is 6%.
   The 1-year ¥ interest rate is 4%.
   The ¥/$ spot exchange rate is 100.
   Find the 1-year forward rate to satisfy CIP.

2. The 1-year euro interest rate is 3 %.
   The 1-year yen interest rate is 4 %.
   Is the euro expected to depreciate or appreciate against the yen? At what rate?
Perfect Capital Mobility and Perfect Substitutability of Assets

• **Perfect capital mobility** (between countries): actual portfolio composition adjusts instantaneously to desired portfolio composition
  – *Under no default risk or future capital controls, PCM implies covered interest parity.*

• **Perfect substitutability** (between domestic and foreign assets): asset holders are indifferent as to the composition of their bond portfolios as long as the expected rate of return on the two countries’ bonds is the same when expressed in any common numeraire.
  – *This is a much stronger assumption (risk neutrality) and implies uncovered interest parity.*

• Mundell’s PCM assumes both.
More Exercises

Q: Use the CIP or UIP to find how the exchange rate \((S)\) will change if

a. the domestic interest rate rises.

b. the foreign interest rate rises.

c. the domestic currency is expected to be weaker in the future.
Exchange Rates, Interest Rates and Inflation

1. The currency of a high inflation country tends to depreciate. (Relative PPP)

2. The nominal interest rate is high in a high inflation country. (Fischer effect)

3. The nominal interest rate is high if the currency is expected to depreciate. (Uncovered interest parity)

In Symbol

1. $\pi^\$ - \pi^£ = (S^e-S)/S$

2. $i^\$ = r^\$ + \pi^\$ ; \quad i^£ = r^£ + \pi^£$

3. $i^\$ - i^£ = (S^e-S)/S$

Show that (1)+(3) imply real interest parity.
Paradox

(CIP) \[ i^S - i^£ = (F-S)/S = F/S - 1 \]
(UIP) \[ i^S - i^£ = (S^e-S)/S = S^e/S - 1 \]

1. A higher domestic interest rate means that domestic currency is expected to depreciate over time. \( (S^e > S \text{ or } F > S) \)

2. Holding \( F \) (or \( S^e \)) and \( i^£ \) fixed, an increase in the domestic interest rate appreciates the domestic currency, making \( S \) lower.

Q: A higher interest rate may mean a weaker currency (in 1) or a stronger currency (in 2). How do we explain the paradox?
Tests of CIP and UIP
Tests of CIP

1. Regression analysis
   • $f_{t+k} - s_t = \alpha + \beta (i_t - i_t^*) + u_t \quad H_0: \alpha = 0 & \beta = 1$
   • This is NOT a proper test. Why?

2. Do the actual deviations from interest parity differ ‘significantly’ from zero?
   • A neutral band determined by transactions costs
   • ‘tranquil’ periods and ‘turbulent’ periods

3. Threshold models
   • Q: is the dynamic behavior of deviations from CIP different outside the neutral band than it is inside the band?
Tests of CIP

• For developed economies since the dismantling of capital controls, CIP holds fairly well.
• Most tests are conducted using offshore rates, in which case (2) is sometimes termed “closed interest parity”, although CIP is often used as a term encompassing this concept.
• Frenkel and Levich (1975):
  – “after accounting for transactions costs, CIP holds for 3-month horizons.
  – Offshore rates sometimes diverge from onshore rates
• Popper (1993) finds that covered interest differentials at long maturities are not appreciably greater than those for short (up to one year) maturities.
Tests of CIP

- Prior to the dismantling of capital controls, and in many emerging markets today, CIP is unlikely to hold.
- Aliber (1973): covered interest differentials could be interpreted as political risk, associated with the possibility of governmental authorities placing restrictions on deposits located in different jurisdictions
  - Evidence of capital controls
UIP

• Assumptions for UIP
  – Investors are risk neutral
  – Transaction costs are negligible
  – Underlying assets are identical in terms of liquidity, maturity and default risk
  – There is a sufficient number of investors with ample funds available for arbitrage
References

Tests of UIP

- UIP is a more difficult condition to test, essentially because expected exchange rate changes are unobservable.
- Most tests of UIP are actually a joint test of UIP and the rational expectations (RE) hypothesis, i.e., that ex post realizations of the exchange rate are a unbiased measure of the ex ante exchange rate.
  \[ s_{t,t+1}^e = E(s_{t+1}|I_t) \]
- This assumption combined with Eq (2) yields the standard regression equation (sometimes called the “Fama equation”):
Testing UIP

1 + i_{t,k} = (1 + i^*_{t,k}) \frac{S^e_{t+k}}{S_t} \quad \text{(1) UIP}

\Delta_k S_{t+k} = i_{t,k} - i^*_{t,k} \quad \text{(2) log-approximation & RE}

where \Delta_k S_{t+k} = s_{t+k} - s_t

\Delta_k S_{t+k} = \beta_0 + \beta_1 (i_{t,k} - i^*_{t,k}) + u_{t+k} \quad \text{(3) regression equation}

H_0: \beta_0 = 0, \quad \beta_1 = 1 \quad \text{and } u_{t+k} \text{ is orthogonal to the information available at } t

Alternative form: (using CIP)
\Delta_k S_{t+k} = \beta_0 + \beta_1 (f^k_t - s_t) + u_{t+k} \quad \text{(4) the “Fama equation”
• The evidence in favor of the joint hypothesis of UIP and RE is quite weak.

  – The estimated regression coefficient on either the forward rate or the interest rate differential typically is not only from unity, but in fact negative and significantly different from zero.
  – This is true for reserve currencies at horizons up to a year.
  – $R^2$ is typically very small; adjusted $R^2$ is often negative.
Using survey data

• Froot and Frankel (1989) rely upon survey-based measures of exchange rates to calculate expected depreciation.
• They find that for reserve currencies (against the USD) it is much more difficult to reject the null hypothesis that $\beta_1 = 1$.
• Using a broader set of currencies over a different sample period, Frankel and Chinn (1993) find that while the estimates of the slope coefficient are always greater than zero, the null of a unit coefficient is rejected in one instance.
• Hence, for a wider set of currencies – including some emerging market currencies – the UIP hypothesis does seem to carry less weight.
Tests of UIP

• At longer horizons, (3, 5, 10 years) the evidence is more supportive of the combined UIP-RE hypothesis.
• Chinn and Meredith (2004) document that estimates of the $\beta_1$ coefficient are usually not significantly different from the posited value of unity at 5 and 10 year horizons. The panel regression coefficient at different horizons in these regressions is depicted in Figure 1.
Figure 1: Panel beta coefficients at different horizons.

Notes: Up to 12 months, panel estimates for 6 currencies against US$, eurodeposit rates, 1980Q1-00Q4; 3 year results are zero coupon yields, 76Q1-99Q2; 5 and 10 years, constant yields to maturity, 80Q1-00Q4 and 83Q1-00Q4.
Tests of UIP

- Other interesting results pertain to periods of extreme market turmoil.
- Flood and Rose (2002) find that UIP holds better in recent times when the sample encompasses successful attacks on currency pegs. Nonetheless, they still find lots of heterogeneity in experiences with UIP.
UIP in Emerging Markets

• A new area of research involves investigation of whether UIP holds for emerging markets.
• Bansal and Dahlquist (2000) found that there was a basic asymmetry in whether UIP holds.
  – In particular, they find that when the U.S. interest rate is lower than foreign country rates, UIP holds, while UIP fails to hold when the U.S. rate is higher.
  – Idiosyncratic factors, such as the GDP per capita of the foreign country, are important in determining the degree of failure of UIP to hold.
Frankel and Poonawala (2010)

- Apply the Fama regression tests to a sample of 14 emerging market currencies and find a smaller bias than for advanced country currencies.
- The coefficient is on average positive, i.e., the forward discount at least points in the right direction. It is never significantly less than zero.
- This suggests that a time-varying exchange risk premium may not be the explanation for traditional findings of bias.
- The reasoning is that emerging markets are probably riskier; yet we find that the bias in their forward rates is smaller. Emerging market currencies probably have more easily-identified trends of depreciation than currencies of advanced countries.
The (partial) rehabilitation of interest rate parity in the floating rate era: Longer horizons, alternative expectations, and emerging markets

Menzie D. Chinn\textsuperscript{a,b,}\textsuperscript{*}

\textsuperscript{a} Robert M. La Follette School of Public Affairs and Department of Economics, University of Wisconsin, Madison, WI, USA
\textsuperscript{b} NBER, Cambridge, MA, USA
Abstract

• This paper examines several new empirical findings in the study of uncovered interest parity.
• It reviews recent developments in the study of long-horizon interest parity regressions, the implications of relaxing the rational expectations methodology and the characteristics of results pertaining to the non-G7 currencies, including those in less developed economies.
• In brief, the evidence against UIP in the current floating rate era is not as great as is commonly thought, although it is still true that for the major currencies, the short-term interest differential remains a biased predictor of ex post changes in the exchange rate.
Table 1
Short-horizon estimates of $\beta$

\[ \Delta s_{t,t+k} = \alpha + \beta(i_{t,k} - i^*_{t,k}) + \varepsilon_{t,t+k} \]  

<table>
<thead>
<tr>
<th>Currency</th>
<th>Maturity</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 mo.</td>
<td>6 mo.</td>
<td>12 mo.</td>
<td></td>
</tr>
<tr>
<td>Deutschmark</td>
<td>-0.809 * (1.134)</td>
<td>-0.893 *** (0.760)</td>
<td>-0.587 *** (0.642)</td>
<td></td>
</tr>
<tr>
<td>Japanese yen</td>
<td>-2.887 *** (0.997)</td>
<td>-2.926 *** (0.777)</td>
<td>-2.627 *** (0.747)</td>
<td></td>
</tr>
<tr>
<td>U.K. pound</td>
<td>-2.202 *** (1.086)</td>
<td>-2.046 *** (1.036)</td>
<td>-1.418 *** (1.041)</td>
<td></td>
</tr>
<tr>
<td>French franc</td>
<td>-0.179 (0.904)</td>
<td>-0.154 (0.825)</td>
<td>-0.009 (0.853)</td>
<td></td>
</tr>
<tr>
<td>Italian lira</td>
<td>0.518 (0.606)</td>
<td>0.635 (0.670)</td>
<td>0.681 (0.770)</td>
<td></td>
</tr>
<tr>
<td>Canadian dollar</td>
<td>-0.477 *** (0.513)</td>
<td>-0.572 *** (0.419)</td>
<td>-0.610 *** (0.557)</td>
<td></td>
</tr>
<tr>
<td>Constrained panel</td>
<td>-0.757 *** (0.374)</td>
<td>-0.761 *** (0.345)</td>
<td>-0.536 *** (0.369)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: point estimates from the regression in Eq. (6) (serial correlation robust standard errors in parentheses, calculated assuming \( 2(k-1) \) moving average serial correlation, following Cochrane, 1991). Sample is 1980Q1–2000Q4. 
* (**) [***] Different from null of unity at 10%(5%)[1%] marginal significance level.
Source: Chinn and Meredith (2004).

* Fixed effects regression. Standard errors adjusted for serial correlation (assumes \( k-1 \) moving average serial correlation, cross averaging across currency pairs).
Fig. 1. One-year DM/US$ depreciation and 1-year offshore interest differential.
Table 2
Ex post depreciation and 5-year government bond yields

<table>
<thead>
<tr>
<th></th>
<th>$\hat{\alpha}$</th>
<th>$\hat{\beta}$</th>
<th>Reject $H_0$: $\beta = 1$</th>
<th>$R^2$</th>
<th>$N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deutschemark</td>
<td>$-0.005 (0.010)$</td>
<td>$0.902 (0.532)$</td>
<td></td>
<td>0.07</td>
<td>100</td>
</tr>
<tr>
<td>U.K. pound</td>
<td>$0.001 (0.009)$</td>
<td>$0.515 (0.311)$</td>
<td></td>
<td>0.02</td>
<td>100</td>
</tr>
<tr>
<td>Canadian dollar</td>
<td>$-0.007 (0.005)$</td>
<td>$0.512 (0.332)$</td>
<td></td>
<td>0.02</td>
<td>100</td>
</tr>
<tr>
<td>Constrained panel$^a$</td>
<td>$-$</td>
<td>$0.709 (0.404)$</td>
<td></td>
<td>0.08</td>
<td>300</td>
</tr>
</tbody>
</table>

Notes: point estimates from the regression in Eq. (6) (serial correlation robust standard errors in parentheses, using a bandwidth equal to $2 \times (k - 1)$).
Sample period: 1980Q1–2004Q1. *(**)[***] Different from null hypothesis at 10%(5%)[1%] marginal significance level.

$^a$ Fixed effects regression. Standard errors adjusted for serial correlation (assumes $k - 1$ moving average serial correlation, cross averaging across currency pairs).
Table 3
Ex post depreciation and 10-year government bond yields

<table>
<thead>
<tr>
<th></th>
<th>( \hat{\alpha} )</th>
<th>( \hat{\beta} )</th>
<th>Reject ( H_0: \beta = 1 )</th>
<th>( R^2 )</th>
<th>( N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deutschemark</td>
<td>0.001 (0.005)</td>
<td>1.025 (0.225)</td>
<td></td>
<td>0.51</td>
<td>88</td>
</tr>
<tr>
<td>Japanese yen</td>
<td>0.027 (0.011)</td>
<td>0.469 (0.202)</td>
<td>***</td>
<td>0.10</td>
<td>88</td>
</tr>
<tr>
<td>U.K. pound</td>
<td>0.006 (0.003)</td>
<td>0.767 (0.098)</td>
<td>***</td>
<td>0.45</td>
<td>88</td>
</tr>
<tr>
<td>Canadian dollar</td>
<td>-0.004 (0.003)</td>
<td>0.672 (0.138)</td>
<td>***</td>
<td>0.09</td>
<td>88</td>
</tr>
<tr>
<td>Constrained panel(^a)</td>
<td>-</td>
<td>0.758 (0.168)</td>
<td></td>
<td>0.56</td>
<td>352</td>
</tr>
</tbody>
</table>

Notes: point estimates from the regression in Eq. (6) (serial correlation robust standard errors in parentheses, calculated assuming approximately \( 2 \times (k - 1) \) moving average serial correlation).
Sample period: 1983Q1–2004Q4. \(^*\)(\(^**\))(\(^***\)) Different from null of unity at 10%(5%)[1%] marginal significance level.
\(^a\) Fixed effects regression. Standard errors adjusted for serial correlation (assumes \( k - 1 \) moving average serial correlation, cross averaging across currency pairs).
Table 4
Expected depreciation and 5-year government bond yields

<table>
<thead>
<tr>
<th></th>
<th>( \hat{\alpha} )</th>
<th>( \hat{\beta} )</th>
<th>Reject ( H_0: \beta = 1 )</th>
<th>( R^2 )</th>
<th>( N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deutschemark</td>
<td>-0.031 (0.010)</td>
<td>0.219 (0.731)</td>
<td>-0.11</td>
<td>0.36</td>
<td>10</td>
</tr>
<tr>
<td>U.K. pound</td>
<td>-0.002 (0.011)</td>
<td>1.613 (0.570)</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Canadian dollar</td>
<td>0.007 (0.005)</td>
<td>0.724 (0.378)</td>
<td></td>
<td>0.13</td>
<td>10</td>
</tr>
<tr>
<td>Constrained panel(^a)</td>
<td>-</td>
<td>0.737 (0.384)</td>
<td></td>
<td>0.37</td>
<td>30</td>
</tr>
</tbody>
</table>

Notes: point estimates from the regression in Eq. (7) (serial correlation robust standard errors in parentheses, using a bandwidth equal to 2).

Sample period: 1988Q4—1997Q4. \(* (**)[***\) Different from null hypothesis at 10\% (5\%)[1\%] marginal significance level.

\(^a\) Fixed effects regression (heteroskedasticity robust standard errors).
Table 5
Individual emerging market country regressions (12/31/1996–04/30/2004) coefficients with robust standard errors

\[ s_{t+1} - s_t = \alpha + \beta(f_t - s_t) + \epsilon_t \]

<table>
<thead>
<tr>
<th>Dates</th>
<th>N</th>
<th>( \beta ) (S. E.)</th>
<th>t: ( \beta = 0 )</th>
<th>t: ( \beta = 1 )</th>
<th>DW</th>
<th>F prob</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emerging and newly industrialized economies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>88</td>
<td>0.4260 (0.6604)</td>
<td>0.65</td>
<td>0.76</td>
<td>1.90</td>
<td>0.5206</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>88</td>
<td>-0.0439 (0.0376)</td>
<td>-1.17</td>
<td>768</td>
<td>2.44</td>
<td>0.2468</td>
</tr>
<tr>
<td>Hungary</td>
<td>78</td>
<td>0.7541 (1.2594)</td>
<td>0.60</td>
<td>0.04</td>
<td>1.82</td>
<td>0.5511</td>
</tr>
<tr>
<td>India</td>
<td>78</td>
<td>-0.6181 (0.8612)</td>
<td>-0.72</td>
<td>3.53</td>
<td>1.43</td>
<td>0.4751</td>
</tr>
<tr>
<td>Indonesia</td>
<td>73</td>
<td>0.1456 (0.2055)</td>
<td>0.71</td>
<td>17.28</td>
<td>1.55</td>
<td>0.4807</td>
</tr>
<tr>
<td>Kuwait</td>
<td>88</td>
<td>0.4050 (0.9394)</td>
<td>0.43</td>
<td>0.40</td>
<td>1.89</td>
<td>0.6674</td>
</tr>
<tr>
<td>Mexico</td>
<td>88</td>
<td>-0.6399 (0.4079)</td>
<td>-1.57</td>
<td>16.16</td>
<td>1.99</td>
<td>0.1204</td>
</tr>
<tr>
<td>Philippines</td>
<td>88</td>
<td>1.6770 (1.7128)</td>
<td>0.98</td>
<td>0.16</td>
<td>1.87</td>
<td>0.3303</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>88</td>
<td>-0.0831 (0.0835)</td>
<td>-1.00</td>
<td>168.17</td>
<td>2.94</td>
<td>0.3223</td>
</tr>
<tr>
<td>Singapore</td>
<td>88</td>
<td>0.1911 (1.2898)</td>
<td>0.15</td>
<td>0.39</td>
<td>1.86</td>
<td>0.8826</td>
</tr>
<tr>
<td>South Africa</td>
<td>88</td>
<td>-3.2693 (1.8403)</td>
<td>-1.78</td>
<td>5.38</td>
<td>1.74</td>
<td>0.0792</td>
</tr>
<tr>
<td>Taiwan</td>
<td>88</td>
<td>0.1442 (0.5252)</td>
<td>0.27</td>
<td>2.65</td>
<td>1.75</td>
<td>0.7842</td>
</tr>
<tr>
<td>Thailand</td>
<td>88</td>
<td>0.9613 (0.6853)</td>
<td>1.40</td>
<td>0.00</td>
<td>1.62</td>
<td>0.1643</td>
</tr>
<tr>
<td>Turkey</td>
<td>88</td>
<td>-0.0031 (0.0284)</td>
<td>-0.11</td>
<td>1241</td>
<td>1.54</td>
<td>0.9133</td>
</tr>
</tbody>
</table>

Forecast horizon is 1 month.

Notes: point estimates from the regression in Eq. (6) (robust standard errors in parentheses).

Table 6
Five-year horizon uncovered interest parity results with ex post spot exchange rates

<table>
<thead>
<tr>
<th>Country</th>
<th>Period</th>
<th>( \hat{\alpha} )</th>
<th>( \hat{\beta} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark krone</td>
<td>1983:2–1994:2</td>
<td>0.038*** (0.011)</td>
<td>1.699** (0.294)</td>
</tr>
<tr>
<td>Irish pound</td>
<td>1985:1–1993:4</td>
<td>0.013 (0.010)</td>
<td>0.013* (0.556)</td>
</tr>
<tr>
<td>Netherlands gulden</td>
<td>1986:2–1993:4</td>
<td>0.015*** (0.005)</td>
<td>0.833 (0.386)</td>
</tr>
<tr>
<td>Norway krone</td>
<td>1986:1–1994:2</td>
<td>-0.014** (0.006)</td>
<td>-0.392*** (0.280)</td>
</tr>
<tr>
<td>Spanish peseta</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sweden krona</td>
<td>1987:1–1994:2</td>
<td>-0.006 (0.016)</td>
<td>0.600 (0.471)</td>
</tr>
<tr>
<td>Swiss franc</td>
<td>1979:1–1994:2</td>
<td>-0.011*** (0.003)</td>
<td>1.023 (0.074)</td>
</tr>
</tbody>
</table>

Notes: Point estimates from the regression in Eq. (6) (serial correlation robust standard errors in parentheses, calculated assuming approximately \((k-1)\) moving average serial correlation). Reported sample period pertains to the interest rates; to obtain samples pertaining to the ex post depreciations, add 5 years. ** [***] Different from null of unity at 10% (5%) (1%) marginal significance level.

Source: Madarassy and Chinn (2002), Table 2.
Discussion
The forward market in emerging currencies: Less biased than in major currencies

Jeffrey Frankel*, Jumana Poonawala

John F. Kennedy School of Government, Harvard University, Cambridge, MA 02138, USA
Abstract

• Many studies have replicated the finding that the forward rate is a biased predictor of the future change in the spot exchange rate. Usually the forward discount actually points in the wrong direction.

• But, at least until recently, those studies applied only to advanced economies and major currencies.

• We apply the same tests to a sample of 14 emerging market currencies. We find a smaller bias than for advanced country currencies. The coefficient is on average positive, i.e., the forward discount at least points in the right direction. It is never significantly less than zero.
Abstract

• This suggests that a time-varying exchange risk premium may not be the explanation for traditional findings of bias.

• The reasoning is that emerging markets are probably riskier; yet we find that the bias in their forward rates is smaller.

• Emerging market currencies probably have more easily-identified trends of depreciation than currencies of advanced countries.
\[ \Delta s_{t+1} = \alpha + \beta (f_t - s_t) + \varepsilon_{t+1} \]

- The null hypothesis of unbiasedness is \( \beta = 1 \).
- The null would imply that there is no systematic time-varying component to the prediction errors:
- The null hypothesis is a joint hypothesis, comprising two distinct conditions:
  - (1) rational expectations: \( E_t \Delta s_{t+1} = \Delta s^e_{t+1} \)
  - (2) no time-varying risk premium: \( r p_t \equiv E_t \Delta s_{t+1} - f d_t - \alpha = 0 \)
    - \( E_t \Delta s_{t+1} \): the mathematical expectations
    - \( \Delta s^e_t \): expectations held by investors
• The null hypothesis is almost always rejected statistically, and often the finding is $\beta < 0$

• The question then becomes whether the findings of bias are to be interpreted as a time-varying risk premium, or as systematic expectation errors.
Emerging Market currencies

- Intuitively, EM currencies are probably riskier to hold than major currencies; one might think that the risk premium would therefore be larger and more variable than for major currencies.

- At the same time, EM currencies are more prone to bouts of high inflation and other sources of medium-term trends, so that one might think it would be easier to forecast the direction of movement of the spot rate than is the case for major currencies, where the exchange rate is closer to a random walk.

- If the bias is greater for EM currencies, that would point toward the risk premium interpretation; if less, then the other interpretation.
• We hasten to add that this suggested motivation is not demonstrated on the basis of formal theory. It would be hard to do so. It would not be easy, for example, to rule out the possibility that even though emerging market currencies have higher variance, their risk is highly diversifiable so that the risk premium could in theory go the other way. However, there is a bit of evidence, from survey data, that investors indeed find it easier to forecast the direction of movement of EM currencies than of major currencies.
• Exploiting the bias means “going long” in the currency that sells at a forward discount, relative to others.
• By CIP, this is the same thing as going long in the currency that pays a higher short-term nominal interest rate, relative to others.
• Examples
  – Convergence play in the early 1990s among ERM currencies
  – Convergence play in the 2000s for Central European euro-candidate countries
  – Yen carry trade in the mid-1990s
  – Dollar carry trade during 2001-09
• One striking pattern about these episodes is that there are long intervals during which one would have happily made money on average with these strategies, but that these intervals were dramatically punctuated (though not fully reversed) by crises, in 1992 in Western Europe, 1997–1998 in East Asia, and 2008 in Central Europe, Iceland, and elsewhere.
Table 1
Individual advanced country regressions (12/31/96-04/30/04). Coefficients with robust standard errors (forecast horizon is 1 month): $s_{t+1} - s_t = \alpha + \beta (\hat{f}_t - s_t) + \epsilon_{t+1}$.

<table>
<thead>
<tr>
<th>Advanced economies</th>
<th>Dates</th>
<th>N</th>
<th>$\beta$ (SE)</th>
<th>$t$: $\beta = 0$</th>
<th>$t$: $\beta = 1$</th>
<th>DW</th>
<th>$F$ prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>12/96-4/04</td>
<td>88</td>
<td>-5.6437 (2.1666)</td>
<td>-2.60</td>
<td>9.40</td>
<td>1.95</td>
<td>0.0108</td>
</tr>
<tr>
<td>Austria</td>
<td>12/96-4/04</td>
<td>88</td>
<td>-5.2804 (1.9551)</td>
<td>-2.70</td>
<td>10.32</td>
<td>1.75</td>
<td>0.0083</td>
</tr>
<tr>
<td>Belgium</td>
<td>12/96-4/04</td>
<td>88</td>
<td>-5.5236 (1.9642)</td>
<td>-2.81</td>
<td>11.03</td>
<td>1.75</td>
<td>0.0061</td>
</tr>
<tr>
<td>Canada</td>
<td>12/96-4/04</td>
<td>88</td>
<td>-3.2183 (1.8926)</td>
<td>-1.70</td>
<td>4.97</td>
<td>1.96</td>
<td>0.0927</td>
</tr>
<tr>
<td>Denmark</td>
<td>12/96-4/04</td>
<td>88</td>
<td>-5.5150 (2.0319)</td>
<td>-2.71</td>
<td>10.28</td>
<td>1.76</td>
<td>0.0080</td>
</tr>
<tr>
<td>Euro</td>
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<td>-5.6024 (2.0813)</td>
<td>-2.69</td>
<td>10.06</td>
<td>1.81</td>
<td>0.0086</td>
</tr>
<tr>
<td>Finland</td>
<td>12/96-4/04</td>
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<td>-5.4680 (1.9057)</td>
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<td>11.52</td>
<td>1.78</td>
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<td>France</td>
<td>12/96-4/04</td>
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<td>-5.1522 (1.9419)</td>
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<td>10.04</td>
<td>1.74</td>
<td>0.0095</td>
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<tr>
<td>Germany</td>
<td>12/96-4/04</td>
<td>88</td>
<td>-5.2964 (1.9384)</td>
<td>-2.73</td>
<td>10.55</td>
<td>1.75</td>
<td>0.0076</td>
</tr>
<tr>
<td>Greece</td>
<td>12/96-4/04</td>
<td>88</td>
<td>2.4052 (2.0348)</td>
<td>1.18</td>
<td>0.48</td>
<td>1.77</td>
<td>0.2405</td>
</tr>
<tr>
<td>Ireland</td>
<td>12/96-4/04</td>
<td>88</td>
<td>-5.6322 (2.1612)</td>
<td>-2.61</td>
<td>9.42</td>
<td>1.77</td>
<td>0.0108</td>
</tr>
<tr>
<td>Italy</td>
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<td>-3.6422 (2.2115)</td>
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<td>4.41</td>
<td>1.66</td>
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<tr>
<td>Japan</td>
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<td>-5.1816 (1.9166)</td>
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<td>10.40</td>
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<td>-3.9942 (2.0142)</td>
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<td>6.15</td>
<td>1.62</td>
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<td>Norway</td>
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<td>-3.8507 (1.4636)</td>
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<td>10.98</td>
<td>2.18</td>
<td>0.0101</td>
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<td>Portugal</td>
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<td>-2.02</td>
<td>6.15</td>
<td>1.69</td>
<td>0.0462</td>
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<tr>
<td>Spain</td>
<td>12/96-4/04</td>
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<td>-4.8614 (2.2027)</td>
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<td>7.08</td>
<td>1.68</td>
<td>0.0300</td>
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<tr>
<td>Sweden</td>
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<td>-5.5293 (1.8184)</td>
<td>-3.04</td>
<td>12.89</td>
<td>2.01</td>
<td>0.0031</td>
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<tr>
<td>Switzerland</td>
<td>12/96-4/04</td>
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<td>-4.3037 (2.0588)</td>
<td>-2.09</td>
<td>6.64</td>
<td>1.85</td>
<td>0.0395</td>
</tr>
<tr>
<td>UK</td>
<td>12/96-4/04</td>
<td>88</td>
<td>-3.9999 (2.8715)</td>
<td>-1.39</td>
<td>3.03</td>
<td>2.10</td>
<td>0.1673</td>
</tr>
</tbody>
</table>
Table 2
Individual emerging market country regressions (12/31/96–04/30/04). Coefficients with robust standard errors. Forecast horizon is 1 month: $s_{t+1} - s_t = \alpha + \beta (f_t - s_t) + \epsilon_t$.

<table>
<thead>
<tr>
<th>Emerging and newly industrialized economies</th>
<th>Dates</th>
<th>N</th>
<th>$\beta$ (SE)</th>
<th>$t$: $\beta = 0$</th>
<th>$t$: $\beta = 1$</th>
<th>DW</th>
<th>$F$ prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Czech Republic</td>
<td>12/96–4/04</td>
<td>88</td>
<td>0.4260 (0.6604)</td>
<td>0.65</td>
<td>0.76</td>
<td>1.90</td>
<td>0.5206</td>
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<tr>
<td>Hong Kong</td>
<td>12/96–4/04</td>
<td>88</td>
<td>-0.0439 (0.0376)</td>
<td>-1.17</td>
<td>768</td>
<td>2.44</td>
<td>0.2468</td>
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<tr>
<td>Hungary</td>
<td>10/97–4/04</td>
<td>78</td>
<td>0.7541 (1.2594)</td>
<td>0.60</td>
<td>0.04</td>
<td>1.82</td>
<td>0.5511</td>
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<tr>
<td>India</td>
<td>10/97–4/04</td>
<td>78</td>
<td>-0.6181 (0.8612)</td>
<td>-0.72</td>
<td>3.53</td>
<td>1.43</td>
<td>0.4751</td>
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<tr>
<td>Indonesia</td>
<td>12/96–12/02</td>
<td>73</td>
<td>0.1456 (0.2055)</td>
<td>0.71</td>
<td>17.28</td>
<td>1.55</td>
<td>0.4807</td>
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<td>Kuwait</td>
<td>12/96–4/04</td>
<td>88</td>
<td>0.4050 (0.9394)</td>
<td>0.43</td>
<td>0.40</td>
<td>1.89</td>
<td>0.6674</td>
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<tr>
<td>Mexico</td>
<td>12/96–4/04</td>
<td>88</td>
<td>-0.6399 (0.4079)</td>
<td>-1.57</td>
<td>16.16</td>
<td>1.99</td>
<td>0.1204</td>
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<td>Philippines</td>
<td>12/96–4/04</td>
<td>88</td>
<td>1.6770 (1.7128)</td>
<td>0.98</td>
<td>0.16</td>
<td>1.87</td>
<td>0.3303</td>
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<tr>
<td>Saudi Arabia</td>
<td>12/96–4/04</td>
<td>88</td>
<td>-0.0831 (0.0835)</td>
<td>-1.00</td>
<td>168.17</td>
<td>2.94</td>
<td>0.3223</td>
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<tr>
<td>Singapore</td>
<td>12/96–4/04</td>
<td>88</td>
<td>0.1911 (1.2898)</td>
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<td>0.39</td>
<td>1.86</td>
<td>0.8826</td>
</tr>
<tr>
<td>South Africa</td>
<td>12/96–4/04</td>
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<td>-1.78</td>
<td>5.38</td>
<td>1.74</td>
<td>0.0792</td>
</tr>
<tr>
<td>Taiwan</td>
<td>12/96–4/04</td>
<td>88</td>
<td>0.1442 (0.5252)</td>
<td>0.27</td>
<td>2.65</td>
<td>1.75</td>
<td>0.7842</td>
</tr>
<tr>
<td>Thailand</td>
<td>12/96–4/04</td>
<td>88</td>
<td>0.9613 (0.6853)</td>
<td>1.40</td>
<td>0.00</td>
<td>1.62</td>
<td>0.1643</td>
</tr>
<tr>
<td>Turkey</td>
<td>12/96–4/04</td>
<td>88</td>
<td>-0.0031 (0.0284)</td>
<td>-0.11</td>
<td>1241</td>
<td>1.54</td>
<td>0.9133</td>
</tr>
</tbody>
</table>

Note on DW stat: For the test of null hypotheses (no autocorrelation) at the 5% significance level, the appropriate $dl$ and $dU$ critical values for 80–99 observations and one explanatory variable are 1.61 and 1.66 respectively, i.e., we reject if $d < 1.61$ and do not reject if $d > 1.66$. For 60–79 observations, $dl = 1.55$ and $dU = 1.62$. 
Uncovered interest-rate parity over the past two centuries
James R. Lothian\textsuperscript{a,}\textsuperscript{*}, Liuren Wu\textsuperscript{b,1}
Abstract

• We study the validity of UIP by constructing ultra-long time series that span two centuries.
• The forward-premium regressions yield positive slope estimates over the whole sample. The estimates become negative only when the sample is dominated by the period of 1980s.
• We also find that large interest-rate differentials have significantly stronger forecasting powers for currency movements than small interest-rate differentials. Furthermore, when we regress domestic currency returns on foreign bonds against returns on domestic bonds as an alternative test of the parity condition, the null hypotheses of zero intercept and unit slope cannot be rejected in most cases.
• These results are consistent with a world in which expectations formation is highly imperfect and characterized on the one hand by slow adjustment of expectations to actual regime changes and on the other by anticipations for extended periods of regime changes or other big events that never materialize.

• An historical account of expected and realized regime changes adds credence to this explanation and illustrates how uncovered interest-rate parity holds over the very long haul but nevertheless can be deviated from over long periods of time due to ex post-expectation errors.