# International Parity Conditions: Interest Rate Parity and Fisher Parities

- The Usefulness of Parity Conditions in International Financial Markets: A Reprise
- Interest Rate Parity: (quick review)
  - » With and w/o PCM conditions, empirical evidence
- International Fisher Effect (Uncovered Interest Parity):
  - » With and w/o PCM conditions, empirical evidence
  - » What do interest rates predict about current and future exchange rates?
- Forward Rate Unbiased:
  - » Evidence for a forward bias is strong
  - » Explanations and interpretations vary considerably
  - » Developing a forward rate bias strategy

## Usefulness of Parity Conditions in International Financial Markets: A Reprise

- Compared to PPP, violations in the other parity conditions may present more immediate profit opportunities. Why?
  - » Because the cost of entering into financial transactions is typically less than in goods markets.
- If a financial parity condition is violated, an immediate profit opportunity may be present.
- However, note that financial markets are often subject to controls and taxes.

# ***Interest Rate Parity (IRP)***

*or Covered Interest Parity*

The forward exchange rate premium equals (approximately) the U.S. interest rate minus the foreign interest rate.

$$\left(F - S\right)/S \cong i_{\$} - i_{£}$$

Driving force: Arbitrage between the spot and forward exchange rates, and money market interest rates.

# Interest Rate Parity in a PCM

- IRP draws on the principle that in equilibrium, two investments exposed to the same risks must have the same returns.
- Suppose an investor puts \$1 in a US\$ security. At the end of one period, wealth = \$1 $\times$ (1 + $i_{\$}$)
- Alternatively, the investor can put the \$1 in a UK£ security and *cover* his or her exposure to UK£ exchange rate changes. At the end of one period, wealth =

$$\$1 \times \frac{1.0}{S_t} \times \left(1 + i_{£}\right) \times F_{t,1}$$

# Interest Rate Parity in a PCM

- Driven by *covered interest arbitrage*, the two investments should produce identical ending wealth. So,

$$\$1 \times \frac{1.0}{S_t} \times (1 + i_{£}) \times F_{t,1} = \$1 \times (1 + i_{\$})$$

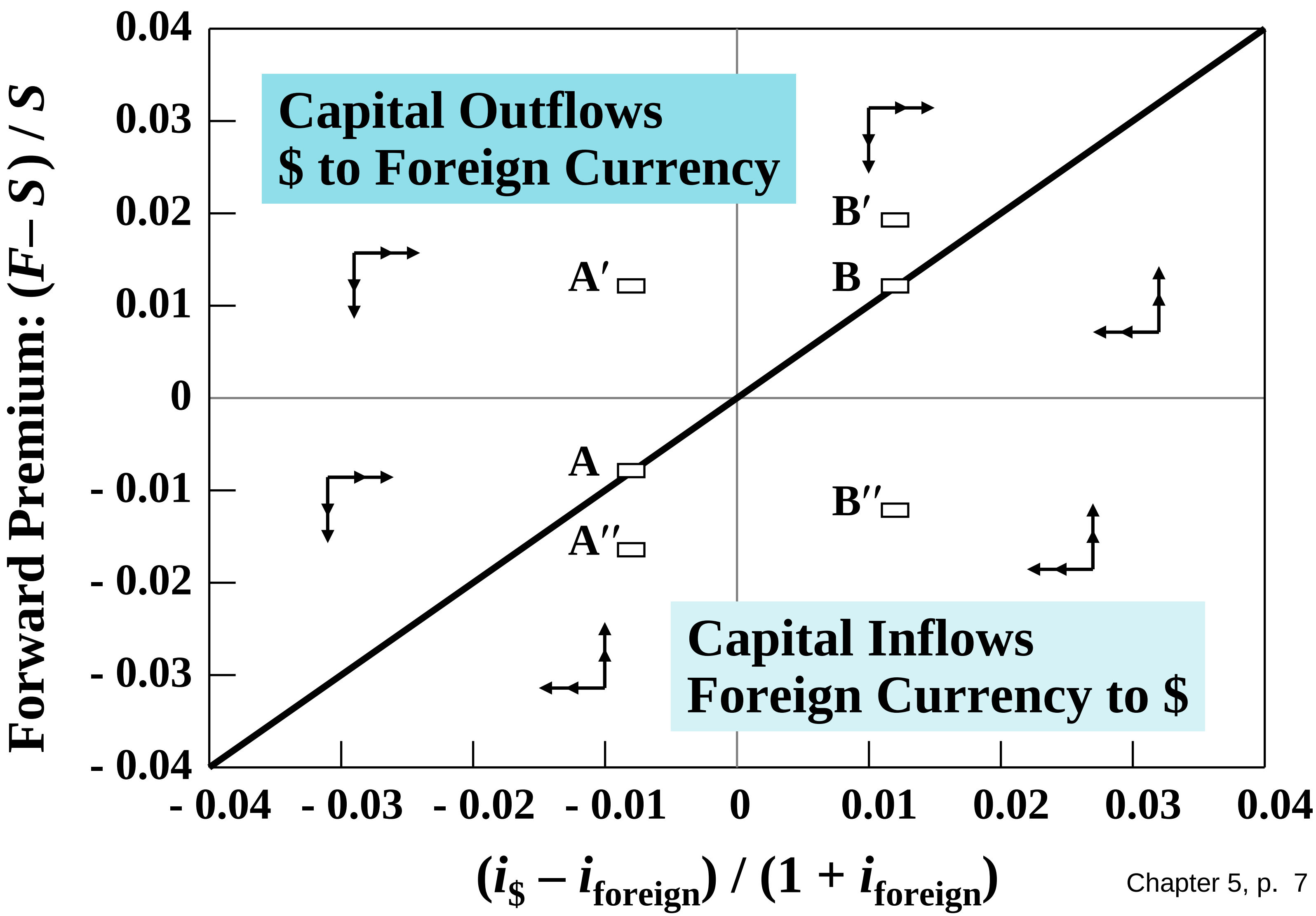
$$\Rightarrow \qquad \frac{F_{t,1} - S_t}{S_t} = \frac{i_{\$} - i_{£}}{1 + i_{£}}$$

% forward premium = % interest differential

# Interest Rate Parity in a PCM

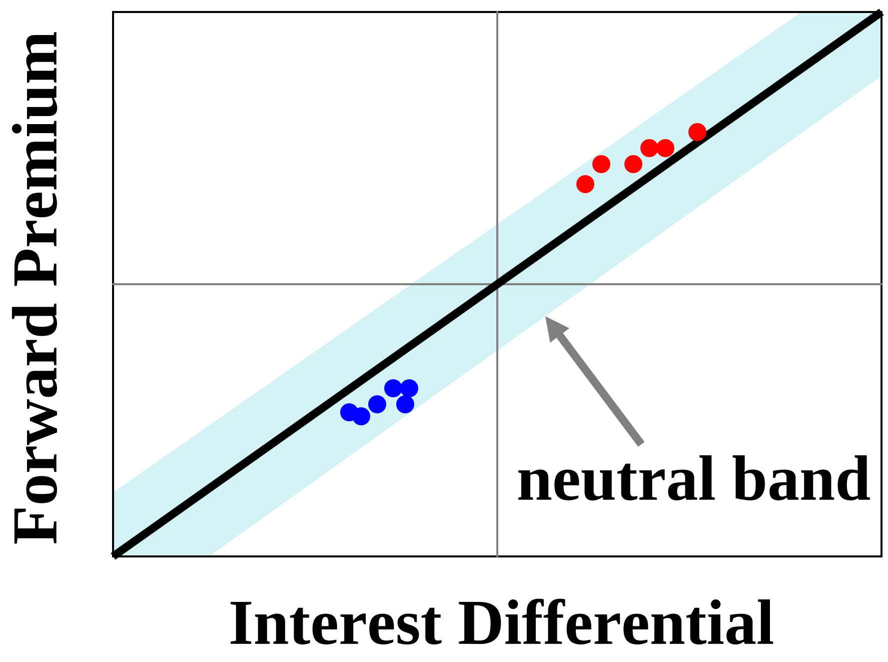
- The term (F–S)/S is called the ***forward premium***. When (F–S)/S < 0, the term ***forward discount*** is often used.
- When the forward premium or discount is plotted against the interest rate differential, the 45° line represents the ***interest rate parity line***.
- The IRP line represents the dividing line between investments in the domestic security and investments in the foreign security that have been covered against exchange risk.

# The Interest Rate Parity Line
## Equilibrium and Disequilibrium Points



# Interest Rate Parity: Relaxing the PCM

- Transaction costs have the effect of creating a "neutral band" within which covered interest arbitrage transactions will not occur.



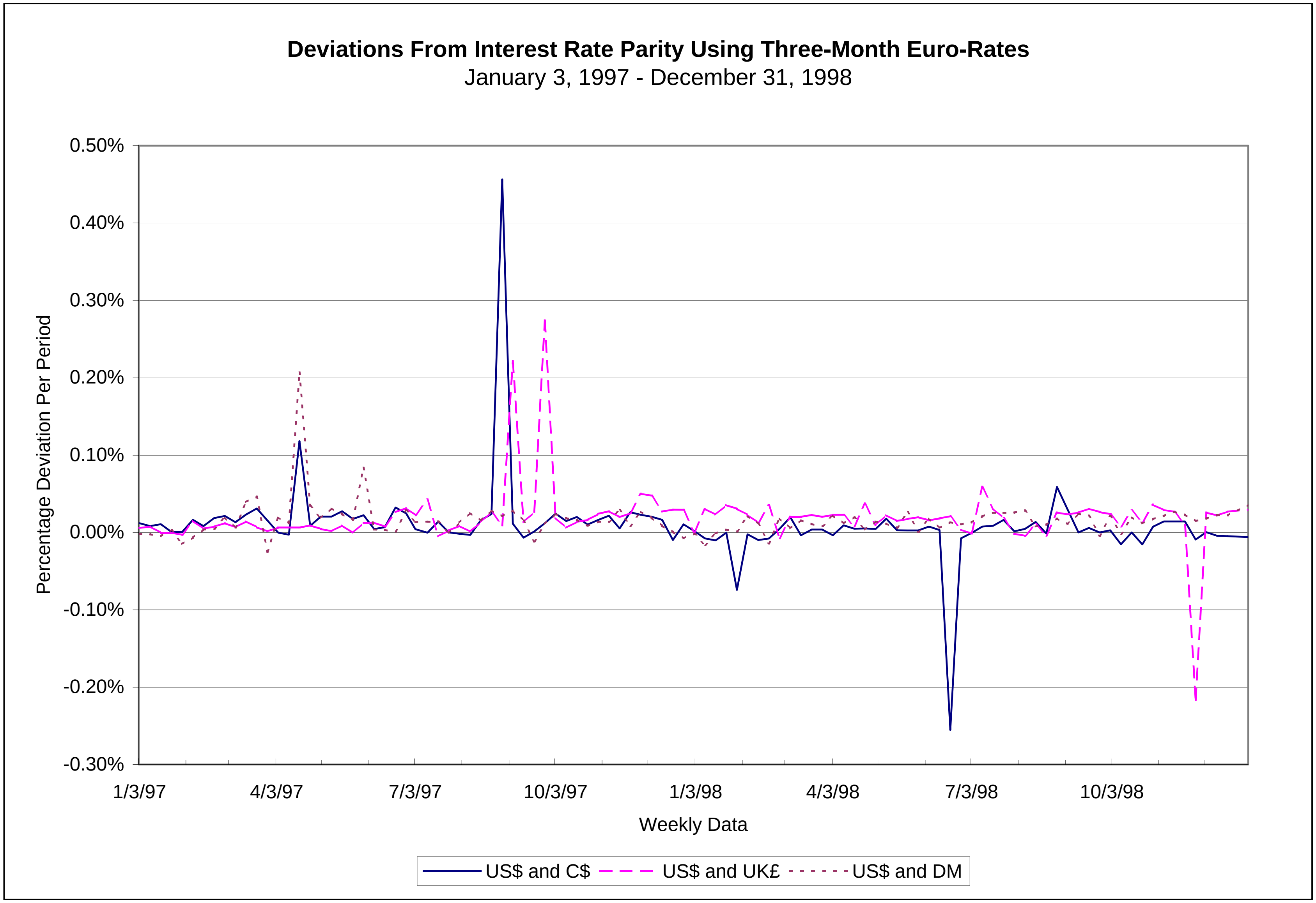
# Interest Rate Parity: Relaxing the PCM

- Differential capital gains and ordinary income tax rates can tilt the 45° slope of the IRP line.
  - » Why?
    - (F-S)/S is taxed at $\tau_k$, while (i-i*) is taxed at $\tau_y$
    - $\tau_k$ may not equal $\tau_y$
  - » However, the actual impact depends on the exact tax rates, the number of people who are subject to those rates, and transactions costs which may dominate the role of taxes.
- Uncertainty may be present when attempting arbitrage.
  - » Placing orders takes time and market prices may change.
  - » The foreign investment may include country risks.(What is CR?)
    - Example: CSFB and Russia in 1998 (See Box 1.1, p. 9)

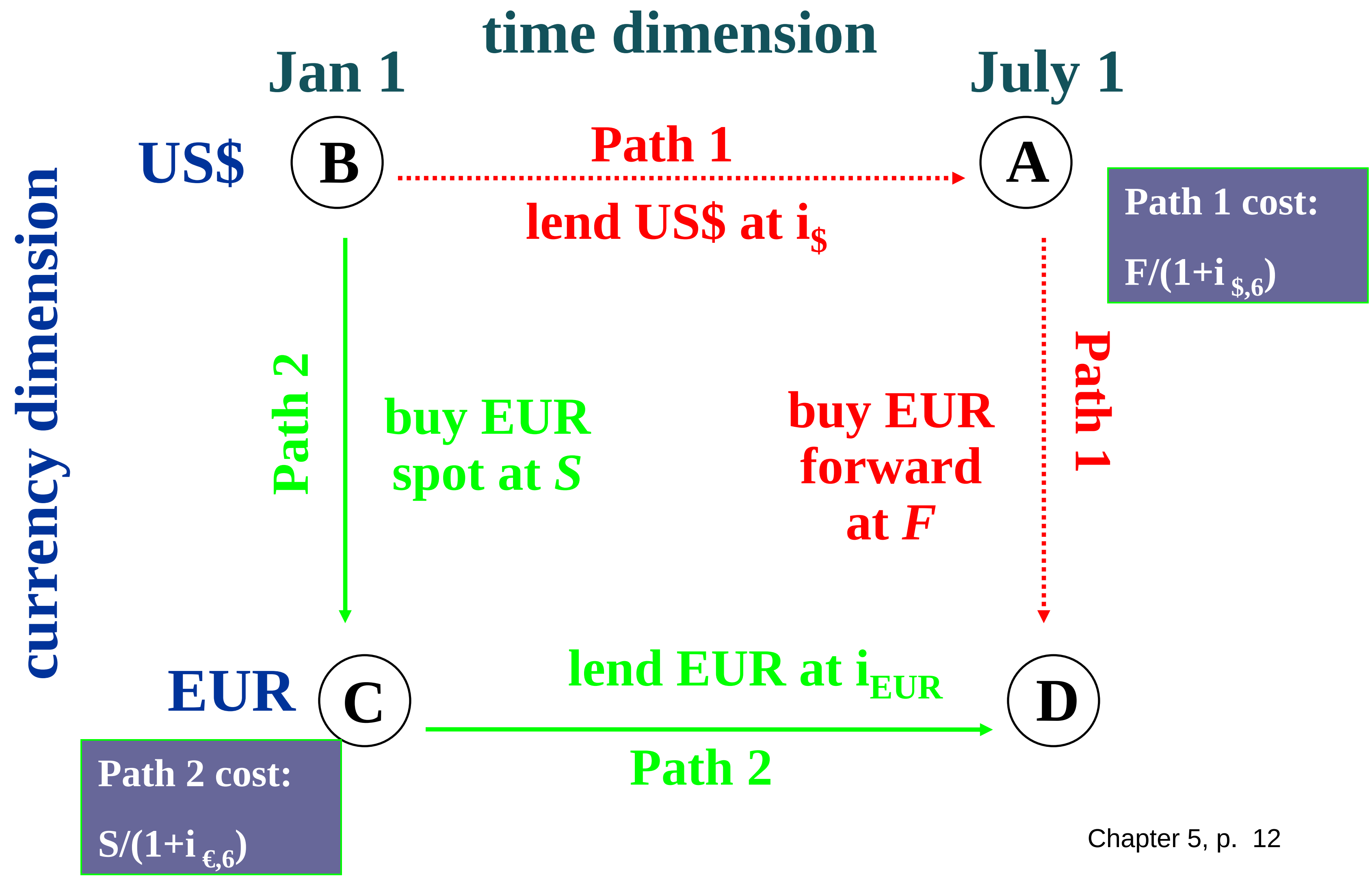
# Empirical Evidence on Interest Rate Parity

- The Eurocurrency markets made it possible to examine two securities that differed only in terms of their currency of denomination.
- The general result is that IRP holds in the short-term Eurocurrency market after accounting for transaction costs.
- For longer-term securities, studies show that deviations from parity are larger, and in some cases represent profit opportunities even after adjusting for transaction costs.

# Interest Rate Parity: Empirical Evidence



# One-Way Arbitrage:
## A Possible Strategy Even When IRP Holds



# The Fisher Parities: #1

## *Fisher Effect (Fisher Closed)*

For a single economy, the nominal interest rate equals the real interest rate plus the expected rate of inflation.

$$i_{\$} = r_{\$} + E\left(\Delta \tilde{P}_{\text{US}}\right)$$

Driving force: Desire to insulate the real interest rate against expected inflation,
and arbitrage between real and nominal assets.

# The Fisher Effect

- The Fisher effect represents arbitrage between real assets and nominal (or financial) assets within a single economy.
- At the end of one period, a $1 commodity holding can be liquidated for $\$1[1+E(\tilde{p})]$, where $E(\tilde{p})$ is the expected rate of inflation.
- To be indifferent, an interest-bearing security will need an end-of-period value of $\$1(1+r)[1+E(\tilde{p})]$, or $\$1(1+i)$.

# The Fisher Effect

- So, $(1+i) = (1+r)[1+E(\tilde{p})]$

  $\Rightarrow \quad i = r + E(\tilde{p}) + r\,E(\tilde{p})$

- Where inflation and the real interest rate are low, the Fisher effect is usually approximated as:

$$i = r + E(\tilde{p})$$

% nominal interest rate = % real interest rate + % expected inflation

# The Fisher Parities:  #2

## ***International Fisher Effect (Fisher Open)***

*or uncovered interest parity*

For two economies, the U.S. interest rate minus the foreign interest rate equals the expected percentage change in the exchange rate.

$$i_{\$} - i_{£} = E\left(\Delta \tilde{\text{S}}\text{pot}\right)$$

Driving force: Arbitrage between bonds denominated in two currencies, assuming no currency risk premium.

# The International Fisher Effect

- Interest rates across countries must also be set with an eye toward expected exchange rate changes.
- Suppose an investor puts \$1 in a US\$ security. At the end of one period, wealth = \$1 × (1 + $i_{\$}$)
- Alternatively, the investor can put the \$1 in a UK£ security. At the end of one period, wealth =

$$\$1 \times \frac{1.0}{S_t} \times \left(1 + i_{£}\right) \times E\left(\tilde{S}_{t+1}\right)$$

# The International Fisher Effect

- Under PCM assumptions, the ending wealth should be identical:

$$\$1 \times (1 + i_{\$}) = \$1 \times \frac{1.0}{S_t} \times (1 + i_{£}) \times E\left(\tilde{S}_{t+1}\right)$$

$$\Rightarrow \quad \frac{E\left(\tilde{S}_{t+1}\right) - S_t}{S_t} = \frac{i_{\$} - i_{£}}{1 + i_{£}} \qquad (5.5)$$

% expected exchange rate change = % interest differential

# What do Interest Rates Predict About Current and Future Exchange Rates? (1 of 2)

- The International Fisher Effect tells us about the market's *implied future spot rate* :

$$E\left(\tilde{S}_{t+1}\right) = \frac{\left(1+i_{\$}\right)}{\left(1+i_{£}\right)} \times S_t \qquad (5.6)$$

- Answers the question:
  - » Based on today's spot rate and interest rates, where does the market think the spot rate will be in one period?
  - » So, the market expects the US$ to de*preciate* when US$ interest rates are higher than foreign interest rates, and vice versa.
- Note: The International Fisher Effect implicitly assumes that real interest rates are equal in the two countries.

# What do Interest Rates Predict About Current and Future Exchange Rates? (2 of 2)

- By rearranging equation (5.6), we can see how the market sets the current spot exchange rate:

$$S_t = \frac{(1+i_{£})}{(1+i_{\$})} \times E\left(\tilde{S}_{t+1}\right) \approx \frac{E\left(\tilde{S}_{t+1}\right)}{1+(i_{\$}-i_{£})} \quad (5.7, 5.7a)$$

- These equations imply that the current spot rate is the discounted, or net present value of the expected future spot rate, using ($i_{\$}$ - $i_{£}$) as the discount rate
  - » The “Asset Approach” to valuing exchange rates. (Chapter 6)
  - » Answers the question: Conditional on our expected future spot rate and today’s interest rates, what would happen immediately to today’s spot rate if one of those variables changed?
  - » Equation implies that a higher $i_{\$}$ [keeping $i_{£}$ and $E(\tilde{S}_{t+1})$ fixed] leads to a $ appreciation.

# The International Fisher Effect: Relaxing the PCM Assumptions

- Transaction costs result in a neutral band around the parity line, while differential taxes can possibly tilt the parity line.
- Since the ending value of the foreign investment depends on an *uncertain* future spot rate, an exchange-risk premium *may be* required.
  - » Big issues
    - ◆ Is currency risk
      - – Diversifiable: Then no risk-premium
      - – Non-diversifiable: Then risk-premium
    - ◆ Are investors
      - – Risk averse: Then willing to pay a risk-premium
      - – Risk neutral: Then not willing to pay a risk-premium

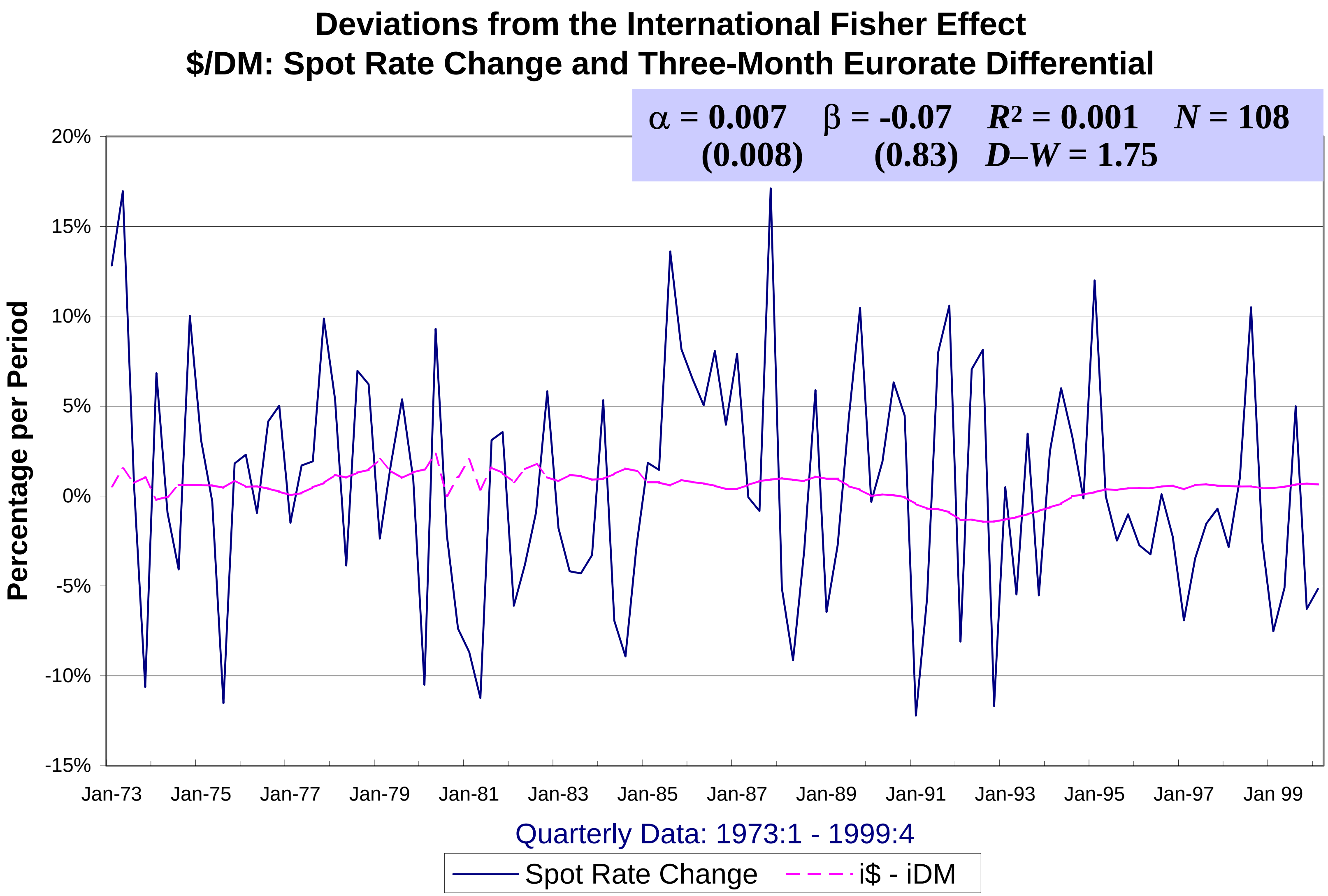
# Empirical Evidence on the International Fisher Effect

- To examine the International Fisher Effect (UIP), we can compare the future exchange rate change to the current interest rate differential:

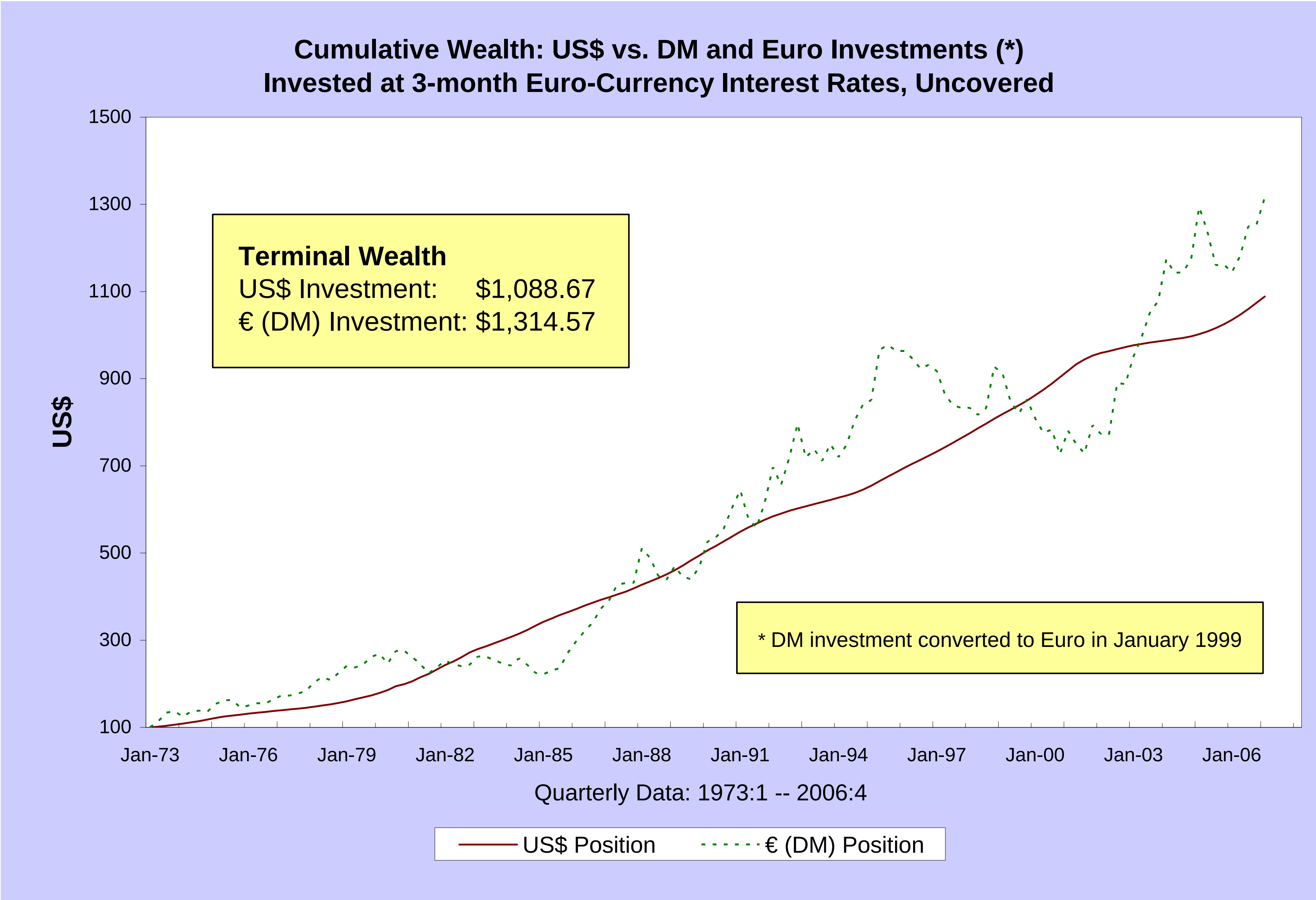
$$s_{t+1} = \alpha + \beta\,(i_{\$} - i_{DM})_t + \varepsilon_t$$

  - » Null hypotheses: $\alpha$=0, $\beta$=1, and $R^2$ is high
- Empirical tests indicate that UIP performs poorly in short time periods. (Figure 5.5 on next page. $R^2 < 0.01$)
- However, it appears that UIP performs better for longer maturity securities. (Chinn & Meredith, *IMF Staff Papers*, 2004)
- And also, over extended periods of time, it appears that currencies with high interest rates tend to depreciate, and vice versa, as predicted.

# Empirical Evidence on the International Fisher Effect



# Empirical Evidence on the International Fisher Effect



# Further Evidence on UIP – Short and Long

- Widespread documentation that UIP (where the present interest differential is an unbiased predictor of the future exchange rate change) fails with short-term interest rates
- Froot and Thaler (1990) report that in 75 published studies, average relationship was $\beta$ = -0.88 rather than $\beta$ = 1.0 as under the null
  - » So countries with high short-term interest rates tend to appreciate, rather than depreciate, contrary to UIP
  - » This supports the simple “carry trade” investment strategy
- Nearly all studies use short-term maturities ($\leq$ 12 months). Would longer maturities affect results? Can longer maturities shed light on UIP puzzle?

# Chinn and Meredith (2004) Short-Horizon

$$\Delta S(t,t+k) = \alpha + \beta\,[i(t,k) - i^{*}(t,k)] + \varepsilon(t,t+k)$$

Table 1. Short-Horizon Estimates of $\beta$

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

| | Maturity | | |
|---|---|---|---|
| Currency | 3 months | 6 months | 12 months |
| Deutsche mark | −0.809* (1.134) | −0.893*** (0.802) | −0.587*** (0.661) |
| Japanese yen | −2.887*** (0.997) | −2.926*** (0.800) | −2.627*** (0.700) |
| U.K. pound | −2.202*** (1.086) | −2.046*** (1.032) | −1.418*** (0.986) |
| French franc | −0.179 (0.904) | −0.154 (0.787) | −0.009 (0.773) |
| Italian lira | 0.518 (0.606) | 0.635 (0.670) | 0.681 (0.684) |
| Canadian dollar | −0.477*** (0.513) | −0.572*** (0.390) | −0.610*** (0.490) |
| Constrained panel[1] | −0.757*** (0.374) | −0.761*** (0.345) | −0.536*** (0.369) |

Notes: Point estimates from the regression in equation (7) (serial correlation robust standard errors in parentheses, calculated assuming *k*-1 moving average serial correlation). Sample is 1980: Q1–2000: Q4. *, **, *** indicate different from null of unity at, respectively, the 10 percent, 5 percent, and 1 percent marginal significance level.

[1]Fixed-effects regression. Standard errors adjusted for serial correlation (see text).

- Average $\beta$ = -0.8 (about like past studies)
- In most cases, reject $\beta$=1.0

# Chinn and Meredith (2004) Long-Horizon

## Long-Horizon Tests

- Sample period 1983Q1 – 2000Q4 (ten years after start of floating rates)
- Bond maturities 5-year and 10-year for 6 countries
- Data problems ("Data are inherently somewhat less pure" for testing UIP)
  - » Onshore instruments – Can be subject to taxes, capital controls, …
  - » For some instruments, maturities are approximate
  - » Not zero coupon rates, so not exactly consistent with UIP equation.
  - » Errors in variables problem would bias $\beta$ estimate toward zero
- Regression estimated by currency, and pooled to add power.

# Chinn and Meredith (2004) Long-Horizon

Long-Horizon Results

- 10-year Benchmark bonds – Panel 2a
  - For pooled sample ( “constrained panel”), $\beta$=0.616
  - Less than 1.0, but still closer to 1.0 than 0.0
  - $R^2$ = 0.53 which is quite reasonable
- 10-year synthetic constant maturity bonds – Panel 2b
  - Pooled results very similar to results for Benchmark bonds
- 5-year Government bond yields –Panel 2c
  - $\beta$(i) > 0; not statistically different from $\beta$=1 (but also not different than $\beta$=0)
  - $R^2$ is smaller than for 10-year bonds

# Chinn and Meredith (2004) Long-Horizon

Table 2. Long-Horizon Tests of Uncovered Interest Parity

Panel 2b. 10-Year Government Bond Yields
*(MA(39)-adjusted standard errors in parentheses)*

| | $\hat{\alpha}$ | $\hat{\beta}$ | Reject $H_0$: $\beta = 1$ | $R^2$ | $N$ |
|---|---|---|---|---|---|
| Deutsche mark | 0.004 (0.004) | 0.918 (0.214) | | 0.45 | 72 |
| Japanese yen | 0.036 (0.006) | 0.431 (0.170) | *** | 0.10 | 72 |
| U.K. pound | 0.003 (0.003) | 0.716 (0.102) | *** | 0.45 | 72 |
| Canadian dollar | –0.005 (0.003) | 0.603 (0.254) | | 0.08 | 72 |
| Constrained panel[1] | . . . | 0.682 (0.143) | *** | 0.65 | 288 |

Notes: Point estimates from the regression in equation (7) (serial correlation robust standard errors in parentheses, calculated assuming *k*-1 moving average serial correlation). Sample period: 1983: Q1–2000: Q4. *, **, *** indicate different from null of unity at, respectively, the 10 percent, 5 percent, and 1 percent marginal significance level.

[1]Pooled regression, with fixed effects. Sample period: 1983: Q1–2000: Q4.

Panel 2c. 5-Year Government Bond Yields
*(MA(19)-adjusted standard errors in parentheses)*

| | $\hat{\alpha}$ | $\hat{\beta}$ | Reject $H_0$: $\beta = 1$ | $R^2$ | $N$ |
|---|---|---|---|---|---|
| Deutsche mark | –0.000 (0.012) | 0.870 (0.694) | | 0.08 | 84 |
| U.K. pound | –0.000 (0.015) | 0.455 (0.385) | | 0.03 | 84 |
| Canadian dollar | –0.009 (0.009) | 0.373 (0.464) | | 0.02 | 84 |
| Constrained panel[1] | . . . | 0.674 (0.412) | | 0.10 | 252 |

Notes: Point estimates from the regression in equation (7) (serial correlation robust standard errors in parentheses, calculated assuming *k*-1 moving average serial correlation). Sample period: 1980: Q1–2000: Q4. *, **, and *** indicate different from null hypothesis at, respectively, the 10 percent, 5 percent, and 1 percent marginal significance level.

[1]Fixed-effects regression. Standard errors adjusted for serial correlation (see text).

# Forward Rate Unbiased

- Because Covered Interest Parity holds

  $(F-S)/S = (i_{\$} - i_{£})$

- Tests of Forward Rate Unbiased

$$\Delta S(t,t+k) = \alpha + \beta\,[\,f(t,k) - s(t,k)] + \varepsilon(t,t+k)$$

  - » where $f$ = ln(F) and $s$ = ln(S) are identical to

- Tests of **Un**covered Interest Parity

$$\Delta S(t,t+k) = \alpha + \beta\,[i(t,k) - i^{*}(t,k)] + \varepsilon(t,t+k)$$

  - » The following table shows in the "changes" regressions that β is often negative, sometimes significantly negative, and $R^2$ are always trivially small.

# Empirical Tests of Forward Rate Unbiased

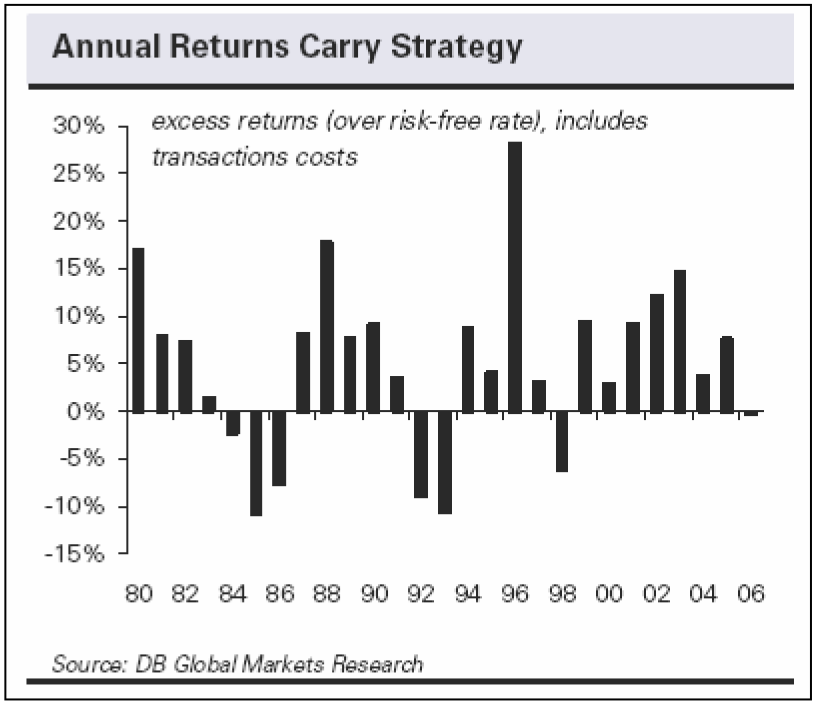
| | Levels | | | Percentage Changes | | |
|---|---|---|---|---|---|---|
| | $S_{t+n} = \alpha + \beta F_{t,n} + e_t$ | | | $\ln(S_{t+n}/S_t) = \alpha + \beta \ln(F_{t,n}/S_t) + e_t$ | | |
| Country | $\alpha$ | $\beta$ | $R^2$ | $\alpha$ | $\beta$ | $R^2$ |
| Belgium | 0.002 (0.001) | 0.933 (0.036) | 0.89 | -0.216 (0.721) | -0.025 (1.119) | 0.00 |
| Canada | -0.004 (0.028) | 1.005 (0.035) | 0.91 | -0.532 (0.289) | -0.788 (0.597) | 0.02 |
| France | 0.014 (0.006) | 0.917 (0.035) | 0.90 | -0.144 (0.758) | 0.506 (0.814) | 0.00 |
| Germany | 0.018 (0.021) | 0.963 (0.037) | 0.90 | 0.394 (0.806) | -0.540 (0.823) | 0.01 |
| Italy | 0.000 (0.000) | 0.949 (0.028) | 0.94 | 0.994 (1.094) | 1.497 (0.714) | 0.05 |
| Japan | 0.000 (0.000) | 0.969 (0.026) | 0.95 | 3.491 (1.111) | -3.212 (0.984) | 0.12 |
| Netherlands | 0.018 (0.018) | 0.960 (0.037) | 0.89 | 0.463 (0.778) | -0.969 (0.892) | 0.01 |
| Switzerland | 0.030 (0.027) | 0.948 (0.041) | 0.88 | 1.132 (1.018) | -1.024 (0.770) | 0.02 |
| United Kingdom | 0.140 (0.070) | 0.918 (0.041) | 0.86 | -1.180 (0.727) | -1.935 (0.893) | 0.06 |

Sample period Jan. 1979 – Dec. 1998, 3-mo. forwards, N=80 observations, standard errors in parenthesis.

# Forward Rate Bias – Trading Implications

- Contrary to UIP, countries with high short-term interest rates tend to appreciate, not depreciate,
- The simple "carry trade" investment strategy
  - » Own the high interest rate currency, financed by borrowing the low interest rate currency.
- More complex variations
  - » Own some basket of high interest rate currencies, financed by a basket of low interest rate currencies (Deutsche Bank)
  - » Selections can be ad-hoc (e.g. top three yielding currencies) or optimized in some way (e.g. Bilson (2003) based on covariance structure of expected returns).
  - » More on this in Chapter 7 (FX market efficiency)

# Excess Returns for Basket Carry Trade





- DB carry strategy ranks G10 currencies by their 3-month interest rates, and buys the top-3 yielding currencies and sells the bottom-3 yielding currencies. Annual excess returns since 1980 have been 5% with a Sharpe ratio of 0.6.

Source: Deutsche Bank, "Currencies: Carry Investing, March 29, 2007.

# Summary on UIP and Forward Bias

- Data on Interest Rate Parity (Covered Interest Parity) and the International Fisher Effect (Uncovered Interest Parity) produce radically different findings
  - » Deviations from IRP using eurocurrency rates tend to be small $\Rightarrow$ market efficiency
  - » Deviations from IFE (UIP) tend to be large in the short-run $\Rightarrow$ possible market inefficiency, or currency risk premium
  - » Deviations from UIP and the forward rate bias are similar, because the interest differential and forward premium are virtually identical.
- Both parity relationships offer useful information re: market expectations, and establish a benchmark for covered and uncovered financial strategies.