# INTERNATIONAL FINANCIAL MANAGEMENT

## THIRD EDITION

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# Chapter 7

Speculation and Risk in the Foreign Exchange Market

# 7.1 Speculating in the Foreign Exchange Market

- Uncovered foreign money market investments
  - Kevin Anthony, a portfolio manager, is considering several ways to invest $10M for 1 year
  - The data are as follows:
    - USD interest rate: 8.0% p.a.; GBP interest rate: 12.0% p.a.; Spot: $1.60/£
  - Remember that if Kevin invests in the USD-denominated asset at 8%, after 1 year he will have $10M \times 1.08 = \$10.8M$
  - What if Kevin invests his $10M in the pound money market, but decides not to hedge the foreign exchange risk?

# 7.1 Speculating in the Foreign Exchange Market

- As before, we can calculate his dollar return in three steps:
  - Convert dollars into pounds in the spot market
    - The $10M will buy $\$10M/(\$1.60/£) = £6.25M$ at the current spot exchange rate
      - This is Kevin's pound principal.
  - Calculate pound-denominated interest plus principal
    - Kevin can invest his pound principal at 12% yielding a return in 1 year of $£6.25M \times 1.12 = £7M$
  - Sell the pound principal plus interest at the spot exchange rate in 1 year
    - $Dollar\ proceeds\ in\ 1\ year = £7M \times S(t+1, \$/£)$
- $Excess\ return\ (t+1) = S(t+1) \times (£7M/\$10M) - (1+0.08)$

# Return and Excess Return in Foreign Market

- We can use the previous calculation to deduce a formula for calculating the return in the foreign market,

$$r(t+1) = \frac{1}{S(t)} \times \left(1 + i(t, \pounds)\right) \times S(t+1)$$

- The return on the British investment is uncertain because of exchange rate uncertainty.

- The excess return is the difference between the risky investment and the riskless investment in dollar deposits:

$$exr(t+1) = \frac{S(t+1)}{S(t)} \times \left(1 + i(t, \pounds)\right) - \left(1 + i(t, \$)\right)$$

# 7.1 Speculating in the Foreign Exchange Market

- Speculating with forward contracts
  - Break-even spot rate: $S^{BE} = S(t) \times \frac{[1+i(\$)]}{[1+i(£)]}$. The excess return is zero if $S(t+1) = S^{BE}$
  - Kevin's breakeven rate would be:
    - $SBE = \$1.60/£ \times (1 + 0.08)/(1 + 0.12) = \$1.5429/£$
  - If future exchange rate < forward: negative excess return
  - If future exchange rate > forward: positive excess return
- Comparing forward market and foreign money market investments
  - $Forward\ Market\ return\ (per\ \$) = fmr\ (t + 1) = [S(t + 1) - F(t)]/S(t)$
  - $fmr(t + 1) \times [1 + i(£)] = [S(t + 1)/S(t)] \times [1 + i(£)] - [1 + i(\$)]$
  - That is, the forward market return is simply the excess return when interest parity holds

# 7.1 Speculating in the Foreign Exchange Market

- Currency speculation and profits and losses
  - Quantifying expected losses and profits
    - Use the conditional expectation of the future exchange rate
    - Kevin expects the £ to depreciate against the $ by 3.57% over next year
      - $\$1.60/£ \times (1 - 0.0357) = \$1.5429/£$
        - $£7M \times \$1.5429/£ = \$10.8003M$
    - At what forex rate will Kevin just get his $10M back?
      - $£7M \times S = \$10M \rightarrow S = \$1.4286/£$
    - Probability that he will lose with 10% standard deviation of appreciation of £ would be $[S(t + 1, \$/£) - \$1.5429/£]/(\$0.16/£)$
      - $Test\ statistic = [\$1.4286/£ - \$1.5429/£]/(\$0.16/£) = -0.7144$
      - This works out to 23.75% probability that $S(t + 1/\$/£) < \$1.4286/£$

# Probability Kevin is a Loser

- Kevin finds the standard deviation of the change in the exchange rate is 10%. The current spot rate is $1.60, so one standard deviation is $0.16

- Since the exchange rate change has a normal distribution, if we divide the change by the standard deviation, we have a "standard Normal", N(0,1) distribution.

- Here we want the probability that [$1.4286/£ − $1.5429/£]/($0.16/£) will occur, or worse
  - $Test\ statistic\ =\ [\$1.4286/£ − \$1.5429/£]/(\$0.16/£) = −0.7144$
  - This works out to 23.75% probability that $S(t + 1/\$/£) < \$1.4286/£$

# Exhibit 7.2 Standard Normal Distribution
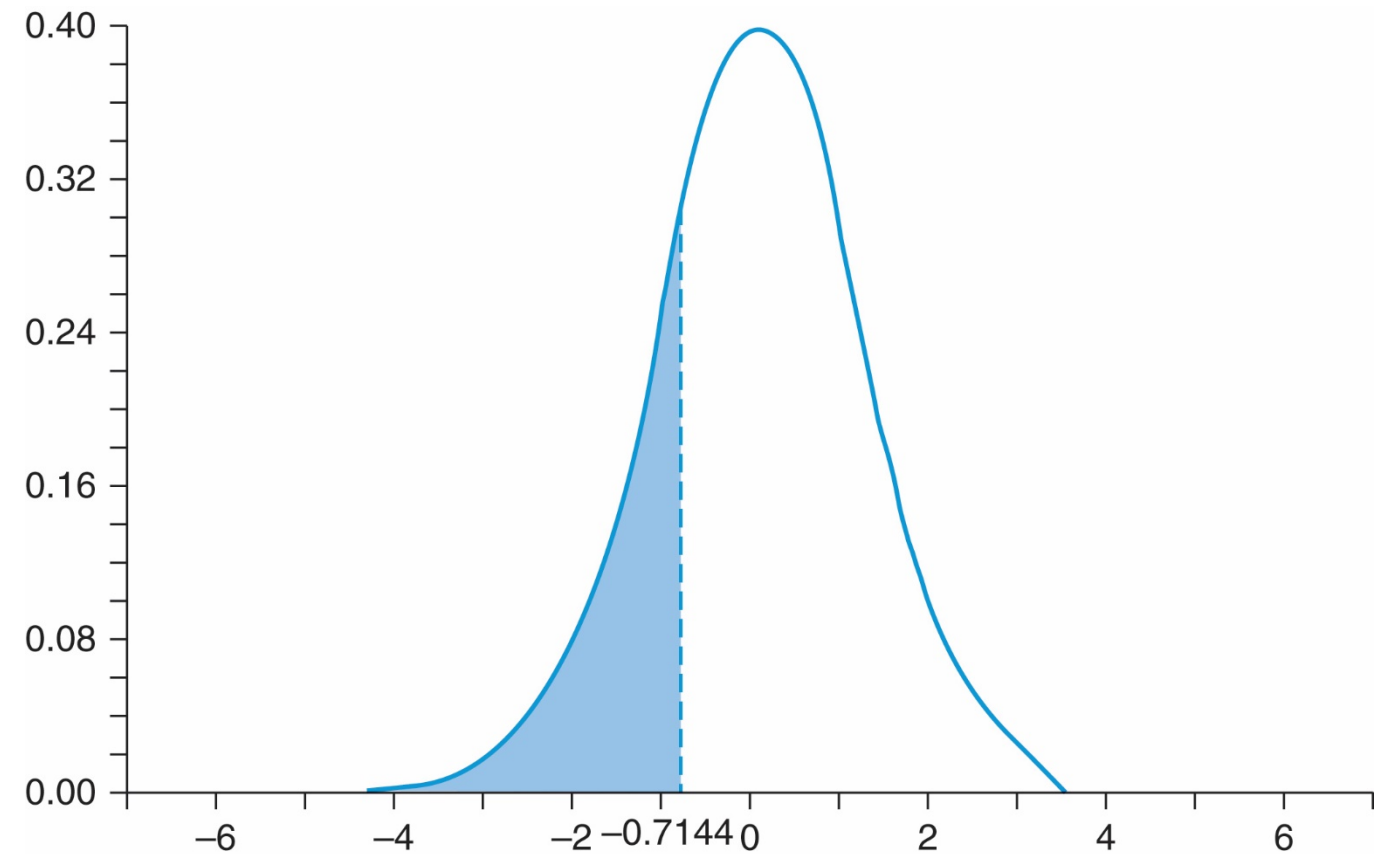
# 7.2 Uncovered Interest Rate Parity and the Unbiasedness Hypothesis

- Covered interest rate parity
  - Doesn't matter where you invest – you'll have the same domestic currency return as long as the foreign exchange risk is covered using a forward contract

- Uncovered interest rate parity
  - Domestic and foreign investments have same expected returns
  - In the context of Kevin's investment, suggests that the pound is not a great investment relative to the dollar – in fact, it suggests that the pound will depreciate by 3.57%

- Unbiasedness hypothesis
  - No systematic difference between the forward rate and the expected future spot rate

# 7.2 Uncovered Interest Rate Parity and the Unbiasedness Hypothesis

$$E_t \left[\frac{S(t+1)}{S(t)}\right][1 + i(\pounds)] = [1 + i(\$)] = \frac{F(t)}{S(t)}[1 + i(\pounds)]$$

Uncovered Interest Rate Parity

Covered Interest Rate Parity

$$E_t S(t+1) = F(t)$$

# 7.2 Uncovered Interest Rate Parity and the Unbiasedness Hypothesis

- Forecast error
  - The difference between the actual future spot exchange rate and its forecast

$$S(t+1) - E_t S(t+1)$$

- Unbiased predictors
  - Implies expected forecast error = 0
  - Can have large errors as long as not favoring one side

# 7.2 Uncovered Interest Rate Parity and the Unbiasedness Hypothesis

- The unbiasedness hypothesis and market efficiency
  - If the forward rate were biased then one side or the other of a bet (i.e., futures contract) would be expected the win
    - Then no one would volunteer to be on the other side of that bet
  - Consistency problem
    - If unbiased from one perspective, it must be biased in the other perspective, i.e., $/£ and £/$
    - Known as the Siegel Paradox – not important in practice, however

# 7.3 Risk Premiums in the Foreign Exchange Market

- How much are you willing to pay for fire insurance?
  - If your home is worth $250,000
  - Probability of a fire is 0.1%
  - $250,000 \times 0.001 = $250$
  - Some are willing to pay more because they are risk averse
- Analogous premiums in other areas to avoid uncertainty
  - Risk premium
- What determines risk premium?
  - Expected return on the asset in excess of the risk-free rate
  - Modern portfolio theory posits that risk-averse investors like high expected returns but dislike a high variance

# 7.3 Risk Premiums in the Foreign Exchange Market

- Systematic risk
  - Risk associated with an asset's return arising from the covariance of the return with the return on a large, well-diversified portfolio
    - Correlation: how two assets covary with each other [-1, 1]
  - The part of risk that commands a risk premium

- Unsystematic (idiosyncratic) risk
  - Risk that is attributed to the individual asset and can be diversified away

# 7.3 Risk Premiums in the Foreign Exchange Market

- Capital Asset Pricing Model (CAPM)
  - Nobel Prize (1990) – William Sharpe
  - Determines an asset's systematic risk
    - $E(r_{asset}) = r_f + \beta(r_m - r_f)$
      - $\beta(r_m - r_f)$ is the premium
    - $\beta = Covariance(r_{asset}, r_m)/Variance(r_m)$

# 7.3 Risk Premiums in the Foreign Exchange Market

- Applying the CAPM to forward market returns
  - Since forward contract is an asset, there could be an associated risk premium
    - Dollar profits / losses can covary with the dollar return on the market portfolio
    - Can be viewed as risky and therefore deserving of premium
      - The other side would have to hold with knowledge that they expect a loss
      - i.e., like fire insurance, or in this case, portfolio insurance

# More on Risk Premiums in the Foreign Exchange Market

- A general statement of the CAPM relationship for excess returns on asset $j$:

$$E_t\left\{R_j(t+1)-[1+i(t,\$)]\right\}=\beta_j E_t\left\{R_M(t+1)-[1+i(t,\$)]\right\}$$

where $\beta_j=\dfrac{\sigma_{jM}}{\sigma_{MM}}$ . $\sigma_{jM}$ is the covariance of $R_j(t+1)$ with $R_M(t+1)$

$\sigma_{MM}$ is the variance of $R_M(t+1)$

- Now we are interested in the excess return on a foreign investment

$$exr(t+1)=\frac{S(t+1)}{S(t)}\times\left(1+i(t,£)\right)-\left(1+i(t,\$)\right)=R_£(t+1)-\left(1+i(t,\$)\right)$$

# Risk premium continued

- Applying the general formula, we have:

$$E_t \left[ exr \left( t+1 \right) \right] = \beta_u E_t \left\{ R_M \left( t+1 \right) - [1 + i \left( t, \$ \right)] \right\}$$

where

$$\beta_j = \frac{Cov_t \left[ R_£ \left( t+1 \right), R_M \left( t+1 \right) \right]}{Var_t \left[ R_M \left( t+1 \right) \right]}$$

- We will spend some time deriving this model soon!

# 7.5 Empirical Evidence on the Unbiasedness Hypothesis

- An econometric test of the unbiasedness hypothesis
  - $fp(t, \$/£) = \frac{F(t,\$/£) - S(t,\$/£)}{S(t,\$/£)} = \frac{E_t[S(t+30,\$/£) - S(t,\$/£)]}{S(t,\$/£)} = E_t[s(t+30), \$/£]$
  - fp (left-hand side variable) is the 30-day forward premium/discount
  - If hypothesis holds, the expected return to currency speculation will be exactly zero
  - Problem: Statisticians cannot observe how market participants form their expectations, so assumptions have to be made
    - Investors act rationally (no mistakes or bias)
    - Realized appreciation = Expected appreciation + Forecast error where error is news-induced (i.e., unexpected)

- A test using the sample means
  - Weakest implication of unbiasedness hypothesis is that the unconditional mean of the realized appreciation is equal to the unconditional mean of the forward premium

# Exhibit 7.4 Means of Monthly Rates of Appreciation, Forward Premiums, and the Differences Between the Two

**Exhibit 7.4** Means of monthly rates of appreciation, forward premiums, and the differences between the two

| Exchange rate | Mean | | |
| --- | --- | --- | --- |
| | Rate of appreciation (s.e.) Conf. | Forward premium (s.e.) Conf. | Difference (s.e.) Conf. |
| $/€ | 1.65 | 1.19 | 0.45 |
| | (1.82) | (0.23) | (1.83) |
| | 0.64 | 1.00 | 0.19 |
| $/£ | −0.24 | −1.80 | 1.55 |
| | (1.74) | (0.21) | (1.75) |
| | 0.11 | 1.00 | 0.63 |
| ¥/$ | −1.78 | −2.88 | 1.10 |
| | (1.91) | (0.23) | (1.93) |
| | 0.65 | 1.00 | 0.43 |
| ¥/€ | −0.72 | −1.70 | 0.98 |
| | (1.94) | (0.17) | (1.95) |
| | 0.29 | 1.00 | 0.39 |
| £/€ | 2.20 | 3.00 | −0.80 |
| | (1.49) | (0.25) | (1.51) |
| | 0.86 | 1.00 | 0.40 |
| ¥/£ | −2.45 | −4.68 | 2.23 |
| | (2.11) | (0.23) | (2.12) |
| | 0.75 | 1.00 | 0.71 |

# Regression refresher

. Suppose that our model has $Y_t$ as a function of only one variable, $X_{1t}$:

$$Y_t = a + b_1 X_{1t} + U_t.$$

Since $\text{cov}(X_t, U_t) = 0$ (we are assuming it is valid to estimate by a regression), then we have

$$\text{cov}(Y_t, X_{1t}) = b_1 \text{var}(X_{1t}).$$

This tells us that maybe one way we could estimate the parameter $b_1$ is to take sample estimates of $\text{cov}(Y_t, X_{1t})$ and $\text{var}(X_{1t})$ (call these estimates $\widehat{\text{cov}}(Y_t, X_{1t})$ and $\widehat{\text{var}}(X_{1t})$, and then take our estimate of $b_1$ as $\widehat{\text{cov}}(Y_t, X_{1t}) / \widehat{\text{var}}(X_{1t})$. In fact, that is exactly the ordinary least squares regression formula for the estimate of $b_1$.

# Exhibit 7A.1 Regression Residuals with Fitted Values
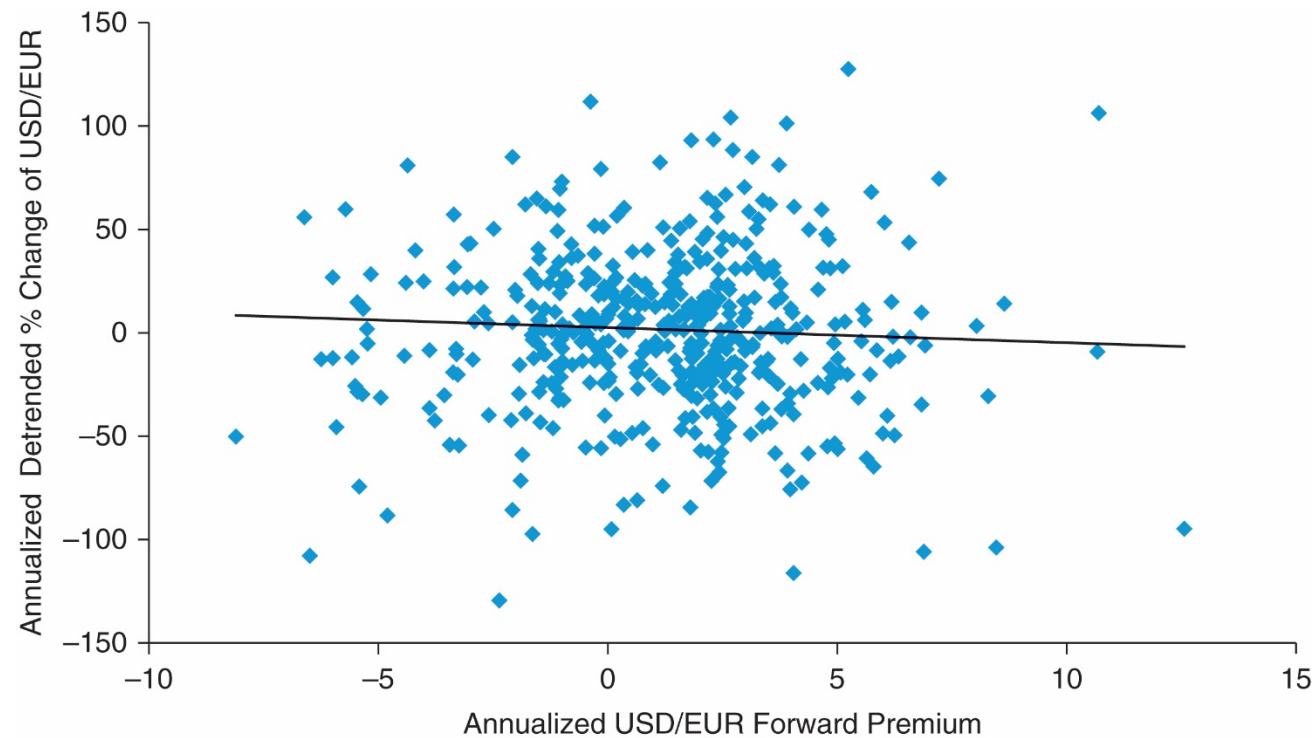
# 7.5 Empirical Evidence on the Unbiasedness Hypothesis

- Regression tests of the unbiasedness of forward rates

$$\frac{S(t+30) - S(t)}{S(t)} = a + b \cdot fp(t) + \varepsilon(t+30)$$

- Unbiasedness hypothesis is true if a = 0 and b = 1
- Results suggest existence of a forward rate bias

# Exhibit 7.5 Regression Tests of the Unbiasedness Hypothesis

**Exhibit 7.5** Regression tests of the unbiasedness hypothesis

$$s(t+30) = a + b\,fp(t) + \varepsilon(t+30)$$

| Currency | Const.<br>(s.e)<br>Conf. (a = 0) | Forward premium<br>(s.e.)<br>Conf. (b = 1) | $R^2$ |
|---|---|---|---|
| $/€ | 2.52<br>(2.02)<br>0.79 | −0.73<br>(0.74)<br>0.99 | 0.003 |
| $/£ | −2.49<br>(1.95)<br>0.80 | −1.25<br>(0.75)<br>1.00 | 0.010 |
| ¥/$ | −4.74<br>(2.52)<br>0.94 | −1.03<br>(0.61)<br>1.00 | 0.006 |
| ¥/€ | −2.06<br>(2.44)<br>0.60 | −0.79<br>(0.87)<br>0.98 | 0.002 |
| £/€ | 2.72<br>(1.95)<br>0.84 | −0.17<br>(0.54)<br>0.98 | 0.0003 |
| ¥/£ | −4.77<br>(3.63)<br>0.81 | −0.50<br>(0.60)<br>0.99 | 0.001 |

# 7.6 Alternative Interpretations of the Test Results

- Market inefficiency
  - Interest rate differentials contain information from which profit can be obtained
  - Exploiting forward bias and carry trades: use regression results to calculate expected return on forward position
    - Strategy called "carry trade":
      - If positive – go long; negative – go short

# 7.6 Alternative Interpretations of the Test Results

- Example: Spot = ¥100/$; F3mo= ¥99.17/$
  - $4 \times (99.17 - 100)/100 = -3.32\%$
- Japanese investor buys $ forward hoping the spot will not change much
  - $fmr(t + 1) = s(t + 1) - fp(t) = s(t + 1) + 3.32\%/4$
    - Last term is her carry
  - As long as the yen does not appreciate more than this (83 bp) over the next 3 months, the investor comes out ahead
- Popular strategy among hedge funds
  - Standard strategy is to go long in 3 currencies that trade at steepest forward discounts against $ and go short 3 currencies that trade at highest forward premiums against $

# 7.6 Alternative Interpretations of the Test Results

- Have carry trades been profitable?
  - Sharpe ratio – excess return per unit of risk
    - In U.S. stock market – 0.3 – 0.4; excess return 5-6% and annualized standard deviation is 15%
  - Leverage
    - Makes correcting for volatility even more important
  - Many financial institutions held abnormally high risk and were wiped out in the crisis

# 7.6 Alternative Interpretations of the Test Results

- Existence of risk premiums suggested by regression results, but is it definitely risk?
  - Some economists argue that market participants are irrational
  - Basic models of risk, such as CAPM, have a hard time generating risk premiums as variable as implied by the regressions
    - The implication is that the exchange rate risk premium on a foreign deposit increases as the foreign interest rate goes up relative to the home interest rate.
    - That could happen if the beta of the foreign investment increases as the foreign interest rate rises relative to the domestic interest rate.

# 7.6 Alternative Interpretations of the Test Results

- Problems interpreting the statistics
  - Unstable coefficients in the unbiasedness hypothesis regressions
  - Assumption of rational expectations may be a potential issue

# Exhibit 7.7 Rolling Monthly 5-Year Regression: Monthly Spot Rate Percentage Change Versus Monthly Forward Premium, February 1976 – December 2014
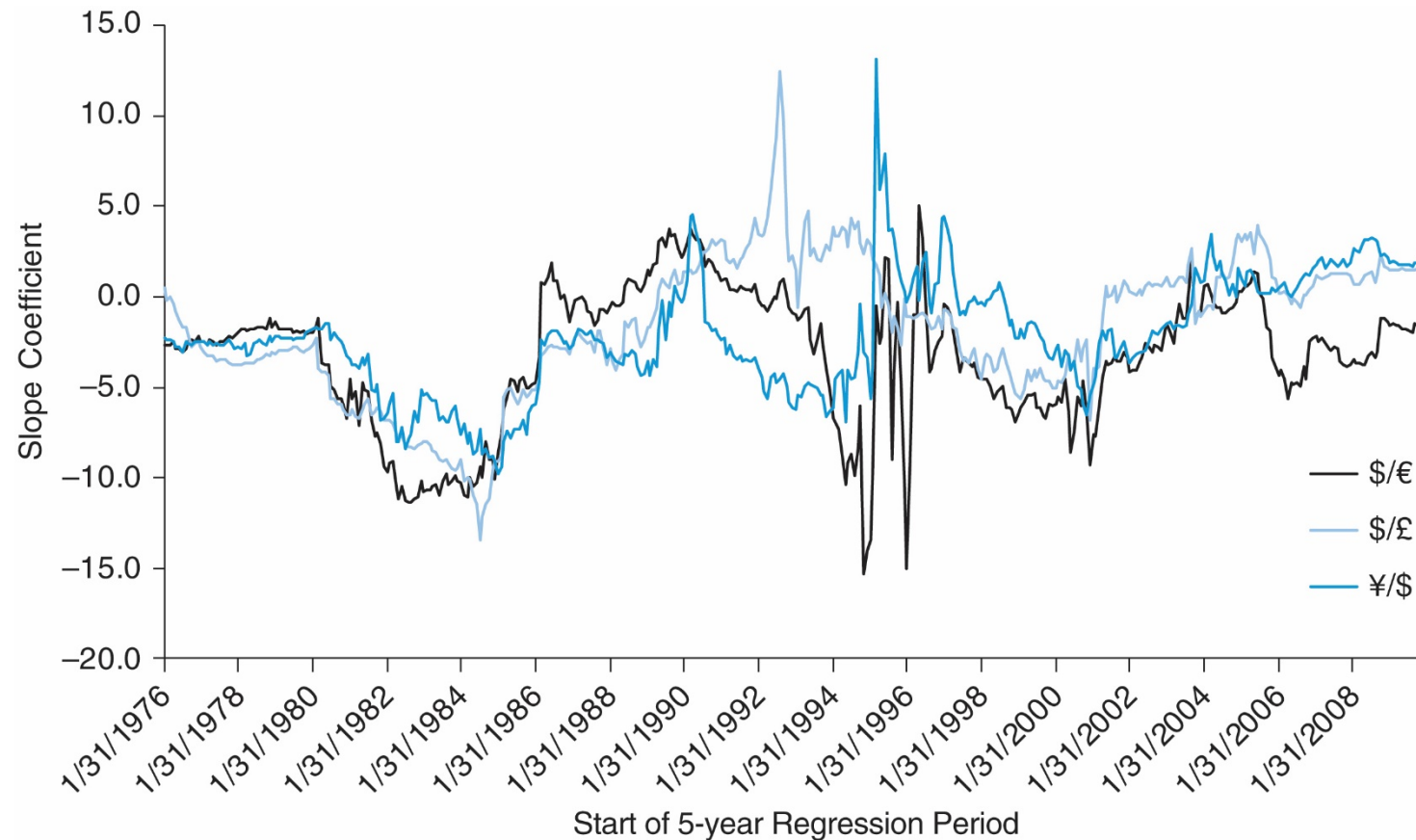
# 7.6 Alternative Interpretations of the Test Results

- Peso problem
  - Expecting something dramatic to happen and it does not (at least not when you expect it to)
  - Named from Mexico's experience with fixed exchange rates – rational investors anticipated a devalue of the peso
- Can peso problem explain carry trades performance?
  - Yes, if one assumes agents become very risk averse when an unwinding happens (i.e., time-varying risk premiums)