INTERNATIONAL FINANCIAL MANAGEMENT

THIRD EDITION

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Chapter 3

Forward Markets and
Transaction Exchange Risk

3.1 Transaction Exchange Risk

- Transaction exchange risk
  - Possibility of taking a loss in foreign exchange transactions because future spot rate not known with certainty

- Who incurs transaction exchange risk?
  - Corporations
  - Institutional investors
  - Individuals

- How to avoid?
  - Hedging: protect against losses and remove uncertainty

Transaction Exchange Risk Example

- Fancy Foods
  - FF has to pay £1,000,000 in 90 days in return for supplies
  - The spot rate is $1.50/£ and FF expects the £ to appreciate by 2%
  - They can (i) wait and buy £'s on the market or (ii) hedge
    - No hedge
      - $Cost = S(t + 90, \$/£) \times (£1M) = (\$1.53/£)(£1M) = \$1.53M$
    - Hedge
      - Purchase a forward contract and lock in rate (No uncertainty)
        - Forward is the market's best guess as to what the spot will be in 90 days so if the market is right, you're only out the bid/ask spread
      - If the market is wrong, hedging could be good or bad
        - If £ appreciates (takes more $'s to buy a £), hedging would have been better
        - If £ depreciates (takes fewer $'s to buy a £), then hedging would have been worse.

For example, suppose the current spot rate is \$1.50/£, and FF thinks there is a 50% chance the spot rate in 90 days is still \$1.50/£, but there is a 50% chance it will be \$1.56/£ .

The expected spot rate is $(0.5 \times 1.50) + (0.5 \times 1.56) = 1.53$

If the spot rate turns out to be \$1.50/£, FF owes \$1.50*M*

If the spot rate turns out to be \$1.56/£, FF owes \$1.56*M*

We will consider the possibility of hedging risk by agreeing now on an exchange rate that will be paid in 90 days. Suppose that someone agreed to sell FF pounds sterling in 90 days for \$1.525/£.

Then FF would know today that it will pay \$1.525*M*

As you know, the probability of ranges of outcomes for random variables is determined by the probability distribution and probability density. For example, if we rolled the dice, it might be sensible to assume that the six possible outcomes are equally likely:

Outcome	Probability
1	1/6
2	1/6
3	1/6
4	1/6
5	1/6
6	1/6

The mean or expected value of the dice role is given by the sum of the products of the outcome and the probability: $1\times\dfrac{1}{6}+2\times\dfrac{1}{6}+3\times\dfrac{1}{6}+4\times\dfrac{1}{6}+5\times\dfrac{1}{6}+6\times\dfrac{1}{6}=3.5$. Of course, if the outcomes were continuous rather than discrete, we would take the integral not the sum of these products.

The variance is just another expected value. $E(X)$ is the mean or expected value of the random variable X. Its variance is $E(X-E(X))^2$. In words, here is the recipe for the variance: From every possible realization of X, subtract off the mean, $E(X)$. Square the difference, to get $(X-E(X))^2$. Then get the expectation of $(X-E(X))^2$ by multiplying each value of $(X-E(X))^2$ by its probability and summing up, to get $E(X-E(X))^2$.

In the dice roll example, here is how we calculate the variance:

Outcome	Probability	$(X-E((X))^2$
1	1/6	$(2.5)^2 = 6.25$
2	1/6	$(1.5)^2 = 2.25$
3	1/6	$(0.5)^2 = 0.25$
4	1/6	$(0.5)^2 = 0.25$
5	1/6	$(1.5)^2 = 2.25$
6	1/6	$(2.5)^2 = 6.25$

The variance is given by $\frac{1}{6}(6.25 + 2.25 + 0.25 + 0.25 + 2.25 + 6.25) = \frac{17.5}{6}$.

The standard deviation is simply the square root of the variance. We will use the notation $sd(X)$ for the standard deviation of X.

Conditional Expectation

consider the random variable that is the sum of the outcome of the roll of two dice. There are eleven possible outcomes, ranging from 2 to 12. Here is the probability of each event occurring (convince yourself that you understand where this comes from):

Outcome	Probability
2	1/36
3	2/36
4	3/36
5	4/36
6	5/36
7	6/36
8	5/36
9	4/36
10	3/36
11	2/36
12	1/36

The expected value of this random variable is seven. What if, however, we knew the value of one of the dice? Let's introduce some notation. Call the outcome of the first dice X_1 and of the second dice, X_2. Then let's call the sum of the outcomes Y, so $Y = X_1 + X_2$. We will use the notation $E()$ or simply E to stand for the expected value. In this case, we would write $E(Y) = 7$ or $EY = 7$. Now if we have some "conditioning information", such as knowledge that $X_1 = 2$, we write the expectation conditional on that information as $E(Y | X_1 = 2)$. It is clear that $E(Y | X_1 = 2) = 5.5$. If we know that $X_1 = 2$, then we must have that $E(Y | X_1 = 2) = 2 + E(X_2)$. In general, if we aren't specifying exactly what the value of X_1 is that people know, we can still write $E(Y | X_1) = X_1 + E(X_2)$.

3.2 Describing Uncertain Future Exchange Rates

- Assessing exchange rate uncertainty using historical prices
  - Percentage change:
    - $$s(t) = \frac{S(t) - S(t-1)}{S(t-1)}$$
      - Appreciation if positive
      - Depreciation if negative
- Alternatively, we often simply use the change in the log:
  - $$s(t) = \ln\big(S(t)\big) - \ln\big(S(t-1)\big)$$
  - Mean and standard deviation
    - Normal distribution for major currencies
    - Skewed distribution for emerging markets

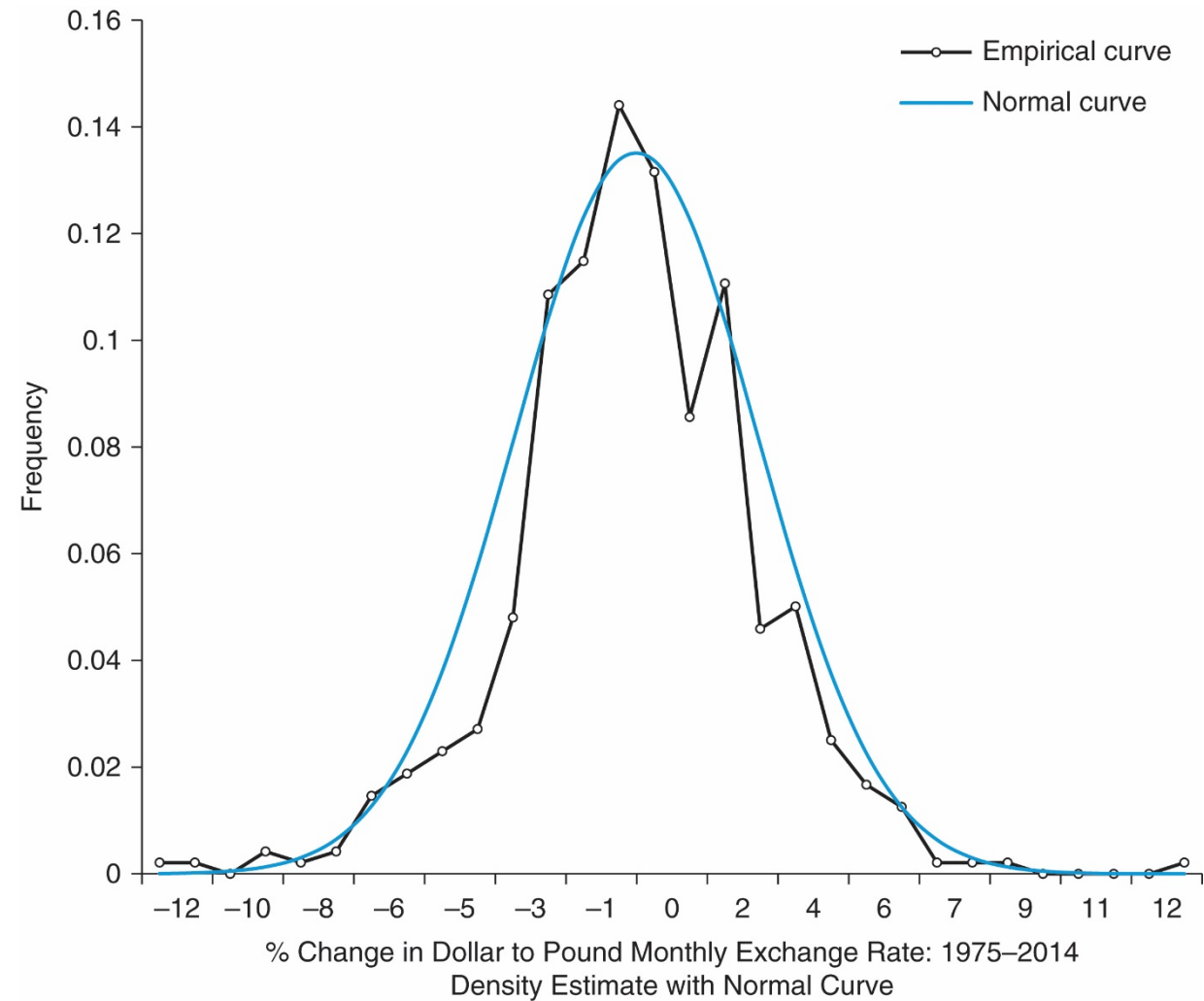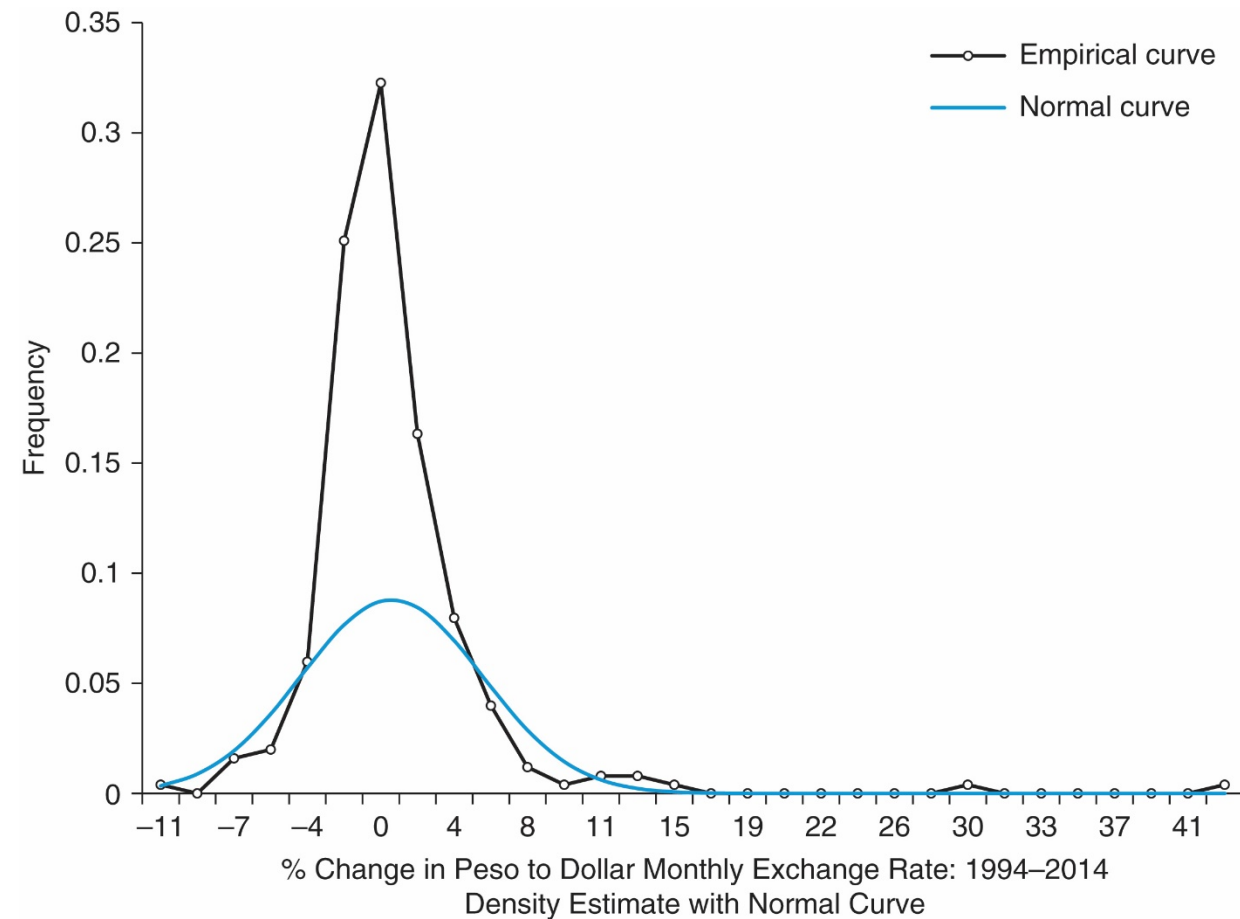# Exhibit 3.1 Dollar/Pound Monthly Exchange Rate: 1975–2014

Exhibit 3.2 Peso/Dollar Monthly Exchange Rate: 1994–2014

% Change in Peso to Dollar Monthly Exchange Rate: 1994–2014
Density Estimate with Normal Curve

3.2 Describing Uncertain Future Exchange Rates

- The probability distribution of future exchange rates
  - Depends on all of the information available at time t, so we say it is "conditional"
  - We call it $E_t\left(S\left(t+90\right)\right)$
    - Conditional mean/expectation at time t of the future spot exchange rate:
      - $S(t) \times (1 + \mu)$
        - $\$1.50/\pounds \times (1 + 0.02) = \$1.53/\pounds$
    - Conditional volatility:
      - $S(t) \times \sigma$
        - $\$1.50/\pounds \times (0.04) = \$0.06/\pounds$
    - Range (within one σ) is therefore: $\$1.47/\pounds$ - $\$1.59/\pounds$. With a Normal distribution, the exchange rate will be within plus or minus one standard deviation 68.27% of the time.

Exhibit 3.3 Probability Distribution of S(t+90)
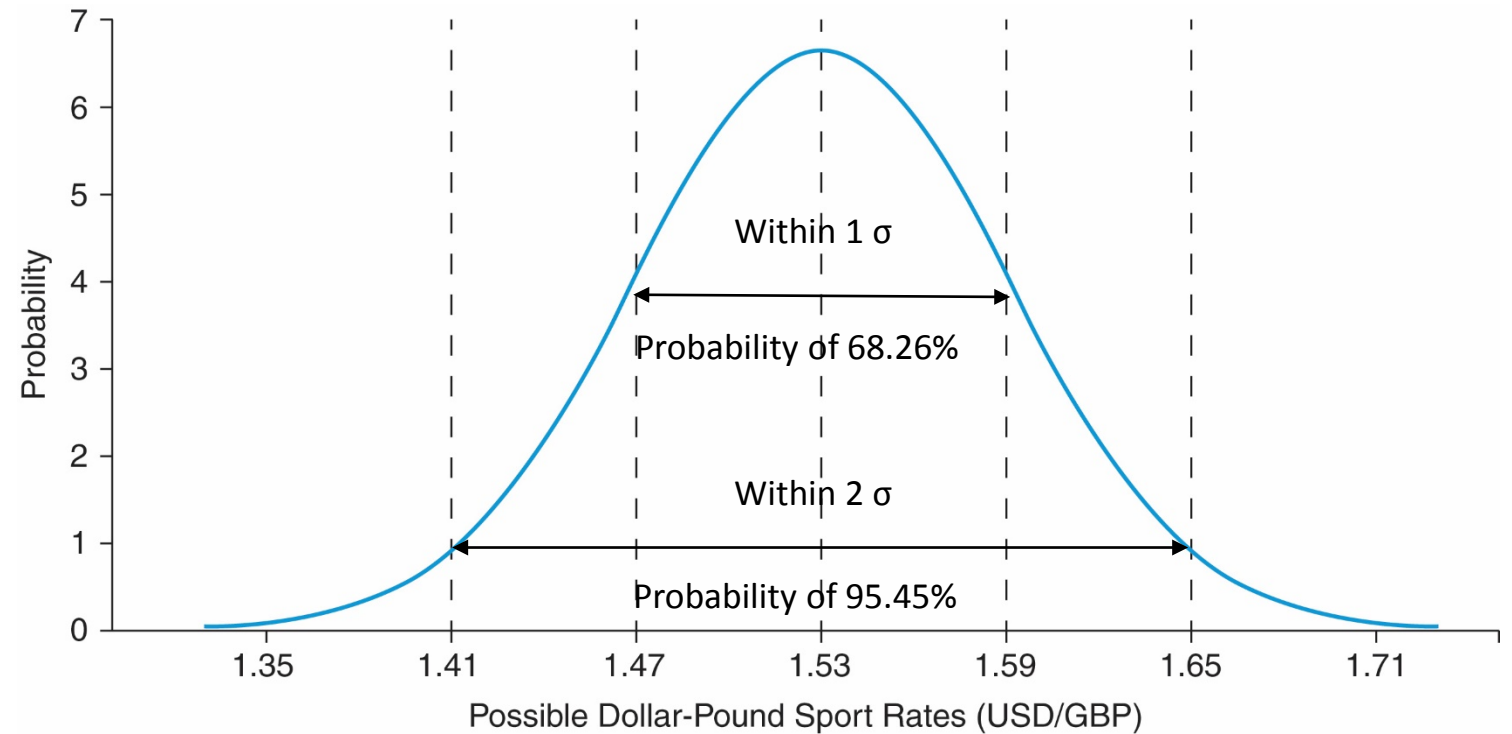
3.2 Describing Uncertain Future Exchange Rates

- Assessing the likelihood of particular future exchange rate ranges
  - How likely is it that the £ will appreciate in 90 days to $1.60/£?
    - $0.07/£ greater than conditional mean of $1.53/£
    - (0.07/0.06) = 1.167 standard deviations away, or 12.16% for normal distribution
- If FF expects the exchange rate to be $1.53/£ and the standard deviation is 0.06, then there is a 95.45% chance that the spot exchange rate in 90 days will be within $\pm$ two standard deviations
  - There is a 95.45% chance it will be between $1.41/£ and $1.65/£

3.3 Hedging Transaction Exchange Risk

- Forward contracts and hedging
  - Forward rate
    - Specified in a forward contract
  - Eliminates risk/uncertainty
  - Usually a large sum of money
  - With bank
  - Example: Fancy Foods can buy £1,000,000 at $1.53/£
    - Which gives them an asset to match the liability (also £1,000,000)
    - They will also only have a $ liability ($1,530,000)
    - However, no exchange rate risk

Exhibit 3.4 Panel A Gains and Losses Associated with Hedged Versus Unhedged Strategies
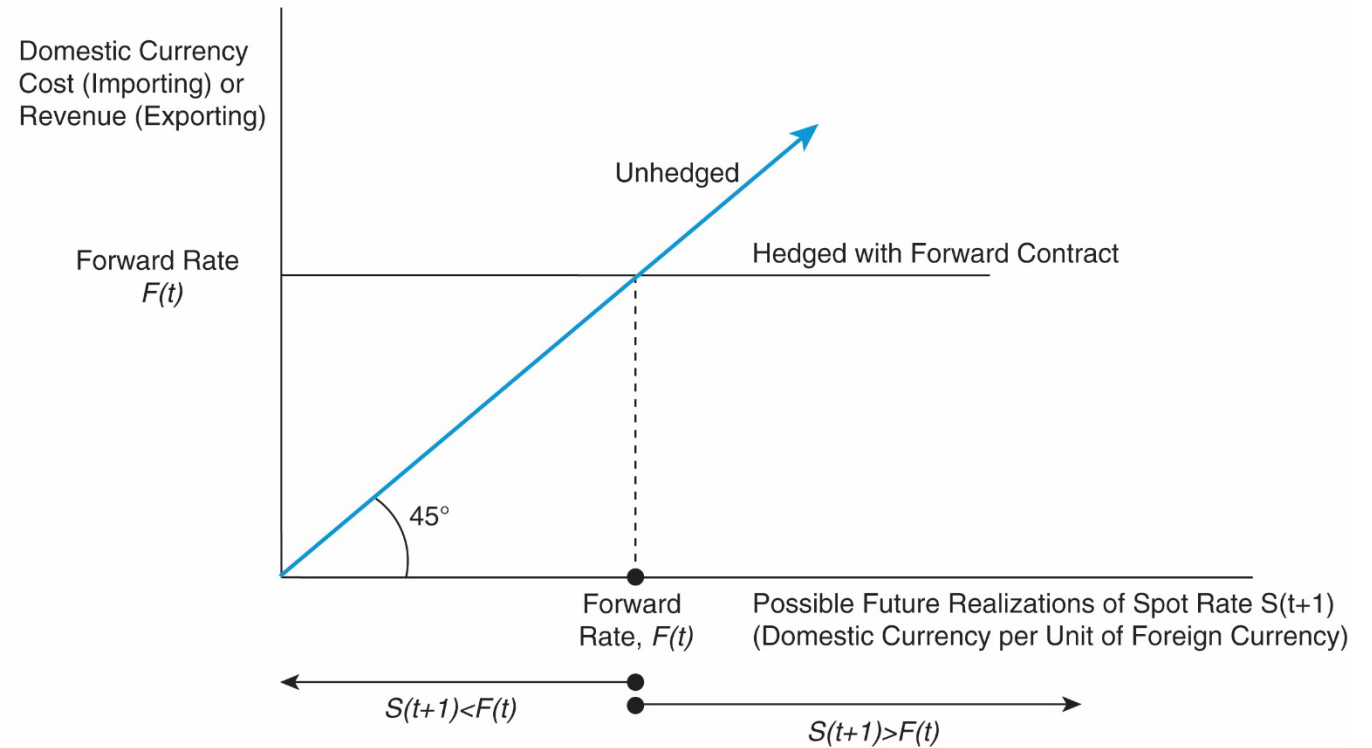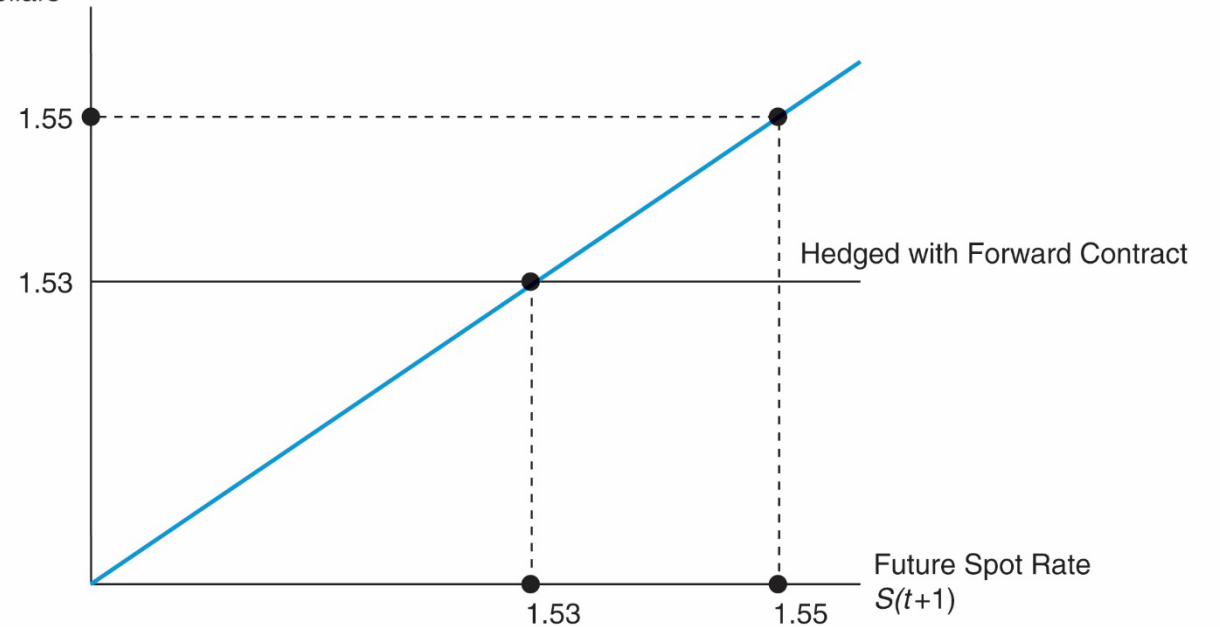

Panel A : General Case

Exhibit 3.4 Panel B Gains and Losses Associated with Hedged Versus Unhedged Strategies

Panel B: Fancy Foods / Nancy Foods
Cost or revenue in dollars

3.3 Hedging Transaction Exchange Risk

- The cost and benefits of a forward hedge
  - What is the appropriate way to view the cost of a forward hedge?
    - Ex ante (before)
    - Ex post (after)
    - To hedge or not to hedge?

Exhibit 3.5 Costs and Benefits of Hedging

Cost of 1 foreign currency unit

Exhibit 3.5 Costs and benefits of hedging

	$F(t,k) < S(t+k)$	$F(t,k) > S(t+k)$
Foreign currency asset	Cost of hedging	Benefit of hedging
Foreign currency liability	Benefit of hedging	Cost of hedging

3.3 Hedging Transaction Exchange Risk

- Hedging import payments
  - Example: Hedge a €4M payment due in 90 days
    - Spot: $1.10/€; 90-day forward: $1.08/€
    - Hedged you will pay $€4M \times \$1.08/€ = \$4,320,000$
    - However, if dollar strengthens, you could lose money relative to remaining unhedged

- Hedging export receipts
  - Example: Hedge a ¥500M receivable to arrive in 30 days
    - Spot: ¥176/£; 30-day forward: ¥180/£
    - Hedged you will receive $¥500M/(¥180/£) = £2,777,778$
    - However, if the yen strengthens, you could lose money relative to remaining unhedged

3.4 The Forward Foreign Exchange Market

- Market organization
  - Outright forward contracts
    - Only 13% of all foreign exchange transactions
  - Swap
    - Simultaneous purchase and sale of a certain amount of foreign currency for two different dates in the future
    - More than 42% of forex transactions are swaps

3.4 The Forward Foreign Exchange Market

- Forward contract maturities and value dates
  - Forward value or settlement date
    - Most active maturities are 30, 60, 90, 180 days
    - Highly customizable
    - Exchange takes place on the forward value date

- Forward bid/ask spreads
  - Larger than in spot market
  - Spreads higher for greater maturities
  - Less than 0.05% for major currencies
  - 90 day: Less than a pip wider than the spot spreads

Exhibit 3.6 Risks in Forward Contracts

- Panel B Case 1
  - 1 day later the C$ appreciates to $0.92, so BofA needs to long C$ to cover the position
- Panel C Case 2
  - Hedging from the beginning

Exhibit 3.6 Risks in forward contracts

Panel A: Original positions

Bank of America	
Assets	Liabilities
$1,000,000 due from Canada Beer in 30 days	CAD1,111,111 payable to Canada Beer in 30 days

Panel B: Bank of America risk management – Case 1

Canada Beer	
Assets	Liabilities
$1,000,000 Export revenues in 30 days	$1,000,000 payable to Bank of America
CAD1,111,111 due from Bank of America in 30 days	

Forward contract @ $0.90/C$

Panel C: Bank of America risk management – Case 2

Bank of America	
Assets	Liabilities
$1,000,000 due from Canada Beer in 30 days	CAD1,111,111 payable to Canada Beer in 30 days
CAD1,111,111 due from interbank counterparty in 29 days	$1,022,222 payable to interbank counterparty in 29 days

3.4 The Forward Foreign Exchange Market

- Net settlement
  - Settling a contract by paying or receiving a net settlement that depends on the value of the contract
  - Can be used in the case where the situation differs from the original scenario
  - Often used in forex futures market (Ch. 20)

3.4 The Forward Foreign Exchange Market

- Foreign exchange swap types
  - Most common:
    - The purchase of foreign currency spot against the sale of foreign currency forward
    - The sale of foreign currency spot against the purchase of foreign currency forward
  - Others:
    - The purchase of foreign currency short-term forward against the sale of foreign currency long-term forward
    - The sale of foreign currency short-term forward against the purchase of foreign currency long-term forward

3.4 The Forward Foreign Exchange Market

- How swap prices are quoted
  - Spot: ¥/$ 104.30 (bid) – 35 (ask)
  - 30-day swap points: 15 (bid) / 20 (ask)
    - Basis points that must be added/subtracted to/from the current spot bid/ask price to yield the actual 30-day bid/ask forward prices
- A rule for using swap points
  - If first number in swap quote is smaller than the second, you add the points to the bid and ask prices to get the forward quotes; if larger - subtract

3.5 Forward Premiums and Discounts

- Forward premium
  - Occurs when the price of the currency forward contract is higher then the spot rate
  - F\$/€ > S\$/€ (the price of a € is higher for Forward)

- Forward discount
  - Occurs when the price of the currency forward contract is lower then the spot rate
  - F\$/€ < S\$/€ (the price of a € is lower for Forward)

- Calculation
  - $Ann.\,Percent = \left(\dfrac{Forward - Spot}{Spot}\right) \times \left(\dfrac{360}{N\,days}\right) \times 100$

Exhibit 3.7 Cash Flows in a Spot-Forward Swap
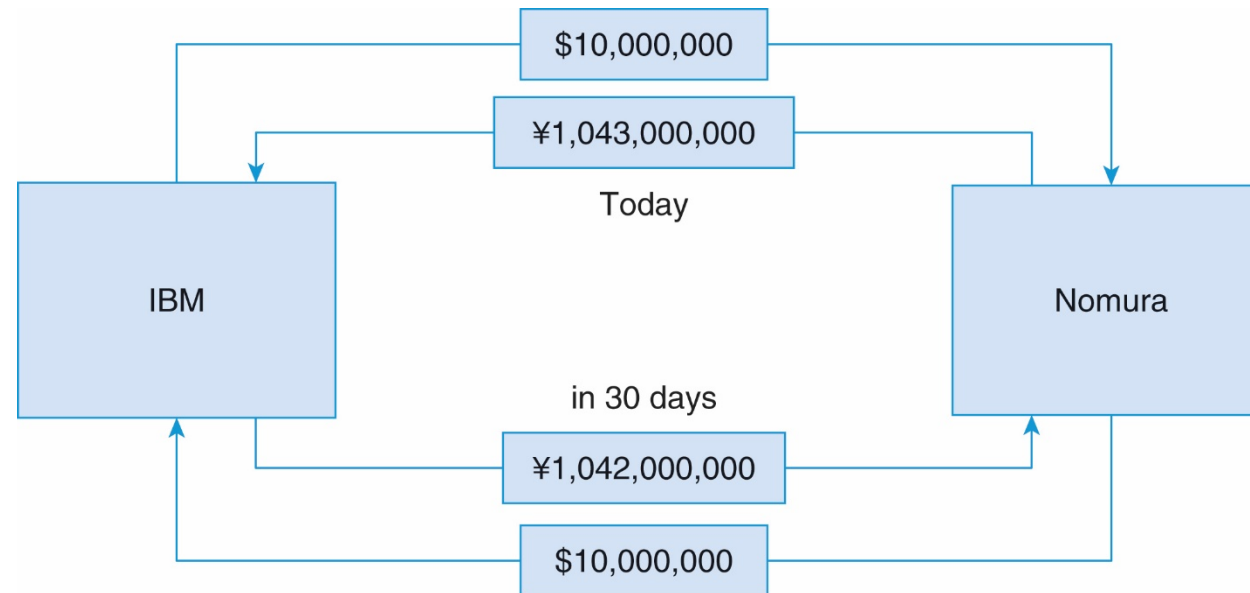
3.5 Forward Premiums and Discounts

- Forward premiums and swap points
  - Because forward contracts typically trade as part of a swap, the swap points indicate the premium or discount for the denominator currency
  - 1st < 2nd (swap points added)
    - Currency in denominator is at a forward premium
  - 1st > 2nd (swap points subtracted)
    - Currency in denominator is at a forward discount

Exhibit 3.8 Historical Means of Forward Premiums or Discounts

Exhibit 3.8 Historical means of forward premiums or discounts

	$/£	$/€	¥/$
30-day forward (mean)	−1.423%	0.871%	−2.356%
30-day forward (2014 mean)	−0.306%	0.058%	0.057%
90-day forward (mean)	−1.326%	0.629%	−2.402%
90-day forward (2014 mean)	−0.299%	0.095%	−0.167%

3.6 Changes in Exchange Rate Volatility

- Understanding how forex rates move involves more than just means and standard deviations
    - Volatility clustering: When standard deviations (volatility) in forex rate demonstrate a pattern
        - i.e., has been high and remains high
    - GARCH model
        - Developed by Tim Bollerslev (1986)
        - $V(t) = a + b\,v(t-1) + c\,e(t)2$
            - A = minimum variance if past volatility and news terms = 0
            - B = sensitivity of current conditional variance to past volatility
            - C = sensitivity to current news
    - Other models exist, but none of which have received as much attention
        - Clustering of macroeconomic news events, reactions to changes in uncertainty regarding macroeconomic fundamentals, trading processes

Exhibit 3.9 Monthly Standard Deviations of Daily Rates of Appreciation