Derivatives and Currency Management

CFA三级培训项目

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101% Contribution Breeds Professionalism

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- **工作职称：**金程教育资深培训师、CFA持证人、RFP（注册财务策划师）
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- **服务客户：** Areva，Lubrizal，Arkema，International Paper，Johnson Controls，Augusta、Philips、中国工商银行、中国银行、建设银行、农业银行、杭州银行、兴业证券、南京证券、湘财证券、兴业银行、杨浦区党校、太平洋保险、泰康人寿、中国人寿、人保资产管理、中国平安、华夏基金、中邮基金、富国基金、中国再保险、中国进出口银行、中信建投、北京外经贸大学、安徽省投资集团、阿里巴巴、携程等

Topic in CFA Level III

Session	Content
Study Session 1-2	ETHICS & PROFESSIONAL STANDARDS (1)&(2)
Study Session 3	BEHAVIORAL FINANCE
Study Session 4	CAPITAL MARKET EXPECTATIONS
Study Session 5	ASSET ALLOCATION AND RELATED DECISIONS IN PORTFOLIO MANAGEMENT
Study Session 6	**DERIVATIVES AND CURRENCY MANAGEMENT**
Study Session 7-8	FIXED-INCOME PORTFOLIO MANAGEMENT (1)&(2)
Study Session 9-10	EQUITY PORTFOLIO MANAGEMENT (1)&(2)
Study Session 11	ALTERNATIVE INVESTMENTS FOR PORTFOLIO MANAGEMENT
Study Session 12-13	PRIVATE WEALTH MANAGEMENT (1)&(2)
Study Session 14	PORTFOLIO MANAGEMENT FOR INSTITUTIONAL INVESTORS
Study Session 15	TRADING, PERFORMANCE EVALUATION, AND MANAGER SELECTION
Study Session 16	CASES IN PORTFOLIO MANAGEMENT AND RISK MANAGEMENT

Framework

Risk Management Applications of Derivatives

➢ **SS6: Derivatives and Currency Management**

- R15: Option Strategies
- R16: Swaps, Forwards, and Futures Strategies
- R17: Currency Management: An Introduction

Reading 15

Option Strategies

Framework

1. Reviews of Option Fundamentals
2. Synthetic Asset
3. Option Strategies
4. Option Greeks
5. Volatility Smile

Reviews of Option Fundamentals

- **Moneyness**
  - **Moneyness**
    - ✓ **In the money**: Immediate exercise would generate a positive payoff.
    - ✓ **At the money**: Immediate exercise would generate no payoff.
    - ✓ **Out of the money**: Immediate exercise would generate a negative payoff.
  - The following table summarizes the moneyness of options based on the stock's current price, S, and the option's exercise strike price, X.

Moneyness	Call option	Put Option
In-the-money	$S>X$	$S<X$
At-the-money	$S = X$	$S = X$
Out-of-the-money	$S<X$	$S>X$

Reviews of Option Fundamentals

- **Intrinsic Value and Time Value**
  - **Intrinsic Value**: the amount of immediate exercise.
    - ✓ Intrinsic value of call option: C=max[0, S-X]
    - ✓ Intrinsic value of put option: P=max[0, X-S]
  - **Time Value**
    - ✓ The difference between the price of an option (called its premium) and its intrinsic value is due to its time value
    - ✓ Generally, the less time to expire, the less time value
- **Option value = intrinsic value + time value**
  - Before expiration: option value>intrinsic value
  - At expiration: option value=intrinsic value

Reviews of Option Fundamentals

➢ **Factors affect the value of an option**

Sensitivity Factor	Calls	Puts
Underlying price	Positively related	Negatively related
Volatility	Positively related	Positively related
Risk-free rate	Positively related	Negatively related
Time to expiration	Positively related	Positively related*
Strike price	Negatively related	Positively related
Payments on the underlying	Negatively related	Positively related
Carrying cost	Positively related	Negatively related

- * There is an **exception** to the general rule that European put option thetas are negative. The put value may increases as the option approaches maturity if the option is deep in-the-money and close to maturity.

Reviews of Option Fundamentals

- **The BSM Model to Value an option**

$$C_0 = [S_0 \times N(d_1)] - [X \times e^{-R_f^c \times T} \times N(d_2)]$$

- **Historical volatility and implied volatility**
  - Historical volatility is using historical data to calculate the variance and standard deviation of the continuously compounded returns.

$$\sigma = \sqrt{S^2_{R_i^c}} = \sqrt{\frac{\sum_{i=1}^{N}\left(R_i^c - \overline{R}_i^c\right)^2}{N-1}}$$

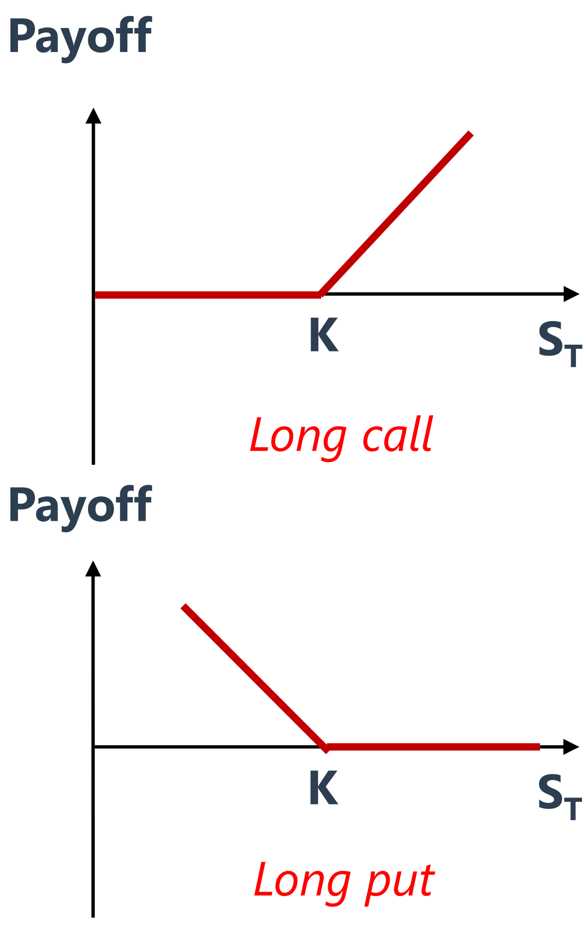
  - **However, the market price and the BSM price are not always the same**.
    - ✓ If we have S_0, X, R_f , and T, we can set the BSM price equal to the market price and then work backwards to get the volatility. This volatility is called the **implied volatility**.

Reviews of Option Fundamentals

- **Payoff for options**
  - Long call: c_T=Max (0, S_T-X)
  - Short call: c_T=-Max (0, S_T-X)
  - Long put: p_T= Max (0, X-S_T)
  - Short put: p_T= -Max (0, X-S_T)
- **Profits for options**
  - Long call: c_T=Max (0, S_T-X) – c_0
  - Short call: c_T=-Max (0, S_T-X) +c_0
  - Long put: p_T= Max (0, X-S_T) – p_0
  - Short put: p_T= -Max (0, X-S_T)+ p_0

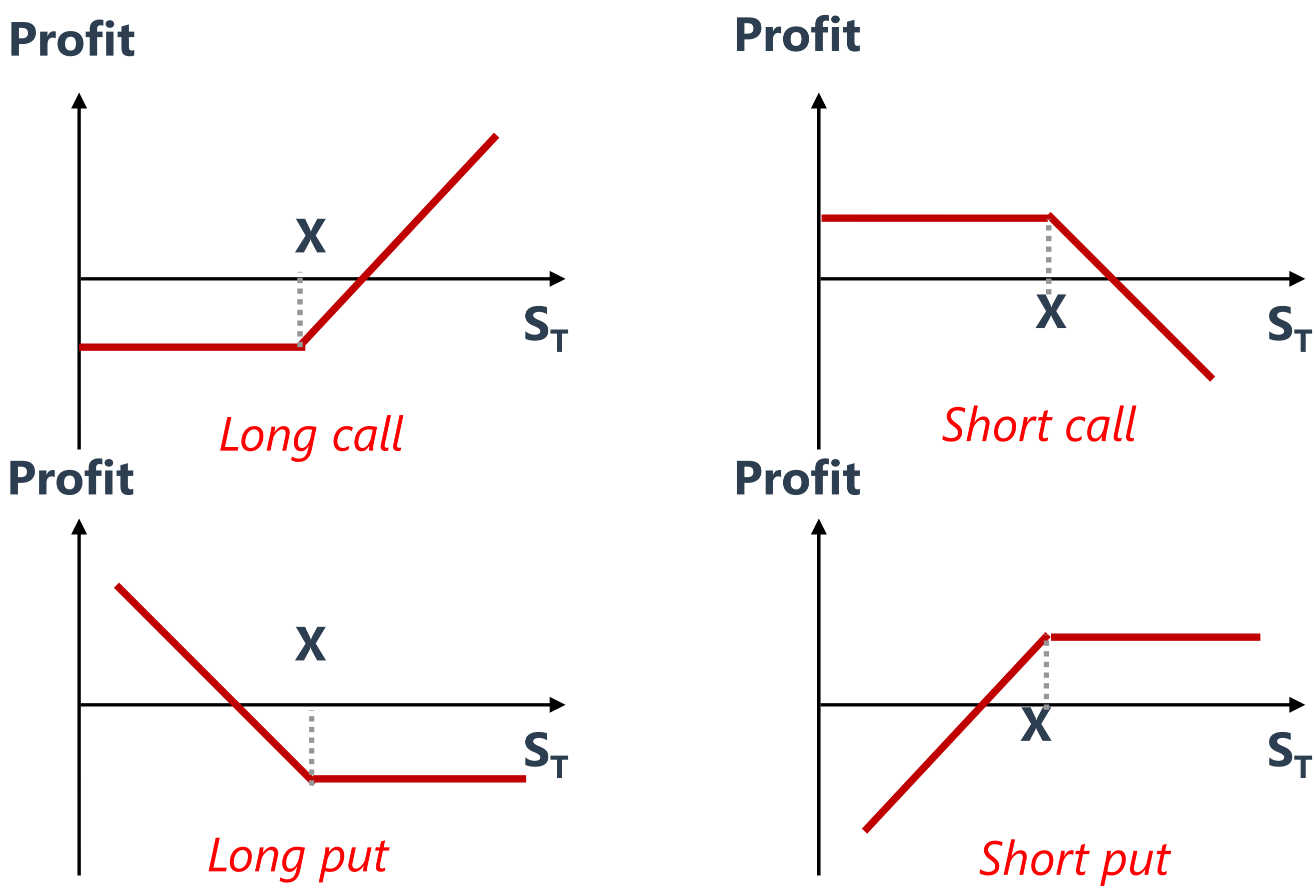
Reviews of Option Fundamentals

- **Payoff**



Reviews of Option Fundamentals

➢ **Gain/Loss**



Synthetic Asset

- **Put call parity**
  - Put call parity: $c+\frac{X}{(1+R_f)^T}=S+p$ or $c+\frac{K}{(1+R_f)^T}=S+p$
  - Positions replicating
    - ✓ Condition A: $-S=-c+p-X/(1+R_f)^T$
    - ✓ Condition B: $p=c+X/(1+R_f)^T-S$
    - ✓ Condition C: $c=p+S-X/(1+R_f)^T$
    - ✓ Condition D: $-p=-c+S-X/(1+R_f)^T$
    - ✓ Condition E: $-c=-p+X/(1+R_f)^T-S$

Synthetic Asset

- Synthetic long/short forward
  - Long call + short put= long forward
  - Long put + short call= short forward
- Synthetic call/put
  - Long call = long asset + long put
  - Long put = short asset + long call

Example

1. Which of the following is most similar to a long put position?
   A. Buy stock, write call
   B. Short stock, buy call
   C. Short stock, write call
2. Which of the following is most similar to a long call position?
   A. Buy stock, buy put
   B. Buy stock, write put
   C. Short stock, write put

Example

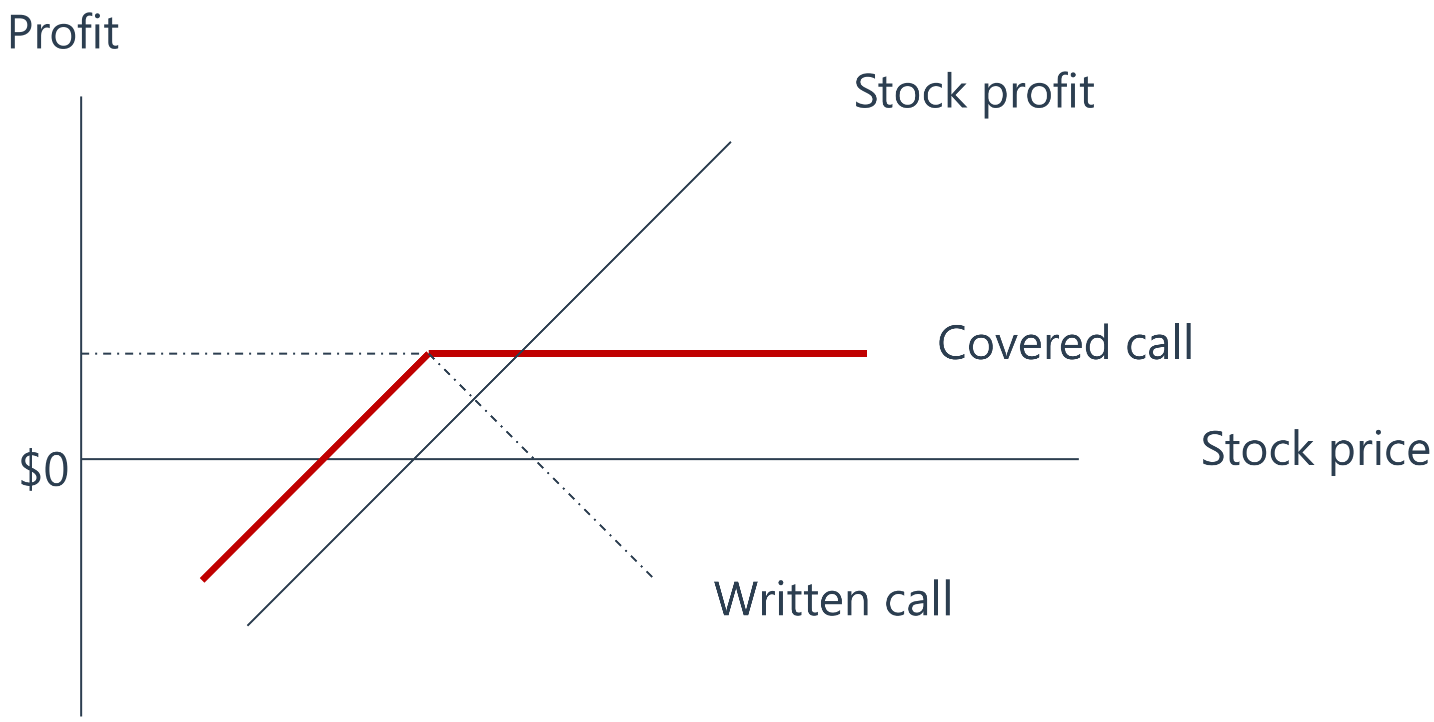
- **Correct Answer for Q1: B.**
  - The long call "cuts off" the unlimited losses from the short stock position.
- **Correct Answer for Q2: A.**
  - The long put provides a floor value to the position, making the maximum loss flat below the exercise price. The profit and loss diagram is the same shape as a long call.

Covered call strategy

➢ An investor creates covered call position by selling a call option on a stock that is owned by the option writer.

- Yield enhancement
  - ✓ The most common motivation. By writing an OTM call option. Cash generation in anticipation of limited upside moves.
- Reducing a position at a favorable price
  - ✓ Covered calls might be written, when an investor holds a position in a stock and intends to reduce that holding in the near future. (ITM call option)
- Target price realization
  - ✓ Hybrid of the previous two. Calls are written with a strike price just above the current market price. (OTM call option)

Covered call strategy



Profit profile for a covered call

Covered call strategy

- **Covered call**: In this strategy, someone who already owns shares sells a call option giving someone else the right to buy their shares at the exercise price.

$$S_T - S_0 - \max\{0, (S_T - X)\} + C$$

- Conclusion:
  - When $S_T > X$, we have maximum gain

$$S_T - S_0 - \max\{0, (S_T - X)\} + C = (S_T - S_0) - (S_T - X) + C = X - S_0 + C$$

  - When $S_T = 0$, we have maximum loss

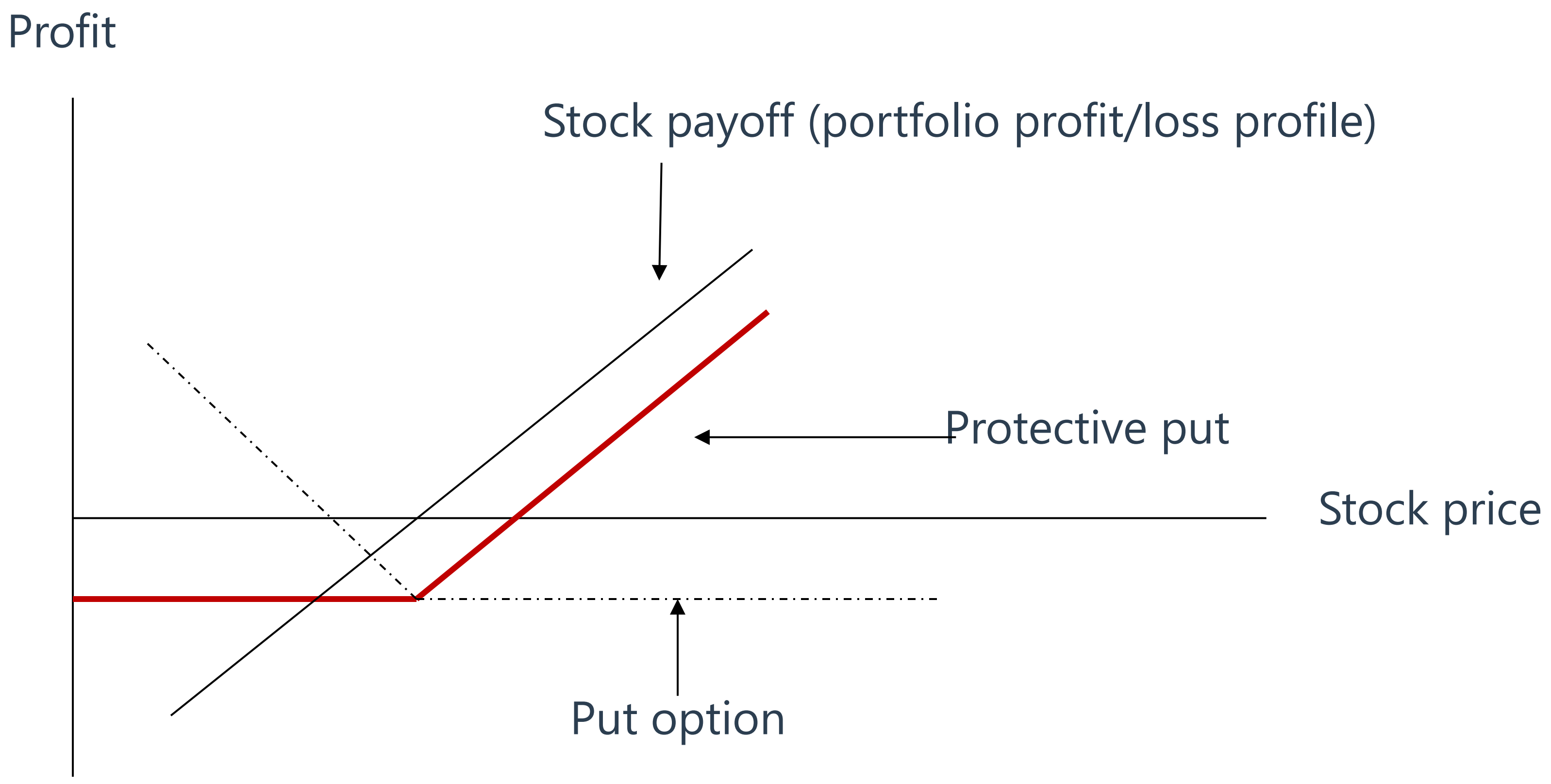
$$S_T - S_0 - \max\{0, (S_T - X)\} + C = (0 - S_0) - 0 + C = C - S_0$$

  - Breakeven point $S_T = S_0 - C$

Protective put strategy

- **A protective put** (also called portfolio insurance or a hedged portfolio) is constructed by holding a long position in the underlying security and buying a put option.
  - **You can use a protective put limit the downside risk at the cost of the put premium, P_0.**
  - You will see by the diagram that the investor will still be able to benefit from increases in the stock's price, but it will be lower by the amount paid for the put, P_0.
  - Notice that the combined strategy looks very much like a call option.

Protective put strategy



Protective put strategy

Protective put strategy

- **Protective put**: Someone simultaneously holds a long position in an asset and a long position in a put option on that asset.
- Conclusion:
  - When S_T>X, the profit is unlimited

$$(S_T - S_0) + \max\{0, (X - S_T)\} - P$$

  - When S_T=0, we have maximum loss

$$(S_T - S_0) + \max\{0, (X - S_T)\} - P = 0 - S_0 + X - P = X - S_0 - P$$

  - Breakeven point: $S_T = S_0 + P$

Option as a hedge of a short position

- If an investor starts with a short position in the underlying, they will gain if the price falls and lose if the price rises.
- Buy a call (probably above the current stock price) would provide a hedge against the stock rising.
- Similarly, the sale of a put (probably below the current stock price) sells off the benefit of the stock falling.

Applications

- **Delta of the strategy**
  - Delta of covered call = delta of stock - delta of call stock
  - Delta of protective put = delta of stock + delta of put
- **Both covered call and protective put are not delta neutral.**
- **Cash secured put**
  - If someone writes a put option and simultaneously deposits an amount of money equal to the exercise price into a designated account, it is called writing a cash-secured put.
  - Comparisons between covered call, protective put, fiduciary call and cash-secured put.

Example

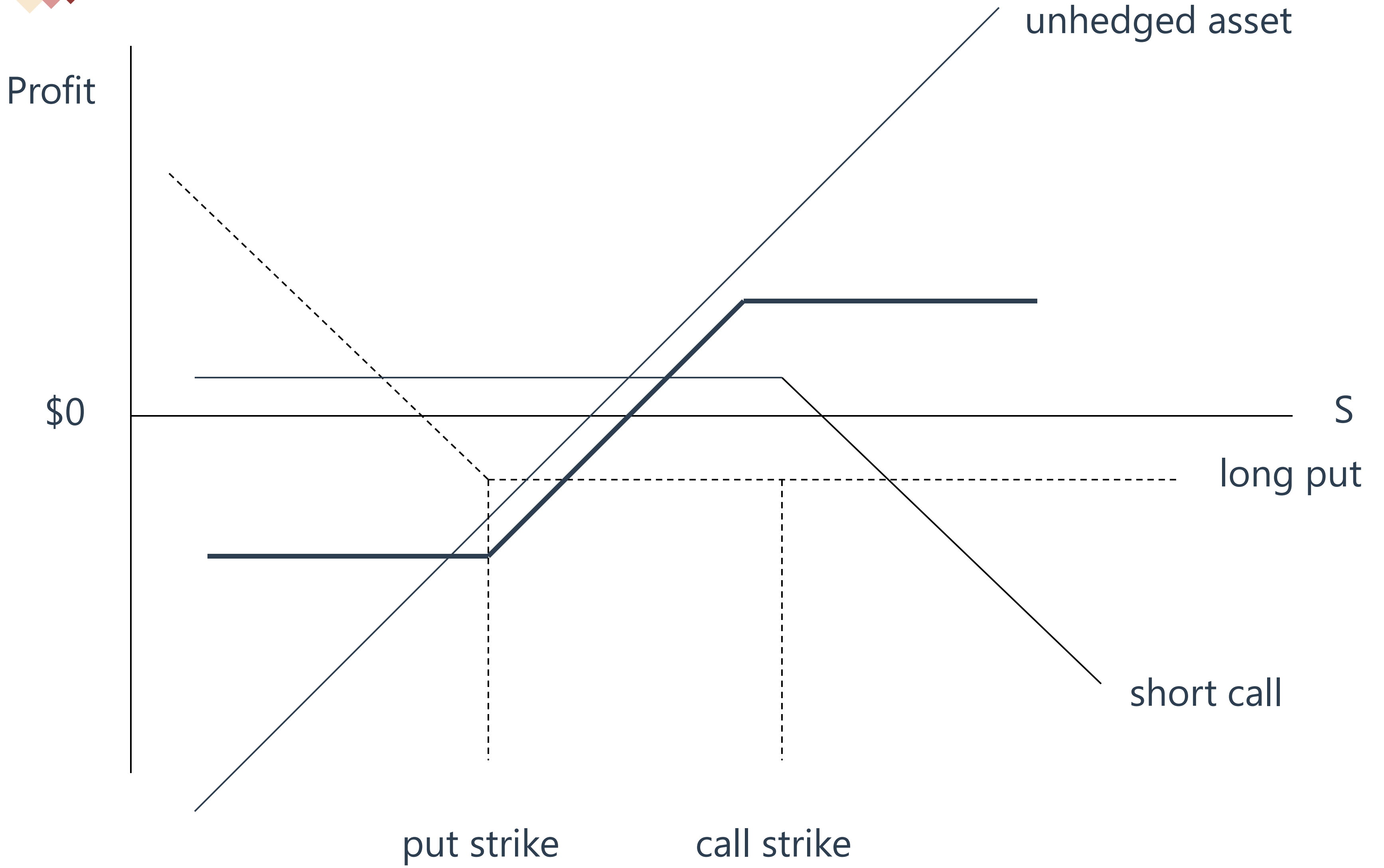
- **Question:** Abbe is using two option strategies including covered call & protective put or forwards combined with a long position in 100 shares of ABC, Inc. The call option has a delta of 0.7 and the put option has a delta of -0.8. How Abbe hold forward positions that she could keep the same position delta as the covered call? Protective put?

- **Correct Answer:**
  - Abbe could go short in a forward contract for 70 shares to duplicate the delta of a covered call.
    - ✓ Long stock delta + short forward delta = 1 - 0.7 = 0.3.
  - Abbe could go short position in a forward contract for 80 shares to duplicate the delta of a protective put.
    - ✓ Long stock delta + short forward delta =1 - 0.8 = 0.2.

Collar

- A collar is an option position in which the investor is long shares of stock and then buys a put with an exercise price below the current stock price and writes a call with an exercise price above the current stock price.
- The cost of the put is largely and often precisely offset by the income from writing the call.
- **Profit and loss for a collar** (where the strike price of the put(X_L) is usually smaller than that of the call(X_H)).
  - $Profit=S_T-S_0+\max\{0,X_L-S_T\}-P_0-\max\{0,S_T-X_H\}+C_0$
  - Maximum profit$=X_H-S_0-P_0+C_0$
  - Maximum loss$=S_0-X_L+P_0-C_0$
  - Breakeven price$=S_0+P_0-C_0$
- A collar limit the downside risk at a cost of giving up the upside return.

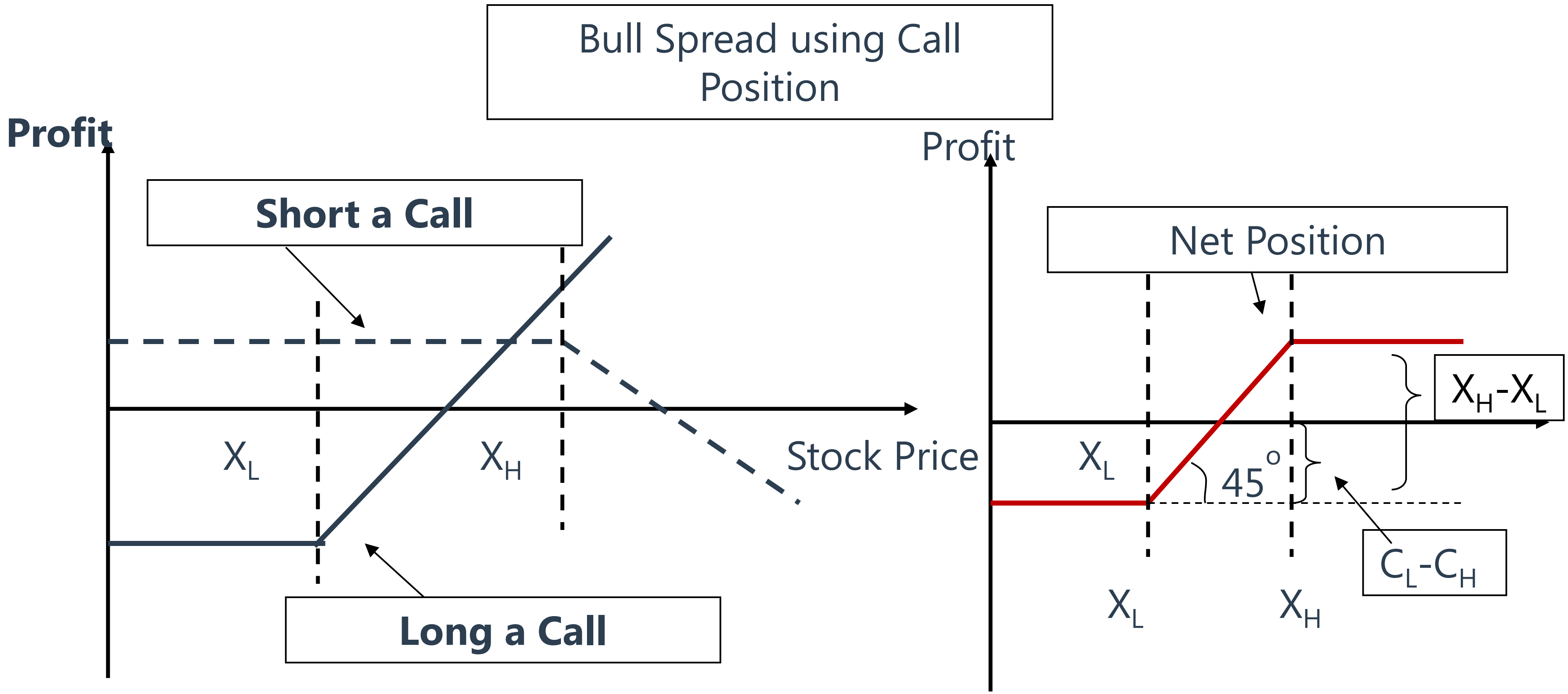
Collar


unhedged asset
Profit
$0
S
long put
short call
put strike
call strike

Bull spread

- In a bull spreads using call: construct with buying one call option and writing another with a higher exercise price.
- The buyer of a bull spread using call expects the stock price to rise and the purchased call to finish in-the-money. However, the buyer does not believe that the price of the stock will rise above the exercise price for the out-of-the-money written call.
- **A bull spread limit the downside risk at a cost of giving up the upside return.**

Bull spread



Bull Spread using Call Position
Profit
Short a Call
X_L
X_H
Stock Price
Long a Call
Profit
Net Position
X_H-X_L
X_L
45°
C_L-C_H
X_L
X_H

Bull spread using call

- Bull Spread strategy requires buying one option and writing another with a *higher* exercise price under the same underlying asset and time to maturity.

$$\max\{0,(S_T-X_L)\}-\max\{0,(S_T-X_H)\}-C_L+C_H$$

- Conclusion:
  - When $S_T>X_H$, we have maximum profit:

$$\max\{0,(S_T-X_L)\}-\max\{0,(S_T-X_H)\}-C_L+C_H$$
$$=(S_T-X_L)-(S_T-X_H)-C_L+C_H=X_H-X_L+C_H-C_L$$

  - When $S_T<X_L$, we have maximum loss:

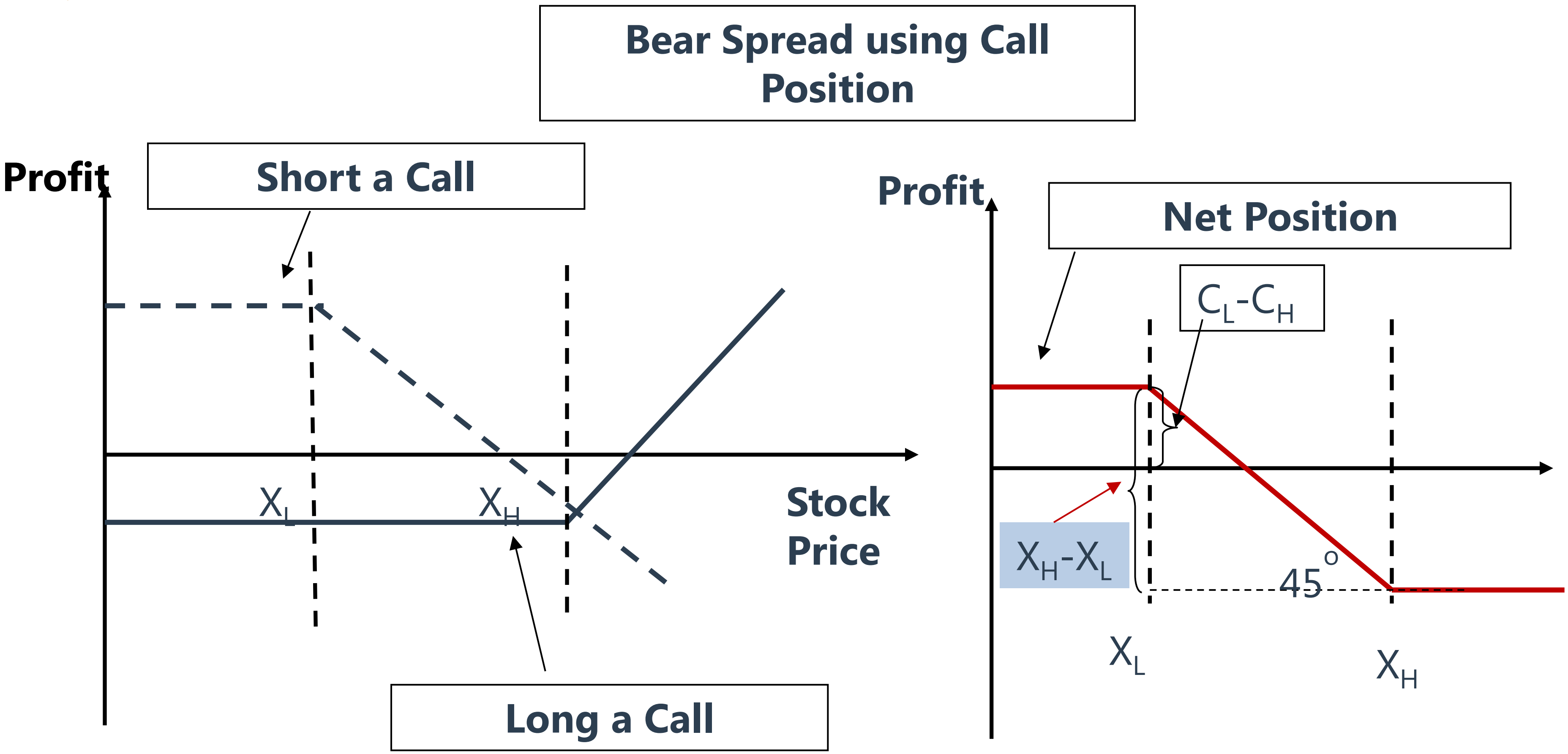
$$\max\{0,(S_T-X_L)\}-\max\{0,(S_T-X_H)\}-C_L+C_H$$
$$=0-0-C_L+C_H=C_H-C_L$$

  - Breakeven point: $S_T=X_L+C_L-C_H$

Bear spread

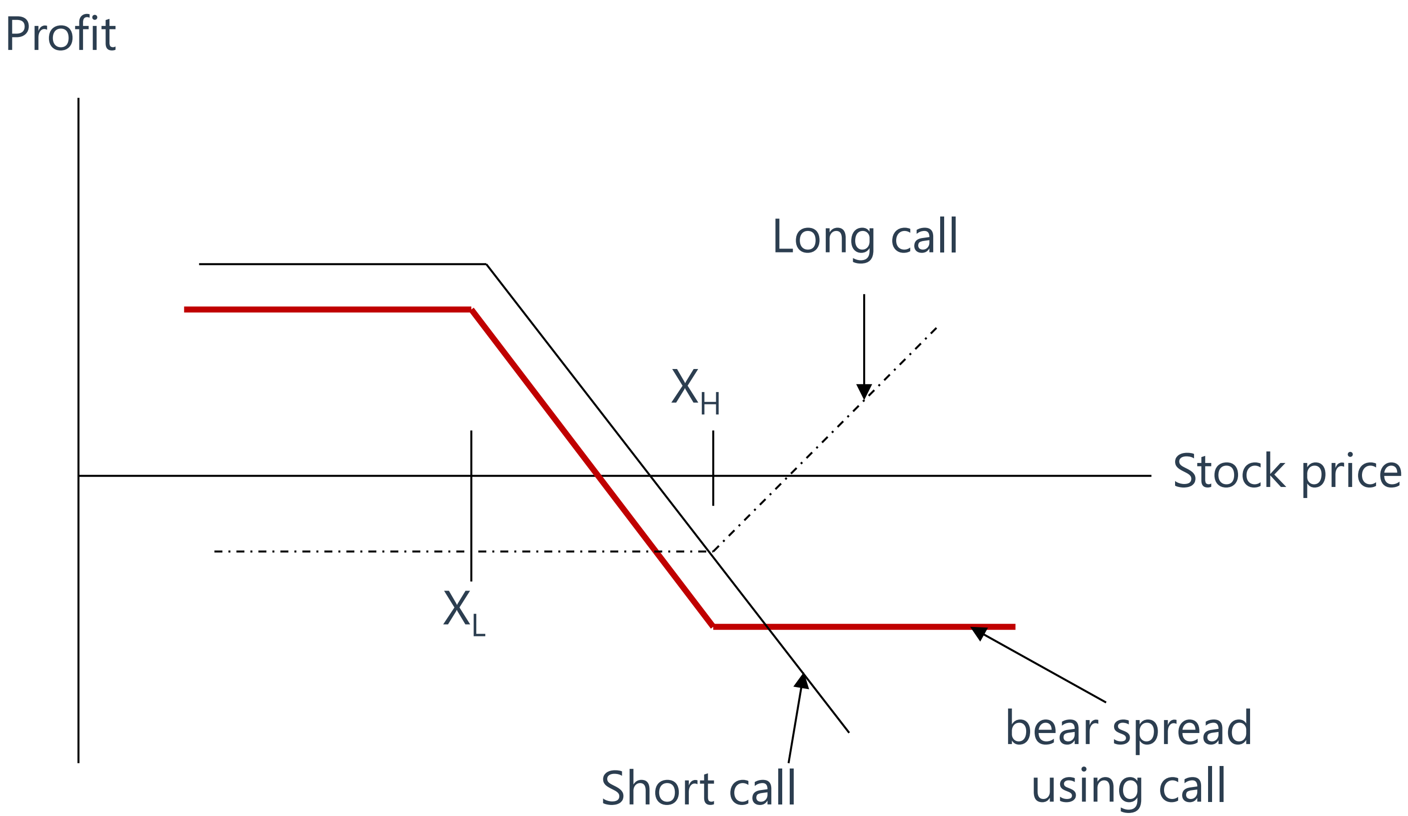
- A **bear spread** using call is the sale of a bull spread. The investors buy the higher exercise price and writes the lower exercise price.
  - This strategy is designed to profit from falling stock prices.
  - Investors could keep the call premium net of cost of long call when the stock price decreases.
  - Protection from large increase in stock price is the objective of longing a call option.
  - The payoff is the opposite (mirror image) of the bull spread using call and is shown in following figure.
- **A bear spread limit the downside risk at a cost of giving up the upside return.**

Bear spread



Bear Spread using Call Position
Profit
Short a Call
X_L
X_H
Stock Price
Long a Call
Profit
Net Position
C_L-C_H
X_H-X_L
45°
X_L
X_H

Bear spread



bear spread using call

Bear spread using call

- **Bear spread requires buying call option with higher exercise price and selling the call option with lower exercise price.**

$$\max(0,S_T-X_H)-\max(0,S_T-X_L)+C_L-C_H$$

- **Conclusion:**
  - When $S_T<X_L$, we have maximum profit:

$$\max(0,S_T-X_H)-\max(0,S_T-X_L)+C_L-C_H=0-0+C_L-C_H=C_L-C_H$$

  - When $S_T>X_H$, we have maximum loss:

$$\max(0,S_T-X_H)-\max(0,S_T-X_L)+C_L-C_H=(S_T-X_H)-(S_T-X_L)+C_L-C_H$$
$$=X_L-X_H+C_L-C_H$$

  - Breakeven point: $S_T=X_L+C_L-C_H$

Example

➢ **Suppose:**

- S_0 = 44.50
- OCT 45 call = 2.55 OCT 45 put = 2.92
- OCT 50 call = 1.45 OCT 50 put = 6.80

1. What is the maximum gain with an OCT 45/50 bull call spread?
   A. 1.10
   B. 3.05
   C. 3.90
2. What is the maximum loss with an OCT 45/50 bear put spread?
   A. 1.12
   B. 3.88
   C. 4.38
3. What is the breakeven point with an OCT 45/50 bull call spread?
   A. 46.10
   B. 47.50
   C. 48.88

Example

- **Correct Answer for Q1: C.**
  - With a bull spread, the maximum gain occurs at the high exercise price. At an underlying price of 50 or higher, the spread is worth the difference in the strikes, or 50 – 45 = 5. The cost of establishing the spread is the price of the lower-strike option minus the price of the higher-strike option: 2.55 – 1.45 = 1.10. The maximum gain is 5.00 – 1.10 = 3.90.
- **Correct Answer for Q2: B.**
  - With a bear spread, you buy the higher exercise price and write the lower exercise price. When this strategy is done with puts, the higher exercise price option costs more than the lower exercise price option. Thus, you have a debit spread with an initial cash outlay, which is the most you can lose. The initial cash outlay is the cost of the OCT 50 put minus the premium received from writing the OCT 45 put: 6.80 – 2.92 = 3.88.

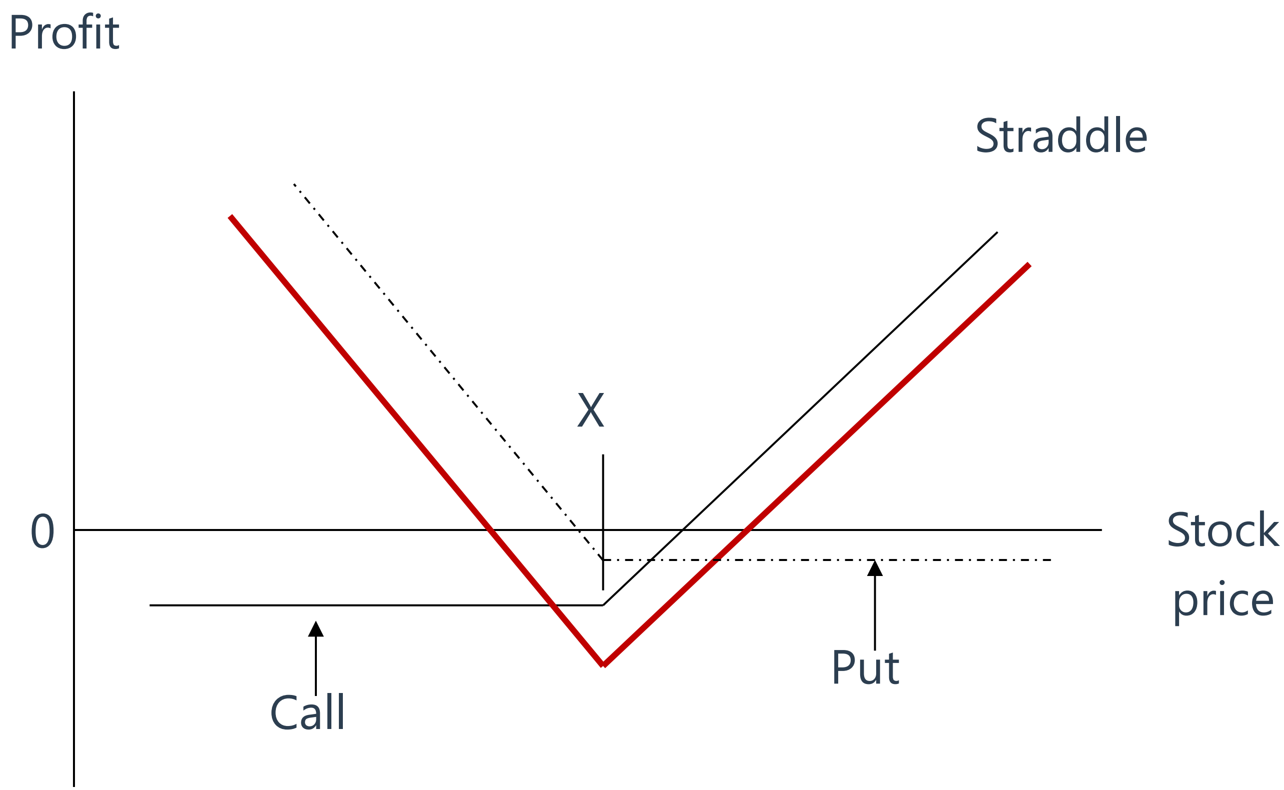
Example

- **Correct Answer for Q3: A.**
  - You buy the OCT 45 call for 2.55 and sell the OCT 50 call for 1.45, for a net cost of 1.10. You breakeven when the position is worth the price you paid. The long call is worth 1.10 at a stock price of 46.10, and the OCT 50 call would expire out of the money and thus be worthless. The breakeven point is the lower exercise price of 45 plus the 1.10 cost of the spread, or 46.10.

Straddle

- **A long straddle is created by purchasing a call and a put with the same strike price and expiration.**
  - Both options have the same exercise price and expiration;
  - This strategy is profitable when the stock price moves strongly in either direction;
  - This strategy bets on volatility.
- **A short straddle sells both options and bets on little movement in the stock.**
  - A short straddle bets on the same thing as the butterfly spread, except the losses are not limited;
  - It is a bet that will profit more if correct but also lose more if it is incorrect;
  - Straddles are symmetric around the strike price.

Straddle



Long straddle profit/loss

Straddle

- **Profit and loss for a straddle**
  - Profit=max{0, S_T-X}- C_0 +max{0,X-S_T}-P_0
  - Maximum profit: unlimited
  - Maximum loss=P_0+C_0
  - Breakeven price=X-(P_0+C_0) or X+(P_0+C_0)

Example

➢ **Suspose:**

- XYZ stock = 100.00
- 100-strike call = 8.00
- 100-strike put = 7.50
- Options are three months until expiration

1. If Smith buys a straddle on XYZ stock, he is best described as expecting a:
   A. high volatility market.
   B. low volatility market.
   C. average volatility market.
2. This strategy will break even at expiration stock prices of:
   A. 92.50 and 108.50.
   B. 92.00 and 108.00.
   C. 84.50 and 115.50.
3. Reaching a breakeven point implies an annualized rate of return closest to:
   A. 16%.
   B. 31%.
   C. 62%.

Example

- **Correct Answer for Q1: A.**
  - A straddle is directionally neutral; it is neither bullish nor bearish. The straddle buyer wants volatility and wants it quickly, but does not care in which direction. The worst outcome is for the underlying asset to remain stable.
- **Correct Answer for Q2: C.**
  - To break even, the stock price must move enough to recover the cost of both the put and the call. These premiums total $15.50, so the stock must move up to $115.50 or down to $84.50.
- **Correct Answer for Q3: C.**
  - The price change to a breakeven point is 15.50 points, or 15.5% on a 100 stock. This is for three months. This outcome is equivalent to an annualized rate of 62%, found by multiplying by 4 (15.5% × 4 = 62%).

Calendar Spread

- A strategy in which someone **sells a near-dated call and buys a longer-dated one** on the same underlying asset and with the same strike is commonly referred to as a calendar spread.
  - When the investor buys the more distant option, it is a long calendar spread. The investor could also buy a near-term option and sell a longer-dated one, which would be a short calendar spread;
  - As discussed previously, a portion of the option premium is time value. Time value decays over time and approaches zero as the option expiration date approaches. **Taking advantage of this time decay is a primary motivation behind a calendar spread.**
    - ✓ **Time decay is more pronounced for a short-term option** than for one with a long time until expiration;
    - ✓ A calendar spread trade seeks to exploit this characteristic by purchasing a longer-term option and writing a shorter-term option.

Calendar Spread-Application

- Here is an example of how someone might use such a spread.
  - Suppose XYZ stock is trading at 45 a share in August. XYZ has a new product that is to be introduced to the public early the following year. A trader believes this new product introduction is going to have a positive impact on the shares;
  - Until the excitement associated with this announcement starts to affect the stock price, the trader believes that the stock will **languish** around the current level;
  - Based on the bullish outlook for the stock going into January, the trader **purchases the XYZ JAN 45 call at 3.81**. Noting that the near-term price forecast is neutral, the trader also decides to **sell a XYZ SEP 45 call for 1.55**.
- Now move forward to the September expiration and assume that XYZ is trading at 45. The September option will now expire with no value, which is a good outcome for the calendar spread trader.
- If the trader still believes that XYZ will stay around 45 into October before starting to move higher, the trader may continue to execute this strategy. An XYZ OCT 45 call might be sold for 1.55 with the hope that it also expires with no value.

Investment Objectives and Strategy Selection

- **Option Investment Objectives**
  - the direction the underlying headed
  - the volatility of the underlying
- **Strategy Selection**

		Direction		
		Bearish	Neutral/No Bias	Bullish
Volatility	High	Buy puts	Buy straddle	Buy calls
	Average	Write calls & buy puts	Spreads	Buy calls & write puts
	Low	Write calls	Write straddle	Write puts

Option Greeks

- Measures that capture movements in the option value for a movement in one of the factors that affect the option value, while holding all other factors constant are called the **Greeks**.

Greeks	Sensitivity factor	Relationship	
		Call option	**Put option**
Delta	Underlying price	Positive (Delta>0)	Negative (Delta<0)
Gamma	Underlying price	Positive (Gamma>0)	Positive (Gamma>0)
Vega	Volatility	Positive (Vega>0)	Positive (Vega>0)
Rho	Risk-free rate	Positive (Rho>0)	Negative (Rho<0)
Theta	Passage of time	Closer to maturity → value declines (Theta<0)	Closer to maturity → value declines (Theta<0*)

- The features of Theta is also called **time decay**. There is an exception when the European put option is deep in the money, the residual time to maturity has not worthy to long position.

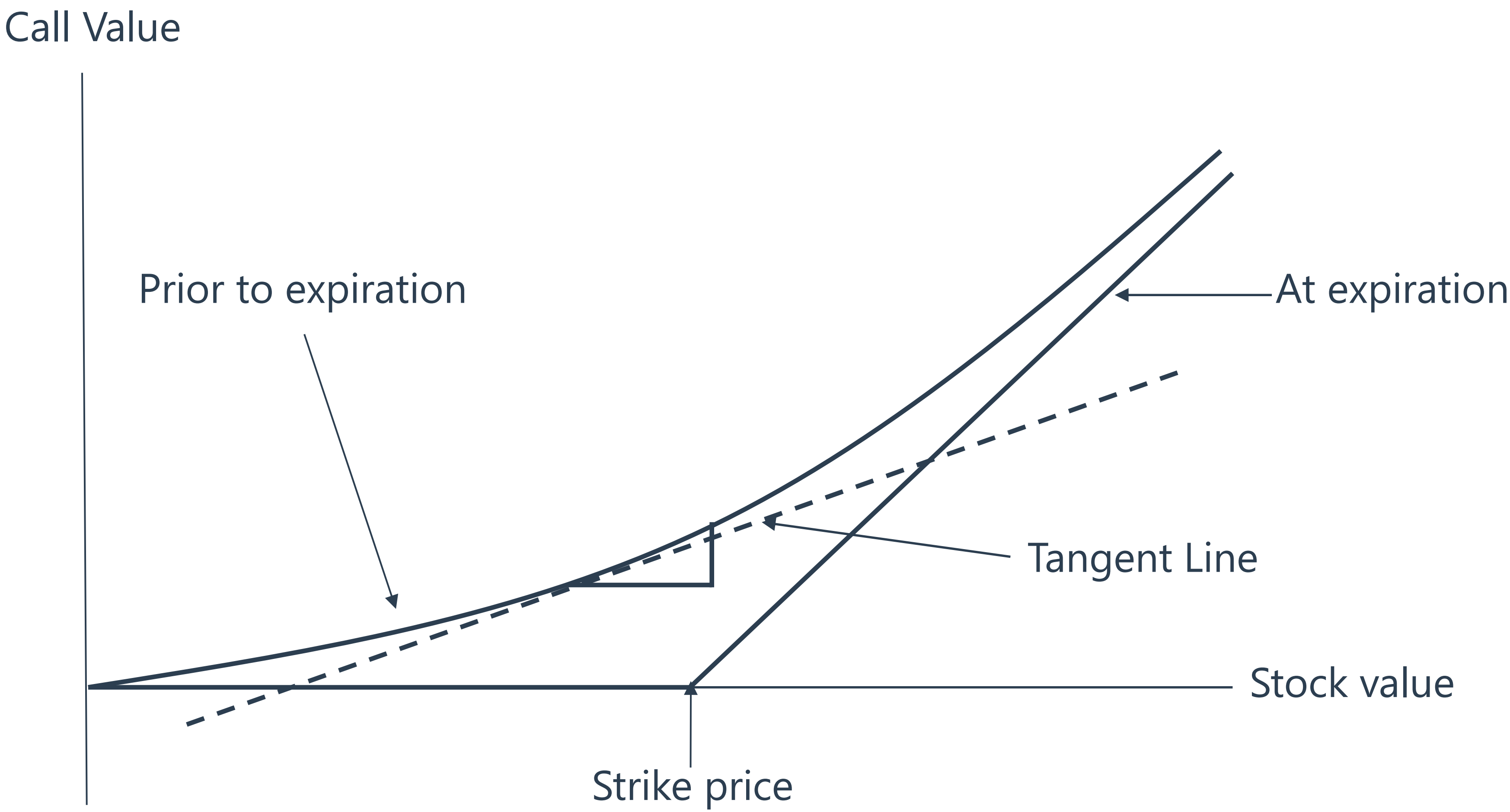
The Option Delta

- The relationship between the option price and the price of the underlying asset has a special name: the delta. The option delta is defined as:
  - delta = Change in option price / Change in underlying price
- The relationship between delta of a call and put:
  - The call option's delta is defined as:
    - ✓ $delta_{call} = (C_1 - C_0)/(S_1 - S_0) = \Delta C/\Delta S$
  - The delta of a put option is the call option's **delta minus one**:
    - ✓ $delta_{put} = (P_1 - P_0)/(S_1 - S_0) = \Delta P/\Delta S = delta_{call} - 1$
- The BSM perspective:
  - The call option's delta is also equal to $N(d_1)$ from the BSM model, and the put option's delta equals $N(d_1) - 1$.

The Option Delta

- **The call delta increases from 0 to 1 as stock price increases.**
  - When the call option is deep out-of-the-money, the call delta is close to zero. The option price changes a very small amount for a given change in the stock price.
  - When the call option is deep in-the-money, the call delta is close to one. The option price changes almost one dollar for a one-dollar change in the stock price.
- **The put delta increases from −1 to 0 as stock price increases.**
  - When the put option is deep in-the-money, the put delta is close to −1.
  - When the put option is deep out-of-the-money, the put delta is close to zero.
- **When t approaches maturity, a in-the-money call's delta is close to 1,while a out-of-the-money call's delta is close to 0.**

The Option Delta



Dynamic hedging

- If we long a stock and short 1/delta calls, the value of the portfolio does not change, when the value of the stock changes. For example, if the stock price increases by n dollar, the call price will **decrease by delta×n dollar and then 1/delta calls decrease n dollar.**
- We make money by buying the stock and lose money by selling the call options; the value of the portfolio remains unchanged. This portfolio is referred to as a delta-neutral portfolio.

Dynamic hedging

- However, the delta-neutral hedging is a **dynamic process**, since **the delta is constantly changing**. The delta will change if the underlying stock price changes. Even if the underlying stock price does not change, the delta would still change as the option moves toward the expiration day. As the delta changes, the number of calls that should be sold to construct the delta-neutral portfolio changes. Delta-neutral hedging is often referred to as dynamic hedging.

$$number\ of\ options\ needed\ to\ delta\ hedge\ = \frac{number\ of\ shares\ hedged}{delta\ of\ call\ option}$$

The Option Gamma

- **The gamma defines** the sensitivity of the option delta to a change in the price of the underlying asset. The option gamma is defined as:
  - gamma = $(\text{delta}_1 - \text{delta}_0)/(S_1 - S_0) = \Delta\text{delta}/\Delta S$
- **Call and put options on the same stock with the same T and X have equal gammas.**
  - A long position in calls or puts will have a positive gamma.
  - Gamma is largest when the option is near-the-money.
  - If the option is deep in- or out-of-the-money, gamma approaches zero.
- **Gamma is largest when the option is near the money**, which means delta is very sensitive to a change in the stock price. Then we must rebalance the delta-neutral portfolio more frequently. This leads to higher transaction cost .

Vega, Theta and Rho

- **Vega**
  - **Vega** is defined as the change in a given portfolio for a given small change in volatility, holding everything else constant.
  - Positive to the long, both call option and put option.
- **Theta**
  - **Theta** defines the sensitivity of the option value to a change in the calendar time.
  - Negative to the long, both call option and put option, usually refers to time decay.
- **Rho**
  - **Rho** is defined as the change in a given portfolio for a given small change in the riskfree interest rate, holding everything else constant.
  - The rho of the call is positive while the call of a put is negative(leverage effect).
  - Small impact compared to vega.

Example

➢ Klein, CFA, has owned 100,000 shares of a biotechnology company A, A is waiting for its approving from FDA who will release its decision in six months, now the current is share price is $38, and if the latest pharmaceutical is rejected by the FDA, it will have a great impact on the share price of company in six month and will eventually become $26. Expected annual volatility of return is 20%, current annual risk-free rate is 1.12%.

Klein wants to use BSM model to implement a hedging strategy in using 6-month European option if company A's new product rejected by the FDA and gathers the data below:

Option	W	X	Y	Z
Type of Option	Call	Call	Put	Put
Exercise Price	$38	$46	$38	$36
$N(d_1)$	0.56	0.30	0.56	0.64
$N(d_2)$	0.45	0.21	0.45	0.53

Example

① Using the data above, the number of option X contracts that Klein would have to sell to implement the hedge strategy would be closet to:

- The required number of call options to sell = Number of shares of underlying to be hedged / $N(d_1)$, where $N(d_1)$ is the estimated delta used for hedging a position with call options. There are 100,000 shares to be hedged and the $N(d_1)$ for Option X from Exhibit 2 is 0.30. Thus, the required number of call options to sell is 100,000 / 0.30 =333,333

② **Based on the data above, which of the following options(X,Y or Z) is most likely to exhibit the largest gamma measure?**

- The gamma will tend to be large when the option is at-the-money. The exercise price of Option Y is equal to the underlying price, hence at-the-money, whereas both Option X and Option Z are out-of-the-money.

Example

③ If Klein using Option Z from the data above, and company A's share price subsequently dropped to \$36, Klein would most likely need to take the following action to maintain the same hedged position:

- The required number of put options = Number of shares of underlying to be hedged / [$N(d_1)$ - 1], where $N(d_1)$ - 1 is the estimated delta used for hedging a position with put options (otherwise known as the put delta). As the share price drops to \$36, the delta of a put position will decrease toward -1.0, requiring less put options than the original position.

④ If company A pays a dividend, holding all other factors constant, what would be the most likely effect on the price of option W?

- Including the effect of cash flows lowers the underlying price. Lowering the underlying price causes the price of the call option to decrease.

Volatility Smile

- **What is volatility smile?**
  - Volatility smile is a plot of the implied volatility of an option as a function of its strike price.
    - ✓ This chapter describes the volatility smiles that traders use in **equity** and **foreign currency** markets.

Volatility Smile

- **Based on the put-call parity:**

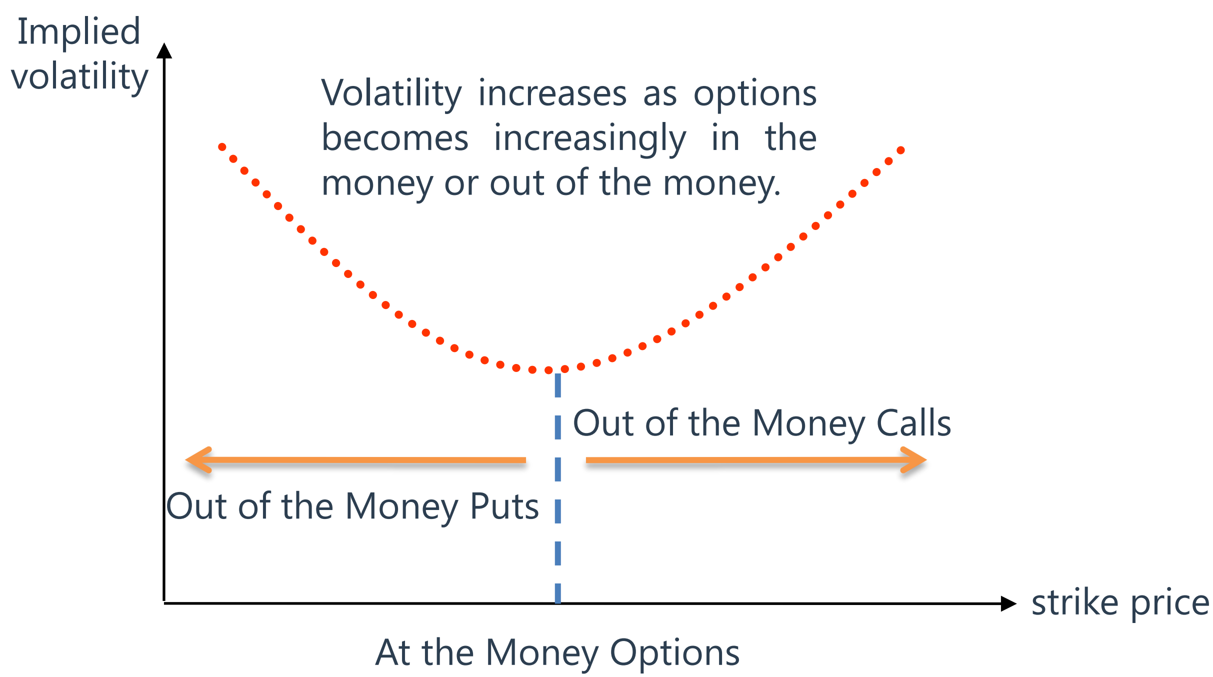
$$\begin{cases} p_{BS} + S_0 e^{-qT} = c_{BS} + Ke^{-rT} ----(1) \\ p_{mkt} + S_0 e^{-qT} = c_{mkt} + Ke^{-rT} ----(2) \end{cases}$$

  - (1) - (2): we can get: $p_{BS} - p_{mkt} = c_{BS} - c_{mkt}$

- **Conclusions:**
  - The dollar pricing error when the Black-Scholes model is used to price a European put option **should be exactly the same as** the dollar pricing error when it is used to pricing a European call option with the same strike price and time to maturity.
  - The **implied volatility** of a European call option is always the same as the implied volatility of a European put option when the two have the same strike price and maturity date.

Volatility Smile for Foreign Currency Options

- The implied volatility is relatively low for **at-the-money** options. It becomes progressively higher as an option moves either **into the money or out of the money.**

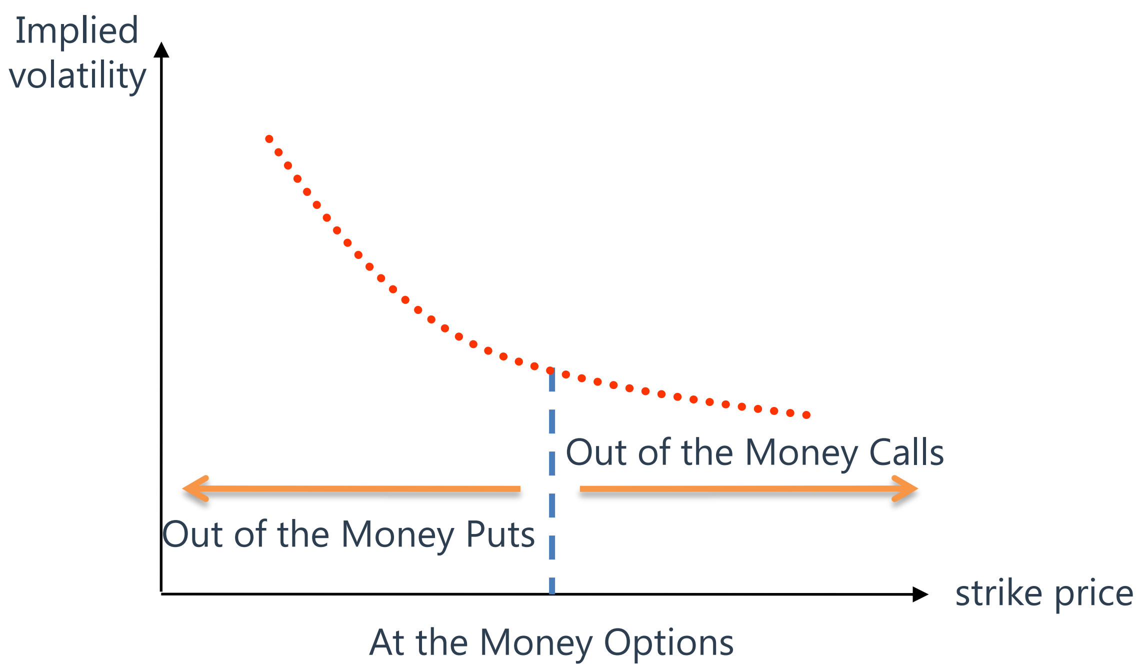


Reasons for Smile in Foreign Currency Options

- Why are exchange rate **not lognormally distributed?** Two of the contidions for an asset price to have a lognormal distribution are:
  - **The volatility of the asset is constant.**
  - **The price of the asset changes smoothly with no jumps.**
- **In practice, neither of these conditions is satisfied** for an exchange rate. The volatility of an exchange rate is far from constant, and exchange rates frequently exhibit jumps (sometimes the jumps are in response to the actions of **central banks**).

Volatility Smiles (skew) for Equity Options

- The volatility used to price a low-strike-price option (i.e., a deep out of the money put or a deep in the money call) is significantly higher than that used to price a high-strike-price option (i.e., a deep in the money put or a deep out of the money call).



Reasons for the Smile in Equity Options

- **Leverage (equity price→volatility)**
  - As a company's equity declines in value, the company's leverage increases. This means that the equity becomes more risky and its volatility increases.
- **Volatility Feedback Effect (volatility→equity price)**
  - As volatility increases (decreases) because of external factors, investors require a higher (lower) return and as a result the stock price declines (increases).
- **Crashophobia (expected equity price→implied volatility)**
  - 1987 stock market crash: higher premiums for put prices when the strike prices lower.

Strategy Related to Volatility Skew

- **A long risk reversal combines long call and short put on the same underlying with same expiration.**
- **For example**
  - If a trader believes that put implied volatility is relatively too high, compared to that for calls, a long risk reversal could be created by <u>buying the OTM call(underpriced) and selling the OTM put(overpriced)</u> for the same expiration.
  - However, this would create a long exposure to the underlying, which could be problematic.

Volatility Smile

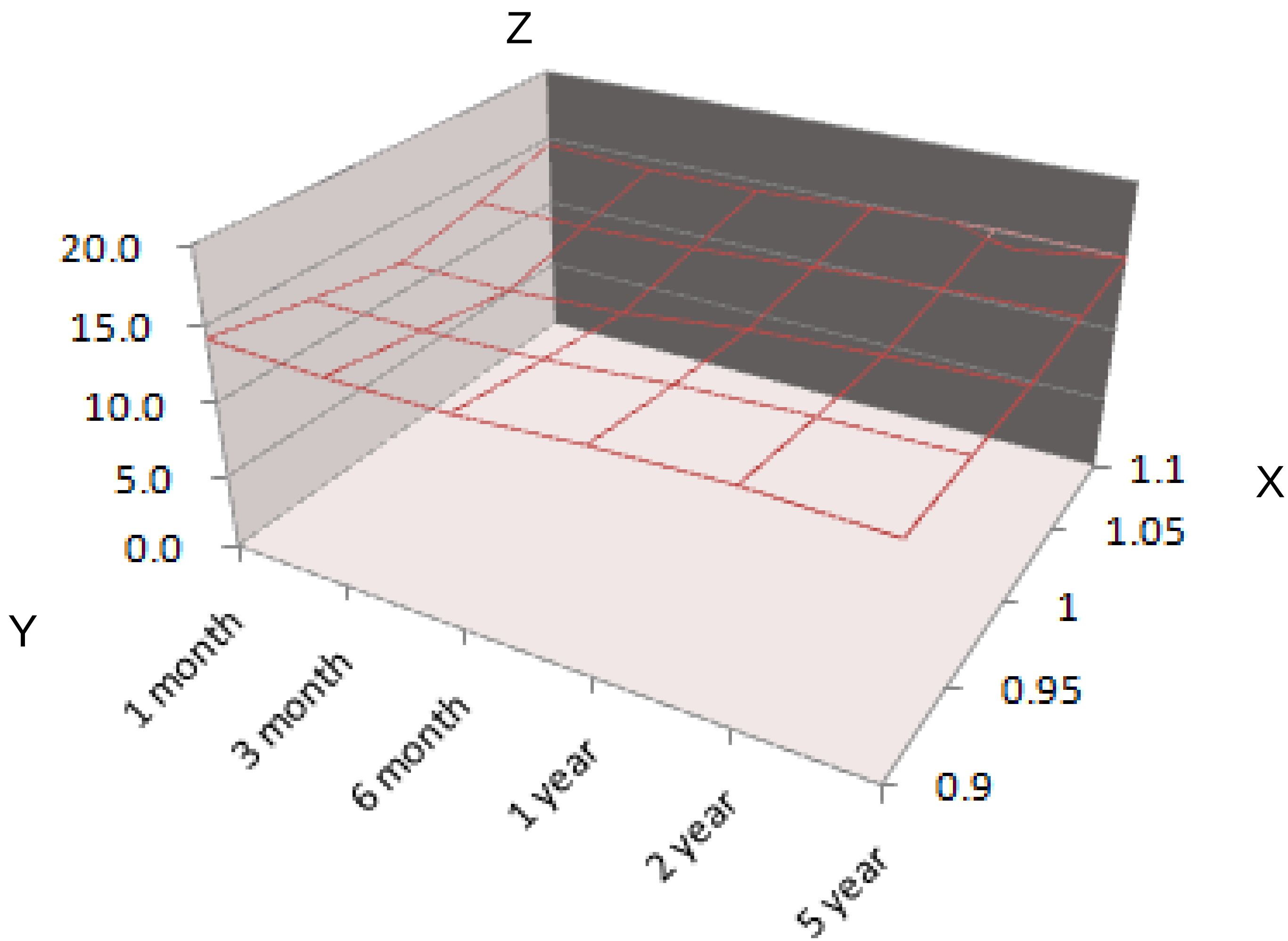
➢ **Alternative ways of characterizing the volatility smile**

- The volatility smile is often calculated as the relationship between the **implied volatility** and **K/S_0** rather than as the relationship between the implied volatility and K.
  - ✓ A refinement of this is to calculate the volatility smile as the relationship between the **implied volatility** and **K/F_0**, where F_0 is the forward pirce of the asset for a contract maturing at the same time as the options that are considered.
- Another approach to defining the volatility smile is as the relationship between **the implied volatility** and the **delta** of the option.

Volatility Smile

- Traders allow the implied volatility to **depend on time** to maturity as well as strike price.
- **Volatility surfaces** combine volatility smiles with the time to maturity and K/S_0.
  - Implied volatility tends to be an **increasing function** of maturity when short-dated volatilities are historically low.
  - Volatility tends to be a **decreasing function** of maturity when short-dated volatilities are historically high.

Volatility Term Structure and Volatility Surface



Implied volatility on the z-axis; maturity (x-axis); and K/S_0 (y-axis).

Volatility Smile

- Which of the following statements is incorrect regarding volatility smiles?

  A. Currency options exhibit volatility smiles because the at-the-money options have higher implied volatility than away-from-the-money options.

  B. Equity options exhibit a volatility smirk because low strike price options have greater implied volatility.

  C. Relative to currency traders, it appears that equity traders' expectations of extreme price movements are more asymmetric.

- **Answer: A**

Reading 16

Swaps, Forwards, and Futures Strategies

Framework

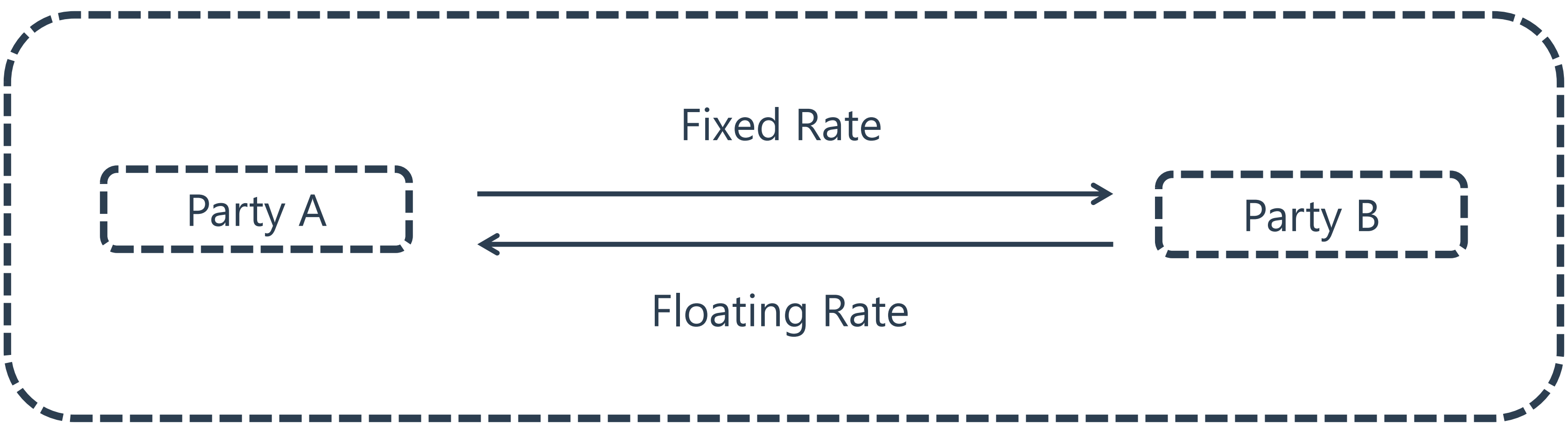
1. Managing Interest rate risk
   - Interest rate swap
   - Forward Rate Agreements(FRAs)
   - Eurodollar futures
   - T-bond futures
2. Managing Equity risk
   - Equity swap
   - Equity futures and forwards
3. Using Derivative to altering asset allocation
4. Managing Currency risk
   - Currency swap
   - Currency forwards and futures
5. Managing Volatility risk
6. Inferring Market Expectations

Managing Interest rate risk

- **Managing Interest rate risk**
  - Interest rate swap
  - Forward Rate Agreements(FRAs)
  - Short-dated interest rate(STIR) futures
    - ✓ Eurodollar futures
  - Longer-dated fixed-income(bond) futures
    - ✓ T-bond futures

Interest rate swap

- A payer swap is a contract to make a series of fixed-rate payments and receive a series of floating-rate payments, both based on a specified notional principal (amount).
- Interest rate swaps can be used to
  - convert between floating exposure and fixed exposure
  - alter the duration of a fixed-income portfolio



Interest rate swap

- A company with a floating-rate liability can use a payer swap (pay fixed, receive floating) to change it into a fixed-rate liability.
  - The swap must have settlement dates that match the payment dates on the floating-rate liability.
  - It benefits from rising floating rates.
- Converting Fixed-Rate and Floating-Rate Exposures

Existing Exposure	Converting	Interest Rate Swap Required	Beneficial When
Floating-rate liability	Floating to fixed	Payer swap	Floating rates expected to rise
Fixed-rate liability	Fixed to floating	Receiver swap	Floating rates expected to fall
Floating-rate asset	Floating to fixed	Receiver swap	Floating rates expected to fall
Fixed-rate asset	Fixed to floating	Payer swap	Floating rates expected to rise

Interest rate swap

- **Duration of the swap**
  - A pay-fixed, receive-floating swap has a negative duration, because the duration of fixed-rate bond is positive and larger than the duration of a floating-rate bond, which is near zero.
  - A pay-floating, receive-fixed swap has a positive duration.

$$Duration_{pay-floating} = Duration_{fixed} - Duration_{floating} > 0$$

- **The Fixed side and Floating side of the swap**
  - For floating-rate side, it doesn't has zero duration at all the time, especially when the cash flow has been set. The duration of floating-rate side will be the time to next payment if the next payment is known.
    - ✓ E.g.: for a semi-annually reset swap, the duration of the floating payment is 0.5 on any coupon reset days.
  - For fixed-rate side, the duration is approximately 0.75 (assuming a convention of 3/4 of the maturity).

Example

- Assume a 2-year swap, the duration of the fixed payment is 1.3, and the duration of the floating payments is 0.5. The duration of the pay-floating party is?
- **Correct Answer:**

$$Duration_{pay-floating} = Duration_{fixed} - Duration_{floating}$$
$$= 1.3 - 0.5 = 0.8$$

- The sign.
  - The pay-fixed side of the swap has effectively added a fixed-rate liability, so the duration for the swap in this example is -0.8, which reduces the duration of the overall portfolio.
  - The receive-fixed side of the portfolio, however, has effectively added a fixed-rate asset, so the duration of this same swap is +0.8.
  - In other words, <u>the duration is determined primarily by the fixed side of the swap</u>; that is, whether it is being received (like receipts on a fixed-rate asset) or paid (like the payments on a fixed-rate liability).

Interest rate swap

- **Market value risk and cash flow risk**
  - Cash flow risk, uncertainty regarding the *size* of cash flows, is a concern with floating-rate instruments.
  - Market value risk is a concern with fixed-rate instruments.
- **For individual assets and liabilities, the tradeoff is between the market value risk associated with fixed rates and the cash flow risk associated with floating rates.**
  - If by entering a swap the floating-rate instrument is effectively changed to fixed, the cash flow risk is neutralized but the instrument is now subject to market value risk.
  - When changing a fixed-rate instrument to floating. As a floating instrument, the former fixed-rate instrument is now subject to cash flow risk, but its market value risk has been mostly eliminated.

Interest rate swap

- **Portfolio duration with a swap contract, the notional principal would be:**

$$MV_p \times (MDur_T) = MV_p \times (MDur_p) + N_s \times (MDur_s)$$

$$N_s = MV_p \times \left(\frac{MDur_T - MDur_p}{MDur_s}\right)$$

Example

- A fund manager holds a fixed-income portfolio with $40 million, and the duration of the portfolio is 4.8, and the manager wants to lower the duration to 3.6 and wants to enter into a swap contract with a net duration of 2.8.

  The notional principal should the manager to choose to meet the manager need?

- **Correct Answer:**

$$N_s = MV_p \times \left(\frac{MDur_T - MDur_p}{MDur_s}\right) = \$40{,}000{,}000 \times \left(\frac{3.6 - 4.8}{-2.8}\right)$$
$$= \$17{,}142{,}857$$

- The manager should take pay-fixed and receive-floating swap to reduce the duration of the portfolio. So, the swap the manager choose has a negative duration which is -2.8.

Example

- A European bond portfolio manager wants to increase the modified duration of his €30 million portfolio from 3 to 5. She would most likely enter a receive-fixed interest rate swap that has principal notional of €20 million and:

  A. a modified duration of 2.

  B. a modified duration of 3.

  C. a modified duration of 4.

Example

- **Correct Answer: B.**
  - The portfolio manager's goal is to use the receive-fixed, pay-floating swap such that the €30 million of bonds, with modified duration of 3, and the €20 million swap will combine to make up a portfolio with a market value of €30 million and modified duration of 5. This relationship can be expressed as follows:

    $€30{,}000{,}000(3) + (N_S \times MDur_S) = €30{,}000{,}000(5).$
  - Given the swap's notional (N_S) of €20,000,000, its required modified duration can be obtained as:

    $MDur_S = [(5 - 3)€30{,}000{,}000]/€20{,}000{,}000 = 3.$

Forward Rate Agreements(FRAs)

- FRAs are typically used to **hedge the uncertainty** about a future short-term borrowing or lending rate.
- The long position in an FRA will receive a payment at settlement if the market rate of interest rate is higher than the (forward) rate specified in the FRA, and will make a payment to settle the FRA otherwise. Thus, the firm’s borrowing costs in the future are **essentially fixed** by the FRA hedge.

Example

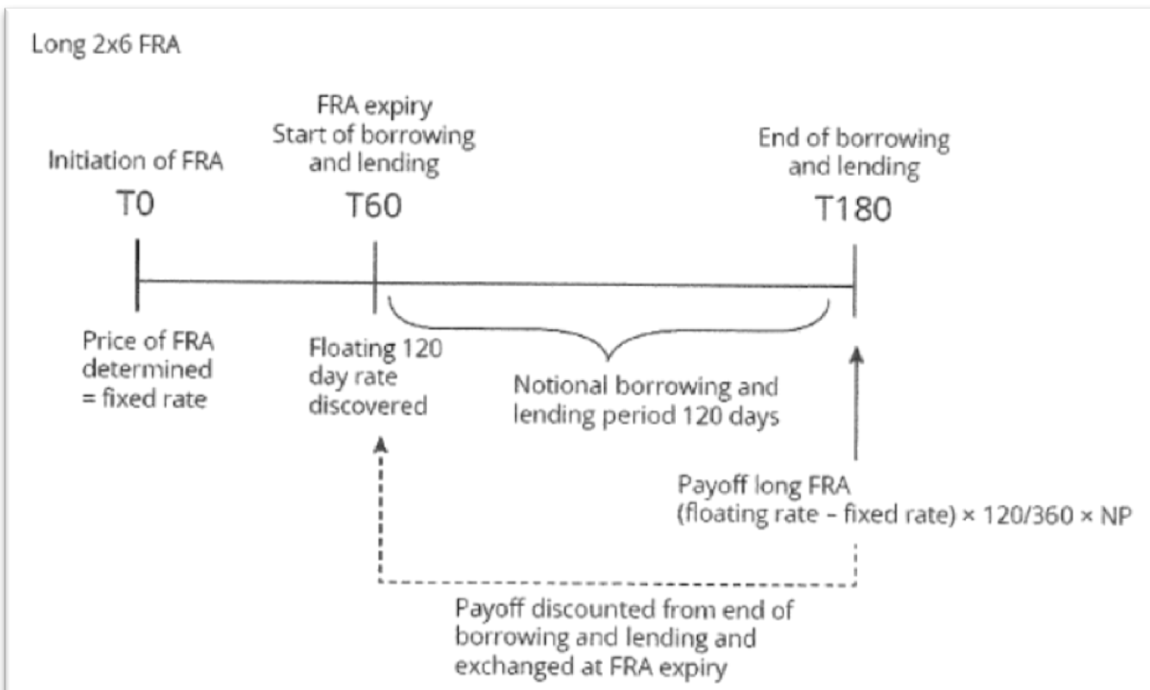
- Smithies Plc needs to borrow £1,000,000 for 180 days, 90 days from now, at LIBOR + 50 basis points(BP). The company is concerned that interest rates will rise over the 90-day period, increasing the cost of the 180-day loan. Smithies takes a long position in an FRA on 180-day LIBOR, 90 days in the future with a forward rate of 5% (annualized) and a notional principal of £1,000,000.
- **Calculate** the firm's borrowing costs on the loan net of the FRA payment for realized 180-day LIBOR values, 90 days from now of 7% and 3%.

Example

- **Correct Answer:**
  - LIBOR 7% at FRA expiry:
    - ✓ Cost of loan: (7% + 0.5%)×180/360×£1,000,000 = £37,500
    - ✓ Long FRA receipt: (7% - 5%)×180/360×£1,000,000 = **£10,000***
    - ✓ Net cost: £37,500 - £10,000 = £27,500
  - LIBOR 3% at FRA expiry:
    - ✓ Cost of loan: (3% + 0.5%)×180/360×£1,000,000 = £17,500
    - ✓ Long FRA payment: (3% - 5%)×180/360×£1,000,000 =**£10,000***
    - ✓ Net cost: £17,500 + £10,000 = £27,500
  - The payoff(£10,000*) at the end of the borrowing and lending period is typically discounted and exchanged between FRA counterparties at settlement at day 90.
  - The firm has effectively hedged its future borrowing costs.

Forward Rate Agreements(FRAs)

- Note that the FRA payment is made at the future borrowing or lending date(or FRA expiration date) and is equal to
  - the present value of the difference in interest between a market-rate loan and a loan at the forward rate (rate specified in the FRA).
  - Example:



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Short-dated interest rate(STIR) futures

- **STIR futures** are conceptually very similar to FRAs. The standardization of futures means that contracts are only available on specific maturities (typically quarterly).
  - Eurodollar futures ($-based STIR futures) are based on deposits of **$1 million** and are priced using the IMM Index convention (i.e., **100-annualized forward rate**).
  - The pricing convention means that futures prices will rise when forward rates fall.
    - ✓ The forward interest rate is calculated from current spot LIBOR rates in the same way the forward price of an FRA is established.
  - One basis point change in the forward rate will cause the contract's value to change by $25 ($1 million × 0.0001 × 90/ 360 = $25).

Eurodollar futures vs FRA

- A long Eurodollar futures position will increase in value as forward rates decrease, and decrease in value as forward rates increase.
- A long FRA position, which increases in value as forward rates increase, and decreases in value as forward rates decrease.
- Both Eurodollar futures and FRA agreements allow lenders and borrowers to lock in rates for future borrowing and lending.

Example

- Allan Luard is expecting to receive a $20 million inheritance in 120 days. Allan intends to invest the $20 million in a 90-day deposit account at LIBOR -25 BP. Currently, Eurodollar futures expiring in 120 days are trading at 95. Allan **is concerned that short-term rates may fall** before he makes his deposit and would like to lock in a guaranteed interest rate today. He takes a **long position in 20 Eurodollar futures** contracts.
- 1. After 120 days, 90-day LIBOR is quoted at 3.5%. Allan closes out his future position and invests his inheritance in a 90-day deposit account at LIBOR - 25 BP. What is Allan's $ return from depositing his inheritance combined with his futures position?
- 2. If 3-month LIBOR is 6.5% in 120 days, what is Allan's $ return from depositing his inheritance combined with his futures position?

Example

- **1. Correct Answer:**
  - Interest received on deposit:

    $$\$20\,million \times (3.5\% - 0.25\%) \times 90 / 360 = \$162{,}500$$
  - Number of futures contracts: \$20 million / \$1 million = 20
  - Futures price at settlement: 100-3.5 = 96.5
  - Profit on futures 96.5-95=150 BP;
    - ✓ 150 BP × \$25 × 20 contracts=\$75,000
  - Total return: \$162,500 + \$75,000=\$237,500
  - Allan has locked in the 90-day forward rate of 5%-0.25%
    - ✓ \$20 million × (5%-0.25%) × 90/360 =\$237,500

Example

- **2. Correct Answer:**
  - Interest received on deposit:
    - ✓ $20 million × (6.50% – 0.25%) × 90/ 360=$312,500
  - Futures price: 100 - 6.5 = 93.5
  - Loss on futures: 93.5 - 95 = -150 BP;
    - ✓ -150 BP × $25 × 20 contracts =-$75,000
  - Total return: $312,500 -$75,000 = $237,500

Example

- The CIO of a Canadian private equity company wants to lock in the interest on a three-month “bridge” loan his firm will take out in six months to complete an LBO deal. He **sells** the relevant interest rate futures contracts at 98.05. In six-months’ time, he initiates the loan at 2.70% and unwinds the hedge at 97.30. The effective interest rate on the loan is:

  A. 0.75%.

  B. 1.95%.

  C. 2.70%.

Example

➢ **Correct Answer: B.**

- The CIO **sells** the relevant interest rate future contracts at 98.05, locking in a forward rate of 1.95% (= 100 – 98.05). After six months, the CIO initiates the bridge loan at a rate of 2.70%, but he unwinds the hedge at the lower futures price of 97.30, thus gaining 75 bps (= 98.05 – 97.30). The effective interest rate on the loan is 1.95% (= 2.70% – 0.75%).

Longer-dated fixed-income(bond) futures

- STIR futures can be used to hedge the interest rate risk of short-maturity bonds, however, liquidity of interest rate futures decreases for forward rates further in the future.
- Longer-maturity bonds are most often hedged with **fixed-income futures** (bond futures), which have very good liquidity.
  - **Treasury futures** are widely used as fixed-income futures, which are available on T-bills, Treasury notes and Treasury bonds and are traded on the CBOT (Chicago Board of Trade) and CME (Chicago Mercantile Exchange) in US.

Longer-dated fixed-income(bond) futures

- Underlying: Hypothetical 30 year treasury bond with 6% coupon rate.
- Bond can be deliverable: $100,000 par value T-bonds with any coupon but with a maturity of at least 15 years.
- The quotes are in points and 32nds: A price quote of 95-18 is equal to 95.5625 and a dollar quote of $95,562.50.
- The short has a delivery option to choose which bond to deliver. Each bond is given a **conversion factor (CF),** which means a specific bond is equivalent to CF standard bond underlying in futures contract.
  - For a specific Bond A: $FP_f = FP_A \times \frac{1}{CF_A}$
- The short designates which bond he will deliver (**cheapest-to-deliver** bond).

Longer-dated fixed-income(bond) futures

- **The target dollar duration of portfolio is set equal to the dollar duration of the bonds we hold and the dollar duration of the futures contracts:**

$$BPV_T = BPV_P + BPV_f \times BPVHR$$

  - Basis Point Value (BPV) is the expected change in value of a security or portfolio given a one basis point (0.01%) change in yield(PVBP)

$$BPV_T = MV_P \times (MDur_T) \times 0.01\%$$

  - BPVHR is a BPV-based hedge ratio, also called the number of shorted futures contracts.

- **Recall that a CTD bond is delivered instead of hypothecated bond of the treasury bond.**

$$BPV_f = BPV_{CTD} \times \frac{1}{CF_{CTD}}$$

- **Solving for BPVHR, we obtain:**

$$BPVHR = \frac{BPV_T - BPV_P}{BPV_{CTD}} \times CF_{CTD}$$

Example

- A fixed income portfolio manager is holding a portfolio with a market value of £60 million and wants to fully hedge the portfolio value against parallel movements in the yield curve. The portfolio has a modified duration of 10.75. The portfolio manager will sell U.K. Government Long Gilt futures to hedge the portfolio.

U.K. Government Long Gilt Futures Specifications	
Futures price	£130.32
Futures contract size	£100,000
CTD	4.75% coupon, 12 years to redemption
CTD price	£139.56
CTD CF	1.0709
CTD modified duration	9.7

- 1. Compute the number of U.K. Government Long Gilt futures to be sold to immunize the portfolio.
- 2. Compute the number of Gilt futures that need to be sold to achieve at target duration of 8.7.

Example

➢ **1. Correct Answer:**

- Step 1: Compute the BPV of the portfolio ($BPV_{portfolio}$):
  - ✓ $BPV_{portfolio} = 10.75 \times 0.0001 \times £\ 60 \text{ million} = £64{,}500$
- Step 2: Compute the BPV of the CTD (BPV_{CTD}):
  - ✓ $BPV_{CTD} = 9.7 \times 0.0001 \times [(£139.56 / £100) \times £100{,}000] = £135.37$
- Step 3: Compute the BPV hedge ratio:
  - ✓ $BPVHR = \frac{BPV_{target} - BPV_{portfolio}}{BPV_{CTD}} \times CF = \frac{£0 - £64{,}500}{£135.37} \times 1.0709$

    $= -510.25 \approx -510$
  - ✓ The fund manager will need to **sell** 510 Long Gilt futures to fully hedge the portfolio.

Example

- **2. Correct Answer:**
  - $BPV_{target} = MD_{target} \times 0.0001 \times MV_{portfolio} = 8.7 \times 0.0001 \times £60$ million=£52,200

    ✓ $BPVHR = \frac{BPV_{target} - BPV_{portfolio}}{BPV_{CTD}} \times CF = \frac{£52,200 - £64,500}{£135.37} \times 1.0709$

    $= -97.30 \approx -97$
  - **Selling** 97 Long Gilt futures will achieve the portfolio's target modified duration of 8.7.

Managing Equity risk

- **Managing Equity risk**
  - Equity swap
  - Equity futures and forwards
    - ✓ Achieving a Target Portfolio Beta
    - ✓ Cash equitization

Equity swap

- Equity swaps can be used to create a synthetic exposure to physical stocks, allowing market participants to change their exposure to equity returns. Equity swaps enable users to achieve the economic benefits of share ownership without the cost and expense of ownership.
- There are **three types** of equity swaps
  - pay fixed rate and receive equity return;
  - pay floating rate and receive equity return;
  - pay one equity return and receive another equity return.
- The equity return <u>may include dividend return</u> plus price return based on
  - A single stock.
  - A basket of equities.
  - An equity index.

Equity futures and forwards

- Equity futures are exchange traded, standardized, require margin, have low transaction costs, and are available on indexes and single stocks.
  - Index futures have a multiplier. The actual futures price is the quoted futures price (in points) × the multiplier.

Stock Index Futures	Multipliers (q)
S&P 500 Index	250
NASDAQ 100	100
DJIA Index	10

- Equity forwards provide many of the same advantages but lack liquidity and are not subject to mark-to-market margin adjustments.
  - Because there is no clearinghouse, the credit quality of the counterparties is a concern.
  - The major advantage of forward contracts is they can be customized.

Equity futures and forwards

- Equity futures can be used to alter portfolio beta
  - As a risk measure, beta is similar to duration.
  - Solve for N_f and obtain

$$N_f = \left(\frac{\beta_T - \beta_S}{\beta_f}\right)\left(\frac{MV_p}{F}\right) = \left(\frac{\beta_T - \beta_S}{\beta_f}\right)\left(\frac{MV_p}{f \times multiplier}\right)$$

Example

- A manager decides to adjust the beta on $38,500,000 of large-cap stocks from its current level of 0.90 to 1.10 for the period of the next two months. It has selected a futures contract deemed to have sufficient liquidity; the futures price is currently $275,000 and the contract has a beta of 0.95. Calculate the number of futures contracts.

- **Correct Answer:**
  - $Target\ beta\ = 1.1$

$$N_f = \left(\frac{\beta_T - \beta_S}{\beta_f}\right)\left(\frac{MV_p}{F}\right) = \left(\frac{1.1 - 0.9}{0.95}\right) \times \left(\frac{\$38{,}500{,}000}{\$275{,}000}\right) = 29.47 \approx 29$$

✓ The fund manager will need to **purchase** 29 futures to fully hedge the portfolio.

Equity futures and forwards

- **Cash equitization(Cash securitization or cash overlay)** refers to purchasing index futures to replicate the returns that would have been earned by investing the cash in an index with risk and return characteristics similar to those of the portfolio.
  - Synthetic risk-free asset = Long stock – Stock index futures

$$N_f = \left(\frac{0 - \beta_S}{\beta_f}\right)\left(\frac{MV_p}{F}\right) = -\frac{\beta_S}{\beta_f}\left(\frac{MV_p}{f \times multiplier}\right)$$

  - Synthetic equity = Long risk-free asset + Stock index futures

$$N_f = \left(\frac{\beta_T - 0}{\beta_f}\right)\left(\frac{MV_p}{F}\right) = \frac{\beta_T}{\beta_f}\left(\frac{MV_p}{f \times multiplier}\right)$$

Using Derivatives to Altering Asset Allocation

- **Altering asset allocation between equity and debt with futures**
  - Step 1: Calculate the reallocating amount
  - Step 2: To reallocate an amount from equity to bonds:
    - ✓ Remove all systematic risk from the position (beta = 0) by shorting equity futures.
    - ✓ Add duration to the position (BPV > 0) by going long bond futures.
  - Step 3: To reallocate an amount from bonds to equity:
    - ✓ Remove all duration from the position (BVP = 0) by shorting bond futures.
    - ✓ Add systematic risk to the position (beta > 0) by going long equity futures.

Example

- A fund manager holds a £200 million equity portfolio, which is passively tracking the FTSE 100 Index. The fund manager wishes to hedge 30%) of the portfolio against equity market risk.

Contract Details for FTSE 100 Index Futures	
Quotation	Index points
Multiplier	£10 per point
Tick size	0.5 points
Delivery dates	March, June, September, December
Settlement price	FTSE 100 cash price on last day of trading
Futures price - September delivery	7,300

- Compute the number of contract required to hedge 30% of the portfolio's equity position. Compute the profit or loss if the FTSE 100 increases by 5% and the futures price is 7,665. Compute the profit or loss if the FTSE 100 falls by 5% and the futures price changes to 6,935.

Example

➢ **Correct Answer:**

- Number of futures contracts needed:

$$N_f = \left(\frac{0 - \beta_S}{\beta_f}\right)\left(\frac{MV_p}{f \times multiplier}\right) = \left(\frac{0-1}{1}\right)\frac{£60{,}000{,}000}{7{,}300 \times £10}$$

$$= -821.9 \approx -822 \text{ futures}$$

✓ The fund manager will need to **sell** 822 futures to hedge the portfolio.

- Futures gain/(loss): 7,665 - 7,300 = 365 points

✓ 365 points × £10 × -822=-£3,000,300

✓ Portfolio value: (1 + 0.05) × £200 ,000,000 = £210 ,000,000

✓ Net position: £210,000,000 -£3,000,300 = £206 ,999,700

Impact of hedge	**£**
Future position	-3,000,300
Portfolio £60 ,000,000 × 0.05	3,000,000
Net gain	-300

Example

- Futures gain/(loss): 6,935 - 7,300 = -365 points
  - ✓ -365 points × £10 × (-822) = £3,000,300
  - ✓ Portfolio value: (1 - 0.05) × £200,000,000 = £190,000,000
  - ✓ Net position: £190,000,000 +£3,000,300= £193,000,300

Impact of hedge	£
Future position	3,000,300
Portfolio £60 ,000,000 × (-0.05)	-3,000,000
Net gain	300

- The imperfection in the hedge is the result of **rounding the hedge ratio.**

Example

- A fund manager has a $60 million portfolio of aggressive stocks with a portfolio beta of 1.2 relative to the S&P 500. The fund manager believes the market will decline over the next six months and wishes to reduce the beta of the portfolio to 0.8 using S&P 500 futures. S&P 500 futures currently have a contract price of 2,984 and a multiplier of $250. At the end of the six-month period, the S&P 500 Index has decreased by 1.5%. By definition, beta of the S&P 500 Index equals 1.
- **Calculate** the number of futures contracts and **determine** whether they should be bought or sold to achieve the target portfolio beta.
- **Compute** the effectiveness of the strategy at the end of the six-month period.

Example

➢ **Correct Answer:**

- Number of futures contracts needed

$$N_f = \left(\frac{0 - \beta_S}{\beta_f}\right)\left(\frac{MV_p}{f \times multiplier}\right) = \left(\frac{0.8 - 1.2}{1}\right) \times \left(\frac{\$60{,}000{,}000}{\$746{,}300}\right)$$

$= -32.17 \approx -32$

  ✓ Futures contract value = 2,984 × \$250 = \$746,000

  ✓ The fund manager will need to **sell** 32 futures to hedge the portfolio.

- Value of portfolio in six months:

  ✓ \$60,000,000 × [1 −(0.015 × 1.2)] = \$58,920,000

  ✓ Note that if the market falls by 1.5%, the portfolio will fall by more than 1.5% because its beta is greater than 1.

Example

- Profit on futures contract:
  - ✓ Futures contracts value in six months: 2,984 × (1 - 0.015) = 2,939.24 =2,939 (**rounded to the nearest 0.5 index point**)
  - ✓ Futures profit: (2,984 - 2,939) × \$250 × 32 = \$360,000
  - ✓ Net position: \$58,920,000 + \$360,000 = \$59,280,000
  - ✓ $\text{Return} = \frac{\$59{,}280{,}000}{\$60{,}000{,}000} - 1 = -0.0121 \text{ or } -1.2\%$
  - ✓ $\text{Beta of portfolio} = \frac{\%\text{change in portfolio}}{\%\text{change in index}} = \frac{-0.012}{-0.015} = 0.8$

Example

➢ Josh Birmingham is the fund manager for a portfolio that has a target asset allocation of 70% equity and 30% government bonds. The portfolio increased in value from $200 million to $210 million over the previous month. The following table shows the portfolio's current position and what is needed to maintain the target allocations:

Equity	**Current**	**Target**	**Change in Exposure**
U. S. large cap	$140 million (66.67%)	147 million (70%)	+$7 million
Fixed Income			
U.S. Treasury bonds	$70 million (33.33%)	63 million (30%)	-$7 million
Total	$210 million	$210 million	
Equity portfolio beta = 0.8			
Fixed-income portfolio modified duration = 9.5			

Example

S&P 500 futures	S&P 500	Classic U.S. Treasury futures	
Futures price	2,930	Futures price	$135.00
Multiplier	$250	Contract size	$100,000
Beta	1	CTD	$110.25
Tick size	0.5 points	CF	0.814
		CTD modified duration	8.5

- Determine the futures positions Josh will need to use to rebalance the asset allocation.

Example

➢ **Correct Answer:**

- Equity portfolio:
  - ✓ Aim: increase exposure by $7 million

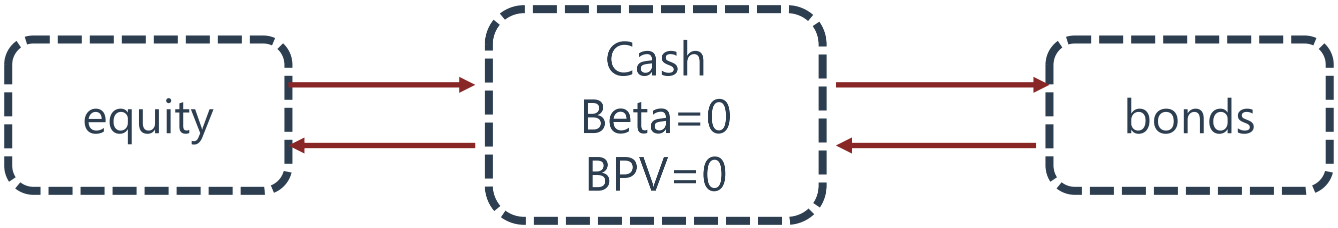
$$N_f = \left(\frac{\beta_T - \beta_P}{\beta_F}\right)\left(\frac{MV_P}{F}\right) = \left(\frac{0.8-0}{1}\right)\left(\frac{7{,}000{,}000}{732{,}500}\right) = 7.65 \approx 8$$

  - ✓ F = 2,930 × $250 = $732,500
  - ✓ Josh will need to **purchase** 8 S&P 500 futures.
- Fixed-income portfolio:
  - ✓ Aim: decrease exposure by $7 million
  - ✓ $BPV_{portfolio} = MD_{portfolio} \times 0.0001 \times MV_{portfolio} = 9.5 \times 0.0001 \times 7$ million=$6,650
  - ✓ $BPVHR = \frac{BPV_{target} - BPV_{portfolio}}{BPV_{CTD}} \times CF = \frac{\$0 - \$6650}{\$93.71} \times 0.8140 = -57.76$

    $\approx$ -58 futures
  - ✓ Josh will need to **sell** 58 Treasury futures contracts.

Altering Asset Allocation

- 关键在于**Cash position** 的中介作用



Example

- An equity portfolio manager is invested 100% in US large-cap stocks, but he wants to reduce the current allocation by 20%, to 80%, and allocate 20% to US small caps. He decides not to sell the stocks because of the high transaction costs. Rather, he will use S&P 500 Index futures and Russell 2000 Index futures for achieving the desired exposure in, respectively, US large caps and small caps. To achieve the new allocation, he will for an equivalent of 20% of the portfolio value:

  A. purchase Russell 2000 futures only.

  B. purchase Russell 2000 futures and sell S&P 500 futures.

  C. sell Russell 2000 futures and purchase S&P 500 futures.

Example

- **Correct Answer: B.**
  - To reduce the current allocation by 20%, to 80%, in US large-cap stocks, the portfolio manager will sell S&P 500 futures. At the same time, to allocate this 20% to US small caps, he will purchase Russell 2000 futures for the same notional amount.

Managing Currency risk

- **Managing Currency risk**
  - Currency swap
    - ✓ Cross-currency basis swap
    - ✓ Synthetic borrowing
  - Currency Forwards and Futures

Currency swap

➢ **Reasons for currency swap**

- **Converting a loan in one currency into a loan in another currency**
  - ✓ A **cross-currency basis swap** is used in the case with principals switched at the beginning of the swap.
  - ✓ **Cross-currency basis** represents the additional cost of borrowing dollars synthetically with a currency swap relative to the cost of borrowing directly in the USD cash market.
    - ◆ The additional cost indicated the foreign currency to be exhibiting negative basis. <u>Most currencies shown a negative basis against the dollar since the financial crisis</u>.
- **Converting foreign cash receipts into domestic currency**
  - ✓ Also known as **synthetic borrowing** with no principal switched at the beginning of the swap.

Currency swap

➢ **Features of cross-currency basis swap:**

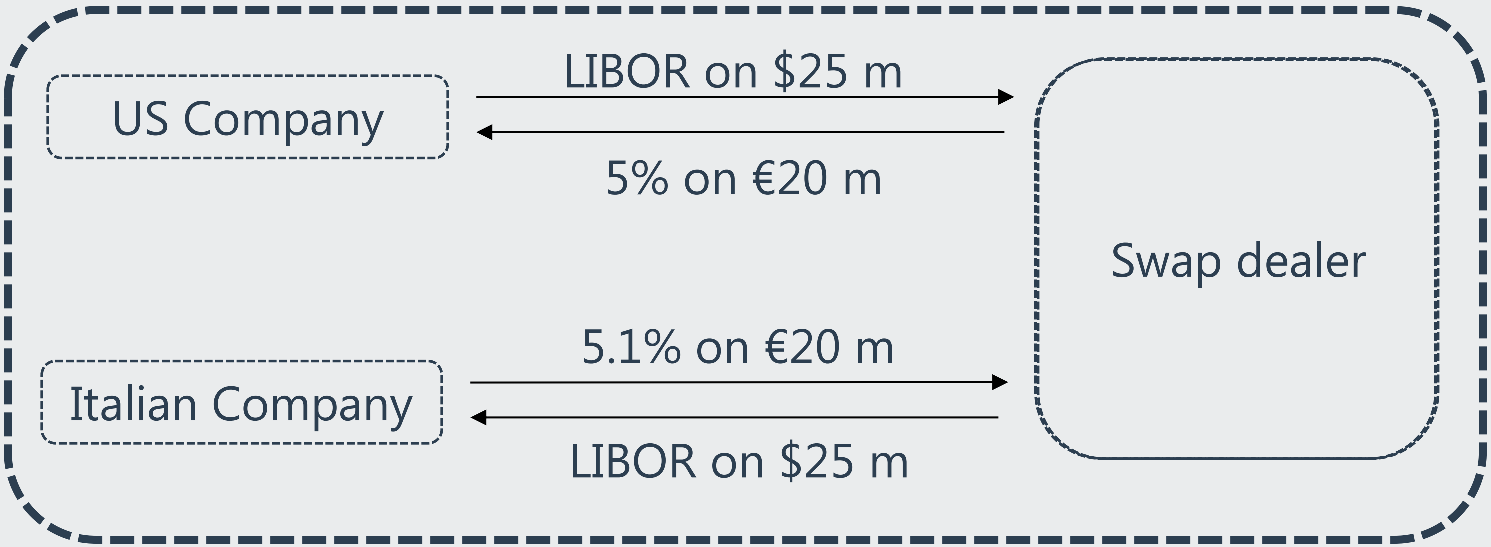
- Two notional principals exists in the currency swap and it needs to exchange and return the principal at the effective date and maturity date.
- The periodic interest payment couldn’t be netted as there are different currencies.

Example

- Two different companies in different countries have the following liabilities and loans:
  - The US company with €20 million liability with fixed-rate at 5%.
  - The Italian company with $25 million loan with floating-rate at LIBOR.
  - Current exchange rate is $1.25/ €.
- The US company and the Italian company enter into a cross-currency basis swap with a same dealer. US company pays LIBOR on $25 million and receives the swap rate of 5% on €20 million. Italian company pays swap rate of 5.1% on €20 million and receives LIBOR on $25 million.
- Current LIBOR for one-year is 5.3%.

Example

➢ **Cash flows for the cross-currency basis swap.**

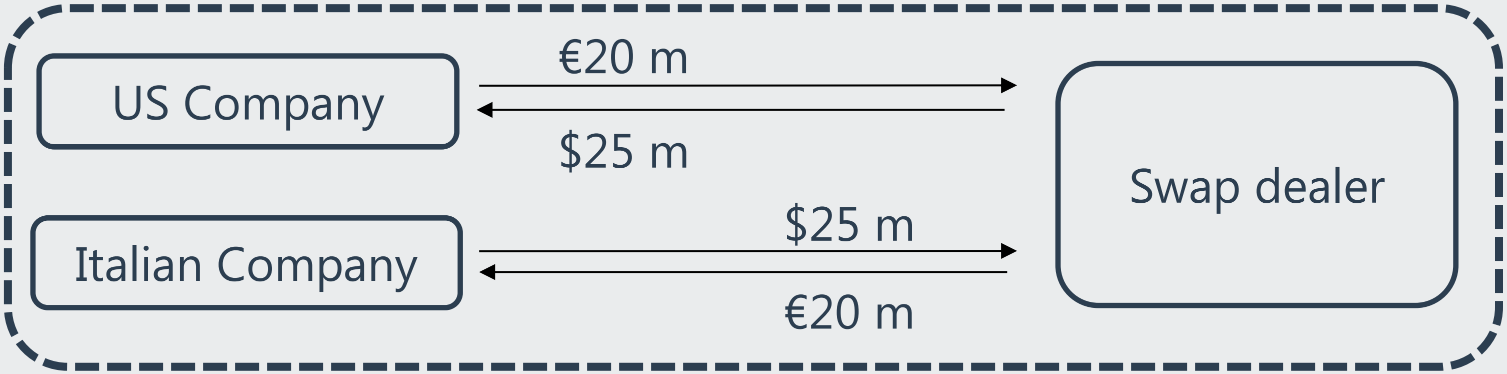


Example

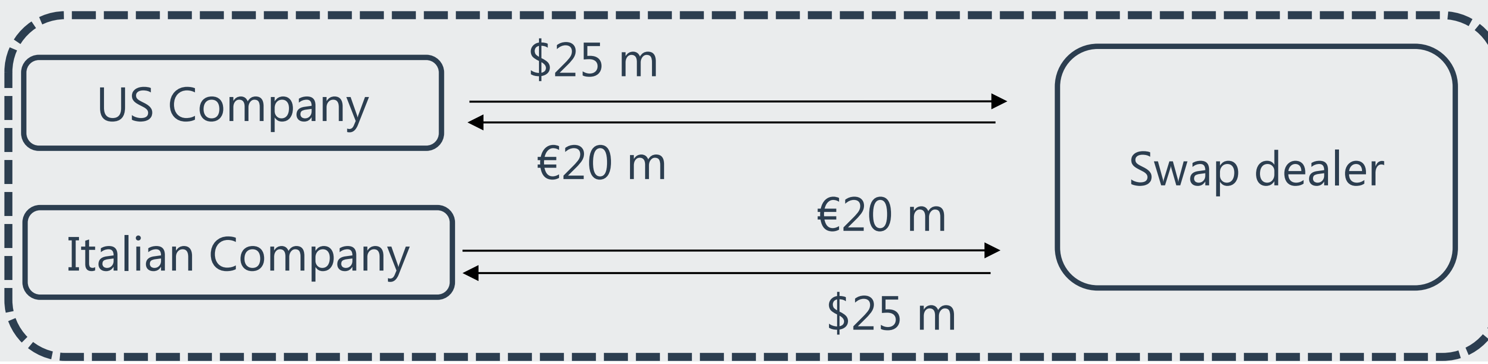
- **Correct Answer:**
  - The U.S. company's net borrowing cost: LIBOR on $25 million
    - ✓ (5% on €20 million) + (LIBOR on $25 million - 5% on €20 million)
  - The Italian company's net borrowing cost: 5.1% on €10 million
    - ✓ (LIBOR on $25 million) + (5.1% on €20 million - LIBOR on $25 million)
  - The swap dealer's spread: 0.1% on €20 million = €20,000
    - ✓ (LIBOR on $25 million - 5.0% on €20 million) + (5.1% on €20 million - LIBOR on $25 million)

Example

- Two companies exchange notional principals at the beginning of the swap contract besides the paying in different currencies during the contract.
- Exchange of Notional Principals



- Cash Flows at the Maturity of the Swap



Currency swap

- **Features of synthetic borrowing:**
  - Do not require an exchange of notional principals.
  - A series of exchange-rate cash flows in the future at a fixed exchange rate.
  - The amounts exchanged are based on the exchange rate and interest rate.

Example

- A US firm wants to exchange its cash flow received quarterly which is €5 million each to USD. Current exchange rate is €0.85/$. The swap rate in US and Euro are 4% and 4.5% separately. We calculate the notional principals in Euro, then translate it to dollar notional principal and dollar interest.
  - NP(0.045/4) = €5,000,000 → NP= €444,444,444 → Dollar principal = €444,444,444/ (€0.85/$) = $522,875,816.
  - Quarterly interest payments = $ 522,875,816×(0.04/4) = $5,228,758.16
  - So, the US firm could exchange its €5,000,000 for $ 5,228,758.16 quarterly. No principal exchange is required.

Currency Forwards and Futures

- Currency forwards and futures allow users to exchange a specified amount of one currency for a specified amount of another currency on a future date.

$$HR = \frac{Amount\ of\ currency\ to\ be\ exchanged}{Futures\ contract\ size}$$

Example

- A U.S. firm is due to receive €20 million in 90 days for goods they sold. The firm is seeking to hedge this risk by selling EUR futures contracts maturing closest to date the euros will be received. The EUR-USD FX future contract size is (€ 125,000. The futures price is 1.3150 USD/EUR. The firm will sell futures contracts (promising to deliver euros at the rate of 1.3150 USD per EUR).
- Calculate the number of futures contracts required to hedge the liability and the amount of USD to be received at contract settlement.

$$HR = \frac{€\ 20\ million}{€\ 125{,}000} = 160\ EUR/USD\ futures$$

Managing Volatility risk

➢ **Managing Volatility risk**

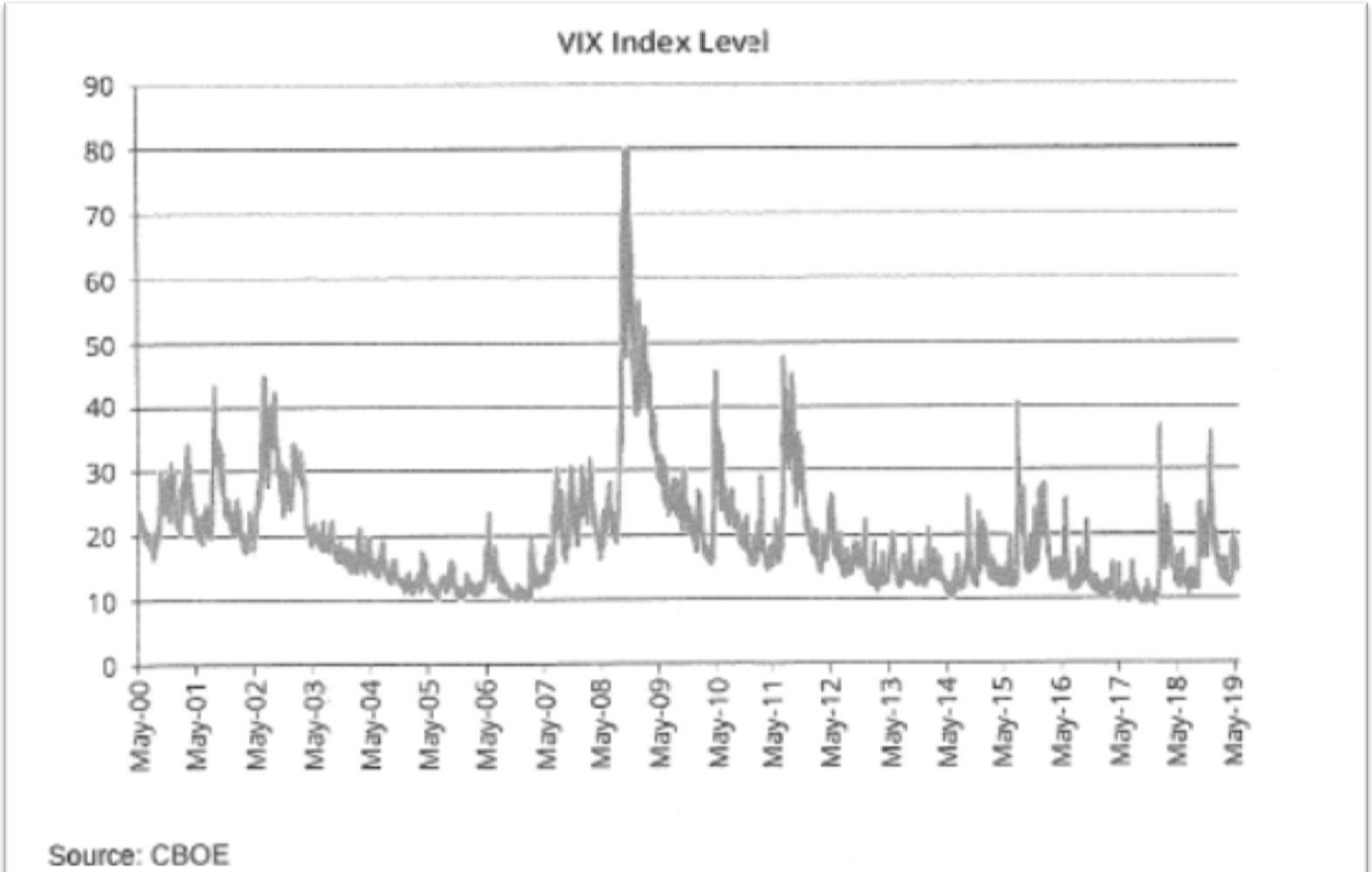
- Volatility derivatives
  - ✓ VIX futures
  - ✓ VIX options
  - ✓ Volatility indexes
- Variance swap

Volatility derivatives

- The best known measure of market volatility is the CBOE Volatility Index (more commonly known as VIX).
  - The VIX Index measures **implied volatility** in the S&P 500 Index over a forward period of 30 days. More specific, VIX computes a weighted average of implied volatility inferred from S&P 500 traded options (calls and puts) with an average expiration of 30 days.
  - As VIX returns and equity returns are mostly negatively correlated. VIX is also known as the **fear index or fear gauge** as we can directly view the market's expectations of future volatility.
  - Specifically, the VIX Index value is the **annualized standard deviation** of the expected percentage moves in the S&P 500 Index over the following 30 days.

Volatility derivatives

➤ The graph VIX Index



Volatility derivatives

- **VIX futures**
  - Unlike other futures contracts, the cost-of-carry model cannot be used to determine the fair value of the future because it is not possible to directly invest in spot VIX
  - An equity holding can be protected from extreme downturns (tail risk) by buying VIX futures.
  - Selling VIX futures creates a short volatility position and captures the volatility risk premium embedded in S&P 500 options.
- **VIX option**
  - VIX options are cash-settled European-style options
  - VIX call options will gain in value if expectations of volatility at maturity of the option increase
- **Other Volatility Index**
  - S&P 100,DJIA, Nasdaq 100, and Russell 2000.

Example

- A volatility trader observes that the VIX term structure is upward sloping. In particular, the VIX is at 13.50, the front-month futures contract trades at 14.10, and the second-month futures contract trades at 15.40. Assuming the shape of the VIX term structure will remain constant over the next three-month period, the trader decides to implement a trade that would profit from the VIX carry roll down. She will most likely purchase the:

A. VIX and sell the VIX second-month futures.

B. VIX and sell the VIX front-month futures.

C. VIX front-month futures and sell the VIX second-month futures.

Example

- **Correct Answer: C.**
  - Since one cannot directly invest in the VIX, trades focusing on the VIX term structure must be implemented using either VIX futures or VIX options, so Answers A and B are not feasible.
  - VIX futures converge to the spot VIX as expiration approaches, and the two must be equal at expiration.
    - ✓ Buying the VIX front-month futures will result in a loss of 0.60.
    - ✓ Selling the VIX second-month futures will result in a gain of 1.3.
    - ✓ The overall proceed will be 0.70.

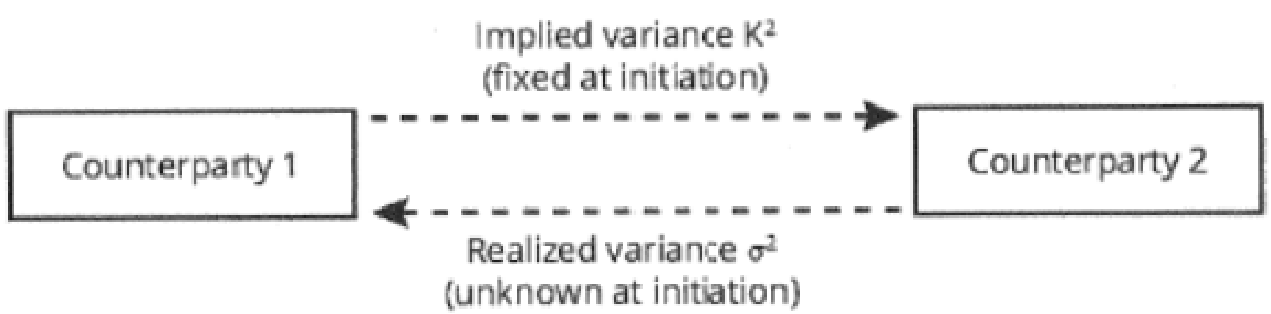
Variance Swap

- **Variance swaps** payoffs are based on variance rather than volatility (standard deviation).
- These products are termed swaps as they have two counterparties, one making a fixed payment and the other making a variable payment.
  - The fixed payment is typically based on **implied volatility^2** (implied variance) over the period and is known at the initiation of the swap, this is referred to as the **variance strike**.
  - The variable payment is unknown at swap initiation and is only known at swap maturity. It is the actual variance of the underlying asset over the life of the swap and is referred to as **realized variance**.

Variance Swap

➢ **The features of variance swap**

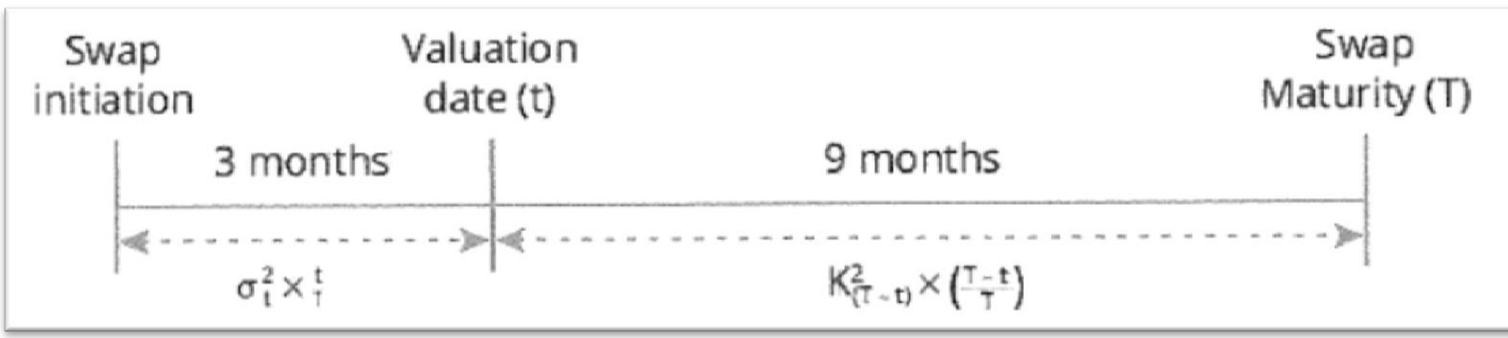
- no exchange of notional principal and no interim settlement periods.
- With a variance swap, there is a single payment at the expiration of the swap based on the difference between actual and implied variance over the life of the swap
  - ✓ $settlement\ amount(long)\ = \boldsymbol{variance\ notional} \times (\sigma^2 - K^2)$
  - ✓ $settlement\ amount(long) = \boldsymbol{vega\ notional} \times (\frac{\sigma^2 - K^2}{2K})$
    - ◆ $\boldsymbol{vega\ notional} = \boldsymbol{variance\ notional} \times 2K$
    - ◆ The approximate gain or loss for a 1% change in volatility for a variance swap is the swap's vega notional.



Variance Swap

➢ **The Mark-to-Market value of variance swap**

- The value of a variance swap is zero at initiation, but over time, the swap will either gain or lose value as realized and implied volatility diverge.
- Consider a one-year swap where three months have elapsed since inception, the MtM value of the swap can be calculated as follow:



Variance Swap

- **The Mark-to-Market value of variance swap**
  - Consider a one-year swap where three months have elapsed since inception, the MtM value of the swap can be calculated as follow:
    - ✓ Step 1: Compute expected variance at maturity (the time-weighted average of realized variance and implied variance over the remainder of the swap's life).

$$Expected\ variance\ to\ maturity = \left(\sigma_t^2 \times \frac{t}{T}\right) + (K_{(T-t)}^2 \times \frac{T-t}{T})$$

    - ✓ Step 2: Compute expected payoff at swap maturity:
      - $Expected\ Payoff = variance\ notional \times (expected\ variance\ to\ maturity - original\ strike^2)$
    - ✓ Step 3: Discount expected payoff at maturity back to the valuation date.

Example

- Luke Amos, an equity fund manager, has purchased a one-year variance swap on the S&P 500 with vega notional of $100,000 and a strike of 20%. Nine months have passed and the S&P has realized a volatility of 21%. The strike price for a three-month variance swap at this time is quoted at 22%, and the three-month interest rate is 2%.
- Compute the current value of the swap.

Example

➢ **Correct Answer:**

- Step 1: Compute the expected variance at maturity:

$$\left(21^2\times\frac{9}{12}\right)+\left(22^2\times\frac{3}{12}\right)=330.75+121=451.75$$

- Step 2: Compute the expected payoff at maturity:
  - ✓ Variance notional $=\frac{\text{Vega notional}}{2\times K}=\frac{\$100{,}000}{2\times 20}=\$2{,}500$
  - ✓ Expected payoff at maturity= $(\sigma^2 - K^2)\times$ variance notional,
    - ◆ where $K^2 = 20^2 = 400$
    - ◆ expected payoff at maturity = $(451.75 - 400)\times \$2{,}500$ $=\$129{,}375$
- Step 3: Discount expected payoff from maturity to the valuation date (3 months):
  - ✓ Unannualize the interest rate = $2\%\times(3/12) = 0.5\%$
  - ✓ Current value of swap $=\frac{\$129{,}375}{1.005}=\$128{,}731$
  - ✓ This is a gain to the purchaser (long) and a loss to the seller (short).

Inferring Market Expectations

- Market expectations are current expectations derived from market prices. In the event of a market shock, market expectations can change rapidly.

Application	Derivative
Inferring expectations of FOMC moves	Fed funds futures
Inferring expectations of inflation	CPI swaps
Inferring expectations of futures volatility	VIX futures and options

- **Fed funds futures**
  - Fed funds futures are traded on the Chicago Board of Trade, and the contract price is quoted as 100 minus the market's expectation for the FFE rate, as follows:
    - ✓ Fed funds futures contract price = 100 – Expected FFE rate.
- **Eurodollar futures**
  - Eurodollar is a dollar deposited in a US or foreign bank outside US.
  - The futures pries quote is 100 minus the futures interest rate.

Inferring Market Expectations

- Market participants can use Fed funds futures to infer the **expected probabilities** of upcoming Fed interest rate changes. Some terms and definitions used in the analysis include the following
  - **Federal funds rate**. This is the interest rate that deposit institutions (banks and credit unions) charge other deposit institutions for loans in the overnight interbank markets.
    - ✓ **The federal funds effective (FFE) rate** is the weighted average of interest rates charged on overnight interbank loans.
  - **Federal funds target rate**. This is the rate set by governors of the Federal Reserve in Federal Open Market Committee (FOMC) meetings.
    - ✓ The target rate is typically set as a range (e.g., 2.25%—2.50%).

Example

- Sarah Ko, a private wealth adviser in Singapore, is developing a short-term interest rate forecast for her private wealth clients who have holdings in the US fixed-income markets. Ko needs to understand current market expectations for possible upcoming central bank (i.e., US Federal Reserve Board) rate actions. The current price for the fed funds futures contract expiring after the next FOMC meeting is 97.175. The current federal funds rate target range is set between 2.50% and 2.75%.
- Explain how Ko can use this information to understand potential movements in the current federal funds rate.

Example

- **Solution:**
  - First, Ko knows that the FFE rate implied by the futures contract price of 97.175 is 2.825% (= 100 – 97.175). This is the rate that market participants expect to be the average federal funds rate for that month.
  - Second, Ko should determine the probability of a rate change. She knows the 2.825% FFE rate implied by the futures signals a fairly high chance that the FOMC will increase rates by 25 bps from its current target range of 2.50%–2.75% to the new target range of 2.75%–3.00%. She calculates the probability of a rate hike as follows:

$$\frac{2.825\% - 2.625\%}{2.875\% - 2.625\%} = 0.80, or\ 80\%$$

  - Ko can now incorporate this probability of a Fed rate hike into her forecast of short-term US interest rates.

Reading 17

Currency Management: An introduction

Framework

1. Currency quotes, Currency Markets and Products
2. Effects of Currency on Portfolio Return and Risk
3. Strategic Currency Management
4. Active (Tactical) Currency Management
   - Carry trade
   - Volatility trading
5. Tools of Currency Management
6. Currency Management of Emerging Markets

Price and Base Currencies

- **Base currency:** with respect to a foreign exchange quotation of the price of one unit of a currency, the currency referred to in "one unit of a currency."
- **Quoting conventions**
  - Currency pairs involving the EUR will use the EUR as the base currency (for example, GBP/EUR).
  - Currency pairs involving the GBP, other than those involving the EUR, will use the GBP as the base currency (for example, CHF/GBP).
  - Currency pairs involving either the AUD or NZD, other than those involving either the EUR or GBP, will use these currencies as the base currency (for example, USD/AUD and NZD/AUD). The market convention between these two currencies is for a NZD/AUD quote.
  - All other currency quotes involving the USD will use USD as the base currency (for example, MXN/USD).

Bid/Asked Rule

- **Bid/Asked rules**
  - The **bid price** is the price, defined in terms of the price currency, at which the counterparty providing a two-sided price quote is willing to buy one unit of the base currency.
  - The **offer price** is the price, in terms of the price currency, at which that counterparty is willing to sell one unit of the base currency.
    - ✓ E.g., quote a two-sided price on the spot USD/EUR exchange rate of 1.3648/1.3652. This quote means that the dealer is willing to pay USD1.3648 to buy one euro (bid) and that the dealer will sell one euro (offer) for USD1.3652.
  - The **market width**, usually referred to as dealer's **spread** or the bid–offer spread, is the difference between the bid and the offer.
    - ✓ E.g.,if one wants to buy 1 EUR, 1.3652 is more USD per EUR than 1.3648.
    - ✓ When selling 1 EUR, hitting the bid at 1.3648 means less USD received than 1.3652.

Spot and Forward Bid/Asked Quotes

- For illustration purposes, assume that the bid–offer for the spot and forward points for the USD/EUR exchange rate are as shown in Exhibit below:

Maturity	Spot Rate or Forward Points
Spot (USD/EUR)	1.3549/1.3651
One month	–5.6/–5.1
Three months	–15.9/–15.3
Six months	–37.0/–36.3
Twelve months	–94.3/–91.8

- To convert any of these quoted forward points into a forward rate, one would divide the number of points by 10,000 and then add the result to the spot exchange rate quote.

Spot and Forward Bid/Asked Quotes

- the three-month forward bid rate in this case would be based on the bid for both the spot and the forward points, and hence would be:

$$1.3549+\left(\frac{-15.9}{10,000}\right)=1.35331$$

- This result means that the market participant would be selling EUR three months forward at a price of USD1.35331 per EUR.

Offsetting Transactions and Mark To Market

- **Forward contracts**
  - Although there is no cash flow on a forward contract until settlement date, it is often useful to do a **mark-to-market valuation** on a forward position before then to
    - ✓ **judge the effectiveness** of a hedge based on forward contracts (i.e., by comparing the change in the mark-to-market of the underlying asset with the change in the mark-to-market of the forward), and
    - ✓ **measure the profitability** of speculative currency positions at points before contract maturity.
- The **mark-to-market value** of forward contracts reflects the profit (or loss) that would be realized from closing out the position at current market prices.

Mark-to-market Value

- **Mark-to-market value of a forward contract**
  - The value of the forward contract will changes as forward quotes for the currency pair change in the market.
  - The value of a forward contract (to the party buying the base currency) at maturity (time T) is：

$$V_T = (FP_T - FP)(\text{contract size})$$

  - The value of a forward currency contract prior to expiration (time t) is also known as the mark-to-market value.

$$V_t = \frac{(FP_t - FP)(\text{contract size})}{\left(1 + R\left(\frac{days}{360}\right)\right)}$$

Spot and Forward Bid/Asked Quotes

- Suppose that a market participant bought GBP10,000,000 for delivery against the AUD in six months at an "all-in" forward rate of 1.6100 AUD/GBP. Three months later, the market participant wants to close out this forward contract. To do that would require selling GBP10,000,000 three months forward using the AUD/GBP spot exchange rate and forward points in effect at that time. Assume the bid–offer for spot and forward points three months prior to the settlement date are as follows: (the three-month AUD Libor is 4.80%)

Maturity	Spot Rate or Forward Points
Spot rate (AUD/GBP)	1.6210/1.6215
Three months	130/140

Spot and Forward Bid/Asked Quotes

- To sell GBP (the base currency in the AUD/GBP quote) means calculating the bid side of the market. Hence, the appropriate all-in three-month forward rate to use is:

$$1.6210 + 130/10{,}000 = 1.6340$$

- The AUD amounts will not net to zero because the forward rate has changed. The AUD cash flow at settlement date will be equal to:

$$(1.6340 - 1.6100) \times 10{,}000{,}000 = \text{AUD}240{,}000$$

- To calculate the mark-to-market value on the dealer's position, this cash flow must be discounted to the present.

$$\text{present value} = \frac{\text{AUD}240{,}000}{1 + 0.048\left[\frac{90}{360}\right]} = \text{AUD}237{,}154$$

FX Swap

- FX swaps are **distinct** from currency swaps.
  - Similar to currency swaps, FX swaps involve an exchange of principal amounts in different currencies at swap initiation that is reversed at swap maturity.
  - **Unlike currency swaps**, FX swaps have no interim interest payments and are nearly always of much shorter term than currency swaps.
    - ✓ FX swaps are important for managing currency risk because they are used to **"roll" forward contracts** forward as they mature.
    - ✓ If a trader wanted to **adjust the size** of the currency hedge (i.e., the size of the outstanding forward position), the forward leg of the FX swap can be of a different size than the spot transaction when the hedge is rolled.

Example

- Consider the case of a trader who bought GBP1,000,000 one month forward against the CHF in order to set up a currency hedge. One month later, the forward contract will expire. To maintain this long position in the GBP against the CHF, what should the trader do two days prior to contract maturity, **given T+2 settlement**?

- **Correct Answer:**
  - The trader should engage in an FX swap.
  - First, sell GBP1,000,000 against the CHF spot, to settle the maturing forward contract;
  - Then, buy GBP1,000,000 against the CHF forward.

Currency Options

- **Currency options**
  - **Call and put options** are the most common options in FX markets.
    - ✓ Call and put options are referred to as **vanilla options.**
  - **Exotic options** are also used in FX markets.
    - ✓ Exotic options have a variety of features that make them exceptionally flexible risk management tools, compared with vanilla options
- **Size of FX options market**
  - Although daily turnover in FX options market is **small in relative terms** compared with the overall daily flow in global spot currency markets, because the overall currency market is so large.
  - The **absolute size** of the FX options market is still **very considerable**.

Effects of Currency on Portfolio Return

- **Investing Foreign Asset**
  - **Domestic currency or home currency**: The currency of the investor, i.e., the currency in which he or she typically makes consumption purchases, e.g., the Swiss franc for an investor domiciled in Switzerland.
  - **Domestic asset**: An asset that trades in the investor's domestic currency (or home currency).
  - **Foreign assets**: Assets denominated in currencies other than the investor's home currency.
  - **Foreign currency**: Currency that is not the currency in which an investor makes consumption purchases, e.g., the US dollar from the perspective of a Swiss investor.

Effects of Currency on Portfolio Return

- **Foreign-currency return(R_{FC})**: The return of the foreign asset measured in foreign-currency terms. 外国资产部分
- **Local currency return(R_{FX})**: the percentage change of the foreign currency against the domestic currency. 外汇部分
- **Domestic-currency return (R_{DC}):** A rate of return **stated in domestic currency terms** from the perspective of the investor;
  - reflects **both the foreign-currency return** on an asset as well as **percentage movement in the spot exchange rate** between the domestic and foreign currencies.

Effects of Currency on Portfolio Return

➢ **The domestic-currency return is multiplicative with respect to these two factors:**

- The foreign-currency return;
- The percentage change of the foreign currency against the domestic currency.

$$R_{DC} = (1 + R_{FC})(1 + R_{FX}) - 1$$

Example of Single Foreign Asset

- The domestic-currency return for the Eurozone-domiciled investor on the USD-denominated bond will reflect both the bond's USD-denominated return as well as movements in the exchange rate between the USD and the EUR. Suppose that the foreign-currency return on the USD-denominated bond is 10% and the USD appreciates by 5% against the EUR. In this case. What is the domestic-currency return to the Eurozone investor?
- **Correct Answer:**
  - $(1 + 10\%)(1 + 5\%) - 1 = (1.10)(1.05) - 1 = 0.155 = 15.5\%$
  - The domestic-currency return to the Eurozone investor will be 15.5%.

Effects of Currency on Portfolio Return

- More generally, the domestic-currency return on a portfolio of multiple foreign assets will be equal to:

$$R_{DC} = \sum_{i=1}^{n} \omega_i (1+R_{FC,i})(1+R_{FX,i})-1$$

- Where:

  $R_{FC,i}$ is the foreign-currency return on the i-th foreign asset,

  $R_{FX,i}$ is the appreciation of the i-th foreign currency against the domestic currency, and

  ω_i are the portfolio weights of the foreign-currency assets (defined as the percentage of the aggregate domestic-currency value of the portfolio)

Example of Multi Foreign Asset

- Assume the following information for a portfolio held by an investor in India. At the beginning of the period, are 80% for the GBP-denominated asset and 20% for the EUR-denominated asset, respectively. What is the domestic return for this investor?

	One Year Ago	Today
INR/GBP spot rate	84.12	85.78
INR/EUR spot rate	65.36	67.81
GBP-denominated asset value, in GBP millions	43.80	50.70
EUR-denominated asset value, in EUR millions	14.08	12.17
GBP-denominated asset value, in INR millions	3,684.46	
EUR-denominated asset value, in INR millions	920.27	
GBP-denominated assets, portfolio weight (INR)	80%	
EUR-denominated assets, portfolio weight (INR)	20%	

Example of Multi Foreign Asset

- **Correct Answer:**
  - The domestic-currency return (R_{DC}) is calculated as follows:

$$R_{DC} = 0.80(1 + R_{FC,GBP})(1 + R_{FX,GBP}) + 0.20(1 + R_{FC,EUR})(1 + R_{FX,EUR}) - 1$$

  - Note that given the exchange rate quoting convention, the INR is the price currency in the P/B quote for both currency pairs. Adding the data from the table leads to:

$$R_{DC} = 0.8\left(\frac{50.70}{43.80}\right)\left(\frac{85.78}{84.12}\right) + 0.2\left(\frac{12.17}{14.08}\right)\left(\frac{67.81}{65.36}\right) - 1$$

  - This solves to 0.124 or 12.4%.

Effects of Currency on Portfolio Risk

- **The expected future return on a foreign-currency asset portfolio**
  - expected price movement in the foreign assets ($R_{A,i}$)
  - expected price movement in the exchange rates ($R_{FX,i}$)
- **Variance for a two asset portfolio:**
  - $\sigma^2(R_{DC}) \approx \sigma^2(R_{FC})+\sigma^2(R_{FX})+2\sigma(R_{FC})\sigma(R_{FX})\rho(R_{FC},R_{FX})$
  - Where ρ represents the correlation between R_{FC} and R_{FX}

Effects of Currency on Portfolio Risk

- **The variance of domestic-currency returns, $\sigma^2(R_{DC})$**
  - Exchange rate exposure will generally cause the variance of domestic-currency returns, $\sigma^2(R_{DC})$, to increase to more than that of the foreign-currency returns, $\sigma^2(R_{FC})$, considered on their own.
    - ✓ **If there was no exchange rate risk**, then it would be the case that $\sigma^2(R_{DC}) = \sigma^2(R_{FC})$.
    - ✓ Adding exchange rate risk exposure to the portfolio **usually** adds to domestic-currency return variance .
      - ◆ The effect is indeterminate if exchange rate movements are negatively correlated with foreign asset returns.

Effects of Currency on Portfolio Risk

➢ **If R_{FC} *is* a Risk-Free Return: its standard deviation and correlation with R_{FX} are zero.**

$$\sigma(R_{DC})=\sigma(R_{FX})(1+R_{FC})$$

- Where:

R_{FC}=the return on a foreign currency denominated risk-free asset

Strategic Currency Management

- **One camp of thought holds that in the long run currency effects cancel out to zero due to: 不hedge**
  - exchange rates revert to historical means or their fundamental values;
  - an efficient currency market is a zero-sum game;
  - management and transaction costs.
- **Another camp of thought notes that currency movements can have a dramatic impact on short-run returns and return volatility: 短期hedge，长期不hedge**
  - there are pricing inefficiencies in currency markets;
  - much of the flow in currency markets is related to international trade or capital flows in which FX trading is being done on a need-to-do basis and these currency trades are just a spinoff of the other transactions.
  - some market participants are either not in the market on a purely profit-oriented basis (e.g., central banks, government agencies) or are believed to be “uninformed traders”.

#1 Formulate IPS

- **The Investment Policy Statement (IPS)** mandates **the degree of discretionary** currency management that will be allowed in the portfolio, how it will be **benchmarked**, and the **limits on the type of trading polices and tools** (e.g., such as leverage) than can be used. It also specifies:
  - the general objectives of the investment portfolio;
  - the risk tolerance of the portfolio and its capacity for bearing risk;
  - the time horizon over which the portfolio is to be invested;
  - the ongoing income/liquidity needs (if any) of the portfolio; and
  - the benchmark against which the portfolio will measure overall investment returns.

#1 Formulate IPS

- **The currency risk management policy will usually address such issues as the:**
  - target proportion of currency exposure to be passively hedged;
  - latitude for active currency management around this target;
  - frequency of hedge rebalancing;
  - currency hedge performance benchmark to be used; and
  - hedging tools permitted (types of forward and option contracts, etc.).

#2 Choice of Currency Exposures

① **Diversification Considerations:**

- Many investment practitioners believe that in the long run, adding unhedged foreign-currency exposure to a portfolio does not affect expected long-run portfolio returns; hence in the long run, it would not matter if the portfolio was hedged.
- If there is a **negative correlation** between the foreign-currency asset returns (R_{FC}) and the foreign-currency returns (R_{FX}), having at least some currency exposure may help portfolio diversification and moderate the domestic-currency return risk, $\sigma(R_{DC})$.
- Optimal hedge ratio also seems to depend on market conditions and longer-term trends in currency pairs.
- It is often asserted that the correlation between foreign-currency returns and foreign-currency asset returns tends to be **greater** for **fixed-income** portfolios than for **equity portfolios**. This assertion makes intuitive sense: both bonds and currencies react strongly to movements in interest rates, whereas equities respond more to expected earnings.
- It is not surprising to see actual **hedge ratios** vary widely in practice among different investors.

#2 Choice of Currency Exposures

② **Cost Considerations:**

- The most immediate costs of hedging involve **<u>trading expenses</u>**. Trading involves dealing on the bid–offer spread offered by banks. Maintaining a 100% hedge and rebalancing frequently with every minor change in market conditions would be **<u>expensive</u>**.
- Some hedges involve currency options; a long position in currency options requires the payment of up-front premiums. If the options expire **<u>out of the money</u>** (OTM), this cost is unrecoverable.
- Forward contracts will eventually mature and have to be “rolled” forward with an FX swap transaction to maintain the hedge. **Rolling hedges will typically generate cash inflows or outflows**.
  - ✓ Even though the currency hedge may <u>reduce</u> the volatility of the domestic mark-to-market value of the foreign-currency asset portfolio, it will typically <u>increase</u> the volatility in the organization’s cash accounts.
- One of the most important trading costs is the need to **maintain an administrative infrastructure** for trading.

Strategic Decisions

- A second form of costs associated with hedging are the **opportunity cost of the hedge**:
  - ✓ To be 100% hedged is to forgo any possibility of favorable currency rate moves. Confronted with this ex ante dilemma of whether to hedge, many portfolio managers decide simply to “split the difference” and have **a 50% hedge ratio** (or some other rule-of-thumb number).
  - ✓ The portfolio manager (and IPS) would likely not try to **hedge every minor,** daily change in exchange rates or asset values, but only the **larger adverse movements** that can materially affect the overall domestic-currency returns (R_{DC}) of the foreign-currency asset portfolio.

#3 Choice of Currency Management Strategies

① **Passive hedging:**

- The goal is to keep the portfolio's currency exposures close, if not equal to, those of a **benchmark portfolio** used to evaluate performance.
- Passive hedging is **a rules-based approach** that removes almost all discretion from the portfolio manager.
- The hedge ratio has a tendency to "drift" with changes in market conditions, and even passive hedges need periodic rebalancing to realign them with investment objectives.

② **Discretionary hedging:**

- Portfolio manager now has some limited discretion on how far to allow actual portfolio risk exposures to vary from the neutral position. (the portfolio's currency exposures are allowed to vary plus or minus x% from the benchmark.) **The primary duty is to protect the portfolio from currency risk.**
- This discretion allows the portfolio manager at least some limited ability to express directional opinions about future currency movements order to add value to the portfolio performance.

#3 Choice of Currency Management Strategies

③ **Active currency management**

- The portfolio manager is allowed to express directional opinions on exchange rates, but is nonetheless kept within mandated risk limits.
- The difference between discretionary hedging and active currency management is one of emphasis more than degree.
- **The active currency manager is supposed to take currency risks and manage them for profit.**

④ **Currency overlay**

- A broader view of currency overlay allows the externally hired currency overlay manager to take directional views on future currency movements.
- Sometimes a distinction is made between **currency overlay and "foreign exchange as an asset class."**
- The concept of foreign exchange as an asset class does not restrict the currency overlay manager, who is free to take FX exposures in any currency pair where there is value-added to be harvested.

#4 Formulating a Currency Mgt. Program

- **The strategic currency positioning of the portfolio should be biased toward a more-fully hedged currency management program the more:**
  - Short term the investment objectives of the portfolio;
  - Risk averse the beneficial owners of the portfolio are (and impervious to ex post regret over missed opportunities);
  - Immediate the income and/or liquidity needs of the portfolio;
  - Fixed-income assets are held in a foreign-currency portfolio;
  - Cheaply a hedging program can be implemented;
  - Volatile (risky) financial markets are; and
  - Skeptical the beneficial owners and/or management oversight committee are of the expected benefits of active currency management.

Tactical Currency Management

- Considering the case in which the IPS has given the portfolio manager (or currency overlay manager) **at least some limited discretion for actively managing currency risk** within these mandated strategic bounds**. This then leads to *tactical* decisions.**
- **Tactical decisions involve active currency management based on**
  - Economic fundamentals
  - Technical analysis
  - Carry trade
  - Volatility trading

Economic Fundamentals

- **Assumption: In the long run, the real exchange rate will converge to its "fair value," but short- to medium-term factors will shape the convergence path to this equilibrium.**
  - The model indicates that all else equal, the base currency's real exchange rate should appreciate if there is an upward movement in:
    - ✓ its long-run equilibrium real exchange rate;
    - ✓ either its real or nominal interest rates, which should attract foreign capital;
    - ✓ expected foreign inflation, which should cause the foreign currency to depreciate; and
    - ✓ the foreign risk premium, which should make foreign assets less attractive compared with the base currency nation's domestic assets.
  - The base currency's real exchange rate should depreciate if there is an downward movement.

Technical Analysis

- **Technical analysis is based on three broad themes(Principles):**
  - First, market technicians believe that in a liquid, freely traded market the historical price data can be helpful in projecting future price movements.
  - Second, market technicians believe that historical patterns in the price data have a tendency to repeat, and that this repetition provides profitable trade opportunities.
  - Third, technical analysis does not attempt to determine where market prices should trade but where they will trade.

Technical Analysis

- The three principles of technical analysis define a discipline dedicated to identifying patterns in the historical price data, especially as it relates to identifying market trends and market turning points.
  - Sometimes two moving averages are used to establish when a price trend is building momentum. (**Golden Cross and Dead Cross**)
  - Identify when markets have become **overbought or oversold**, meaning that they have trended too far in one direction and are vulnerable to a trend reversal, or correction.
  - Identify what are called support levels and resistance levels, either within ongoing price trends or at their extremities
    - ✓ These support and resistance levels has **clustering** of bids and offers
    - ✓ At these exchange rate levels, the price action is expected to get "**sticky**" because it will take more order flow to pierce the wall of either bids or offers. But once these price points are **breached**, the price action can be expected to accelerate as stops are triggered.

The Carry Trade

- **The carry trade is a trading strategy of borrowing in low-yield currencies and investing in high-yield currencies.**
  - Covered interest rate parity (CIRP) :

$$\frac{F_{P/B}-S_{P/B}}{S_{P/B}}=\frac{(i_P-i_B)\left(\frac{t}{360}\right)}{1+i_B\left(\frac{t}{360}\right)}$$

✓ When the base currency has a lower interest rate than the price currency, the base currency will trade at a forward premium.

- $F_0 > S_0$

✓ Being a high-yield currency means trading at a forward discount.

- $F_0 < S_0$

The Carry Trade

- **The carry trade is a trading strategy of borrowing in low-yield currencies and investing in high-yield currencies.**
  - The carry trade is based on exploiting a well-recognized **violation** of one of the international parity conditions often used to describe these economic fundamentals: $\%\Delta S_{H/L} \approx i_H - i_L$
    - ✓ Uncovered interest rate parity:
  - If uncovered interest rate parity **holds**,
    - ✓ The yield spread advantage for the high-yielding currency (the right side of the equation) will, on average, be matched by the depreciation of the high-yield currency (the left side of the equation; the low-yield currency is the base currency and hence a positive value for $\%\Delta S_{H/L}$ means a depreciation of the high-yield currency)
  - Recall that uncovered interest rate parity asserts that, on a longer-term average, the return on an unhedged foreign-currency asset investment will be the same as a domestic-currency investment.

The Carry Trade

- **But in reality, the historical data show that there are persistent deviations from uncovered interest rate parity in FX markets, at least in the short to medium term.**
  - Indeed, high-yield countries often see their currencies *appreciate,* not depreciate, for extended periods of time.
  - The positive returns from a combination of a favorable yield differential plus an appreciating currency can remain in place long enough to present attractive investment opportunities.

The Carry Trade: Implementation

- Long periods of **market stability** can make these extra returns enticing to many investors, and the longer the yield differential persists between high-yield and low-yield currencies, the more carry trade positions will have a tendency to build up.
- Any time **global financial markets are under stress** there is a flight to safety that causes rapid movements in exchange rates, and usually a panicked unwinding of carry trades. As a result, traders running carry trades often get caught in losing positions, with the **leverage involved magnifying their losses.**
- **One guide to the riskiness of the carry trade is the volatility of spot rate movements for the currency pair; all else equal, lower volatility is better for a carry trade position.**

The Carry Trade

- This persistent violation of uncovered interest rate parity described by the carry trade is often referred to as the **forward rate bias**.
  - Trading the forward rate bias involves **buying currencies selling at a forward discount, and selling currencies trading at a forward premium**.
    - ✓ This makes intuitive sense: It is desirable to buy low and sell high.
- The difference between carry trade and forward rate bias
  - Carry Trade: borrowing in low-yield currencies, investing in high yield currencies(借入低利率的A货币，换成高利率的B货币，即现货市场卖出A买入B)
  - Forward rate bias: Being low-yield currency and trading at a forward premium. Being high-yield currency means trading at a forward discount. (A是低利率所以A的远期合约是溢价，B是高利率所以B的远期合约是折价。所以在现货市场里卖出A，买入B)

Example

- **Carry Trade**

Today's one-year	Currency Pair	Exchange Rates	
LIBOR		Today	One year later
JPY 0.1%	JPY/USD	81.30	80.00
AUD 4.5%	USD/AUD	1.0750	1.0803

- After one year, the all-in return to this trade, measured in JPY terms, would be close to?
- **Correct Answer:**

$$JPY\ /\ AUD\ spot = 81.3 \times 1.0750 = 87.4$$

$$JPY\ /\ AUD\ one\ year\ later = 80.00 \times 1.0803 = 86.42$$

$$gross\ return = \frac{1}{87.40}(1 + 4.50\%) \times 86.42 = 1.0333$$

$$net\ return = all - in\ return = 3.33\% - 0.1\% = 3.23\%$$

套利

- An investor examines the following rate quotes for the Brazilian real and the Australian dollar:

Spot rate BRL/AUD	2.1131	BRL 1-year interest rate	4%
Forward rate BRL/AUD	2.1392	AUD 1-year interest rate	3%

- **If the investor shorts BRL400,000 he will achieve a risk-free arbitrage profit (in BRL) closest to:**

- **1088 BRL**

Summary for Arbitrage

If $\dfrac{F}{S} > \dfrac{1+r_x}{1+r_Y}$, $\dfrac{F}{S} \times (1+r_Y) > 1+r_X$,

then borrow X currency, the profit will be $\dfrac{F}{S} \times (1+r_Y) - (1+r_X)$

If $\dfrac{F}{S} < \dfrac{1+r_x}{1+r_Y}$, $\dfrac{S}{F} \times (1+r_X) > 1+r_Y$,

then borrow Y currency, the profit will be $\dfrac{S}{F} \times (1+r_X) - (1+r_Y)$

Summary of the Carry Trade

	Buy/invest	Sell/borrow
Implementing the carry trade	High-yield currency	Low-yield currency
Trading the forward rate bias	Forward discount currency	Forward premium currency

Volatility Trading

- **Delta hedging** is the act of hedging away the option position's exposure to delta, the price risk of the underlying (the FX spot rate), which leads to a **delta-neutral position**.
  - **Delta** shows the sensitivity of the option price to changes in the spot exchange rate
  - **The option's hedge ratio:** The size of the offsetting hedge position that will set the *net* delta of the combined position (option plus delta hedge) to zero.
- Typically implementing this delta hedge is done using either **forward contracts or a spot transaction**
  - Spot, by definition, has a delta of one, and no exposure to any other of the Greeks;
  - Forward contracts are highly correlated with the spot rate.

Volatility Trading

- One simple option strategy that implements a volatility trade is a **straddle,** which is a combination of both an at-the-money (ATM) put and an ATM call.
  - A **long straddle** buys both of these options.
    - ✓ This position is profitable in more volatile markets, when either the put or the call go sufficiently in the money to cover the up front cost of the two option premiums paid.
  - A **short straddle** sells both of these options.
    - ✓ It is a bet that the spot rate will stay relatively stable. In this case, the payout on any option exercise will be less than the twin premiums the seller has collected; the rest is net profit for the option seller.

Volatility Trading

- A similar option structure is a **strangle** position for which a long position is buying out-of-the-money (OTM) puts and calls with the same expiry date and the same degree of being out of the money.
  - Because OTM options are being bought, the cost of the position is cheaper;
  - But conversely, it also does not pay off until the spot rate passes the OTM strike levels. As a result, the risk-reward for a strangle is more moderate than that for a straddle.
- Although pure volatility trading is based on a zero-delta position, this need not always be the case; **the overall trading position has net vega and delta exposures that reflect the *joint* market view.**

Factors Affect Tactical Trading Decision

Expectations		Actions
Relative currency	Appreciation	Reduce the hedge Or increase the long position in the currency
	Depreciation	Increase the hedge Or decrease the long position in the currency
Volatility	Rising	Long straddle (or strangle)
	Falling	Short straddle (or strangle)
Market conditions	Stable	A carry trade
	Crisis	Discontinue the carry trade

Tools of Currency Management

- **Implementing both strategic and tactical viewpoints requires the use of trading tools**
  - Forward contract
  - Strategies to Reduce Hedging Costs and Modify a Portfolio's Risk Profile
  - Hedging Multiple Foreign Currencies
  - Basic Intuitions for Using Currency Management Tools

Forward Contract

- Futures or forward contracts on currencies can be used to obtain full currency hedges, **although most institutional investors prefer to use forward contracts for the following reasons:**
  - Futures contracts are standardized in terms of settlement dates and contract sizes. These may not correspond to the portfolio's investment parameters.
  - Futures contracts may not always be available in the currency pair that the portfolio manager wants to hedge.
  - Futures contracts require initial margin and ongoing margin when the spot exchange rate moves against the investor's position. These margin requirements tie up the investor's capital and require careful monitoring through time, adding to the portfolio management expense.
  - Moreover, the daily trade volume globally for OTC currency forward and swap contracts dwarfs that for exchange-traded currency futures contracts; that is, forward contracts are more liquid than futures for trading in large sizes.

Forward Contract

- **Static hedge:** unchanging hedge
- **Dynamic hedge:** rebalancing the portfolio periodically
- **The considerations of choice:**
  - Rebalancing a dynamic hedge will keep the actual hedge ratio close to the target hedge ratio, it will also lead to increased transaction costs compared with a static hedge. The manager will have to assess **the cost-benefit trade-offs** of how frequently to dynamically rebalance the hedge.
  - The **higher the degree of risk aversion**, the more frequently the hedge is likely to be rebalanced back to the "neutral" hedge ratio.
  - Similarly, **the greater the tolerance for active trading, and the stronger the commitment to a particular market view**, the more likely it is that the actual hedge ratio will be allowed to vary from a "neutral" setting, possibly through entering into new forward contracts.

Example

- Jiao Yang works at Hong Kong-based Kwun Tong Investment Advisor; its reporting currency is HKD. Kwun Tong has a short position of EUR 8,000,000 coming due on a HKD/EUR forward contract. The market value of the EUR-denominated assets has increased (measured in EUR). Yang expects the HKD/EUR spot rate to depreciate.
  - The foreign-currency value of the underlying assets has increased; Yang recognizes that this implies that she should increase the size of the hedge greater than EUR 8,000,000. She also believes that the HKD/EUR spot rate will depreciate, and recognizes that this implies a hedge ratio of more than 100%.
- How to adjust hedge ratio for the position?

Example

- **Correct Answer:**
- **He can do either static hedging or dynamic hedging.**
  - Under static hedging, he will do nothing, but his assets will be exposed to currency risk.
  - While, rebalancing a dynamic hedge will keep the actual hedge ratio close to the target hedge ratio, it will also lead to increased transaction costs compared with a static hedge.
    - ✓ Hence, Yang uses a mismatched swap, buying EUR 8,000,000 at spot rate against the HKD, to settle the maturing forward contract and then selling an amount more than EUR 8,000,000 forward to increase the hedge size.

Forward Contract

- The **roll yield**, also called the **roll return**, on a hedge results from the fact that forward contracts are priced at the spot rate adjusted for the number of forward points at that maturity
- The magnitude of **roll yield** is given by $\left|\dfrac{F_{P/B}-S_{P/B}}{S_{P/B}}\right|$
  - The sign depends on whether the investor needs to buy or to sell the base currency forward in order to maintain the hedge.
  - A *positive* roll yield results from buying the base currency at a forward discount or selling it at a forward premium (the intuition here is that it is profitable to "buy low and sell high"). Otherwise, the roll yield is negative (i.e., a positive cost).

Forward Contract

- Given the equivalence between implementing a carry trade, trading the forward rate bias, and earning positive roll yield, we can complete

<table>
<tr><th></th><th>Buy/Invest</th><th>Sell/Borrow</th><th></th></tr>
<tr><td>Implementing the carry trade</td><td>High-yield currency</td><td>Low-yield currency</td><td rowspan="2">Earning a positive-roll yield</td></tr>
<tr><td>Trading the forward rate bias</td><td>Forward discount currency</td><td>Forward premium currency</td></tr>
</table>

- Essentially the tendency to hedge will vary depending on whether implementing the hedge happens to be trading in the same direction of the forward rate bias strategy or against it.
  - It is easier to sell a currency forward if there is a "cushion" when it is selling at a forward premium.
  - Likewise, it is more attractive to buy a currency when it is trading at a forward discount.

Example

- The reporting currency of Hong Kong-based Kwun Tong Investment Advisors is HKD. The investment committee is examining whether it should implement a currency hedge for the firm’s exposures to the GBP and ZAR (the firm has long exposures). The hedge would use forward contracts. The following data relevant to assessing the expected cost of the hedge and the expected move in the spot exchange rate has been developed by the firm's market strategist.

	Current Spot Rate	Six-Month Forward Rate	Six-Month Forecast Spot Rate
HKD/GBP	12.4610	12.6550	12.3000
HKD/ZAR	0.9510	0.9275	0.9300

- Calculated the roll yield respectively and recommend whether to hedge the firm's long exposure. Justify your recommendation.

Example

- **Correct Answer:**
  - Kwun Tong is long the GBP against the HKD, and HKD/GBP is selling at a forward premium of +1.6% compared with the current spot rate. All else equal, this is the expected roll yield. Moreover, the firm's market strategist expects the GBP to *depreciate by* 1.3% against the HKD. Both of these considerations argue for hedging this exposure.
  - KwunTong is long the ZAR against the HKD, and HKD/ZAR is selling at a forward discount of -2.5% compared with the current spot rate. Implementing the hedge would require the firm to *sell* the base currency in the quote, the ZAR, at a price *lower* than the current rate. This would imply that, all else equal, the roll yield would go against the firm; that is, the expected cost of the hedge would be 2.5%. But the firm's strategist also forecasts that the ZAR will depreciate against the HKD by 2.2%. A risk-neutral investor would not hedge because the expectecl cost of the hedge is more than the expected depreciation of the ZAR.

Strategies to Reduce Hedging Costs & Modify Risk

- Completely hedging currency risk is possible, but can also be expensive. It can be even more expensive when trying to avoid all downside risk while keeping the full upside potential for favorable currency movements.
- The **key point** to keep in mind is that all of these various cost-reduction measures invariably involve some combination of ***less downside protection* and/or *less upside potential* for the hedge**.
  - In efficient markets, lower insurance premiums mean lower insurance.
- These cost-reduction measures also start moving the portfolio away from a passively managed 100% hedge ratio toward discretionary hedging in which the manager is allowed to take directional positions.

Strategies to Reduce Hedging Costs & Modify Risk

➤ **Over-/Under-Hedging using forward contracts**

- When the IPS gives the manager discretion either to over- or under-hedge the portfolio, relative to the neutral" benchmark, there is the possibility to add incremental value **based on the manager's market view.**
  - ✓ If the portfolio manager has a market opinion that the base currency is likely to <u>depreciate, then over-hedging </u>through a short position in P/B forward contracts might be
  - ✓ If the manager's market opinion is that the base currency is likely to <u>appreciate</u>, the currency exposure might <u>be under-hedged</u>.
  - ✓ Doing so adds <u>"convexity" </u>to the portfolio.

Strategies to Reduce Hedging Costs & Modify Risk

- **Protective put using OTM options**
  - One way to reduce the cost of using options is to accept some downside risk by using an OTM option, such as a 25- or 10-delta option.
  - These options will be less costly, but also do not fully protect the portfolio from adverse currency movements.
  - Conversely, it makes sense to insure against larger risks but accept some smaller day-to-day price movements in currencies.
  - Fully hedging a currency position with a protective put strategy using an ATM option is the most expensive mean.

Strategies to Reduce Hedging Costs & Modify Risk

- **Risk reversal or collar**
  - One strategy to obtain downside protection at a lower cost than a straight protective put position is to *buy* an OTM put option and *write* an OTM call option.
    - ✓ For example, buying a 25-delta put and writing a 25-delta call
  - Essentially, the portfolio manager is selling some of the upside potential for movements in the base currency (writing a call) and using the option's premiums to help pay the cost of the long put option being purchased.
  - The portfolio is protected against downside movements, but its upside is limited to the strike price on the OTM call option; the exchange rate risk is confined to a corridor or "collar".

Strategies to Reduce Hedging Costs & Modify Risk

- **Put spread**
  - Similarly, the put spread position involves buying a put option and writing another put option to help cover the cost of the long put's premiums.
  - This position is typically structured by buying an OTM put, and writing a deeper-OTM put to gain income from premiums; both options involved have the same maturity.
    - ✓ For example, buying a 35-delta put and writing a 25-delta put
  - The put spread structure will not be zero-cost because the deeper-OTM put being written will be cheaper than the less-OTM put being bought.
    - ✓ Altering the strike prices of the put options would mean moving them closer together. However, this would reduce the downside protection on the hedge.
    - ✓ Instead, the portfolio manager could write a larger notional amount for the deeper-OTM option.

Strategies to Reduce Hedging Costs & Modify Risk

- **Seagull spread**
  - An alternative would be to combine the original put spread position with a covered call position; that is, be long a protective put and then write *both* a call and a deep-OTM put.
  - For example, if the current spot price is 1.3550, a seagull could be constructed by going *long* an ATM put at 1.3550 *short* an OTM put at 1.3500, and *short* an OTM call at 1.3600.
  - The risk/return profile of this structure gives full downside protection from 1.3550 to 1.3500 (at which point the short put position neutralizes the hedge) and participation in the upside potential in spot rate movements to 1.3600 (the strike level for the short call option).
  - As always, lower structure costs come with some combination of lower downside protection and/ or less upside potential.

Strategies to Reduce Hedging Costs & Modify Risk

- **Exotic options**

  - An option with a **knock-in** feature is essentially a vanilla option that is created only when the spot exchange rate touches a pre-speci:fied level (this trigger level, called the "barrier", is not the same as the strike price).
  - Similarly a **knock-out option** is a vanilla option that ceases to exist when the spot exchange rate touches some pre-specified barrier level.
  - **Digital options** are also called **binary options**, or all-or-nothing options. They are called this because they pay a *fixed* amount if they "touch" their exercise level at any time before expiry (even if by a single pip).

Hedging Multiple Foreign Currencies

- The hedging tools and strategies are very similar to those discussed for hedging a single foreign-currency asset, except now the currency hedge must consider **the *correlation* between the various foreign-currency risk exposures.**
- For example, consider the case of a US-domiciled investor who has exposures to foreign-currency assets in Australia and New Zealand.
  - These two economies are roughly similar in that they are resource-based and closely tied to the regional economy of the Western Pacific, especially the large emerging markets in Asia.
  - As a result, the USD / AUD and USD /NZD currency pairs will tend to move together.
  - If the portfolio manager has a net long position in the Australian foreign-currency asset and a net short position in the New Zealand foreign-currency asset.
  - In this case, there may be less need to hedge away the AUD and NZD currency exposures separately because the portfolio's long exposure to the AUD is diversified by the short position on the NZD.

Hedging Multiple Foreign Currencies

- A **cross hedge, also** referred to a **proxy hedge, occurs** when a position in one asset (or a derivative based on the asset) is used to hedge the risk exposures of a different asset (or a derivative based on it).
  - Normally, cross hedges are not needed because forward contracts and other derivatives are widely available in almost every conceivable currency pair.
  - However, if the portfolio already has "natural” cross hedges in the form of negatively correlated residual currency exposures—as in the long-AUD/short-NZD—this helps moderate portfolio risk without having to use a direct hedge on the currency exposure.

Hedging Multiple Foreign Currencies

- **Macro hedges** is more focused on the entire portfolio, particularly when individual asset price movements are highly correlated, rather than on individual assets or currency pairs.
  - Another way of viewing a macro hedge is to see the portfolio not just as a collection of financial assets, but as a collection of risk exposures, such as term risk, credit risk, and liquidity risk.
  - Using a volatility overlay program can also hedge the portfolio against such risks because financial stress is typically associated with a spike in exchange rates' implied volatility.
  - One macro hedge specific to foreign exchange markets uses derivatives based on fixed-weight baskets of currencies.
    - ✓ In a multi-currency portfolio, it may not always be cost efficient to hedge each single currency separately, and in these situations a macro hedge using currency basket derivatives is an alternative approach.

Hedging Multiple Currencies

- **A mathematical approach to determining the hedge ratio is known as the minimum-variance hedge ratio (MVHR).**

$$y_t = \alpha + \beta x_t + \varepsilon_t \text{ where } \hat{\varepsilon}_t = y_t - (\hat{\alpha} + \hat{\beta} x_t)$$

  - Where:
    - ✓ y_t =the percentage change in the value of the asset to be hedged;
    - ✓ x_t =the percentage change in value of the hedging instrument;
    - ✓ β =**the optimal hedging ratio**, which means it minimizes the variance of s and the tracking error between changes in the value of the hedge and changes in the value of the asset it is hedging.
- Calculating the minimum-variance hedge ratio typically applies only for "indirect" hedges based on cross hedging or macro hedges; it is not typically applied to a "direct" hedge in which exposure to a spot rate is hedged with a forward contract in that same currency pair.
  - Because the correlation between movements in the spot rate and its forward contract is likely to be very close to +1.

Practical Implication

- When there is only a single foreign-currency asset involved, one can **perform a joint optimization** over both of the foreign-currency risks (i.e., both R_{FC} and R_{FX}) by regressing changes in the domestic returns (R_{DC}) against percentage changes in the value of the hedging instrument.
- The result will be a better hedge ratio than just basing the regression on R_{FX} alone because this joint approach will also **pick up any correlations between R_{FC} and R_{FX}).**
- Cross hedges and macro hedges bring basis risk into the portfolio, and **optimal hedge ratios are calculated on historical data that may not be representative of future price dynamics, thus, they will have to be monitored and managed.**

Basis Risk

- The portfolio manager must be aware that any time a direct currency hedge (i.e., a spot rate hedged against its own forward contract) is replaced with an indirect hedge (**cross hedge, macro hedge**), basis risk is brought into the portfolio.
- **Basis risk** reflects the fact that
  - The price movements in the exposure being hedged and the price movements in the cross hedge instrument **are not perfectly correlated**;
  - And that the **correlation will change with time**-and sometimes both dramatically and unexpectedly, because it is estimated over historical data that may not be representative of future price dynamics.
- At a minimum, this means that all cross hedges and macro hedges will have to be carefully monitored and, as needed, rebalanced to account for the drift in correlations.

Determining and Applying the MVHR

- Annie McYelland is an analyst at Scotland-based Kilmarnock CapitaL Her firm is considering an investment, a long CHF1,000,000, in an equity index fund based on the Swiss Stock Market Index (SMI); McYelland is asked to formulate a currency-hedging strategy. Because this investment involves only one currency pair and one investment (the SMI); she decides to **calculate the minimum-variance hedge ratio for the entire risk exposure, not just the currency exposure.** McYelland collects 10 years of monthly data on the CHF/GBP spot exchange rate and movements in the Swiss Market Index. She calculates the minimum variance hedge ratio with the following OLS regression: $\mathbf{R_{DC} = -0.12+1.35(\%\Delta S_{GBP/CHF}) + \varepsilon}$
  - Indeed, over the 10 years of data she collected, McYelland notice that the correlation between %ΔSMI and $\%\Delta S_{GBP/CHF}$ *is* equal to+0.6;
  - Calculate the hedged size and comment on.

Determining and Applying the MVHR

- **Correct answer:**
  - The long CHF1,000,000 exposure to the SMI should be hedged with a *short* position in CHF against the GBP of approximately CHF1,350,000.
  - This minimum-variance hedge ratio is only approximate and must be closely monitored because it is estimated over historical data that may not be representative of future price dynamics.

Basic Intuitions for Using Currency Mgt. Tools

① A currency hedge is **not a free good**, particularly a complete hedge. The **hedge cost** will consist of some combination of lost upside potential, potentially negative roll yield and upfront payments of option premiums.

② The cost of any given hedge structure will **vary** depending on market conditions.

③ The cost of the hedge is focused on its **"core."** There are various cost mitigation methods:

- Writing options to gain upfront premiums.
- Varying the strike prices of the options written or bought.
- Varying the notional amounts of the derivative contracts.
- Using various "exotic" features, such as knock-ins or knock-outs.

④ A reduced cost (or even a zero-cost) hedge structure is perfectly acceptable, but only as long as the portfolio manager fully understands all of the **residual risks** in the hedge structure and is prepared to accept and manage them.

⑤ There are often **"natural" hedges** within the portfolio and offer portfolio diversification effects. **Cross hedges** and **macro hedges** bring basis risk into the portfolio, which will have to be monitored and managed.

⑥ There is **no single or "best" way** to hedge currency risk.

Managing Emerging Market Currency

- Managing emerging market currency exposure involves unique challenges. Perhaps the two most important considerations are:
  - **Higher trading costs** than the major currencies under "normal" market conditions
  - The **increased likelihood of extreme market events** and **severe illiquidity** under stressed market conditions

Managing Emerging Market Currency

- **Higher trading costs**
  - Many emerging market currencies are **thinly traded**, causing higher transaction costs (bid-offer spreads). There may also be fewer derivatives products to choose from, especially exchange-traded products.
  - Typically, any trade between these two emerging market currencies would go through a major intermediary currency, usually the USD. Hence, the trade would be broken into two legs.

Managing Emerging Market Currency

- **Extreme market events** and **severe illiquidity** under stressed market conditions
  - The liquidity issue is especially important when trades in these less-liquid currencies get "crowded”. Trades can be much easier to gradually enter into than to quickly exit.
  - Frequent extreme events have fatter tails and a pronounced **negative skew**. Risk measurement and control tools that depend on normal distributions can be misleading.
  - The higher interest rates, the **deeper the forward discount** for its currency, and sell the currency forward at increasingly deep discounts will cause losses through negative roll yield.
  - Crises not only affect the volatility in asset prices but also their correlations, primarily through "**contagion" effects**.
  - Government involvements such as foreign exchange market intervention, capital controls, and pegged (or at least tightly managed) exchange rates can lead to occasional extreme events in markets.

Managing Emerging Market Currency

- **Non-deliverable forwards (NDFs):** Currencies of many emerging market countries trade with some form of capital controls.
  - A partial list of some of the most important currencies with NDFs would include CNY, KRW, RUB, INR, and BRL.
  - These are similar to regular forward contracts, but they are cash settled (in the non-controlled currency of the currency pair) rather than physically settled (the controlled currency is neither delivered nor received).
  - The **credit risk of an NDF is typically lower** than for the outright forward because the principal sums in the NDF do not move, unlike with an outright "vanilla" forward contract.
  - Sudden changes in government policy can lead to sharp movements in spot and NDF rates. The implicit market risk of the NDF embodies an element of "tail risk”.

Calculate Cash Settlement Values for an NDF

- A trader buys USD1,000,000 and enters into a long position in a three-month NDF for the BRL/USD at the forward rate of 2.0280. Suppose that three months later the BRL/USD spot rate is 2.0300 and the trader closes out the existing-NDF contract with an equal and offsetting spot transaction at this rate. Calculate the net cash flow to the long position.
- **Correct answer:**
  - Can be calculated as
    $(2.0300-2.0280)\times 1{,}000{,}000=\text{BRL } 2{,}000$
    But with an NDF, there is no delivery in the controlled currency (hence the name non-deliverable forward). Settlement must be in USD, so this BRL amount is converted to USD at the then-current spot rate of 2.0300. This leads to a USD cash inflow for the long position in the NDF of

    BRL 2,000÷2.0300 BRL/USD = USD 985.22

It’s not an end but just the beginning.

Ideal is the beacon. Without ideal , there is no secure direction; without direction, there is no life.

理想是指路明灯。没有理想，就没有坚定的方向；没有方向，就没有生活。

问题反馈

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