Chapter 5 - FX Derivatives
Last Lecture
Use FX to reduce uncertainty about future S_t
> Futures/Forward: Agreement to buy/sell FC at a given price
> Options: Give Flexibility. No obligation. Different Strike prices.

• Currency Options
An option is a contract that gives the holder the right to do something for a certain amount of time or at a certain date. The holder of the option buys this right at a cost: the *premium*.

In the FX market, the "right to do something" is the right to buy/sell an amount of FC at a given price.

• Options: Brief Review
- Major types of option contracts:
  - ◊ C*alls* gives the holder the right to buy a certain amount of the underlying asset
  - ◊ *Puts* gives the holder the right to sell a certain amount of the underlying asset.
- The complete definition of an option must specify:
  - ◊ *Exercise* or *strike price* (X): price at which the right is "exercised."
  - ◊ *Expiration date* (T): date when the right expires.
  - ◊ *Size*: Amount of the underlying asset.
  - ◊ When the option can be exercised: Anytime (American)

                                                           At expiration (European).
- The option to buy or sell an asset has a price: the *premium* (paid upfront).
- Options are priced using variations of the Black-Scholes formula.
- Currency premiums are affected by six factors:
  - i. S_t (underlying asset's market price)
  - ii.   X.   (exercise or strike price)
  - iii. T-t   (time till expiration)
  - iv.   σ   (volatility of underlying asset)
  - v. i_d (domestic interest rate)
  - vi. i_f (foreign interest rate)
- Moneyness. The relation between $\mathbf{S_t,}$ and the option's strike price, **X**, determines the *moneyness* of the option (if exercised today how profitable the option is for the holder). An option can be:.
  - ◊ *At-the-money* (ATM)   if $S_t = X$
  - ◊ *In-the-money* (ITM)   if $S_t > X$ (calls)
  -   if $S_t < X$ (puts)
  - ◊ *Out-the-money* (OTM)   if $S_t < X$ (calls)
  -   if $S_t > X$ (puts)

• Real Life Examples of Options
Insurance, layaways, tuition, movie tickets.

Example 1: An advanced purchase of a movie ticket.
I have the right to go to a movie. If I have something better to do, I do not have to go.
Size: 1 ticket.
Premium: ticket price.
Maturity: time at which the movie ends.

Example 2: College tuition and Moneyness.
Paying tuition allows a student to come to class. Unless attendance is mandatory, some students only attend when it is convenient/valuable –i.e., when, for them, the option is ITM. Usually, the class before the exam is considered by all students ITM. On the other hand, the class after the exam is considered, for many students, OTM.

• OTC and Exchange-traded Currency Options
There are 2 markets for FX options:
(1) Interbank (OTC) market centered in London, New York, and Tokyo.
OTC options are tailor-made as to size, maturity, and exercise price.

(2) Exchange-based markets centered in Philadelphia (PHLX) or NY (ISE).
PHLX options are on spot amounts of 10,000 units for the main FC (JPY: 1M, MXN: 100K).
PHLX maturities: 1, 3, 6, and 12 months.
PHLX expiration dates: March, June, September, December, and the two nearby months.

Exercise price of an option at the PHLX or CME is stated as the price in USD cents of a unit of FC.
A typical newspaper option quote is shown in Exhibit 5.1.

Exhibit 5.1: PHLX Option quote

OPTIONS
PHILADELPHIA EXCHANGE
May 15, 2013

		Calls		Puts		
		Vol.	Last	Vol.	Last	
Euro					**135.54**	($\leftarrow S_t = 1.3554$ USD/EUR)
10,000 Euro-cents per unit.($\leftarrow$ Size of EUR contract)						
132	Oct	....	0.01	3	0.38	
134	Sep	3	1.74	90	0.15	
134	Oct	3	1.90	....	....	
134	Dec	2	2.17	25	1.70	($\leftarrow$Premium in USD cents=USD .017 per EUR)
136	Dec	8	1.85	12	2.83	
138	Oct	75	0.43	....	0.01	
142	Dec	1	0.08	1	7.81	
Australian Dollar				**95.37**		
10,000 Australian Dollars-cents per unit.						
94	Oct	....	0.01	20	0.31	
95	Sep	20	0.30	....	....	
96	Oct	30	0.42	....	0.01	

Q: Who buys options?
A: Speculators/Hedgers

Q: Why options and not futures?
A: Options simply expire if S_t moves in a beneficial way. (But, they are not free. There is an upfront payment.)

Example: We buy a EUR Dec call with X=1.34 USD/EUR and also a futures contract with $F_{t,Dec}$=1.34 USD/EUR.

If $S_t > 1.34$ USD/EUR,   we exercise the call and we get EUR at USD 1.34.
                                          with the future contract we get EUR at USD 1.34.
If $S_t < 1.34$ USD/EUR,   we do not exercise the option and we get EUR at less than USD 1.34.
                                          with the future contract we get EUR at USD 1.34.

Figure 5.3 shows the net cash flows in December associated with the long Dec call with X=1.34 USD/EUR.

Figure 5.3: Profit Diagram for a Long Call

premium (p)

out-of-the-money
(OTM, no exercise)

in-the-money
(ITM, exercise)

X=1.34

$S_{t=Dec}$ (USD/EUR)

USD -.0217
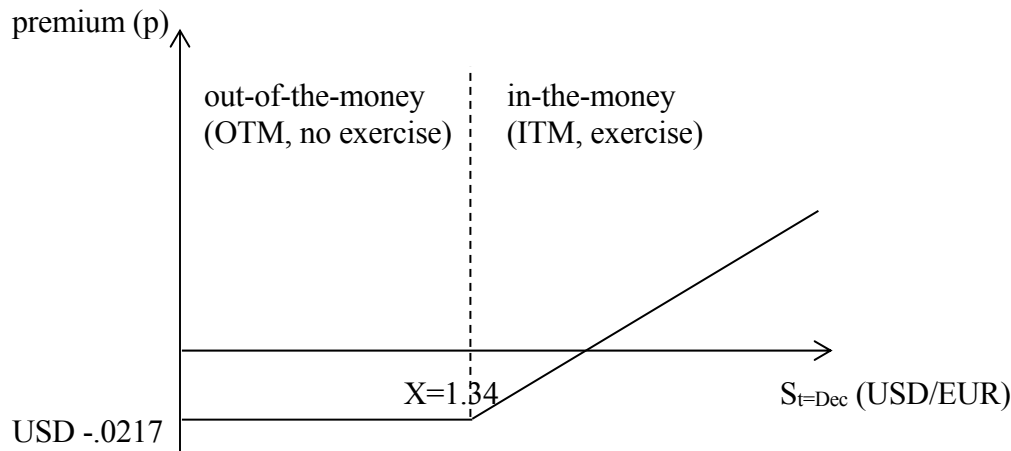
• Hedging with Currency Options
Hedging with options is simple:

- *Situation 1*:   Underlying position: Short in foreign currency.
                  Hedging position: Long in foreign currency calls.

- *Situation 2*:   Underlying position: Long in foreign currency.
                  Hedging position: Long in foreign currency puts.

Example: *Situation 1* - A U.S. investor is considering buying U.K bonds for GBP 1M in December. She hedges using Dec call options with X= USD 1.60 (at-the-money).

Underlying position: Short GBP 1,000,000.
S_t = 1.60 USD/GBP.
Size of the PHLX contract: GBP 10,000.
X = USD 1.60
P = premium of Dec call = USD .05.

Cost of Dec calls = 1,000,000 x USD .05 = USD 50,000.   (Cost of Dec call is a sunk cost.)
Number of contracts = GBP 1,000,000/ GBP 10,000 per contract = 100 contracts.

There are 3 situations at exercise (third Wednesday of December):
1) $S_{t=Dec}$ < X (call is out-of-the-money, OTM)
Suppose that on Dec, S_{Dec}=1.30 USD/GBP, option is not exercised.
        → If the U.S. investor decides to buy the UK bonds, she will pay USD 1.30M.
2) $S_{t=Dec}$ = X (call is at-the-money, ATM)
Suppose that on Dec, S_{Dec}=1.60 USD/GBP, option is not exercised (technically, indifferent).

→ If the U.S. investor decides to buy the UK bonds, she will pay USD 1.60M.

3) $S_{t=Dec} > X$ (call is in-the-money, ITM)

Suppose that on Dec S_{Dec}=1.80 USD/GBP, option is exercised.

→ If the U.S. investor decides to buy the UK bonds, she will pay USD 1.60M.

Figure 5.4: CFs under an FX Call
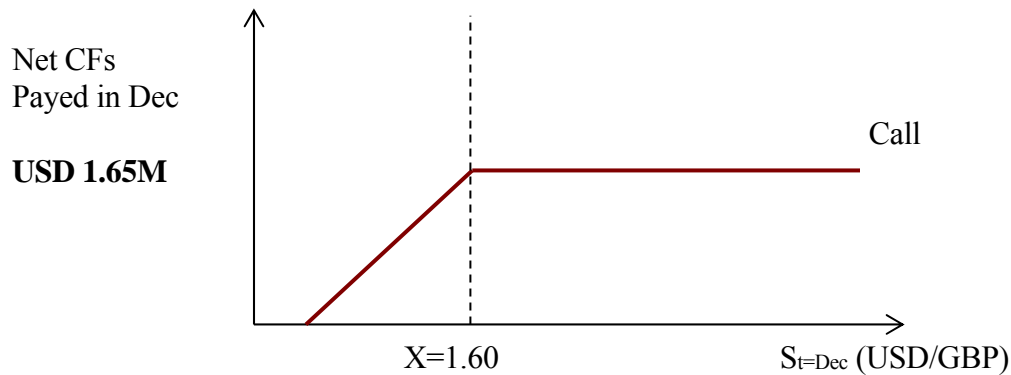
As shown in Figure 5.4, the maximum Net Amount to Pay is (USD 1.60M+USD .5M)=**USD 1.65M.**

Note: The U.S. investor has established a *cap*: Maximum net amount she may pay is USD 1.65M. ¶

Example: *Situation 2* - IBM will receive a EUR 5M payment in 90 days from a French customer.
Date: September 15, 2014 (90 days from today).
Underlying Position = Short EUR 5,000,000.
Hedging Position = EUR Sep put options: X =1.34 USD/EUR (Premium= USD 0.0217 per EUR)
S_t = 1.3554 USD/EUR.

Number of contracts = EUR 5M/EUR 10,000 = 500 contracts.
Cost of Sep puts = 5M x USD .0217 = USD 108,500.
Minimum amount received = EUR 5M x 1.34 USD/EUR = USD 6.70M (Net = **USD 6.6915M**)

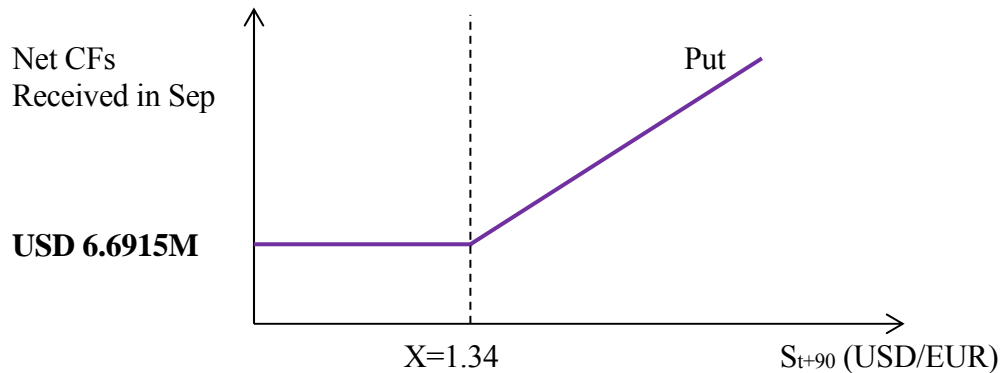If $S_{t=Sep}$ < 1.34 USD/EUR, put is ITM:
⇒ IBM will exercise the put option. IBM will receive USD 6.70M
If $S_{t=Sep}$ > 1.34 USD/EUR, put is OTM:
⇒ IBM will not exercise the put option. IBM will receive more than USD 6.70M.

Figure 5.5 shows the net cash flows for IBM in 90 days.

Figure 5.5: CFs under an FX Put

Minimum Net Amount to Receive: USD 6.70M - USD .1085M = **USD 6.5915M.**

<u>Note</u>: IBM has established a *floor*. The minimum amount IBM will receive is USD 6.70M. ¶

• **Hedging Strategies**
Hedging strategies with options can be more sophisticated:
    $\Rightarrow$ Investors can play with several exercise prices with options only.

Example: Hedgers can choose different options for the same maturity:
   - Out-of-the-money (OTM, least expensive)
   - At-the-money (ATM, expensive)
   - In-the-money options (ITM, most expensive). ¶

• Same trade-off of car insurance: High deductible/high floor (cheap)
                                           Low deductible/low floor (expensive)

Example: It is June 15, 2014.
UP = Long bond position EUR 1,000,000.
HP= EUR Dec put options: X =134 and X=136.
S_t = 1.3554 USD/EUR.

(A) OTM Sep 134 put.
Total cost = USD .0170 x 1,000,000 = USD 17,000
Floor = 1.34 USD/EUR x EUR 1,000,000 = USD 1,340,000.

(B) OTM Sep 136 put.
Total cost = USD .0283 x 1,000,000 = USD 28,300
Floor = 1.36 USD/EUR x EUR 1,000,000 = USD 1,360,000

Typical trade-off: A higher minimum (floor) amount for the UP (USD 1,360,000) is achieved by paying a higher premium (USD 28,300). ¶

CHAPTER 5 – BRIEF ASSESMENT

1. Walmart has to pay in 180 days GBP 5M to a U.K. supplier. Walmart is offered a forward contract at 1.40 USD/GBP. Draw a graph showing the GBP cash flow (in USD) in 180 days relative to S_{t+180}. Does Walmart face uncertainty regarding the amount to pay (in USD) in 180 days?

2. Fifi Bank sold a call option on GBP for USD .03 per unit. The strike price was 1.45 USD/GBP, and the spot rate at the time the option was exercised was 1.40 USD/GBP. Using the following table, fill in the net profit (or loss) per unit to Fifi Bank, based on the listed possible spot rates of the GBP on the expiration date.

Possible S_t (USD/GBP) on Expiration Date	Net Profit (Loss) per Unit if S_t Occurs
1.31	
1.36	
1.39	
1.42	
1.45	
1.49	

What is the maximum net profit and the maximum net loss per unit?

3. It is September 2017. Pez Inc., a Houston-based fishing company, has a GBP 20 million payable due in November 2017. Pez decides to use options to reduce FX risk. Available options with November maturity are:

X	Calls	Puts
1.38 USD/CAD	3.77	0.65
1.42 USD/CAD	1.08	2.88
1.45 USD/CAD	0.16	5.40,

where X represents the strike price and premiums are expressed in USD cents –i.e., 1.08 equals to USD 0.0108.
The exchange rate is 1.40 USD/GBP.

Calculate the premium cost and use a graph to describe the *net* cash flows, including premium paid, (in USD) in December 2017 for Pez Oil under the following choices:
i) in-the-money option
ii) out-of-the money option

4. Using an example, explain how a U.K. company with BRL receivables can establish a floor (in GBP).

5. Using an example, explain how a U.K. company with BRL payables can establish a cap (in GBP).