Rauli Susmel
Dept. of Finance
Univ. of Houston

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Chapter 11 - Managing TE

Last Lecture
Managing TE

- Forwards/Futures
- Options
- Money Market (same as IRP)

This Lecture
We will review two cases: Receivables in FC and Payables in FC.

Example 1: CASE I - Receivables in FC
MSFT exports Windows to Switzerland for CHF 3M Payment due in 90 days.
S_t = 0.60 USD/CHF
TE(in USD) = CHF 3M * 0.60 USD/CHF = USD 1.8M

To manage TE, MSFT considers the following tools: forwards/futures, options, Money market instruments (used to replicate IRPT). MSFT also considers keeping the position open –i.e., no hedging.

Hedging Tools- Futures/Forwards/Options/Money Market Hedge/Do Nothing

Data:
Interest USD = **5%** - 5.125%
Interest CHF = 4% - **4.25%**
$F_{t,90\text{-day}}$ = .650 USD/CHF - .651 USD/CHF
Put (**X_p = 0.64 USD/CHF; p_p = USD .059-.060**)
Call (X_c = 0.63 USD/CHF; p_c = USD .019-.020)
T = 90 days
Possible scenarios for S_{t+90} (distribution for S_{t+90} based on the ED)

S_{t+90} (USD/CHF)	Probability
0.58	.10
0.62	.10
0.65	.50
0.68	.30

1. Forward Hedge – Sell Forward CHF
   Sell CHF forward at **$F_{t,90\text{-day}}$ = .65 USD/CHF**
   Amount to be received in 90 days = CHF 3M * 0.65 USD/CHF = USD 1.95M

Note**:** No uncertainty. MSFT will receive USD 1.95M, regardless of S_{t+90}.

2. MMH (Replication of IRP) – borrow FC, convert to DC, deposit in domestic bank
   Today, we do the following: (1) Borrow CHF at **4.25%**
   (2) Convert to USD at 0.60 USD/CHF
   (3) Deposit in US Bank at **5%**

   MMH Calculations:
   Amount to be borrowed = CHF3M/(1+**.0425***90/360) = **CHF 2.9684M**
   CHF 2.9684M * 0.60 USD/CHF = **USD 1.781M** = amt to be deposited in US Bank
   Amount to be received in 90 days = **USD 1.781M** (1+**.05***90/360) = **USD 1.8032M**

Note**:** There is no uncertainty about how many USD MSFT will receive for CHF 3M.

*Compare FH vs MMH***:** MSFT should select the **FH.** MMH is *dominated* by FH.

3. Option Hedge -Buy CHF puts: **X_p = 0.64 USD/CHF**, **p_p = USD .06/CHF**
   Floor = **0.64 USD/CHF** * CHF 3M = USD 1.92 M - Total premium cost
   Premium cost = CHF 3M * **USD .06/CHF** = USD .18M
   Opportunity Cost (OC) = USD .18M***.05***.25=USD .0025M

   Total premium cost = Premium cost + OC = **USD .1825M**

Scenarios

S_{t+90} (USD/CHF)	Probability	Exercise?	Amount received (Net of cost, in USD)
0.58	.20	Yes	1.92M - **.1825M** = 1.7375M
0.62	.20	Yes	1.92M - **.1825M** = 1.7375M
0.65	.50	No	1.95M - **.1825M** = 1.7675M
0.68	.30	No	2.04M - **.1825M** = 1.8575M

E[Amount to be received in 90 days] = (1.7375)*.2 + (1.7675)*.5 + (1.8575)*.3 = **1.7885M**

Notes:
1. An option establishes a worst case scenario. In this case, MSFT establishes a *floor*, a minimum amount to be received: USD 1.92M (or net USD 1.7375).
2. The opportunity cost (OC) is included to make a fair comparison with FH and MMH, which require no upfront payment. (OC=Time value of money!)

*Compare FH vs OH***: FH** seems to be better; but preferences matter. A risk taker may like the 30% chance of doing better with the **OH**.

4. No Hedge (Leave position open, that is, do nothing and wait 90 days)

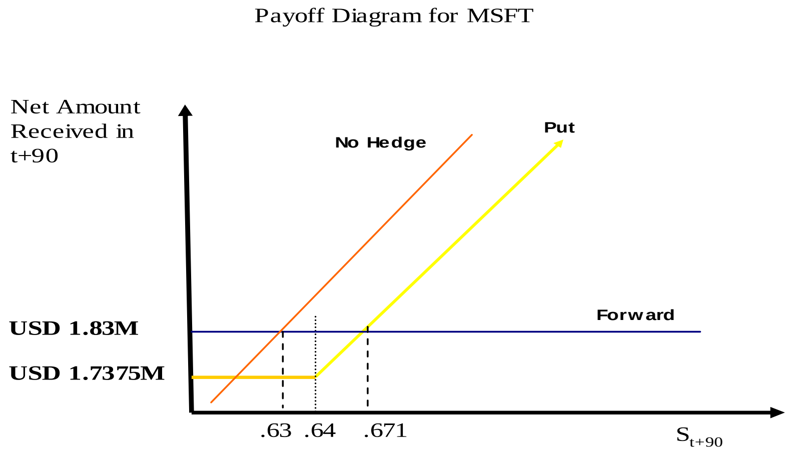
Scenarios

S_{t+90} (USD/CHF)	Probability	Amount received (Net of cost)
0.58	.10	USD 1.74M
0.62	.10	USD 1.86M
0.65	.50	USD 1.95M
0.68	.30	USD 2.04M

E[Amount to be received in 90 days] = **USD 1.947M**

Compare FH vs NH: **NH** seems to be better. But, preferences matter (a very conservative manager might not like the 20% chance of the NH doing worse than the FH).

Graph 11.1: General CF Diagram for all Strategies



Graph 11.1 displays the CF for all hedging strategies. In general, the preference of one alternative over another will depend on the probability distribution of S_{t+90}. If the probability of S_{t+90}>.63 USD/CHF (the break even S_{t+90} that makes the CF under the FH and the NH equal) is very low, then the forward hedge dominates.

Q: Where do the probabilities come from? We can estimate them using the empirical distribution (ED).

Example: CASE II - Payables in FC
MSFT has payable in GBP for GBP 10M in 180 days.
S_t = 1.60 USD/GBP
TE(in USD) = USD 16M
MSFT decides to manage this TE with the following tools:
Hedging Tools: Futures/Forwards/Options/Money Market Hedge/Do Nothing

Data:
Interest USD = 5%-5.25%
Interest GBP = 6%-6.5%
$F_{t,180\text{-day}}$ = 1.58 USD/GBP
Put (X_p = 1.64 USD/GBP; p_p = USD .05)
Call (X_c = 1.58 USD/GBP; p_c = USD .03)

Distribution for S_{t+90}

S_{t+90} (USD/GBP)	Probability
1.55	.30

1.59	.60
1.63	.10

Which alternative is best? The hedge that delivers the least USD amount

1. FH – Buy forward GBP
   Amount to be paid in 180 days = GBP 10M*1.58 USD/GBP = **USD 15.8M**

2. MMH –Borrow DC, convert to FC, deposit in foreign bank
   Today, we do the following: (1) Borrow USD at 5.25
   (2) Convert to GBP at 1.60 USD/GBP
   (3) Deposit in US Bank at 6%

   MMH Calculations (we go backwards):
   Amount to deposit = 10M/[1+(.06*180/360)] = **GBP 9.708M**
   Amount to borrow = **GBP 9.708M** * 1.60 USD/GBP = **USD 15.533M**
   Amount to repay = **USD 15.533** *(1+.0525*180/360) = **USD 15.94M**

Compare FH vs MMH: **FH is better**

3. Option Hedge –Buy GBP calls: X_c= 1.58 USD/GBP, p_c = USD .03/GBP
   Cap = GBP 10M*1.58 USD/GBP = **USD 15.8M**
   Total premium cost = Total premium + OC = 10M*USD .03*(1+.05*.5) = **USD .31M**

Scenarios

S_{t+90} (USD/GBP)	Probability	Exercise?	Amount paid (Net of cost, in USD)
1.55	.30	No	USD 15.5M + **.31M** = USD 15.81M
1.59	.60	Yes	USD 15.8M + **.31M** = USD 16.11M
1.63	.10	Yes	USD 15.8M + **.31M** = USD 16.11M

E[Amt to be paid in 180 days] = **USD 16.02M**

Compare FH vs OH: **FH** is better always**.** (Preferences do not matter.)

Note: Again, the option establishes a worst case scenario. In this case, MSFT establishes a *cap*, a maximum amount to be paid: USD 15.8M (or net USD 16.11M).

4. No Hedge –leave position open; that is, do nothing and wait.
   E[Amt] = GBP 10M [1.55(.3)+1.59(.6)+1.63(.1)] = **USD 15.82M**

Compare FH vs OH: **FH** is better; but *preferences matter***.**

- **Summary of Strategies**

	Receivables in FC	Payables in FC
Forward Hedge (FH)	Sell FC at $F_{t,T}$	Buy FC at $F_{t,T}$
Money Market Hedge (MMH)	Borrow FC at i_{FC}, Convert to DC at S_t, Deposit DC at i_{DC}	Borrow DC at i_{DC}, Convert to FC at S_t, Deposit FC at i_{FC}
Option Hedge (OH)	Buy FC puts; pay p_p	Buy FC calls; pay p_c

Options hedging (with different X)

With options it is possible to play with different strike prices –different insurance coverage.

Key Intuition: The more the option is out of the money, the cheaper it is.
The higher the cost, the better the coverage.

Example: Revisit MSFT payables situation: MSFT has to pay GBP 10M in 180 days.
Notation: X_j = Strike Price (j = call; put)
p_j = Option premium (j = call; put)
S_t = 1.60 USD/GBP
Options available:
X_c = 1.56 USD/GBP, p_c = USD .08, T=180 days (call)
X_c = 1.58 USD/GBP, p_c = USD .07, T=180 days (call)
X_c = 1.63 USD/GBP, p_c = USD .05, T=180 days (call)
X_c = 1.65 USD/GBP, p_c = USD .04, T=180 days (call)
X_p = 1.58 USD/GBP, p_p = USD .055, T=180 days (put)
X_p = 1.61 USD/GBP, p_p = USD .095, T=180 days (put)

1. Out-of-the-Money (S_t < X)
Alternative 1: Call used: X_c = 1.63 USD/GBP, p_c = USD .05
Cost = Total premium = GBP 10M * USD .05/GBP = ***USD 500K***
Cap = worst amount to be paid = 1.63 USD/GBP * GBP 10M = USD 16.3M
(Net cap = **USD 16.8**)
Alternative 2: Call (X_c =1.65 USD/GBP, p_c = USD .04)
Cost = GBP 10M * USD .005/GBP = ***USD 400K***
Cap = 1.65USD/GBP * GBP 10M = USD 16.5M ⇒ Net cap = **USD 16.9M**

Note: The tradeoff is very clear: The higher the cost, the better the coverage.

2. (Closest At-the-money) In-the-money ($S_t \geq X$)
Call used: X_c = 1.58 USD/GBP, p_c = USD .07
Cost = Total premium = ***USD 700K***
Cap = USD 15.8M ⇒ Net cap = **USD 16.5M**

Compare to Out-of-the-money: Advantage: Lower cap.

Disadvantage: Its cost.

Companies do not like to pay high premiums. Many firms finance the expense of an option by selling another option. A typical strategy: A collar (form a portfolio with one put and one call: Long one option, short the other).

3. Collar (buy one call, sell one put. In general, both are OTM)

Buy Call (X_c = 1.63 USD/GBP, p_c = USD .05);

Sell Put (X_p = 1.58 USD/GBP, p_p = USD .055)

Collar's premium = USD .05 - USD .055 = **USD -0.005** (negative!)

Cost = GBP 10M*USD (**-.005/GBP**) = ***USD -50K***

Cap = 1.63 USD/GBP * GBP 10M = USD 16.3M

Floor = Best case scenario = 1.58 USD/GBP*GBP 10M = USD 15.8M

⇒ Net cap = **USD 16.25**; Net floor = **USD 15.75M**

Notes:

◊ With a collar you get a lower cost (advantage), but you give up the upside of the option (disadvantage) ⇒ there is always a trade-off!

◊ Zero cost insurance is possible ⇒ sell enough options to cover the premium of the option you are buying.

CHAPTER 11 - BONUS COVERAGE: Getting probabilities from the Empirical Distribution

Firms will use probability distributions to make hedging decisions. These probability distributions can be obtained using the empirical distribution, a simulation, or by assuming a given distribution. For example, a firm can assume that changes in exchange rates follow a normal distribution. Here, we present an example on how to use the empirical distribution.

Example: We want to get probabilities associated with different exchange rates. Let's take the historical monthly USD/AUD exchange rates 1976:1-2017:1. First, we transform the data to changes ($e_{f,t}$). Excel produces a histogram, with bins and frequency. Below we show the bins for $e_{f,t}$ frequency and relative frequency. We calculate $S_{t+30} = S_t * (1+e_{f,t})$. Today, S_t =0.7992 USD/AUD.

$e_{f,t}$ (USD/AUD)	*Frequency*	*Rel frequency*	S_t =.7992*(1+$e_{f,t}$)
-0.17761	1	0.002049	0.657257
-0.16533	1	0.002049	0.667066
-0.15306	0	0	0.676874
-0.14079	0	0	0.686682
-0.12852	0	0	0.69649
-0.11624	1	0.002049	0.706298
-0.10397	1	0.002049	0.716106
-0.0917	2	0.004098	0.725914
-0.07943	4	0.008197	0.735722
-0.06715	4	0.008197	0.745531
-0.05488	6	0.012295	0.755339
-0.04261	12	0.02459	0.765147
-0.03034	29	0.059426	0.774955
-0.01806	56	0.114754	0.784763
-0.00579	86	0.17623	0.794571
0.006481	91	0.186475	0.804379
0.018753	82	0.168033	0.814187
0.031025	54	0.110656	0.823996
0.043298	29	0.059426	0.833804
0.05557	18	0.036885	0.843612
0.067843	8	0.016393	0.85342
0.080115	3	0.006148	0.863228
More	5	0.010246	0.871128

You can plot the histogram to get the above empirical distributions.