Managing FX Exposure

Transaction Exposure

Class Announcements

• **Second Midterm:**
July 3 (6pm – 8pm). It will be run through Canvas.

• **First Midterm:**
Mean = 79 (Median = 81) & SD = 12.
Highest 97 – Lowest 54

⇒ Overall, a solid exam.

• **Next presentations:**
June 26 (Thursday) - Chapter 11
July 1 (Tuesday) - Chapter 16 (& maybe Chapter 17).

• **Second Midterm Review:** July 1.

Review: Exposure and NTE

• Exposure (Risk)

- At the firm level, currency risk is called *exposure*.

• Three areas

(1) *Transaction exposure*: Risk of transactions denominated in FC with a certain payment date or maturity.

(2) *Economic exposure*: Degree to which a firm's expected cash flows are affected by unexpected changes in S_t.

(3) *Translation exposure*: Accounting-based changes in a firm's consolidated statements that result from a change in S_t. Translation rules create accounting gains/losses due to changes in S_t.

We say a firm is "*exposed*" or has exposure if it faces currency risk.

Example: Exposure.

A. *Transaction exposure*.

Swiss Cruises, a Swiss firm, sells cruise packages priced in USD to a broker. Payment in 30 days.

B. *Economic exposure*.

Swiss Cruises has 50% of its revenue denominated in USD and only 20% of its cost denominated in USD. A depreciation of the USD will affect future CHF cash flows.

C. *Translation exposure*.

Swiss Cruises obtains a USD loan from a U.S. bank. This liability has to be translated into CHF following Swiss accounting rules. ¶

Review: Exposure and NTE

• Transaction exposure (TE) is easy to identify and measure.
- Identification: Transactions denominated in FC with a fixed future date
- Measure: Translate identified FC transactions to DC using S_t.

$TE_{j,t}$ = **Value of a fixed future transaction in FC$_j$** * S_t

Example: Swiss Cruises.
Sold cruise packages for USD 2.5 million. Payment: 30 days.
Bought fuel oil for USD 1.5 million. Payment: 30 days.
S_t = **1.45 CHF/USD**.
Thus, the net transaction exposure in USD 30 days is:
Net $TE_{j=USD}$ = (USD 2.5M – USD 1.5M) * **1.45 CHF/USD**
= **USD 1M** * **1.45 CHF/USD** = CHF 1.45M. ¶

Managing TE

• **A Comparison of External Hedging Tools**

Transaction exposure: Risk from the settlement of transactions denominated in foreign currency.

Example: Imports, exports, acquisition of foreign assets.

• Organizational Tools to manage TE (Internal Methods):
- Contracts that limit TE (Risk shifting (pricing in DC), Risk sharing)
- Leading-lagging payments between subsidiaries
- Inflows/Outflows Matching

• Financial Tools to mange TE (External Methods):
Futures/forwards (FH)
Options (OH)
Money market (MMH)

External Methods (Market-based Tools)

- **Review from Chapter 5 (FX Hedging Tools)**
- **Hedging Market-based Tools**:
  - ♦ **Futures/Forward**: Completely eliminates uncertainty
    - ◊ UP: *short* in the foreign currency.
      HP: ***long*** in currency futures.
    - ◊ UP: *long* in the foreign currency.
      HP: ***short*** in currency futures.
  - ♦ **Options**: Reduces uncertainty. How much? It depends on **X**.
    - ◊ UP: *short* in the foreign currency.
      HP: ***long*** in currency **calls**.
    - ◊ UP: *long* in the foreign currency.
      HP: ***long*** in currency **puts**.

- New tool: MMH

Money market hedge: Based on a replication of IRPT arbitrage.

Let's take the case of ***receivables*** denominated in FC:

1) **Borrow FC**
2) Convert to DC
3) Deposit DC in domestic bank
4) **Transfer FC receivable** to cover loan (+ interest) from (1).

Under IRPT, step 4) involves buying FC forward, to repay loan in (1)

⇒ This step is not needed, instead, we just transfer the FC receivable.

- New tool: MMH

Now, let's take the case of ***payables*** denominated in FC:

1) **Borrow DC**
2) Convert to FC
3) Deposit FC in domestic bank
4) **Transfer FC deposit** (+ interest) to cover payable in FC.

Under IRPT, step 4) involves selling FC/buying DC forward, to repay loan in (1)

⇒ This step is not needed, instead, we just transfer the FC deposit.

Q: Why MMH instead of FH?

- Under perfect markets ⇒ MMH = FH
- Under less than perfect markets ⇒ MMH ≠ FH

- **Comparison of Hedging Strategies**

Example: Iris Oil Inc. has a large FC exposure in the form of a CAD cash flow from its Canadian operations. Iris decides to transfer **CAD 300M** to its USD account in 90 days.

FX risk to Iris: CAD may depreciate against the USD.

Data:

S_t = **0.8451 USD/CAD**

$F_{t,90\text{-day}}$ = **0.8493 USD/CAD**

i_{USD} = **3.92%**

i_{CAD} = **2.03%**

X	Calls	Puts
.82 USD/CAD	----	0.21
.84 USD/CAD	1.58	**0.68**
.88 USD/CAD	**0.23**	----

Example (continuation):

Date	Spot market	Forward market	Money market
t	S_t = .8451 USD/CAD	$F_{t,T=90-day}$ = .8493 USD/CAD	i_{USD} = 3.92% i_{CAD} = 2.03%

$t + 90$ Receive **CAD 300M** and transfer into USD.

NTE = **CAD 300M** * .8451 USD/CAD = **USD 253.53M**

- **Hedging Strategies:**

1. Do Nothing

Do not hedge and exchange the **CAD 300M** at S_{t+90}.

2. Forward Market

At t, sell the **CAD 300M** forward and at time $t + 90$ guarantee:

CAD 300M * **.8493 USD/CAD** = **USD 254,790,000**

Example (continuation):

3. Money Market

At t, Iris Oil takes the following three steps, simultaneously:

1) Borrow from Canadian bank at **2.03%** for 90 days :

CAD 300M / [1 + **.0203** * (90/360)] = **CAD 298,485,188**.

2) Convert to USD at S_t:

CAD 298,485,188 * **0.8451 USD/CAD** = **USD 252,249,832**

3) Deposit in US bank at **3.92%** for 90 days to guarantee at time t+90:

USD 252,249,832 * [1 + **.0392** * (90/360)] = **USD 254,721,880**.

Note: Both the FH and the MMH guarantee certainty at time t+90

FH delivers to Iris Oil: **USD 254,790,000**

MMH delivers to Iris Oil: **USD 254,721,880**

⇒ Iris Oil selects the FH. (MMH is a *dominated* strategy.)

Example (continuation):

4. Option Market

At t, buy a **put**. Available 90-day options:

X	Calls	Puts
.82 USD/CAD	----	0.21
.84 USD/CAD	1.58	**0.68**
.88 USD/CAD	**0.23**	----

Buy the **.84 USD/CAD put** ⇒ Total premium cost of **USD 2.04M**.

Position	**Initial CF**	**Cash flows at t+90**	
		S_{t+90} < .84 USD/CAD	**S_{t+90} >.84 USD/CAD**
Option (HP)	**USD 2.04M**	(**.84** – S_{t+90}) * **CAD 300M**	0
Underlying (UP)	0	S_{t+90} * **CAD 300M**	S_{t+90} * **CAD 300M**
Total CF	**USD 2.04M**	USD 252M	S_{t+90} CAD 300M

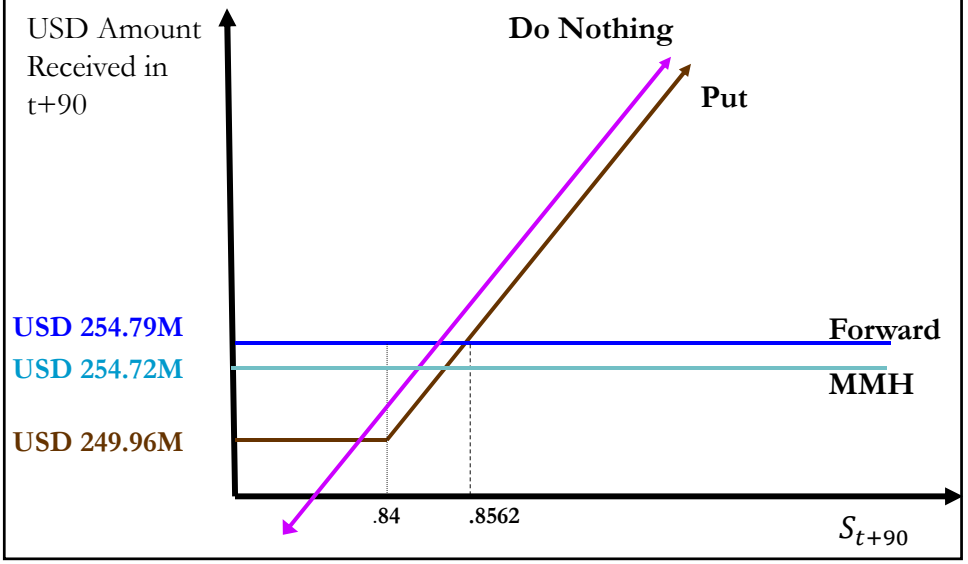
Net CF at $t + 90$:

USD 249,960,000 for S_{t+90} < **.84 USD/CAD**

or S_{t+90} * **CAD 300M** – **USD 2.04M** for S_{t+90} > **.84 USD/CAD**

Example (continuation):

• Let's plot all strategies:



Example (continuation): Companies do not like paying premiums.

5. Collar

At time t, *buy* a **put** and *sell* a **call**.

Buy **.84** put at **USD 0.0068**

Sell **.88** call at **USD 0.0023**. ⇒ Initial cost = **USD 0.0045** per collar

⇒ Total cost: **USD 1.35M**

Position	Initial CF	Cash flows at t+90		
		$S_{t+90} < .84$	$.84 < S_{t+90} < .88$	$S_{t+90} > .88$
Put	**USD 2.04M**	$(.84 - S_{t+90})$ * **CAD 300M**	0	0
Call	**-USD 0.69M**	0	0	$(.88 - S_{t+90})$ * **CAD 300M**
UP	**0**	S_{t+90} * **CAD 300M**	S_{t+90} * **CAD 300M**	S_{t+90} * **CAD 300M**
Total CF	**USD 1.35M**	USD 252M	S_{t+90} CAD 300M	USD 264M

Net CF at $t + 90$:

USD 250.65M for $S_{t+90} <$ **.84 USD/CAD**

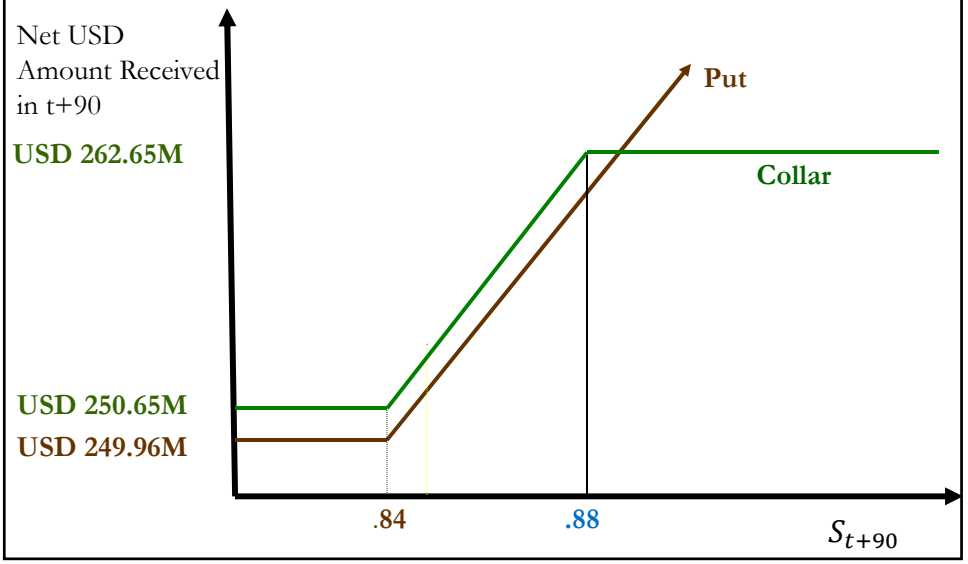
or S_{t+90} **CAD 300M – USD 1.35M** for **.84 USD/CAD** $< S_{t+90} <$ **.88 USD/CAD**

or USD 262.65M for $S_{t+90} >$ **.88 USD/CAD**

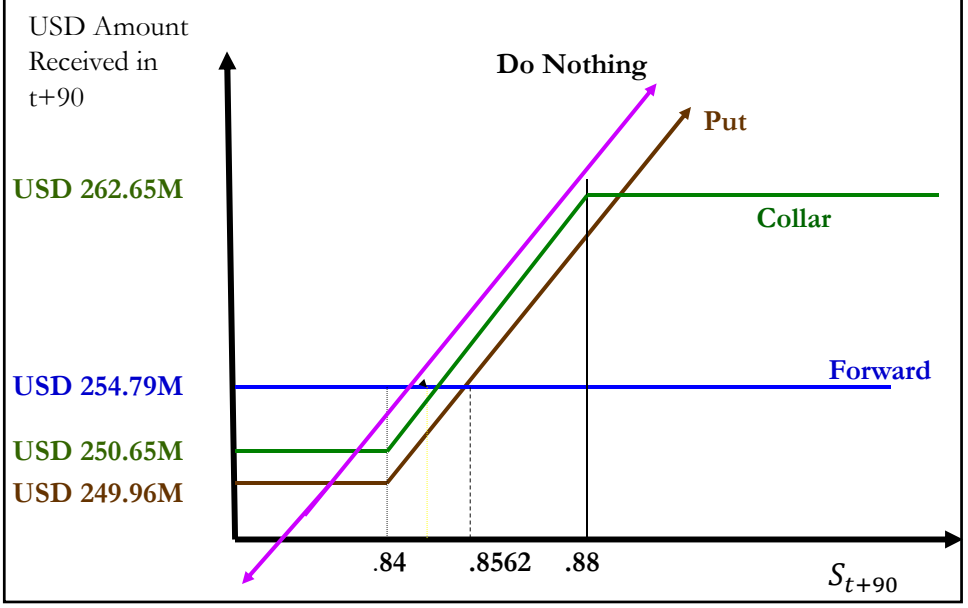
Note: This collar reduces the upside: establishes a floor and a cap.

Example (continuation):

Let's plot the Collar and Put option strategies together. Relative to the put, the Collar limits the upside: The best case scenario is **USD 262.65M** (when sold put is exercised).



Example (continuation):
Let's plot all strategies:



Managing TE – Hedging with FX Options

•**Review: Reading Newspaper Quotes**

PHILADELPHIA OPTIONS (PHLX is the exchange)
Wednesday, March 21, 2022 (Trading Date)

		Calls		Puts		
		Vol.	Last	Vol.	Last	⇒ (Contracts traded) ⇒ (Vol=Volume, Last=Premium)
Australian Dollar					79.92	⇒ (S_t=.7992 USD/AUD)
10,000 Australian Dollars-cents per unit.						⇒ (AUD 10,000 = Size, prices in USD cents)
78	June	9	3.37	20	1.49	
79	April	20	1.79	16	0.88	
80	May	15	1.96	8	2.05	
80	June	11	2.29	9	2.52	
82	June	1	1.38	2	3.61	
↑	↑		↑		↑	
X=Strike Price	T=Maturity		Call Premium		Put Premium	

• **Receivables in FC**

Example : Receivables AUD 20M ⇒ Hedge with **FX puts**

OTM: $X_{put\text{-}June}$ = **0.78 USD/AUD**, P = **USD .0149**

Cost = Total premium = **AUD 20M** * **USD .0149/AUD** = ***USD 298K***

Floor = **0.78 USD/AUD** * **AUD 20M** =USD 15.6M (Net: **USD 15.302M**)

ITM: - $X_{put\text{-}June}$ = 0.82 USD/AUD, P = **USD .0361**

- $X_{put\text{-}June}$ = .80 USD/AUD, P = USD .0252 (almost ATM)

• $X_{put\text{-}June}$ = 0.82 USD/AUD

Cost = Total premium = **AUD 20M** * **USD .0361/AUD** = ***USD 722K***

Net Floor = 0.82 USD/AUD * **AUD 20M** – ***USD 722K*** = **USD 15.678M**

• $X_{put\text{-}June}$ = 0.80 USD/AUD (ATM option)

Cost = Total premium = ***USD 504K***

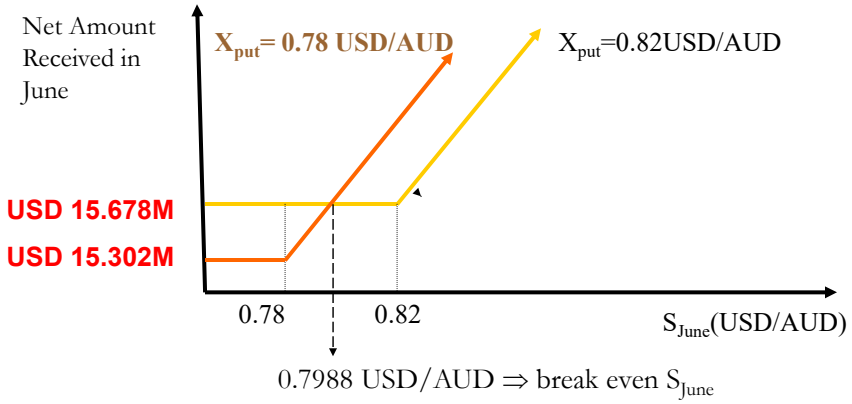
Net Floor = 0.82 USD/AUD * **AUD 20M** – ***USD 504K*** = **USD 15.496M**

Note: The higher the cost, the higher the floor for the AUD 20M. ¶

• All the FX options limit FX risk:

- $X_{put\text{-}June}$ = **0.78 USD/AUD** ⇒ Net floor: **USD 15.302M**
- $X_{put\text{-}June}$ = 0.80 USD/AUD ⇒ Net floor: **USD 15.496M**
- $X_{put\text{-}June}$ = 0.82 USD/AUD ⇒ Net floor: **USD 15.678M**

Q: Which one is better? It depends on your preferences and expectations.



Lesson from these examples:

1) Options offer the typical insurance trade-off: Better coverage (lower cap, higher floor) ⇒ Higher cost (higher premium)

2) Insurance is expensive. For the $X_{put\text{-}June}$ = **0.80 USD/AUD** case, it costs **USD .504M** to insure **USD 15.496M** (a 3.2% premium).

• We can lower the cost of insurance with a Collar, in this case: buy put & sell call, usually OTM.

Example: Buy $X_{put\text{-}June}$ **= 0.78 USD/AUD** (P = USD .0149)
Sell $X_{call\text{-}June}$ = **.82 USD/AUD** (P = USD .0138)

Cost = USD .0149 * **20M** – USD .0138 * **20M** = ***USD 22K*** (very low!)

Net Floor = **0.78 USD/AUD** * **AUD 20M** – ***USD .022M*** = **USD 15.578M**

Net Cap = **0.82 USD/AUD** * **AUD 20M** – ***USD .022M*** = **USD 16.378M**

A collar is cheaper, but it limits the upside of the option. ¶

• **Payables in FC**

Example: Payable AUD 100M in Mid-June ⇒ Hedge with **FX calls**

S_t **= .7992 USD/AUD**

$X_{call\text{-}June}$ = **.78 USD/AUD,** P = USD .0337
$X_{put\text{-}June}$ = .78 USD/AUD, P = USD .0149
$X_{call\text{-}June}$ = **.80 USD/AUD,** P = USD .0229
$X_{put\text{-}June}$ = .80 USD/AUD, P = USD .0252
$X_{call\text{-}June}$ = **.82 USD/AUD**, P = USD .0138
$X_{put\text{-}June}$ = .82 USD/AUD, P = USD .0361

OTM: - $X_{call\text{-}June}$ = **0.82 USD/AUD**
- $X_{call\text{-}June}$ = **0.80 USD/AUD** (≈ATM)

• $X_{call\text{-}June}$ = **0.82 USD/AUD,** Premium = USD .0138

Cost = Total premium = **AUD 100M** * USD .0138/AUD = ***USD 1.38M***

Cap = **AUD 100M** * **0.82 USD/AUD** = USD 82M (Net: **USD 83.38M**)

• $X_{call\text{-}June}$ = **0.80 USD/AUD**, Premium = USD .0229 (almost ATM)
Cost = Total premium = **AUD 100M** * USD .0229/AUD = ***USD 2.29M***
Net Cap = **AUD 100M** * **0.80 USD/AUD** + ***USD 2.29M*** = **USD 82.29M**

ITM: $X_{call\text{-}June}$ = **0.78 USD/AUD**, Premium = USD .0337
Cost = Total premium = ***USD 3.37M***
Net Cap = **AUD 100M** * **0.78 USD/AUD** + ***USD 3.37M*** = **USD 81.37M**

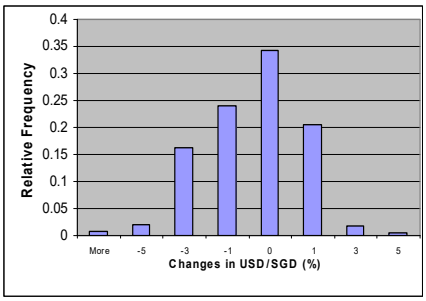
Note**:** The higher the cost, the lower the cap established for the A**UD 100M** payable.

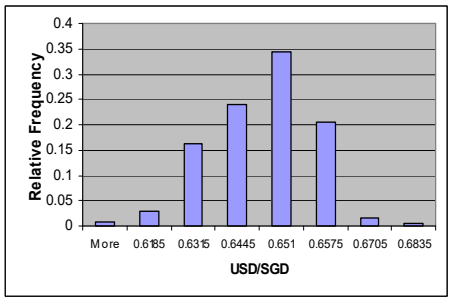
Again, we can lower the cost of insurance using a Collar, in this case: buy a call & sell a put, usually, both OTM.¶

• Optimal Hedging Strategies?

Q: Which strategy is better? We need to say something about S_{t+T}. In the Iris Oil example, we need to make assumptions about S_{t+90}. For example, we can assume a distribution (normal) or use the ED to say something about future changes in S_t.

Example: Suppose we have a **receivable in SGD** in 30 days. We can use the **distribution** for monthly USD/SGD changes from the past 30 years. Then, we get the distribution for S_{t+30} (USD/SGD).





• **Examples assuming an explicit distribution for S_{t+T}**

Example – Receivables: Evaluate (1) FH, (2) MMH, (3) OH & (4) NH.

Cud Corp will receive **SGD 500,000** in 30 days. (SGD Receivable.)

Data:

- S_t = **.6500 - .6507 USD/SGD**.
- $F_{t,T=30-day}$ = **.6510 - .6519 USD/SGD**.
- 30-day interest rates: i_{SGD}: **2.65% - 2.75%** & i_{USD}: **3.20% - 3.25%**
- A 30-day put option on SGD: **X = .65 USD/SGD** and P_t= **USD.01**.
- Forecasted S_{t+30}:

Possible Outcomes	**Probability**
USD .63	18%
USD .64	24%
USD .65	34%
USD .66	21%
USD .68	3%

(1) FH: Sell SGD 30 days forward

USD received in 30 days = Receivables in SGD * $F_{t,30}$

= **SGD 500,000** * **.651 USD/SGD** = **USD 325,500**.

(2) MMH:

- Borrow SGD at **2.75%** for 30 days,
- Convert to USD at **.65 USD/SGD,**
- Deposit USD at **3.2%** for 30 days,
- Repay SGD loan in 30 days with SGD 500,000 receivable

Amount to borrow = **SGD 500,000**/(1 + **.0275** * 30/360) =

= SGD 498,856.79

Convert to USD (Amount to deposit in U.S. bank) =

= SGD 498,856.79 * **.65 USD/SGD** = USD 324,256.91

Amount received in 30 days from U.S. bank deposit =

= USD 324,256.91 * (1 + **.032** * 30/360) = **USD 325,121.60**

(3) OH: Purchase put option. **X = .65 USD/CHF**

P_t = premium = **USD .01**

Possible S_{t+30}	**Premium per SGD + Op Cost**	**Exercise?**	**Net USD Received for SGD 0.5M**	**Prob**
.63 USD/SGD	USD .010027	Yes	**USD 319,986.5**	18%
.64 USD/SGD	USD .010027	Yes	**USD 319,986.5**	24%
.65 USD/SGD	USD .010027	No	**USD 319,986.5**	34%
.66 USD/SGD	USD .010027	No	**USD 324,986.5**	21%
.68 USD/SGD	USD .010027	No	**USD 334,986.5**	3%

Note: In the Total Amount Received (in USD) we have subtracted the *opportunity cost* involved in the upfront payment of a premium:

USD .01 * **.032** * 30/360 = **USD .000027** (Total = **USD 13.50**)

⇒ Total Premium Cost: **USD 5,013.50**

E[Amount Received in USD] = **319,986.5** * .76 + **324,986.50** * .21 +

+ **334,986.50** * .03 = **USD 321,486.5**

(4) No Hedge (NH): Sell **SGD 500,000** in the spot market in 30 days.

Possible S_{t+30}	**USD Received for SGD 0.5M**	**Probability**
.63 USD/SGD	USD 0.315M	18%
.64 USD/SGD	USD 0.320M	24%
.65 USD/SGD	USD 0.325M	34%
.66 USD/SGD	USD 0.330M	21%
.68 USD/SGD	USD 0.340M	3%

Note: When we compare (1) to (4), it's not clear which one is better. Preferences will matter. We can calculate and expected value:

E[Amount Received in USD] = 315K * .18 + 320K * .24 + 325K * .34+

+ 330K * .21 + 335K * . 03 = **USD 323,500**

Conclusion: Cud Corporation is likely to choose the FH. But, risk preferences matter. ¶

Example – Payables: Evaluate (1) FH, (2) MMH, (3) OH, (4) No Hedge

Situation: Cud Corp needs **CHF 100,000** in 180 days. (CHF Payable.)

Data:

- S_t = **.675 - .680 USD/CHF**.
- $F_{t,180}$ = **.695 - .700 USD/CHF.**
- 180-day interest rates are as follows:
  - i_{CHF}: **9% - 10%;**
  - i_{USD}: **13% - 14.0%**
- A 180-day call option on CHF: **X** = **.70 USD/CHF** and P_t = **USD.02**.

- Cud forecasted S_{t+180}:

Possible Outcomes	**Probability**
USD .67	30%
USD .70	50%
USD .75	20%

(1) FH: Purchase CHF 180 days forward

USD needed in 180 days = Payables in CHF x $F_{t,180}$

= **CHF 100,000** * **.70 USD/CHF** = **USD 70,000**.

(2) MMH:

- Borrow USD at **14%** for 180 days,
- Convert to CHF at **.680 USD/CHF** ,
- Invest CHF at **9%** for 180 days,
- Repay USD loan in 180 days & transfer CHF deposit to cover payable

Amount in CHF to be invested = **CHF 100,000**/(1 + **.09** * 180/360)

= **CHF 95,693.78**

Amount in USD needed to convert into CHF for deposit =

= **CHF 95,693.78** * **.680 USD/CHF** = **USD 65,071.77**

Interest and principal owed on USD loan after 180 days =

= **USD 65,071.77** * (1 + **.14** * 180/360) = **USD 69,626.79**

(3) OH: Purchase call option. **X = .70 USD/CHF**
C_t = premium = **USD .02**.

Possible S_{t+180}	**Premium per CHF + Op Cost**	**Exercise?**	**Net Paid for CHF 0.1M**	**Prob**
.67 USD/SGD	USD .0213	No	USD 69,130	30%
.70 USD/SGD	USD .0213	No	**USD 72,130**	50%
.75 USD/SGD	USD .0213	Yes	**USD 72,130**	20%

Note: In the Total USD Cost we have included the opportunity cost involved in the upfront payment of a premium = **USD 130**.

E[Amount to Pay in USD] = USD 69,130 * .30 + **USD 72,130** * .70
= **USD 71,230**

• *Preferences matter*: A risk taker may like the 30% chance of doing better with the OH than with the MMH.

(4) Remain Unhedged: Purchase **CHF 100,000** in 180 days.

Possible S_{t+180}	**Net Paid for CHF 0.1M**	**Probability**
.67 USD/SGD	USD 67,000	30%
.70 USD/SGD	USD 70,000	50%
.75 USD/SGD	USD 75,000	20%

Preferences matter: Again, a risk taker may like the **30% chance** of doing better with the NH than with the MMH. (Actually, there is also an additional 50% chance of being very close to the MMH.)

E[Amount to Pay in USD] = USD 67,000 * .30 + USD 70,000 * .50
+ USD 75,000 * .20 = **USD 70,100**

Conclusion: Cud Corporation is likely to choose the MMH. ¶