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Chapter 18 - Long term financing – Part 2: Swaps (continuation)

Review from last class: Swaps

- Four types of swaps, similar in structure, but different in how the legs are indexed.
    1. Interest Rate Swap
    2. Currency Swap
    3. Equity Swap
    4. Commodity Swap.
    5. CDS

- Value of Swap: NPV(Receivables) – NPV(Payables)

Q: Why does the value of the currency swap change?

A: The value is a function of the coupons and the exchange rate. When these variables change, the value of the swap also changes.

For example, going back to the IBM currency swap, the value is a function of the exchange rate (USD/EUR), and interest rates (i_{EUR} and i_{USD}):

$V_{IBM} = f(coupon_{EUR}, coupon_{USD}, S_t, i_{EUR}, i_{USD}, T)$

Only the exchange rate and interest rates constantly and randomly change.

Comparative statics-V_{IBM} (IBM pays USD, receives EUR):

If S_t falls (USD appreciates) $\Rightarrow V_{IBM}$ falls.
If i_{USD} falls $\Rightarrow V_{IBM}$ falls
If i_{EUR} goes up $\Rightarrow V_{IBM}$ falls.

The opposite happens for the Swap Dealer.

Note**:** You can think of currency swaps as a collection of forward currency contracts. From last class, IBM exchanges semi-annually USD 4M for EUR 5.25M for 1 year, setting an implicit forward exchange rate S_{t+j} = .762 USD/EUR, j=6-mo, and 12-mo.

• Decomposition into Forward Contracts

We can decompose the currency swap into a series of forward contracts. Then, we can value the currency swap as the sum of the values of the series of forward contracts.

Example: IBM entered into a 3-year currency swap, which has one year left. The swap terms, current exchange rate and discount rates are given below:

T: 1 year
Notional Principals: USD 200M, EUR 210M
Coupons: 4% USD (USD 4M), 5% EUR (EUR 5.25M)
S_t = 1.05 USD/EUR
Discount rates: In USD: 6 mo= 5%, 1 yr=5.1%

In EUR: 6 mo= 6%, 1 yr=6.2%

Then, the swap sets the following implicit forward FX rates:

2 semi-annual exchanges: EUR 5.25M = USD 4M $\Rightarrow S_{t+j}$= .762 USD/EUR

At maturity, final exchange: EUR 210M = USD 200M $\Rightarrow S_2$= .9524 USD/EUR. ¶

• Each of the currency exchanges in a swap represents a implicit (swap) forward contract. We can value the implicit swap forward rate relative to the forward rate determined by IRPT, $F_{t,T}$.:

$$\mathbf{F_{t,Tj}} = S_t\,(1 + I_{d,Tj} \times T_j/360)/(1 + i_{f,Tj} \times T_j/360).$$

Suppose in the swap, we are long the FC (say, IBM is long EUR). Then, the PV, using i_d as the discount rate, of each annual payment j is:

($F_{t,j}$ – Swap forward rate at time j) x Amount of FC/$(1+i_d)^j$

Example (continuation): We calculate IBM's value of the exchange of principals at T=1 year ($Value_{IBM,Principal}$).

$\mathbf{F_{t,T=12\text{-}mo}}$ = 1.05 USD/EUR * $(1+.051/2)^2/(1+.062)^2$ = **1.038827 USD/EUR**

Swap forward rate = USD 200M/EUR 210M = **0.952381 USD/EUR.**

$Value_{IBM,Principals}$ = (**1.038827 USD/EUR** – **0.952381 USD/EUR**) * 210M $/(1+.051/2)^2$ =

= **USD 17.2621**

Note: We can do the same for each exchange of CFs. ¶

• Alternatively, we can value the CFs in terms of forward DC.

Notation:

T_j: time of the jth settlement date

i_{Tj}: interest rate (appropriate to discount the CFs) applicable to time T_j

$F_{t,Tj}$: forward exchange rate applicable to time T_j.

• IBM's NPV of the forward contract corresponding to the exchange of payments at T_j:

(EUR 5.25M x $F_{t,Tj}$ – USD 4M)$/(1+i_{USD,Tj})^{Tj}$

• Similarly, IBM's NPV of the forward contract corresponding to the exchange of principals at T (maturity):

(EUR 215.25M x $F_{t,T}$ – USD 204M)$/(1+i_{USD,T})^T$.

⇒ The value of a currency swap can be calculated from the term structure of forward rates and the term structure of domestic interest rates (yield curve).

Example (continuation): Reconsider IBM's example with two payments left. Using IRPT, the 6-mo, and 12-mo forward exchange rates are:

$F_{t,6\text{-}mo}$ = 1.05 USD/EUR x (1+.05/2) /(1+.06/2) = **1.0449029 USD/EUR**

$F_{t,12\text{-}mo}$ = 1.05 USD/EUR x $(1+.051/2)^2/(1+.062/2)^2$ = **1.038827 USD/EUR**

• The exchange of interest payments involves receiving EUR 5.25M and paying USD 4M. Thus, the values of the CFs in terms of forward USD are (in millions):

(EUR 5.25 x **1.0449029 USD/EUR** - USD 4)/(1+.05/2) = **USD 1.4495027**
(EUR 5.25 x **1.038827 USD/EUR** - USD 4)/(1+.051/2)^2 = **USD 1.3824395**

• Final exchange of principals: IBM receives EUR 210M and pays USD 200M. The value of the forward contract is (in millions):

(EUR 210 x **1.038827 USD/EUR** – USD 200)/(1+.051/2)^2 = **USD 17.262119**

• The total value of the swap (in USD M) is:

1.4495027 + **1.3824395** + **17.262119** = **20.094061** (check value from last class!)

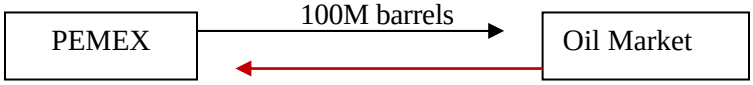
⇒ IBM would be willing to sell this swap for **USD 20,094,061**. ¶

Financial Engineering

Financial engineers combine different financial instruments to solve problems for firms. In this section, we present one example of combination of swaps. We combine swaps to deal with a typical situation for non-US commodity markets participants: Commodity prices are set in USD.

Problem: Two sources of uncertainty: commodity price risk and FX risk.
Solution: Use swaps to fix the price of the commodity in terms of the domestic currency.

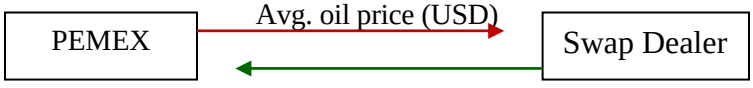
Example: Mexican Oil Producer – PEMEX (Petróleos Mexicanos)
Pemex sells 100M barrels every six months in the Oil Market.



Avg. oil price (USD)

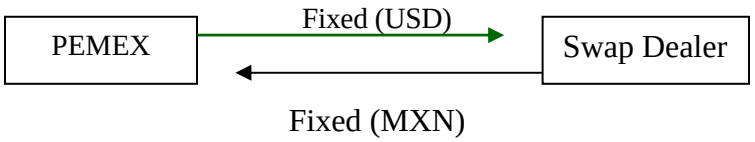
The price for oil is set in USD. Not in MXN. This creates transaction/economic exposure.

1. **Commodity price risk** – use a commodity swap



Fixed oil price (USD)

1. **Exchange rate risk** – use a currency swap



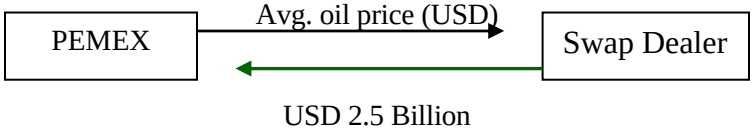
With two swaps, PEMEX has fixed the price of oil in terms of MXN.

SWAP DETAILS
◊ Commodity swap
Dealer pays 25 USD/barrel against market price for 2 years.
Notional = 100M Barrels
Duration: 2 yrs
Frequency: semiannual

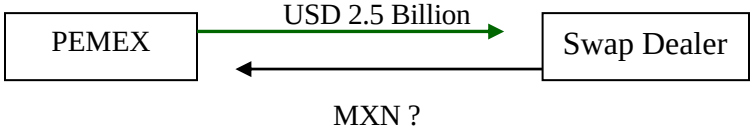
◊ Currency swap (fixed by fixed)
SD pays 6.5% in MXN against 5% in USD.
S_t = .105 USD/MXN
i_{USD} = 5%
i_{MEX} = 6.5%
Duration: 2 yrs
Frequency: semiannual

* We need to find out the fixed price of oil in terms of MXN

1. **Commodity Swap** (Notional = 100M Barrels)



2. **Currency Swap**



Calculations for the SD MXN payments:
(1) Need to determine the Notionals of Swap
Notional of USD part = USD 2.5B/.025 = USD 100B
(2) Determine MXN payment. (Recall that at inception the Value of the Swap is zero.)
NPV (USD payments) = USD 100B
NPV (MXN payments) = USD100B/.105 USD/MXN = MXN 952.38B
⇒ SD's MXN payment = MXN 952.38B (.0325) = MXN 30.952381B

Note: The price of oil in MXN for 2 years has been fixed:
P_t = MXN 30,9524M/100M barrels = 309.52 MXN/Barrel. ¶

Chapter 20 – Short-term Financing

• Sources of short-term financing
  - Commercial Paper/Bank Notes
  - Bank Debt
    Cost of debt: call a bank. Example for a US MNC $\Rightarrow i_{USD} = 5\%$
    Banks set cost of borrowing: Base Rate + Spread (reflecting risk)

• MNCs can borrow anywhere. If an MNC borrows abroad faces FX Risk (needs to pay attention to $e_{f,t}$). We are back to the IFE context.

Q: Where should they borrow?
A: Wherever it is cheaper (look for lowest interest rate).
  Borrow in a place that reduces economic exposure (remember Laker Airlines)

We will pay attention to the lowest cost.

Example: IBM needs financing for 15 days. It can borrow 4% in the USD or 9% in Mexico. We need more information to make a decision. Need info about the future exchange rate.

IBM will look at the effective borrowing cost (in USD). From IFE:

$$R_b^{MXN}(\text{in USD}) = (1+i_{MXN} \times T/360)*(1+e_{f,t}) - 1$$

Problem: Since we do not know $e_{f,t}$, we work with expectations, $E[e_{f,t}]$. Now, R_b^{MXN} is also an expected quantity. There are risks involved!

$E[e_{f,t}] = -1\%$ (The USD is expected to appreciate against the MXN by 1%)
$R_b^{USD} = i_{USD} = .04 \times 15/360 = 0.0016667$ (0.167%)
$E[R_b^{MXN}] = (1+.09 \times 15/360)*(1 + (-.01)) - 1 = -.006288$ (or -0.629%)
$\Rightarrow$ IBM should borrow in Mexico. ¶

Note: If the forward rate is used to set the expected change, then the effective borrowing costs would be the same everywhere. (Remember IRP!)

CHAPTER 18 – BRIEF ASSESMENT

1. Green Lion, an Irish design company, wants to refinance debt amounting to USD 200 million. An investment bank suggests issuing a straight bond, with annual coupon payments. The investment bank has the following data available:

Irish government bond yields: 4-year 5.75 % (p.a.)
U.S. Treasury government bond yield: 4-year 1.85 % (s.a.)
German government bond yield: 4-year 2.25 % (s.a.)
Green Lion Euro-Eur bond yield (outstanding debt): German government bonds + 345 bps (s.a.)

Given the current tight market conditions, an investment bank suggests: a 5-year full-coupon USD Eurobond and an issue price of 100% (P=100).

(A) Following usual market practices, set the coupon and the yield of the new Green Lion bond.
(B) A year from now, there is a big debt crisis in Europe. What would the effect of this crisis be on the value of the bond? Briefly explain your logic.
(C) Two years from now, the Irish government has a budget surplus. What would the effect of this budget surplus be on the value of the bond? Briefly explain your logic.
(D) Three years from now, Green Lion wants to buy back the bond. If the yield to maturity for similar bonds is 8% and S_t = 1.20 USD/EUR, how much does Green Lion have to pay (in EUR) for the bond buyback?

2. The annual Chinese yuan (CNY) interest rate is 5% (s.a.), while the annual USD interest rate is 1% (s.a.). Padres Co., a U.S. firm, entered into a currency swap with a swap dealer, where Padres pays 3% semi-annually in USD and receives 4% semi-annually in CNY. The notional principals in the two currencies are USD 6 million and CNY 26 million. The swap will last for another two years. The exchange rate is 0.16 USD/CNY. For simplicity, assume the term structure in Chinese and in the U.S. is flat.

A. Draw a diagram showing the semi-annual swap cash flows (in CNY and in USD).
B. Value this currency swap for Padres Co.
C. A year from now, the exchange rate is 0.13 USD/CNY. Assuming that nothing else has changed, use the forward contract decomposition approach to calculate the new value of the swap for Padres Co.

3. Metales Inc, a Mexican company, imports 100 tons of copper per quarter. The company wants to set the price of copper in terms of MXN. Combine swaps to achieve this goal. Draw a diagram.