SWAPS 2

Decomposition & Combination

Currency Swaps

- Also called *Cross currency swaps* (XCCY).
- The legs of the swap are denominated in different currencies.
- Currency swaps change the profile of cash flows.
- Many possibilities for the CF exchanges: fixed-fixed, fixed-floating *(Circus swap) &* floating-floating (*XCCY basis swap*).
- Reference rates are IBOR, usually USD LIBOR, Euribor (EUR IBOR), JPY LIBOR/TIBOR.

Example:

Situation: ExxonMobil has USD debt, but wants to increase EUR debt.

Solution: A swap.

ExxonMobil pays EUR. A Swap Dealer pays USD.

Example (continuation):

ExxonMobil pays EUR. A Swap Dealer pays USD.

• Swap Details:

- ExxonMobil pays 3.5% in EUR, with a Notional principal: EUR 2 M
- Swap Dealer pays 4.75 % in USD, with a Notional principal USD 2 M
- Frequency of payments = 6-mo.
- Duration = 4 years
- S_t = 1.31 USD/EUR.

Every six month, Exxon pays EUR 35,000 & receives USD 47,500.

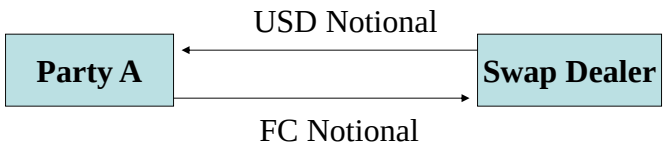
Note that Exxon and SD have fixed the exchange rate for 4 years at:

S_{t+i} = USD 47,500/EUR 35,000 = 1.357143 USD/EUR i=6,12,..,48. ¶

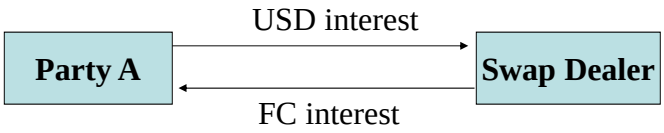
Usual CFs in a XCCY swap

Since in currency swaps the notional principals are usually exchanged. There are three sets of cash flows:

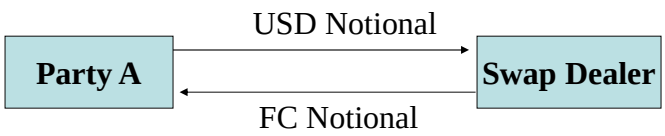
• At inception



• Periodic interest payments



• At end of term



Variations

The key is that both legs are denominated in different currencies. There are different possibilities here:

1. Fixed-Fixed

Example: Exxon-Mobile example.

2. Fixed-Floating (also called *Circus swap*)

Example: IBM pays LIBOR in USD and receives 5% in EUR. ¶

3. Floating-Floating (also called *cross currency basis swap,* if initial exchange of notionals occurs)

Example: IBM pays LIBOR in USD and receives LIBOR in EUR. ¶

The difference between the two floating rates in a currency swap is called the *basis swap spread*, usually quoted against USD LIBOR flat.

• Euro-USD XCCY Basis Swaps Spreads: 2008-2012

• The XCCY basis swap spread has not been positive since September 2007. That is, institutions have been willing to receive fewer interest rate payments on funds lent in non-USD currencies (in exchange for USD) since Sep 2007. The XCCY spread is taken as an indicator of funding conditions.

Valuation of Currency Swaps

A currency swap can be decomposed into a position in two bonds.

V = Value of a swap = NPV of FC bond minus NPV of DC bond

In previous example the swap value to ExxonMobil is:

$$V = B_D - S\,B_F$$

B_F: value of the foreign denominated bond underlying the swap.
B_D: the value of the domestic currency bond underlying the swap.
S_t: spot exchange rate.

Example: FI

Term structure in Denmark and the U.S. is flat.
Interest rates: i_{DKK}= 5% & i_{USD}= 6.5%.
A U.S. financial institution (FI) is involved in a currency swap:
Terms:

- FI receives 5.5% annually in DKK against 6% annually in USD
- Frequency of payment: annual.
- Notional principals: DKK 53 million and USD 10 million.

Swap will last for another three years.
S_t=.18868 USD/DKK.

$B_D = .6/(1+.065) + .6/(1+.065)^2 + 10.6/(1+.065)^3$ = USD 9,867,577
$B_F = 2.915/(1+.05) + 2.915/(1+.05)^2 + 55.915/(1+.05)^3$= DKK 53,721,661
$V_{US\ FI}$ = (53,721,661)x(.18868) - 9,867,577 = **USD 268,585.45**.
$V_{other\ party}$ (paying DKK and receiving USD) = USD -268,585.45. ¶

Decomposition into Forward Contracts

The CFs of currency swap can be valued as a series of forward contracts.

• **Example FI (continuation)**:

Annual exchanges: DKK 2,915,000 = USD 600,000

At maturity, final exchange: DKK 53 M = USD 10 M

$\Rightarrow$ Each of these payments represents a forward contract. ¶

Notation:

t_j: time of the jth settlement date

r_j: interest rate applicable to time t_j

$F_{t,ti}$: forward exchange rate applicable to time t_j.

$$F_{t,T} = S_t (1 + i_d \times T/360)/(1 + i_f \times T/360).$$

• The value of a long forward contract is the present value of the amount by which the forward price exceeds the delivery price.

• The present value to the financial institution of previous Example of the forward contract corresponding to the exchange of payments at time t_j:

$$(\text{DKK } 2.915\text{M} \times F_{t,j} - \text{USD } 0.6)/(1+r_j)^{tj}$$

• The value to the financial institution of the forward contract corresponding to the exchange of principal payments at time T (maturity):

$$(\text{DKK } 53\text{M} \times F_{j,T} - \text{USD } 10\text{M})/(1+r_T)^T.$$

$\Rightarrow$ The value of a currency swap can be calculated from the term structure of forward rates and the term structure of domestic interest rates.

- **Example (continuation)**: Reconsider FI Example.

S_t = .18868 USD/DKK.

i_{USD} = 6.5% per year.

i_{DKK} = 5% per year.

Using IRP, the one-, two- and three-year forward exchange rates are:

.18868 USD/DKK x (1+.065) /(1+.05) = **.19137** USD/DKK

.18868 USD/DKK x $(1+.065)^2/(1+.05)^2$ = **.19411** USD/DKK

.18868 USD/DKK x $(1+.065)^3/(1+.05)^3$ = **.19688** USD/DKK

- The exchange of interest involves receiving DKK 2.915 million and paying USD .6 million.

- **Example (continuation)**: Reconsider FI Example.
- The value of the forward contracts corresponding to the exchange of interest are therefore (in millions of USD)

(DKK 2.915 x **.19137** USD/DKK– USD .6)/(1+.065) = USD -.03957

(DKK 2.915 x **.19411** USD/DKK– USD .6)/$(1+.065)^2$= USD -.03013

(DKK 2.915 x **.19688** USD/DKK– USD .6)/$(1+.065)^3$= USD -.02160

- The final exchange of principal involves receiving DKK 53 million and paying USD 10 million. The value of the forward contract is:

(DKK 53 x **.19688** USD/DKK – USD 10)/$(1+.065)^3$ = USD .359816

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

359,816 - 39,570 - 30,130 - 21,600 = **USD 268,516**.

$\Rightarrow$ FI would be willing to sell this swap for USD 268,516. ¶

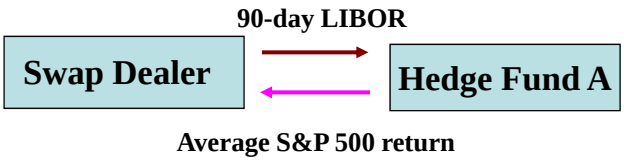
Equity Swaps

Equity swaps have two legs: an interest rate leg (usually LIBOR) and an equity leg, pegged to the return of a stock or market index.

Terms include notional principal, duration and frequency of payments.

Example: Equity swap: Stock returns against a floating rate.

On April 1, Hedge Fund A enters into a 3-year equity swap. Every quarter, Hedge Fund A pays the average S&P 500 return in exchange of 90-day LIBOR (count 30/360) .



Example (continuation):

Suppose the notional principal is USD 40 million. On April 1 (at inception), the S&500 index is 1150 and 90-day LIBOR is 0.30%. On July 1, Hedge Fund A will pay (or receive if sum is negative):

USD 40 M x [S&P 500 return (04/01 to 07/01) – 0.0030 x 90/360].

If on July 1, the S&P 500 is 1165, then the payment will be:

USD 40M x [.0130 – 0.0030 x 90/360] = USD 0.49M.

On July 1, LIBOR is set for the next 90-day period (07/01 to 10/01). ¶

• Variations

- Equity return against a fixed rate (S&P500 against 2%)
- Equity return against another equity return (S&P500 against NASDAQ)
- Equity return against a foreign equity return (S&P500 against FTSE)
- Equity swaps with changing notional (“reinvested”) principals

• **Variations**

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• **Q: Why equity swaps?**

(1) *Avoid transaction costs and taxes.*
(2) *Avoid legal limits (margins, capital controls) and institutional rules.*
(3) *Keep equity positions (and voting shares) without equity risk.*

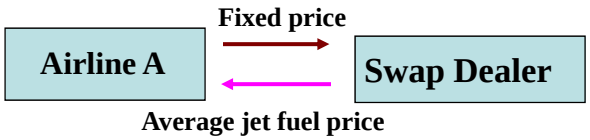
Commodity Swaps

Commodity swaps work like any other swap: one legs involves a fixed commodity price and the other leg a (variable) commodity market price.

Unlike futures commodity contracts, cash settlement is the norm.

Example: Jet fuel oil swap.

Airline A enters into a 2-year jet-fuel oil swap. Every quarter, Airline A receives the average market price –based on a known price quote- and pays a fixed price.



Example (continuation):

Settlement is in cash: If the average jet-fuel price paid is above (below) the fixed price, the SD will repay (repay) the airline the difference in what it paid versus the fixed price. ¶

Note: There is no futures contract for jet fuel oil. A swap completes the market.

You can consider the 2-year swap as a collection of 8 forward contracts.

• Q: Why commodity swaps?

(1) *A commodity swap eliminates basis risk*

Southwest Airlines has used NYMEX crude oil and heating oil futures contracts to hedge jet fuel price risk. But, this introduces basis risk.

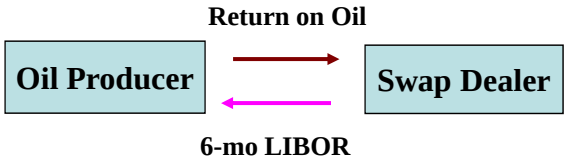
(2) *Expanded market*

Since there is cash settlement, market participants do not need to have the infrastructure to take delivery.

• Commodity for interest swap

They work like an equity swap: One leg pays a return on a commodity, the other leg pays an interest rate (say, LIBOR plus or minus a spread).

Example: An oil producer enters into a 2-year swap. Every six month, the oil producer pays the return on oil –based on NYMEX Light Crude Oil- and receives 6-mo LIBOR.



• Valuation of Commodity Swaps

Commodity swap are valued as a series of commodity forwards, each priced at inception with zero value.

Credit Default Swaps

• A CDS is an agreement between two parties. One party buys protection against specific risks associated with credit events –i.e., defaults, bankruptcy or credit rating downgrades.

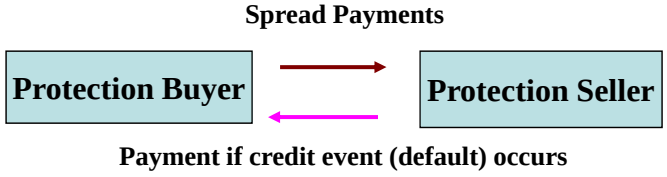
• Facts:

- Today, CDS is the most widely traded credit derivative product.
- Outstanding amount: USD 19.6 trillion (June 2014).
- Maturities range from 1 to 10 years (5 years is the most common).
- Most CDS's are in the USD 10M to 20M range.

• CDS contracts are governed by the International Swaps and Derivatives Association (ISDA), which provides standardized definitions of CDS terms, including definitions of what constitutes a credit event.

CDS Mechanism

- One party buys protection –i.e., "sells" risk or "short credit exposure- and the counterparty sells protection –i.e., "buys" risk or credit exposure.
- The protection buyer pays a periodic fee (the *spread*) to the protection seller.
- In return, the protection seller agrees to pay the protection buyer a set amount if there is a credit event (usually, default).



Though it is not necessary to buy a CDS, the protection buyer tends to own the underlying asset subject to risk.

CDS Benefits

In addition, to hedging event risk, the CDS provides the following benefits:

- A short positioning vehicle that does not require an initial cash outlay.
- Access to maturity exposures not available in the cash market.
- Access to credit risk not available in the cash market due to a limited supply of the underlying bonds.
- Investments in foreign credits without currency risk.
- Ability to effectively 'exit' credit positions in periods of low liquidity.

CDS: Not Insurance

- The protection buyer does not need to own the underlying credit exposure.
- Protection seller is not necessarily regulated. No reserves are required.
- CDS's are mark-to-market (in the US).

Typical CDS Quote

A 5-year CDS quote for Bertoni Bank (on April 17, 2014)

Notional amount = USD 10 million

Premium or Spread: 160 bps

Maturity: 5 years

Frequency: Quarterly Payments

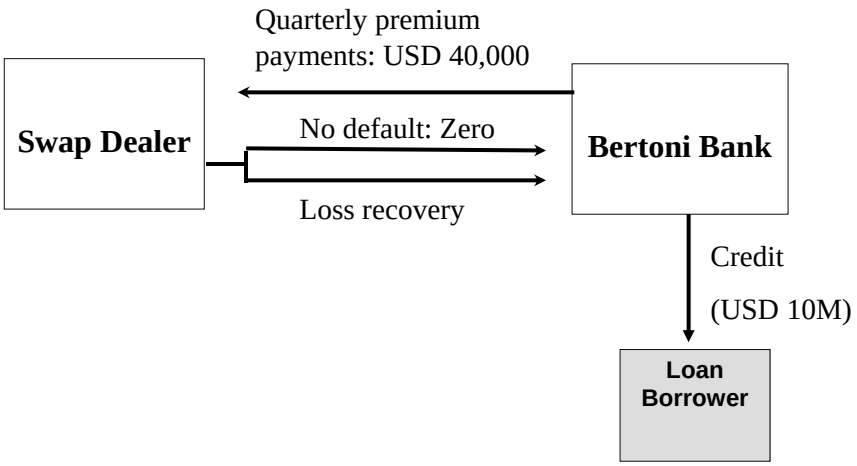
Credit event: Default

• Calculation of the Spread

Q; How much will you pay for protection?

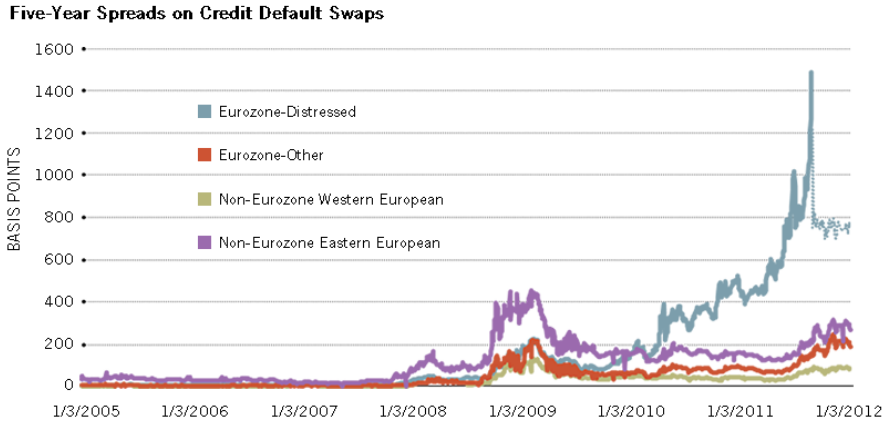
(0.0160 / 4) x USD 10M = USD 40,000 *(every quarter as a premium for protection against company default)*

Diagram for Bertoni Bank's CDS



High-risk entity for default

• CDS spreads do reflect default risk.



Combination of Swaps

• Swaps change the profile of cash flows.

• Swaps solve problems: *Financial Engineering*.

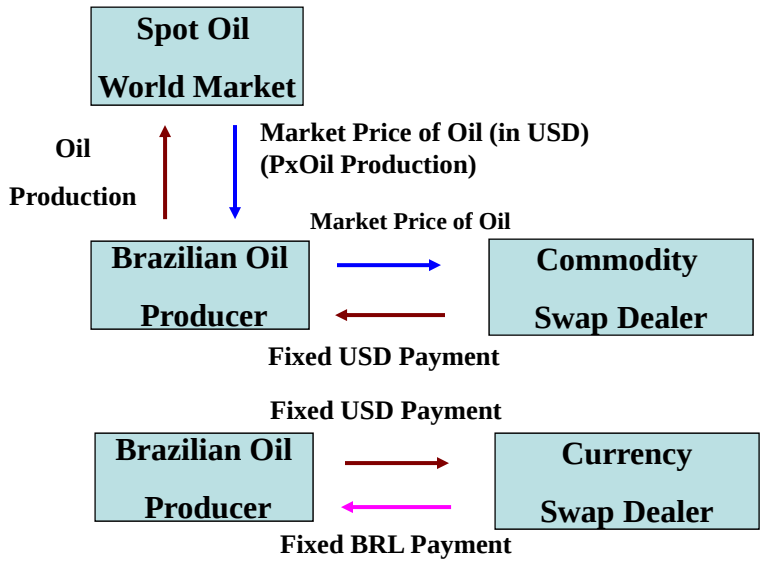
Example: A Brazilian oil producer is exposed to two forms of price risk:

- the price of oil (P), priced in USD ⇒ commodity price risk.
- the price of dollars (S_t) ⇒ FX risk.

Expenses are in BRL. The Brazilian oil producer would like to fix the price of oil in BRL/barrel of oil. A combination of swaps can do it!

Note: This is a typical problem for international commodity producers and buyers: Commodities are priced in USD.

Diagram: Structured Solution for Brazilian Oil Producer



Example: Combining Swaps.

- Belabu, a Lituanian coffee refiner, uses 500,000 pounds of Colombian coffee every 6-months.
- Belabu has contracts to sell its output at a fixed price for 4 years.
- S_t = **4.74 LTT/USD**
- P = Spot price of Colombian coffee = 1.95 USD/pound.

- Belabu wants to fix the price of coffee in LTT/pound.

• Belabu approaches three swap dealers.

(1) Commodity swap dealer:

Belabu pays: a fixed-price of **USD 2.05 per pound**

Belabu receives: the average market price of coffee.

Current mid-price quote for a 4-yr coffee swap is USD 1.99 per pound. (Dealer adds USD .06 to its mid-price.)

Example (continuation):

(2) Interest rate swap dealer:

Belabu pays: a USD floating rate amount

Belabu receives: a USD fixed rate amount

4-yr swap interest rate quote: **8.2%** against 6-mo. LIBOR.

(3) Currency swap dealer:

Belabu pays: a LTT fixed-rate amount

Belabu receives: a USD floating rate amount

4-year LTT-for-USD currency swap quote: **7.8%** against 6-mo. LIBOR.

• Solution for Belabu: to simultaneously enter three swaps.

Example (continuation):

Details

1. Determine the number of USD Belabu will need every six months:

   500,000 pounds x **USD 2.05/pound** = USD 1,025,000

2. Determine notional principal required on a USD interest rate swap for the fixed-rate side to generate USD 1,025,000 every 6-mo (**8.2%** rate)

   1,025,000 / **.041** = USD 25,000,000

3. Calculate the present value of the cash flows on the fixed-rate side of the interest rate swap using the current **8.2%.**

   PV(1,025,000,**.041**,8 periods) = USD 6,872,600

4. Translate the PV of the USD cash flows to its LTT equivalent.

   4.74 LTT/USD x USD 6,872,600 = LTT 32,576,124

Example (continuation):

Details (continuation)

5. Determine the LTT CFs on the fixed-rate side of the LTT-for-USD currency swap having a NPV of LTT 32,576,124 at **7.8%** current rate.

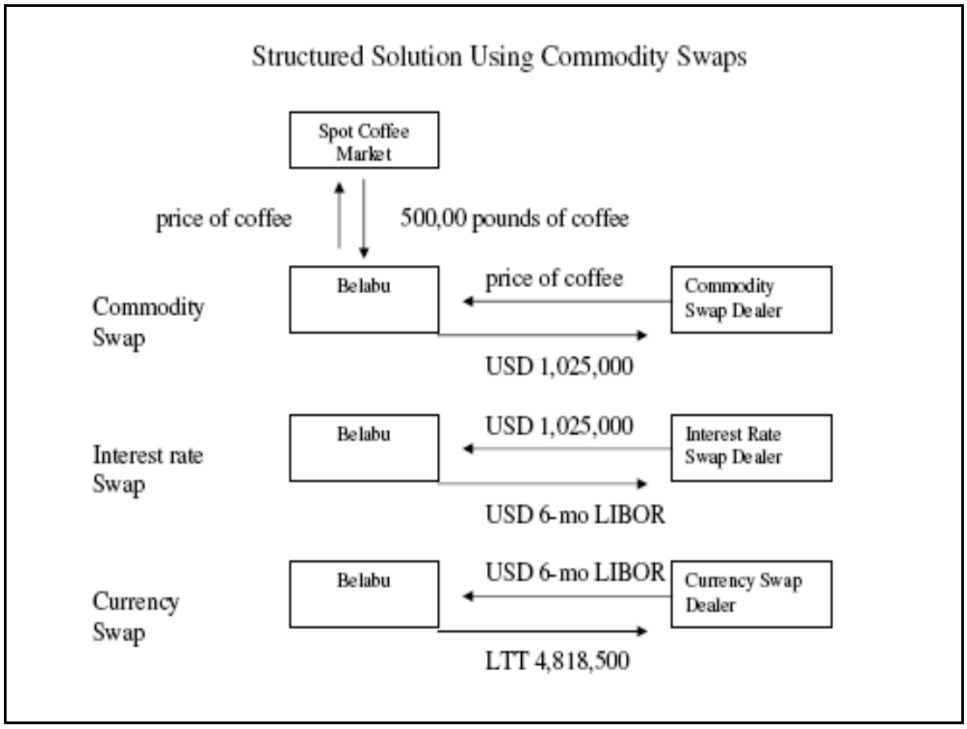
   Coupon(PV=LTT 32,576,124,**.039**,8 periods) = **LTT 4,818,500**

6. Determine the LTT notional principal that would generate the semiannual payments of **LTT 4,818,500** at **7.8%.**

   LTT 4,818,500 / **.039** = LTT 123,551,282.10

⇒ The structured solution has fixed the price of coffee for four years:

LTT 4,818,500 / 500,000 = **9.637 LTT/pound of coffee**.


Structured Solution Using Commodity Swaps
Spot Coffee Market
price of coffee
500,00 pounds of coffee
Belabu
price of coffee
Commodity Swap Dealer
Commodity Swap
USD 1,025,000
Belabu
USD 1,025,000
Interest Rate Swap Dealer
Interest rate Swap
USD 6-mo LIBOR
Belabu
USD 6-mo LIBOR
Currency Swap Dealer
Currency Swap
LTT 4,818,500