Derivatives II

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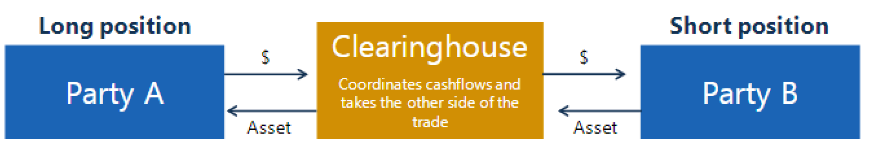
Derivatives

- A financial instrument that <u>derives</u> its value from movements in an underlying security; a contract whereby two parties agree to exchange cash flows or to enter into a transaction in the <u>future</u>

1. Futures

- An agreement to buy or sell a certain quantity of a specified asset for a certain price on a specified future date
  - Obligation: long must buy and short must sell
  - Traded on exchanges and guaranteed by clearinghouse (e.g. CME)
  - Initial amount required on a margin account
- 

A. Cost of carry model

Price of futures contract is determined by the **cost of carry model**

Futures price (F) = Spot (cash) price (S_0) + Risk-free rate (Rf)

$F = S_0 \times (1 + Rf)^T$ → discrete compounding

$F = S_0 \times e^{(Rf \times T)}$ → continuous compounding

Example: Spot = \$100 Rf = 2% T = 1
<u>Discrete</u>
F = \$100 x $(1 + 2\%)^1$
F = \$100 x 1.02
F = \$102.**00**
<u>Continuous</u>
F = \$100 x $e^{(2\% \times 1)}$
F = \$100 x 1.0202
F = \$102.**02**

- No arbitrage principle ensures market price doesn't deviate from cost of carry model

B. Futures in Equities

Futures price (F) = Spot index level (S_0) + Risk-free rate (Rf) − Dividends (δ)

Equity index: **$F = S_0 \times e^{(Rf-\delta) \times T}$**
•Continuous compounding
•Cash settled
•Contract notional value = index level x contract multiplier

Single-stock:
$F = S_0 \times (1 + Rf)^T - FV(\delta)$
•Discrete compounding
•Physical settlement

Example: Spot = \$100 Rf = 2% T = 1 δ = 4%
<u>Index</u>
F = \$100 x $e^{(2\%-4\%) \times 1}$
F = \$100 x 0.9802
F = \$98.02

Example: Spot = \$100 Rf = 2% T = 1 δ = 4%
t = 0.5
<u>Single-stock</u>
F = [\$100 x $(1 + 2\%)^1$] - [4 x $(1 + 2\%)^{0.5}$]
F = \$102.00 – 4.04
F = \$97.96

C. Futures in Fixed Income

Futures price (F) = Spot bond price (S_0) + Risk-free rate (Rf) − Coupons (C)

Treasury note/bond: **$F = S_0 \times (1 + Rf)^T - FV(C)$**
•Based on \$100K face value 2, 3, 5, 10 year Treasury notes and 30 year Treasury bonds
•Physical delivery (CTD)

Example: Spot = \$102 Rf = 2% T = 1.25
C = 3.5%
<u>Treasury</u>
FV(C) = (1.75 x $1.02^{0.75}$) + (1.75 x $1.02^{0.25}$)
FV(C) = 3.53
F = (\$102 x $1.02^{1.25}$) - \$3.53
F = \$101.03

Eurodollar: time deposits denominated in USD held at banks outside the U.S.
•Based on \$1M face value 90-day maturity Eurodollar time deposit (**LIBOR**)
•Quoted as (100 – annualized LIBOR in %)
•1 bps = \$25.00

Example: $Libor_{90}$ = 1.31%
<u>Eurodollar</u>
IMM Index = 100.00 - 1.31%
IMM Index = 98.69

D. Futures in Commodities

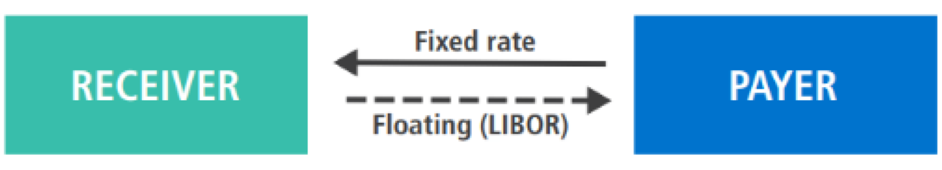
Price of futures contract is determined by the **cost of carry model**

Futures price (F) = Spot price (S_0) + Risk-free rate (Rf) + Storage costs (u) - Convenience yield (y)

Commodity: **$F = S_0 \times (1 + Rf)^T + FV(u) - FV(c)$**
•Storage costs (u): costs associated with storing or holding the asset (e.g. insurance, risk of spoilage, storage)
•Convenience yield (y): non-monetary benefit from holding the physical asset (i.e. the asset is in short supply)

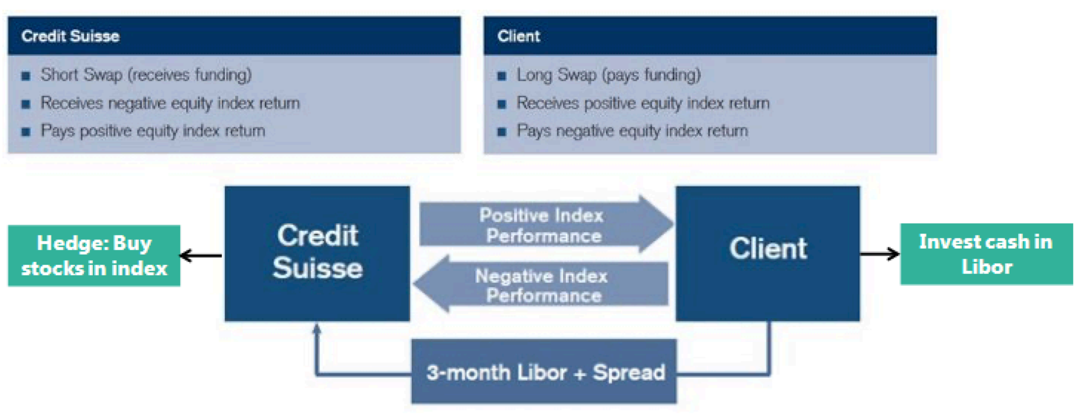
2. Swaps

A. Interest Rate Swap (IRS)

- Agreement to exchange (swap) a series of cashflows for a stated period of time
- "Vanilla swap": exchanged fixed rate payments for floating-rate payments based on LIBOR (London Inter-Bank Offered Rate)
- 

B. Total Return Swap (TRS)

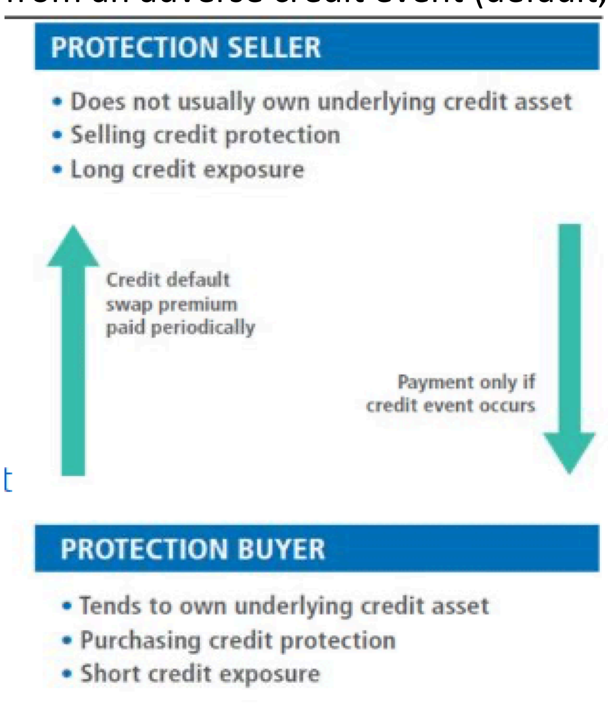
- A bilateral contract to swap the total future return of an underlying asset in exchange for a set rate
- The rate is typically 3-month LIBOR + spread



- ** long swap = long equity -> payer (long swap) holds exposure to equity

C. Credit Default Swap

- A bilateral contract in which one party purchases protection from another against losses <u>from an adverse credit event (default, bankruptcy, etc.)</u>



- *** Long CDS == Short credit exposure == Get payment if default occurs

3. Options

- The right (but not obligation) to buy or sell an asset at a set price within a specified period of time
  - Call option: the right to purchase the underlying asset at the strike price
  - Put option: the right to sell the underlying asset at the strike price

•Key elements:
- **S**: underlying asset and its price
- **K**: exercise (strike) price
- **T**: expiration date
- **C**: call option premium (price)
- **P**: put option premium (price)

•Put-call parity: **$C_0 + PV(K) = P_0 + S_0$**
- Arbitrage ensures that a **fiduciary call** has the same cost as a **protective put**
  - Fiduciary call: **$C_0 + PV(K)$**
  - Protective put: **$P_0 + S_0$**

- Moneyness: refer to the relative position of the current price of the asset with respect to the strike price of the option

Strike (K) vs. asset (S)	Long put	Long call
K > S	In-the-money (ITM)	Out-the-money (OTM)
K = S	At-the-money (ATM)	At-the-money
K < S	Out-the-money	In-the-money

	Call option	Put option
Buy	Purchased the right to buy the underlying security (**Long security**)	Purchased the right to sell the underlying security (**Short security**)
Sell or write	Sold the right to buy the underlying security (**Short security**)	Sold the right to sell the underlying security (**Long security**)

Derivatives Summary

	Long	Short
Rates	Buy Treasuries	Sell Treasuries
	Long Treasury futures	Short Treasury futures
	Receive fixed	Pay fixed
	Buy receiver	Sell receiver
	Sell payer	Buy payer
Equity	Buy index	Sell index
	Long index futures	Short index futures
	Buy call option	Sell call option
	Sell put option	Buy put option
	Long index TRS	Short index TRS
Credit	Buy bond	Sell bond
	Sell CDS protection	Buy CDS protection
Commodities	Long commodity futures	Short commodity futures
Volatility	Buy call/put option	Sell call/put option
	Buy receiver/payer	Sell receiver/payer
	Buy straddle/strangle	Sell straddle/strangle