Topic 9. Derivatives

Derivatives - any financial instrument whose payoff is derived from another asset's.

Derivatives with linear payoffs:

Forward – an obligation to buy/sell an underlying asset at a specified date (maturity, settlement date) and at a specified price (forward price).

- OTC = > risk of default
- Long/short positions
- Underlying assets: stocks, bonds, indices, currencies, commodities, interest rates, etc.

Futures – a standardized forward

- Exchange-traded => marked to market

Swap – an obligation to regularly exchange specified cash flows at specified dates, like a collection of forwards

- Mostly OTC
- Underlying assets: interest rates, currencies

Derivatives with non-linear payoffs:

Option – a right of a buyer to buy/sell an underlying asset at a specified date (exercise, expiration date) and at a specified price (exercise, strike price). The seller has an obligation.

- Put, call
- European, American
- Underlying assets: stocks, bonds, indices, currencies, commodities, interest rates, futures
- Prices:

➢ Exercise Price (Strike Price): The price in the option contract at which you have the right to buy or sell the underlying asset
➢ Option Premium: The price paid for the option
➢ Intrinsic Value: Value of an option based on immediate exercise. For call option it is the maximum of zero and the difference between the strike price and the stock price.
➢ Time Premium: Value of option above the intrinsic value

Embedded options (convertible bonds, callable bonds), Exotic options, Swaptions, Structured notes, Asset-backed securities (ABS), Mortgage-backed securities (MBS)

<u>Hedging with forwards (futures)</u>

- A <u>farmer</u> is currently growing 1 ton of wheat for harvest and sale in September
- The farmer needs to plan his September budget now, because of upcoming expenses
- Wheat currently sells for $100 per ton
- Wheat prices can change unexpectedly
- A <u>cereal maker</u> plans to purchase 1 ton of wheat in September to make cereal
- The cereal maker needs to set its sales price for September now, for marketing purposes
- The farmer and cereal maker can BOTH hedge their September cash flows by signing a <u>forward contract</u>:
  – Cereal maker promises to purchase 1 ton of wheat from the farmer on September 1st at $100
  – This is called "going long" or "buying" a forward contract
  – Farmer promises to sell the same amount and price
  – This is called "going short" or "selling" the forward contract
  – No money changes hands at contract signing
- On September 1st the spot price of wheat is $110 per ton
- Cash settlement saves transport costs:
  – Farmer sells his wheat for $110 to his local grainstore
  – Cereal maker purchases his wheat for $110 from his local depot
  – The farmer sends the cereal maker a check for $10
  – Both parties effectively "traded" at $100, as agreed.

But there is counterparty risk (the farmer may default)!

<u>Pricing forward (futures) contracts</u>

Find the <u>forward price</u> => No-arbitrage pricing!

Two strategies:

1) A long position in the forward contract
2) Buying the underlying asset at spot and

borrowing $\frac{F_T}{(1+r_f)^T}$ at risk-free rate for T periods

Payoffs:

	t=0	t=T
Strategy 1	0	$S_T - F_T$
Strategy 2	$-S_o + \frac{F_T}{(1+r_f)^T}$	$S_T - F_T$

Both strategies have the same risk and the same payoff at t=T. Therefore, they MUST have the same cost => $\boxed{F_T = S_0(1+r_f)^T}$

<u>If continuous compounding</u>: $\boxed{F_T = S_0 e^{r_f T}}$

<u>For interest–bearing assets</u>: $\boxed{F_T = S_0(1+r_f)^T - I_T}$

or in terms of yield: $\boxed{F_T = S_0(1+r_f - y)^T, y = I_t / S_0}$

Pricing currency forwards (futures)

Find the forward exchange rate

Two strategies:

1) Deposit 1RUR at r_f for T periods
2) Convert 1RUR into USD at spot exchange rate $S_0^{RUR/USD}$, deposit the USD at r_f^* for T periods, then convert the proceeds back at forward exchange rate $F_T^{RUR/USD}$

Payoffs:

	t=0	t=T
Strategy 1	-1	$1*(1+r_f)^T$
Strategy 2	-1	$\frac{1}{S_0}(1+r_f^*)^T F_T$

Both strategies are riskless and have the same cost at t=0. Therefore, they MUST have the same payoff => $F_T = S_0\left(\frac{1+r_f}{1+r_f^*}\right)^T$

If continuous compounding: $F_T = S_0 e^{(r_f - r_f^*)T}$

This is called Covered Interest Parity (CIP).