2. Forwards and Options
Risk - sharing

\{ diversifiable risk \\
\{ non-diversifiable risk \\

Derivative

Agreement between two people.
Bid - Ask spread.

ask price = price you can buy.

bid price = price you can sell.
Definition:

Financial position - any combination of investments. (long, short, risk-free, borrowing)
Payoff vs Profit

Payoff = value of asset at time T

Profit = Payoff - what you would have made in 'risk-free' rate

Diagram:
- Payoff = \( S_T \)
- Profit = \( S_T - S_0(1+r)^T \)

Asset in long position
Financial Derivative

- A forward (future) contract - buy/sell on future date

- A option: 
  - Option to buy (call option)
  - Option to sell (put option)

  
  \{ 
  \begin{align*} 
  \text{American} & \quad \text{(by the due date)} \\
  \text{European} & \quad \text{(on the)} \\
  \text{ Bermudian} & \quad \text{(within the same date)} 
  \end{align*} \}
Assumption:

1. There's always "risk-free" rate of return.

2. Any asset can be purchased long or sold short.
Forward Contract

- Agreement to buy/sell asset at
don delivery date at delivery price.

- Must happen. Can't cancel.

- No premiums. (no initial cost)

- Underlying asset:
long position – will get an asset on d-date

short position – will get paid on d-date.
Payoff of Future Contract (same as profit)

\[ \text{Long} \]

\[ St - F_{0,T} \]

\[ \text{Short} \]

\[ -St + F_{0,T} \]

\[ \rightarrow F_{0,T} \quad \text{Delivered Price} \]

\[ \rightarrow (\text{long position}) = - (\text{short position}) \]
Example

Long future contract with $1020 delivery price, 1yr delivery date

Same as

Long asset bought $1000 annual risk-free rate 2%

Future

payoff/profit

Asset

Payoff

Profit
Credit Risk

- Risk that the other party fails to meet the agreement.
Call Options

gives option holder right to buy specified amount of underlying asset from issuer.

\[
\begin{align*}
& \text{Strike price (exercise price)} \\
& \text{Expiration date}
\end{align*}
\]

American - any time up to E-date

European - only on E-date

Bermudian - set number of dates.
Ex

long position

Call option 1 yr at $950

premium = $30 (pay)

risk-free rate 3%

Payoff = \( \max \{ S_t - 950, 0 \} \)

Profit = \( \max \{ S_t - 950, 0 \} - 30 \cdot (1.03) \)
Written Call Option

\begin{align*}
\text{Profit} &= -\max \{ S_t - 950, 0 \} + 30(1.03) \\
\text{Payout} &= -\max \{ S_t - 950, 0 \} \\
\text{Receive Premium} &= \$30
\end{align*}
**Put Option**

- Option to sell (purchased)

Ex: Long put 1 yr at $950

premium = $30

risk-free rate 3%

\[
\text{pay off} = \max \{ 950 - S_t, 0 \}
\]

\[
\text{profit} = \max \{ 950 - S_t, 0 \} - 30(1.03)
\]
Written Put Option

= Short pos. on put

\[ \text{profit} \]

\[ \text{payoff} \]
'Moneyness'

- In-the-money
  - Positive
- Out-of-the-money
  - Negative
- At-the-money
  - Zero

If you exercise immediately you would make payoff of.