Future Options
An option on futures gives the holder the right but not the obligation to buy or sell a futures at a specified price on a specified date.

Options on futures are usually traded in an exchange.

It is used to hedge against adverse changes in interest rates.

The buyer normally can exercise the option on any business day (American style) prior to expiration by giving notice to the exchange.

Option sellers (writers) receive a fixed premium upfront and in return are obligated to buy or sell the underlying asset at a specified price.

Option writers are exposed to unlimited liability.
An investor who expected short-term interest rates to decline would also be expecting the price of the future contracts to increase. Thus, they might be inclined to purchase a 3-month Eurodollar futures call option to speculate on their belief.

The advantage of option of a futures over options of a spot asset stems from the liquidity of futures contracts.

Futures markets tend to be more liquid than underlying cash markets.

Interest rate futures options are leveraged instruments.
The price of an option on futures is quoted by the exchange.

A model is mainly used for calculating sensitivities and managing risk.

European option approximation

Options on futures are normally American options. One may use an European option to approximate.

The present value of a call option is given by

\[ V(t) = N\tau D(L(t)\Phi(d_1) - K\Phi(d_2)) \]

The present value of a put option is given by

\[ V(t) = N\tau D(K\Phi(-d_2) - L(t)\Phi(-d_1)) \]
Interest Rate Future Option

Valuation (Cont.)

where
- $t$ - the valuation date,
- $L(t) = 100 - Y(t; T, T_E) + C$ - the forward rate; $C$ is used to match market future price.
- $K$ - the strike
- $N$ - the notional
- $\tau$ - the day count fraction for the forward period $[T, T_E]$ 
- $T$ - the maturity of the future contract and also the start date of forward period 
- $T_E$ - the end date of the forward period
- $D = D(t, T)$ - the discount factor
- $\Phi$ - the accumulative normal distribution function
- $d_{1,2} = \left( \ln \left( \frac{L}{K} \right) \pm 0.5 \sigma^2 (T - t) \right) / (\sigma \sqrt{T - t})$
American option

- Price options on futures as American options
- Tree, PDE or lattice can be used to price an American option
- Given options on futures are simple products, we use Black Scholes dynamics plus binomial tree to price an American option on futures.
## Interest Rate Future Option

### Example

<table>
<thead>
<tr>
<th>Option specification</th>
<th>Underlying future specification</th>
</tr>
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<tbody>
<tr>
<td>Quote Price</td>
<td>Contract Size 10000</td>
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<tr>
<td>Trade Date</td>
<td>First Delivery Date 5/30/2017</td>
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<tr>
<td>Option Maturity Date</td>
<td>Last Delivery Date 6/30/2017</td>
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<td>Settlement Amount</td>
<td>Future Maturity Date 6/19/2017</td>
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<td>Call Put</td>
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<td>Buy Sell</td>
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<td>Future Ticker Size</td>
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