Derivative Securities

Topics included:

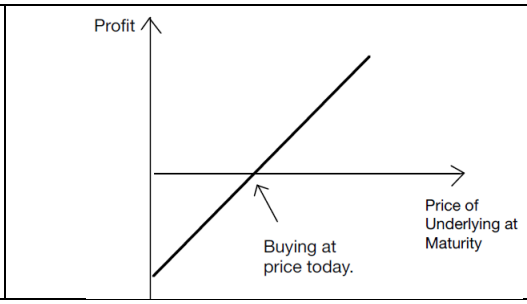
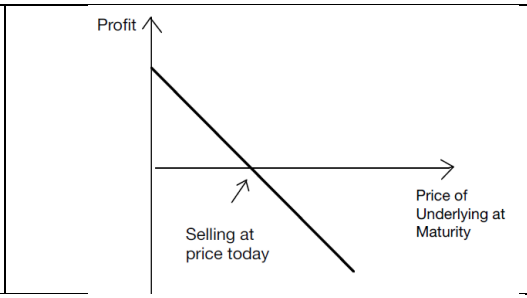
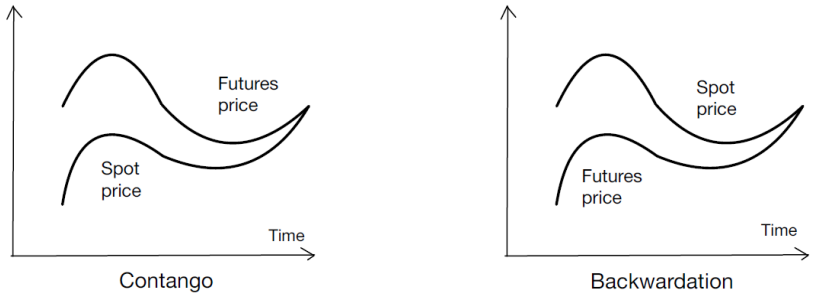
1. *Introduction to Futures Market*
2. *Futures and Hedging*
3. *Futures Markets Pricing I & II*
4. *Introduction to Options and Basic Operation*
5. *Trading Strategies Involving Options*
6. *Binomial Model*
7. *Early Exercise of American Options*
8. *Black, Scholes & Merton Model (BSM)*
9. *The Greeks*

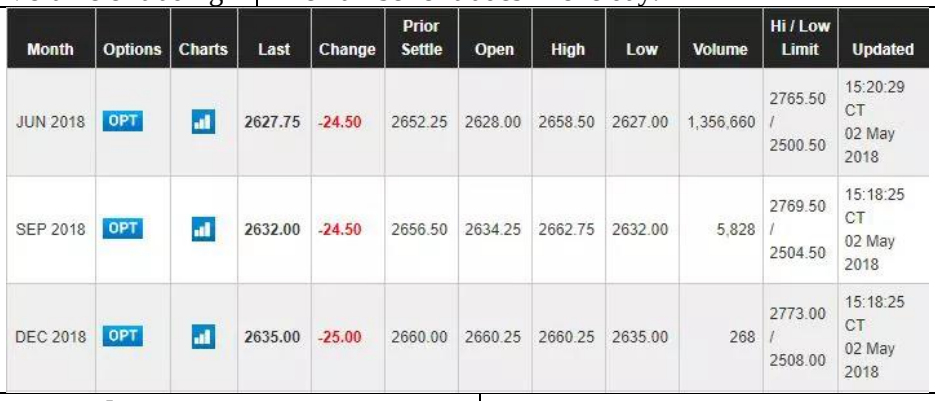
Additional Material

https://docs.google.com/spreadsheets/d/1kI5akvP6zLY1FkodFfoaRVvDnLOYL8JrIezyEp_9dEQ/edit#gid=283245888

Topic 1: Introduction to Derivatives and Futures Market

Derivatives	Definition	A derivatives security is an instrument (or contract) whose payoff and, thus, value depends on the values (or, prices) of one (or, more) other variables (referred to as the underlying assets). Such security derives its value from the value of other assets.
	Types of UA	Commodities, Stocks, bonds, currencies, interest rates, live cattle, weather etc.
	Types of Derivatives	• Futures and Forwards Contracts • Standard (or, Plain Vanilla) Options
	Trading Methods	Derivatives can be traded on exchange or over-the-counter (OTC). Products and trading terms on exchange are more standardized carrying virtually no risks. On the other hand, OTC market is relative unregulated. Contracts traded OTC offers more flexibility which unfortunately carries higher credit risk.
Types of Trader	Hedgers	Hedgers use futures, forwards, and options to reduce the risk they face from potential future movements in the spot market.
	Speculators	Speculators use derivatives to bet on the future direction of a market variable.
	Arbitrageurs	Arbitrageurs take offsetting positions in two or more instruments to lock in a profit.
Futures	A futures contract is an agreement to buy or sell an asset at a certain time in the future for a certain price. All futures contracts are traded on exchange which offers a range of delivery date (usually specified to months) and settled daily.	
	Contracts specification	1. The underlying asset 2. The contract size 3. The delivery arrangement (where/ how) 4. The delivery months 5. The delivery price 6. Position limits
Exchange Trading	The contract between the two parties (long and short position) is replaced with separate contracts with an intermediary (clearinghouse). The clearinghouse is both long and short. The main purpose of this system is to monitor credit risk.	
	Opening Positions	• To open a position you call your broker to enter into the contract via an online trading account. Contracts are referred to by their delivery month. • No initial payment, except bid-ask spreads, margins and commissions. Price agreed upon today is the price at which transactions will take place in the future. • Buyer pays the seller the futures price and seller delivers the asset (If the delivery ultimately took place).
	Closing Out Positions	• Traders have the option to either take delivery or take a reverse position of the same contracts to close out. • Most contracts don't lead to delivery (less than 2%) This is because 1). It is inconvenient and expensive to have a physical delivery (transportation, storage cost etc.), they are better off purchasing at the spot market. 2). They don't necessarily need the underlying assets. (Speculators, arbitragers) • Profit or loss is determined by the change in the futures price between opening and closing date of the position.
	Delivery	The alternatives about how and where the UA is delivered are chosen by the short position → more rights means lower price

<table>
<tr><td rowspan="2">Long position</td><td colspan="2">The long position of a futures contract agreed to receive (buy) the underlying asset at today's futures price at a pre-determined future date.
They profit when spot price increases.</td></tr>
<tr><td>Payoff: $F_t/S_T - F_0$</td><td> 
</td></tr>
<tr><td rowspan="2">Short Position</td><td colspan="2">The short position of a futures contract agreed to deliver (sell) the underlying asset at today's futures price at a pre-determined future date.
They profit when spot price decreases.</td></tr>
<tr><td>Payoff: $F_0 - F_t/S_T$</td><td> 
</td></tr>
<tr><td rowspan="2">Convergence of Futures Price</td><td colspan="2"> 
</td></tr>
<tr><td colspan="2">As futures approaches expiration, futures price converges to the spot price.
Otherwise there is an arbitrage opportunity.
If the $F_T > S_T$, short sell futures and buy at spot.
If the $F_T < S_T$, buy futures and sell spot.</td></tr>
<tr><td>Margin Account</td><td colspan="2">• Margin account is a safe deposit to show that the traders have some money to commit to their contracts. → reduce the risk of default.
• Usually 2%-5% of the value of the position.
• Both long and short position in futures contract need margin accounts.</td></tr>
<tr><td rowspan="3"></td><td>Initial Margin</td><td>Amount must be paid with cash when a margin account was placed with clearinghouse.</td></tr>
<tr><td>Maintenance Margin</td><td>The minimum amount that is required by a futures clearinghouse to maintain a margin account and to protect against default.</td></tr>
<tr><td>Marking-to-Market</td><td>Margin accounts are adjusted daily to reflect gains and losses. If the balance in the margin account dips below the maintenance margin, the holder would get a 'margin call'. → Need to post additional margin or the position would be closed out.</td></tr>
<tr><td>Margin Call</td><td colspan="2">Parties receive margin calls when:
Short: $(F_0 - S_t) * unit\ of\ asset = Maintain\ margin - initial\ margin$
Long: $(S_t - F_0) * unit\ of\ asset = Maintain\ margin - initial\ margin$</td></tr>
</table>

<table>
<tr><td>Liquidity Problem</td><td colspan="3">Long position would run into liquidity issue if spot price falls dramatically.
Short position would run into liquidity issue if spot price rises dramatically.</td></tr>
<tr><td rowspan="4">Futures Price Quotes</td><td>Settlement Price</td><td colspan="2">The price just before the final bell each day, used for the daily settlement.</td></tr>
<tr><td>Open interest</td><td colspan="2">The total number of contracts outstanding.
Indicating the liquidity of the contracts.
Equals to the number of long or short positions.</td></tr>
<tr><td>Volume of trading</td><td colspan="2">The number of trades in one day.</td></tr>
<tr><td colspan="3"> 
<table>
<tr><th>Month</th><th>Options</th><th>Charts</th><th>Last</th><th>Change</th><th>Prior Settle</th><th>Open</th><th>High</th><th>Low</th><th>Volume</th><th>Hi / Low Limit</th><th>Updated</th></tr>
<tr><td>JUN 2018</td><td>OPT</td><td></td><td>2627.75</td><td>-24.50</td><td>2652.25</td><td>2628.00</td><td>2658.50</td><td>2627.00</td><td>1,356,660</td><td>2765.50 / 2500.50</td><td>15:20:29 CT 02 May 2018</td></tr>
<tr><td>SEP 2018</td><td>OPT</td><td></td><td>2632.00</td><td>-24.50</td><td>2656.50</td><td>2634.25</td><td>2662.75</td><td>2632.00</td><td>5,828</td><td>2769.50 / 2504.50</td><td>15:18:25 CT 02 May 2018</td></tr>
<tr><td>DEC 2018</td><td>OPT</td><td></td><td>2635.00</td><td>-25.00</td><td>2660.00</td><td>2660.25</td><td>2660.25</td><td>2635.00</td><td>268</td><td>2773.00 / 2508.00</td><td>15:18:25 CT 02 May 2018</td></tr>
</table></td></tr>
<tr><td rowspan="7">Futures VS Forwards</td><td colspan="2">Forwards</td><td>Futures</td></tr>
<tr><td colspan="2">Private contract between two parties.</td><td>Traded on an exchange</td></tr>
<tr><td colspan="2">Not standardized</td><td>Standardized</td></tr>
<tr><td colspan="2">Usually one specified delivery date</td><td>Range of delivery dates</td></tr>
<tr><td colspan="2">Settled at end of contract (no margin)</td><td>Settled daily</td></tr>
<tr><td colspan="2">Usually lead to delivery</td><td>Usually closed out prior to maturity</td></tr>
<tr><td colspan="2">Some credit risk</td><td>Virtually no credit risk</td></tr>
</table>

Topic 2: Hedging Using Futures and Forwards

<table>
<tr><td>Hedging</td><td colspan="2">A hedge is a trade used to reduce some pre-existing risk exposure due to uncertainty about the evolution of asset prices.
• A static hedge is not rebalanced during its lifetime once entered.
• A dynamic hedge must be rebalanced periodically to continue to reduce the pre-existing risk once entered.</td></tr>
<tr><td rowspan="4">Hedging Position</td><td colspan="2">$Natural\ Long\ position \rightarrow\ Concern\ price\ decrease\ \rightarrow Short\ Hedge$
$Natural\ Short\ position \rightarrow\ Concern\ price\ increase\ \rightarrow Long\ Hedge$</td></tr>
<tr><td>Short Hedge</td><td>Already have the UA and planning to sell the asset in the future → want to lock in a relatively high price→ short futures</td></tr>
<tr><td>Long Hedge</td><td>Need the UA and planning to buy the asset in the future → want to lock in a relatively low price → long futures</td></tr>
<tr><td>Notation</td><td>S_0: $spot\ price\ today$
S_t: $spot\ price\ at\ time\ t$
S_T: $spot\ price\ at\ expiration$
F_0: $futures\ price\ today$
F_t: $futures\ price\ at\ time\ t$
F_T: $futures\ price\ at\ expiration$
t: $some\ point\ prior\ to\ expiration$
T: $last\ day\ of\ hedge$
π: $profit/loss\ from\ the\ strategy$</td></tr>
<tr><td>Profit/Loss at expiration</td><td colspan="2">$\prod(short\ hedge) = (S_t - S_0) - (F_T - F_0) \times hedge\ ratio$
$\prod(long\ hedge) = -(S_t - S_0) + (F_T - F_0) \times hedge\ ratio$</td></tr>
<tr><td>Profit/ Loss prior to expiration</td><td colspan="2">$\prod(short\ hedge) = (S_t - S_0) - (F_t - F_0) \times hedge\ ratio$
$\prod(long\ hedge) = -(S_t - S_0) + (F_t - F_0) \times hedge\ ratio$</td></tr>
<tr><td rowspan="3">Perfect vs Imperfect Hedge</td><td colspan="2">A hedge is perfect if there is no maturity mismatch and asset mismatch; otherwise the hedge is imperfect. Both of these two factors cause <u>basis risk.</u></td></tr>
<tr><td>Asset mismatch</td><td>Assets to be hedged is not the same as the asset underlying the futures contracts.</td></tr>
<tr><td>Maturity mismatch</td><td>1). Hedge requires the futures contract to be closed out before expiration date.
2). Hedger may not be sure about the exact date the asset will be bought or sold.</td></tr>
<tr><td rowspan="2">Basis</td><td colspan="2">Basis = Spot price of asset to be hedged – futures price used to hedge
➔ $b_t = S_t - F_t$</td></tr>
<tr><td colspan="2">Basis risk arises because of the uncertainty about the basis when closed out.
1. both <u>maturity mismatch</u> and <u>asset mismatch</u> can lead to <u>basis risk</u>
2. A <u>perfect hedge</u> has no basis risk → future price = spot price</td></tr>
<tr><td>Change in Basis</td><td colspan="2">Basis strengthen → basis increase → Short position better off
Basis weaken → basis decrease → long position better off</td></tr>
<tr><td>Effective price when closing</td><td colspan="2">Short: $S_t + (F_0 - F_t) = F_0 + B_t$
Long :$-[S_t + (F_0 - F_t)] = -F_t - B_t$</td></tr>
<tr><td>Effective Price (hedge ratio ≠ 1)</td><td colspan="2">Short: $S_t + (F_0 - F_t) \times hedging\ ratio$
Long :$-[S_t + (F_0 - F_t) \times hedging\ ratio]$</td></tr>
<tr><td rowspan="2">Reduce Basis Risk</td><td>Cross-Hedge</td><td>A cross-hedge in constructed using a futures contract so that there is the highest possible correlation among the hedged asset and the asset underlying the futures contract.</td></tr>
<tr><td>Stack and Roll</td><td>1. Closing out the initial position
2. Taking the same position in the same contracts with a later delivery date</td></tr>
</table>