



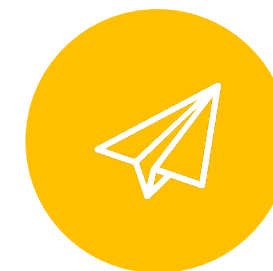
INSTRUCTOR: BAHATTIN
BUYUKSAHIN



PRINCIPAL AT COMEX CONSULTING
AND ADVISING



EMAIL:
BAHATTIN.BUYUKSAHIN@GMAIL.COM



PREFERRED WAY OF
COMMUNICATION: EMAIL

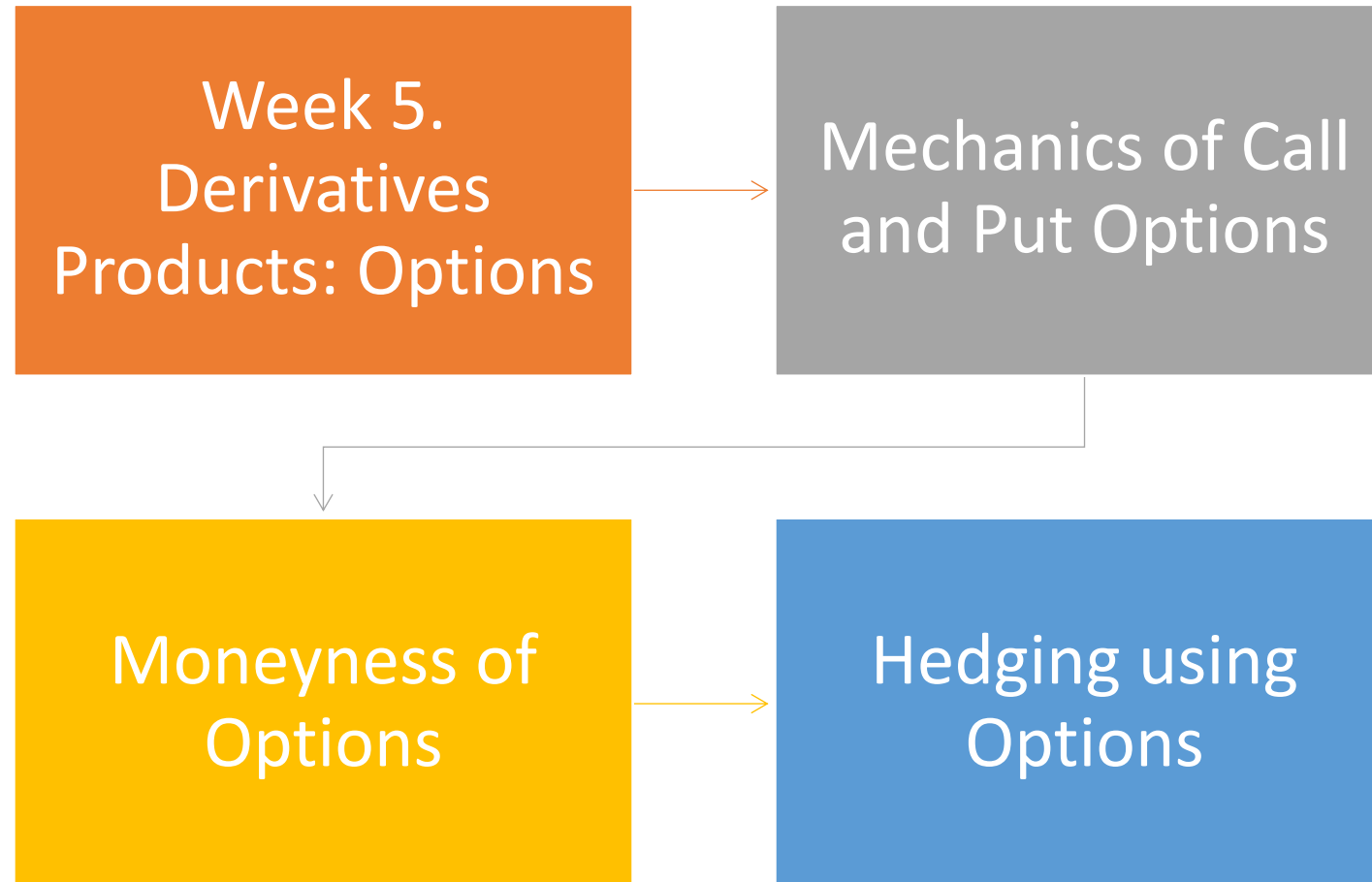
Introduction to Derivatives

Last Week

Derivatives Products: Swaps

- What is a swap?
- Mechanics of Swaps/ Use of Swaps (Hedging Speculation/...)
 - Commodity Swaps
 - Interest Rate Swaps
 - Forex Swaps
- Advantages and Disadvantages

This Week





Week 4: Derivatives Products: Options



Definitions and terminologies

- An **option** gives the option holder the right/option, **but no obligation**, to buy or sell a security to the option writer/seller
 - ❖ for a pre-specified price (the **strike price**, K)
 - ❖ at (or up to) a given time in the future
(the **expiry date or maturity date**)
- An option has positive value.
Comparison: a forward contract has zero value at inception.

Option types

➤ A **call option** gives the holder the right to buy a security. The payoff is

$(S_T - K)^+$ when exercised at maturity.

- If the stock price is less than strike price, the investor clearly choose not to exercise, the investor loses only the option premium.

➤ A **put option** gives the holder the right to sell a security. The payoff is

$(K - S_T)^+$ when exercised at maturity.

- If the stock price is more than strike price, the investor clearly choose not to exercise and loses only the option premium.

➤ **American options** can be exercised at any time priory to expiry.

➤ **European options** can only be exercised at the expiry.

➤ **Bermudan option** can only be exercised during specified period

More Terminologies

- **Strike or Exercise Price:** The price at which the futures contract underlying an option can be purchased (if a call) or sold (if a put). In the call and put definitions above, this is the predetermined price.
- **Premium:** The price paid by the buyer to the seller to purchase an option. This price is arrived at through trading on an exchange market, as with futures.
- **Purchaser or holder:** The person who buys a call or a put option and pays the option premium, i.e. the person who establishes a long options position. This is the party with the right, but not the obligation, under the terms of the contract.

More Terminologies

- **Grantor:** The person who sells a call or put option and receives the option premium, i.e. the person who establishes a short position. This party is obligated to perform under the terms of option.
- **Exercise:** The exercise of a call gives the the option purchaser a long position in the underlying futures contract at the option's strike price; the exercise of a put option gives the option purchaser a short futures position at the option's strike price.

Assets Underlying Exchange-Traded Options

- Stocks
- ETFs (and other ETPs)
- Foreign Currency
- Stock Indices
- Futures



Specification of Exchange-Traded Options

- Expiration date
- Strike price
- European or American
- Call or Put (option class)



AAPL Option Prices June 29, 2020 (Nasdaq)

Expires July 24, 2020

Calls							Puts						
Last	Change	Bid	Ask	Volume	Open Int.	Strike	Last	Change	Bid	Ask	Volume	Open Int.	
31.2	5.24	28.7	32.65	23	455	335	4.05	-2.7	3.85	4.1	112	330	
26.4	0.7	26.85	31.4	2	152	337.5	4.9	-2.25	2.59	4.55	62	332	
25.22	2.82	25.9	27.45	29	546	340	4.89	-3.41	4	5.05	112	543	
25	2.25	22	25.65	4	78	342.5	5.77	-2.73	3.1	5.65	30	295	
22.4	2.85	22.15	23.75	20	439	345	6.3	-2.2	5.85	6.3	114	338	
20.28	2.61	18.5	22	49	113	347.5	6.85	-3.85	5.75	7	42	161	
19	3.1	19.1	20.25	220	989	350	7.7	-4.2	7.5	8.5	128	573	
16.45	1.8	17.5	18.65	30	369	352.5	9	-4.16	8	8.6	117	117	
16	2.68	15.9	16.5	299	1101	355	9.49	-4.71	8.45	9.5	112	285	
13.82	1.27	14.4	15	330	483	357.5	11	-4.5	8.8	10.5	244	147	
12.92	2.32	12.95	14	1096	1243	360	11.7	-4.94	10.65	11.6	849	410	
Last Trade 361.78 as of 06/29/20 4:00 PM ET													
11.75	2.05	11.65	12.5	584	875	362.5	12.85	-4.2	11.65	12.75	56	87	
10.4	1.7	9.85	11.75	346	1143	365	14.26	-5.42	11.7	14	77	188	
8.85	0.75	9.25	10	247	373	367.5	16.44	-4.79	14.4	15.35	10	37	
7.82	0.8	7.65	8.95	389	1264	370	16.8	-5.2	14.3	16.8	19	115	
6.83	0.68	5.1	8.3	141	299	372.5	19.85	-3.3	17.2	20.7	4	20	
6.3	0.8	6.3	7	505	607	375	25.46		19.2	20.6	2	12	
5.25	0.3	3.3	6.6	108	78	377.5			19.25	22.55	0		
4.85	0.45	4.8	5.4	187	796	380	24.02	-3.78	21.2	25.5	4	30	
4.1	0.4	4.2	4.7	46	46	382.5	26.97	1.79	23.2	27.5	1	3	
3.4	0.1	3.65	3.85	108	488	385	35.05	5.95	25.6	29.3	3	9	
2.75	0.09	2.7	3.15	265	573	390	31.49		30.25	33.4	0	7	
1.98	-0.08	0.8	2.36	130	659	395	36.3	-8.52	34.55	36.6	5	2	

- **Call option** is a contract where the buyer has the right to buy, but not the obligation.
- Since buyer decide whether to buy, the seller cannot make money at expiration. To take this risk, the seller is compensated by option premium, which is agreed when the contract signed.

Call Option

Call Option vs Forward Contract

- **Example Call Option:** Consider a call option on the S&R index with 6 months to expiration and strike price of \$1000 and premium of \$93.81. And assume that the risk-free rate is 2% over 6 months.
 - Suppose that the index in 6 months is \$1,100. Clearly it is worthwhile to pay the \$1000 strike price to acquire the index worth \$1100.
 - If on the other hand the index is 900 at expiration, it is not worthwhile paying the \$1000 strike price to buy the index worth \$900.

Call Option

- Remember the buyer is not obliged to buy the index and hence will only exercise the option if the payoff is positive.

$$\text{Purchased call payoff} = \max(0, S_T - K)$$

- In our example, $K=1000$. If $S=1100$ then the call payoff

$$\text{Purchased call payoff} = \max(0, 1100 - 1000) = \$100$$

- If $S=900$, then the call payoff is

$$\text{Purchased call payoff} = \max(0, 900 - 1000) = \$0$$

- Payoff does not take into account of the initial cost of acquiring the position. For a purchased option, the premium is paid at the time the option is acquired. In computing profit at expiration, we use future value of the premium.

$$\text{Purchased call profit} = \max(0, S_T - K) - \text{future value of option premium}$$

Purchased call profit = Purchased call payoff - future value of option premium

Profit from Call Option

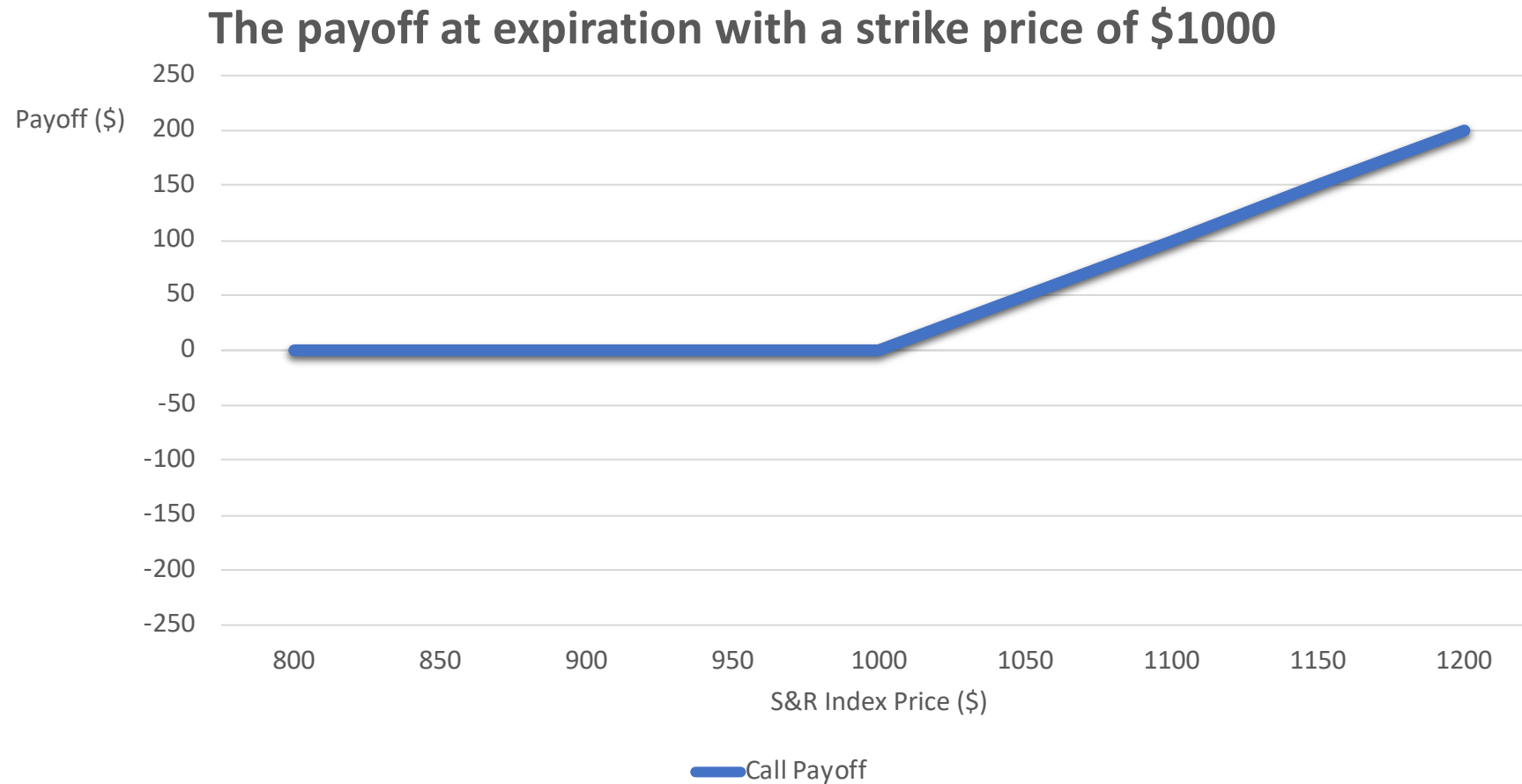
- If the index at the expiration is 1100, then profit is

$$\text{Purchased call profit} = \max(0, 1100 - 1000) - 93.81 * 1.02 = \$4.32$$

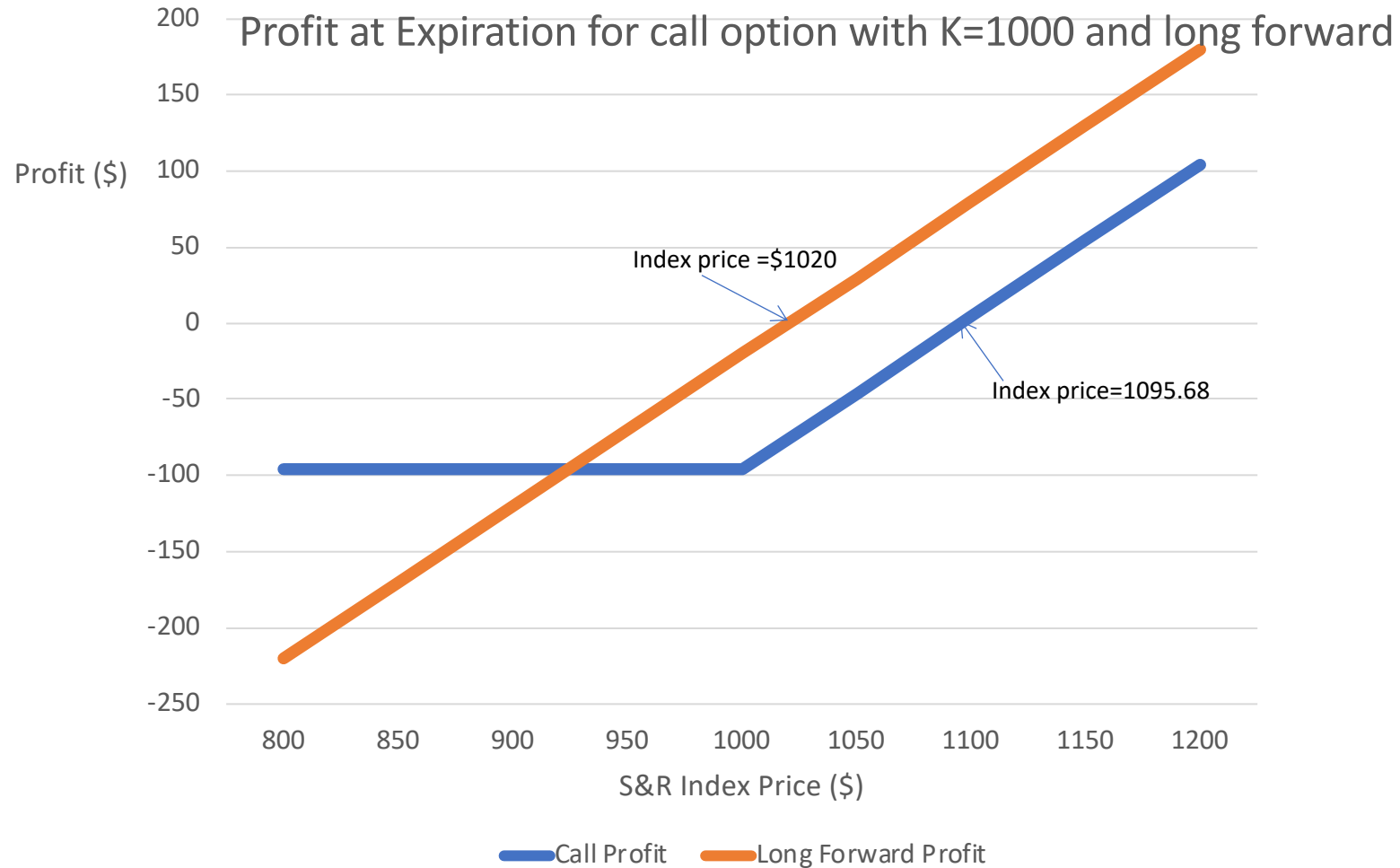
- If the index at the expiration is 900, then the owner does not exercise the option. The loss will be future value of option premium. Maximum loss will be the option premium.

$$\text{Purchased call profit} = \max(0, 900 - 1000) - 93.81 * 1.02 = -\$95.68$$

Payoff from Call Option



Profit from Call Option and Long Forward



Payoff and Profit for a Written Call Option

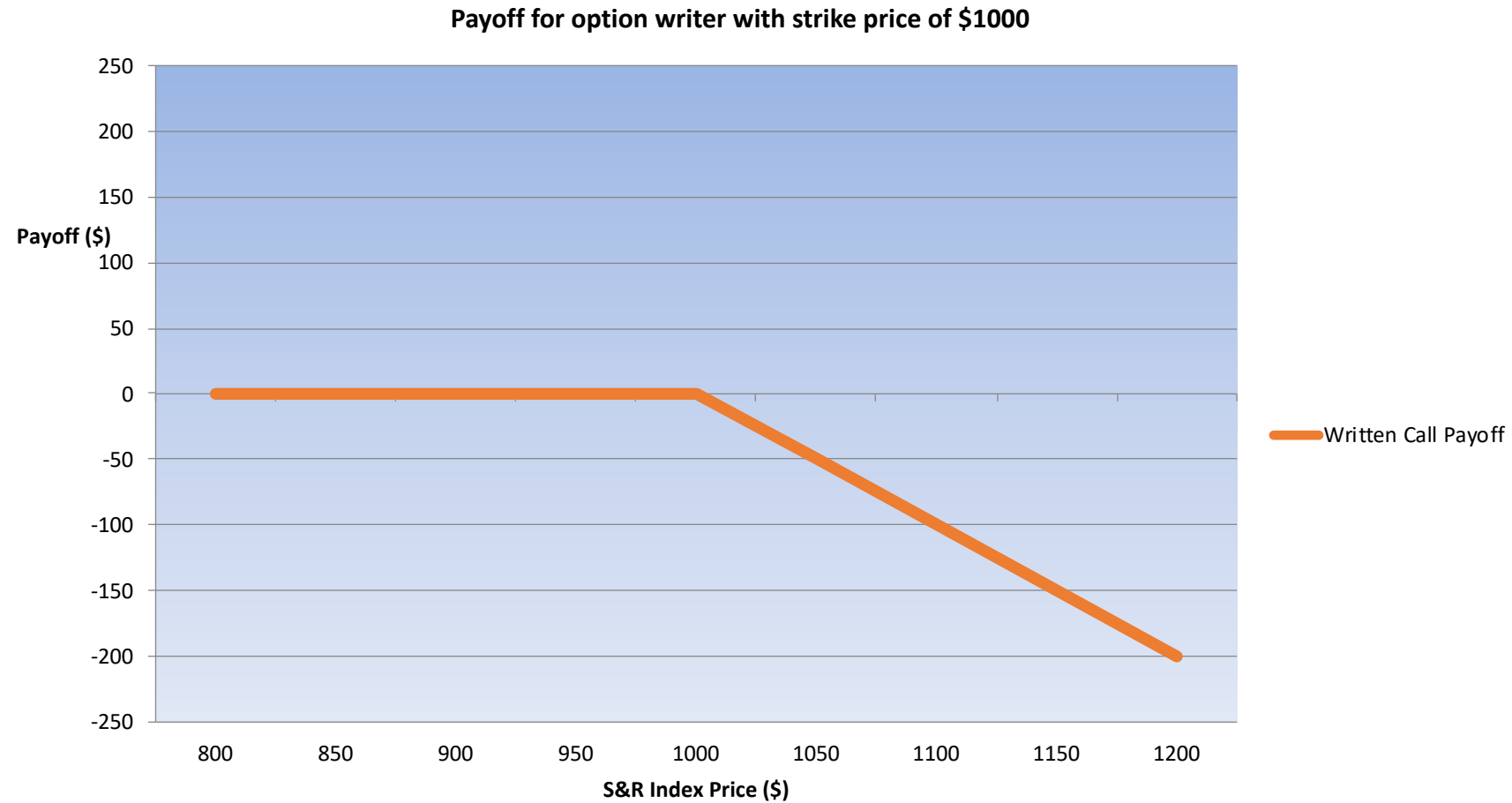
- Option writer (seller of option) has a short position in a call option. The writer receives the premium for the option and then has an obligation to sell the underlying security in exchange for the strike price if the option buyer exercises the option.
- The payoff and profit to a written call are just the opposite of those for a purchased call.

$$\text{Written call payoff} = -\max(0, S_T - K) = \min(0, K - S_T)$$

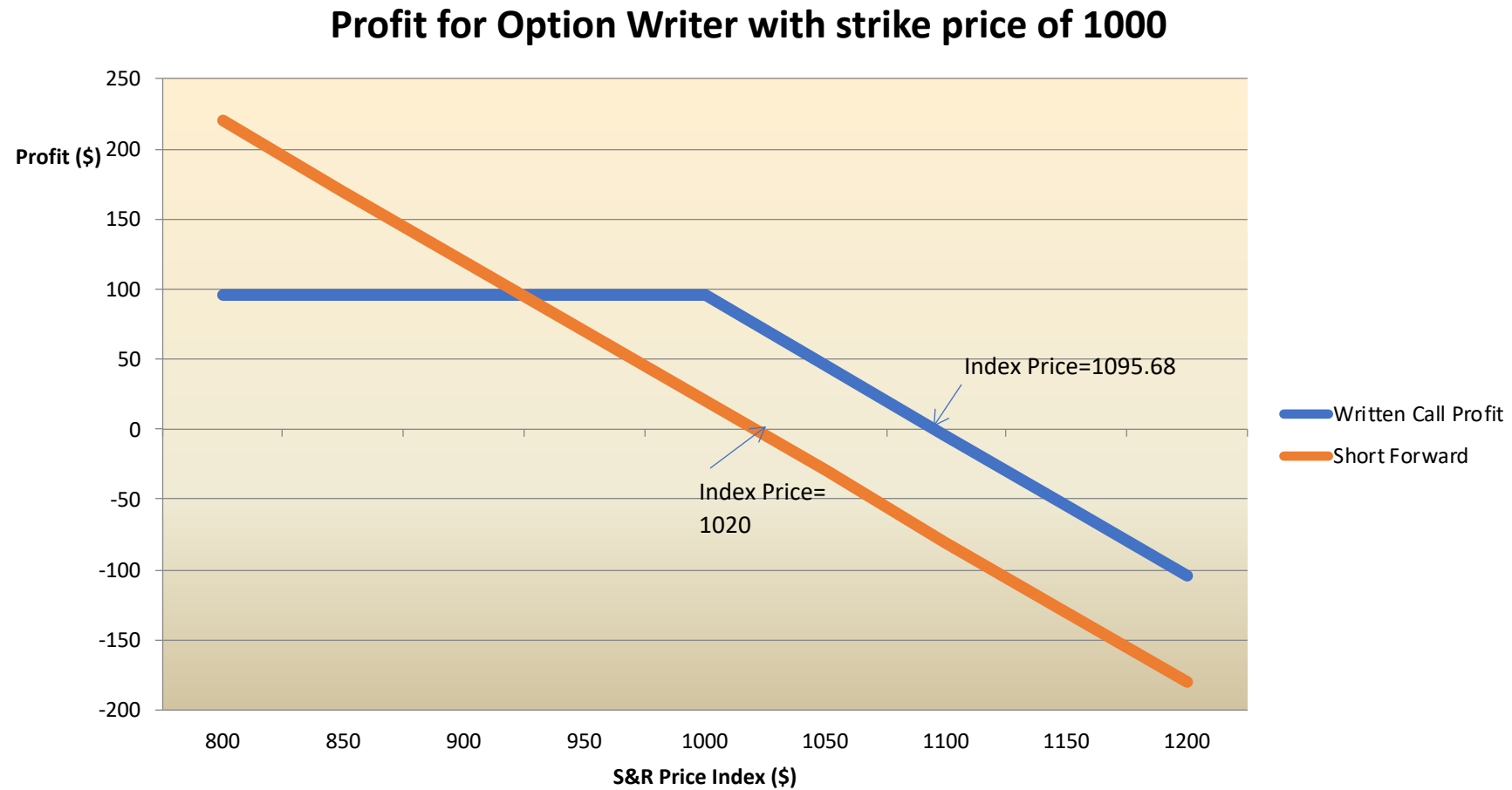
$$\text{Written call profit} = -\max(0, S_T - K) + \text{future value of option premium}$$

- In our example, if $S=1100$ then option writer payoff will be $-100\$$ and profit will be $-\$4.32$. If on the other hand, $S=900$, then payoff will be 0 and profit will be the future value of premium, $\$95.68$

Payoff for Option Writer



Profit for Option Writer



Put Option

- Put option is a contract where the buyer has the right to sell, but not the obligation.
- Since buyer decide whether to sell, the seller cannot make money at expiration. To take this risk, the seller is compensated by option premium, which is agreed when the contract signed.
- Example: Consider a put option on the S&R index with 6 months to expiration and strike price of \$1000 and premium of \$74.20. And assume that the risk free rate is 2% over 6 months. Suppose that the index in 6 months is \$1,100. Clearly it is not worthwhile to sell the index worth \$1100 for the strike price of \$1000. If on the other hand the index is 900 at expiration, it is worthwhile selling the index for \$1000.

Put Option

- Remember the buyer is not obliged to sell the index and hence will only exercise the option if the payoff is positive.

Purchased put payoff= $\max(0, K - S_T)$

- In our example, $K=1000$. If $S=1100$ then the put payoff

$$\text{Purchased put payoff} = \max(0, 1000 - 1100) = \$0$$

- If $S=900$, then the put payoff is

$$\text{Purchased put payoff} = \max(0, 1000 - 900) = \$100$$

- Payoff does not take into account of the initial cost of acquiring the position. For a purchased option, the premium is paid at the time the option is acquired. In computing profit at expiration, we use future value of the premium.

Purchased put profit = $\max(0, K - S_T)$ - future value of option premium

Purchased put profit = Purchased put payoff - future value of option premium

Profit from Put Option

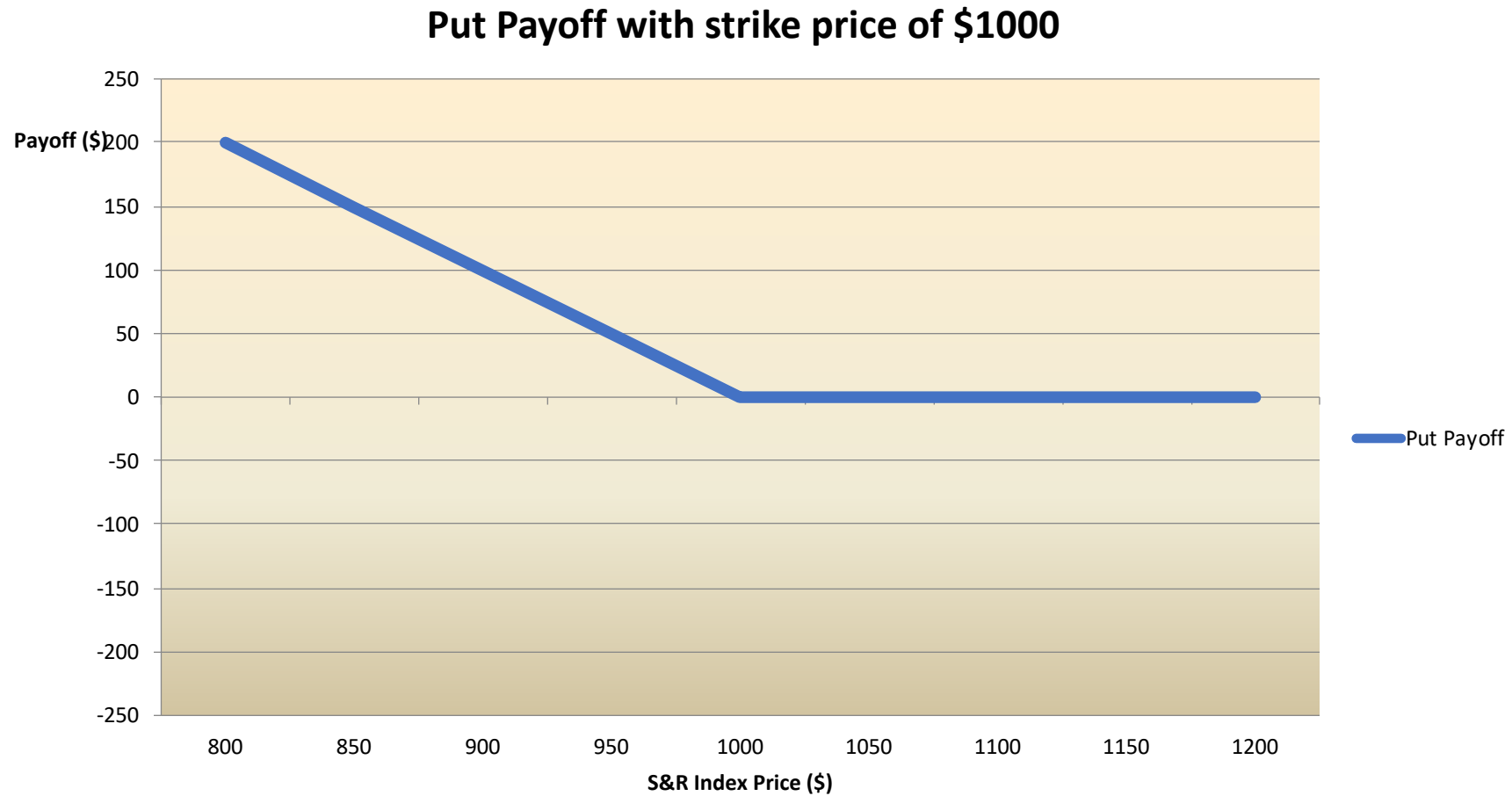
- If the index at the expiration is 1100, then option buyer will not exercise and maximum loss will be the future value of option premium.

Purchased put profit= $\max(0, 1000 - 1100) - 74.2 * 1.02 = -\75.68

- If the index at the expiration is 900, then the owner exercise the option. The profit will be

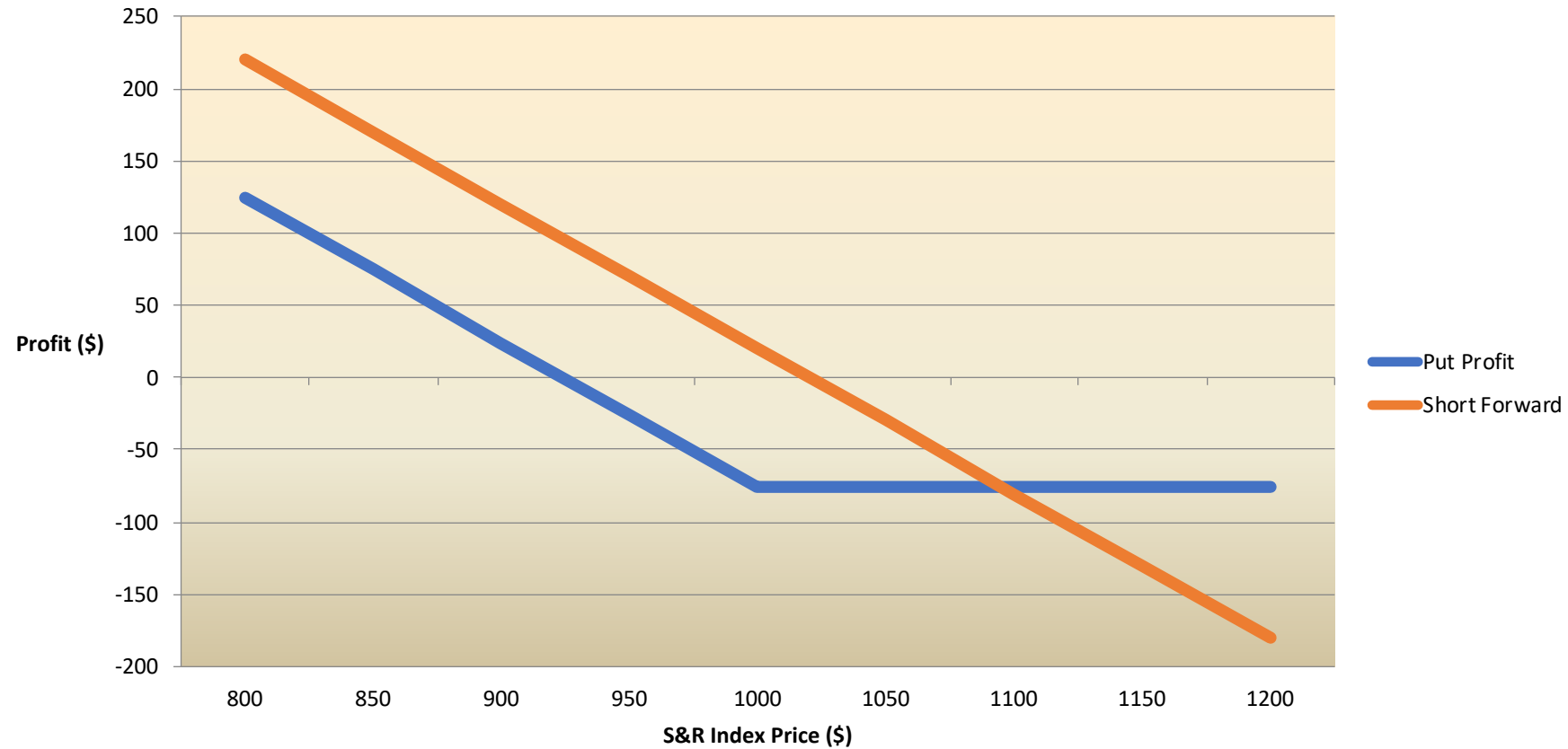
Purchased put profit= $\max(0, 1000 - 900) - 74.2 * 1.02 = \24.32

Put Payoff



Purchased Put Profit

Profit on purchased S&R index put option with strike price of \$1000



Payoff and Profit for a Written Put Option

- Option writer (seller of option) has a long position in a put option. The writer receives the premium for the option and then has an obligation to buy the underlying security in exchange for the strike price if the option buyer exercises the option.
- The payoff and profit to a written put are just the opposite of those for a purchased put.

$$\text{Written put payoff} = -\max(0, K - S_T) = \min(0, S_T - K)$$

$$\text{Written put profit} = -\max(0, K - S_T) + \text{future value of option premium}$$

- In our example, if $S=1100$ then put buyer will not exercise the put, thus put writer earn profit, which will be option premium. If, on the other hand, $S=900$, then option buyer exercise option and option seller (writer) will lose \$24.32 $(-100 + \$75.68)$

Moneyness of Option

- Moneyness: the strike relative to the spot/forward level
 - ❖ An option is said to be in-the-money if the option has positive value if exercised right now:
 - $S_t > K$ for call options and $S_t < K$ for put options. Sometimes it is also defined in terms of the forward price at the same maturity (in the money forward): $F_t > K$ for call and $F_t < K$ for put
 - The option has positive intrinsic value (defined as the maximum of zero and the value of the option would have if it is exercised today) when in the money. The intrinsic value is $(S_t - K)_+$ for call, $(K - S_t)_+$ for put. We can also define intrinsic value in terms of forward price.

At the Money and Out of Money Options

- ❖ An option is said to be at-the-money when when the strike is equal to the spot.
 - $St = K$ for call options and $St = K$ for put options. At-the-money forward: $Ft = K$ for call and $Ft = K$ for put.
- ❖ An option is said to be out-of-the-money when it has zero intrinsic value.
 - $St < K$ for call options and $St > K$ for put options. Out-of-the-money forward: $Ft < K$ for call and $Ft > K$ for put.

Assets Underlying Exchange-Traded Options

- Stocks
- ETFs (and other ETPs)
- Foreign Currency
- Stock Indices
- Futures



Options on Futures

- Futures options (the futures contract normally matures shortly after the expiration of the option. When the holder of a call option exercises, he/she acquires a long position in the underlying futures contract plus a cash amount equal to the excess of the futures price over the strike price ==> the futures contract has zero value - Chicago Board of Trade, Treasury bond futures options)
- Over-the-counter Options (OTC)
 - OTC markets: Financial institutions and corporations trade directly with each other (foreign currencies & interest rates).
 - Advantage: The OTC option can be designed to suit the needs of the parties involved - non standard features can be incorporated into the design of the option.
 - *Bermudan* option: It is exercisable only on certain specific days.
 - *Asian* option: the payoff is designed in terms of the average value of the underlying asset during a certain time period rather than in terms of its final value.

Thursday, 02 Jul 2020 August 2020 WTI American Option

Call Option						Put Option					
OPEN	CHANGE	SETTLE	Vol	Open Int	STRIKE	OPEN	CHANGE	SETTLE	Vol	Open Int	
5.59	0.66	5.9	3	6,074	3500	0.44	-0.17	0.25	663	9,762	
-	0.65	5.44	2	812	3550	0.39	-0.18	0.29	120	1,666	
4.25	0.62	4.98	3	4,749	3600	0.53	-0.21	0.33	732	2,818	
4.06	0.6	4.53	7	1,200	3650	0.51	-0.23	0.38	289	2,071	
3.59	0.57	4.09	215	2,214	3700	0.74	-0.26	0.44	1,583	2,263	
3.5	0.53	3.66	3	1,092	3750	0.84	-0.3	0.51	733	1,445	
2.5	0.5	3.25	365	2,813	3800	0.9	-0.33	0.6	1,252	2,357	
-	0.46	2.85	2	3,012	3850	1.1	-0.37	0.7	2,435	1,123	
2.15	0.42	2.47	253	2,521	3900	1.3	-0.41	0.82	482	1,934	
1.71	0.37	2.11	30	1,564	3950	1.46	-0.46	0.96	570	1,864	
1.36	0.34	1.79	1,680	10,397	4000	1.59	-0.49	1.14	1,162	5,517	
1.12	0.29	1.49	508	1,963	4050	1.96	-0.54	1.34	2,308	871	

August 2020 WTI Contract Settlement Price 40.65

0.91	0.25	1.23	759	5,158	4100	1.94	-0.58	1.58	13	720
0.7	0.21	1	545	835	4150	2.51	-0.62	1.85	82	310
0.62	0.16	0.8	932	3,459	4200	-	-0.67	2.15	76	582
0.47	0.12	0.64	370	1,459	4250	-	-0.71	2.49	26	532
0.36	0.09	0.51	627	3,279	4300	3.27	-0.74	2.86	7	260
0.29	0.06	0.41	206	1,555	4350	-	-0.77	3.26	0	84
0.25	0.05	0.34	4,340	3,764	4400	4.13	-0.78	3.69	1	617
0.24	0.04	0.28	153	718	4450	-	-0.79	4.13	0	51
0.18	0.04	0.24	466	7,449	4500	-	-0.79	4.59	0	2,551

Example: Call Option

August call option contract on WTI futures has a strike of \$35 per barrel. It is exercised when futures price is \$40.00 on July 2nd. WTI settlement price on July 1st (most recent settlement) is \$39.82. One contract is on 1000 barrels

Trader receives

Long August. futures contract on
WTI

1000 times \$4.82 or \$4,820 in cash

The Call Payoffs

If the futures position is closed out immediately:

Payoff from call = $F - K$

where F is futures price at time of exercise

Example: Put Option

August put option contract on WTI futures has a strike of \$43 per barrel. It is exercised when futures price is \$40.00 on July 2nd. WTI settlement price on July 1st (most recent settlement) is \$39.82.. One contract is on 1000 barrels



Trader receives

Short August. futures contract on
WTI

1000 times \$3.18 or \$3,180 in cash

The Put Payoffs

If the futures position is closed out immediately:

$$\text{Payoff from put} = K - F$$

where F is futures price at time of exercise

Hedging with Options on Futures

- Options can be used for hedging and speculation purposes.
- Hedges can be established by buying or selling call and/or put options
- However the concept of short or long hedge does not apply in options

On July 2nd, Dec 2020 Contract Settlement Price 41.11

On July 2nd, Dec 2020 WTI American Option

Call				STRIKE	Put		
SETTLE	Vol	Open Int	SETTLE		Vol	Open Int	
8.49		2	12,350	3500	2.38	54	17,017
5.15		263	17,157	4000	4.04	234	19,638
2.77		103	20,330	4500	6.66	102	21,906
1.41	1,718		32,786	5000	10.3	0	20,073
0.76	2,624		25,988	5500	14.65	0	11,911
0.46	167		30,505	6000	19.34	0	4,910
0.3	20		20,908	6500	24.19	2	563
0.22	2		17,709	7000	29.1	0	728
0.17	5		15,827	7500	34.05	0	1
0.13	115		6,725	8000	39.01	0	1
0.11	375		5,946	8500	43.99	0	2
0.09	3		5,805	9000	49.96	0	1
0.06	24		18,286	10000	59.44	0	2

Hedging Inventory with Futures/Forward and Options Futures

- Owning inventory requires
 - establishing a short position in futures, which will gain if prices fall (Short hedge).
 - reward: Forward/futures price (downside), risk unlimited(upside), break-even point $F=S$
 - alternatively, buying put option (purchased put)
 - reward: unlimited (downside), limited risk –limited to the premium paid(upside) Breakeven point=strike price - premium
 - or selling call option (written call)
 - Reward : limited to premium received (downside) risk unlimited (upside) Breakeven point=strike price+premium

Hedging short cash position with futures/forward and options on futures

- Hedging a short cash position requires
 - establishing a long position in futures, which will gain if prices rise (Short hedge).
 - reward: unlimited (upside), risk limited to forward price (downside), break-even point $F=S$
 - alternatively, a hedger who holds short cash position could buy call options (purchased call)
 - Reward: unlimited profit (upside), risk is limited to forward premium paid (downside), break-even point = strike price + premium
 - Or could sell put option (written put)
 - Reward: Limited to premium received (upside), unlimited risk (downside), breakeven point = strike price - premium



Thank You

bilkenteprc.com



@bilkenteprc

eeeps@bilkent.edu.tr