1. Options

Basic Characteristics

Managers often look for derivative instruments that can protect them from decreasing their cash flows, but allow them to benefit from expected price movements that would increase their cash flows. An option is such a derivative instrument. Options allow an investor to profit from expected price movements while at the same time offer the investor protection from adverse changes in prices.

An option is a derivative instrument that provides the buyer the right to buy or sell a specified quantity of a specified underlying asset at a specified price or to make cash settlement within a specified time period. The buyer is also called the long or option holder. An option contract differs from the futures contract in that the option contract gives the buyer the right, but not the obligation, to purchase or sell an underlying asset. The buyer of an option contract pays the option price, which is called the option premium or just the premium. He can loose at most the premium paid for the option.

The seller of an option is also called the short or option writer. For the seller an option is an obligation to sell or buy a specified quantity of a specified underlying asset at a specified price or to make cash settlement within a specified time period.

The specified fixed price at which the option buyer can buy or sell the underlying asset is called the exercise price, striking price or strike.

Calls and Puts

There are two basic types of options: calls and puts. A **call option** on an underlying asset allows the holder of the option to buy (to „call") a fixed quantity of the underlying asset at a specified price within a specified time period. A **call holder** expects the price of the underlying asset to rise. A **call writer** expects the opposite.

A **put option** on an asset allows the buyer of the option to sell (to „put") a fixed quantity of the underlying asset at a specified price within a specified time period.

ITM, OTM, ATM

A call option for which the current price exceeds the exercise price the option is said to be **„in-the-money" (ITM)**. If the current market price is lower than the exercise price the option is said to be **„out of money" (OTM)**. An option for which the current price and the exercise price are the same is said to be **„at the money" (ATM)**.

OTC and Exchange-Listed Options

One way of creating options is through single contracts that are individually negotiated between parties, usually banks and their clients (OTC options). Two parties can create options with any set of terms they wish. For an OTC option, the two parties decide each of the terms through negotiations. The OTC options are tailor-made agreements and are subject to credit risk.

There are many options exchanges usually specializing in certain types of option contracts. Organized option exchanges provide the standardization of the assets on which the contracts are based and of the contract sizes and maturity dates. An investor has not only the right to exercise the option, but also the ability to sell or buy the option. An investor can get into and out of options before they expire.

Credit risk in options is different than in the forward or futures markets. The credit risk in forward contracts is bilateral. The credit risk in an option is unilateral. Because the option buyer paid the premium up front and is not required to pay anything else, the seller does no face any credit risk. There is no risk of default on the buyer an option. But the option holder faces credit risk because the seller can default. There is a default risk on the party issuing the option.

The option seller in organized option exchanges is usually required to post margin, as in a futures contract. The seller has unlimited liability similar to the parties to a futures contract. In exchange-listed options the clearinghouse eliminates the credit risk. Therefore clearinghouses and margin accounts are still necessary. The clearinghouse guarantees payments to the holder of an option.

Options trade in a different manner from futures. Instead of an open-outcry system options trade on the floor of the exchanges using a market-maker system.

Characteristics of Options

1. Options are not free. The option premium is paid when the option contract is initiated.
2. Options may or may not be exercised. The use of the right to buy or sell an underlying asset is referred to as exercise or exercising the option.
3. Options can be exercised at a specified price called the exercise price or striking price. An European option is one that can be exercised only on its expiration date. This contracts with an American option that can be exercised at any time before maturity. These terms have nothing to do with Europe or America.
4. Options have fixed maturity. They expire on a certain date. If the holder of the option does not exercise it before this maturity date, the option simply expires. For the holder of an OTM option it is worthless, but the holder of an ITM option receives a cash settlement. The holder of an ITM call option receives the difference between the spot price and the exercise price in cash. The holder of a an ITM put option receives the difference between the exercise price and the spot price in cash.
5. Options do not affect the market value of the underlying asset. Options derive their value from the underlying asset on which they are based.

Types of Options

There are options based on interest bearing assets, currencies, options on common stock, options on commodities and options on futures contracts.

Exotic Options

1. In a forward-start option, the premium is paid when the option contract is initiated, but the life of the option starts at a future date.
2. A compound option is an option on option.
3. Chooser options allow an investor to determine whether the option will become a call or a put by a specified date. These options are also known as as-you-like-it options.
4. Barrier options, also known as knock-in options and knock-out options, can be "in" options or "out" options. An "in" option becomes a plain vanilla option when the price of the underlying asset hits a certain barrier price. An "out" option is initially a plain vanilla option, but if the price of the underlying asset touches a certain barrier, the option expires worthless.
5. Binary options (digital options) pay nothing or a considerable amount depending on the satisfaction of a specified condition. There are many types of binary options: cash-or-nothing, asset-or-nothing, gap options and supershares. The payoff of a gap option is determined as a function of the exercise price.
6. In a lookback option, the exercise price is a function of the price of the underlying asset. For a lookback call, the exercise price is the minimum price experienced over the life of the option.
7. An Asian option (average price option) is on option whose payoff depends in the average of the price of the underlying asset.
8. An exchange option is an option to exchange one underlying asset for another.
9. Rainbow options are based on two ("two=color") or more risky assets.

Properties of call options

1. A call option's price increases as the market value of the underlying asset increases.
2. The higher the exercise price is, the smaller the price of the option is.
3. The longer the remaining life of the call option is, the larger the option premium is.
4. The price of the call option increases as the risk-free interest rate increases.
5. A call option's price increases as the volatility of the underlying asset increases.

Call-put parity

The relationship between put and call prices, called put-call parity, is given by equation

(1) $C - P = S - Ee^{-rT}$

where

C is the call price
P is the put price
S is the asset price
E is the exercise price
Ee^{-rT} represents the present value of E (exercise price) with continuous compounding.
R is the risk-free interest rate
T is the life of the option.

This is extremely useful equation because it allows us to infer the value of a put option from the price of a similar call option, and vice versa.

Problem 1. Option Premium. Dynamics

r = risk-free rate				5%			
volatility				40%			
Maturity		28	118	208	28	118	208
ABC			CALLS			PUTS	
Spot price	Exercise price	Feb	May	August	Feb	May	August
380	340	44,4	60,0	71,8	3,1	14,5	22,3
	360	29,2	47,7	60,5	7,8	21,9	30,4
	380	17,5	37,3	50,5	16,0	31,2	39,8
	400	9,5	28,6	41,9	28,0	42,2	50,6
	430	3,2	18,8	31,3	51,5	61,9	69,2

CALLS				PUTS			
Intr. val.	Time Value			Intr. val.	Time Value		
	Feb	May	August		Feb	May	August
40,0	4,4	20,0	31,8	0,0	3,1	14,5	22,3
20,0	9,2	27,7	40,5	0,0	7,8	21,9	30,4
0,0	17,5	37,3	50,5	0,0	16,0	31,2	39,8
0,0	9,5	28,6	41,9	20,0	8,0	22,2	30,6
0,0	3,2	18,8	31,3	50,0	1,5	11,9	19,2

One week later

Maturity		21	111	201	21	111	201
ABC			CALLS			PUTS	
Spot price	Exercise price	Feb	May	August	Feb	May	August
410	340	71,3	83,0	94,1	0,3	7,9	14,9
	360	52,4	68,3	80,9	1,4	12,8	21,1
	380	35,5	55,2	68,9	4,4	19,5	28,6
	400	21,7	43,9	58,3	10,5	27,9	37,4
	430	8,4	30,2	44,8	27,1	43,7	53,1

CALLS				PUTS			
Intr. val.	Time Value			Intr. val.	Time Value		
	Feb	May	August		Feb	May	August
70,0	1,3	13,0	24,1	0,0	0,3	7,9	14,9
50,0	2,4	18,3	30,9	0,0	1,4	12,8	21,1
30,0	5,5	25,2	38,9	0,0	4,4	19,5	28,6
10,0	11,7	33,9	48,3	0,0	10,5	27,9	37,4
0,0	8,4	30,2	44,8	20,0	7,1	23,7	33,1

Change in stock prices 8%

ABC			CALLS			PUTS	
Spot price	Exercise price	Feb	May	August	Feb	May	August
410	340	61%	38%	31%	-90%	-46%	-33%
	360	80%	43%	34%	-82%	-41%	-31%
	380	103%	48%	36%	-73%	-38%	-28%
	400	128%	53%	39%	-62%	-34%	-26%
	430	163%	61%	43%	-47%	-29%	-23%

Feb	May	August
-70%	-35%	-24%
-74%	-34%	-24%
-69%	-32%	-23%
23%	18%	15%
163%	61%	43%

Luty	Maj	Sierpień
-90%	-46%	-33%
-82%	-41%	-31%
-73%	-38%	-28%
32%	25%	22%
366%	100%	73%

One week later

Maturity		14	104	194	14	104	194
ABC			CALLS			PUTS	
Spot price	Exercise price	Feb	May	August	Feb	May	August
410	340	70,7	82,1	93,3	0,1	7,3	14,4
	360	51,3	67,2	80,0	0,6	12,1	20,5
	380	33,3	54,0	67,9	2,6	18,6	28,0
	400	18,7	42,6	57,3	8,0	26,9	36,8
	430	5,7	28,9	43,8	24,9	42,8	52,5

CALLS				PUTS			
Intr. val.	Time Value			Intr. val.	Time Value		
	Feb	May	August		Feb	May	August
70,0	0,7	12,1	23,3	0,0	0,1	7,3	14,4
50,0	1,3	17,2	30,0	0,0	0,6	12,1	20,5
30,0	3,3	24,0	37,9	0,0	2,6	18,6	28,0
10,0	8,7	32,6	47,3	0,0	8,0	26,9	36,8
0,0	5,7	28,9	43,8	20,0	4,9	22,8	32,5

Change in stock prices 0

ABC			CALLS			PUTS	
Spot price	Exercise price	Feb	May	August	Feb	May	August
410	340	-1%	-1%	-1%	-76%	-8%	-3%
	360	-2%	-2%	-1%	-59%	-6%	-3%
	380	-6%	-2%	-1%	-41%	-4%	-2%
	400	-14%	-3%	-2%	-24%	-3%	-2%
	430	-32%	-4%	-2%	-8%	-2%	-1%

Feb	May	August
-44%	-7%	-3%
-48%	-6%	-3%
-39%	-5%	-2%
-25%	-4%	-2%
-32%	-4%	-2%

Luty	Maj	Sierpień
-76%	-8%	-3%
-59%	-6%	-3%
-41%	-4%	-2%
-24%	-3%	-2%
-32%	-4%	-2%

One week later

Maturity		7	97	187	7	97	187
ABC		CALLS			PUTS		
Spot price	Exercise price	Feb	May	August	Feb	May	August
350	340	13,9	36,0	48,8	3,5	21,5	30,2
	360	3,9	26,4	39,4	13,6	31,7	40,3
	380	0,6	18,9	31,6	30,3	43,9	52,0
	400	0,1	13,2	25,1	49,7	58,0	65,0
	430	0,0	7,5	17,5	79,6	81,8	86,7

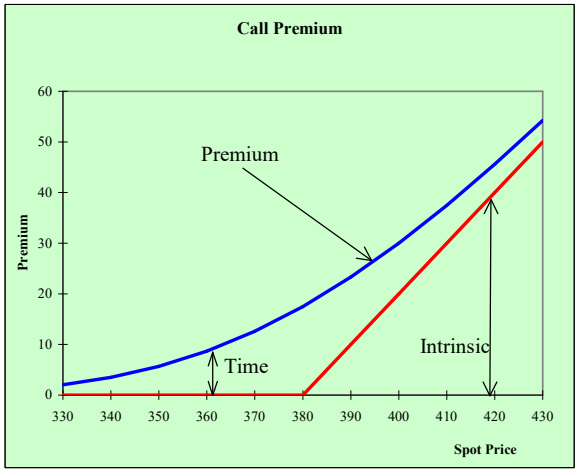
CALLS				PUTS			
Intr. val.	Time Value			Intr. val.	Time Value		
	Feb	May	August	0	Feb	May	August
10,0	3,9	26,0	38,8	0,0	3,5	21,5	30,2
0,0	3,9	26,4	39,4	10,0	3,6	21,7	30,3
0,0	0,6	18,9	31,6	30,0	0,3	13,9	22,0
0,0	0,1	13,2	25,1	50,0	-0,3	8,0	15,0
0,0	0,0	7,5	17,5	80,0	-0,4	1,8	6,7

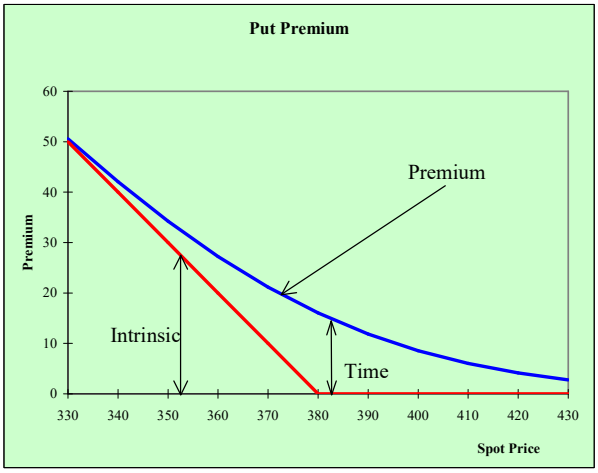
Change in stock prices -15%

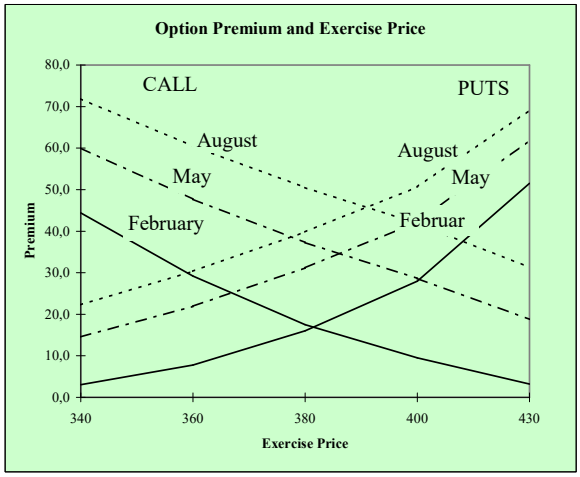
ABC		CALLS			PUTS		
Spot price	Exercise price	Feb	May	August	Feb	May	August
350	340	-80%	-56%	-48%	4557%	194%	109%
	360	-92%	-61%	-51%	2283%	162%	97%
	380	-98%	-65%	-53%	1064%	136%	86%
	400	-100%	-69%	-56%	522%	115%	77%
	430	-100%	-74%	-60%	220%	91%	65%

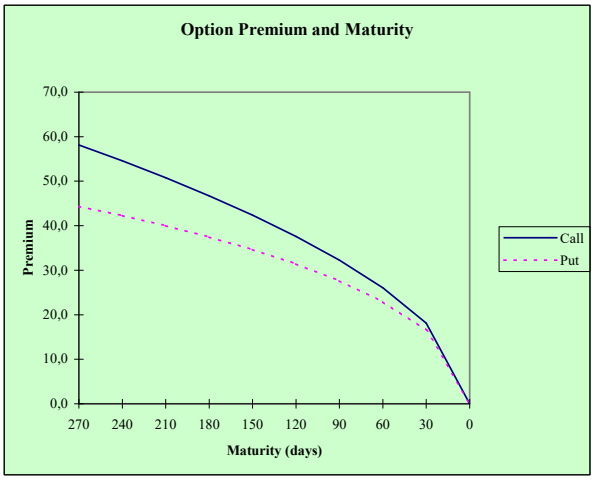
Feb	May	August
432%	114%	66%
213%	54%	32%
-81%	-21%	-17%
-99%	-59%	-47%
-100%	-74%	-60%

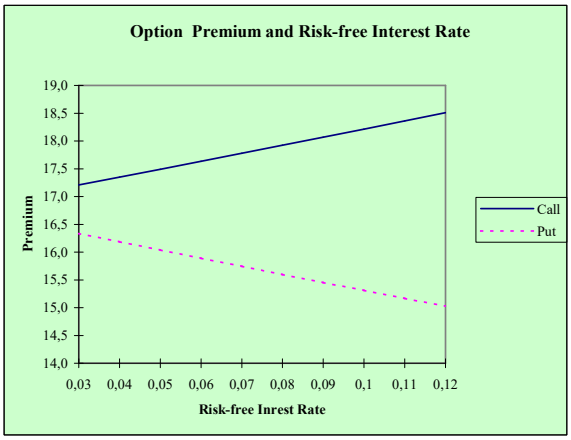
Luty	Maj	Sierpień
4557%	194%	109%
530%	79%	48%
-90%	-25%	-21%
-104%	-70%	-59%
-108%	-92%	-80%

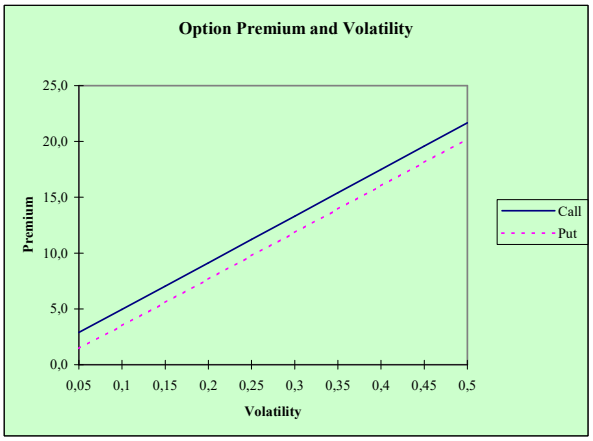

Call Premium
Premium
Time
Intrinsic
Premium
Spot Price
60
50
40
30
20
10
0
330 340 350 360 370 380 390 400 410 420 430


Put Premium
Premium
Intrinsic
Time
Premium
Spot Price
60
50
40
30
20
10
0
330 340 350 360 370 380 390 400 410 420 430


Option Premium and Exercise Price
CALL
PUTS
August
May
February
August
May
Februar
Premium
Exercise Price
80,0
70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0
340 360 380 400 430


Option Premium and Maturity
Premium
Maturity (days)
Call
Put
70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0
270 240 210 180 150 120 90 60 30 0


Option Premium and Risk-free Interest Rate
Premium
Risk-free Inrest Rate
Call
Put
19,0
18,5
18,0
17,5
17,0
16,5
16,0
15,5
15,0
14,5
14,0
0,03 0,04 0,05 0,06 0,07 0,08 0,09 0,1 0,11 0,12


Option Premium and Volatility
Premium
Volatility
Call
Put
25,0
20,0
15,0
10,0
5,0
0,0
0,05 0,1 0,15 0,2 0,25 0,3 0,35 0,4 0,45 0,5