Option Markets:

Introduction

Option Terminology

- Buy - Long
- Sell – Short
- Call
  - Holder has the right to purchase an asset for a specified price
- Put
  - Holder has the right to purchase an asset for a specified price
- Key Elements
  - Exercise or Strike Price
    - Specified price set in option contract
  - Premium or Price
    - Price of option
  - Maturity or Expiration
    - When to exercise an option

Market and Exercise Price Relationships

<u>In the Money</u> - exercise of the option would be profitable.

Call: market price>exercise price

Put: exercise price>market price

<u>Out of the Money</u> - exercise of the option would not be profitable.

Call: market price<exercise price

Put: exercise price<market price

<u>At the Money</u> - exercise price and asset price are equal.

American vs. European Options

American - the option can be exercised at any time before expiration or maturity.

European - the option can only be exercised on the expiration or maturity date.

Options Trading

- ## OTC markets
  - Terms tailor to the needs of traders
  - Costs higher

- ## Exchange
  - Standardized
    - 100 shares of stock
    - Limited and uniform set of securities
  - Two benefits
    - Ease of trading
    - Liquid secondary market

Figure 20.1 Stock Options on IBM

PRICES AT CLOSE MARCH 23, 2006

I B M (IBM)   Underlying stock price: 83.20

		Call			Put		
Expiration	Strike	Last	Volume	Open Interest	Last	Volume	Open Interest
Apr	75.00	8.50	201	2568	0.10	27	19877
May	75.00	...	...	239	0.20	29	170
Jul	75.00	10.10	1	962	0.50	30	9616
Oct	75.00	11.10	1	378	1.10	56	541
Apr	80.00	4.10	1390	19671	0.55	3378	32086
May	80.00	4.40	174	215	0.75	1052	513
Jul	80.00	5.50	57	4357	1.44	234	10156
Oct	80.00	7.30	5	892	2.20	79	1114
Apr	85.00	0.95	2221	42456	2.45	1548	16330
May	85.00	1.35	331	1300	2.90	676	959
Jul	85.00	2.59	570	19451	3.50	103	7963
Oct	85.00	4.10	9	1073	...	...	804
Apr	90.00	0.15	989	21447	6.80	146	587
May	90.00	0.25	7	348	6.80	26	89
Jul	90.00	0.85	353	17257	7.00	670	792
Oct	90.00	2.15	2516	4587	7.40	25	194

IBM US 11/16/13 C175 $ C **8.05** +.13   X7.85 /8.35X   119×81   Prev 7.92
..... On 12 Nov d OpInt 2,785   Vol 517   O 8.85I H 9.00I L 7.50A

IBM US Equity | 95) Templates▾ | 90) Actions ▾ | 97) Expiry ▾ | Option Monitor: Option Monitor

IBM   183.07   .19   .1039%   182.90 / 183.16   Hi 184.0487   Lo 182.26   Volm 300   HV 26.90   91) News (CN)
■ Calc Mode   Center 183.07   Strikes   5   Exch US Composite ▾   92) Next Earnings(EM) 01/21/14 C

295) Center Strike | 296) Calls/Puts | 297) Calls | 298) Puts | 299) Term Structure

			Calls					Strike				Puts				
	Ticker	Bid	Ask	Last	IVM	DM	Volm	OInt		Ticker	Bid	Ask	Last	IVM	DM	Volm	OInt
	16 Nov 13 (3d); CSize 100; R .19; IFwd 183.14								5▾	16 Nov 13 (3d); CSize 100; R .19; IFwd 183.14							
1)	IBM 11	7.85y	8.35y	8.05y	29.69	.96	517	2785	175.00	36) IBM 11	.04y	.05y	.04y	26.66	-.03	334	5355
2)	IBM 11	3.30y	3.45y	3.35y	17.85	.86	1412	9259	180.00	37) IBM 11	.22y	.24y	.21y	18.60	-.15	1256	7160
3)	IBM 11	.43y	.46y	.44y	17.43	.26	8304	11194	185.00	38) IBM 11	2.27y	2.34y	2.29y	17.68	-.73	979	3362
4)	IBM 11	.06y	.07y	.07y	22.58	.04	507	8111	190.00	39) IBM 11	6.75y	7.10y	6.70y		-1.0	121	1226
5)	IBM 11	.01y	.02y	.01y	28.64	.01	69	4179	195.00	40) IBM 11	11.55	12.20	12.05	31.53	-.99	106	351
	21 Dec 13 (38d); CSize 100; R .18; IFwd 183.19								5▾	21 Dec 13 (38d); CSize 100; R .18; IFwd 183.19							
6)	IBM 12	9.20y	9.35y	9.10y	16.92	.81	117	1833	175.00	41) IBM 12	1.04y	1.07y	1.07y	16.65	-.19	306	4013
7)	IBM 12	5.45y	5.55y	5.50y	15.65	.65	1413	5217	180.00	42) IBM 12	2.26y	2.31y	2.30y	15.62	-.35	570	5755
8)	IBM 12	2.71y	2.76y	2.73y	15.04	.43	7686	4545	185.00	43) IBM 12	4.45y	4.55y	4.55y	14.90	-.57	1824	2251
9)	IBM 12	1.11y	1.15y	1.13y	14.68	.23	769	6378	190.00	44) IBM 12	7.85y	8.00y	7.70y	14.59	-.78	67	1646
10)	IBM 12	.41y	.44y	.43y	14.98	.10	392	2587	195.00	45) IBM 12	11.85	12.55	12.68	16.11	-.88		344
	18 Jan 14 (66d); CSize 100; R .21; IFwd 183.22								5▾	18 Jan 14 (66d); CSize 100; R .21; IFwd 183.22							
11)	IBM 1/	10.25	10.40	10.42	17.15	.75	274	3303	175.00	46) IBM 1/	2.03y	2.06y	2.08y	16.86	-.25	223	4448
12)	IBM 1/	6.75y	6.85y	6.90y	16.35	.61	608	3731	180.00	47) IBM 1/	3.50y	3.55y	3.45y	16.13	-.39	288	4417
13)	IBM 1/	4.05y	4.10y	4.00y	15.72	.46	693	6433	185.00	48) IBM 1/	5.75y	5.85y	5.85y	15.46	-.55	1688	9455
14)	IBM 1/	2.19y	2.23y	2.23y	15.34	.30	1057	7822	190.00	49) IBM 1/	8.85y	9.00y	8.70y	15.01	-.71	135	5604
15)	IBM 1/	1.08y	1.11y	1.10y	15.19	.18	110	5228	195.00	50) IBM 1/	12.75	12.95	12.90	14.90	-.83	28	3184
	19 Apr 14 (157d); CSize 100; IDiv .67 USD; R .32;								5▾	19 Apr 14 (157d); CSize 100; IDiv .67 USD; R .32							
16)	IBM 4/	13.20	13.30	13.13	18.94	.67	22	582	175.00	51) IBM 4/	5.40y	5.50y	5.50y	18.71	-.34	66	1875

93) Default color legend   Zoom ─ ▬▬▬▬ 100%

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900   Singapore 65 6212 1000   U.S. 1 212 318 2000   Copyright 2013 Bloomberg Finance L.P.
                                                    SN 541209 CET   GMT+1:00 H429-2945-0 13-Nov-2013 11:50:45

CALL OPTIONS

IBM US 11/16/13 C175 Equity — Equity Option Description

| Underlying | International Business M | 1) Desc (DES) | Ticker IBM US Equity | Price 183.07 |

Contract Information

Ticker	IBM US 11/16/13 C175
Bid/Ask	7.85 / 8.35
Last	8.05
Strike	175
Expiration	16-Nov-2013
Exercise	American
Cycle	JAN
Csize/Multiplier	100 / 100

Exchange Data

Exch	UA UO UX UL UP UB UQ UF UE
	UT UM UI
Hours	9:30 - 16:00
In	New York
Tick Size	.05 .10
Tick Val	$ 5.00 $ 10.00
Pos Limit	25000000 shares

Identifiers

BBGID	BBG0055CWQ76
OPR17	IBM K1613C175000
OCC21	IBM 131116C00175000

2) Option Chain (OMON)

	Ticker	Exp Date	DExp	Csize	Multiplier	Periodicity
1.	IBM	16-Nov-2013	3	100	100	Monthly
2.	IBM	22-Nov-2013	9	100	100	Weekly
3.	IBM	29-Nov-2013	16	100	100	Weekly
4.	IBM	06-Dec-2013	23	100	100	Weekly
5.	IBM	21-Dec-2013	38	100	100	Monthly
6.	IBM	18-Jan-2014	66	100	100	Monthly
7.	IBM	19-Apr-2014	157	100	100	Monthly

3) Volatility Analysis (GIV)

30D	26.904	IVol	29.685	Vega	0.016
60D	21.032	Delta	0.955	Theta	-0.078
90D	18.751	Gamma	0.035	Rho	0.000

4) Option Price (GP)

Volume 517   Open Interest 2785

5) General Notes: No Notes Available

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900   Singapore 65 6212 1000   U.S. 1 212 318 2000   Copyright 2013 Bloomberg Finance L.P.
SN 541209 CET   GMT+1:00 H429-2945-0 13-Nov-2013 12:04:14

IBM US K1613C190000 Equity DES

Equity Option Description

| Underlying | International Business M | 1) Desc (DES) | Ticker IBM US Equity | Price 183.07 |

Contract Information

Ticker	IBM US 11/16/13 C190
Bid/Ask	0.06 / 0.07
Last	.07
Strike	190
Expiration	16-Nov-2013
Exercise	American
Cycle	JAN
Csize/Multiplier	100 / 100

2) Option Chain (OMON)

	Ticker	Exp Date	DExp	Csize	Multiplier	Periodicity
1.	IBM	16-Nov-2013	3	100	100	Monthly
2.	IBM	22-Nov-2013	9	100	100	Weekly
3.	IBM	29-Nov-2013	16	100	100	Weekly
4.	IBM	06-Dec-2013	23	100	100	Weekly
5.	IBM	21-Dec-2013	38	100	100	Monthly
6.	IBM	18-Jan-2014	66	100	100	Monthly
7.	IBM	19-Apr-2014	157	100	100	Monthly

Exchange Data

Exch	UA UO UX UL UP UB UQ UF UE UT UM UI
Hours	9:30 - 16:00
In	New York
Tick Size	.05 .10
Tick Val	$ 5.00 $ 10.00
Pos Limit	25000000 shares

3) Volatility Analysis (GIV)

30D	26.904	IVol	22.583	Vega	0.015
60D	21.032	Delta	0.043	Theta	-0.056
90D	18.751	Gamma	0.044	Rho	0.000

4) Option Price (GP)

IBM US 11/16/13 C190 Equity 0.07

Aug 22 Aug 30 Sep 9 Sep 16 Sep 23 Sep 30 Oct 8 Oct 15 Oct 23 Oct 31 Nov 8
2013

| Volume | 507 | Open Interest | 8111 |

Identifiers

BBGID	BBG0054N1D85
OPR17	IBM K1613C190000
OCC21	IBM 131116C00190000

5) General Notes: No Notes Available

PUT OPTION

DES

IBM US 11/16/13 P195 Equity | Equity Option Description

Underlying   International Business M   1) Desc (DES)   Ticker IBM US Equity   Price 183.07

Contract Information

Ticker	IBM US 11/16/13 P195
Bid/Ask	11.55 / 12.20
Last	12.05
Strike	195
Expiration	16-Nov-2013
Exercise	American
Cycle	JAN
Csize/Multiplier	100 / 100

2) Option Chain (OMON)

	Ticker	Exp Date	DExp	Csize	Multiplier	Periodicity
1.	IBM	16-Nov-2013	3	100	100	Monthly
2.	IBM	22-Nov-2013	9	100	100	Weekly
3.	IBM	29-Nov-2013	16	100	100	Weekly
4.	IBM	06-Dec-2013	23	100	100	Weekly
5.	IBM	21-Dec-2013	38	100	100	Monthly
6.	IBM	18-Jan-2014	66	100	100	Monthly
7.	IBM	19-Apr-2014	157	100	100	Monthly

Exchange Data

Exch	UA UO UX UL UP UB UQ UF UE UT UM UI
Hours	9:30 - 16:00
In	New York
Tick Size	.05 .10
Tick Val	$ 5.00 $ 10.00
Pos Limit	25000000 shares

3) Volatility Analysis (GIV)

30D	26.904	IVol	31.527	Vega	0.006
60D	21.032	Delta	-0.985	Theta	-0.031
90D	18.751	Gamma	0.015	Rho	0.000

4) Option Price (GP)

IBM US 11/16/13 P195 Equity 12.05

Aug 29 ... Sep 16 Sep 23 Sep 30 Oct 8 Oct 15 Oct 24 Oct 31 Nov 8
2013

Volume 106   Open Interest 324

Identifiers

BBGID	BBG0054N1F08
OPR17	IBM W1613C195000
OCC21	IBM 131116P00195000

5) General Notes: No Notes Available

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900   Singapore 65 6212 1000   U.S. 1 212 318 2000   Copyright 2013 Bloomberg Finance L.P.
SN 541209 CET   GMT+1:00 H429-2945-1 13-Nov-2013 12:57:16

DES

		Equity Option Description

Underlying   International Business M   1) Desc (DES)   Ticker IBM US Equity   Price 183.07

Contract Information

Ticker	IBM US 11/16/13 P175
Bid/Ask	0.04 / 0.05
Last	.04
Strike	175
Expiration	16-Nov-2013
Exercise	American
Cycle	JAN
Csize/Multiplier	100 / 100

2) Option Chain (OMON)

	Ticker	Exp Date	DExp	Csize	Multiplier	Periodicity
1.	IBM	16-Nov-2013	3	100	100	Monthly
2.	IBM	22-Nov-2013	9	100	100	Weekly
3.	IBM	29-Nov-2013	16	100	100	Weekly
4.	IBM	06-Dec-2013	23	100	100	Weekly
5.	IBM	21-Dec-2013	38	100	100	Monthly
6.	IBM	18-Jan-2014	66	100	100	Monthly
7.	IBM	19-Apr-2014	157	100	100	Monthly

Exchange Data

Exch	UA UO UX UL UP UB UQ UF UE UT UM UI
Hours	9:30 - 16:00
In	New York
Tick Size	.05 .10
Tick Val	$ 5.00 $ 10.00
Pos Limit	25000000 shares

3) Volatility Analysis (GIV)

30D	26.904	IVol	26.656	Vega	0.011
60D	21.032	Delta	-0.026	Theta	-0.044
90D	18.751	Gamma	0.026	Rho	0.000

4) Option Price (GP)

Volume   334   Open Interest   5301

Identifiers

BBGID	BBG0055CWQ67
OPR17	IBM W1613C175000
OCC21	IBM 131116P00175000

5) General Notes: No Notes Available

Different Types of Options

- Stock Options
- Index Options
  - Base on a stock market index
    - Broad base or industry specific indexes or commodity price indexes
    - In contrast to stock options, index options do not require that the writer actually "deliver the index" or "purchase the index"
      - Cash settlement procedure is used
- Futures Options
  - For a specific futures contract
- Foreign Currency Options
  - Quantity of foreign currency for a specified amount of domestic currency
- Interest Rate Options
  - On T-notes or T-bonds, LIBOR, EUROBOR, etc

Payoffs and Profits at Expiration - Calls

Recall that a call option gives the right to purchase a security at exercise price

Exercise price $100, now sellin $110

<u>Notation</u>

  Stock Price = ST   Exercise Price = X

<u>Payoff to Call Holder</u>

   (ST - X)   if ST > X

        0   if ST $\leq$ X

<u>Profit to Call Holder</u>

   Payoff - Purchase Price

Payoffs and Profits at Expiration - Calls

Payoff to Call Writer

$-(S_T - X)$ if $S_T > X$

0   if $S_T \leq X$

Profit to Call Writer

Payoff + Premium

Figure 20.3 Payoff and Profit to Call Option at Expiration
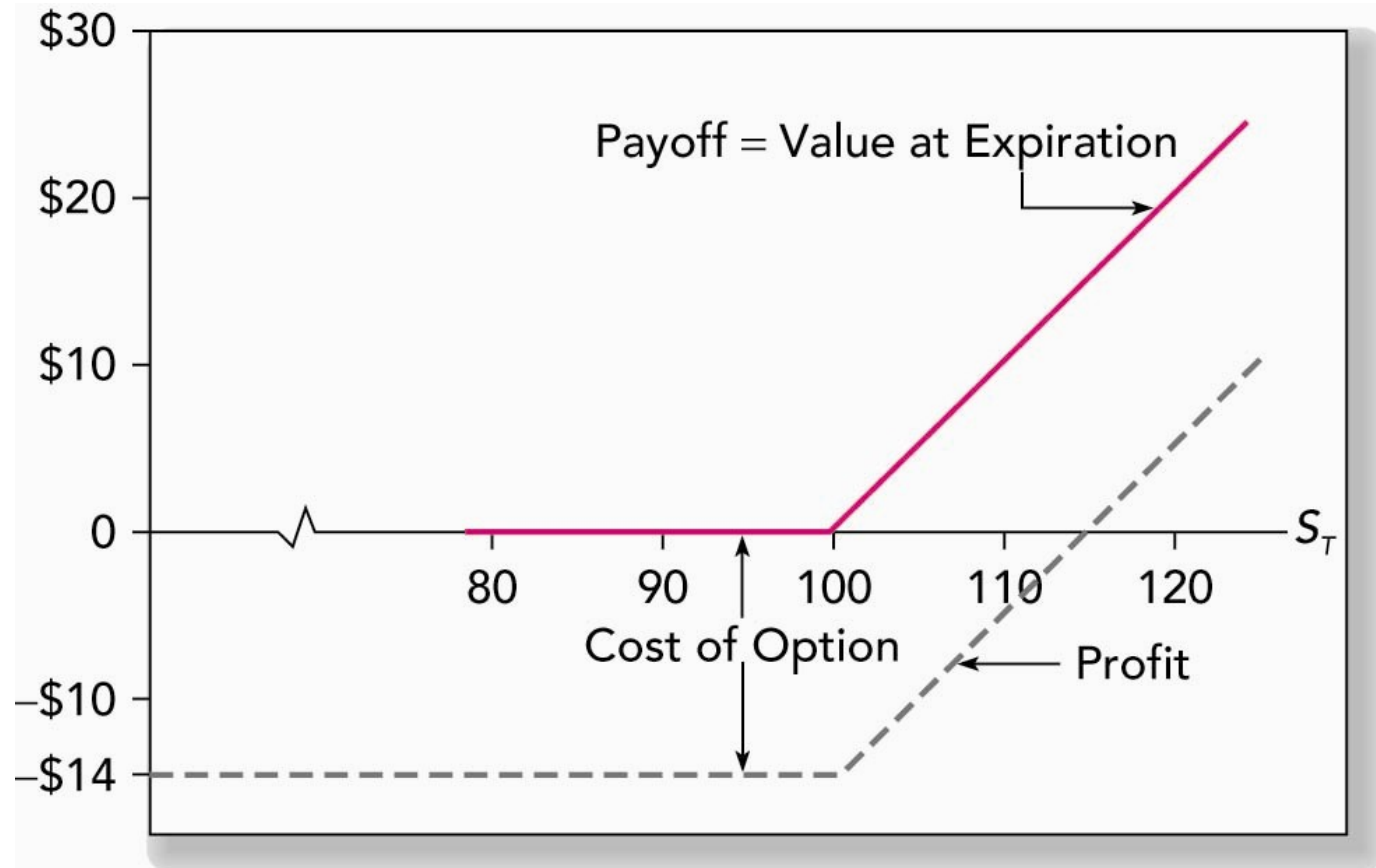
Figure 20.4 Payoff and Profit to Call Writers at Expiration
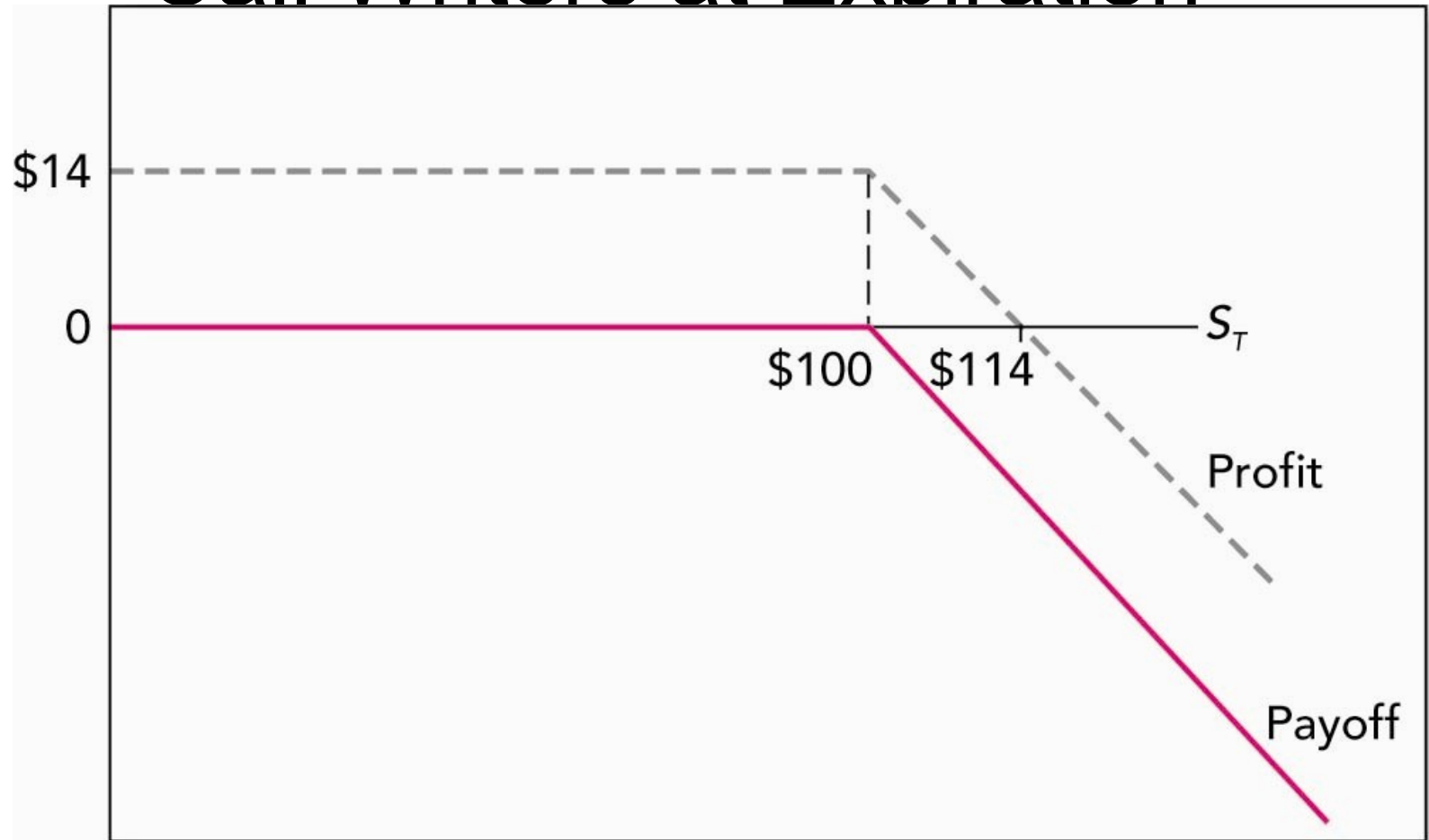
Payoffs and Profits at Expiration - Puts

A put options is the right to sell an asset
at the exercise price

The holder will not exercise the option unless the asset
is worth less than the exercise price

Payoffs to Put Holder

$\quad\quad$ 0 $\quad\quad\quad\quad\quad\quad$ if $S_T \geq X$

$\quad$ (X - S_T) $\quad\quad\quad\quad\quad$ if $S_T < X$

Profit to Put Holder

Payoff - Premium

Payoffs and Profits at Expiration - Puts

Payoffs to Put Writer

$$0 \qquad \text{if} \quad S_T \geq X$$
$$-(X - S_T) \qquad \text{if} \quad S_T < X$$

Profits to Put Writer

Payoff + Premium

Figure 20.5 Payoff and Profit to Put Option at Expiration
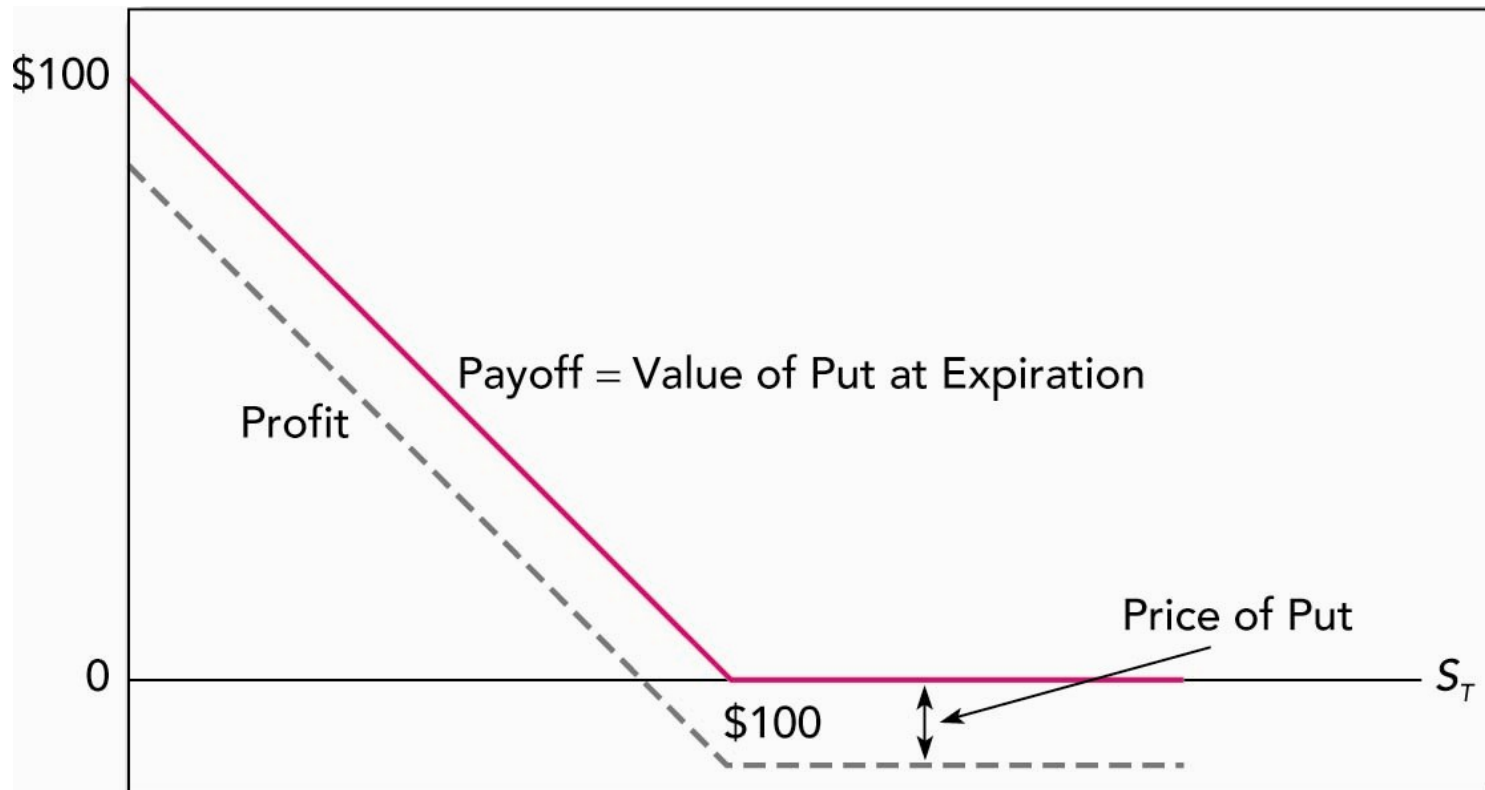
Equity, Options & Leveraged Equity

- Purchasing call option
  - Bullish strategy
  - Profit when stock prices are increase
- Writing call option
  - Bearish strategy
- Purchasing put option
  - Bearish strategy
- Writing put option
  - Bullish strategy
- Because option values depend on the price of the underlying stock, purchase of options may be viewed as a substitute to direct purchase or sale of a stock

Equity, Options & Leveraged Equity

Investment	Strategy		Investment
Equity only	Buy stock @ 100	100 shares	$10,000
Options only	Buy calls @ 10	1000 options	$10,000
Leveraged equity	Buy calls @ 10	100 options	$1,000
	Buy T-bills @ 3% Yield		$9,000

Equity, Options Leveraged Equity - Payoffs

	IBM Stock Price		
	$95	**$105**	**$115**
All Stock	$9,500	$10,500	$11,500
All Options	$0	$5,000	$15,000
Lev Equity	$9,270	$9,770	$10,770

Rates of Return

	IBM Stock Price		
	$95	**$105**	**$115**
All Stock	-5.0%	5.0%	15%
All Options	-100%	-50%	50%
Lev Equity	-7.3%	-2.3%	7.7%

Figure 20.6 Rate of Return to Three Strategies
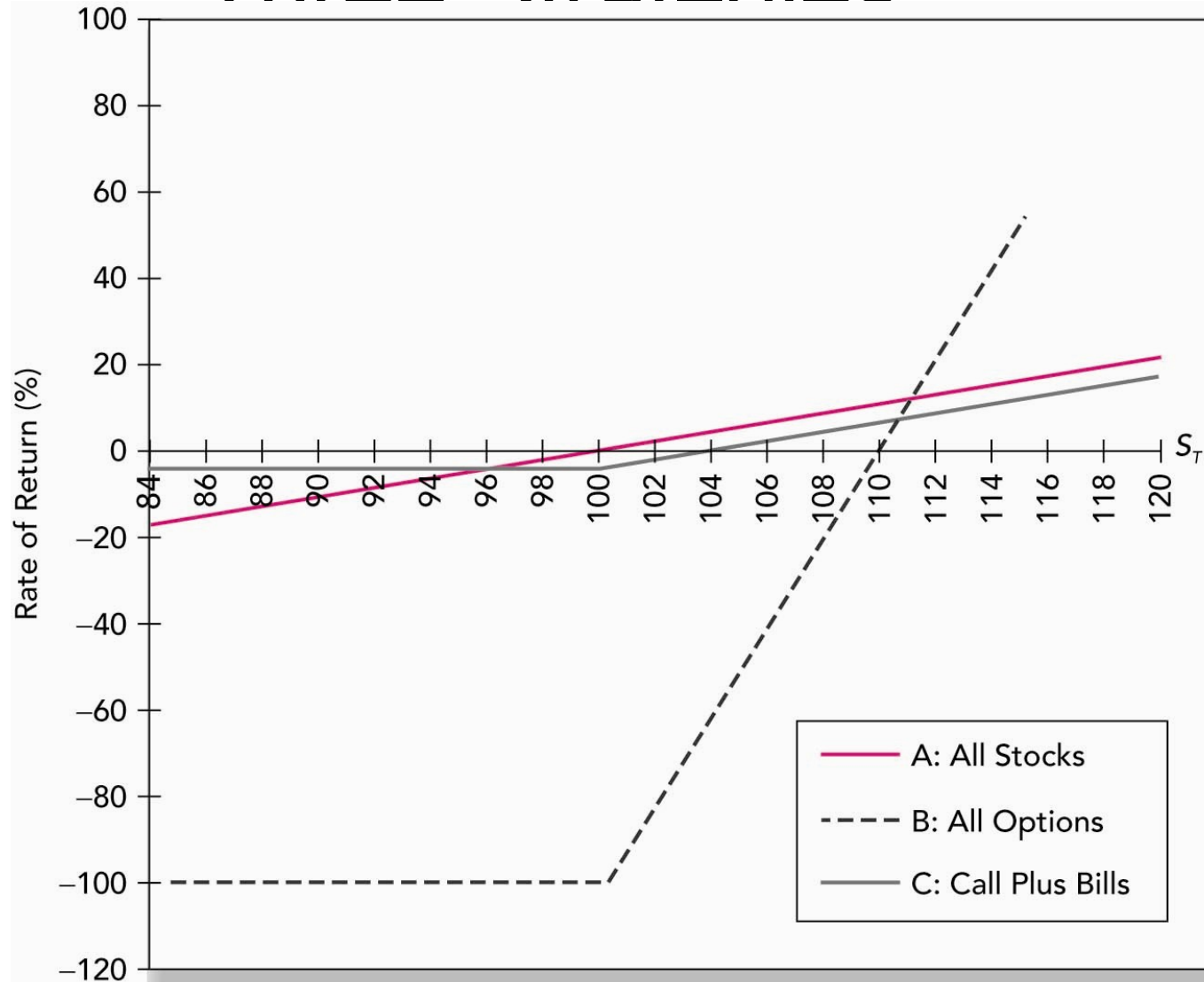
Option strategies

Protective Put

- Investing in a stock but with unwillingness to bear potential losses beyond some given level
  - Investing in stock with purchasing a put option on stock

Table 20.1 Value of a Protective Put Position at Option Expiration

TABLE 20.1

Value of protective put portfolio at option expiration

		$S_T \leq X$	$S_T > X$
	Stock	S_T	S_T
	+ Put	$X - S_T$	0
	= TOTAL	X	S_T

Figure 20.7 Value of a Protective Put Position at Option Expiration
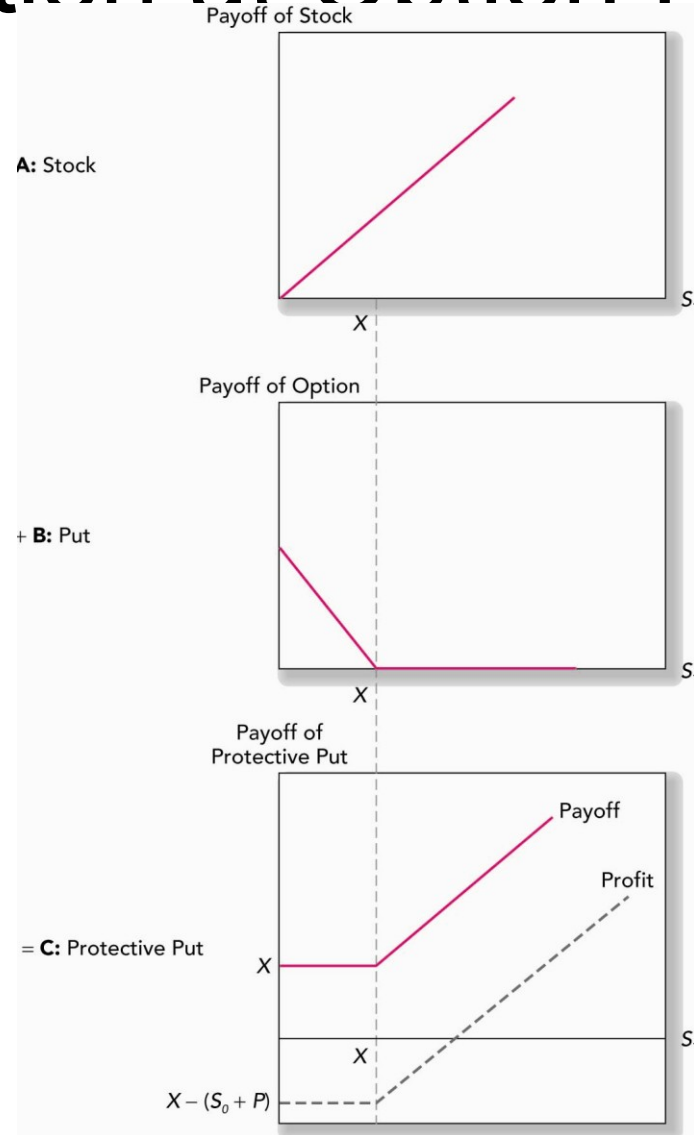
Figure 20.8 Protective Put versus Stock Investment (at-the-money option)
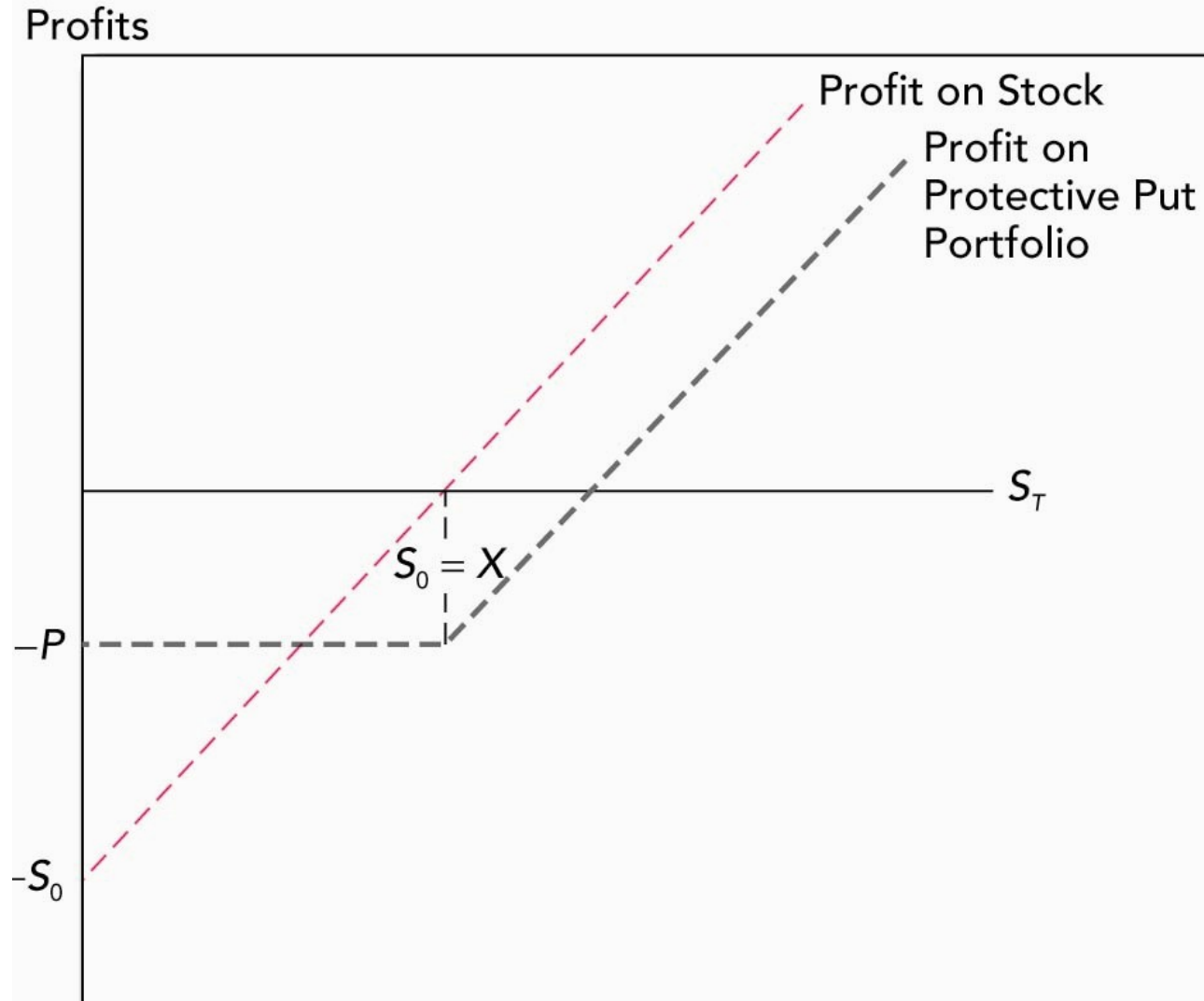
Covered Calls

- The purchase of a share of stock with a simultaneous sale of a call on the stock
  - The call is covered because the potential obligation to deliver the stock is covered by the stock held in the portfolio
- Writing covered call options has been a popular investment strategy among institution investors
- The written call guarantees the sale will occur as planned

Table 20.2 Value of a Covered Call Position at Expiration

TABLE 20.2

Value of covered call position at option expiration

		$S_T \leq X$	$S_T > X$
	Payoff of stock	S_T	S_T
+	Payoff of written call	-0	$-(S_T - X)$
=	TOTAL	S_T	X

Figure 20.9 Value of a Covered Call Position at Expiration
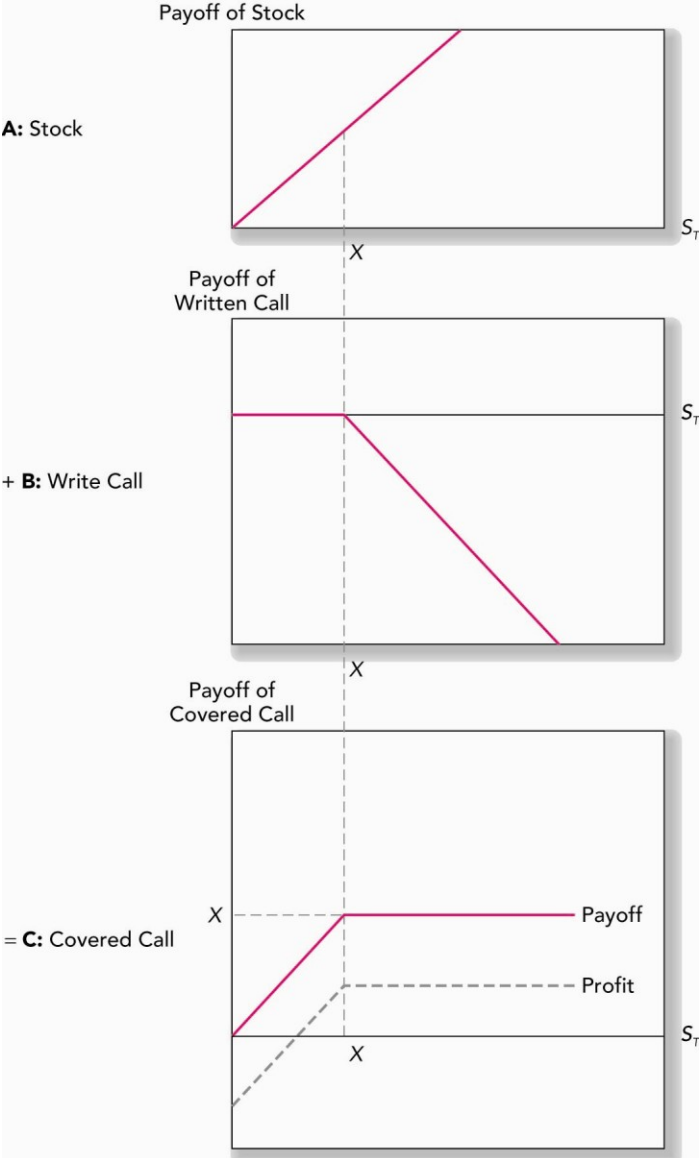
Option Strategies

- A long straddle buying both a call and a put on a stock with the same exercise price
- For investors who expect move a lot in price but are not certain about direction of the move
- The straddle position will do well regardless of the outcome because its value is higher when the stock price makes extreme upward or downward move from X
- The worst scenario for straddle is no movement in the stock price
- Bets on volatility

Table 20.3 Value of a Straddle at Option Expiration

	$S_T < X$	$S_T \geq X$
Payoff of call	0	$S_T - X$
+ Payoff of put	$X - S_T$	0
= TOTAL	$X - S_T$	$S_T - X$

TABLE 20.3

Value of a straddle position at option expiration

Figure 20.10 Value of a Straddle at Expiration
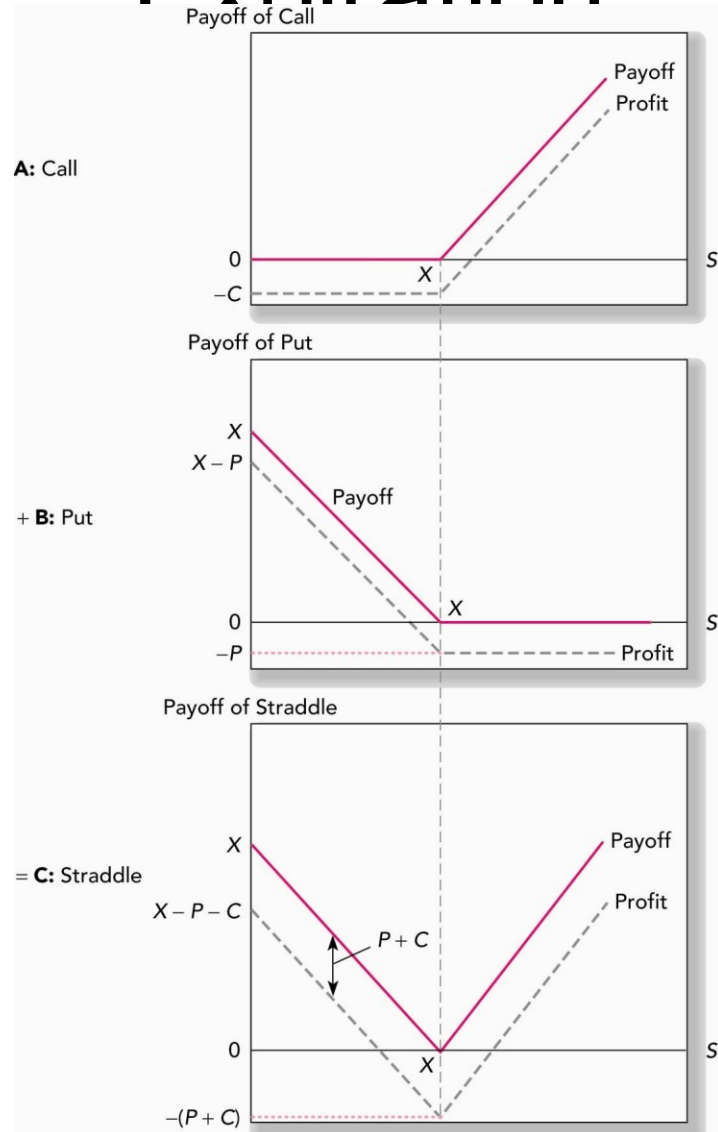
Option Strategies

- Spread is a combination of two or more call options (or two or more puts) on the same stock with differencing exercise prices or times to maturity
- Some options are bought, sold or written
- A money spread
  - Purchase of one option and the simultaneous sale of another with different exercise price
- A time spread
 - The sale and purchase of options with differing expiration dates

Table 20.4 Value of a Bullish Spread Position at Expiration

TABLE 20.4		$S_T \leq X_1$	$X_1 < S_T \leq X_2$	$S_T \geq X_2$
Value of a bullish spread position at expiration	Payoff of purchased call, exercise price = X_1	0	$S_T - X_1$	$S_T - X_1$
	+ Payoff of written call, exercise price = X_2	$-\,0$	$-\,0$	$-\,(S_T - X_2)$
	= TOTAL	0	$S_T - X_1$	$X_2 - X_1$

Figure 20.11 Value of a Bullish Spread Position at Expiration
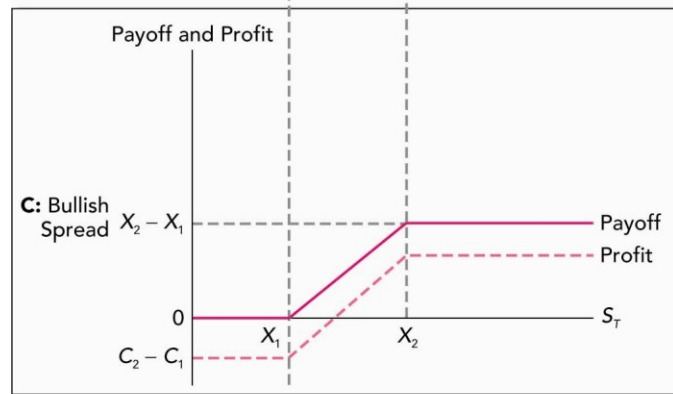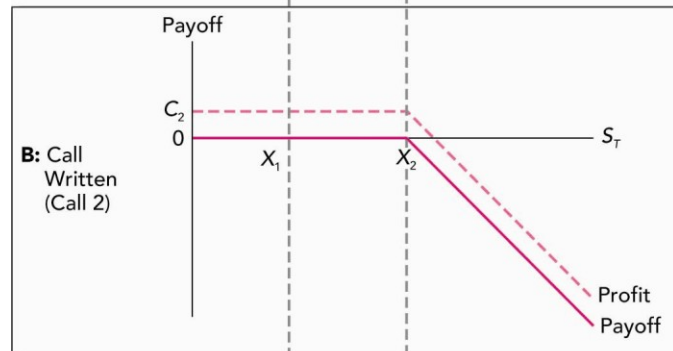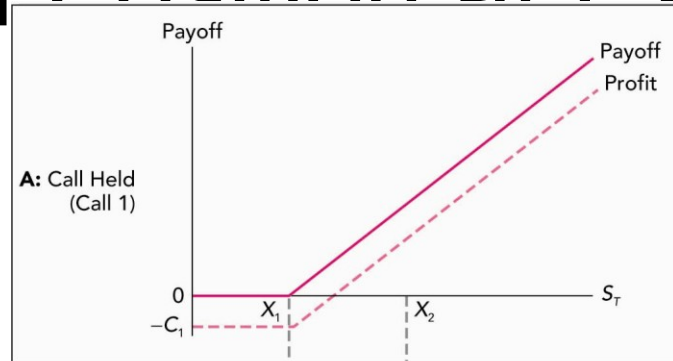
Option Strategies

- Collars

- Brackets value of portfolio between two bounds

The Put-Call parity relationship

- Protective put portfolio provides a payoff with guarantees minimum value, but unlimited upside potential

Put Call Parity

$$C + X / (1 + r_f)^T = S_0 + P$$

- Put-call parity theorem
  - Proper relation between put and call prices

If the prices are not equal arbitrage will be possible.

Put Call Parity - Disequilibrium Example

Stock Price = 110   Call Price = 17

Put Price = 5   Risk Free = 5%

Maturity = 1 yr   X = 105

$$C + X / (1 + r_f)^T > S_0 + P$$

$$117 > 115$$

Since the leveraged equity is less expensive, acquire the low cost alternative and sell the high cost alternative.

Table 20.5 Arbitrage Strategy

Position	Immediate Cash Flow	Cash Flow in 1 year	
		$S_T < 105$	$S_T \geq 105$
Buy stock	−110	S_T	S_T
Borrow $105/1.05 = $100	+100	−105	−105
Sell call	+17	0	$-(S_T - 105)$
Buy put	−5	$105 - S_T$	0
TOTAL	2	0	0

TABLE 20.5

Arbitrage strategy

- More general formulation of put-call parity
- $P = C - S_0 + PV(X) + PV(\text{dividends})$

Optionlike Securities

- Callable Bonds
- Convertible Securities
- Warrants
- Collateralized Loans

Callable Bonds

- Corporate bonds are issued with call provisions
  - Issuer can buy bonds back from bondholders at some time in the future at a specified call price
- Callable bond
  - Straight bond and concurrent issuance of a call option
- Compensation for conveying this implicit call option to the firm
  - If callable bond is issued with coupon rate, it would sell at a lower price than the straight bonds
    - Difference would equal the value of the call
  - To sell callable bonds at par, firms must issue them with coupon rates higher than the coupon an straight debt

Figure 20.12 Values of Callable Bonds Compared with Straight

Value of Straight Debt

Value of Callable Bond

Value of Firm's Call Option

Value of Straight Debt

Call Price
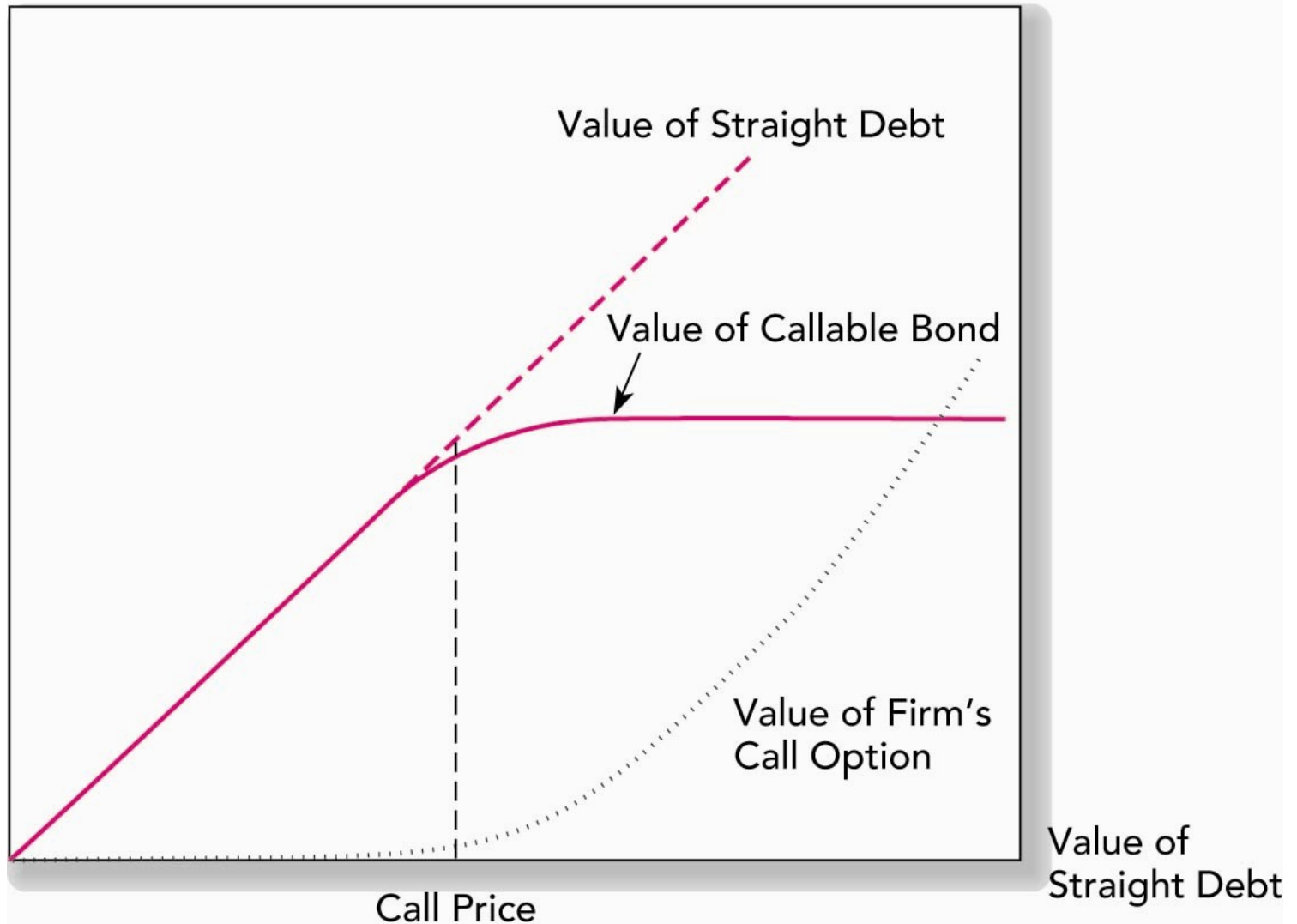
Convertibles Securities

- Convertible preferred stock convey options to the holder of the security rather than to the issuing firm
- Right to exchange each bond or share of preferred stock for a fixed number of shares of common stock, regardless of the market prices of the securities at the time
- Most convertible bonds are issued "deep out of money"
  - Issuer sets the conversion ration so that conversion will not be profitable unless there is a substantial increase in stock prices or decrease in bond prices from the time of issue

Figure 20.13 Value of a Convertible Bond as a Function of Stock Price
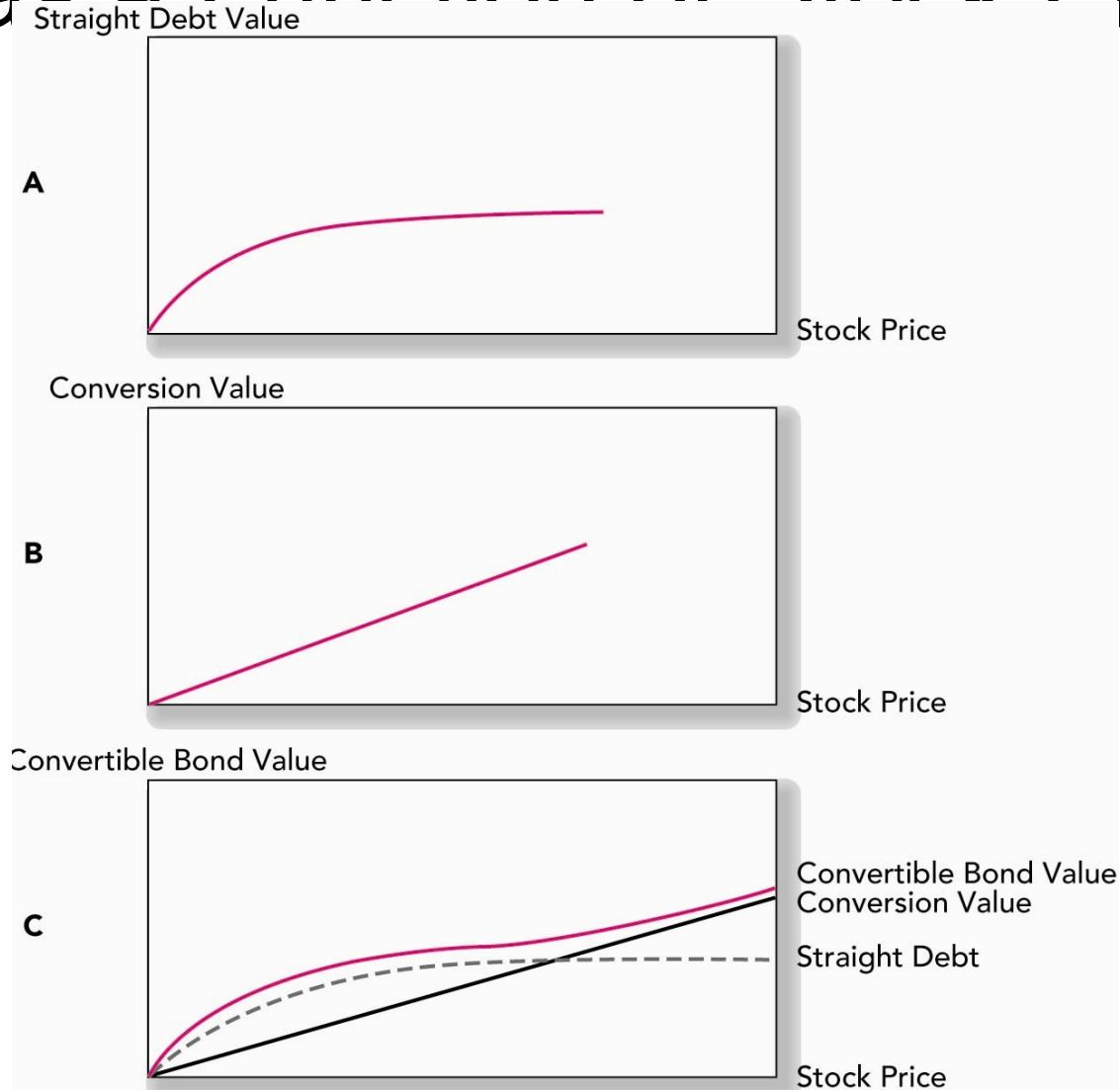
Warrants

- Call option issued by a firm
- Exercise of a warrant requires the firm to issue a new share of stock – total number of shares outstanding increases
- Warrants result in a cash flow to the firm when the warrant holder pays the exercise price
  - Warrants values will somewhat from the values of call options with identical terms
- Issued in conjunction with another security

Collateralized Loans

- Many loan arrangements require that the borrower put up collateral to guarantee the loan will be paid back

  - This arrangements gives an implicit call option to the borrower
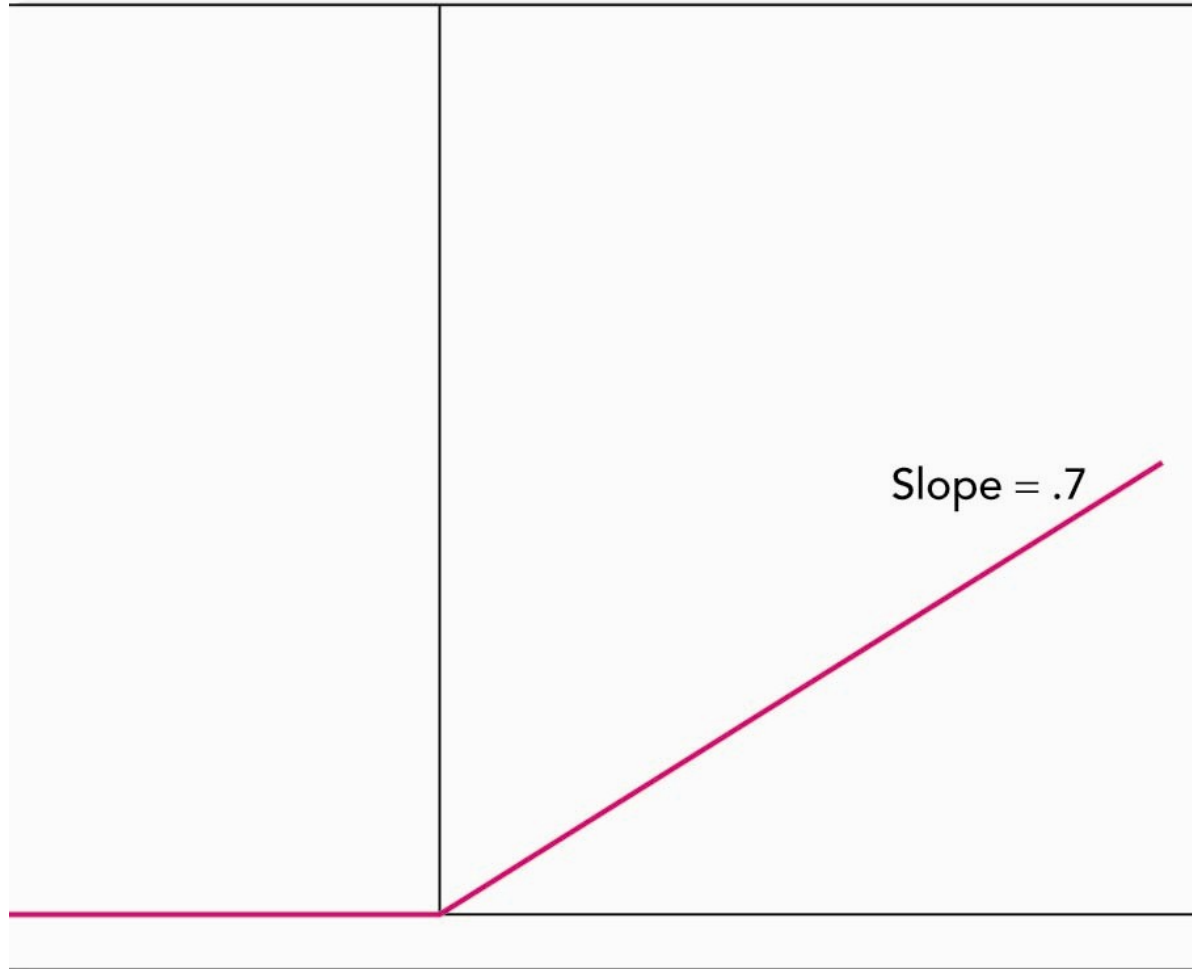
Exotic Options

- Asian Options
- Barrier Options
- Lookback Options
- Currency Translated Options
- Digital Options

Financial Engineering

- One of the attractions of options is the ability they provide to create investment positions with payoffs that depend in a variety of ways on the values of other securities.

- Index-linked certificate of deposit
  - Small position in index options
    - Guarantee a minimum rate of return the market fall

- The index-linked CD is clearly a type of call option
  - If market rises, the depositor profits according to the participation rate or multiplies
  - If the market falls, the investor is insured against loss
- Bank offering these CDs
  - Writing call options
  - Hedge its position by buying index call
- Multiplier

Rate of Return on Index-Linked CD

Slope = .7

r_M = Market Rate of Return