Corporate Finance

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DERIVATIVES: FORWARDS, FUTURES & OPTIONS

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Derivatives: Definition

A derivative is an instrument whose value depends on the values of other more basic underlying variables (stock prices, market indices, FX rates, etc.

Derivatives Markets

- **Exchange traded**
  - Traditionally exchanges have used the open-outcry system, but increasingly they are switching to electronic trading
  - Contracts are standard there is virtually no credit risk
- **Over-the-counter (OTC)**
  - A computer- and telephone-linked network of dealers at financial institutions, corporations, and fund managers
  - Contracts can be non-standard and there is some small amount of credit risk

Spot and Forward Transactions - Markets

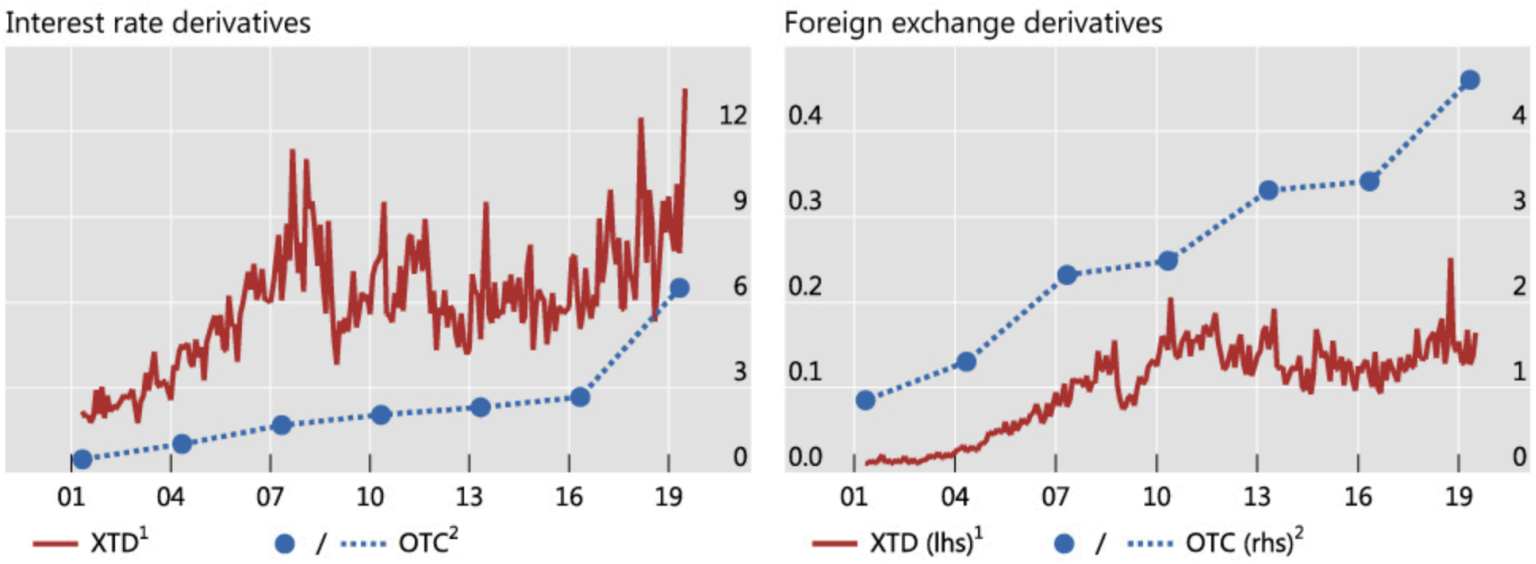
	Spot Transaction	**Forward Transaction**
Agreement	*on the spot*	*on the spot*
Settlement	*on the spot*	*on a future date*

Size of OTC and Exchange Markets

OTC trading of interest rate and FX derivatives outpaced exchange trading

Daily average turnover, in trillions of US dollars

Graph A1



XTD = exchange-traded derivatives; OTC = over-the-counter derivatives.

[1] Turnover on exchanges worldwide, at monthly frequency. [2] Turnover in April, adjusted for local and cross-border inter-dealer double-counting. The dashed line shows a linear interpolation of data between Triennial Surveys.

Sources: Euromoney TRADEDATA; Futures Industry Association; The Options Clearing Corporation; BIS derivatives statistics.

Ways Derivatives are Used

- To hedge risks
- To speculate (take a view on the future direction of the market)
- To lock in an arbitrage profit
- To change the nature of a liability
- To change the nature of an investment without incurring the costs of selling one portfolio and buying another

Forward Contracts

- A forward contract is an agreement to buy or sell an asset at certain future time for a certain price
- Forward contracts are similar to futures except that they trade in the over-the-counter market
- Forward contracts are particularly popular on currencies and interest rates

Foreign Exchange Quotes USD/GBP June 3, 2003

	Bid	Offer
Spot	1.6281	1.6285
1-month forward	1.6248	1.6253
3-month forward	1.6187	1.6192
6-month forward	1.6094	1.6100

Forward Price

- The forward price for a contract is the delivery price that would be applicable to the contract if were negotiated today (i.e., it is the delivery price that would make the contract worth exactly zero)
- The forward price may be different for contracts of different maturities

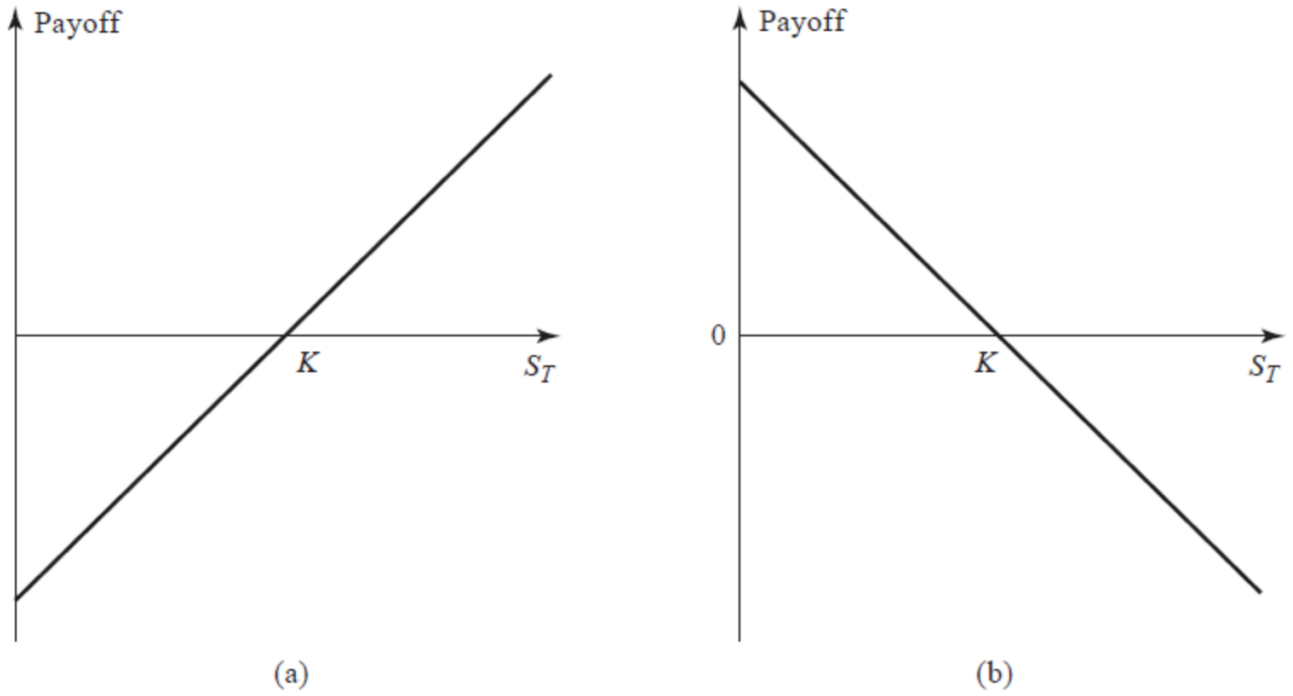
Terminology

- The party that has agreed to buy has what is termed a **long position**
- The party that has agreed to sell has what is termed a **short position**

Example

- On June 3, 2003 the treasurer of a corporation enters into a **long forward contract** to buy £1 million in six months at an exchange rate of 1.6100
- This obligates the corporation to pay $1,610,000 for £1 million on December 3, 2003
- What are the possible outcomes?

Payoff Diagrams for Forward Positions



Payoffs from forward contracts: (a) long position, (b) short position. Delivery price: K; price of asset at contract maturity: S_T.

Futures Contracts

- Agreement to buy or sell an asset for a certain price at a certain time
- Similar to forward contract
- Whereas a forward contract is traded OTC, a futures contract is traded on an exchange

Major Exchanges Trading Futures

- Chicago Board of Trade (CBOT)
- Chicago Mercantile Exchange (CME)
- LIFFE (London)
- Eurex (Europe)
- BM&F (Sao Paulo, Brazil)
- TIFFE (Tokyo)

Examples of Futures Contracts

Agreement to:

- buy 100 oz. of gold @ US$400/oz. in December (NYMEX)
- sell £62,500 @ 1.5000 US$/£ in March (CME)
- sell 1,000 bbl. of oil @ US$20/bbl. in April (NYMEX)

Closing Out Positions

- The vast majority of futures contracts do not lead to delivery – the delivery of the underlying asset is relatively rare
- Most traders **close out** their positions prior to the delivery period specified in the contract
- **Closing out** a position means entering into the opposite type of trade from the original one

Closing Out Positions: An Example

- March 6: short position on a July futures contract
- April 20: long position on a July futures contract
- End result: **the position is closed**
- The total gain or loss is determined by the difference in the futures price between March 6 and April 20

Margins

- A margin is cash or marketable securities deposited by an investor with his or her broker
- The balance in the margin account is adjusted to reflect daily settlement
- Margins minimize the possibility of a loss through a default on a contract

The Operation of Margins

- **Margin Account**: the account where funds are being deposited when at the time the contract is first entered to
- **Initial Margin**: the amount that must be deposited at the time the contract is first entered to (usually as % of the nominal value of the position)
- **Marking to Market**: at the end of each trading day the margin account is adjusted to reflect the investor's gain or loss
- **Maintenance Margin**: somewhat lower than the initial margin – if the balance in the margin account falls below the maintenance margin, the investor receives a **margin call** and is requested to top up the margin account to the initial margin level within a very short period of time
- **Variation Margin**: the extra funds deposited as a result of a margin call

Example of a Futures Trade

An investor takes a long position in 2 December gold futures contracts on June 3

- contract size is 100 oz.
- futures price is US$400
- margin requirement is US$2,000/contract (US$4,000 in total)
- maintenance margin is US$1,500/contract (US$3,000 in total)

A Possible Outcome

Day	Futures Price	Daily Gain (Loss)	Cumulative Gain (Loss)	Margin Acc. Balance	Margin Call
	400,00			4.000	
June 3	397,00	(600)	(600)	3.400	
June 4	396,10	(180)	(780)	3.220	
June 7	398,20	420	(360)	3.640	
June 8	397,10	(220)	(580)	3.420	
June 9	396,70	(80)	(660)	3.340	
June 10	395,40	(260)	(920)	3.080	
June 11	393,30	(420)	(1.340)	2.660	1.340
June 14	393,60	60	(1.280)	4.060	
June 15	391,80	(360)	(1.640)	3.700	
June 16	392,70	180	(1.460)	3.880	
June 17	387,00	(1.140)	(2.600)	2.740	1.260
June 18	387,00	0	(2.600)	4.000	
June 21	388,10	220	(2.380)	4.220	
June 22	388,70	120	(2.260)	4.340	
June 23	391,00	460	(1.800)	4.800	
June 24	392,30	260	(1.540)	5.060	

More Terminology

- **Open interest**: the total number of contracts outstanding
  - equal to number of long positions or number of short positions
- **Settlement price**: the price just before the final bell each day or a weighted average of the last (10-15 minutes before the and of the trading session)
  - used for the daily settlement process
- **Volume of trading**: the number of trades in 1 day

Delivery & Cash Settlement

- If a futures contract is not closed out before maturity, it is usually settled by delivering the assets underlying the contract. When there are alternatives about what is delivered, where it is delivered, and when it is delivered, the party with the short position chooses.
- A few contracts (for example, those on stock indices and Eurodollars) are settled in cash
- When a contact is settled in cash is marked to market at the end of the last trading day and all positions are declared closed
- Generally, the settlement price on the last trading day is the closing spot price of the underlying asset

Future Value & Continuous Compounding

- Future value with periodic compounding

  Assume: Capital: *A* Euros
  Investment horizon: *n* years
  Rate : *R* % annually

- Annual compounding

$$FV = A(1+R)^n$$

- Compounding m times per annum

$$FV = A\left(1+\frac{R}{m}\right)^{nm}$$

- Future value with continuous compounding

  Assume: Capital: *A* Euros
  Investment horizon: *n* years
  Rate : *R* % annually

$$FV = Ae^{Rn}$$

where e = 2,71828

Future Price of an Investment Asset

$$F = Se^{rT}$$

where

S : is the spot price

r : annualized continuously compounded risk-free rate, for an investment maturing at the delivery date

T : time until delivery date, expressed in years

Stock Index Futures

- Theoretical price of a stock index futures contract:

$$F = Se^{(r - q)T}$$

where

S : current index level

r : annualized continuously compounded risk-free rate, for an investment maturing at the delivery date

q : average annualized dividend yield of the index, during the life of the contract

T : time until delivery date, expressed in years

- Nominal value of a stock index futures contract: F_{actual} x Contract Multiplier

Stock Index Futures
(continued)

- Consider a 3-month futures contract on a stock index.
- Suppose that the index multiplier is $10, the stocks underlying the index provide a dividend yield of 1% per annum, that the current value of the index is 800, and that the continually compounded risk free rate is 6% per annum.
- In this case $r = 0.06$, $S = 800$, $T = 0.25$ and $q = 0.01$
- The theoretical futures price is:

$$F = Se^{(r-q)T} = 800 \text{x} e^{(0.06-0.01)\text{x}0.25} = 810.06$$

- The notional value of the contact is approximately: $8,100

Options

- A **call option** is an option to buy a certain asset by a certain date for a certain price (the strike price, *K*)
- A **put option** is an option to sell a certain asset by a certain date for a certain price (the strike price, *K*)
- An **American option** can be exercised at any time during its life
- A **European option** can be exercised only at maturity

Equity Options shown in the Financial Times

EQUITY OPTIONS

Option		.....Calls.....			.....Puts.....		
		Dec	**Jan**	**Feb**	Dec	Jan	Feb
Diageo	1350	**24**	**41**	**55.5**	18.5	34.5	48
(*1355)	1400	**5**	**18**	**30**	50	61.5	72.5

Option		.....Calls.....			.....Puts.....		
		Dec	**Jan**	**Feb**	Dec	Jan	Feb
Sainsbury	290	**11.75**	**15.75**	**18.75**	2.75	6.25	9.5
(*299.100)	300	**5.5**	**10**	**12.5**	6.5	10.5	13.25

FT *Financial Times*, 3 December/4 December 2011.

Major Exchanges Trading Options

- Chicago Board Options Exchange
- American Stock Exchange
- Philadelphia Stock Exchange
- Pacific Exchange
- LIFFE (London)
- Eurex (Europe)

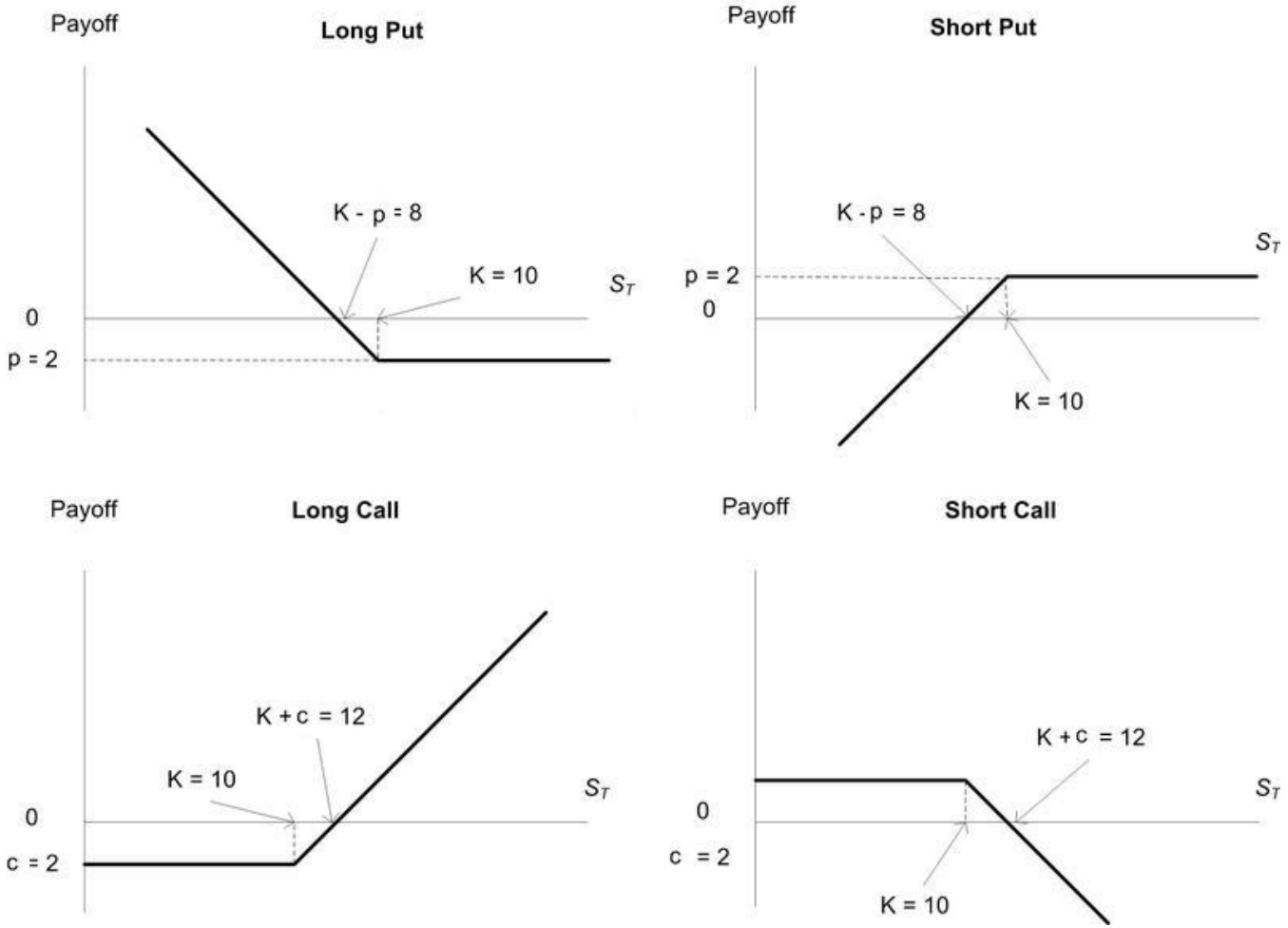
Assets Underlying Exchange-Traded Options

- Stocks
- Foreign Currency
- Stock Indices
- Futures

Options Positions

Position	**Call**	**Put**
Long	call holder	put holder
Short	call writer	put writer

Payoff Diagrams



Margins

- Margins are required when options are sold

- When a naked option is written the margin is the greater of:
  1 A total of 100% of the proceeds of the sale plus 20% of the underlying share price less the amount (if any) by which the option is out of the money
  2 A total of 100% of the proceeds of the sale plus 10% of the underlying share price

- For other trading strategies there are special rules

Closing Out Positions – Early Exercise

- **Option buyer**

  Sell the same option

- **Option seller**

  Buy the same option

- When a transaction is made:
  - If none of the two investors is closing out an existing position: **open interest + 1**
  - If one of the two investors is closing out an existing position: **open interest + 0**
  - If both investors are closing out existing positions: **open interest - 1**

Options vs. Futures/Forwards

- A futures/forward contract gives the holder the obligation to buy or sell at a certain price

- An option gives the holder the right to buy or sell at a certain price

Exercising an Option

1. The investor notifies his/her broker to exercise the option
2. The broker notifies the member that clears its trades
3. This member places an exercise order with the Options Clearing Corporation (OCC)
4. The OCC randomly selects a member with an outstanding short position in the same option
5. The member, using a procedure established in advance, selects a particular investor who has written the option
6. The assigned investor either buys or sells the stock

Option Pricing

- c = value of European call option
- S = current market price of share
- K = exercise price
- r_f = risk-free interest rate (per annum)
- T = time to expiry (in years)
- σ = standard deviation of the share price

Black and Schole's Option Pricing Model

$$c = SN(d_1) - Ke^{-rT}N(d_2)$$

$$d_1 = \frac{ln(S/K) + \left(r_f + \sigma^2/2\right)\mathrm{T}}{\sigma\sqrt{\mathrm{T}}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

ln = natural log

N ( ) = cumulative normal distribution function of d_1 and d_2

Factors Affecting Option Value

- Options have a minimum value of zero, i.e., $C \geq 0$
- The market value of an option will be greater than the intrinsic value at any time prior to expiry (Market value = Intrinsic value + Time value)
- Intrinsic value ($S - K$) rises as share price increases or exercise price falls
- The higher the risk-free rate of return the higher will be intrinsic value
- The maximum value of an option is the price of the share, i.e., $C \leq S$
- A major influence boosting the time value is the volatility of the underlying share price

Warrants

- **Warrants** are options that are issued by a corporation or a financial institution
- The number of warrants outstanding is determined by the size of the original issue and changes only when they are exercised or when they expire
- The issuer settles up with the holder when a warrant is exercised
- When call warrants are issued by a corporation on its own stock, exercise will lead to new treasury stock being issued

Executive Stock Options

- **Executive stock options** are a form of remuneration issued by a company to its executives
- They are usually at the money when issued
- When options are exercised the company issues more stock and sells it to the option holder for the strike price
- They become vested after a period of time (usually 1 to 4 years)
- They cannot be sold
- They often last for as long as 10 or 15 years
- Accounting standards now require the expensing of executive stock options

Convertible Bonds

- **Convertible bonds** are regular bonds that can be exchanged for equity at certain times in the future according to a predetermined exchange ratio

- Very often a convertible is callable

- The call provision is a way in which the issuer can force conversion at a time earlier than the holder might otherwise choose

Corporate uses of options

- Share option schemes
- Warrants
- Convertible bonds
- Rights issues
- Share underwriting
- Commodities
- Taking control of a company
- Protecting the company from foreign exchange rate losses
- Real options