



SECTION - 2

REAL OPTIONS IN CAPITAL INVESTMENT DECISIONS

This Section includes

- Introduction
- Terms and Definitions
- Factors which affect the Value of an Option
- Real Options in Capital Investment Decisions
- A Comparison of Options Pricing Models
- Illustration of options approach to valuation and investments

2.1. INTRODUCTION

- 2.1.1 A **real option** is the right, but not the obligation, to undertake some business decision, typically the option to make a capital investment. For example, the opportunity to invest in the expansion of a firm's factory is a real option. In contrast to financial options, a real option is not often tradeable - e.g. the factory owner cannot sell the right to extend his factory to another party, only he can make this decision; however, some real options can be sold, e.g., ownership of a vacant lot of land is a real option to develop that land in the future. Some real options are proprietary (owned or exercisable by a single individual or a company); others are shared (can be exercised by many parties). Therefore, a project may have a portfolio of embedded real options; some of them can be mutually exclusive.
- 2.1.2 The terminology "real option" is relatively new, whereas business operators have been making capital investment decisions for centuries. However, the description of such opportunities as real options has occurred at the same time as thinking about such decisions in new, more analytically-based, ways. As such, the terminology "real option" is closely tied to these new methods. The term "real option" was coined by Professor Stewart Myers at the MIT Sloan School of Management.
- 2.1.3 The concept of real options was popularized by Michael J. Mauboussin, the chief U.S. investment strategist for Credit Suisse First Boston and an adjunct professor of Finance at the Columbia School of Business. Mauboussin uses real options to explain the gap between the stock market prices and the "intrinsic value" for those businesses as calculated by traditional financial analysis.
- 2.1.4 Additionally, with real option analysis, uncertainty inherent in investment projects is usually accounted for by risk-adjusting probabilities (a technique known as the Equiva-

lent Martingale approach). Cash flows can then be discounted at the risk-free rate. With regular DCF analysis, on the other hand, this uncertainty is accounted for by adjusting the discount rate, using e.g. the cost of capital or the cash flows (using certainty equivalents). These methods normally do not properly account for changes in risk over a project's lifecycle and fail to appropriately adapt the risk adjustment. More importantly, the real options approach forces decision makers to be more explicit about the assumptions underlying their projections.

- 2.1.5 In business strategy, real options have been advanced by the construction of option space, where volatility is compared with value-to-cost. Latest advances in real option valuation are models that incorporate fuzzy logic and option valuation in fuzzy real option valuation models.

2.2. TERMS AND DEFINITIONS

Strategic NPV = Passive NPV + Present value of options arising from the active management of the firm's investment opportunities

2.2.1 The terms used in the study of real options are given below:

1. An option is a right to buy or sell a particular good for a limited time at a specified price (*the exercise price*). A call option is the right to buy. A *put* option is the right to sell.
2. The *expiration* date is the date when the option matures. An *American option* is exercisable anytime until the end of the expiration date while a *European option* is exercised only at the expiration date.
3. The *writer* of an option contract sells the call or put option while the buyer purchases the option contract from the seller. For real options, the firm is the implied buyer and the market is the implied seller. No actual contract is traded.
4. A call option is *out-of-the-money* when the price of the underlying assets is below the exercise price of the call and *in-the-money* when the price of the underlying assets is above the striking price of the call. The opposite is true for a put option, which is *out-of-the-money* when the price of the underlying assets is above the striking price of the call and *in-the-money* when the price of the underlying assets is below the striking price of the call.
5. Buyers may hold a *long (buy)* or *short (write)* position in the option.



2.3. FACTORS WHICH AFFECT THE VALUE OF AN OPTION

2.3.1 The factors which affect the value of an option are given below:

Symbol	Factor as it relates to stock option value	Factor as it relates to capital budgeting
P_0	Price of the underlying asset (i.e., stock price)	PV of expected operation CFs discounted at the project's cost of capital
X	Exercise price	For call options—the initial investment. For put options—the value of the project's assets if sold or shifted to a more valuable use
T	Time until the option expires	Time until the option expires or is no longer available
K_{rf}	Risk-free rate of interest	Risk-free rate of interest (use the yield on U.S. T-bills)
Σ	Standard deviation of the underlying asset (volatility of stock price)	Project risk - standard deviation of the operating cash flow as a percent of total investment

2.4. REAL OPTIONS IN CAPITAL INVESTMENT DECISIONS

Option:	Valued as a :
wait & learn more before investing	call
default during construction (staged investment)	a series of put options
alter operating scale (expand, restart)	call
alter operating scale (contract, shut down)	put
abandon	put
switch inputs or outputs	call + put
grow and build-on previous investments	call

K_{rf} = in all cases, this is the risk-free rate as measured by the return on U.S. T-bills closest to option expiration.

2.5. A COMPARISON OF OPTIONS PRICING MODELS

	Binominal Model	Black-Scholes Model
Description	*assumes that the time to an option's maturity can be divided into a number of subintervals, in each of which, there are only two possible price changes	*the binomial model estimated over an infinite number of sub-intervals
Advantages	*easier for executives to understand *bigger range of applications (B-S model cannot be used in all cases) *similar in structure to a decision tree but a much more concise representation of complex relationships	*easy to calculate with tables
Disadvantages	*more than one or two sub-intervals requires computer simulation *not easy to explain to executives	*not easy to explain to executives

2.6. ILLUSTRATION OF OPTIONS APPROACH TO VALUATION AND INVESTMENTS

Before we go into the options approach to investments, we will briefly recap the Black & Scholes option pricing model.

S	50	Current stock price		
X	50	Exercise price		
r	5.50%	Risk-free rate of interest		
T	5	Time to maturity of option (in years)		
Sigma	24%	Stock volatility		
d_1	0.7759	$\leftarrow (LN(S/X) + (r + 0.5 \cdot \sigma^2) \cdot T) / (\sigma \cdot \sqrt{T})$		
d_2	0.2282	$\leftarrow d_1 - \sigma \cdot \sqrt{T}$		
$N(d_1)$	0.7811	$\leftarrow$ Uses formula NormSDist(d_1)		
$N(d_2)$	0.5903	$\leftarrow$ Uses formula NormSDist(d_2)		
Call price	16.64	$\leftarrow S \cdot N(d_1) - X \cdot \exp(-r \cdot T) \cdot N(d_2)$		
Put price	4.62	$\leftarrow$ call price - $S + X \cdot \exp(-r \cdot T)$: by Put-Call parity		

The above model shows the price of call option and put option, whose values are mainly driven by the current price, the exercise price, the risk free rate of interest and the volatility, namely the standard deviation of the stock price or the underlying

2.6.1 Applying Black and Sholes model for capital investments

You are interested in acquiring the exclusive rights to market a new product that will make it easier for people to access their email on the road. It will cost 50 million upfront to set up the project. You will get the exclusive right for five years and the estimated cash flow is 10 million after tax every year. Assuming the cost of capital to be 15 percent, what is the net present value of this project? Simulation of cash flows indicate a standard deviation of 42% in the present value of cash flows with average as 33.5. Value the rights to this products using the options approach. Five year risk less rate is 5%.

NPV of the project	0	1	2	3	4	5
	-50	10	10	10	10	10
Cost of capital	0.15					
NPV	(\$16.48)					

Value of Underlying	\$33.52
Variance	0.42
Time	5
Dividend yield	0.2
r	0.05

S	33.52	Current stock price
X	50.00	Exercise price
r	0.05	Risk-free rate of interest
T	5.00	Time to maturity of option (in years)
Sigma	0.65	Stock volatility
Dividend yield	0.20	
d_1	0.62	$\leftarrow (LN(S/X) + (r + 0.5 \cdot \sigma^2) \cdot T) / (\sigma \cdot \sqrt{T})$
d_2	-0.83	$\leftarrow d_1 - \sigma \cdot \sqrt{T}$
$N(d_1)$	0.73	$\leftarrow$ Uses formula NormSDist(d_1)
$N(d_2)$	0.20	$\leftarrow$ Uses formula NormSDist(d_2)
Call price	1.10	$\leftarrow S \cdot \exp(-yt) \cdot N(d_1) - X \cdot \exp(-r \cdot T) \cdot N(d_2)$

- In this model, it is the same Black and Scholes that has been used along with dividends
- Dividends are the returns from assets which needs to be incorporated into the model
- In this case, it is 20% which is nothing (1/5), 5 is the life of the asset, namely the option