Quantitative Methods

PART 3: Valuation of Financial Instruments and Companies

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"Company Valuation is more an art than a science as it is all about predicting the future. To predict the future one needs imagination."
- Ph. De Brouwer, 2015.

Contents

PART I

Getting Started

About this Section

1.1 Objectives

Objectives of the program Company Valuation

understand	the building blocks of finance
understand	what are the value drivers for private companies
understand	what are some key financial instruments
know	how to calculate the value of basic financial instruments
know	different valuation methods, assumptions and application
apply	this knowledge to find data, scrutinize data, select a model and make informed decisions

PART I .:. CHAPTER 2 .:.

The Basic Toolbox

2.1 Time Value of Money

Interest

Lending an asset is re-compensated by paying interest to the lender.

If the asset has a value V_0 today and r is the unit interest rate over a unit period (eg. one year), then the interest due over 1 period is

$$I = rV_0$$

So, lending an asset over one period and giving it back at the end of that period plus the interest equals paying $(1+r)V_0$ at the end of that period. Therefore, the value of an asset within one year V_1 is:

$$V_1 = (1+r)V_0$$

The future value of an asset after N years becomes:

$$FV = (1+r)^N V_0$$

Or if there are no payments in between, then the future value of asset V_0 becomes

Compound Interest Rates over different time periods

Question

If the interest rate over one year is r_y, then how much interest is due over one month?(While in general that will depend on how many days the month has, for this exercise work with $\frac{1}{12}^{\text{th}}$).

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Definitions of Specific Interest Rates

It is common knowledge that financial institutions do not always use the same calculations methods and even for commercial reasons it might be possible that for example monthly interest rates are presented in stead of annual ones. For all those reasons regulator and law makers have introduced a concept of Annual Percentage Rate that should be a compound interest rate on an annual base (that takes into account the different costs). This allows easier comparison for the customer.

Definition 1 .:. APR or AER .:.

the Annual Percentage Rate (APR) or Effective Annual Rate or Annual Equivalent Rate (AER) is the annualized compound interest rate (r_y) that takes into account all costs for the borrower.

Question

A loan-shark asks a 5% interest rate for a one-month-loan. What is the APR?

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Question

If now the same loan shark decides to add an "administration fee" (to be paid immediately after getting the loan) of \$5 on a loan of \$100 for one month. What is the APR?

Nominal vs. Real Interest Rates

Definition 2 .:. Nominal Interest Rate .:.

The nominal interest rate (i_n) is the rate of interest (as shown or calculated) with no adjustment for inflation.

Definition 3 .:. Real Interest Rate .:.

The real interest rate (i_r) is the growth in real value (purchase power) of the loan plus interest corrected for inflation (p).

Example 1 .:. Real Interest Rate .:.

Assume that the inflation p is 10% and you borrow $\$100$ for one year and the lender asks you to pay back $\$110$ after one year. In that case you pay back the same amount in real terms as the amount that you have borrowed, so the real interest rate is 0% while the nominal interest rate is 10%.

The relation between the real and nominal interest rate is

$$(1 + i_n) = (1 + i_r)(1 + p)$$

and hence

$$i_r = \frac{1 + i_n}{1 + p} - 1$$

So, the relation $i_n = i_r + p$ is only and approximation of the first order (the proof is left as excercise)

Time Value

The Net Present Value is the Future value discounted today:

$$PV = \frac{FV}{(1 + r)^N}$$

Hence, the Net Present Value (NPV) of a series of cash flows (cf) equals:

$$NPV = \sum_{t=0}^{N} \frac{cf_t}{(1 + r)^t}$$

2.2 Cash

Definition 4 .:. Cash .:.

The strict definition of Cash is money in the physical form of currency, such as banknotes and coins.
In bookkeeping and finance, cash refers to current assets comprising currency or currency equivalents that can be converted to cash (almost) immediately. Cash is seen either as a reserve for payments, in case of a structural or incidental negative cash flow or as a way to avoid a downturn on financial markets.

Example 2

For example typically one considers current accounts, savings accounts, short term Treasury notes, etc. also as "cash".

***Note**: In this book we consider "cash" in its wider definition.*

2.3 Bonds

Definition 5 .:. Bond .:.

In finance, a bond is an instrument of indebtedness of the bond issuer to the holders. It is a debt security, under which the issuer owes the holders a debt and, depending on the terms of the bond, is obliged to pay them interest (the coupon) and/or to repay the principal at a later date, termed the maturity date. Interest is usually payable at fixed intervals (semi-annual, annual, sometimes monthly). Very often the bond is negotiable, i.e. the ownership of the instrument can be transferred in the secondary market. This means that once the transfer agents at the bank medallion stamp the bond, it is liquid on the second market.

Thus a bond is a form of loan: the holder of the bond is the lender (creditor), the issuer of the bond is the borrower (debtor), and the coupon is the interest. Bonds provide the borrower with external funds to finance long-term investments, or, in the case of government bonds, to finance current expenditure. Certificates of deposit (CDs) or short term commercial paper are considered to be money market instruments and not bonds: the main difference is in the length of the term of the instrument.

Bonds and stocks are both securities, but the major difference between the two is that (capital) stockholders have an equity stake in the company (i.e. they are investors), whereas bondholders have a creditor stake in the company (i.e. they are lenders). Being a creditor, bondholders have priority over stockholders. This means they will be repaid in advance of stockholders, but will rank behind secured creditors in the event of bankruptcy. Another difference is that bonds usually have a defined term, or maturity, after which the bond is redeemed, whereas stocks are typically outstanding indefinitely. An exception is an irredeemable bond (perpetual bond), ie. a bond with no maturity.

Features of a Bond

Definition 6 .:. Principal .:.

Nominal, principal, par, or face amount is the amount on which the issuer pays interest, and which –usually– has to be repaid at the end of the term. Some structured bonds can have a redemption amount which is different from the face amount and can be linked to performance of particular assets.

Definition 7 .:. Maturity .:.

The issuer has to repay the nominal amount on the maturity date. As long as all due payments have been made, the issuer has no further obligations to the bond holders after the maturity date. The length of time until the maturity date is often referred to as the term or tenor or maturity of a bond. The maturity can be any length of time, although debt securities with a term of less than one year are generally designated money market instruments rather than bonds. Most bonds have a term of up to 30 years, however some issues have no maturity date ("irredeemables" or "eternal bonds").

In the market for United States Treasury securities, there are three categories of bond maturities:

- short term (bills): maturities between one to five year; (instruments with maturities less than one year are called Money Market Instruments)
- medium term (notes): maturities between six to twelve years;
- long term (bonds): maturities greater than twelve years.

Definition 8 .:. Coupon .:.

The coupon is the interest rate that the issuer pays to the holder. Usually this rate is fixed throughout the life of the bond. It can also vary with a money market index, such as LIBOR.

The name "coupon" arose because in the past, paper bond certificates were issued which had coupons attached to them, one for each interest payment. On the due dates the bondholder would hand in the coupon to a bank in exchange for the interest payment. Interest can be paid at different frequencies: generally semi-annual, i.e. every 6 months, or annual.

Definition 9 .:. Yield .:.

The yield is the rate of return received from investing in the bond. It usually refers either to

- the current yield, or running yield, which is simply the annual interest payment divided by the current market price of the bond (often the clean price), or to
- the yield to maturity or redemption yield, which is a more useful measure of the return of the bond, taking into account the current market price, and the amount and timing of all remaining coupon payments and of the repayment due on maturity. It is equivalent to the internal rate of return of a bond.

Definition 10 .:. Credit quality .:.

The quality of the issue refers to the probability that the bondholders will receive the amounts promised at the due dates. This will depend on a wide range of factors. High-yield bonds are bonds that are rated below investment grade by the credit rating agencies. As these bonds are more risky than investment grade bonds, investors expect to earn a higher yield. These bonds are also called junk bonds.

Definition 11 .:. Market price .:.

The market price of a trade-able bond will be influenced amongst other things by the amounts, currency and timing of the interest payments and capital repayment due, the quality of the bond, and the available redemption yield of other comparable bonds which can be traded in the markets.

The price can be quoted as clean or dirty. ("Dirty" includes the present value of all future cash flows including accrued interest. "Dirty" is most often used in Europe. "Clean" does not include accrued interest. "Clean" is most often used in the U.S.) The issue price at which investors buy the bonds when they are first issued will typically be approximately equal to the nominal amount. The net proceeds that the issuer receives are thus the issue price, less issuance fees. The market price of the bond will vary over its life: it may trade at a premium (above par, usually because market interest rates have fallen since issue), or at a discount (price below par, if market rates have risen or there is a high probability of default on the bond).

Valuation of Bonds

$$P_{bond} = \sum_{t=0}^{N} \frac{cf_t}{(1+r)^t} \tag{2.1}$$

$$= \sum_{t=1}^{N} \frac{coupon_t}{(1+r)^t} + \frac{nominal}{(1+r)^N} \tag{2.2}$$

for a bond that pays annual coupon.

Question

Assume a bond with that has pays for the next five years each year one coupon of 5% while the interest rate is 5% (and the first coupon is due in exactly one year). What is the value of a bond emission of 1'000PLN? This means that buyer of the bond needs will see the following cash flows:

year	cash flow
0	-V_{bond}
1	5 PLN
2	5 PLN
3	5 PLN
4	5 PLN
5	105 PLN

Where we try to find V_{bond} assuming a discount rate of 5%.

Answer
1'000 PLN of course.

Question

You have just bought the bond and the interest rate drops to 3%. How much do you loose or win that day?

Answer
You win 91.59 PLN per bond of 1'000 PLN. This is logical because the interest rates are lower while your bond will still pay 5%, this is a good situation. You should be able to sell the bond for 1'091.59 PLN because your bond will an interest rate higher than the market rate.

Question

You have just bought the bond and the interest rate goes up to 7% in stead of going down. How much do you loose or win that day?

Answer
You loose 82.00 PLN per bond of 1'000 PLN. This is logical because the market interest rates are now higher than your bond. In the market you can buy bonds that yield 7% while your bond only yields five percent. If you would like to sell it one would only pay 917.99 PLN and not 1'000 PLN.

Question

Calculate the value of the bond DS0725, emitted by the Treasury of the Republic of Poland.

2.4 Equities

What is Equity

Definition 12 .:. Stock—shares—equity .:.

The capital stock of an incorporated business constitutes the equity stake of its owners. It represents the residual assets of the company that would be due to stockholders after discharge of all senior claims such as secured and unsecured debt.

Some common classes of shares:

1. **Common stock** usually entitles the owner to vote at shareholders' meetings and to receive dividends.

2. **Preferred stock** generally does not have voting rights, but has a higher claim on assets and earnings than the common shares. For example, owners of preferred stock receive dividends before common shareholders and have priority in the event that a company goes bankrupt and is liquidated.

***Note**: In some jurisdictions the United Kingdom, Republic of Ireland, South Africa, and Australia, stock can also refer to other financial instruments such as government bonds.*

Short History

- **Roman Republic**, the state outsourced many of its services to private companies. These government contractors were called *publicani*, or *societas publicanorum* (as individual company). These companies issued shares called *partes* (for large co-operatives) and *particulae* for the smaller ones.[1]

- **ca. 1250**: 96 shares of the *Société des Moulins du Bazacle* were traded (with varying price) in Toulouse

- **31/12/1600**: the East India Company was granted the Royal Charter by Elizabeth I (earliest recognized joint-stock company in modern times)[2]

- **1602**: the "Vereenigde Oostindische Compagnie" issued shares that were traded on the Amsterdam Stock Exchange

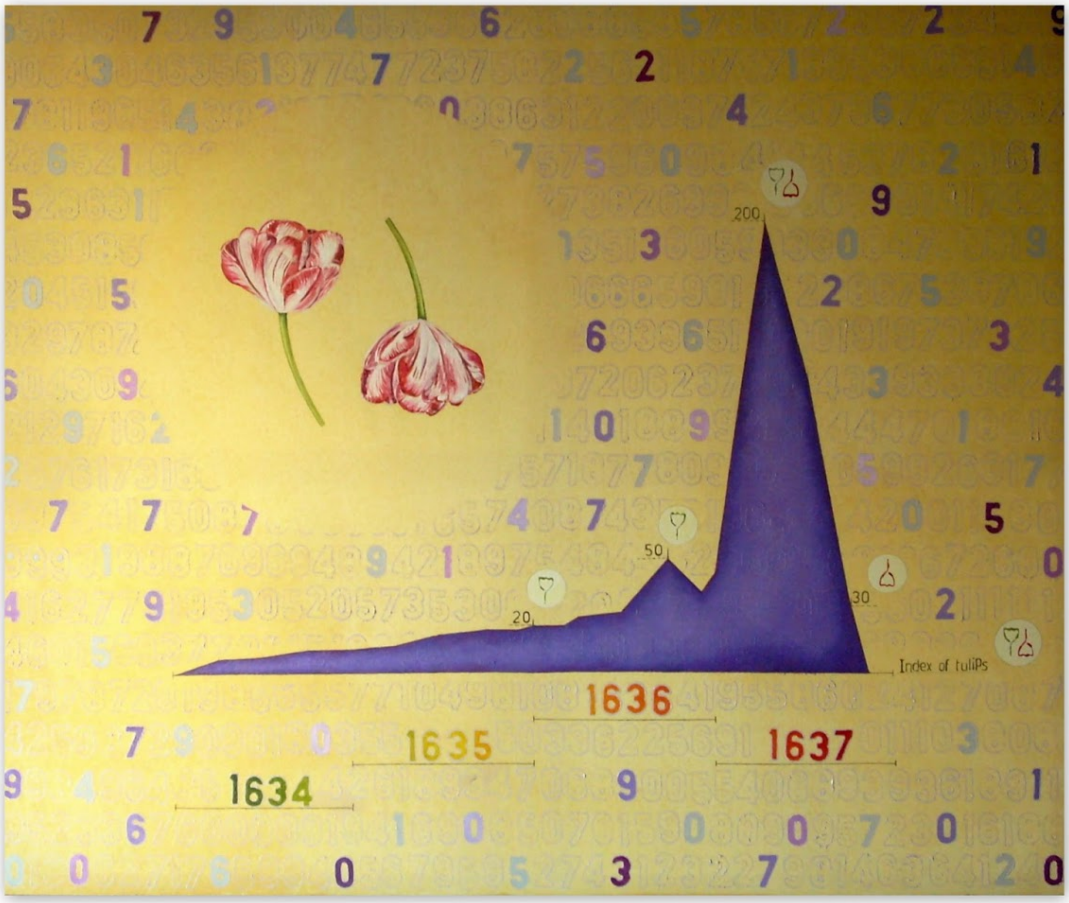
[1]Sources: Polybius (ca. 200—118 BC) mentions that "almost every citizen" participated in the government leases. Marcus Tullius Cicero (03/01/-106 — 07/12/-43) mentions "partes illo tempore carissimae" ("share that had a very high price at that time") (evidence for price fluctuations)

[2]The Royal Charter effectively gave the newly created Honourable East India Company a 15-year monopoly on all trade in the East Indies. This allowed it to acquire auxiliary governmental and military functions and virtually rule the East Indies.

- The invention of the stock exchange made pooling of capital efficient and allowed for larger financial expenses such as building ships . . . the success of The Netherlands as a maritime superpower soon followed

- Dutch stock market of the **17th century** had

  - stock futures,
  - stock options,
  - short selling,
  - credit to purchase stock (margin trading or "trading on a margin"),
  - . . . and the Tulipomania in 1637 – Mackay (1841)



Definition 13 .:. Equities .:.

The stock (also capital stock) of a corporation constitutes the equity stake of its owners. It represents the residual assets of the company that would be due to stockholders after discharge of all senior claims such as secured and unsecured debt. Owning equity/stock typically gives rise to voting rights and dividends

Valuation of Equities

$$P_{equity} = \sum_{t=0}^{N} \frac{cf_t}{(1+r)^t} \tag{2.3}$$

$$= \sum_{t=0}^{\infty} \frac{D_t}{(1+r)^t} \tag{2.4}$$

with $D = dividend$.

The Dividend Discount Model (DDM)

Theorem 2.4.1 (DDM). *The value of a stock is given by the discounted stream of dividends:*

$$V_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+r)^t}$$

Capital gains appear as expected sales value and are derived from expected dividend income.

V_0 the intrinsic value of the stock now

D_t the dividend paid in year t

r is the capitalization rate

constant-growth DDM (CGDDM)

If every year the dividend increases with $100g\%$ (with g the growth rate), then

$$\begin{aligned} D_1 &= D_0(1+g) \\ D_2 &= D_1(1+g) && = D_0(1+g)^2 \\ &\dots \\ D_n &= D_{n-1}(1+g) && = D_0(1+g)^n \end{aligned}$$

Theorem 2.4.2 (constant-growth DDM). *Assume that $\forall t : D_t = D_0(1+g)^t$, then the DDM collapses to*

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{D_1}{r-g}$$

Numeric Example: KTBC

Example 3 .:. KTBC with $g = 0\%$.:.

Assume "Known To Be A Corporate" (KTBC), the company pays now a dividend of € 10 and we believe that the dividend will grow at 0% per year. The risk free rate (on any horizon) is 1% and the market risk premium is 5% and the β is 1. What is the intrinsic value of the company?

Answer

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{D_0}{r} = \frac{10(1+0.00)}{0.01+0.05-0} = \frac{10}{0.06} = 166.67$$

This value is called the "no-growth-value".

Example 3 .:. KTBC with $g = 2\%$.:.

Expected growth rate of the dividend is 2%, ceteris paribus.

Answer

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{10(1+0.02)}{0.01+0.05-0.02} = 255$$

The difference in value compared to the previous example is called the PVGO (present value of growth opportunities). So

$$Price = \text{no-growth-value} + PVGO \tag{2.5}$$

$$P_0 = \frac{D_0}{r} + PVGO \tag{2.6}$$

Example 3

The β is assumed to be 1.5, ceteris paribus.

Answer

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{10(1+0.02)}{0.01+1.5\times 0.05-0.02} = 156.92$$

Example 3

The dividend growth rate is now expected to be 10%, ceteris paribus.

Answer

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{10(1+0.02)}{0.01+1.5\times 0.05-0.10} = -680$$

This example illustrates that the DDM is only valid for dividend growth rates smaller than the required rate of return! Actually the model states that anything above that is unsustainable and will lead to a correction.

2.5 Options

Learning Objectives

Know

- what options are
- how options are different from other derivatives
- the Black&Scholes model is and does

Understand

- what options can do for you
- how options can be dangerous
- what the assumptions of the Black&Scholes Model are

Apply

- calculate basic option price using the spreadsheet
- know the limits of an option price
- avoid pitfalls and risks
- be able to use the spreadsheet `options.ods` or `options.xlsm`

2.5.1 Definitions

An intuitive characterization

Question .:. What are options .:.

What is an option in common English language?

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An intuitive characterization

Question .:. Options in Finance .:.

How can this function in the Financial World?

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2.5.2 Definitions

Definitions

Definition 14 .:. Call .:.

A Call Option is the right to buy the underlying asset at a given price (the Strike) at some point in the future (the maturity date)

Definition 15 .:. Put .:.

A Put Option is the right to sell the underlying asset at a given price (the Strike) at some point in the future (the maturity date)

Definitions of the Parameters in an Option

Definition 16 .:. Strike or Execution Price .:.

the "strike" or "execution price" is the price at which an option can be executed (e.g. for a call the price at which the underlying can be sold when executing the option)
The strike price is denoted as X.

Definition 17 .:. Maturity .:.

The "maturity date" is the expiry date of an option, that is the last moment in time that it can change value because of the movement of the underlying.

More Definitions

Definition 18 .:. Exercising an Option .:.

The act of buying or selling the underlying asset via the option contract.

Definition 19 .:. Delivering of the Underlying .:.

Providing or accepting the underlying from the option buyer who exercises his/her option.

Definition 20 .:. Cash Settlement .:.

Simply pay out the profit of the option to the buyer in cash in stead of delivering the asset.

Definition 21 .:. European Option .:.

A European Option is an option that can be executed by the buyer at the maturity date and only at the maturity date.

Definition 22 .:. American Option .:.

An American Option is an option that can be executed by the buyer from the moment it is bought and till the at maturity date.

Imagine two call options on KBC Group NV

- option A has a strike of EUR 40, and
- option B has a strike of EUR 60

The actual price of the underlying, KBC Group NV, is EUR 50. Which option is worth most?

Definition 23 .:. Spot Price .:.

The actual value of the underlying asset (in the sense of "today's value"), the price to be paid for the asset to buy it today and have it today.
The spot price is traditionally denoted as S.

Definition 24 .:. Intrinsic Value .:.

The value that he option will have at maturity (not discounted, just nominal value). For example

- $IV_{call} = max(S - X, 0)$
- $IV_{put} = max(X - S, 0)$

Definition 25 .:. ITM .:.

An option is in-the-money if its Intrinsic Value is positive. So if the price of the underlying would be the same at maturity date, the option buyer would get some payoff.

Definition 26 .:. ATM .:.

An option is at-the-money if its Intrinsic Value is zero. For a call, this means that $S = X$

Definition 27 .:. OTM .:.

An option is out-of-the-money if the spot price is not equal to the strike and the intrinsic value of the option is zero. For a call, this means that $S < X$. This would mean that if at maturity the spot price would be the same as now, then the buyer would get no payoff.

Definition 28 .:. MTM .:.

A financial instrument is said to be Marked-To-Market is it is valued at its market price.

Illustration of Some Concepts

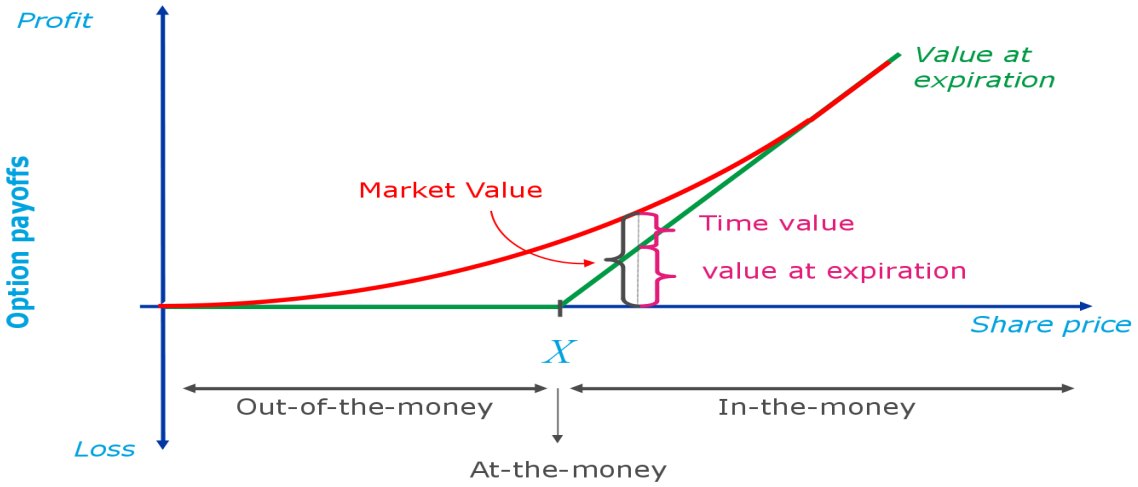

Figure 2.1: *Some concepts illustrated*

2.5.3 Commercial Aspects

Option Sides

On Which Side are You?

An option is "written" by the seller and bought by the buyer.

Definition 29 .:. short position .:.

The option writer has the **obligation** to sell or buy at the pre-agreed price. He/she has a **short** position.

Definition 30 .:. long position .:.

The option buyer has the **right** to sell or buy at the pre-agreed price. He/she has a **long** position.

Other Commercial terminology

An option can be bought or sold on a regulated stock exchange or "over the counter"

Definition 31 .:. OTC .:.

A financial instrument is said to be bought/sold Over-The-Counter if it is bought/sold **outside** a regulated stock exchange.

OTC vs. Exchange Traded:

1. counter-party risks
2. settlement
3. clearing
4. regulator oversight (SEC)

The Exchange Traded Market I

Global Futures and Options Volume

Based on the number of contracts traded and/or cleared at 84 exchanges worldwide

	Jan-Dec 2012	Jan-Dec 2013	% Change
Futures	11,072,105,368	12,217,755,153	10.3%
Options	10,118,012,082	9,425,664,621	-6.8%
Total	**21,190,117,450**	**21,643,419,774**	**2.1%**

Figure 2.2: *source: http://www.futuresindustry.org/downloads/FIA_Annual_Volume_Survey_2013.pdf*

The Exchange Traded Market II

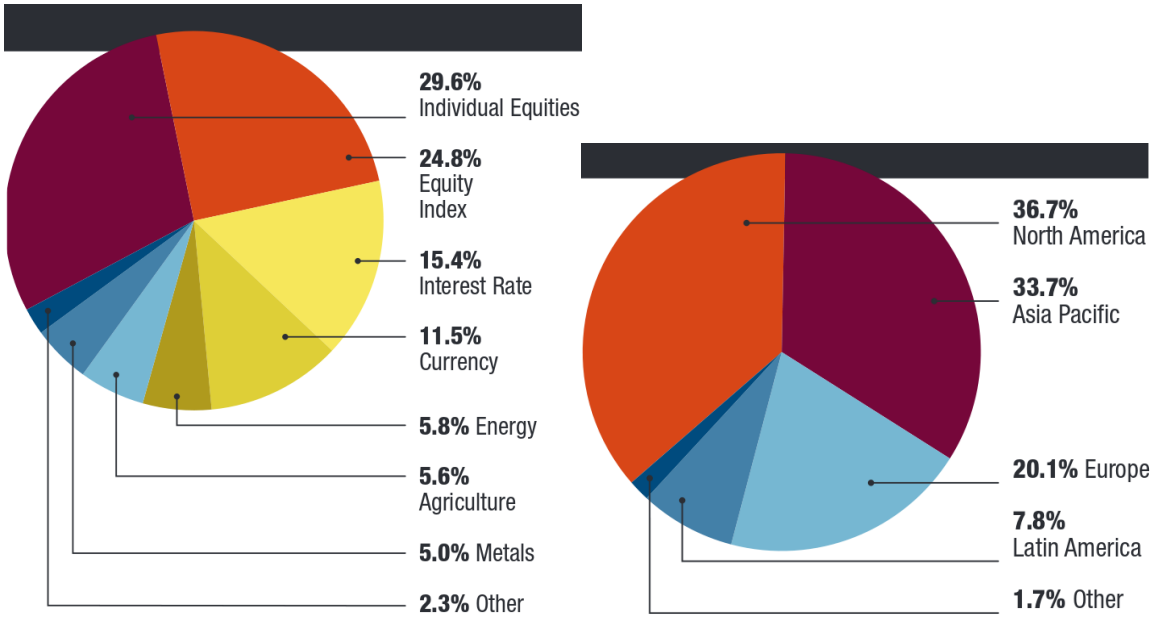

Figure 2.3: *source: http://www.futuresindustry.org/downloads/FIA_Annual_Volume_Survey_2013.pdf*

The Exchange Traded Market III

Examples of Exchanges Listing Options

- American Stock Exchange

- Chicago Board Options Exchange
- Eurex
- Euronext
- International Securities Exchange
- NYSE Arca
- Philadelphia Stock Exchange

The OTC Market

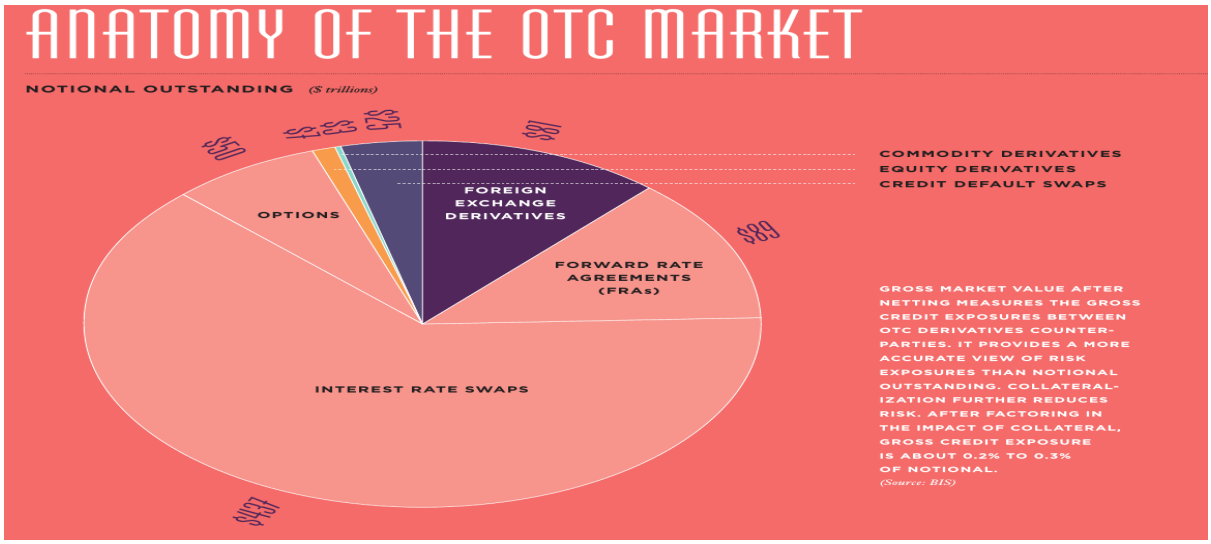

Figure 2.4: *source: ISDA*

ISDA

International Swap and Derivatives Organization

- **aim**: make OTC derivatives markets safe and efficient
- developed the ISDA Master Agreement and other documentation
- engages with policy-makers and legislators around the world
- ISDA has over 800 member institutions from 64 countries. These members include:
  - market participants corporations, investment managers, government and supranational entities, insurance companies, energy and commodities firms, and international and regional banks.
  - others: exchanges, clearinghouses and repositories, law firms, accounting firms and other service providers.

- ISDAs work in three key areas
  - reducing counterparty credit risk,
  - increasing transparency, and
  - improving the industrys operational infrastructure

2.5.4 Short History

History and Examples

1. Supposedly the first option buyer in the world was the ancient Greek mathematician and philosopher **Thales of Miletus** (ca. 624 – ca. 546 BC). On a certain occasion, it was predicted that the season's olive harvest would be larger than usual, and during the off-season he acquired the right to use a number of olive presses the following spring. When spring came and the olive harvest was larger than expected he exercised his options and then rented the presses out at much higher price than he paid for his "option". Kraut (2002)

2. **Tulipomania** (March 1637): on February 24, 1637, the self-regulating guild of Dutch florists, in a decision that was later ratified by the Dutch Parliament, announced that all futures contracts written after November 30, 1636 and before the re-opening of the cash market in the early Spring, were to be interpreted as option contracts. Mackay (1841)

3. In **London**, puts and "refusals" (calls) first became well-known trading instruments in the 1690s during the reign of William and Mary. Smith (2004)

4. **Privileges** were options sold over the counter in nineteenth century America, with both puts and calls on shares offered by specialized dealers. Their exercise price was fixed at a rounded-off market price on the day or week that the option was bought, and the expiry date was generally three months after purchase. They were not traded in secondary markets.

5. in real **estate market**, call options have long been used to assemble large parcels of land from separate owners; e.g., a developer pays for the right to buy several adjacent plots, but is not obligated to buy these plots and might not unless he can buy all the plots in the entire parcel.

6. **Film or theatrical producers** often buy the right but not the obligation to dramatize a specific book or script.

7. **Lines of credit** give the potential borrower the right but not the obligation to borrow within a specified time period.

8. Many choices, or embedded options, have traditionally been included in **bond contracts**. For example many bonds are convertible into common stock at the

buyer's discretion, or may be called (bought back) at specified prices at the issuer's option. Mortgage borrowers have long had the option to repay the loan early, which corresponds to a callable bond option.

9. **the option to buy a car at a pre-agreed price after a lease contract**.

10. etc.

2.5.5 Options among Other Derivatives

Options among Other Derivatives

- an **option** is the right to buy or sell at a pre-agreed price and moment
- a **future** is the obligation to sell or by at pre-agreed price and moment
- a **swap** is agreeing now to exchange a future cash flow with another

For example, one can swap an option where the buyer pays for example LIBOR +5bps during the life time of the option in stead of paying up front the option price ... one can buy a future or an option on that structure ...

2.5.6 Valuation of Options at Maturity

Valuation of Options at Maturity

Example 4

Anna holds one European call option on SAS, the price of the underlying is € 20 and the strike price is € 12 as the maturity date arrives. What is the value of the option for her?

Answer

She can "call" one share of SAS from the option seller at € 12, she then can sell it immediately in the market for € 20. So she has a profit of € 8 on this call.

Valuation of Options at Maturity

Long Call

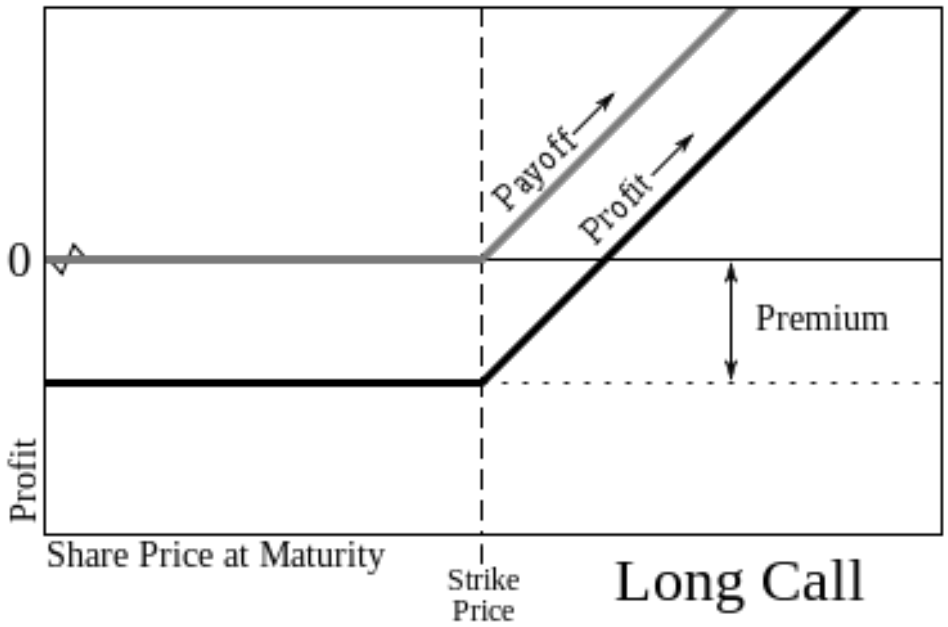

Figure 2.5: *the payoff of a long call option at maturity*

Valuation of Options at Maturity

Short Call

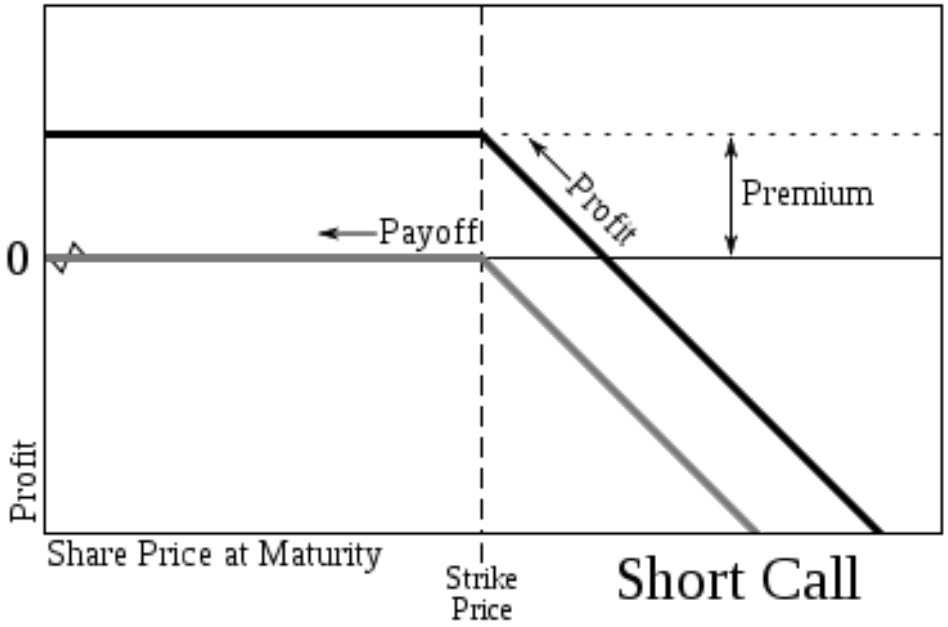

Figure 2.6: *the payoff of a short call option at maturity*

Valuation of Options at Maturity

Long Put

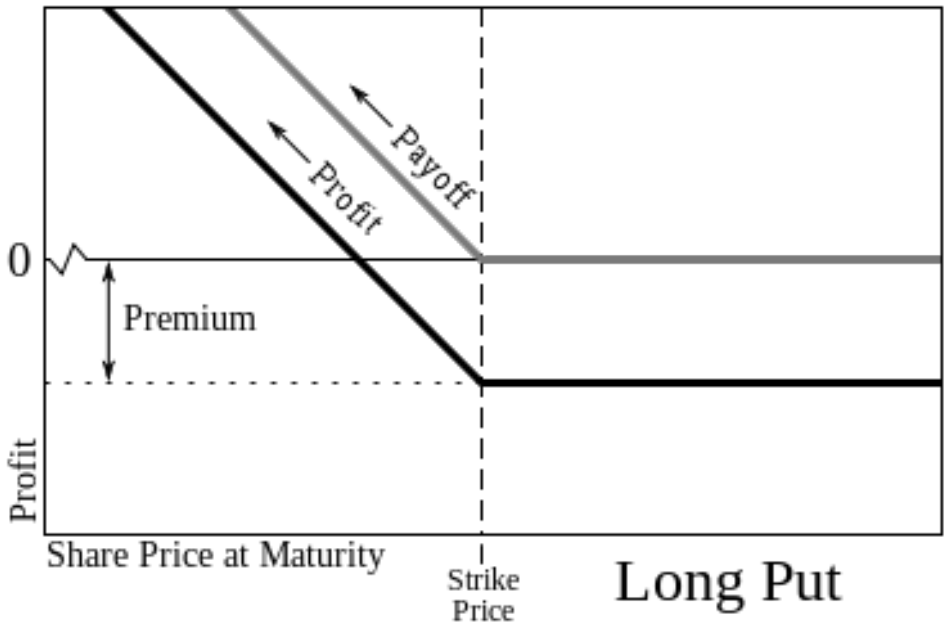

Figure 2.7: *the payoff of a Long Put option at maturity*

Valuation of Options at Maturity

Short Put

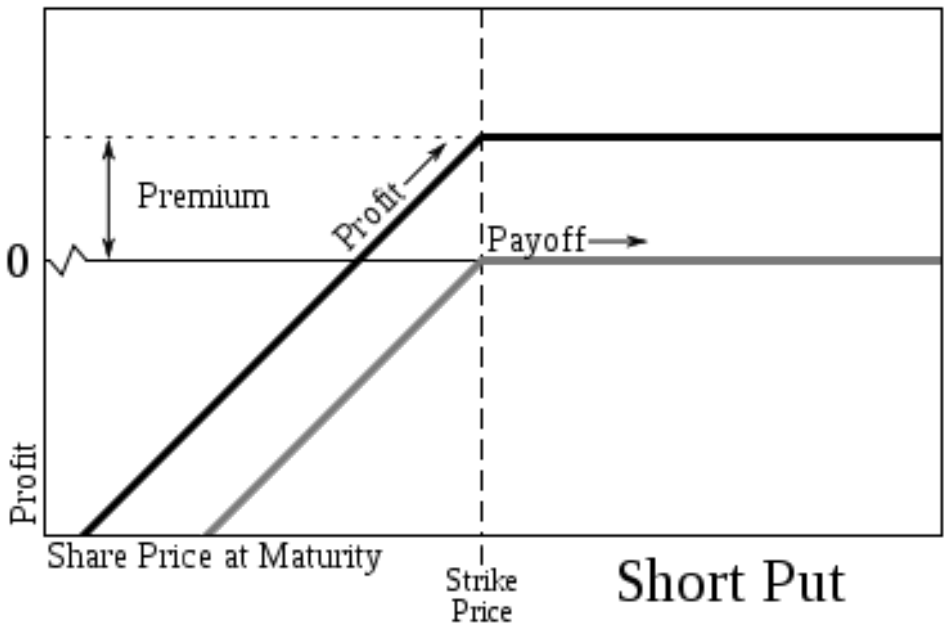

Figure 2.8: *the payoff of a Short Put option at maturity*

2.5.7 Pricing of Options Before Maturity: the Black&Scholes-formula

The Put-Call Parity

The Put-Call Parity

For European Put and European Call

What's the relation between a Put and a Call that

- are both European,
- have the same strike,
- have the same maturity, and
- have the same underlying?

The Put-Call Parity

For European Put and European Call

$$C - P = D(F - X)$$

with

- C = the price of the Call
- P = the price of the Put
- F = the future price of the underlying
- X = the strike price
- D = the discount factor so that $S = D.F$

This can be rewritten as

$$C - P = S - D.X$$

the right hand side is the same as buying a forward contract on the underlying with the strike as delivery price. So, a portfolio that is long a call and short a put is the same as being long a forward.

The Put-Call Parity

For European Put and European Call

The Put-Call Parity can be rewritten as

$$C + DX = P + S$$

Question

What does this mean?

. . . . . .

. . . . . .

. . . . . .

. . . . . .

Introduction

Pricing of Options

The option price is called "the premium".

Question

But how to calculate its value?

. . . . . .

. . . . . .

. . . . . .

. . . . . .

The Black and Scholes model

What Is It?

Use the basic statistical toolbox to calculate the expected value of the the option. This involves:

1. making some (strong!) simplifying assumptions,
2. writing the payoff formulate of the European call,
3. calculating the expected value of a European call,
4. deriving the value of the European Put via the put-call-parity.

Deriving the Formula

The Black and Scholes model

Assumptions

1. log-returns follow a Gaussian distribution on each time interval
2. the returns of one period are statistically independent of the return in other periods
3. volatility and expected return exist and are and stable
4. the continuous time assumption:
   - interest rates are continuous: so that $e^{rt} = (1+i)^t$, implying that the compounded continuous rate can calculated from the annual compound interest rate: $r = \log(1+i)$
   - also returns are can be split infinitesimally and be expressed as a continuous rate

The Black and Scholes Formula

- Call Price: $C(S, X, \tau, r, \sigma) = N(d_1)S - N(d_2)Xe^{-r\tau}$
- Put Price: $P(S, X, \tau, r, \sigma) = Xe^{-r\tau} - S + C(S, X, \tau, r, \sigma)$
- with:

$N(\cdot)$ the cumulative distribution function of the standard normal distribution

τ the time to maturity

S the spot price of the underlying asset

X the strike price

r the risk free rate (annual rate, expressed in terms of continuous compounding)

σ the volatility of the returns of the underlying asset

$$d_1 := \frac{\log(\frac{S}{X}) + \left(r + \frac{\sigma^2}{2}\right)(\tau)}{\sigma\sqrt{\tau}}$$

$$d_2 := \frac{\log(\frac{S}{X}) + \left(r - \frac{\sigma^2}{2}\right)(\tau)}{\sigma\sqrt{\tau}} = d_1 - \sigma\sqrt{\tau}$$

The Results

To Fix the Ideas

We will work with the following example in mind (unless stated otherwise)

- $S = 100$
- $X = 100$ (when $S = X$ one says that the "option is at-the-money")
- $\sigma = 20\%$
- $r = 2\%$
- $\tau = 1\ year$

The Price of a Call Option

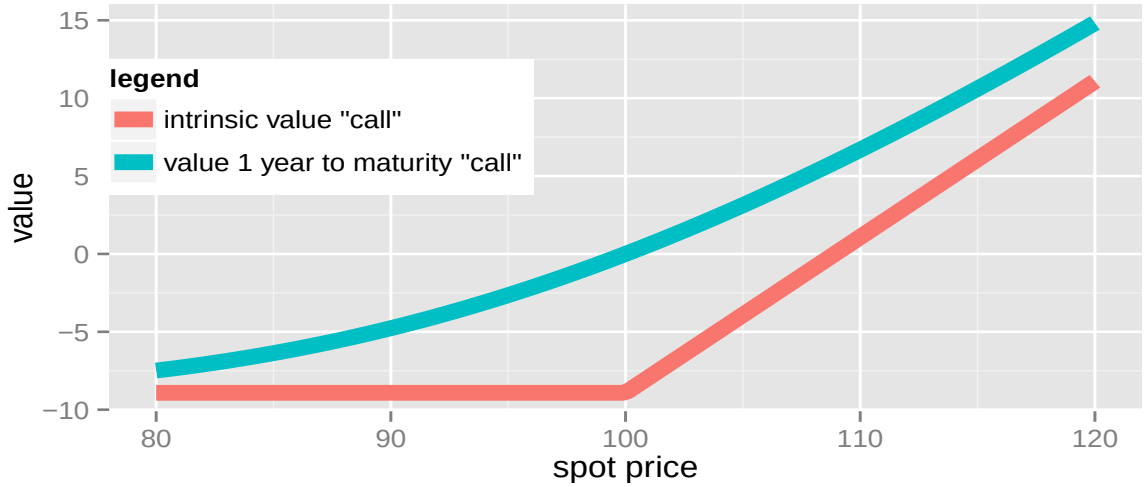

Figure 2.9: *The price of a European call option in function of the spot price, with* $strike = 100$, $time\ to\ maturity = 1\ year$, $\sigma = 0.2$, $r = 2\%$.

The Price of a Put Option

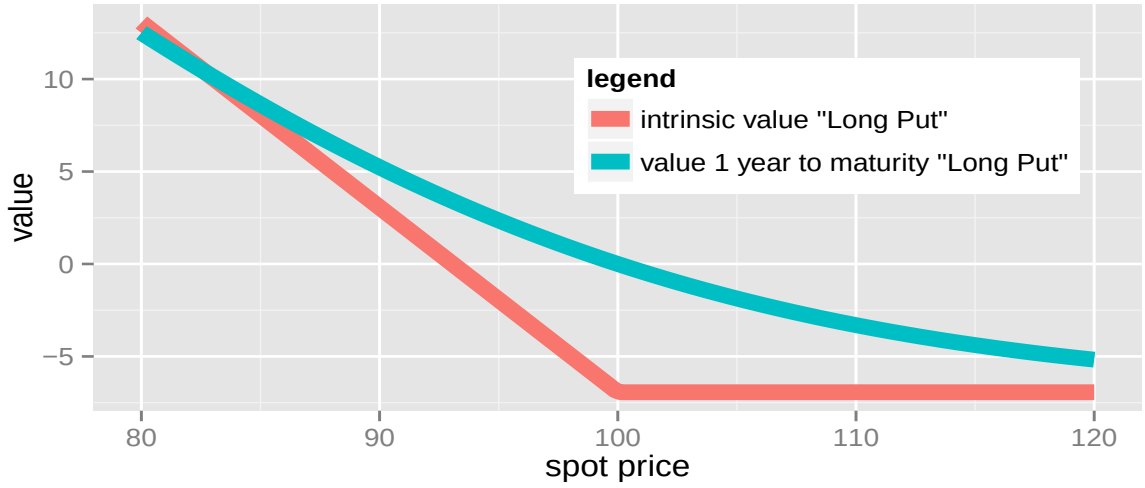

Figure 2.10: *The price of a European Put option in function of the spot price, with* $strike = 100$, $time\ to\ maturity = 1\ year$, $\sigma = 0.2$, $r = 2\%$

2.5.8 Selected Questions

Selected Questions

1. What is the definition of a Call?

2. What is the definition of a Put?

3. What is the difference between a European option and an American one?

4. Is the maturity date the date at which the last fixing is done or at which the payments (if any) arrive to the buyer?

5. Is it possible to pay an option by swapping the option premium with for example the coupon of a bond?

6. How is an option different from an insurance?

7. What does ISDA stands for? What is its relevance?

8. Would you prefer to buy an option that is OTM or one that is ITM?

9. Can the Time Value of a Call be negative? Why?

10. Can the Time Value of a Put be negative? Why?

11. Suppose ABC stock currently is trading at $ 60 per share, has an annualized deviation of 35%, and will not pay any dividends over the next three months; also suppose that the continuously compounded annual risk-free rate is 6%.

    (a) Calculate the equilibrium price for a three month ABC 60 European call option.

    (b) Calculate the equilibrium price for a three month ABC 60 European put option.

    (c) Suppose the ABC call is priced at $ 4,91 when ABC stock is at $ 60. Define the arbitrage strategy you would set up.

    (d) Suppose the ABC put is priced at $ 3,91 when ABC stock is at $ 60. Define the arbitrage strategy you would set up.

Learning Objectives

Know

- what options are
- how options can be used

Understand

- what options can do for you
- when what strategy would be useful
- what "delta" is

Apply

- be able to construct a simple option strategy
- judge when options can be used
- the concept of delta hedging

2.5.9 Dependencies

Call Price Dependence on Time To Maturity

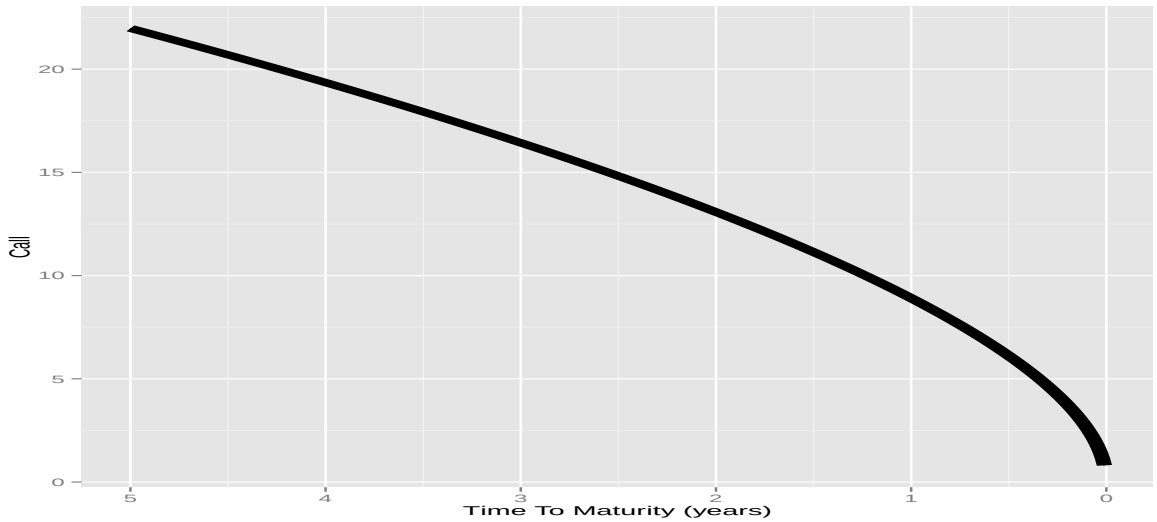

Figure 2.11: *The price of a European call option in function of Time To Maturity, with* $strike = \$\,100$, $spot = \$\,100$, $\sigma = 0.2$, $vol = 0.2$, $r = 2\%$.

Call Price Dependence on Interest Rates

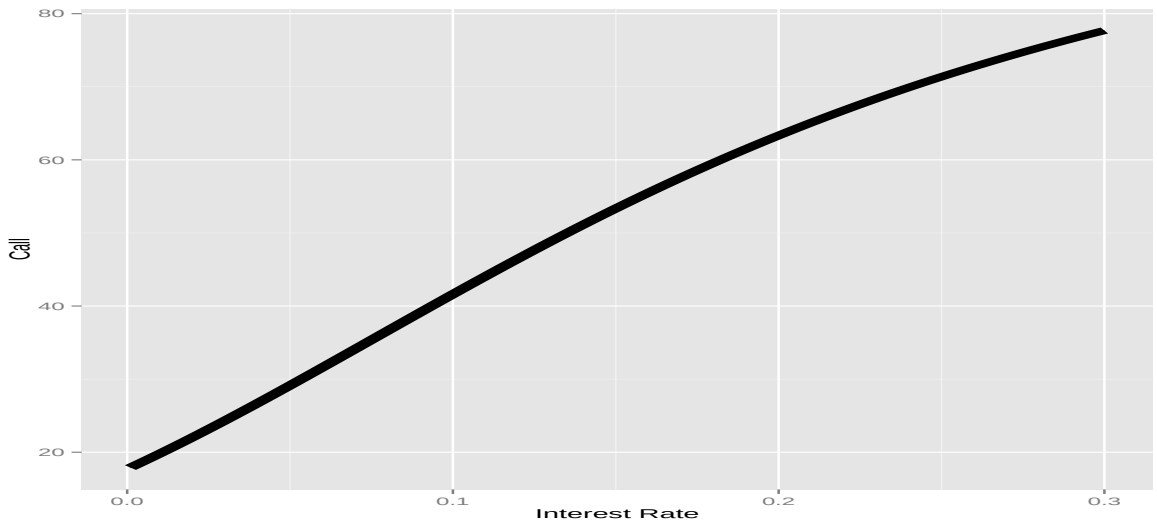

Figure 2.12: *The price of a European call option in function of Interest Rates, with* $strike = \$\ 100$, $time\ to\ maturity = 1\ year$, $spot = \$\ 100$, $\sigma = 0.2$, $vol = 0.2$

Call Price Dependence on Volatility

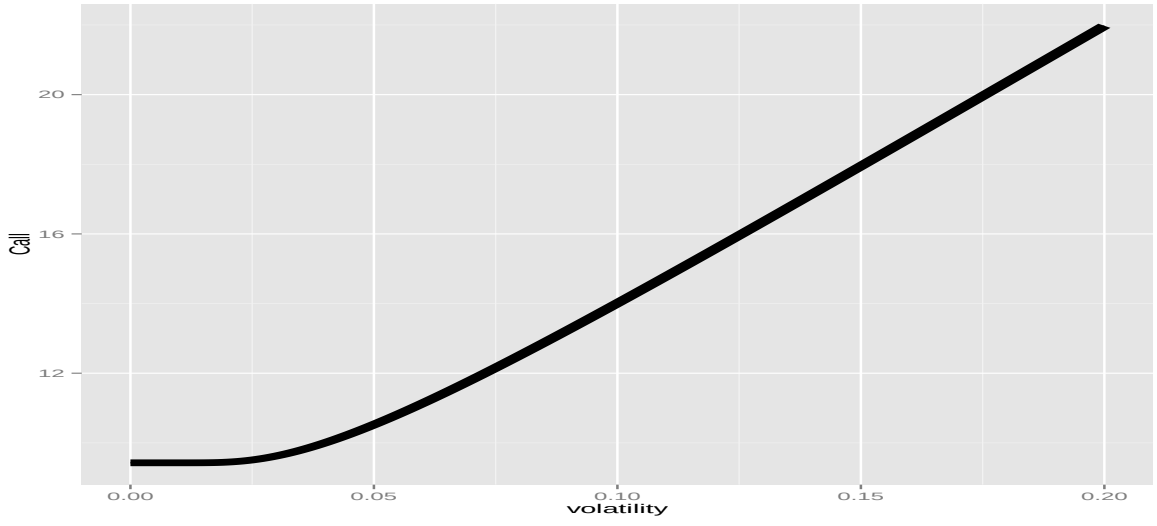

Figure 2.13: *The price of a European call option in function of Volatility, with* $strike = \$\ 100$, $time\ to\ maturity = 1\ year$, $spot = \$\ 100$, $\sigma = 0.2$, $r = 2\%$.

Call Price Dependence on Strike Price

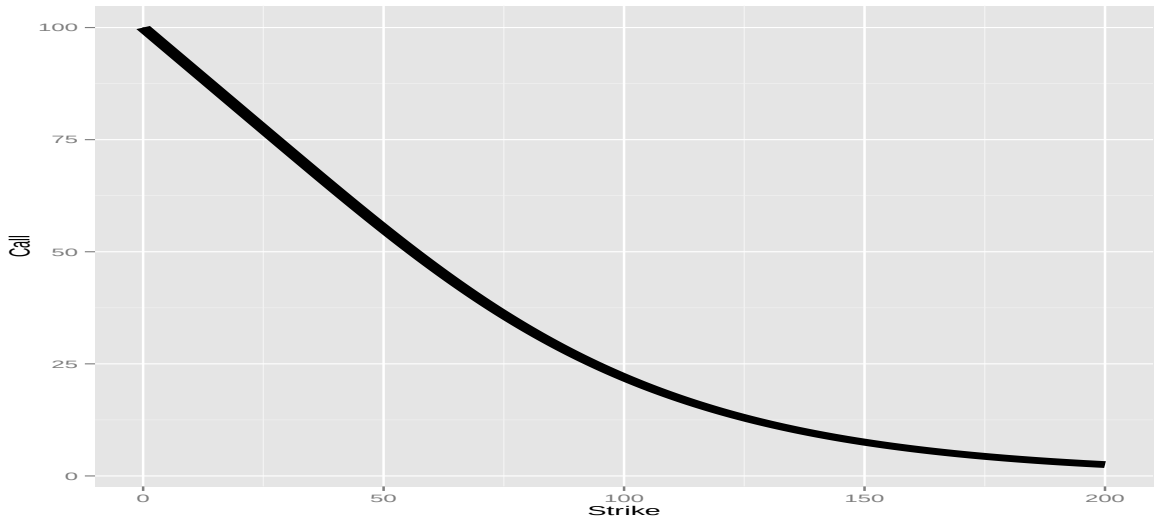

Figure 2.14: *The price of a European call option in function of Strike Price, with* $time\ to\ maturity = 1\ year$ *,* $spot = \$\ 100$ *,* $\sigma = 0.2$*,* $r = 2\%$*.*

Call Price Dependence on Spot Price

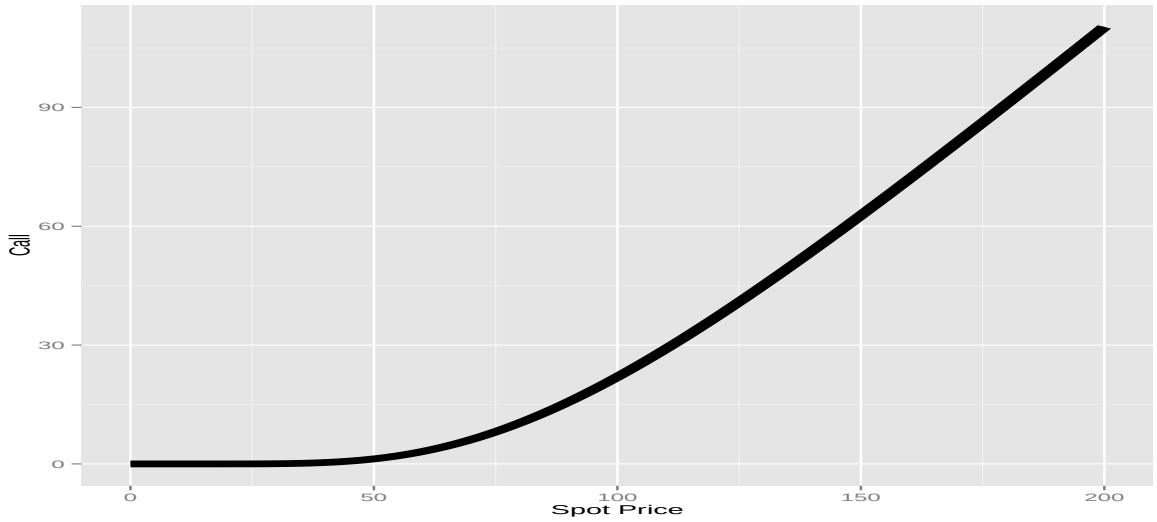

Figure 2.15: *The price of a European call option in function of Spot Price, with* $strike = \$\ 100$*,* $time\ to\ maturity = 1\ year$ *,* $\sigma = 0.2$*,* $r = 2\%$*.*

Summary of Dependencies

2.5.10 Sensitivities: "the Greeks"

The Greeks

Note*: Only the* δ *will be important on the exam. Not even for* δ *you need to know this formula.*

Dependency on ...	Call	Put
Spot (value of underlying)	+	-
Volatility of underlying	+	+
Time to Maturity	+	+
Interest Rate	+	-
Dividend	-	+

Table 2.1: *An overview of the price dependency for call and put options*

	What	Call	Put
delta	$\frac{\partial C}{\partial S}$	$N(d_1)$	$-N(-d_1) = N(d_1) - 1$
gamma	$\frac{\partial^2 C}{\partial S^2}$	$\frac{N'(d_1)}{S\sigma\sqrt{\tau}}$	
vega	$\frac{\partial C}{\partial \sigma}$	$SN'(d_1)\sqrt{\tau}$	
theta	$\frac{\partial C}{\partial t}$	$-\frac{SN'(d_1)\sigma}{2\sqrt{\tau}} - rKe^{-r(\tau)}N(d_2)$	$-\frac{SN'(d_1)\sigma}{2\sqrt{\tau}} + rKe^{-r(\tau)}N(-d_2)$
rho	$\frac{\partial C}{\partial r}$	$K(\tau)e^{-r(\tau)}N(d_2)$	$-K(\tau)e^{-r(\tau)}N(-d_2)$

Table 2.2: *An overview of "The Greeks".*

Delta — δ

Call

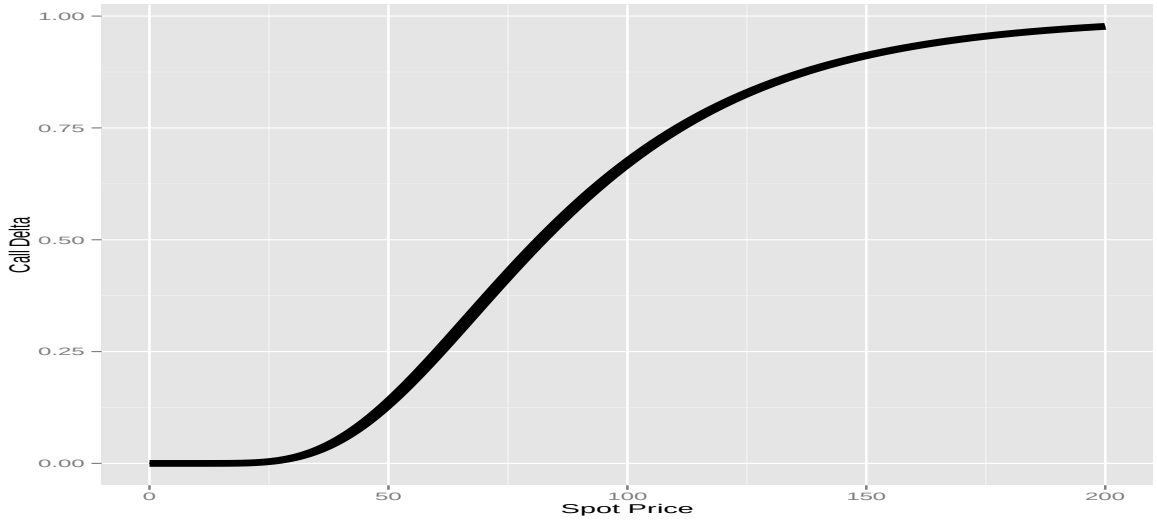

Figure 2.16: *The Delta a European call option in function of Spot Price, with* $strike = \$\ 100$, $time\ to\ maturity = 1\ year$, $\sigma = 0.2$, $r = 2\%$.

Delta — δ

Put

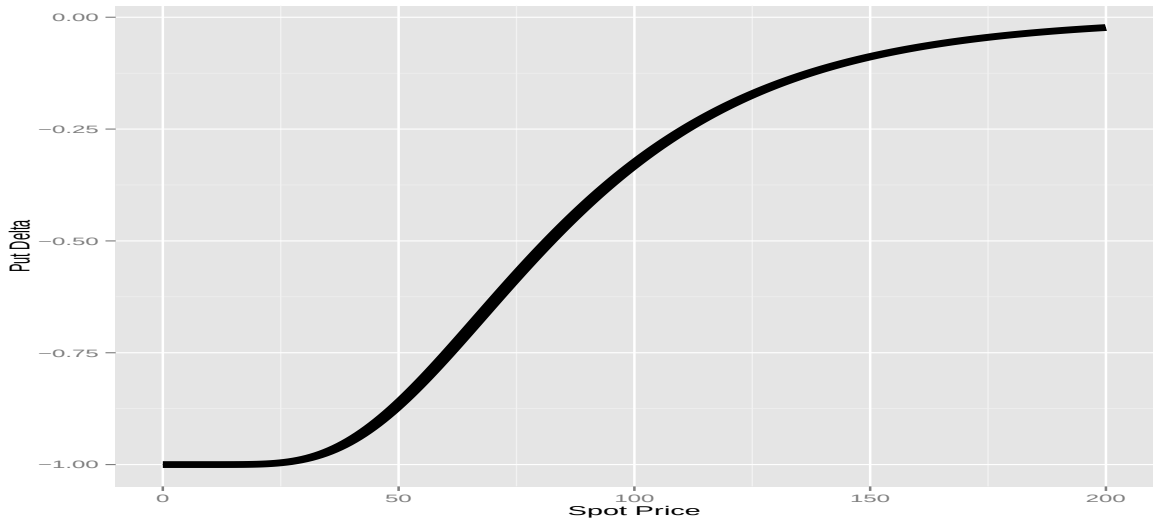

Figure 2.17: *The Delta a European Put option in function of Spot Price, with* $strike = \$\ 100$, $time\ to\ maturity = 1\ year$, $\sigma = 0.2$, $r = 2\%$.

2.5.11 Delta Hedging

How can the option write Insure him/herself?

Delta Hedging

- For a Call, buy as much underlying as indicated by the delta
- For a Put, sell as much underlying as indicated by the delta
- Repeat this step as often as possible

Delta Hedging Example

Example 5

assume an asset with $strike = \$\ 100$, $time\ to\ maturity = 5\ year$, $\sigma = 0.2$, $r = 0.02$ (as continuous, so as percent: 1.98%).

tm 2 mat.	spot	delta	to hedge	portf.	to buy	cash
5.00	100.00	0.67	67.26	0.00	67.26	67.26
4.00	110.00	0.74	81.22	73.99	7.23	74.49
3.00	95.00	0.58	54.97	70.14	-15.18	59.32
2.00	110.00	0.73	80.55	63.65	16.91	76.22
1.00	105.00	0.67	70.50	76.89	-6.39	69.83
0.00	115.00	1.00	115.00	77.22	37.78	107.62

Table 2.3: *Delta hedging in practice.*

Delta Hedging Example

Previous Example Continued

In previous example –where we adapt our position only once a year– the option writer has to buy and sell during the hedge. However,

- the pay-off of the option is $\$\ 15$, that is what the option writer pays the option buyer
- our option writer has spent $\$\ 107$ (non-discounted) and can sell this portfolio for $\$\ 115$ (difference is (non-discounted) $\$\ 8$), this is $\$\ 7$ short for paying his customer, but he did get the premium!
- compared to the option price: $22.02\% \Longrightarrow \$\ 15.02$ profit (non-discounted)
- The difference at the end is $\$\ 37.78$ (additional shares to buy). This is a big risk and results from leaving the position open for one year!

so the option writer should ...

- hedge more often ... as long as it is efficient for transaction costs
- and it is not sufficient to hedge delta only ... all Greeks have to be zero!

2.5.12 Linear Option Strategies

Option Strategies: the Long Call

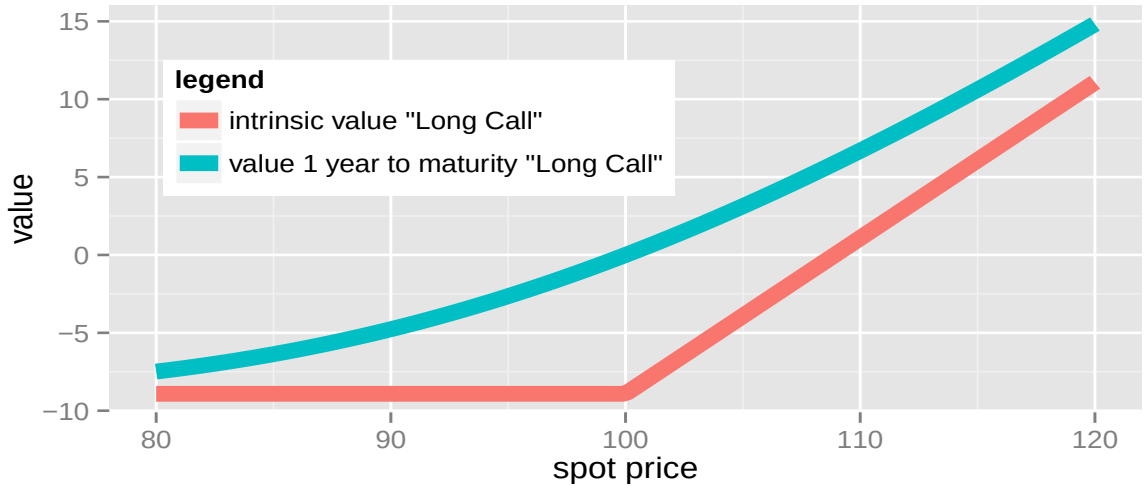

Figure 2.18: *A long Call is the position of the option buyer*

Option Strategies: the Short Call

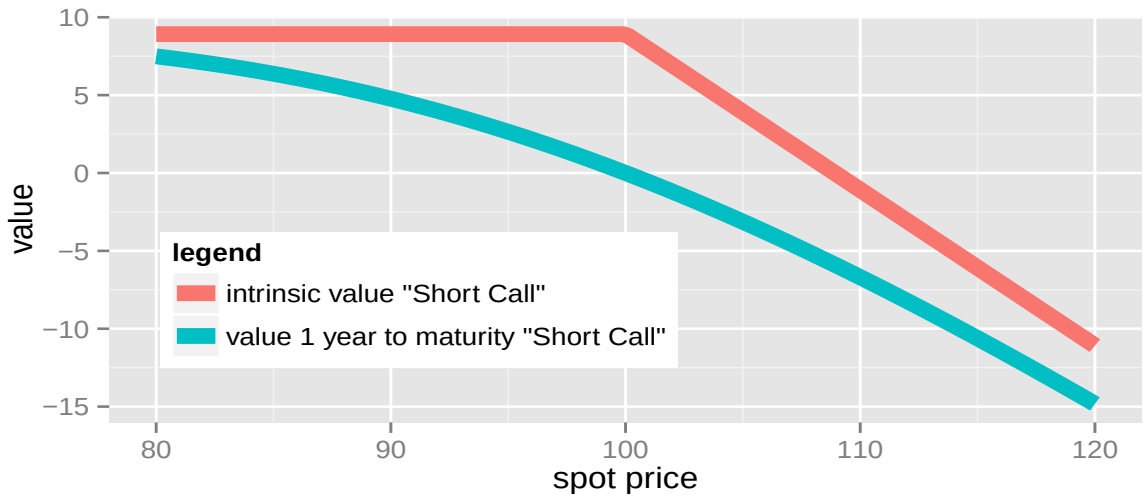

Figure 2.19: A Short Call is the position of the option writer

Option Strategies: the Long Put

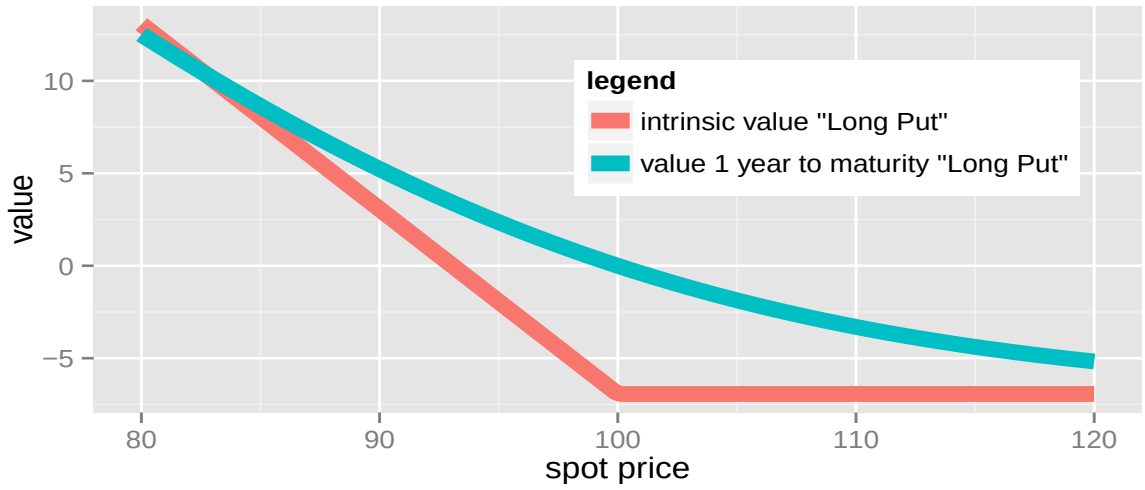

Figure 2.20: A Long Put is the position of the option buyer

Option Strategies: the Short Put

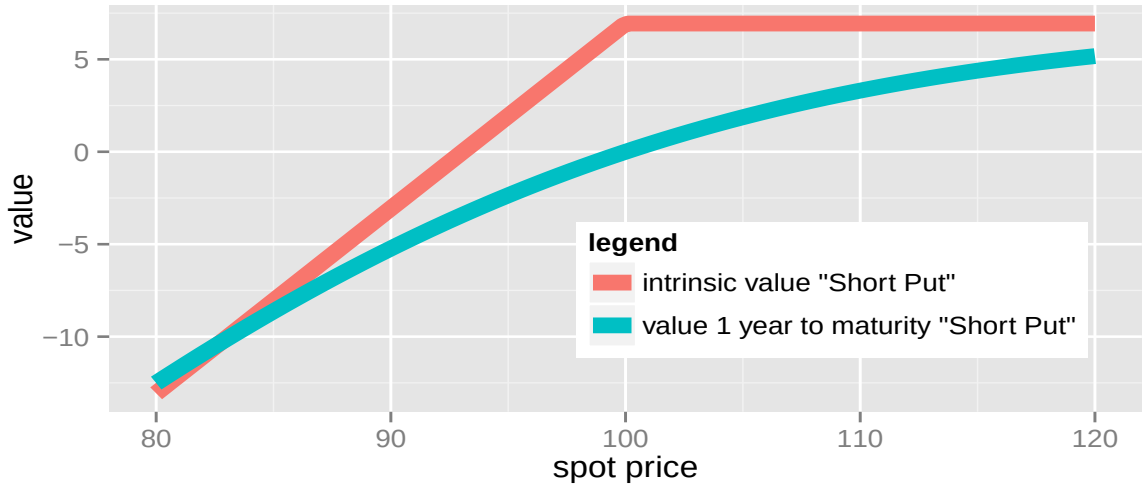

Figure 2.21: *A Short Put is the position of the option writer*

Option Strategies: the Straddle

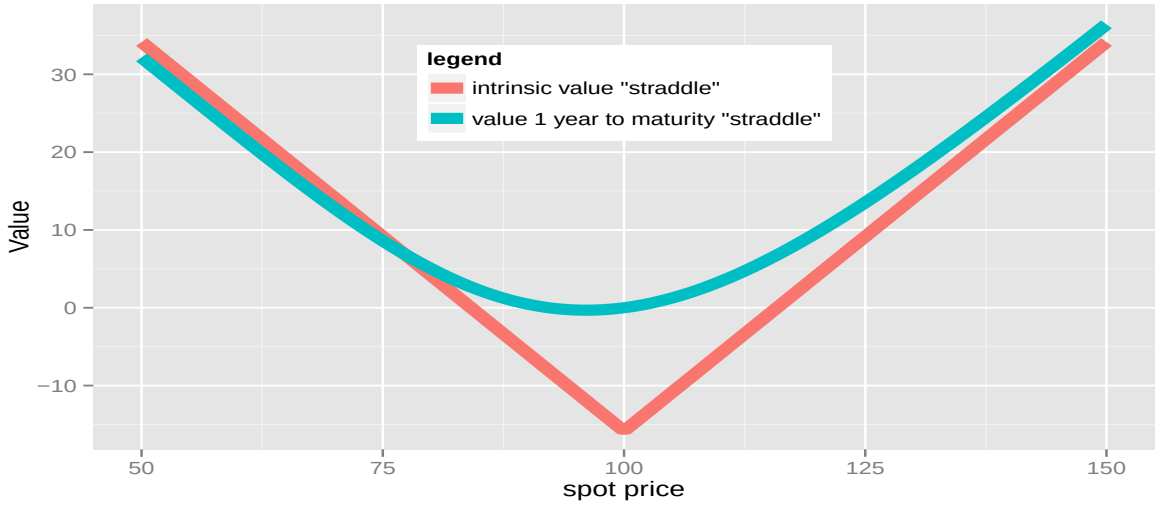

Figure 2.22: *A straddle is a long call and a long put (both ATM)*

Option Strategies: the Strangle

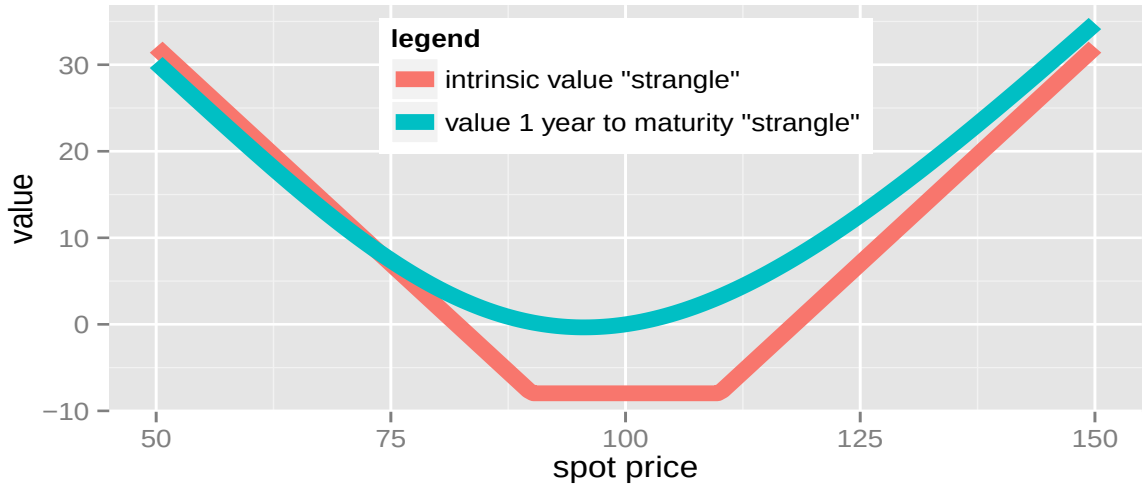

Figure 2.23: *A Strangle is a long call and a long put with different strikes*

Option Strategies: Long Call and Short Put

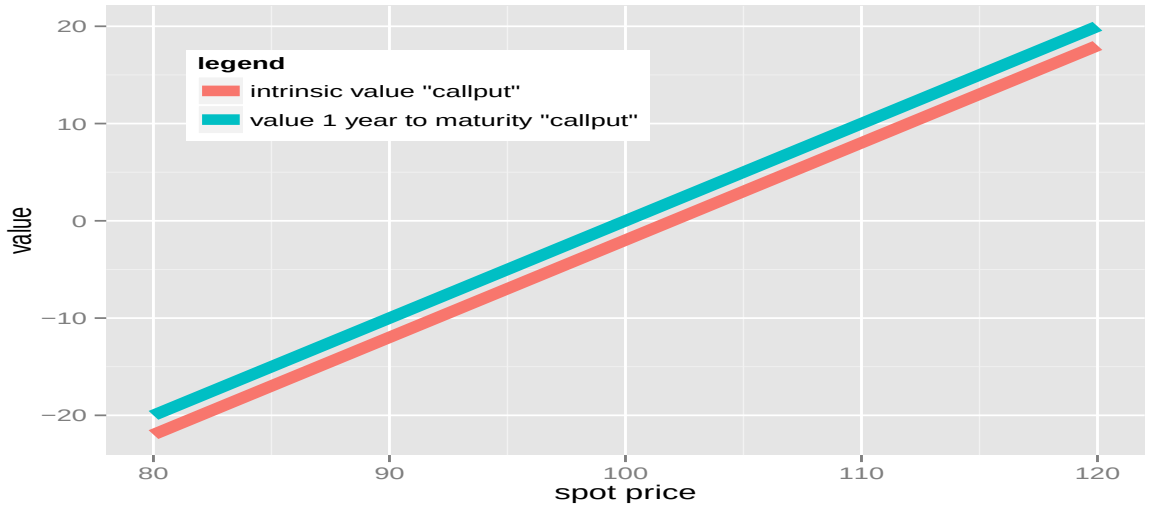

Figure 2.24: *A long call and a short put in one portfolio seems to be an expensive way to buy the underlying*

Option Strategies: the Call-Spread

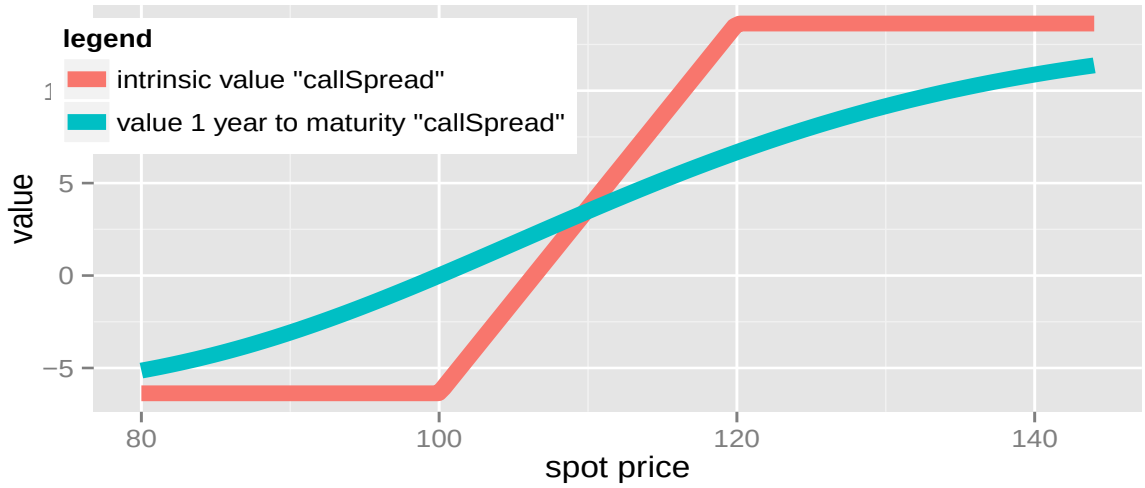

Figure 2.25: *A callSpread is a combination of a long call (here ATM) and a short call (here OTM)*

Option Strategies: the Put-Spread

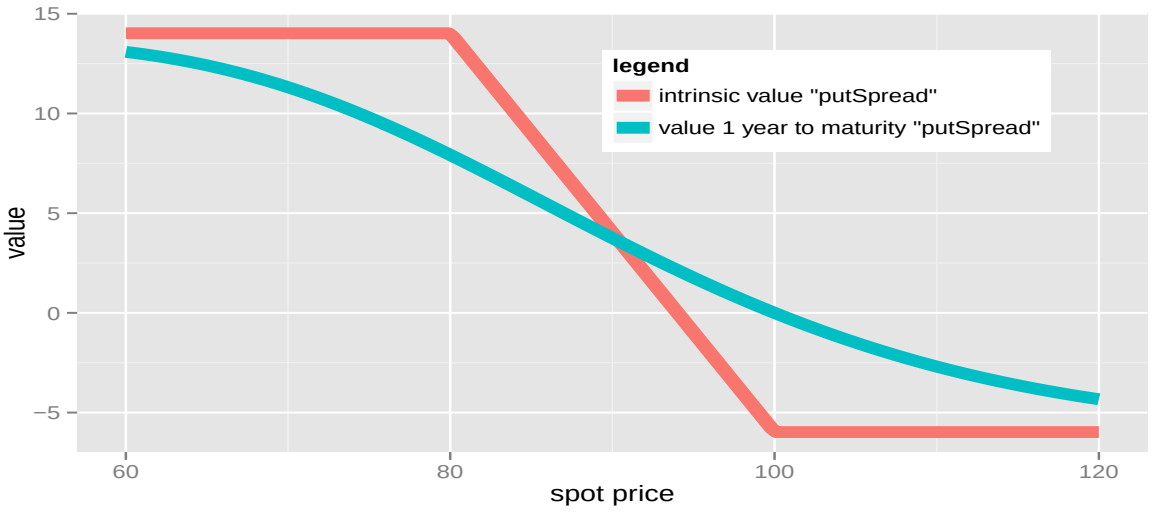

Figure 2.26: *A put-spread is a combination of a long put (here ATM) and a short put (here OTM)*

Option Strategies: the Butterfly

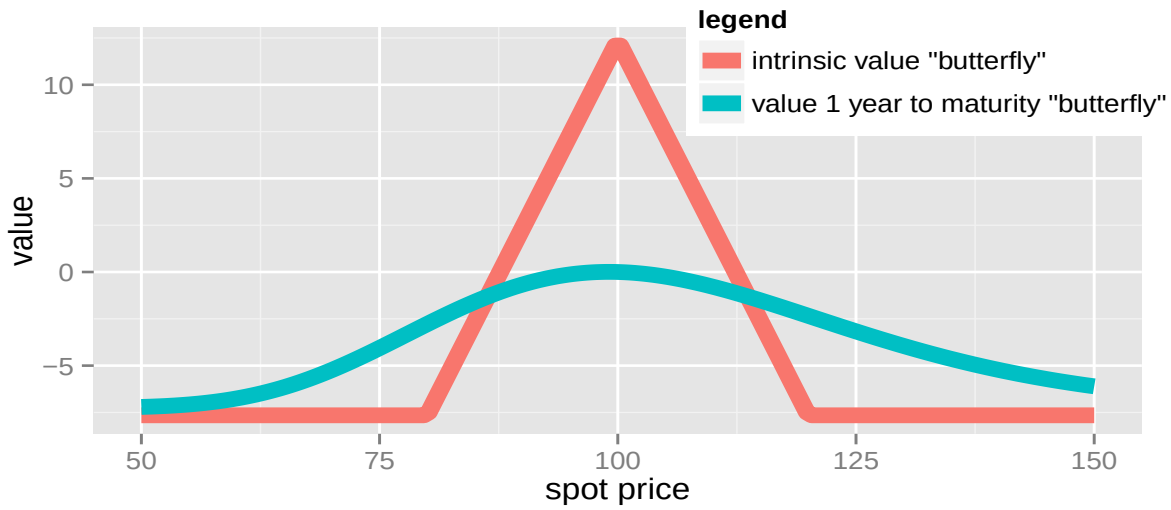

Figure 2.27: *A butterfly is a combination of a call-spread and a put-spread*

Option Strategies: the Condor

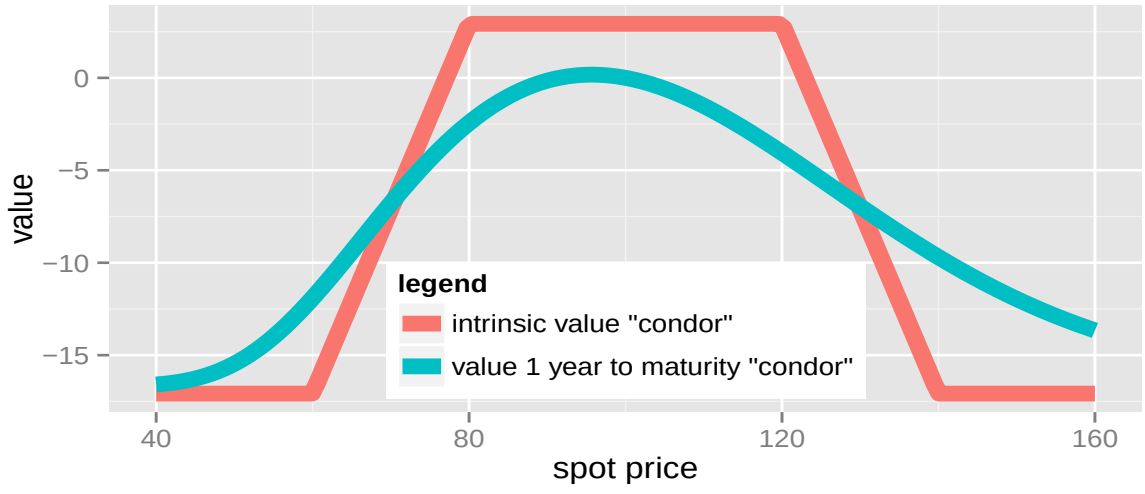

Figure 2.28: *A condor can be seen as a butterfly where the short call and put do not have the same strike.*

Option Strategies: the geared call

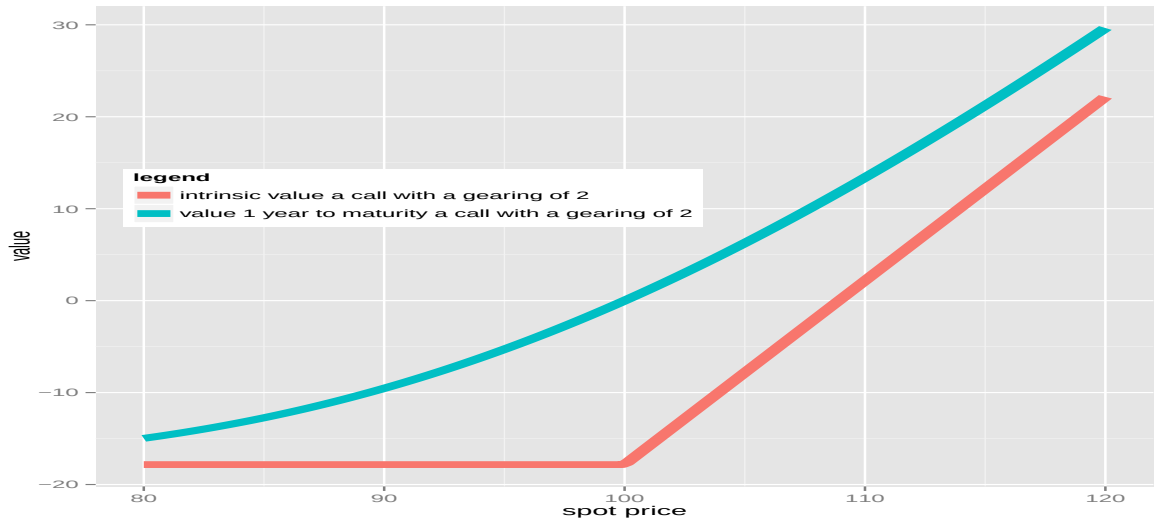

Figure 2.29: *the geared call is simply a call where one does not buy the option for the same nominal as the nominal value of the portfolio.*

Option Strategies: the near-digital

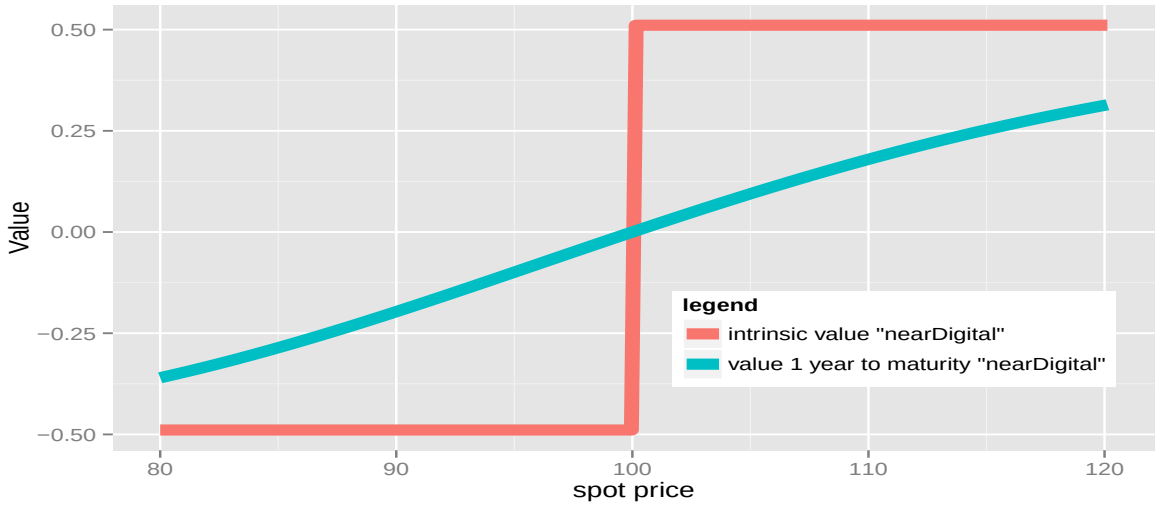

Figure 2.30: *A digital option approached by a callSpread that is geared only* 10 *times, and the spread between the two strike prices has been reduced to* 0.1.

Option Strategies: some fun . . .

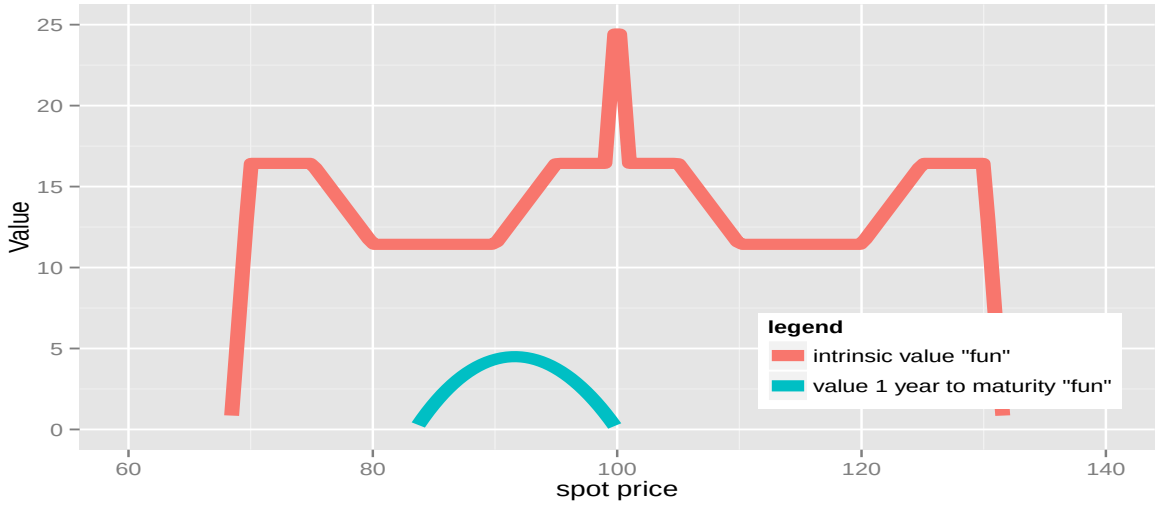

Figure 2.31: *A castle-like structure obtained from the combination of 14 elementary options (call and put). Can you find which?*

Etc, etc, etc.

- Options are as Lego® building blocks ...
- other ideas:
  - Each postion shown there has of course its conterpart as a short positon. Simply switch "long" with "short" in each definition.

Extra: Short Callspread...

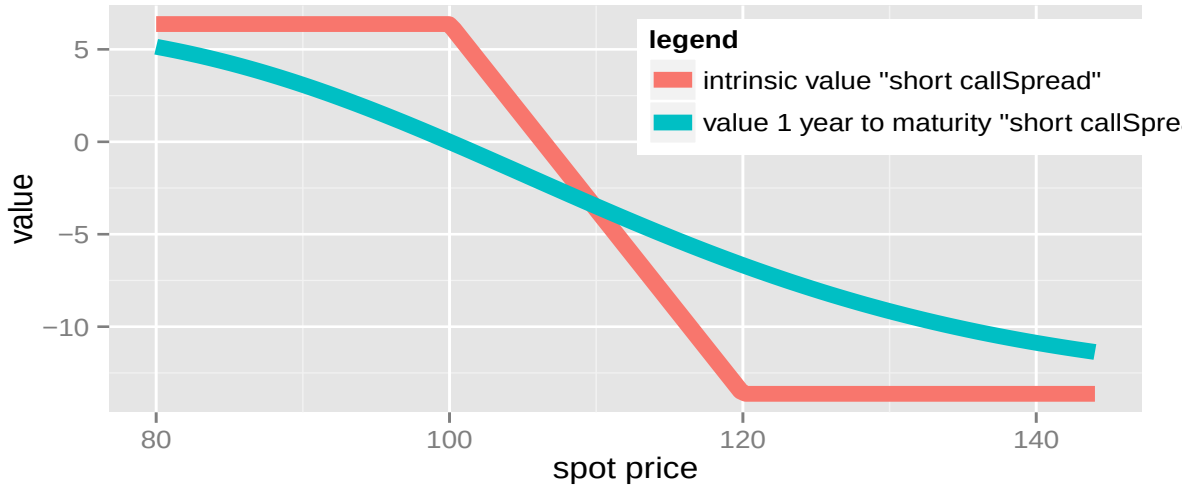

Figure 2.32: *A short CallSpread is a long putSpread*

Extra: call-spread made from puts . . .

Figure 2.33: A short put-spread is a long callspread

Extra: Short Straddle

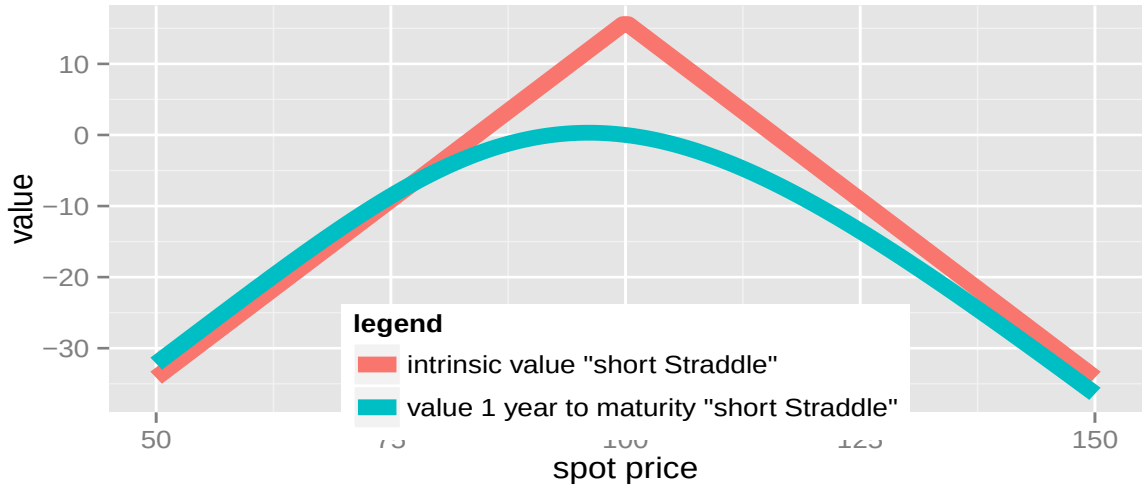

Figure 2.34: A short straddle is a good choice if one does not expect markets to move a lot

Extra: Short Condor

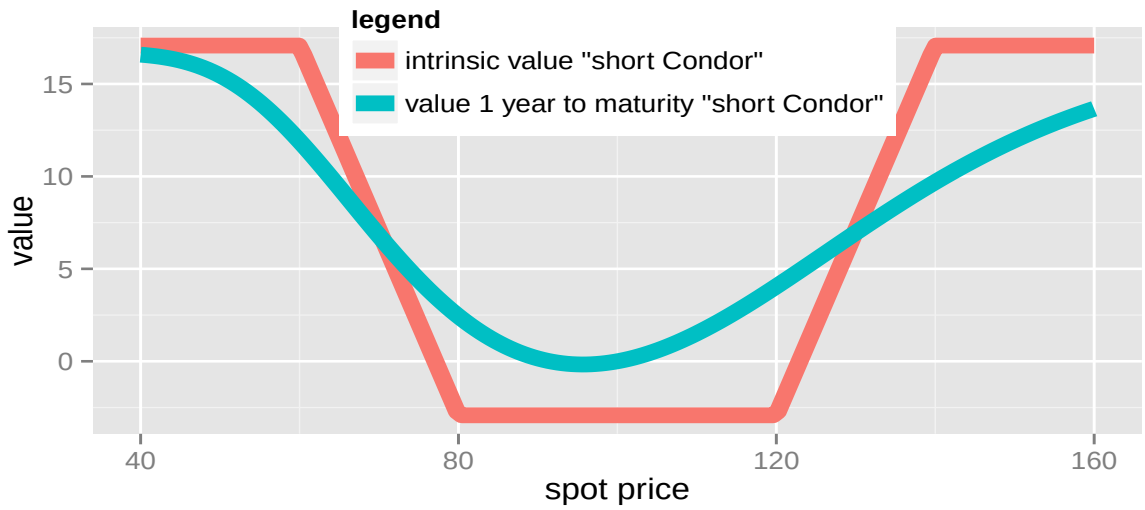

Figure 2.35: *A short condor is a good choice if one does not expect markets to move a lot, but anyhow wants to limit risks*

2.5.13 Selected Questions

Selected Questions

1. What is the delta of an option?
2. What can the delta of an option tell us?
3. How does delta-hedging work?
4. What is a Call-Spread?
5. What is a Put-Spread?
6. You expect prices of the S&P to stay similar (or be back to today's level) in one year. What option strategy should you buy?
7. You expect prices of the S&P to be very different form today's level in one year, but you don't know if it will be up or down. What option strategy could be useful?
8. Can you construct an option strategy that pays nothing unless the price of the underlying increases with more than 50% over 2 years. What does it cost?

Learning Objectives

Know

- what "volatility smile" or "smirk" is
- what the binomial model is

Understand	• what the difference is between the "risk neutral" and the "equivalent portfolio" model is • how the binomial model can be used to price exotic options
Apply	• calculate the value of a one-step binomial model autonomously

2.5.14 The Limits of the Black and Scholes Model

Assumptions

Strong Assumptions

- efficient markets
- the log-returns at maturity are normally distributed (Gaussian distribution)
- stable volatility as opposed to observations smile

Volatility Skew

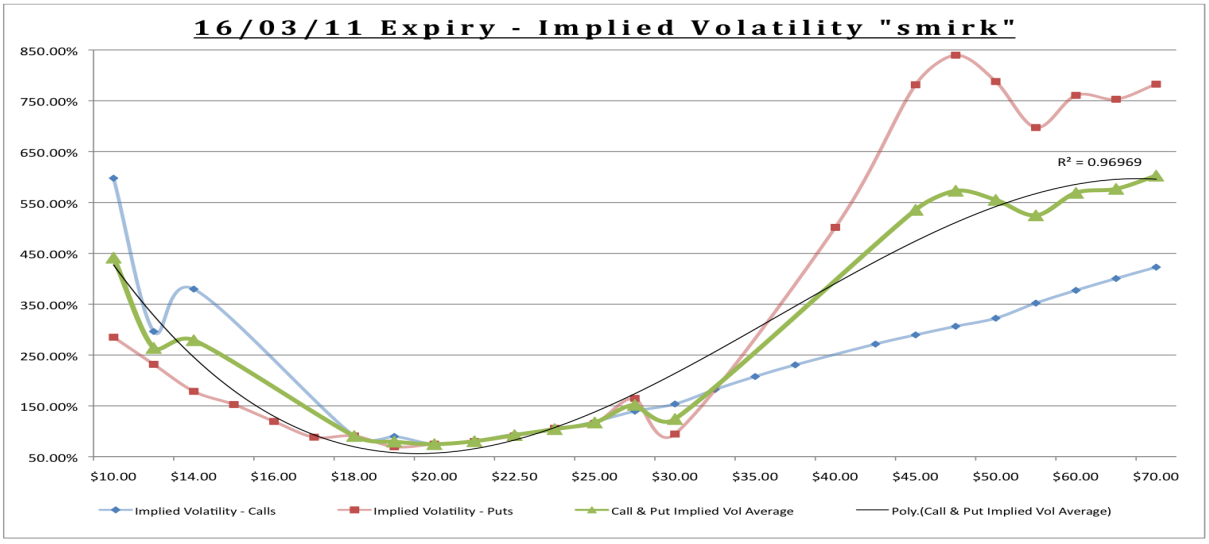

Figure 2.36: *Skewed Implied Volatility Smile or Smirk Over VIX options expiring 16th of March 2011. Note the strong skew, or "smirk", for At-The-Money Options*

Future Implied Volatility Skew

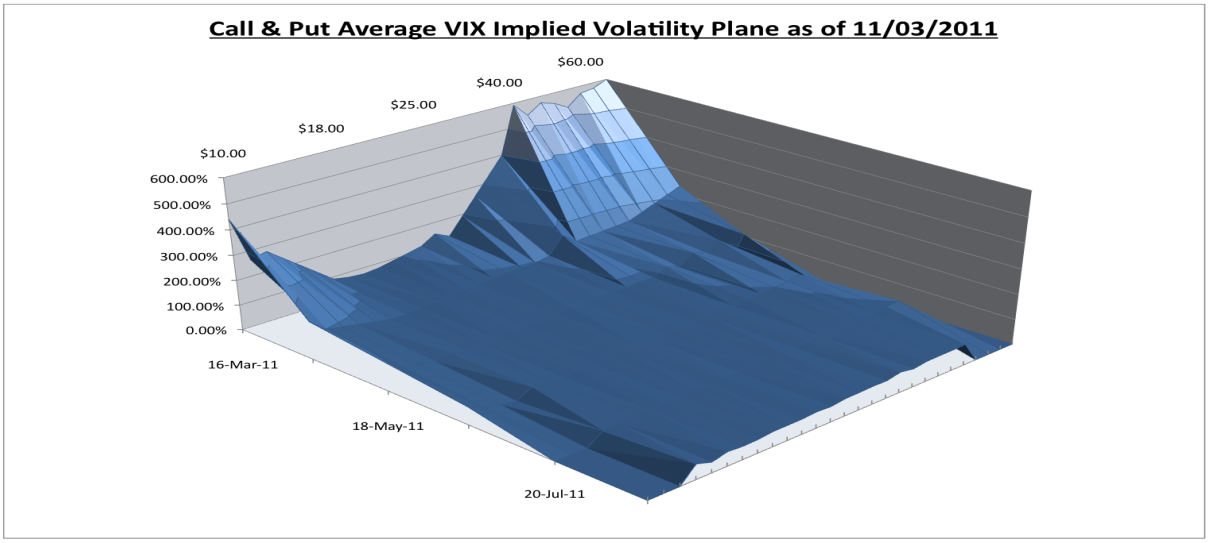

Figure 2.37: *The Implied Volatility Surface illustrates how variance expectations skew heavily nearer expiry.*

Black&Scholes and the Volatility Skew

- What does this mean?
- A higher implied vol means a higher price for the option, so were saying options far in-the-money or out-of-the-money cost more in real life than expected by the BS model.
- In the BS model, the log of the stock price was normally distributed at expiry, but more expensive options at distant strikes means that the real distribution has a higher-than-expected probability of ending up at extreme strikes, so the real probability has fat tails relative to a normal distribution.

More Complicated Structures

What if . . .

Question

How to price a "lookback" option? (a lookback option is an option that will use the best possible strike price over a certain period)

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2.5.15 The Binomial Model

The Binomial Model: the idea

- try a limited number of possibilities (market scenarios)
- see what happens and try to find what can be "expected"

2.5.16 Other Pricing Methods

Binomial Model: Risk Neutral Method

Step 1

$$\text{consider} \begin{cases} S_0 & = stock\ price\ now \\ p & = probability\ of\ stock\ increase \\ u & = price\ increase\ (when\ it\ increases) \\ d & = price\ decrease\ (when\ it\ decreases) \end{cases}$$

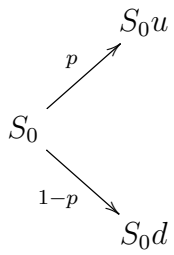


Figure 2.38: *Step 1 in the binomial model.*

hence the future option price is:

$$P_1 = p\ Payoff\ (S_0u) + (1-p)Payoff\ (S_0d)$$

Today's price would then be:

$$P = \frac{P_1}{1+r_1}$$

(with r_1 the interest rate over one period)

Binomial Model — Step 1

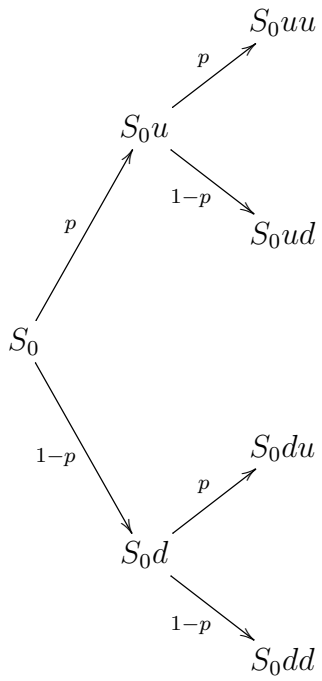


Figure 2.39: *The first 2 steps of the binomial model.*

Example 6 .:. one step Binomial Pricing Model .:.

Calculate the price of a long ATM European call option; using one step in the binomial model and the following assumptions: $S_0 = \$100$, $p = 0.70$, $u = 1.03$ ($\equiv$ 3% increase), $d = 0.95$ ($\equiv$ 5% decrease), $r = 0.1$.

Answer

$$\$103 \Longrightarrow Payout = \$3 \Longrightarrow E[Payout] = \$2.1$$
$$0.7$$
$$\$100$$
$$0.3$$
$$\$95 \Longrightarrow Payout = \$0 \Longrightarrow E[Payout] = \$0$$

$$\Rightarrow FV\,(Price) = 0.7 \times \$3 + 0.3 \times \$0 = 2.1 \Rightarrow Price = \frac{\$2.1}{1+0.1} = \$1.91$$

Binomial Model

Step 2

Binomial Model

- choose (u, d, p) consistent with some other theory of observation. For example the Cox-Ross-Rubinstein model:

  - $u = e^{\sigma\sqrt{\delta t}}$
  - $d = e^{-\sigma\sqrt{\delta t}}$
  - $p = \frac{e^{R_{rf}\delta t} - d}{u - d}$
- iterate till some convergence is satisfactory
- discount the expected value of the option back to today

Cox-Ross-Rubinstein Model

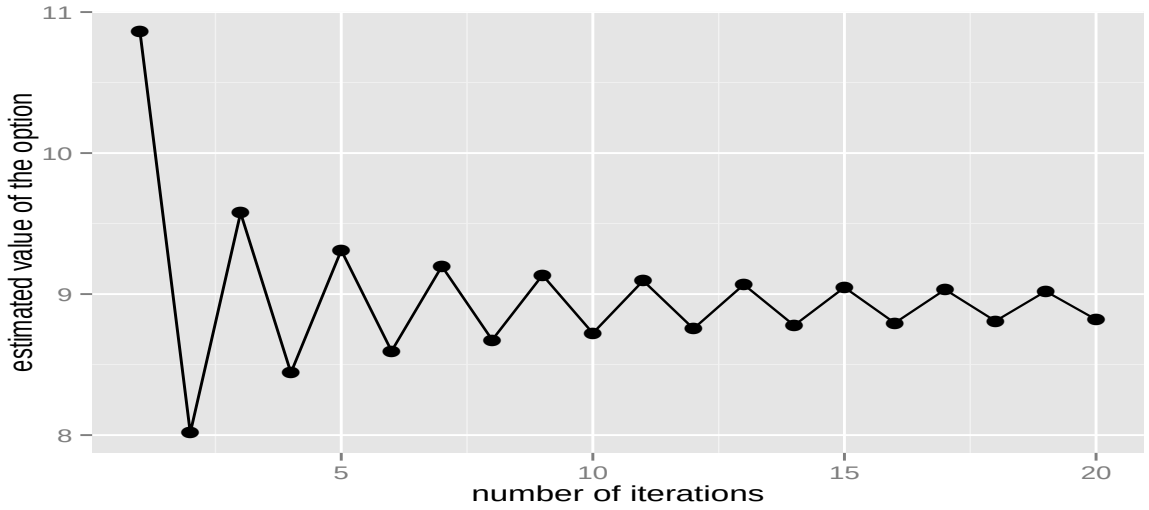


Figure 2.40: *The Cox-Ross-Rubinstein model for the binomial model applied to a call option.*

Cox-Ross-Rubinstein Model

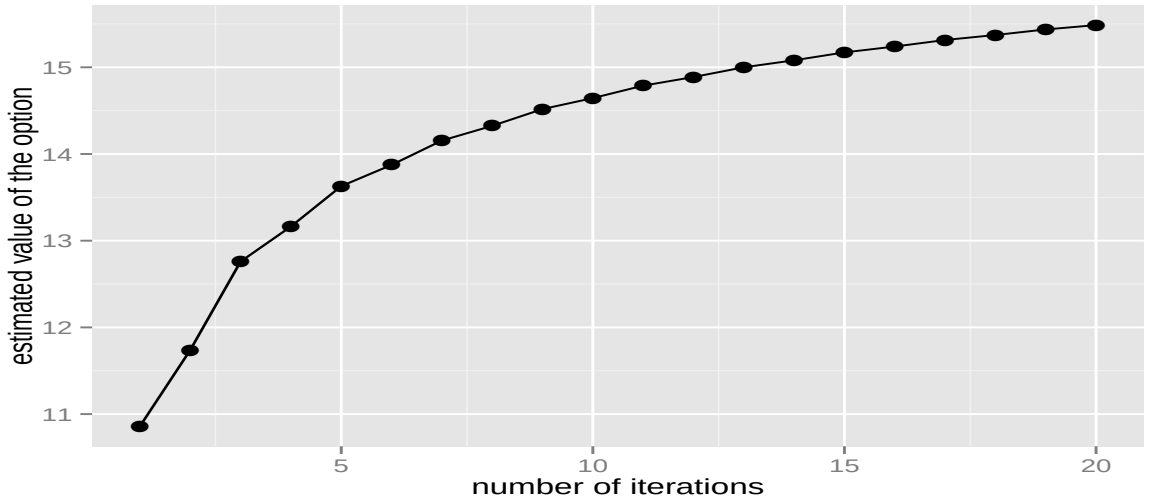
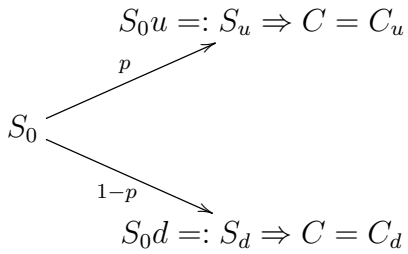


Figure 2.41: *The Cox-Ross-Rubinstein model for the binomial model applied to an unlimited look-back option.*

The Equivalent Portfolio Binomial Model



The same idea, with

- If two portfolios have the same pay-off at time T, then they have the same price at time T-1.
- Choose the Equivalent Portfolio as "invest delta dollar in the underlying and borrow B cash", then

$$C = \delta S - B$$

The Equivalent Portfolio Binomial Model

The Result

If both portfolios have the same price now, then

$$C = \delta S - B$$

If both portfolios have the same price at T + 1, then

$$\begin{cases} C_u &= \delta S_u - (1+r)B \\ C_d &= \delta S_d - (1+r)B \end{cases}$$

We have now two equations with two unknown (δ and B), and hence easily find that:

$$\begin{cases} \delta &= \frac{C_u - C_d}{S_u - S_d} \\ B &= \frac{\delta S_u - C_u}{1+r} = \frac{\delta S_d - C_d}{1+r} \end{cases}$$

The Equivalent Portfolio Binomial Model

In Practice

1. $\delta = \frac{C_u - C_d}{S_u - S_d}$
2. $B = \frac{\delta S_u - C_u}{1+r}$ or $B = \frac{\delta S_d - C_d}{1+r}$
3. $C = \delta S - B$

Question

What is the value of a call option, assuming that: the strike price, X is $\$100$; the spot price, S is $\$100$, $S_d = \$98$, $S_u = \$105$, and the interest is 2%.

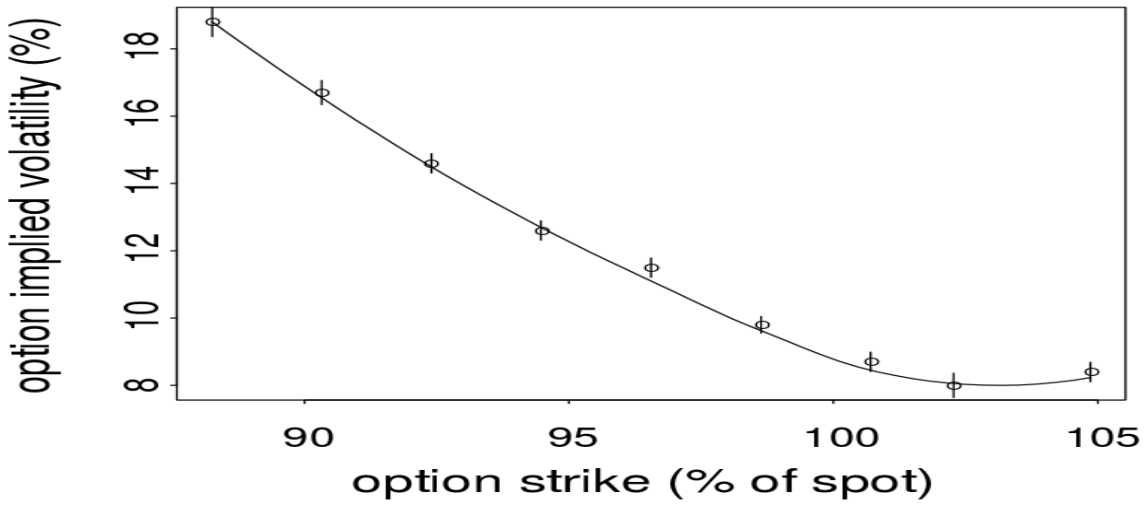


Figure 2.42: *The volatility smirk of January 1994 on S&P options. Source and more info: Emmanuel Derman and Iraj Kani (1994)*

Summary Binomial Model

Risk Neutral vs the Equivalent Portfolio Model

- Both yield mathematically the same option value
- Risk neutral method
  - Is easier to calculate
  - Does not use the economic probability of the stock going up or down
- Equivalent portfolio method
  - Is more challenging computationally
  - Draws upon sound economic principle of arbitrage
  - Provides insight in option delta

Applications of the binomial model

The Binomial Model and Volatility Smirk

Example: Implied Volatilities of S&P 500 Options on Jan 31, 1994

The Binomial Model and Volatility Smirk

Example: Implied Distributions of S&P 500 Options on Jan 31, 1994

The Binomial Model and Volatility Smirk

Example: Implied Distributions of S&P 500 Options on Jan 31, 1994

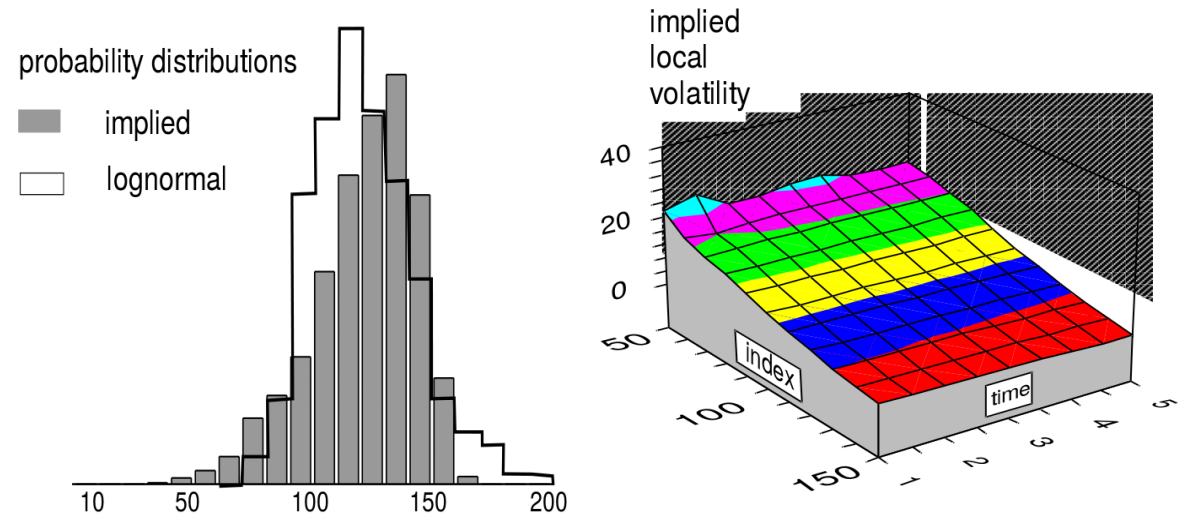


Figure 2.43: *The implied distribution of the S&P in January 1994. Source and more info: Emmanuel Derman and Iraj Kani (1994)*

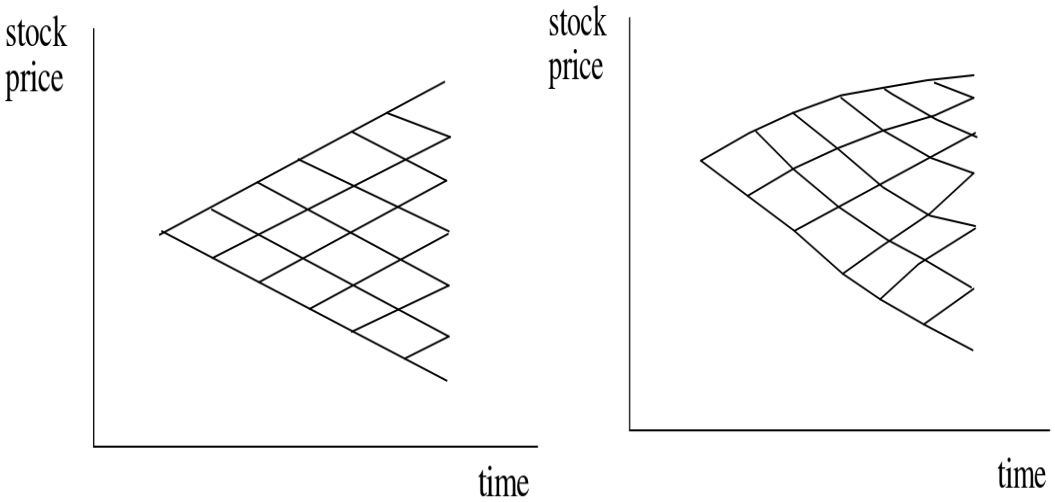


Figure 2.44: *The binomial tree implied by the log-normal distribution (left) and the implied tree of the S&P in January 1994. Source and more info: Emmanuel Derman and Iraj Kani (1994)*

2.5.17 Selected Questions

Selected Questions

1. What is the Binomial Model? What is the idea?
2. How can the binomial model be used to value a look-back option for example?
3. What are the two types of Binomial Models used in this course?
4. How are they different?
5. Which binomial model would you use if you know the delta of the option?
6. During his visit at chicken farm CHICKEN Inc., the prime minister gets a welcome gift: a call option on a stock of CHICKEN Inc. But the prime minister has no idea of how much this present is worth. So, he orders his principal private secretary to value this European call option, expiring in three years with an exercise price of 11.45.

   After some research, the secretary finds that one stock of CHICKEN Inc. is worth 12.39, but stock is very volatile: every year it goes up with 20% or decreases in value with 15%. The risk free rate is 5%.

   (a) What is the value of this call option? Use Binomial Model + Risk-Neutral Valuation.

   (b) Calculate the delta of this call option.

   (c) If you were the prime minister, would you rather have got an American option?

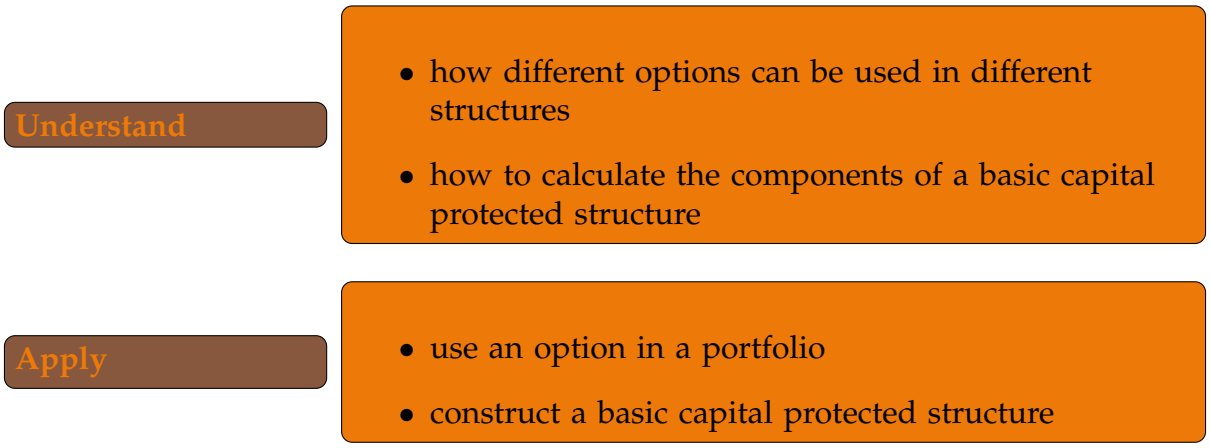
   (d) To secure the balance in the coalition, the prime minister asks his principal private secretary to compose an equivalent portfolio for the other parties in the coalition. Of which assets does this portfolio have to consist?

   (e) How will the principal private secretary have to rebalance this portfolio on a yearly basis, if you assume the stock will be worth 14.87; 12.64 and 15.17 after respectively one, two and three years?

Learning Objectives

Know

- the definition of some basic exotic options
- how options can be used in everyday structures



2.5.18 exotic options

Exotic Options

Regional Specialities

- **Asian options**: the strike or spot is determined by the average price of the underlying taken at different moments
- **Full Asianing**: the average of the Asian feature is taken over some moments over the whole lifetime of the option
- **Look-back options**: the spot is determined as the best price of different moments
- **Russian Look-back options**: the look-back feature is unlimited (the best price over the whole lifetime of the option
- **Callable or Israeli options**: the writer has the opportunity to cancel the option, but must pay the payoff at that point plus a penalty fee

Exotic Options

Mountain Ranges

- **Himalayan** - Pay-off based on the performance of the best asset in the portfolio
- **Everest** - payoff based on the worst-performing securities in the basket
- **Annapurna** - in which the option holder is rewarded if all securities in the basket never fall below a certain price during the relevant time period
- **Atlas** - in which the best and worst-performing securities are removed from the basket prior to execution of the option
- **Altiplano** - a vanilla option is combined with a compensatory coupon payment if the underlying security never reaches its strike price during a given period

Exotic Options

Atlantic Islands

- **Bermuda Option** - an option where the buyer has the right to exercise at a set (always discretely spaced) number of times, ie. between an American and a European one
- **Canary Option** - can be exercised at quarterly dates, but not before a set time period has elapsed
- **Verde Option** - can be exercised at incremental dates(typically annually), but not before a set time period has elapsed

Exotic Options

Even More

- **Knock In** - this option only becomes active when a certain level (up or down) is reached
- **Knock Out** - this option will have a fixed (zero or more) return when a certain level (up or down is reached); if the level is not reached it remains an option
- **Barrier Option** - another word for Knock-in or Knock-Out options
- options on "stock baskets" as opposed to options on stocks or indices
- ...

2.5.19 Integrated Option Strategies

Integrated Strategies

writing of a covered call

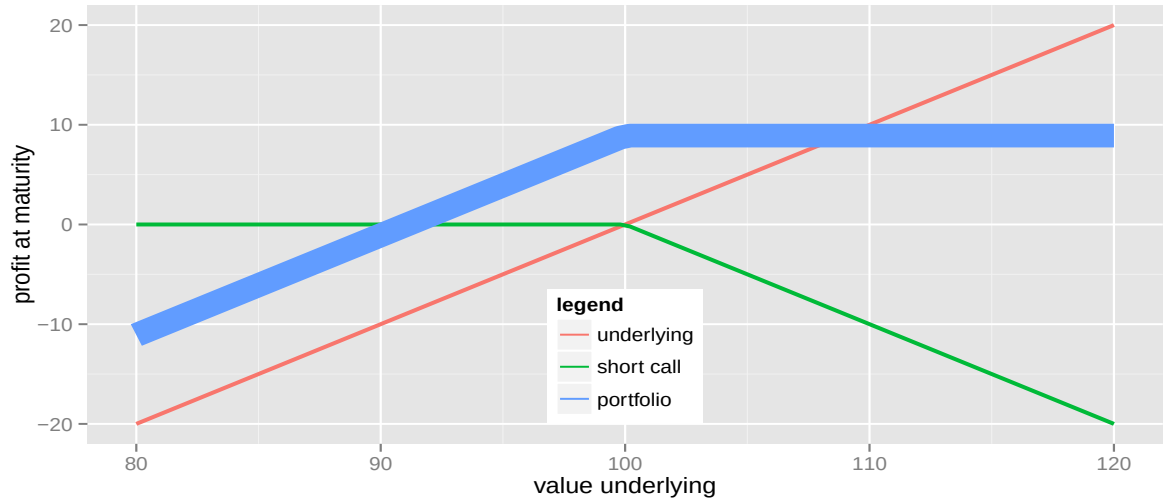


Figure 2.45: *Writing a "covered call" is selling a call while holding the underlying asset.*

Integrated Strategies

the Collar

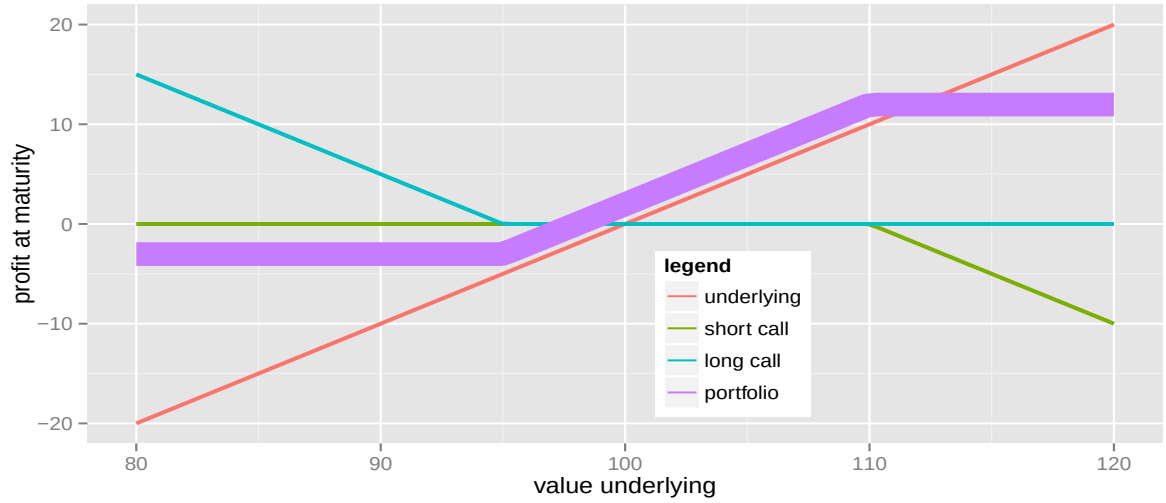


Figure 2.46: *When one holds the the underlying asset, shorts an OTM call and longs an OTM put, one gets the "collar" construction.*

Integrated Strategies

the Married Put

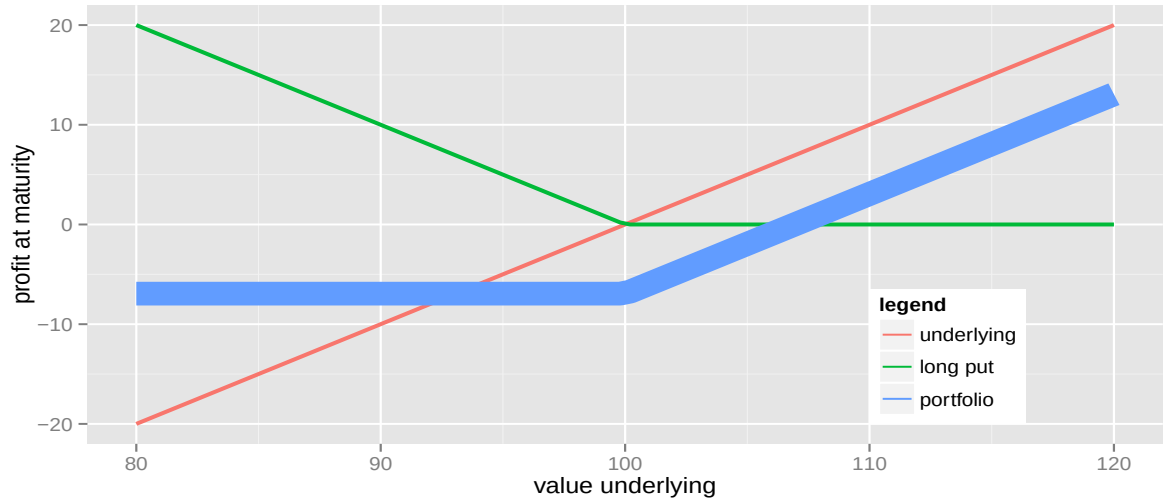


Figure 2.47: *When one holds the the underlying asset, longs an ATM put, one gets the downside protection while keeping upside potential, called "married put".*

2.5.20 Capital Protected Structures

Is It Possible to Offer Capital Protection?

Question

Assume an initial portfolio of $100. Is it possible to construct a portfolio that

- offers capital protection in five years (ie. after five years, the price of the structure should be again $100)
- if the S&P500 increases our customer gets the same increase, eg. if the S&P500 increases by 20% he gets 20% return
- if the S&P500 decreases, our customer gets $100 (so our customer never looses money on the investment)

Construct a Capitial Protected Structure

A simple idea: combine:

- an option (or any combination thereof)

- a fixed term deposit

Example 6 .:. capital protected structure .:.

Using our standard example parameters (see Slide 37), and assuming that

1. we also can place a deposit at $r = 2\%$,
2. that we build a 5 year capital protected structure,
3. that we have no transaction, nor spreads, nor holding costs, and
4. that our nominal amount is €$1,000$;

then we need to invest €$1000\frac{1}{(1+0.02)^5} =$ €905.73 in the fixed term deposit in order to make it increase to 1000 in five year.
This leaves us €94.27 for buying an option. A call option on 5 years costs us €95.35 on a nominal of €$1,000$, so we can make a structure with a gearing of ca. 99%.

***Note**: When adding 1% of annual costs to this structure (and not investing the provisions for these costs), our gearing decreases to 46%.*

2.5.21 Selected Questions

Selected Questions

1. What is Bermuda Option?
2. What is the relation in price between a European, American and Bermuda option (assuming all other parameters the same)?
3. What is a Look-back Option?
4. What is a Himalayan Option?
5. How can the binomial model be used to value a look-back option for example?
6. What are the two types of Binomial Models used in this course?
7. How are they different?
8. Which binomial model would you use if you know the delta of the option?

9. Given that the volatility of the S&P is 20% the interest rate is 3% assume the dividend yield 0%; construct (ie. provide terms and conditions for the client) a capital protected fund on 5 years maturity that offers capital protection

   (a) so that the upside potential is unlimited

   (b) so that the upside potential is limited, but that the participation rate is 100% for small returns.

   (c) What happens if the dividend yield would be 5%?

   (d) What happens if we take an annual management fee of 1%

PART I .:. CHAPTER 3 .:.

Financial Accounting

3.1 The Statements of Accounts

In order to make Management Accounting easier to understand we first give a brief overview of that is called ”Financial Accounting”.

Income Statement

The Income Statement is all cash income minus all cash expenses

Net Income: The P&L statement

Net sales (= revenue = sales)
- Cost of goods sold
- = Gross profit
  - SG&A expenses (combined costs of operating the company)
  - R&D
  - = EBITDA
    - Depreciation and amortization
    - = EBIT
      - Interest expense (cost of borrowing money)
      - = EBT
        - Tax expense
        - = Net income (EAT)

Focus on regular operations

NOPAT = Net Operating Income After Taxes (this is EAT minus extra-ordinary income)

$$\begin{aligned} NOPAT = (&\text{Net Income} - \text{after-tax Non-operating Gains} \\ &+ \text{after-tax Non-operating Losses} + \text{after-tax Interest Expense}) \\ &\approx \text{Operating Profit}(1 - \text{tax rate}) \end{aligned}$$

With: Operating Profit = EBIT - non operating income

Balance Sheet

Assets	**Liabilities and Owner's Equity**
Fixed Assets (Non-Current Assets)	Shareholders Equity = Captial Stock + Retained Earnings
Current Assets = *Liquid Assets + Stock*	Current Liabilities

Detailed Breakdown of Assets:

- Current Assets
  - Cash and cash equivalents
  - Accounts receivable
  - Prepaid expenses for future services that will be used within a year
- Non-Current assets (Fixed Assets)
  - Property, plant and equipment
  - Investment property, such as real estate held for investment purposes
  - Intangible assets
  - Financial assets (excluding investments accounted for using the equity method, accounts receivables, and cash and cash equivalents), such as notes receivables
  - Investments accounted for using the equity method
  - Biological assets, which are living plants or animals. Bearer biological assets are plants or animals which bear agricultural produce for harvest, such as apple trees grown to produce apples and sheep raised to produce wool.

Detailed Breakdown of Liabilities

- Accounts payable
- Provisions for warranties or court decisions (contingent liabilities that are both probable and measurable)
- Financial liabilities (excluding provisions and accounts payables), such as promissory notes and corporate bonds
- Liabilities and assets for current tax
- Deferred tax liabilities and deferred tax assets
- Unearned revenue for services paid for by customers but not yet provided

3.2 Selected Financial Ratios

Terminology

Definition 32 .:. loans .:.

loans := debt = a sum of money borrowed with the obligation to be paid back at pre-agreed terms and conditions

***Note**: For the purpose of this section we will refer to loans (or debt) as the "outstanding amount of debt". So, if for example the initial loan was $10'000'000, but the company already paid back $9'000'000, then we will have only one million of debt.*

Definition 33 .:. equity .:.

share capital := equity = the value of the shares issued by the company = asset - cost of liabilities

Example 7

A company that has only one asset of $100'000 and a loan against that asset (with outstanding amount of $40'000) has $60'000 equity.

Profit Margin

Definition 34 .:. Profit Margin (PM) .:.

$$PM = \frac{EBIT}{Sales}$$

Asset Utilisation

Definition 35 .:. Asset Utilisation (AU) .:.

$$\begin{aligned} AU &= \frac{\text{Sales}}{\text{net Total Assets}} \\ &= \frac{Sales}{TCE} \end{aligned}$$

Liquid Ratio

Definition 36 .:. Liquid Ratio (LR) .:.

$$LR = \frac{\text{Liquid Assets}}{\text{Liquid Liabilities}} = \frac{\text{Current Assets - Stock}}{\text{Current Liabilities}}$$

Gross Margin

Definition 37 .:. Gross Margin (GM) .:.

$$GM = \frac{\text{Gross Profit}}{\text{Sales}}$$

Current Ratio

Definition 38 .:. Current Ratio (CR) .:.

$$CR = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

Capital Expenses (CapEx)

Definition 39 .:. CapEx .:.

Capital Expenditure is an expense made by a company for which the benefit to the company continues over a long period (multiple accounting cycles), rather than being used and exhausted in a short period (shorter than one accounting cycle). Such expenditure is assumed to be a non-recurring nature and results in acquisition of durable assets.

***Note**: CapEx is also referred to as "Capital Expense"*

***Note**: The counterpart of CapEx is OpEx or recurring expense.*

In accounting one will not book CapEx as a cost but rather add them to capital and then depreciate. This allows a regular and durable reduction of taxes. For example a rail-transport company would depreciate a train over ten years, because it can typically be used longer.

Capital Expenses (OpEx)

Definition 40 .:. OpEx .:.

An Operational Expenditure is an ongoing and/or recurring cost to run a business/system/product/asset.

***Note**: OpEx is also referred to as "Operational Expense" or "Operational Cost"*

In accounting, OpEx are booked as "costs" and will reduce the taxable income of that year (except when local rules force it to be re-added for tax purposes).

For example the diesel to run a train, its maintenance, salary costs of the driver, oil for the motor, etc. are all OpEx for the train (which would be booked as CapEx)

PART II

Managing Company Value

PART II .:. CHAPTER 4 .:.

What is Value?

What makes the value of a company? The first reflex might be to look at the sales or profit. However, while that is important and closely related to a company's value it is only one of the important elements.

How to measure success in business?

- **Income**: is my product being sold now?
- **Profit**: are the cost in balance with the income?
- **Growth**: is the potential for future growth?
- **Value**: where will this all lead to?

To answer this question it is wise to take a point of view first. For example imagine that you want to buy the company from a friend. Then the question about the value of the company should be equivalent to the question: "How much should I pay for the company". Buying a company one will get all future dividends (assuming that the company is doing well and it will continue to do well). This means that the value of the company should be the present value of the stream of future dividends.[1]

So, the value of the company is in the first place related to the future, but we will have to rely on the past in order to forecast the future and estimate the company's potential.

[1] In case a company is in a bad shape or already stopped trading this notion will not be valid. If a company stopped trading then it might be that its value is the value of the assets (buildings, machines, brand name, etc.).

PART II .:. CHAPTER 5 .:.

Why Value Matters

Value is the ultimate long-term KPI

But it has much more importance

There are many reasons why the value of a company matters. Here we name just a few:

- **stock market**: the stock market is so far the most efficient way to raise capital and drive economy and welfare.
- **pensions**: because states will be unable to pay pensions in a few decades from now everyone will need to invest in order to save for own retirement. This means that the value of the companies in portfolio becomes very relevant.
- **stock options**: while the practice used to be more popular before the crash of 2008, many companies do not give equity to employees as an incentive and assurance for long term value alignment: options are easier to handle.
- **sale or any other corporate event**: when owners want to sell the company, or employees buy the shares (as in a LBO)
- **tax calculation in case of inheritance, wills, divorces**
- **to monitor long term sustainable growth**

In general there is a strong relation between the value of companies and welfare. If the companies do well and the outlook is good then wealth is created and people will benefit of that growth directly or indirectly. If a company grows, then it is obvious that its owner will be interested in knowing the value of the company, because it indicates his/her wealth. Also all the people that work for the company get a salary and are better of than being jobless. Further down the line, the customers of that company buy something that makes –for them and using their utility curve– sense, the suppliers also benefit, the tax controllers have a job, etc. Of course, also the pensioners that will cash in their savings and sell the stock of the company are well off and even the beneficiaries of the tax money (salaries for non-productive state employees, benefits and of course suppliers to the government and undertakers profiting of public tenders fare better.

This cycle of economic growth, profit and company valuation underpins value creation and welfare.

Typical Reasons to Value a Company

1. **Show the Value**: curiosity of the private owner of the company (this information will help him/her to set long term personal goals, optimal strategy, etc.) or legal requirements for the corporate owner. If shares are owned by other companies or funds (pension, investment, private equity, venture capital, etc.) for all of which valuation is a an important requirement. Also because the owners of the investment funds want or need to know the value.

2. **Accounting Purposes**: Most of the valuations are made for accounting purposes. Shares even if not to be sold for decades, must be valued, tested on impairments etc. by each of the companies that own them. Under IFRS standards shares must be held at its fair value. This is absolutely crucial impact on P&L of those companies and (for instance) on ability of banks to lend – through impact on capital. Even if banks/companies do not sale or buy anything but just simply change value of its assets in the books it means they go bankrupt or need extra equity injection or cannot expand. It is auditor's role to check if assets are valued at fair value. Auditors hire specialists from valuation/M&A-teams to help them in more complicated valuation cases.

3. **Legal and Tax**: estate tax, divorce, inheritance tax

4. Transaction Valuation:

   - sales/purchase of (part of) the shares
   - change of corporate structure (eg. LLC to PLC) — depending on the legislation
   - corporate action such a merger, LBO, ...
   - IPO

5. **Valuation of Part of the company**: as prelude to a spin-off or sale of part of the company

The Relativity of Value

"Beauty is in the eye of the beholder"

1. **Owner who wants to stop**: what I invested? my work? my child?

2. **Competitor**: synergies?

3. **New Entrant**: opportunity?

4. **Investor on stock exchange**: cash return without influence on the management? stock price growth?

5. **Venture Capitalist or other strategic investor looking for a minority stake**: cash return without influence on the management? stock price growth?

6. **Venture Capitalist/Private Equity or other Strategic Investor looking for a majority stake**: This depends on the strategy and idea that they have for the company. In a takeover many things are important but certainly the core idea of how the target is running/organizing the business is key. In their valuation they will count on a much higher cash flows in the future – after their plan is implemented. But it can only be introduced if you have at least 50%+ or even in some cases a qualifying majority of 75%-80% might be needed. In many cases investors acquiring company for maximum freedom of actions within company, purchase 100% of shares.

7. **Investment Fund or other diversified investor**: does the new stock fit in my portfolio? How does it influence the existing its characteristics?

PART II .:. CHAPTER 6 .:.

The Value Chain

Value Creation

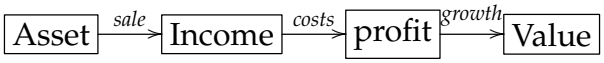


Figure 6.1: *The elements of wealth creation*

Note that a company does not need to show profit in order to be valuable. A fast growing company will have to buy more raw materials than it has sales income an hence can show losses–even if each sale in itself is profitable.[1] The value of the company then comes from the "prospect of growing profit" (once the situation stabilizes.

Observation of Value Creation

For the manager

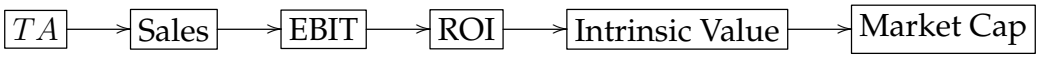


Figure 6.2: *KPIs on the Value Chain*

What the shareholder really should try to obtain is long-term sustainable growth of the share price (and hence the market cap). The idea is that by linking incentives of senior management to sales (annual), EBITDA, growth in share value, etc. that this chain is activated and supported in as many places as possible.

There are a few important points of view. The first is that if one will buy a company then it is essential to have a good idea of it's value. However, once bought the second point of view is managing the value. The owner should make sure that the interest of the management is aligned with the interest of the owners of the company: maximize growth of company value (given the dividend policy).

In the following chapter we will present management accounting as the tool for the owner to align the interest of the management with that of the owners and as a tool for the management to execute this strategy.

[1] These companies are known as "growth companies"

PART II .:. CHAPTER 7 .:.

Managing Value with Management Accounting

7.1 Introduction

The owner(s) of a company should make sure that the interest of the management is aligned with theirs.[1] In the company form where the owners are most remote from the management (the share company) the owners will have at least once a year an Ordinary General Shareholders Meeting. It is in that meeting that the supervisory board is chosen by a majority of votes –that are allocated in function of the number of shares one has: one share one vote.

In that step the owners will choose supervisory board members that they can trust to align the executing management's priorities with those of the owners. This supervisory board will typically set goals for the executive management in form of KPIs (Key Performance Indicators) and their variable pay depends on the results of these KPIs.

For example the executive management might be pushed to increase share value, market share and profit. The executive management in it's turn will then be able to set more concrete goals for team leaders who in their turn will put goals for the executing workers. This cascade of goals and their management is "management accounting".

Definition of MA

Definition 41 .:. Management Accounting (MA) .:.

Management Accounting is the provision of financial and non-financial decision-making information to managers.
According to the Institute of Management Accountants (IMA): "Management accounting is a profession that involves partnering in management decision making, devising planning and performance management systems,and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organization's strategy".

[1] Of course if they are themselves the management, then there is no potential conflict of interest and this step becomes trivial.

Management Accounting (MA) is the section of the company that supports the management to make better informed decisions and planning support. To do so, it will use data to monitor finances, processes and people to prepare a decision and after the decision it will help to follow up the impact. A good introduction to Management Accounting can be found in eg. Drury (2013)

MA Definition

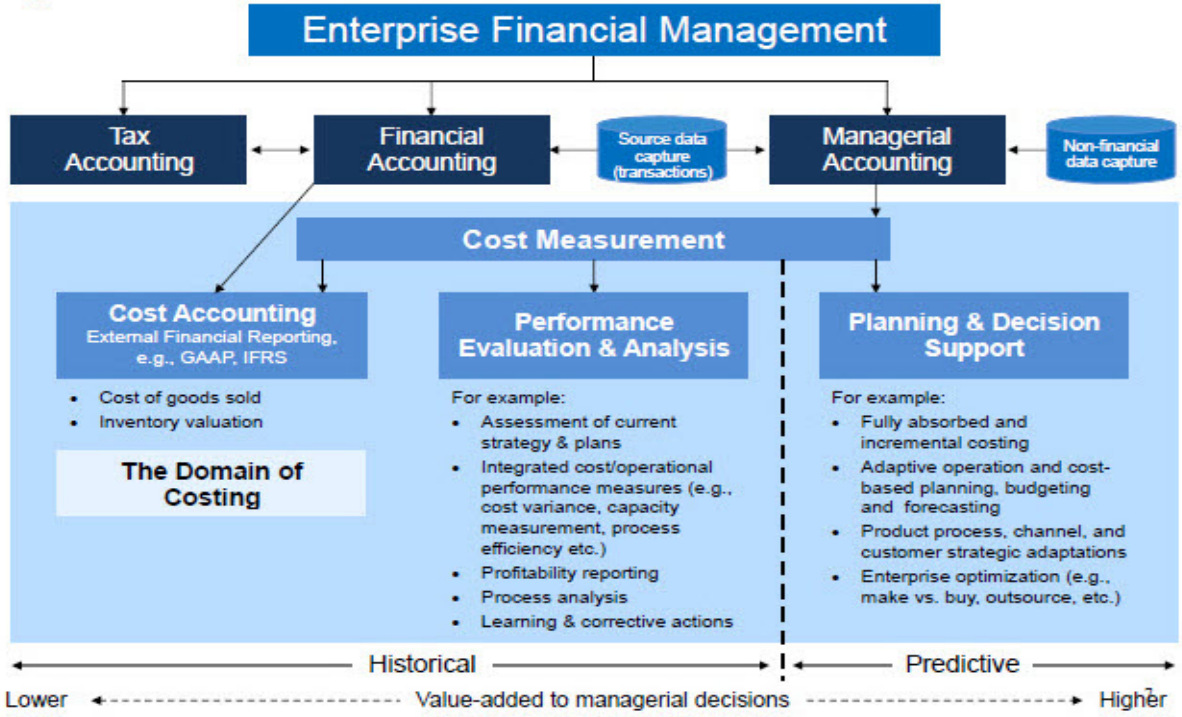


Figure 7.1: *A visual definition of Management Accounting*

The main differences between MI (Management Information) and FI (Financial Information):

Difference between MI and FI

Financial Accounting	Management Accounting
mainly external use (mainly for shareholders, tax, creditors)	internal use (only for management)
past oriented (shows what happened)	future oriented (supports decisions)
fixed reporting period (annual, quarter, month)	flexible reporting period (period as is relevant)
precise (up to £ 0.01)	mainly indicates direction
always in one currency	currency but other measures possible
required by law	not required by law
public information	confidential

Importance of MI

Managing a company without good Management Information is similar to driving a car by only using the rear mirrors.

MIS

Definition 42 .:. MIS .:.

A Management Information Systems (MIS) focuses on the management of information systems to provide efficiency and effectiveness of strategic decision making.

***Note**: The concept may include systems termed transaction processing system, decision support systems, expert systems, and executive information systems. The term MIS is often used in the business schools. Some of MIS contents are overlapping with other areas such as information system, information technology, informatics, e-commerce and computer science. Therefore, the MIS term sometimes can be interchangeable used in above areas.*

Relational Database System

to be completed

7.2 Selected Methods in MA

7.2.1 Cost Accounting

Cost Accounting: Definition

Definition 43 .:. Cost accounting .:.

is an accounting process that measures and analyses the costs associated with products, production and projects so that correct amounts are reported on financial statements.

Cost accounting aids in decision-making processes by allowing a company to evaluate its costs. Some types of costs in cost accounting are direct, indirect, fixed, variable and operating costs.

The idea of cost accounting was very valuable and provided information for managers as opposed to information for shareholders and creditors.

"Flavours" (or Methods) of Cost Accounting

- **Standard cost accounting**
- **Activity-based costing**
- **Lean accounting**
- **Resource consumption accounting**
- **Throughput accounting**
- **Life cycle costing**
- **Environmental accounting**
- **Target costing**

Standard Cost Accounting (SCA)

Definition 44 .:. Standard cost accounting .:.

Standard Cost Accounting (SCA) uses ratios called efficiencies that compare the labour and materials actually used to produce a good with those that the same goods would have required under "standard" conditions — works well if only labour is the main cost driver (as was the case in the 1920s when it was introduced)

Activity Based Costing (ABC)

Definition 45 .:. Activity-based costing .:.

Activity-based costing (ABC) is a costing methodology that identifies activities in an organization and assigns the cost of each activity with resources to all products and services according to the actual consumption by each. This model assigns more indirect costs (overhead) into direct costs compared to conventional costing and also allows for the use of activity-based drivers. — see for example van der Merwe and Clinton (2006)

***Note**: This means that ABC is designed to improve the estimation of cost elements of entire products, activities and services.*

Lean Accounting

Definition 46 .:. Lean accounting .:.

Lean Accounting is introduced to support the lean enterprise as a business strategy (the company that strives to follow the principles of Lean Production see Liker and Convis (2011)). The idea is to promote a system that measures and motivates best business practices in the lean enterprise by measuring those things that matter for the customer and the company.

Resource Consumption Accounting (RCA)

Definition 47 .:. Resource consumption accounting .:.

Resource Consumption Accounting (RCA) is a management theory describing a dynamic, fully integrated, principle-based, and comprehensive management accounting approach that provides managers with decision support information for enterprise optimization. RCA is a relatively new, flexible, comprehensive management accounting approach based largely on the German management accounting approach Grenzplankostenrechnung (GPK)

Grenzplankostenrechnung (GPK)

Definition 48 .:. Grenzplankostenrechnung (GPK) .:.

is a German costing methodology, developed in the late 1940s and 1950s, designed to provide a consistent and accurate application of how managerial costs are calculated and assigned to a product or service. The term Grenzplankostenrechnung, often referred to as GPK, has been translated as either Marginal Planned Cost Accounting or Flexible Analytic Cost Planning and Accounting.

The GPK methodology has become the standard for cost accounting in Germany as a "result of the modern, strong controlling culture in German corporations (**??**). German firms that use GPK methodology include Deutsche Telekom, Daimler AG, Porsche AG, Deutsche Bank, and Deutsche Post (German Post Office). These companies have integrated their costing information systems based on ERP (Enterprise Resource Planning) software and they tend to reside in industries with highly complex processes. However, GPK is not exclusive to highly complex organizations; GPK is also applied to less complex businesses.

Throughput Accounting (TA)

Definition 49 .:. Throughput Accounting (TA) .:.

Throughput Accounting is a principle-based and simplified management accounting approach that aims to maximize throughput (sales reduced with total variable costs). It is not a Cost Accounting approach as it does not try to allocate all costs (only variable costs) and is only cash focused.

Hence TA tries to maximize Throughput (T)

$$T = S - TVC$$

typically expressed as a Throughput Accounting Ratio (TAR)

$$TAR = \frac{\text{return per factory hour}}{\text{cost per factory hour}}$$

***Note**: Where typically Cost Accounting focuses on reducing all costs, TA focuses on increasing throughput: increasing sales, reducing stocks, . . . increase the speed at which throughput is generated*

***Note**: TA was introduced by Goldratt et al. (1992)*

Life Cycle Cost Analysis

Definition 50 .:. Life Cycle Costing (LCCA) .:.

Life-cycle cost analysis (LCCA) is a tool to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain and, finally, dispose of an object or process, when each is equally appropriate to be implemented on technical grounds

Hence LCCA is ideal to decide what to use and how to do it. For example it can be used to decide which types of rails to use, which machine to use to put the rails, how to finance the machine, etc.

***Note**: In order to perform a LCCA scoping is critical - what aspects are to be included and what not? If the scope becomes too large the tool may become impractical to use and of limited ability to help in decision-making and consideration of alternatives; if the scope is too small then the results may be skewed by the choice of factors considered such that the output becomes unreliable or partisan. Usually the LCCA term implies that environmental costs are not included, whereas the similar Whole-Life Costing, or just Life Cycle Analysis (LCA), generally has a broader scope, including environmental costs.*

Environmental Accounting

Definition 51 .:. Environmental Accounting (EA) .:.

Environmental accounting incorporates both economic and environmental information. It can be conducted at the corporate level, national level or international level (through the System of Integrated Environmental and Economic Accounting, a satellite system to the National Accounts of Countries (those that produce the estimates of Gross Domestic Product (GDP))). Environmental accounting is a field that identifies resource use, measures and communicates costs of a companys or national economic impact on the environment. Costs include costs to clean up or remediate contaminated sites, environmental fines, penalties and taxes, purchase of pollution prevention technologies and waste management costs.

Target Costing

Definition 52 .:. Target Costing (TC) .:.

Target Costing is a cost management tool for reducing the overall cost of a product over its entire life-cycle with the help of production, engineering, research and design. A target cost is the maximum amount of cost that can be incurred on a product and with it the firm can still earn the required profit margin from that product at a particular selling price.

***Note**: In the traditional cost-plus pricing method, materials, labour and overhead costs are measured and a desired profit is added to determine the selling price. Target Costing works the opposite way around. One starts from the price that can be obtained on the market and then works back what the costs can be and tries to reduce costs as necessary.*

7.2.2 Selected Cost Types

Direct Costs

Definition 53 .:. Direct Cost .:.

A Direct Cost is a cost used to produce a good or service and that can be identified as directly used for the good or service.

For example: Direct Cost can be (raw) materials, labour, expenses, marketing and distribution costs if they can be traced to a product, department or project.

Marginal Costs

Definition 54 .:. Marginal Cost .:.

The Marginal Cost is the expense to produce one more unit of product. This can also be defined as $C_M = \frac{\partial P}{\partial Q}$ (with P the price, A the quantity produced and C_M the Marginal Cost

Indirect Costs

Definition 55 .:. Indirect Cost .:.

An Indirect Cost is an expense that is not directly related to producing a good or service, and/or cannot be easily traced to a product, department, activity or project.

Example 8 .:. A Computer Assembly Facility .:.

An assembly facility will easily allocate all components and workers to the end-product (eg. a specific mobile phone or tablet). However, the cost to rent the facility, the electricity and the management are not easily allocated to one type of product, so they can be treated as Indirect Costs.

Fixed Costs

Definition 56 .:. Fixed Cost .:.

A fixed cost is an expense that does not vary with the number of goods or services produced (at least in medium or short term)

Definition 57 .:. Variable Cost .:.

A Variable Cost is an expense that changes directly with the level of production output.

Example 9 .:. A Computer Assembly Facility .:.

The lease of the facility will be a fixed cost: it will not vary in function of the number of phone and tablets produced. However, the electricity and salaries might be Variable Costs.

Overhead Costs

Definition 58 .:. Overhead Cost .:.

An Overhead Cost ("operating expense, or "overhead expense) is an on-going expense inherent to operating a business that cannot be easily traced to or identified with any particular cost unit (cost centre).

Overhead expenses can be defined as all costs on the income statement except for direct labour, direct materials, and direct expenses. Overhead expenses may include accounting fees, advertising, insurance, interest, legal fees, labour burden, rent, repairs, supplies, taxes, telephone bills, travel expenditures, and utilities Note that Overhead Cost can be Variable Overhead (eg. office supplies, electricity) or Fixed Overhead (lease of a building)

Other: sunk costs, operating costs

7.3 Selected Functions of MA

7.3.1 Balanced Scorecard

Definition 59

The Balanced Scorecard (BSC) is a structured report that helps managers to keep track of the execution of activities, issues and relevant measures. The critical characteristics that define a balanced scorecard are:

- its focus on the strategic agenda of the organization concerned,
- the selection of a small number of data items to monitor (that are or collections or are expected to monitor a wider concept),
- a mix of financial and non-financial data items,
- a comparison to an expected or hoped for result (closed loop controller)

Third Generation Balanced Scorecard

The third-generation version was developed in the late 1990s to address design problems inherent to earlier generations – see Lawrie and Cobbold (2004). Rather than just a card to measure performance it tries to link into the strategic long-term goals, therefore it should be composed of the following parts:

- A destination statement. This is a one or two page description of the organisation at a defined point in the future, typically three to five years away, assuming the current strategy has been successfully implemented. The descriptions of the successful future are segmented into perspectives for example financial & stakeholder expectations, customer & external relationships, processes & activities, organisation & culture
- A strategic linkage model. This is a version of the traditional strategy map that typically contains 12-24 strategic objectives segmented into two perspectives, activities and outcomes, analogous to the logical framework. Linkages indicate hypothesised causal relations between strategic objectives.
- A set of definitions for each of the strategic objectives.
- A set of definitions for each of the measures selected to monitor each of the strategic objectives, including targets.

***Note**: A good overview of the third generation balanced scorecard can be found in: Kaplan and Norton (2001a), Kaplan and Norton (2001b) as well as Norreklit (2000)*

Also essential is that the design process is driven by the management team who will use the balanced scorecard. The managers themselves, not external experts, make all decisions about the balanced scorecard content. The process starts –logically– with the development of the "destination statement" to build management consensus on longer term strategic goals. This result is then used to create the "strategic linkage model" that presents the shorter term management priorities and how they will help to achieve the longer term goals. Then all "strategic objectives" are assigned at leas one "owner" in the the management team, this owner defines the objective itself, plus the measures and targets associated with the objective. The main difference with the previous generations of BSCs is that the third generation really tries to link in with the strategic objectives, hence improving relevance, buy-in and comfort that more areas are covered.

Key Performance Indicator (KPI)

Definition 60

a measure used to cover bring about behavioural change and improve performance.

Example 10 .:. Net Promoter Score and Customer Satisfaction .:.

Our management thinks that customer engagement is key and identifies NPS as a KPI (or even as *the* KPI). Doing so it engages all employees to provide customers with a better experience, better product, sharp price, after sales service, etc. Almost everything the company does will somehow contribute to this KPI.

A performance indicator or key performance indicator (KPI) measures performance, evaluates the success of an organization or of a particular activity. It can be that success is the repeated, periodic achievement of some levels of operational goal (e.g. zero defects, 10/10 customer satisfaction, etc.), or alternatively it can be the increase or decrease of a measure (eg. decrease the number of accidents, increase the number of customers in the pipeline, etc.).

Leading and Lagging KPIs

Lagging KPIs

Definition 61 .:. Lagging Indicator .:.

A Lagging Indicator is an "output" indicator, it is the result of something but and by the time it is measured it is too late for management to intervene.

Example 11 .:. Lagging Indicator .:.

All financial indicators such as profit, ROI, etc are lagging indicators, they are the result of many actions, but when the financial statements are known they are what makes or breaks the company.

Leading and Lagging KPIs

Leading KPIs

Definition 62 .:. Leading Indicator .:.

A Leading Indicator is a measure that is predicting the strategic result and can be used to manage towards a good result.

Example 12 .:. Leading Indicator .:.

The textbook example would be that when your strategic goal is to live longer and be physically fitter, then most probably your level one KPI is weight loss. But that is a Lagging Indicator: when you are on the scale and you read out the weight, it is too late to do something about it. Leading indicators that feed into this lagging indicator are for example food intake, hours of workout, etc.

***Note**: Typically Leading Indicators feed into Lagging Indicators. The higher up the organization chart, the more KPIs become lagging. One of the finer arts of management is to turn these lagging KPIs into actionable strategies, leading KPIs, leading actions, etc.*

7.3.2 Selection of KPIs

Customer Value Metric (CVM)

Definition 63 .:. Customer Value Metric (CVM) .:.

A Customer Value Metric is an estimation of the monetary value that a customer represents.

Customer Value Metrics can be:

- **Historic**: eg. the net profit on a customer over the last year
- **Expected**: also referred to as Customer Lifetime Value or Lifetime Customer Value this is the present value of the total value that be expected to be derived from this customer.
- **Potential**: the maximal obtainable customer value

***Note**: Note that the forward looking company will always neglect any past income.*

Common Pitfalls in CVM Use and Calculation

- Use **Income or Gross Profit** in stead of Net Income.
- **Not allocating costs logically**

- Allocating costs **politically**.
- Cost allocation is **not detailed enough**.
- Blind use of **existing customer segmentation**
- Trust **intuition** in stead of numbers.
- CVM is an output model (not an input model). If model inputs change then the CVM will change (eg. better customer service will reduce churn).
- **Correlation** between the CVM of different segments can increase **risk**

Net Promoter Score (NPS)

If customer satisfaction is rated on a scale from 1 to 10, then the promoter score (PS) is the percentage of users that score 9 or 10 and the brand Distractors are the percentage of clients that score 1 or 2. Promoters are *believed* to support the brand and detractors are *believed* to discourage peers to use the brand.

Definition 64 .:. Net Promoter Score (NPS) .:.

The difference between the Promoters and Distractors (as defined above)

The NPS was introduced by Reichheld (2003) and Baine & Co (and still is a registered trademark of Fred Reichheld, Bain & Company and Satmetrix).

Good or Bad NPS?

Question

An NPS can be between -100 (everybody is a detractor) or as high as +100 (everybody is a promoter). So, what is a good and what is a bad NPS?

. . . . . .

. . . . . .

. . . . . .

. . . . . .

PART III

Calculating Company Value

PART III .:. CHAPTER 8 .:.

Measures Related to Company Value for External Stakeholders

Already in Chapter 3.2 we discussed some ratios that help the managers of the company to manage value. However, in order to properly value a company we will need to introduce a few more concepts. Some of them will also be ratios and most of them are needed to understand the different valuation models.

Total Capital (Employed)

Definition 65 .:. Total Capital Employed (TC or TCE) .:.

$$TCE = \text{share capital + reserves + loans}$$

note: TCE := TC

ROIC

Return on Invested Capital

Definition 66 .:. Return on Invested Capital (ROIC) .:.

$$\begin{aligned} ROIC &= \frac{\text{Operating Profit}(1 - \text{tax rate})}{\text{Book value of Invested Capital}_{t-1}} \\ &= \frac{OperatingProfit - AdjustedTaxes}{InvestedCapital} \\ &= \frac{EBIT}{FixedAssets + IntangibleAssets + CA - CL - Cash} \\ &= \frac{EBIT}{\text{debt + equity - cash (- goodwill)}} \\ &= \frac{EBIT}{TCE} \end{aligned}$$

note ROIC := ROI := ROC := ROCE

WACC

Weighted Average Cost of Capital (aka Cost of Capital)

Definition 67 .:. WACC .:.

The cost of capital is the cost of a company's funding (debt and equity), or, from an investor's point of view "the required rate of return on a portfolio company's existing securities".

WACC is used to evaluate new projects of a company: it is the minimum rate of return that a new project should bring. WACC is also the minimum return that investors expect in return for capital they allocate to the company (hereby setting a benchmark that a new project has to meet — so both are equivalent).

$$\begin{aligned} WACC &= \frac{\sum_{i=1}^{N} R_i V_i}{\sum_{i=1}^{N} V_i} \\ &= \frac{D}{D+E} K_d + \frac{E}{D+E} K_e \qquad \text{(if only funded by equity and debt)} \end{aligned}$$

With V_i the market value of asset i, R_i the return of asset i, E the total equity, D the total debt, K_e the cost of equity and K_d the cost of debt.

For our purposes we will have to include tax effects. Assuming a tax rate of τ we get:

$$WACC = \frac{D}{D+E} K_d(1-\tau) + \frac{E}{D+E} K_e$$

There are factors that make it difficult to calculate the formula for determining WACC (eg. determining the market value of debt (here one can usually use the book value –in case of a healthy company– and equity (this can be circular), finding a good average tax rate, etc.). Therefore different stakeholders will make different assumption and end up with different numbers.

This is the genesis of a healthy market where no-one has perfect information and the different players have different price calculations. This will then lead to turnover (buying and selling).

EVA

Economic Value Added

Definition 68 .:. EVA .:.

Economic Value Added (EVA) is an estimate of the company's economic profit (the value created in excess of the required return of the company's shareholders). In other words, EVA is the net profit less the opportunity cost for the firm's capital.

$$EVA = (ROIC - WACC)(TA - CL) \tag{8.1}$$
$$= NOPAT - WACC(TA - CL) \tag{8.2}$$

MVA

Market Value Added

Definition 69 .:. MVA .:.

Market value added (MVA) is the difference between the company's current market value and the capital contributed by investors.

$$MVA = V_{market} - K \tag{8.3}$$

with V_{market} the market value and K the capital paid by investors.

If a company has a positive MVA this means that it has created value (in case of a negative MVA it has destroyed value). However, to determine if the company has been a good investment one has to compare the return on the invested capital with the return of the market (r_M), adjusted for the relative risk of that company (it's β) The MVA is the present value of the series EVA values. MVA is economically equivalent to the traditional NPV measure of worth for evaluating an after-tax cash flow profile of a project if the cost of capital is used for discounting.

$$MVA = \sum_{t=0}^{\infty} \frac{EVA_t}{(1+WACC)^t}$$

RIR

Reinvestment Rate

Definition 70 .:. Reinvestment rate .:.

$$RIR = ReinvestmentRate = \frac{g}{ROC}$$

***Note**: Other authors will call "reinvestment rate" the amount of interest that can be earned when one (fixed-income) investment is sold to purchase another.*

ROE

Return on Equity

Definition 71 .:. Return on Equity (ROE) .:.

$$\begin{aligned} ROE &= \frac{\text{Net Income}_t}{\text{Book Value of Equity}} \\ &= \frac{NetIncome}{Sales}\frac{Sales}{TA}\frac{TA}{ShareholdersEquity} \qquad \text{(DuPont Formula)} \\ &= \frac{NOPAT}{Equity} \end{aligned}$$

__Note__: The main difference with ROC is that ROE does not include debt (including loans, bonds and overdue taxes) in the de-numerator. The second difference is that ROE uses in the numerator earnings after taxes (but before dividends), where ROC uses earnings before interest and taxes (EBIT).

ROE shows how profitable a business is for the investor/shareholder/owner, because the denominator is simply shareholders' equity. ROIC and ROA show the overall profitability of the business (and for the business) because the denominator includes debt in addition to equity (which is also capital employed, but not necessarily provided by the owner).

ROE and ROA will differ widely in businesses that employ a lot of leverage. Banks for example, earn a very low return on assets because they earn a small spread (ex: borrow at 0.5%, lend at 3.5%). Regular saving banks have the majority of their capital structure in depositors' money (i.e. low-interest bearing debt) and this leverage magnifies their returns compared to equity. It is typical for banks to have low ROA but a high ROE

Software manufacturers do not need to use leverage to make high returns. Microsoft in its heyday was selling Windows at net profit margins of 25% and turning over its entire inventory almost twice a year, thus earning almost 50% ROE with minimal leverage.

There is no best measure, and all measures have to be used with care. It is important to consider what one wants to obtain before making a choice. It is very different to make a comparative analysis within one sector or compare different sectors for example.

An important footnote is that in the denominator of ROE one will find the book value of the equity (of course one might make the calculation with the market value). However that is not necessarily the most important reference for the investor. The investor might have his/her own book value, purchase price or other price as a reference.

Coverage Ratio

Definition 72 .:. Coverage Ratio (CoverageR) .:.

$$CoverageR = \frac{OperatingIncome}{FinancialExpenses}$$

An alternative for the Coverage Ratio is $\frac{debt}{EBIT}$ ratio when one wants to asses the level of leverage in the company.

Another possibility is the Debt-Service Coverage Ratio (DSCR)

Definition 73 .:. Debt-Service Coverage Ratio (DSCR) .:.

$$DSCR = \frac{NetOperatingIncome}{DebtServices}$$
$$DSCR = \frac{NetIncome + AmortizationAndDepreciations + InterestExpenses + OtherNonCash}{PrincipalRepaymets + InterestPayments + LeasePayments}$$

Operating Assets

Definition 74 .:. Operating Assets (OA) .:.

$$\begin{aligned} OA &= Total\ Assets - Financial\ Assets \\ &= TA - FA \\ &= TA - cash \qquad \text{(usually)} \end{aligned}$$

Operating Liabilities

Definition 75 .:. Operating Assets (OL) .:.

$$\begin{aligned} OL &= TotalLiabilites - FinancialLiabilities \\ &= TL - FL \\ &= TL - ShortTermNotes - LongTermNotes \qquad \text{(usually)} \end{aligned}$$

Net Operating Assets

Definition 76 .:. Net Operating Assets (NOA) .:.

$$\begin{aligned} NOA &= Operating\ Asssets - Operating\ Liabilities \\ &= OA - OL \end{aligned}$$

Working Capital

Definition 77 .:. Working Capital (WC) .:.

$$\begin{aligned} WC &= CurrentAssets - CurrentLiabilities \\ &= CA - CL \end{aligned}$$

Hence WC represents the operating liquidity that is available to the business. A positive WC means that there is enough cash to cover the short term liabilities. If WC is negative this means that the company will need to use more cash to cover short term liabilities than it is getting in via its current assets.

***Note**: Compare this to the definition of Liquid Ratio — see Definition 128 on page 74*

To determine the current assets and current liabilities one needs to use the following three accounts:

- accounts receivable ($\rightarrow$ current assets)
- inventory ($\rightarrow$ current assets), and
- accounts payable ($\rightarrow$ current liabilities) — eg. short term debts such as bank-loans and lines of credit.

If we observe that the working capital increases, then this means that the current assets grew faster than the current liabilities (for example that it has increased its receivables, or other current assets or has decreased current liabilitiesfor example has paid off some short-term creditors, or a combination of both).

Gearing

Definition 78 .:. Gearing Ratio (GR) .:.

$$\begin{aligned} GR &= \frac{\text{Loans}}{\text{TCE}} \\ &= \frac{\text{Loans}}{\text{Shareholders Equity + Reserves + Loans}} \end{aligned}$$

Debt-to-equity ratio

Definition 79 .:. Debt-to-equity ratio (DE) .:.

$$DE = \frac{\text{Loans}}{\text{Equity}}$$

Non-Operation Assets

Definition 80 .:. Non-Operating Assets .:.

A non-operating asset is an assets that is not essential to the ongoing/usual operations of a business but may still generate income (and hence contributes to the return on investment (ROI)).

Typically these assets are not listed separately in the balance sheet, one will have to gather the information from the management or on-site analysis.

PART III .:. CHAPTER 9 .:.

Introduction to Company Value Calculation

Valuation of financial assets is done using one or more of these types of models:

Company Value Calculation Methods

1. **Absolute value models** that determine the present value of an asset's expected future cash flows. These kinds of models take two general forms: multi-period models such as discounted cash flow models or single-period models such as the Gordon model. These models rely on mathematics rather than price observation.

2. **Relative value models** determine value based on the observation of market prices of similar assets.

3. **Option pricing models** are used for certain types of financial assets (e.g., warrants, put options, call options, employee stock options, investments with embedded options such as a callable bond) and are a complex present value model. The most common option pricing models are the BlackScholes-Merton models and lattice models.

Common terms for the value of an asset or liability are market value, fair value, and intrinsic value. The meanings of these terms differ. For instance, when an analyst believes a stock's intrinsic value is greater (less) than its market price, an analyst makes a ″buy″ (″sell″) recommendation. Moreover, an asset's intrinsic value may be subject to personal opinion and vary among analysts.

The International Valuation Standards include definitions for common bases of value and generally accepted practice procedures for valuing assets of all types.

PART III .:. CHAPTER 10 .:.

Intrinsic Value

10.1 Free Cash Flow (FCF)

Flow to Equity

The purpose of most company valuations is to determine the value of a company from the point of view of the equity holder. Further we assume that the only value a company brings to the shareholder is the financial income. This means that the value of the company is the present value of all future cash flows to the equity holder paid up-front (now and at once). Therefore it is important to use only cash flows that go to the shareholder and exclude salaries, bonuses, taxes, etc . . . so we use FCF

Free Cash Flow (FCF)

Definition 81 .:. Free Cash Flow (FCF) .:.

Free Cash Flow is the cash flow available for distribution to equity holders of the company.

***Note**: FCF is also referred to as FCFF (Free Cash Flow to Firm)*

$$FCF = EBIT(1-\tau) + Depreciation + Amortization - \Delta WC - CapEx$$

In other words, starting from EBIT one will want to

- take out the tax paid since that is not going to the shareholders,
- add again depreciations and amortizations because these are no cash outflows,[1]
- reduce by changes in working capital (if the working capital increased, this means that the company needed more cash to operate and this will reduce the owner earnings).
- reduce by changes in capital expenses, because these costs really reduce liquidity (these are of course linked to the amortizations and depreciations)

[1]The defining difference between depreciation and amortization is that amortization charges off the cost of an intangible asset, where depreciation charges of cost of a tangible asset

Alternative Ways to Calculate FCF

$$\begin{aligned} FCF &= EBIT(1-\tau) + Depreciation + Amortization - \Delta WC - CapEx \\ &= NOPAT + InterestExpense + Depreciation + Amortization - \Delta WC - CapEx - TaxShiel \\ &= PAT - (1-d)(Depreciation + Amortization - \Delta WC - CapEx) \end{aligned}$$

Besides FCF there is also the concept "Net free cash Flow" this is the free cash flow available for the company to maintain operations without making more debt, its definition also allows for cash available to pay off the company's short term debt and should also take into account any dividends.

$$NetFreeCashFlow = OperationCashflow - CapitalExpensestokeepcurrentlevelofoperation - divide$$

Here Capex Definition should not include additional investment on new equipment. However maintenance cost can be added.

- Dividends - This will be base dividend that the company intends to distribute to its share holders.
- Current portion of LTD - This will be minimum debt that the company needs to pay in order to not default.
- Depreciation - This should be taken out since this will account for future investment for replacing the current PPE.

Net Free Cash Flow is a useful measure for the management of a company but we will not need it for company valuation.

10.2 Discounted Cash Flow Model

Discounted Cash Flow

Definition 82 .:. Discounted Cash Flow .:.

Discounted cash flow (DCF) is a method of valuing a company, project, or any other asset by discounting future cash flow to today's value (in other words: using the time value of money) and then summing then.

In practice, future cash flows are first estimated and then discounted by using the relevant cost of capital to give their present values (PVs). The sum of all future cash flows, is the then called the net present value (NPV), which is taken as the value or price of the cash flows in question.

Definition 83 .:. NPV .:.

The Net Present Value (NPV) is then the sum of all present values and represents today's value of the asset.

The DCF model in company valuation is simply calculating the NPV of the companies FCF

Future Value

Definition 84 .:. DPV .:.

The Discounted Present Value (DPV) of a Future Value (FV) happening in moment t is

$$DPV := \frac{FV}{(1+r)^t}$$

The DCF value then become the sum of all DPVs.

Calculating the DCF value of a company

$$
\begin{aligned}
V &= \sum_{t=1}^{\infty} \frac{CF_t}{(1+r_t)^t} \\
&= \sum_{t=1}^{\infty} \frac{CF_t}{(1+r)^t} && \text{(assuming } \forall r_t : r_t = r\text{)} \\
&= \sum_{t=1}^{\infty} \frac{CF_{t-1}(1+g_t)}{(1+r)^t} && \text{(with } CF_0 \text{ known)} \\
&= CF_0 \sum_{t=1}^{\infty} \frac{(1+g)^t}{(1+r)^t} && \text{(assuming } \forall g_t : g_t = g\text{)} \\
&= CF_0 \frac{1+g}{r-g} && \text{(assuming } g < r \text{ and } g \neq -1\text{)} \\
&= \frac{CF_0}{r} && \text{(assuming } g = 0\text{)}
\end{aligned}
$$

Question

Proof this as an exercise

DCF Model for Company Valuation

For company valuation we will substitute:

- CF by FCF, because that is the relevant cash flow for the potential buyer of the company
- r by WACC, because the company should at least make good for compensating its capital needs

Hence we get:

$$
\begin{aligned}
V &= \sum_{t=1}^{\infty} \frac{FCF_t}{(1+WACC)^t} \\
&= \sum_{t=1}^{\infty} \frac{FCF_{t-1}(1+g_t)}{(1+r)^t} && \text{(with } FCF_0 \text{ known)} \\
&= FCF_0 \sum_{t=1}^{\infty} \frac{(1+g)^t}{(1+WACC)^t} && \text{(assuming } \forall g_t : g_t = g\text{)} \\
&= FCF_0 \frac{1+g}{WACC-g} && \text{(assuming } g < WACC \text{ and } g \neq -1\text{)} \\
&= \frac{FCF_0}{WACC} && \text{(assuming } g = 0\text{)}
\end{aligned}
$$

10.2.1 Advantages and Disadvantages of the DCF method

Advantages

- Always applicable to all companies
- Logical and complete
- Easy to understand
- DCF allows for the most detailed view on the company's business model
- It can be used to model synergies and/or influence on the company's strategy

Disadvantages

- determining the FCF is not too easy
- one needs to forecast an infinite amount of FCFs (and therefore one needs to model the whole balance sheet)
- therefore one needs many assumptions (costs, inflation, labour costs, sales, etc.)
- one needs to find a good discount rate (which is complex and actually circular)
- it is incomplete without stress testing the result

10.3 Discounted Abnormal Operating Earnings valuation model

Calculating NOA is necessary for applying the Discounted Abnormal Operating Earnings valuation model. DAOE is one of the most widely accepted valuation models because it is considered the least sensitive to forecast errors. NOA can also be used in the calculation of Free cash flow (FCF) and therefore the Discounted cash flow model. However it is not necessary to calculate FCF.

$$DAOE = \frac{NOPAT(t) - WACC \times NOA(t-1)}{WACC} + NOA - BVD$$

$$FCF = NOPAT - Change\ in\ NOA$$

$$DCF = \frac{FCF}{WACC} - BVD \qquad \text{(in case of zero growth)}$$

10.4 Dividend Discount Model

The Dividend Discount Model (DDM)

Theorem 10.4.1 (DDM). *The value of a stock is given by the discounted stream of dividends:*

$$V_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+r)^t}$$

Capital gains appear as expected sales value and are derived from expected dividend income.

V_0 the intrinsic value of the stock now

D_t the dividend paid in year t

r is the capitalization rate and is the same as $E[R_k]$ in the CAPM, see Equation 10.8 on page 127

10.4.1 Constant-Growth DDM

constant-growth DDM (CGDDM)

If every year the dividend increases with $100g\%$ (with g the growth rate), then

$$\begin{aligned} D_1 &= D_0(1+g) \\ D_2 &= D_1(1+g) && = D_0(1+g)^2 \\ &\dots \\ D_n &= D_{n-1}(1+g) && = D_0(1+g)^n \end{aligned}$$

Theorem 10.4.2 (constant-growth DDM). *Assume that* $\forall t : D_t = D_0(1+g)^t$*, then the DDM collapses to*

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{D_1}{r-g}$$

Numeric Example: KTBC

Example 13 .:. KTBC with $g = 0\%$.:.

Assume "Known To Be A Corporate" (KTBC), the company pays now a dividend of € 10 and we believe that the dividend will grow at 0% per year. The risk free rate (on any horizon) is 1% and the market risk premium is 5% and the β is 1. What is the intrinsic value of the company?

Answer

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{D_0}{r} = \frac{10(1+0.00)}{0.01+0.05-0} = \frac{10}{0.06} = 166.67$$

This value is called the "no-growth-value".

Example 13 .:. KTBC with $g = 2\%$.:.

Expected growth rate of the dividend is 2%, ceteris paribus.

Answer

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{10(1+0.02)}{0.01+0.05-0.02} = 255$$

The difference in value compared to the previous example is called the PVGO (present value of growth opportunities). So

$$Price = \text{no-growth-value} + PVGO \tag{10.1}$$

$$P_0 = \frac{D_0}{r} + PVGO \tag{10.2}$$

Example 13

The β is assumed to be 1.5, ceteris paribus.

Answer

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{10(1+0.02)}{0.01+1.5\times 0.05-0.02} = 156.92$$

Example 13

The dividend growth rate is now expected to be 10%, ceteris paribus.

Answer

$$V_0 = \frac{D_0(1+g)}{r-g} = \frac{10(1+0.02)}{0.01+1.5\times 0.05-0.10} = -680$$

This example illustrates that the DDM is only valid for dividend growth rates smaller than the required rate of return! Actually the model states that anything above that is unsustainable and will lead to a correction.

10.4.2 Multi Stage Growth Models

Multi Stage Growth Models

Growth rates are here assumed to be piecewise constant or are modelled in more complex ways in order to account for economic cycle, industry life cycle, company life cycle, etc.

Example 14 .:. UTBC .:.

Assume the company UTBC ("Unknown to be a Corporate"), it is a young company that since its foundation 5 years ago has been. It paid the following dividends: (€ 0,€ 0,€ 10,€ 25,€ 50). Hence the dividend growth rates were: by "0%", $\infty\%$, 250%, and 200%. When considering to buy the company we assume that he high profit increase will continue for 5 more years, then slow down to 20% for the next ten years, and 10% ever after.

More Definitions

Some definitions:

Definition 85 .:. earnings .:.

E := net income

Definition 86 .:. dividend payout ratio .:.

$DPR := \frac{D}{E}$

Definition 87 .:. plow-back ratio (earnings retention ratio) .:.

$PBR := 1 - DPR$

Definition 88 .:. Return on Equity .:.

$ROE := \frac{E}{P}$

***Note**: Note that all definitions work as well per share as for the company as a whole!* ***We will use all concepts per share** unless otherwise stated.*

Some Results

the growth rate of the dividends is related to the DPR.

$$g = ROE \times PBR \tag{10.3}$$

This is because if the company retains $x\%$ earnings, then the next dividend will be $x\%$ higher. More generally:

$$g = \frac{reinvested\ earnings}{book\ value} = \frac{reinvested\ earnings}{total\ earnings}\frac{total\ earnings}{book\ value}$$

Hence –as mentioned earlier–

$$Price = \text{no-growth-value} + PVGO \tag{10.4}$$

$$P_0 = \frac{D_0}{r} + PVGO \tag{10.5}$$

If the stock trades at its intrinsic value (i.e. $P_0 = V_0$) and if we assume the CGDDM then

$$P_0 = \frac{D_1}{r - g} \tag{10.6}$$

Example

Example 15 .:. Maximize P .:.

How can a company maximize its price on the stock exchange?

Answer
To answer this, the management has to assume that the price on the stock exchange P will be close to the real value of the company V. So the question becomes how to inflate the value? This can be done by using Equation 10.6. As we noted before, always $g < r$ (otherwise the growth is unsustainable); and in that region one can increase P_0 by decreasing $r - g$ and hence by increasing g. Since $g = \frac{reinvested\ earnings}{book\ value}$ we can increase the value by not paying any dividend.

Does this work?

10.4.3 Advantages and Disadvantages of the DDM method

Advantages

- Logical and complete in a liquid market
- Easy to understand
- in absence of influence on the management it is all we need
- it only makes assumptions about the outcome (dividend) and not the thousands of variables that influence this variable

Disadvantages

- one needs to forecast an infinite amount of dividends
- one needs to find a good discount rate (which is complex and actually circular)
- it is incomplete without stress testing the result

10.5 Net Asset Value Method or Cost Method

The Net Asset Value Method (hereafter NAV method) is probably the most simple method to value assets but it also has the most narrow field of application. To value a company it will simply take the value of the assets of the company.

Net Asset Value Method (NAV Method)

Definition 89 .:. Net Asset Value Method .:.

The Net Asset Value Method is also known as the Liquidation Method. The idea is to use the liquidation value as a proxy for the company's value. The question one answers is: "if the company stopped trading now, what would be get from all assets (reduced with all liquidation costs)".

This method only considers the assets and liabilities of the business. At a minimum, a solvent company could shut down operations, sell off the assets, and pay the creditors. The money that is left can then be distributed to the shareholders and hence can be considered as the value of the company.

Of course companies are supposed to grow and create value, hence this method is rather a good floor value for the company. In general the discounted cash flows of a well-performing company exceed this floor value. Typical examples are startups and growth companies.

Zombie companies that needs subsidiaries to survive for example that own many tangible assets might be worth more when liquidated than when operations are continued.

This method is probably a good alternative for valuing non-profit organisations, because generating profit (cash flow) is not the main purpose of these companies.

Further it is essential to consider the purpose of this type of valuation. If it is really the idea to stop trading and liquidate the company, in that case one will have to add the liquidation cost. For example selling an asset might involve costs to market it, have it valued, maintain it till it it sold, store it (eg. keep a boat in a harbour), etc.

The time scale becomes also relevant here. If one needs urgently the cash then the expected price will be lower, but also the cost of storing and maintaining the asset might be lower.

Depending on the purpose of the valuation one will also have to choose what value to consider: book value or market value? For example a used car might be worth 0 in the books but still can be sold for good money.

10.5.1 Investment Funds

Investment funds are a very specific type of companies that are created with the sole purpose to invest in other financial assets.[2] The most common type of investment funds will invest in liquid assets and not try to influence the management of the company.

Investment funds can invest in all other financial assets that are explained in Chapter 2 on page 11, but it can do much more. For example, an investment fund can invest in real estate, labour ground or eventually actively play a role in infrastructure works.

The investment funds that are the most relevant for the investor that wants to save money for retirement –for example– are the liquid investment funds that are investing that basic assets of Chapter 2 on page 11. In Europe they are known as UCITS (Undertaking for Collective Investments in Transferable Securities) and regulated by the UCITS IV regulations.

Question

Can an investment fund invest in other investment funds?

. . . . . .

. . . . . .

. . . . . .

. . . . . .

UCISTS will never invest in their own shares. They have a variable capital and buying shares is considered as "redeeming" shares. This means that in stead of buying and holding its own shares these shares stop to exist.

In the same way the fund can create new shares when more people want to buy the fund. Typically there will be a market maker to facilitate this process.

NAV Method: Mutual Funds

Assets are valued with the NAV method

Question

Investment Funds (aka Mutual Funds) are always valued with the NAV method. Why?

[2] In that sense investment funds are comparable to holding companies, which have as sole purpose to invest in other companies and participate in their management.

Market Value

Question

The typical investment fund will value assets at market value (as opposed to book value). Why?

10.5.2 Advantages and Disadvantages of the NAV method

While for investment funds the NAV method is the only method necessary it will not give an appropriate picture of normal operating companies.

Advantages

- Simple and straightforward
- Easy to understand
- No assumption needed about a discount rate
- it is all we need for companies in receivership and investment funds

Disadvantages

For normal operating companies that are not in receivership:

- the NAV is only the lower limit of the real value (and hence merely a reality check) and for normal companies it misses the point of a valuation
- it is irrelevant for growth companies (eg. Google, Uber, Facebook)

10.6 Excess Earnings Method

In this method, first the tangible assets are estimated and an appropriate return on those tangible assets. Then one subtracts that return from the total return for the business, leaving the "excess return". This excess return is presumed to come from the intangible assets. An capitalization rate is applied to this excess return, resulting in the value of those intangible assets. That value is added to the value of the tangible assets and any non-operating assets, and the total is the value estimate for the business as a whole.

10.7 CAPM

10.7.1 The CAPM Framework

The Capital Asset Pricing Model (CAPM)

The "Sharpe-Lintner-Mossin mean-variance equilibrium model of exchange" –the Capital Asset Pricing Model (CAPM)– is used to determine a theoretically appropriate required rate of return of an asset (if that asset is to be added to an already well-diversified portfolio) as a function of that asset's non-diversifiable risk. The model takes into account the asset's sensitivity to non-diversifiable risk (also known as systemic risk or market risk), often represented by the quantity beta (β) in the financial industry, as well as the expected return of the market, and the expected return of a theoretical risk-free asset.

***Note**: All these authors were building on the earlier work of Harry Markowitz on diversification and his Mean Variance Theory. Sharpe received the Nobel Memorial Prize in Economics (jointly with Markowitz and Merton Miller) for this contribution to the field of financial economics.*

CAPM — the Model (1)

$$\frac{E[R_k] - R_{rf}}{\beta_k} = E[R_M] - R_{rf} \tag{10.7}$$

The market reward-to-risk ratio is effectively the market risk premium. Rearranging the above equation and solving for $E(R_k)$, we obtain the Capital Asset Pricing Model (CAPM).

$$E[R_k] = R_{rf} + \beta_k(E[R_M] - R_{rf}) \tag{10.8}$$

Where:

- $E[R_k]$ is the expected return on the capital asset
- R_{rf} is the risk-free rate of interest, such as interest arising from government bonds
- β_k (the beta coefficient) is the sensitivity of the asset returns to market returns, or also $\beta_k = \frac{\text{Cov}(R_k, R_M)}{\text{VAR}(R_M)}$,
- $E[R_M]$ is the expected return of the market
- $E[R_M] - R_{rf}$ the market premium or risk premium.
- $VAR(R_M)$ is the variance of the market return

The CAPM is a model for pricing an individual security or portfolio. For individual securities, we make use of the security market line (SML)

and its relation to expected return and systemic risk (beta), in order to show how the market must price individual securities in relation to their security risk class. The SML enables us to calculate the reward-to-risk ratio for any security in relation to the reward-to-risk ration of the overall market. Therefore, when the expected rate of return for any security is deflated by its beta coefficient, the reward-to-risk ratio for any individual security in the market is equal to the market reward-to-risk ratio. For any security k:

CAPM — the model (2)

Restated in terms of risk premium:

$$E[R_k] - R_{rf} = \beta_k(E[R_M] - R_{rf}) \tag{10.9}$$

which states that the individual risk premium equals the market premium times beta.

CAPM — Example [1]

Example 15 .:. KTBC .:.

The company "Known to be a Corporate Plc." has a β of 1.25, the market return is 10% and the risk free return is 2%.
What is the expected return for that company?

Answer

$$\begin{aligned} E[R_{KTBC}] &= R_{rf} + \beta_{KTBC}\left(E[R_M] - R_{rf}\right) \\ &= 2\% + 1.25\left(10\% - 2\%\right) \\ &= 12\% \end{aligned}$$

CAPM — Example [2]

Example 15 .:. KTBC .:.

The company "Known to be a Corporate Plc." has a β of 0.75, the market return is 10% and the risk free return is 2%.
What is the expected return for that company?

Answer

$$\begin{aligned} E[R_{KTBC}] &= R_{rf} + \beta_{KTBC}\left(E[R_M] - R_{rf}\right) \\ &= 2\% + 0.75\left(10\% - 2\%\right) \\ &= 8\% \end{aligned}$$

10.7.2 The CAPM and Risk

CAPM — Risk and Diversification

The risk of a portfolio consists of

1. **systematic risk or undiversifiable risk**: cannot be diversified away—it is inherent to the market under consideration ("market risk").
2. **unsystematic risk, idiosyncratic risk or diversifiable risk**: the risk of individual assets. Unsystematic risk can be reduced by diversifying the portfolio (specific risks "average out").

CAPM - about Risk

- **A rational investor should not take on any diversifiable risks** $\rightarrow$ the required return on an asset (i.e. the return that compensates for risk taken), must be linked to its riskiness in a portfolio context—i.e. its contribution to the portfolio's overall riskiness—as opposed to its "stand-alone riskiness".
- In CAPM, **portfolio risk is represented by variance**. $\rightarrow$ the beta of the portfolio is the defining factor in rewarding the systematic exposure taken by an investor.
- The CAPM assumes that the volatility-return profile of a **portfolio can be optimized as in Mean Variance Theory**.
- Because the unsystematic risk is diversifiable, the **total risk of a portfolio can be viewed as beta**.

CAPM — Lessons for Investors

It is possible to achieve a particular return in one of two ways:

1. By investing all of one's wealth in a risky portfolio,
2. or by investing a proportion in a risky portfolio and the remainder in cash (either borrowed or invested).

For a given level of return, however, only one of these portfolios will be optimal. Since the risk-free asset is, by definition, uncorrelated with any other asset, option 2 will generally have the lower variance, and hence be the more efficient of the two.

> ***Note**: This relationship also holds for portfolios along the efficient frontier: a higher return portfolio plus cash is more efficient than a lower return portfolio alone, for that lower level of return. For a given risk-free rate, there is only one optimal portfolio which can be combined with cash to achieve the lowest level of risk for any possible return. This is the market portfolio (p_M).*

CAPM — Picture It

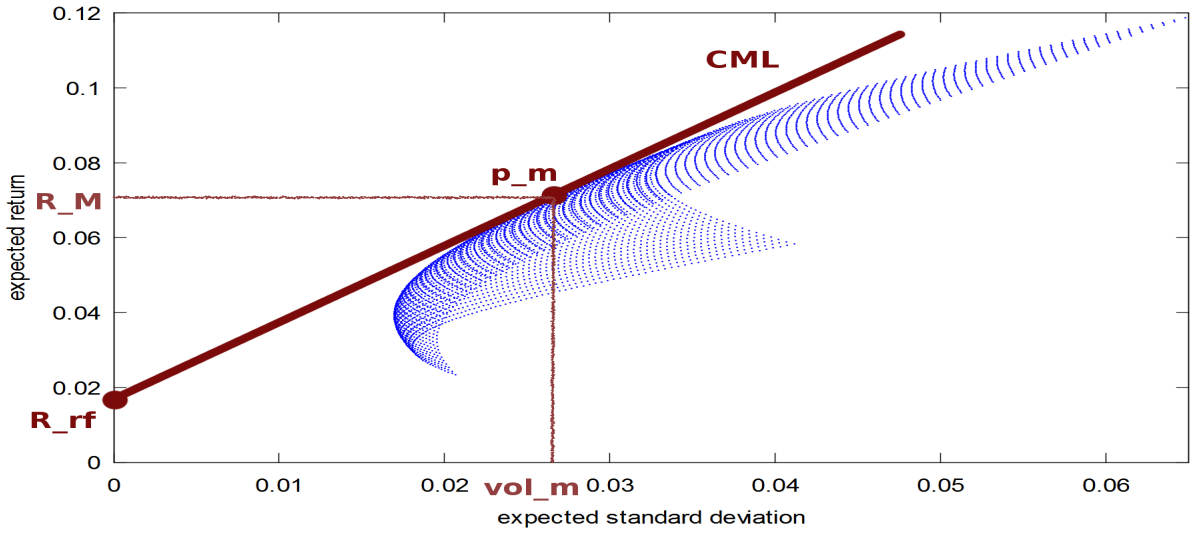


Figure 10.1: *In this plots, some portfolios (blue dots) are ploted and the Capital Allocation Line is drawn. One can observe how CAPM implies that the optimal portfolios appear on the line through* $(0, R_{rf})$ *and* p_M*. — the assets are described on Slide* **??**

10.7.3 The CAPM and its concepts

CAPM — Some Definitions

CML Capital Market Line. The line that connects $(R_{rf}, 0)$ and the market portfolio. The portfolios on the CML are those in which, according to CAPM, an investor should invest. Its equation is:

$$E[R] = R_{rf} + \sigma \frac{E[R_M] - R_{rf}}{\sigma_M} \tag{10.10}$$

CAL Capital Allocation Line. The line that connects all portfolios that can be constructed by combining a risky portfolio (p) and the riskless asset. Its equation is:

$$E[R] = R_{rf} + \sigma \frac{E[R_p] - R_{rf}}{\sigma_p} \tag{10.11}$$

In CAPM, this is the line along which the investor should move his or her portfolios: the investor will allocate more to cash if he or she wants a safer portfolio, and more to the market portfolio if a more dynamic portfolio is sought. An investor who invests according to CAPM will find that the CAL is the same as the CML.

Advisers will generally suggest using more equities and less bonds when a client seeks a more dynamic investment. This is in contradiction with CAPM, and its is

called the "Asset Allocation Puzzle". It has been argued that this can make sense if the bonds serve to hedge for inflation.

SCL **Security Characteristic Line**. The line that represents the relation between the market return and the return of a specific asset i at a given time t; its equation is:

$$R_{i,t} = \alpha_i + \beta_i \, R_{M,t} + \epsilon_{i,t} \tag{10.12}$$

Where α_i and β_i are referred to as the alpha and the beta, respectively, of the security i.

SML **Security Market Line** shows the expected return as a function of β. The intercept is the risk-free rate of return R_{rf}, and the slope is $E[R_M - R_{rf}]$. Its equation is hence:

$$E[R_i] = R_{rf} + \beta_i \, \{E[R_M] - R_{rf}\} \tag{10.13}$$

The SML is actually a single factor model for the price of a given asset i, and so it can be considered as the graph that represents the results of CAPM.

10.7.4 Limitations and Shortcomings

CAPM — Assumes that all investors . . .

1. try to maximize utility that is a function of only return and volatility,
2. have a stable utility function (does not depend on the level of wealth),
3. are rational and volatility-averse,
4. consider all assets in one portfolio,
5. and do not care about liabilities (investments are a life goal in their own right),
6. are price takers, i.e. they cannot influence prices,
7. are able to lend and borrow under the risk-free rate of interest with no limitations,
8. trade without transaction costs,
9. are not taxed in any way on their investments or transactions,
10. deal with securities that are all highly divisible into small units,
11. assume all information is at the same time available to all investors.

Shortcomings of CAPM.

Despite its theoretical appeal and its coherence with other theories for rational behaviour, such as expected utility theory, CAPM has many weak points.

1. CAPM assumes that asset **returns are (jointly) normally distributed** random variables.
2. The model assumes that the **standard deviation (or variance) of returns is an adequate measurement of risk**.
3. CAPM assumes that there exists something as "expected return" in that sense that investors agree about it (**homogeneous expectations assumption**).
4. CAPM assumes that the **beliefs of investors about the probabilities match the true distribution** of returns.
5. CAPM does **not appear to adequately explain the variation in stock returns**. Empirical studies show that low beta stocks may offer higher returns than the model would predict.
6. CAPM does not allow for casino traders.
7. CAPM assumes that there are no taxes or transaction costs, although this assumption may be relaxed with more complicated versions of the model.
8. The **market portfolio consists of all assets in all markets**, where each asset is weighted by its market capitalization.
9. The **market portfolio should in theory include all types of assets that are held by anyone** as an investment (including works of art, real estate, human capital...)
10. CAPM assumes that investment decisions are made by **taking just two dates into account**, so that there is no opportunity to consume and rebalance portfolios repeatedly over time.
11. CAPM **assumes that all investors will consider all of their assets and optimize one portfolio**. This is in sharp contradiction with portfolios that are held by investors. People tend to have separate portfolios for separate goals (retirement, education for children, special expenses, etc.)

Overview of Some Theories

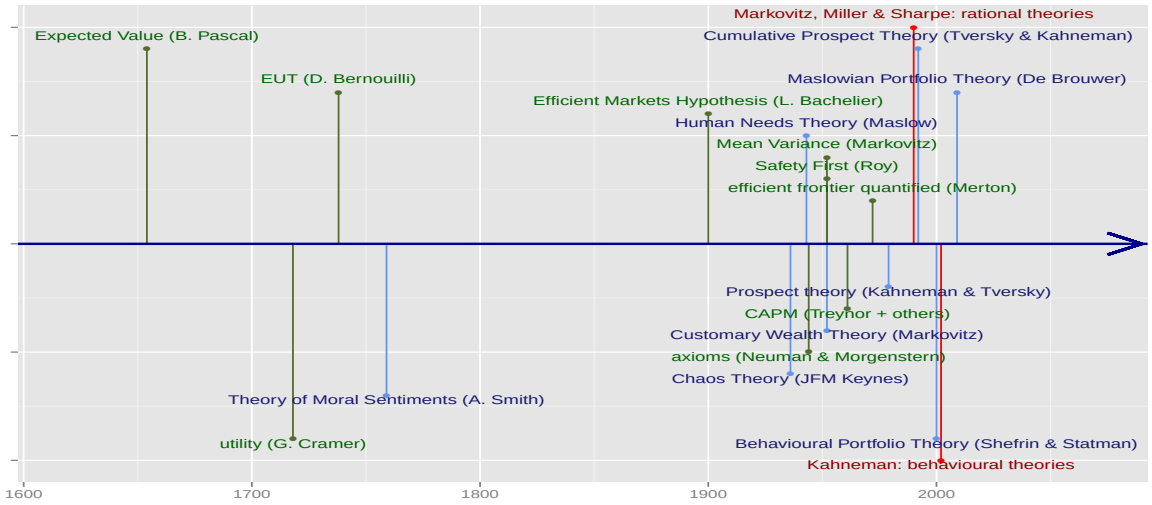


Figure 10.2: *A selection of some contributions and events.*

PART III .:. CHAPTER 11 .:.

Relative Value Models

11.1 The Idea behind Relative Value Models

Relative Value methods are also known as "Guideline Companies Method", "Comparative Value Models", "Comparable Companies Analysis" etc.

This method determines the value of a firm by observing the prices of similar companies. Those sales could be shares of stock on a regulated market or sales or entire firms. The observed prices serve as valuation benchmarks. From the prices, one calculates price multiples such as the price-to-earnings or price-to-book ratiosone or more of which used to value the firm. For example, the average price-to-earnings multiple of the guideline companies is applied to the subject firm's earnings to estimate its value.

Market Value vs Instrinsic Value

Definition 90 .:. Price .:.

$P_0 =$ the price paid for a company on the market (market price)

Definition 91 .:. Value .:.

$V_0 =$ the real value of a company (intrinsic value)

A short-cut: the price is the consensus of the market about he value.

Definition 92 .:. Market Capitalization .:.

$MarktCap =$ the total value of all outstanding stocks at the market price

Depending on the specificities of the companies involved, many price multiples can be calculated. Most are based on a financial statement element such as a firm's earnings (price-to-earnings) or book value (price-to-book value) but multiples can be based on other factors such as price-per-subscriber.

The idea of the comparative value model is to estimate the price of the asset based on previous transactions that are as similar as possible.

Anyone who has bought or sold a piece of real estate will know how this process works. In the real estate market, relative valuation forms the backbone for valuing any property. When one wants to buy something one will scan the market for properties that satisfy certain criteria in a certain area (hence which are very similar). The buyer will then try to buy the real estate that seems –to him– most attractive, hence which is relatively cheap. Other clear examples would be the antique market and the art market.

This method underlines that the value of any asset is the price that someone else is prepared to pay for it. A similar approach can be utilized with respect to companies or shares in companies.

While for a house one can use the the price per square meter, and other desired characteristics such as the number of garages to determine the relative most attractive house, for companies one will use financial ratios such as:

- price to earnings ratio
- return on equity
- operating margin
- enterprise value
- price to free cash flow

Since no two assets (houses or companies) are exactly the same, any relative valuation attempt will typically lead to some inconsistencies (like best operating margin but worst price-to-book ratio). Therefore it is essential to choose companies that are as similar as possible.

For example the price-to-book value of a bank will always be significantly lower than that of a production company because of the business model. However, also an investment bank will have a very different profile and ratios than a wholesale bank or a retail bank. Therefore it is essential to choose the companies being compared as similar as possible. For example Polish domestic banks that focus on retail lending.

11.2 Some Ratios

Price Earnings Ratio (P/E)

Rearranging Equation 10.5 on page 122 shows that:

$$\frac{P_0}{E_1} = \frac{1}{r} + \frac{PVGO}{E} \tag{11.1}$$

$$= \frac{DPR}{r - ROE \times PBR} \tag{11.2}$$

$$= \frac{DPR}{r - g} \tag{11.3}$$

$$= \frac{1 - PBR}{r - g} \tag{11.4}$$

***Note**: If $PVGO = 0$, then Equation 11.1 shows that $P_0 = \frac{E_1}{r}$: the stock is then valuated as a perpetual bond with coupon E_1; and the P/E ratio is then $\frac{1}{r}$. Further one will remark that if $g = 0$, that then $E_1 = E_0$ and hence $P/E = P_0/E_0$.*

***Note**: These formulae make clear that PE is lower for more risky firms; and that when ROE increases that then PE decreases.*

Pitfalls of P/E-Analysis

- E ← accounting ← funny rules
- Earnings management ← too much freedom in accounting rules
- the relevance is limited to the model ← smooth evolution of earnings (economic earnings are not measurable, the accounting earnings are)
- What about the economic cycles?
- In the formula is E_1, in reality one uses E_{-1}
- P/E ratios include the future growth potential and the riskiness in one measure → one must compare likes with likes → has clear relevance within one sector
- P/E ratios include the future growth potential and the riskiness in one measure → so they will jump up when the economic cycle is on its low in short term.

Book Value

Definition 93 .:. Book Value .:.

$BV =$ balance sheet

Note

- in the books are the past values, not the future . . . and that's what it is all about!
- accounting rules

Other Ratios

Definition 94 .:. price-to-book ratio .:.

$PTB := \frac{P}{BV}$ with $BV = book\ value$

Definition 95 .:. price-to-cash-flow ratio .:.

$PTCF := \frac{P}{CF}$ with $CF = (free)\ cash\ flow$

Definition 96 .:. price-to-sales ratio .:.

$PTS := \frac{P}{S}$ with $S = sales$

. . . or define your own!

11.3 Relative Value Models in Practice

As explained before, the first step in to make sure the two businesses to be compared are as similar as possible.

Example 15 .:. Visa Vs. MasterCard .:.

Visa (NYSE:V) and MasterCard (NYSE:MA) are the two most well known branded credit card names in the world. Since both operate similar business models, a relative valuation for both would be an effective exercise.
Looking at both companies in the summer of 2011, Visa shares trade for $85 while MasterCard shares fetch $304. Visa has a market cap of over $60 billion while MasterCard has a market cap of $38 billion. On their own, those numbers don't tell us much except that Visa is a bigger company than MasterCard. Here are the following relative valuation metrics:

	Visa	MasterCard
P/E ratio	18	20
ROE	13	43
Operating Margin	58	51
Enterprise Value	$ 58B	$ 51B
Price-to-FCF	30	20

Comparing the P/E ratios of one might conclude that Visa is a better value because of a lower P/E. However, comparing other metrics may suggest otherwise: despite a lower operating margin, MasterCard has a significantly higher return on equity on an unlevered balance sheet. Also relative to its market cap, MasterCard generates more cash flow per share than Visa. If MasterCard can continue pulling in the free cash flow at similar levels, then it will be creating more value from shareholders.

Another useful metric in relative valuation, return on equity, increases as a company takes on more debt. Without looking at the balance sheet an investor may conclude that company A with an ROE of 30% is more attractive than company B with an ROE of 20%. But if company A has a debt to equity ratio of two while company A is debt-free, the 20% unlevered return on equity may be much more attractive.

11.4 Conclusions and Use

What the comprehensive relative valuation process ultimately does is help prevent investors from anchoring their decisions based on one or two variables. While value investors love to buy stocks with low P/E ratios, that alone may not be effective. Consider Chipotle Mexican Grill (NYSE: CMG). Even during the recession, shares were trading for around 25 times earnings when other restaurants were trading of 10-15 times earnings. But further comparison provided justification for Chipotle's P/E ratio: its margins were higher and it was growing its profits by leaps and bounds while the balance sheet remained healthy. Chipotle shares soared nearly 200% in the two years following the Great Recession.

Like any valuation tool, relative valuation has its limitations. The biggest limitation is the assumption that the market has valued the business correctly. If both Visa and MasterCard are trading at nosebleed levels, it may not matter that one has a lower P/E or better return on equity. During the Internet bubble, investing in a dot-com because its P/E was 60 versus an industry average of 90 turned out to be a painful mistake.

Second, all valuation metrics are based on past performance. Future performance drives stock prices and relative valuation does not account for growth.

Finally and most important, relative valuation is no assurance that the "cheaper" company will outperform its peer.

Like other valuation techniques, relative valuation has its benefits and limitations. The key is to focus on the metrics that matter most for the relevant companies and understand what they convey. But in spite of those limitations, relative valuation is a very important tool used by many market professionals and analysts alike.

Comparative valuation is especially useful after a decision that one wants to invest a certain amount in a certain type of stocks. After that decision the relative valuation will indicate which of the stocks is the best buy. This is the typical situation of a a portfolio manager.

PART III .:. CHAPTER 12 .:.

Selection of Valuation Methods

Selecting a valuation method is not an exact science, there are many methods with each their strong and weak points, point of view and assumptions endogenous and exogenous to the model itself. In general it is not a bad idea to use multiple methods and compare results.

The basic idea could be as follows.

Valuation Method Selection

1. Is it my purpose to buy the company and stop its activities or did it already stop trading or is it an investment fund? — If yes, use Net Asset Value Method (in all other cases this should be the lower limit) — If not, then continue to next question
2. Will you be an important share holder and can you make a business plan? – If yes try to use DCF, if not continue.
3. Do you have the option not to invest? — If yes, use DDM otherwise continue
4. If you ended up here, this means that you have to invest anyhow in similar stocks (eg. you're an equity fund manager). — In this case you might want to use a relative value method.

PART III .:. CHAPTER 13 .:.

Pitfalls and Matters Requiring Attention for all Methods

Buying a company is like a marriage: a decision based on observing the past that will determines the future and only the future will tell how good your forecasting method was.

None of the methods shown in this book, no statistical method, nothing that is in our hands is able to predict the future. Ask the same valuator to calculate the value of the same company after a year and most probably the outcome will be different. As the future reveals itself through the cover of the present we have more information and our assumptions about the future will change.

No method able to solve this problem and there are many more issues to discuss and be aware of. For example calculating FCF makes a lot of assumptions and even if we perfectly forecast the sales, inflation, labour costs, etc then still some variable can be influenced by decisions of the management or higher organs.

In this chapter we will have a closer look at some of those problems.

13.1 Forecasting Performance

Valuating a company is a delicate exercise in forecasting the future while one only has the past and the present to one's disposal.

- **relevance of history**: is the past data relevant for the future? from internal perspective? from external perspective (the market, competitors, etc)
- **short history**: it might be easier to forecast mature companies with long, stable history. Buying a company with only a few years history is a leap of confidence.
- **management differences**: will you attribute cash differently? Is the salary that the owner (not) took relevant for your case? etc.

13.2 Non-Operating Assets

It is not always trivial to identify the non-operating assets in the accountancy of a company. Special care needs to be taken to avoid double counting in valuation. More about this aspect in Chapter 14 on page 155.

13.3 Cost of Capital

13.4 Results and Sensitivity

Since a company valuation is about forecasting the future, it is not a well determined value. Different valuators working on the same valuation will find different prices. The key is to understand how you got your results, what assumptions you made an to what extend variations in price can be accepted.

Elaboration on sensitivity analysis can be found for example in De Brouwer (2016). In this section we will explain the basic tools that should help the reader to get started in practice.

13.4.1 Stress Testing

In order to gain some insight in how robust a certain result of our valuation is or what bad cases can be expected a simple stress test can answer that question.

A simple example could be: allow the price of certain raw materials to fluctuate (simply test a few possibilities), then do the same with labour prices, allow the effect of a strike, an earthquake, fluctuations in exchange rates, one of the lenders that gets into problems, we have to halt digging because we stumbled upon a site of historic importance, etc.

Soon, one of the problems with stress testing become obvious: it becomes bewildering how much possibilities there are, it is impossible to say which is more probable that the other, etc. The answer to that shortcoming is simply to restrict stress testing to what it does best: explore extreme risks –without knowing how likely it is. So for example assume that an earthquake destroys a lot of the half-build site, killed a few people causing a strike, the currency to plunge and the domestic bank in the syndicate gets into problems because of that. Then we have just one scenario, something that we can calculate with your spreadsheet and that gives us a "worst case scenario".

The relevance for each investor is that he should ask the question "can I afford to loose that much", if the answer is "no", then the investor should seek another partner in the syndicate, the sponsor another partner for the SHA, etc. Failing to do so is planning for the next Global Meltdown to start.

In order to do that in practice, a spreadsheet might still be sufficient, however, it might be advisable to follow a few simple rules to keep it organized. For example:

- Use different tabs (sheets) for (a) assumptions, (b) costs, (c) income, (d) P&L and (e) ratios.

- Make sure that each sheet has the same columns (the columns should be something like A, B, C and D hold titles, E is 2015-Jan, F is 2015-Feb, etc.

- Use different colours to make the different function of each cell clear: for example pale yellow for an input cell, no background for the result of a calculation, etc.
- Avoid –where possible– obscure formulae that are difficult to read for humans
- Do use as much as possible underlying programming language (Visual Basic for example) and never ever use marcos (macros are very difficult to read by other humans, not re-useable, slow and confusing).
- Keep different version, have frequent team-meetings when working on one file and agree who will modify what.

Following these simple rules will help you to make rather complex models in the simple spreadsheet that a modern computer offers. The downside of a stress test is that it does not tell how likely a certain result is. To get that essential insight it is necessary to use other techniques.

If you find that the spreadsheet becomes difficult to read or slow we suggest to have a look at the alternatives presented in Chapter 13.4.3 on page 148

13.4.2 Monte Carlo Simulations

A Monte-Carlo simulation can simply be understood as hundreds of thousands of Stress Tests run by an automated machine so that it becomes possible to get an idea about how probable certain outcomes are. This is of course only possible if we are able to say something sensible about the underlying risk factors.

With "something sensible" we mean that we know something about the likelihood of something to happen. We might not know the exact distribution, but at least some probability. For example we might expect an earthquake of force 4 to happen once in thousand years. This simple number is far less than knowing the probability density function, but it can already work.

In that case we would have a 0.000083 probability each month that such earthquake would occur. However if it occurs, then the knock-on effects will be significant for the project: damage, delays, other problems in the region needing attention, etc. It is here that the limitations of a spreadsheet become all too clear. It becomes impossible to model correctly the effect of such events, not only because of the interdependence with other parameters, but also in time. If such event occurred, then is it more or less likely to happen again? Some effects will be immediate (such as if the currency drops 20% with respect to the currency that we use to pay a certain material or service, then that service or material is immediately more expensive). This can still be modelled in a spreadsheet, but in the realistic case with the earthquake one must take into account a whole different scenario for the rest of the project and that becomes almost impossible and at least very convoluted.

The alternative is to use a programming language that allows us to model anything. Best suited for large projects are languages that allow for some object oriented code. We can use the features of an object oriented programming language to represent actors and input in our project. For example the engineering company can be one

"object" and it will decide to hedge currency risk if the exchange rate hits a certain barrier, etc.

This allows us to model dependencies such as in our example with the earthquake. If the earthquake happened, then other objects can "see" that and react accordingly, the exchange rate (also an object) will switch regime (ie. draw its result from a different distribution), the workers can see the impact of the safety conditions and consider a strike with a given probability, etc. This way of working is not so far removed from the way modern computer games work.

Good examples of programming languages that allow vast amounts of complex calculations are C++ and R. The high level of abstraction offered by object oriented programming languages allows the programmer to create objects that can interact with each other and their environment. For example the Engineering Company can be such object. That object can be instructed to employ more workers when a delay threatens to happen but up to the limit that the extra costs are offset by the potential penalties. As the simulation then runs, market parameters change and events happen according to their probability of occurrence and each object will then interact in a pre-programmed or stochastic way.

This allows very complex behaviour and dependencies to be modelled, yet everything will be in a logical place and any other programmer can read it as a book. On top of that there are good free solutions to create free a professional documentation set. For example Doxygen (see `http://www.doxygen.org`) is free and able to create both an interactive website as well as a LaTeX[1] book for the documentation, that details each class, function, handle, property, etc. Code written in such way and documented properly is not only easy to maintain, but also straightforward to audit and as a bonus one gets the speed of C++.

13.4.3 Beyond the Monte Carlo Simulation

Now that we have a good idea how the distribution of the results will look like, we can use this distribution to calculate the relevant risk parameters. In many cases the "historic" distribution that we got by our Monte Carlo simulation will be usable, however for large and complex projects the distribution might not be very smooth. If we believe that this is a sign of the limited number of simulations, then we can try to apply a kernel estimation in order to obtain a smoother results that yield more robust risk parameters.

The technique of kernel density estimation (KDE) could be helpful for all distributions that are estimated from a histogram. As an alternative to parametric estimation where one infers a certain distribution it avoids the strong assumption that the data indeed follows that given distribution. Note a KDE can be used also for any input parameter where the distribution used is based on observations.

[1] LaTeX is a high-quality typesetting system; it includes a large set of features designed for the production of technical and scientific documentation. LaTeXis the de-facto standard for the communication and publication of scientific documents. LaTeXis available as free software in the repositories of your distribution and at `http://www.latex-project.org/`.

Of course one can choose a standard distribution if the we have reasons to assume that this would be a good approximation. However, choosing a non-parametric kernel density estimation, has the advantage of avoiding any assumptions about the distribution, and on top of that:

- it is well documented in the case of expected shortfall—Scaillet (2004); Chen (2008); Scaillet (2005); Bertsimas et al. (2004)e.g.
- there is research on its sensitivity with respect to the portfolio composition, $\boldsymbol{w}$—Scaillet (2004); Fermanian and Scaillet (2005)see

Using a non-parametric kernel density estimation, however, requires one arbitrary parameter: "the bandwidth". The bandwidth is a parameter that is related to the level to which the data sample is representative of the real underlying distribution. If one makes a too-small choice of this parameter, one forces the estimated distribution function, f_{est}, to stick too much to the data, and there is too little of a smoothing effect. If, on the other hand, the parameter is insufficiently restrictive, then f_{est} will be smeared out over an area that is too large.[2] More information on bandwidth selection can be found in Jones et al. (1996b).

Of course, one can ask if it is necessary at all use a kernel estimation instead of working with the histogram obtained from the data. Using the histogram as pdf has a few disadvantages:

- it is not smooth (this observation tells us that the use of histograms is similar to noticing that the dataset is imperfect and not doing anything about it),
- it depends on the end points of the bins that are used (changing the end points can dramatically change the shape of the histograms),
- it depends on the width of the bins (this parameter can also change the shape of the histogram),
- it introduces two arbitrary parameters: the start point of the first bin, and the width of the bins.

An answer to the first two points (and half of the last point) is to use a kernel density estimation. In that procedure, a certain function is centred around each data point (for example, an indicator function, a Gaussian distribution, the top of a cosine, etc.), these functions then are summed to form the estimator of the density function. The kernel density estimation is currently the most popular method for non-parametric density estimation Scott (2015); Wand and Jones (1994); Simonoff (2012)see e.g. the following books

This method consists in estimating the real (but unknown) density function $f(x)$ with

$$f_{est}(x;h) = \frac{1}{N}\sum_{n=1}^{N} K_h(x - x_n) = \frac{1}{Nh}\sum_{n=1}^{N} K\left(\frac{x - x_n}{h}\right) \tag{13.1}$$

[2]Note that we do not use the usual notation for the estimated distribution density function, $\hat{f}$, because we have reserved that notation for the Fourier transform.

where K is the kernel

Definition 97 .:. Kernel .:.

A kernel is a function $K(x) : \mathbb{R} \mapsto \mathbb{R}^+$ that satisfies the following conditions.

$$\begin{cases} \int_{-\infty}^{+\infty} K(u)\,\mathrm{d}u = 1 \\ \forall u \in \mathbb{R} : K(u) = K(-u) \end{cases}$$

If K is a kernel, then also $K^*(u) := \frac{1}{h}K\left(\frac{u}{h}\right)$ (with $h > 0$) is a kernel. This introduces an elegant way to use h as a smoothing parameter, often called "the bandwidth".

This method was hinted by Rosenblatt et al. (1956) and further developed in its actual form by Parzen (1962). The method is thus also known as the "Parzen-Rozenblatt window method"

The Epachenikov kernel Epanechnikov (1969)see is optimal in a minimum variance sense, however it has been shown by Wand and Jones (1994) that the loss of efficiency is minimal for the Gaussian, triangular, biweight, triweight, and uniform kernels.

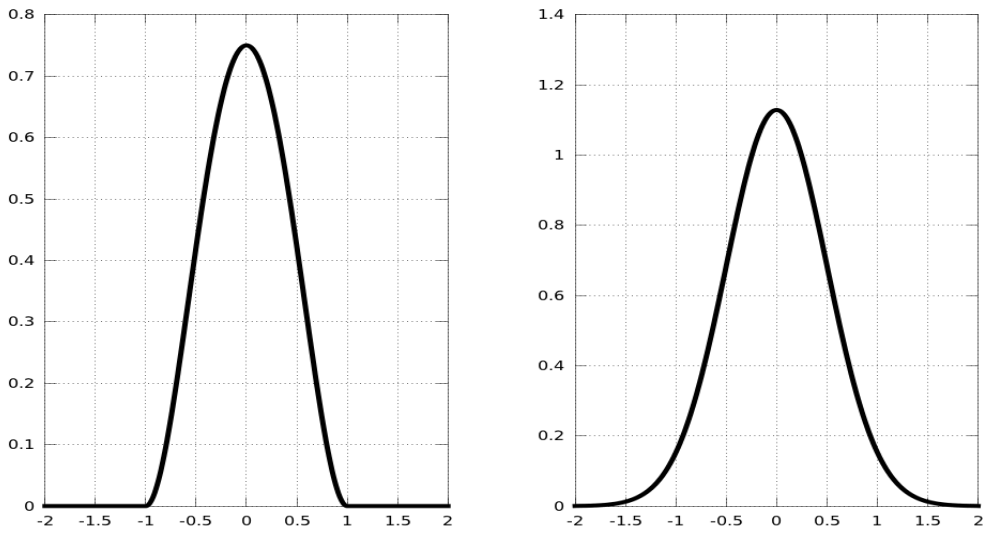


Figure 13.1: *Left, the Epachenikov kernel,* $K_h^E(x) = \frac{3}{4h}\left(1 - \left(\frac{u}{h}\right)^2\right)\mathbf{1}_{\{|u/h|\leq 1\}}$ *for* $h = 1$*; and right the Gaussian kernel,* $K_h^G(u) = \frac{1}{\sqrt{2\Pi h}}e^{-\frac{u^2}{h^2}}$ *for* $h = 0.5$*.*

We believe it if we believe that an underlying pdf exists, kernel density estimations have a few distinct advantages over histograms: they can offer a smooth density function for an appropriate kernel and bandwidth, and the endpoints of the bins are no longer an arbitrary parameter (and hence we have one arbitrary parameter less, but still the bandwith remains an arbitrary parameter).

We also note that Scott (1979) proves the statistical inferiority of histograms compared to a Gaussian kernel with the aid of Monte Carlo simulations. This inferiority

of histograms is measured in the L^2 norm, usually referred to as the "mean integrated squared error" (henceforth MISE), which is defined as follows.

$$MISE(h) = E\left[\int_{-\infty}^{+\infty} \{f_{est}(x;h) - f(x)\}^2 \, \mathrm{d}x\right] \tag{13.2}$$

A variant of this, the AMISE (asymptotic version), can also be defined, and this allows us to write an explicit form of the optimal bandwidth, h. Both measures have their relevance in testing a specific bandwidth selection method, for example. However, for our purpose these formulae cannot be used since they contain the unknown density function $f(x)$. Many alternatives have been proposed and many comparative studies have been carried out. A first heuristic was called "cross validation selectors" Rudemo (1982); Bowman (1984); Hall et al. (1992)see. Sheather and Jones (1991) developed "plug-in selectors" and showed their theoretical and practical advantages over existing methods, as well as their reliable performance. A good overview is in Jones et al. (1996a).

Conclusion

Kernel Estimation is a widely accepted and used method that has many advantages. However, it introduces the arbitrary choice of bandwidth and of type of kernel. However, we note a novel method that automates this selection without the use of arbitrary normal reference rules Botev et al. (2010)see. We also note that it is blind to specific aspects, such as the boundedness of the domain of values (e.g. prices cannot become negative). Therefore the method has to be used with care, and preferably on non-bounded data (e.g. log-returns).

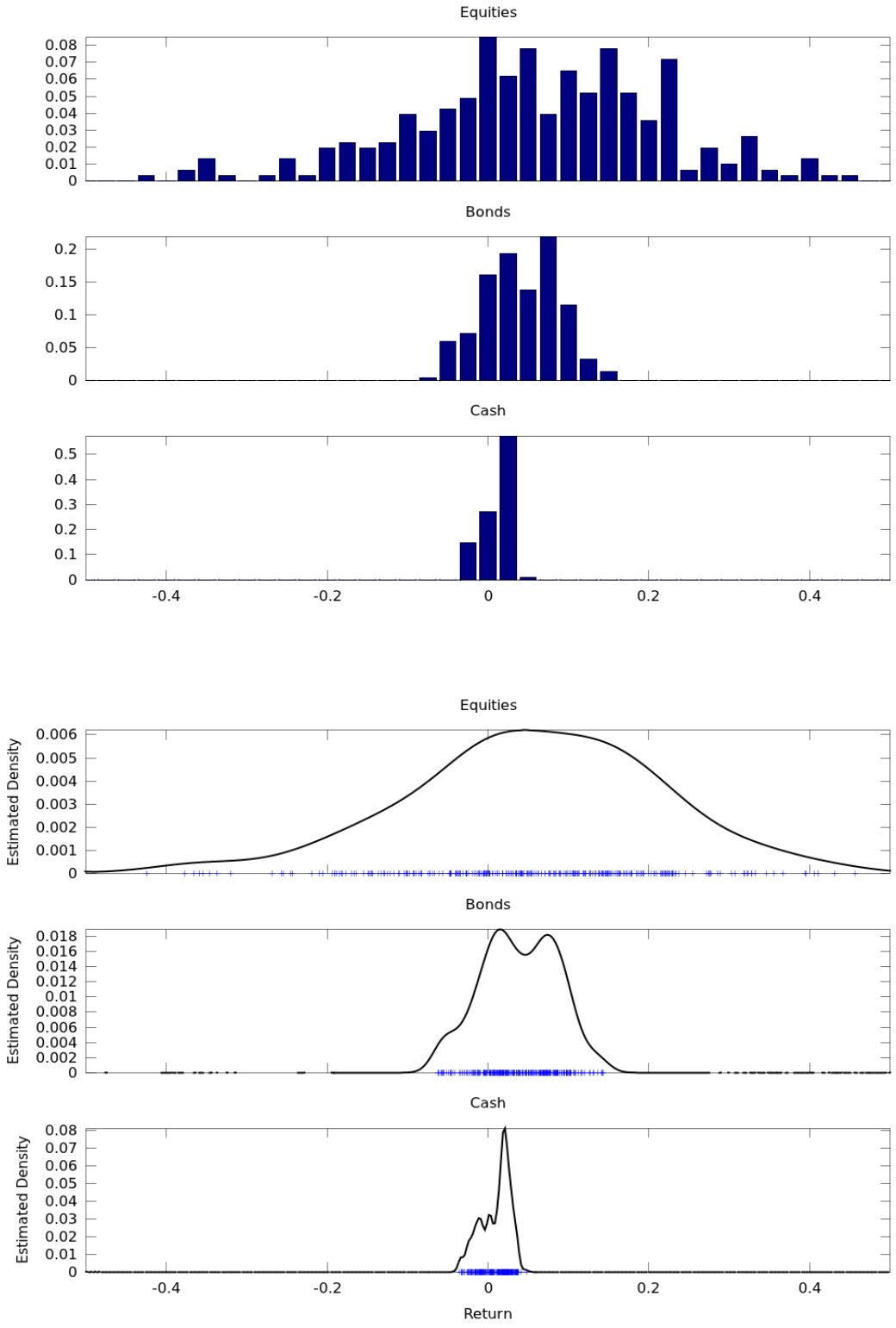


Figure 13.2: *As illustration on how the Epachenikov Kernels Estimation works, we present in the upper graph the histogram of the annual inflation corrected returns of standard asset classes. The lower graph offers a view on what a non-parametric kernel density estimation on those data can do.*

PART IV

Value Calculation in Practice

PART IV .:. CHAPTER 14 .:.

The Company Valuation Work-Flow in Practice

Typically a company valuation is carried out with a clear purpose in mind. Most common is the valuation that should support a transaction. So the two typical cases is the owner selling and the potential new owner buying.

Generally it is not the business owner who will validate the company, not only because this is a very specific skill, but also to avoid too much emotional involvement. Therefore the owner will employ professional company valuators (consultants, investment banks, etc.). In other cases (eg. hedge fund, investment fund, pension fund, etc.) the interested party will have specialists at his disposal to valuate companies. In those companies it is not uncommon to have two teams that use each other as sparring partners. Typical the "investment manager" makes his/her own analysis and is then challenged by the "analyst" who came up with an independent valuation. The bonus of the investment manager is typically related to the performance of the fund while the bonus of the analyst depends only on other factors.

Work-Flow

1. plan the project: understand the scope, point of view, purpose, define outcome and timeline, etc.
2. gather the data and make sure the data is realistic
3. select valuation method(s)
4. do the maths
5. interpret the results and do reality checks
6. use the results: write the report, support the negotiations, debrief the customer, ...

Below we will detail these steps further.

14.1 Preparation of the Valuation Project

The Valuation Project

1. The preparation of a proper valuation takes from couple of days up to several weeks depending on purpose and complexity of the document and experience of valuator.

2. Its vital to manage clients and/or your managers expectations properly (they will not get it as soon as they want to usually by tomorrow)

3. Clear your calendar from all other assignments (if possible!); many young valuators tend to escape from doing difficult valuation to easier tasks letting problem grow the less time to deadline is left.

4. Even if you dont have all necessary information yet about the company you value, you can already work on various tasks (peer group seeking, transactions search, risk free rate update, beta search, financial statement analysis, press search about industry/ company) do not let time pass without tangible results. Do not just read and research do the actual excel, calculations etc.

5. Preparing schedule of the valuation project be prepared that everything may take much longer than expected, manage expectations accordingly. If you do it faster, even better more time for double-checking the results and preparing more additional analysis.

6. Only one person should be responsible for the valuation and business plan. If there are many leaders, problems are in the air - no one feels responsible, especially if problems arise!

7. Young valuators must be closely supported by a very experienced valuator during at least couple of projects before young valuator may be working independently. Its best to start learning on easy projects, and gradually gain necessary experience. However the most difficult projects provides much more know-how than an easy once.

8. Even if you have some experience, do not hesitate to ask more experience colleague for help, support, his expertise. Yes they never have time and are usually not happy to be disturbed but sorry, you dont have choice if you want to do it right.

14.2 Gathering the Data

Necessary Information

1. The company being valuated is the best source of information. Make sure you are properly introduced to the high-rank experts in the organization. It should be done from Management Board level, which would mark project as strategic, allow transfer of any information and allocate sufficient time of its best people to support you.

2. Prepare very clear list of necessary information. Do not request for information which are not vital 100 point list will most likely make financial stuff on client side furious, process of acquisition of any data will be extremely prolonged while what you really needed to start with could be covered in ca. 10 questions. First read materials you already have until you ask for more asking for information you already possess looks unprofessional and makes impression that you dont even read what they have been preparing for you working double shifts (unfortunately many valuators actually do not read all materials they ask form which is a shame).

3. If possible, go to see the company HQ/ factory/ store. Ask them to be toured, ask questions and look impressed they will love you for that and you can acquire fast necessary industry know-how, understand financial data easier afterwards, and meet people who will not be able to say no to you if you win their trust during the visit.

4. First ask for information that company already has you get it fast and it may feet to your needs: financial statements, budget with realization, medium/long term plans (if there are any), information on planned investments, acquisitions, divestments (those important project are usually well documented within any firm), controlling reports etc.

5. If financial information you received is not suitable for your purposes, ask a very precise question about what you need and best practice is to send a table with split that you need and then call them and go through it, until you make sure they understand. Please bear in mind that bookkeepers, controllers are not be very open to people, and will spend o day on preparing wrong split and provide you with unwanted data rather than simply call you and make sure they understand what you need. So you call them. Then also ask politely when it would be possible to receive the data. Asking politely and explaining why its so important to you works best. Pushing hard, escalating and shouting is counterproductive you will get data later and most probably not the one you needed and you will make enemies.

14.2.1 Information Sources for the DCF Method

Information Sources for the DCF Method

1. risk free rates - `https://www.mbank.pl/serwis-ekonomiczny/` - daily, last page IRS quotations, or 10Y gov. bonds estimated profitability in the following years; please make sure that in the long term risk free rate should be ca. 2% above inflation target (currently 2,5%) it is ca. 4,5%.

2. Betas & market risk premium - `http://pages.stern.nyu.edu/~adamodar/`

3. business cycles and normalized cash flow based on historical data for a company and/ or discussion with top managers of the company

4. growth rate in residual value generally nominal growth shouldnt be above 2,5% which is a target level of inflation (in Poland) since no industry can eternally growth in real term. If your company obviously will growth faster than that, make a longer projection until growth flattens. Usually most of the analysts assume g at level of 2-2,5% unless industry is not growing than it should be around 0%. Negative g level is also admissible if industry and/ or company business is shrinking (eg. fix line telecoms?).

14.2.2 Information Sources for the Comparative Method

Information Sources for the DCF Method

1. Choice of a peer group is crucial: Try to select peer group of no less than 5 and probably no more than 20 companies. In case you have a very similar businesses but located in other geographies, and not so similar but located in the desired region, you may build 2 or more different peer groups and achieve different multiples/ valuation for each peer group. You may also consider using one/ two very similar companies to calculate multiples, especially if its a direct competitor of valuated company although please bear in mind that that approach is risky any significant change in peers financial results/ plans and/ or quotations may immediately and drastically influence your valuation so better use it as a cross-check only and not the main method.

2. Its best to have access to paid market information providers: Bloomberg, Thomson, Mergermarket (for transaction method). If you have no such an access, try to download any fresh analyst report on a similar company in some of which a peer group and multiples are presented you may try to directly use this data. You may also try to calculated multiples by yourself, if projection (official or by analyst) is available, showing e.g. expected future net profit, then knowing current market quotation, you may calculate projected P/E multiples etc.

3. Its best to base valuation on projected financial data as well as projected multiples (today's valuation confronted with projected financial data for peer group companies). In practice in many cases only historical data is available and the valuation may only be built on that. In that case use LTM (last 12 months) data as multiples for valuation.

4. Choice of the multiples is also important. Your favourite one will usually be P/E but its recommended to use at least 2-3 different multiples. Use the one that reflect business core drivers best. For industry/ production companies EV/EBITDA usually works. For retail or IT/ software businesses EV/S is frequently used. In case of financial institutions P/E is best choice. You may always think of using P/BV, although its value for valuation purposes may be questioned. Be aware, that if valuated company is not profitable, some multiples just wont work. Having said that, usually valuation is made on projected financial performance which for some reason usually is more positive than the reality from the past. If one of the multiples fits better as a value transmitter, you may also consider weighting results of valuation based on each multiple (for example valuation based on P/E*50%, P/BV*25% and EV/S*25%) though in this case you have to ready to be confronted about weights selection.

5. Unlike in case of DCF, you should use only normalized financial projection to calculate the value. So make sure that you get rid of any extra profits or unusual costs. In theory you should also use normalized data for the peer group multiples to calculate, though in practice its rather impossible. To eliminate unusual peer group results, in most cases you simply exclude from the group all peers with extremely high or very low multiples. In addition use median rather than average to calculate multiple from the peer group results.

6. Remember to add non-operating assets to the valuation just like in case of DCF. Also some discount for lack of liquidity is necessary usually between 10-25%. This is because you compare companies which are liquid to a company which is not listed and listed companies are supposed to be valued higher because you may actually sale the shares instantly.

14.3 Selection of the Valuation Method

Valuation Method Selection

1. If possible keep it simple: DCF/ DDM + comparative method works just fine. Do not try to impress everyone with unusual, highly sophisticated approaches. It will not be appreciated and may even not be accepted.

2. Remember there are no 2 identical companies in the World. So you will not find a perfect and quoted match to the company you are supposed to valuate. There are various approaches you may use if your company is absolutely unique and there are no even slightly similar companies quoted: try other but similar industries, with similar margins and geographical location. If peers to your Polish company are only quoted and operating in Australia, it may still be a match. You may have 2 different peer groups or mix them up. Just make sure to get rid of the most extreme results and use median instead of average as a best practice. It usually is accepted to use multiples based on Last Twelve Months (LTM) results, but the most relevant are those forward looking based on projections. Make sure you understand the main business drivers and use multiples accordingly.

3. If you have access to a certain database such as MergerMarket (or lots of time to make a thorough research) consider using transaction base valuation at least as a cross check if your results are not fare away from the real transactions. There are certain limitations in this method though: in case majority stakes are purchased, you should consider that there is ca. 10-20% of premium for control in it. In case transaction was executed among related parties, the price can hardly be a good reference point (price may not be fully market price but reflect other arrangements/ deals/ tax reasons). Use only relatively fresh transactions 5 year old transactions constitute doubtful base for your valuation today. Even transaction from 2 year ago may be too old if 1 year ago a crisis came and significantly changed prices for assets.

4. Unusual situations such as liquidity issues or other deficits, may require different, specific approach. Make sure that you fully understand company, business model, industry before you choose valuation method. Adjusted net asset value or liquidation method may work for you there.

5. If you valuate holdings make sure not only that you understand variety of businesses that are grouped in the holding. Avoid common mistakes: if mother company owns 51% of a daughter company it should be value less than if it actually owned 100% - and consolidated financial statements show 100% of sales and 100% of EBITDA even in company that is only 51% owned its corrected only on net profit level (minority profits are deducted). If holding is involved in different/ unrelated businesses, its best to make a separate valuation for each part.

14.4 Do the Maths

Building the Business Plan

1. If company has its own projection remember to check it very carefully before you actually use it for valuation purposes. As a person responsible for proper valuation you are also responsible for making sure the business plan that is its vital part actually makes sense. Do not allow only P&L projection without balance sheet and cash flows you dont know if its feasible and you would have problem for instance with working capital to DCF. Verify how much of companys production capacities are used no surprise if in 2023 they actually utilize 150% of it its a common mistake. Make sure investments are on a proper level and sale assumptions are in line with reality talk to technicians or salespeople and not only to financial guys to verify that. Even if the model is complex, take your time to understand it and make sure there are no strange inputs hidden somewhere in it costs declining for no good reason or additional sale of unknown products in year 2025.

2. If you make your own business plan for valuation purposes, it should be at least 5-8 years long. It is vital that the last year of projection actually shows full results of all investments/ acquisitions/ restructuring processes etc. assumed in projection otherwise you may not use it to calculate residual value because it will mangle the results! In case business is cyclical, the last year of projection should be normalized meaning neither on top of the cycle nor on the bottom.

14.4.1 Software Tools

Since more than half a century business is using electronic computers to facilitate complex and/or lengthy calculations. Elaboration on programming tools can be found for example in De Brouwer (2016). In this section we will summarize the key finding and ideas.

Cash Flows can be modelled with a wide range of approaches. A simple spreadsheet such as Libre-Office-Calc or Mircrosoft Excel can get you a long way in order to get a view on the big picture of the project. This "big picture" is always good to have and is not really replaced by more detailed simulations.

However to fully model the complexity of a large infrastructure projects and get a good view on the risks, a spreadsheet approach is bound to create issues. As the model gets more complex, a spreadsheet approach has the following issues:

1. **Complexity**: a spreadsheet is ideal for simple calculations, a more complex model quickly gets the level of transparency of Gordian Knot.

2. **Audit and Challenging**: because of the Gordian Knot structure of a spreadsheet it is basically only possible to unravel its inner workings for the one who de-

signed it, seriously limiting the possibility to challenge and audit the model independently. This increases the Model Risk.

3. **Speed**: spreadsheets are multi-purpose software tools that can do a lot more than a simple calculation, but therefore carry an enormous overhead in memory use, disk space and above all this will seriously drag the speed of any calculation.[1]

4. **Technical Limitations**: while it is ideal to design a stress test (provided that the spreadsheet is structured logically — see Chapter 14.4.2

5. **Limited version control and no Merging possibility**: while spreadsheets have an undo function and allow some primitive versioning, they are nowhere near to a professional (and free) versioning system such as SVN[2] that are able to merge files to such level that it more than one programmer can edit one file and the system will find the final form of the file.

In order to make a serious Monte-Carlo simulation and/or deal with the complexity and interdependency of parameters it is advised to use a programming language in order to make the risk assessment. The market of commercial software applications is large, but there are also great applications freely available, such as the R statistical programming language[3] that has a very wide user base –and hence a lot of support and pre-defined snippets of code– and was recently bought by Microsoft.

Also the C++ on a Linux machine offers full object oriented programming capacities with a compiler that provides extremely fast binaries. Of course, there are also large amounts of commercial softwares available: SAS, SPSS, Mathematica, etc.

14.4.2 The organization of a spreadsheet

We recommend a few simple rules of thumb that can be really helpful in mitigating the "Gordian Knot aspect" of a spreadsheet. The following will be helpful:

- have an organization per sheet: first sheets has all the input parameters, the second the costs, the third the income, the fourth the Profit and Loss Statement, the fifth is a dashboard with useful indicators such as NPV, IRR, etc.;

[1] For example, in 2013 I was helping a bank in Ireland after the crash in their real estate market: roughly half of the customers had payment problems and needed would stop paying if the bank could not propose a restructured loan. The engine that they were using to calculate the best suited offer –built in Microsoft Excel– was not only sub-optimal but really slow: it took the engine 5 minutes per loan to find the best solution. I have built for them a simple application in VBA (Visual Basic for Applications), which is in itself a very slow programming language with massive overhead. The result was an engine that was a lot more user friendly, ca. 1000 times faster and more friendly for customers to keep their houses and more gentle in the use of capital for the bank (not to mention that it was possible to maintain and configure the software).

[2] SVN or Subversion is a brand of the Apache Foundation and can be found here: https://subversion.apache.org/

[3] For more information about R, please refer to `http://www.r-project.org/`.

- in each sheet one should find the same time axis in the rows (example row G is always month 3 from year 2017)
- use a colour coding to show what is input, calculated, etc.;
- avoid formulae and constructs that are difficult to read for humans (for example the “INDEX()” function)

For more explanation, see Chapter 13.4.2 on page 147.

14.5 Interpreting and using the Results

14.5.1 Understanding the Results

Result Interpretation

How to analyze valuation results, prepare scenarios analysis, flexibility study (and to understand its limitations):

1. Common sense is always a good advisor in case of valuation results. If your estimated value stands at zero (or below) or amounts to 5x what anyone else expects just check step by step where the value is generated and look for mistake in assumptions as well as in calculations.

2. Based on company scale of activity, history etc. you may estimate its value in a very simplified manner, say 10-12x normalized net profit or 6-8x EBITDA minus debt. Its not something you may present as a point of reference but for your own internal check point it may actually work in majority of cases (especially if it comes to a mature business).

3. Its not unusual that company with equity value of 100, valuated with DCF amounts only to as little as 10. However be well prepared to answer this question its not a kind of question that you start to think of when someone already asked you on a meeting summarizing valuation results. This may look like you didnt ask yourself this question before, and that undermines credibility of your work. So think of most obvious questions that may be asked and prepare simple and to the point answers. This is also the last moment to actually crosscheck if your valuation is bullet-prove: if there are vital contradictions that you may not explain, maybe you should rethink your valuation approach before actually showing results to client/ others.

4. In some cases preparing valuation based on various scenarios is required. Say someone asks how much would business be worth if best case scenario of the business plan becomes a reality. Similarly for worst case scenario and for base case. However be careful agreeing for multiple scenario valuation approach. First of all it triples your work. Second its more difficult to build all scenarios to be internally consistent and then client may want to play with the scenarios assumptions, multiply number of the scenarios, updating it etc. And all the sudden your 2 week project lasts 3 months and nobody is satisfied with the results. So use scenarios only if justified by situation and everyone is fully aware of consequences.

5. Flexibility study are loved by clients and analysts. You show that with different assumptions results would vary as well. Nowadays flexibility study are even required by International Accounting Standards in case of valuations used in

financial statements. However remember about certain limitations and threats related to flexibility study.

(a) First of all, what is possible from mathematical point of view may not necessarily be feasible in business world. So analyzing say impact of decline in company revenue on its valuation please remember that in case revenue drops by 25%, value of the company will not go down to 0, as your valuation model may show. In real life, in case revenue drops, company closes down or sale on of its factories, reduces employment, limits its portfolio of products, looks for cheaper suppliers, looks for other markets to place its production and bounce the sales back just a year later etc. So please bear in mind major limitations that hummer utility of flexibility studies especially if major changes of parameters are considered.

(b) Second of all by some flexibility studies you may motivate client to put a pressure to your valuation parameters. For instance its market standard to show what results would valuation show if grow rate in residual was different than assumed. By doing so, you may find yourself answering question why you actually didnt assume 3% growth instead of 1% since the company value would grow by PLN 100m in that case. Since PLN 100m is a lot of money the discussion may be tense and you may find yourself spoiling your own valuation to meet clients demands, just because you showed him the easiest way to do so.

14.5.2 Presenting and Discussing the Results

Communication with the Customer

Believe it or not but in real life cases, there are certain situation when you cant just show the client (whoever the client is) your valuation results and explain why he should accept it. In many real life cases the client already has a certainty expectations towards the valuation results. Moreover sometimes knows exactly what the value should be, and needs you only to prove it in a methodically bullet proof manner. If you find yourself in such a situation follow the certain approach:

1. At first try to prepare the valuation fully in line with what you belief would be most proper in that case. As a result you will receive the value reflecting your believes most accurately. In some cases this may even be the expected value or close to expected. Only at that point start playing with parameters that change you may justify easiest, to get to the expected value. Try to spoil as few assumptions/ parameters as possible, to be able to defend the methodology late on.

2. If you spoil each and every parameter/ assumption as you prepare valuation, you will not only be unaware what the true value would be like, but will most certainly problem to defend it is done properly.

3. If you feel that client is manipulating the valuation through altering financial projections, and the projections are quite different from what you could expect by

looking at historical performance of the company and in the same time you are unable to confront the client on that issue, try using flexibility study or multiply scenarios approach to show alternative results. In that case show what external recipients of the valuation may expect: e.g. simple extrapolation of companys history and show that valuation result to the client. At least you will be on a safe side (e.g. in M&A process) when first offers come in and none of them would be even close to what client expected based on his skyrocketing projection.

Presenting the Result

As soon as you have finished the Excel part of valuation and you are fully satisfied with the results, you may start working on Word or PowerPoint document.

1. Its advisable not to start description until the Excel part is ready, since if you change assumptions/ approach it may lead to mistakes in final document by simply forgetting to change description. This may lead to undermining your valuation quality and it will be obvious that you considered different approaches before.

2. Keep the document as concise and simple as possible. You will see, that after putting projection in attachment (or inside the doc) it will grow anyway.

3. Dont forget to make graphics look attractive and have it checked by someone not involved in valuation for cross check. Clients/ other people may not have a clue how much time and know-how it needs to prepare the valuation and may not appreciate it, so make sure that you allocate enough time to the list mile of the process. Otherwise you may end up spending several nights working on the valuation and client will be certain you were not committed since the document he received looks ordinary and there are couple of easy to find mistakes in it.

4. Dont forget to prepare a one-page Executive Summary at the beginning. Some clients dont have time to look through even concise document they just need the highlights.

Discussing the Result

There is a natural conflict when it comes to valuation results. In many cases you, as a person responsible for valuation, wish to prepare it as much with line of your believes and knowledge as possible while client (others) may wish to influence the results for their own purposes. There are ways to approach this issue:

1. First and by far most important: be prepared for the discussions. Know by heart all reasons why methodology/ assumptions must look the way they do. At all cost avoid using arguments which may be used by the client against you! Try to keep initiative on your side and provide information that you want to in a way that you prefer. Its much easier than trying to defense yourself while being attacked by the client with dozen of questions in case you said nothing and just wait for his opinion/ remarks.

2. Knowing that client will push on increase the value to the maximum, some valuators show very low value at the beginning and then after client angrily shows his disappointment increase the value to the level valuator believes is most appropriate. This approach treats client vs. valuator discussion as a kind of bargaining where your position at the beginning should allow you space for change within your acceptable range. Any weakness of the strategy? Well, once you show that your position (valuation) is negotiable, you may end up adjusting it until client is satisfied and you arent.

3. Alternatively you may start with the valuation result that you really feel comfortable with and try not to change it. This requires lots of explanations, showing that your assumptions/ parameters were chosen conservatively but could have been even more conservative (with less attractive results for the client). In case that the client pushes you to the wall saying one parameter has to be changed (so that he gets valuation more appealing in his view) you may always say that if he insists and you had such a long conversation about methodology, you will once more go through the whole valuation and look closer to all parameters/ assumptions. As a result of the process you may then accept change of the parameter in clients favor, but in the same time change the other few to a different direction so that the result remains at the most comfortable level for you. Remember the person preparing valuation is always on a bit stronger position because he/ she knows all about it.

Updating the Result

For many different reasons business plans and valuations often require updates. The main issue in this case is that everyone including client and your boss is convinced that it will take few hours of work, is not worth paying extra and is generally easy. Never underestimate complexity of the process! There are quite a few corners to turn before you can accomplish your work:

1. Despite what client may claim at the beginning (no major change comparing to the last version of business plan), thoroughly examine the situation. You may find out that almost everything changed. The last quarter actuals has nothing to do with planed, therefore the question arises if the full year financial statements will look as supposed? If not will company develop at expected pace in the following years? Also, even if investment plans were not cancelled they usually are rescheduled, costs changed and production mix is not the same. Soon enough you will find it easier to ask again for the same set of information which you needed to prepare the valuation before, rather than to ask what changed.

2. Manage your client and boss expectations. Explain that update in most cases means building a new projection, and some important changes may be applicable to valuation as well. This means time and assets allocation. And in most cases should not be made for free or for low price, since then nobody will allocate necessary assets (and will expect you to do the update in your free time). Also from client side update means work. You will ask them again to prepare certain documents and information sets prepare your client for that effort.

3. The more precise the business plan, the more detailed split (quarters and months far worse than years), the more work you will have with update. Update of consolidated statements will obviously require update of every projection of each consolidated entity being particularly time-consuming process.

4. In case of valuation as such, following elements may require update: risk free rates may have changed as well as beta and even market risk premiums. In case of peer group some companies may get de-listed and some merged and other went bankrupt those need to be replaced. At the end of the day, even if projection doesnt change much, valuation results may be quite different.

Some valuations, especially for financial statement purposes have to be done periodically: every year, half year or quarterly. In those cases its worth to pay some extra attention to methodology that you use. Remember that auditor (or client) may review later on all your valuation documents from the past and if your valuation approach changes every time, without a good reason, you will lose credibility.

PART IV .:. CHAPTER 15 .:.

Common Pitfalls

15.1 The Reality Principle

Value Only Today's Business

Valuate only whats in there. Valuation is about the future and its perfectly normal that almost every company sees its future bright and full of investments, new business opportunities etc. However there is a hard to define borderline between normal expansion and evaluating business which actually is not there. Use common sense and bear in mind the following:

1. You are evaluating existing business. Imagine someone just established limited company and there are neither operations in it, nor employees, nor know-how, with just as much as PLN 100k cash in it. And when President of the company approaches you with a brave plan to establish network of 1000 restaurants worldwide - would you evaluate this startup on PLN 20 bl.? Real life cases will not be so obvious, but similar. Shoes producer may claim to become developer and expect generating PLN 100m of yearly profits. Or 5 stores network may like to become CEE leader with 100 stores in 4 years. Do not use that kind of projection as a base for valuation if you want to do it responsibly.

2. One of the indications that projection may be not acceptable is major difference between results of valuation based on comparative method (low results) and DCF (high results). That shouldnt be the case since other companies from the peer group (as a rule) also plan expansion, profits growth etc. So it seems that your company plans are very unusual/ not realistic.

3. Another way to tamper with companies valuation is assuming attractive acquisition. Its easy to double your company value if you assume merging with highly profitable and fast expanding company, especially if you buy it cheaply. If there is no sale agreement signed and profitability/ synergies/ growth potential verified do not base your valuation on it.

15.2 Common Mistakes and How to Avoid Them

Model Related Mistakes

1. Check the model that generates projection if it is mistakes-free and if assumptions are realistic preferably in line with historical performance. Make sure that projection is internally consistent - for example you should not purchase a new machine to produce a product which will be discontinued in the following year. To avoid the mistakes, have someone cross check your projection or check yourself projection prepared by others so that you fully understand it before actually using it.

2. Make sure normalized projection is a base for residual value calculation and for comparative method valuation. Its also not obvious how the normalized year should look like this is to be discussed with valuated company as well as based on historical long term analysis.

3. Avoid double counting client may push on including the same value twice in valuation. For instance office building to be placed in non-operational assets while the whole HQ are located there and do not pay rent because of it. The easiest check to avoid that mistake is making sure that as non-operational assets are accounted only those assets without which company may fulfill projection.

4. Include all assets and value generators: non-operating assets just go through companys assets and understands how (and if) its used.

15.3 Holdings

Holdings

Holdings are particularly tricky to valuate. You should pay a attention to the following issues:

1. Understand what each and every company in the holding is responsible for and how its reflected in financial statements: both of that company and in consolidated.

2. The main decision for valuator is choice between valuating holding as if it was one company, based on its consolidated statements or valuate every company separately and then sum up the results. The first approach is more natural in case of holdings which are not diversified e.g. operating in fast food business, just through separate entity in each country. If holding consist of 2 separate and very different businesses it would probably be a better idea to evaluate each part separately. Either way there are certain mistakes you should avoid.

3. In case you are valuating whole holding your base will be consolidated statements. Its crucial to understand, that if mother company owns 51% in daughter company, the whole sale and EBITDA is shown in consolidated statement. So if you use EV/ S or EV/ EBITDA multiplayer, you will receive higher results than you should. The results would show you value that assumes 100% of ownership in the daughter company and not just 51%!

4. In case of valuating holding companies as a separate entities make sure that you consider flows and interactions between companies, in particular consider applying consolidation corrections on unrealized profits on assets/ goods that one of the companies sold to another company from the same holding and which were not sold outside the holding.

5. In case you prepare consolidation financial model, its a good idea to try to fit one company projection on one spreadsheet, and keep each of the sheets exactly the same, to be able to easily consolidate them later on.

PART IV .:. CHAPTER 16 .:.

Examples

16.1 Small Vineyard bought by private person

Vineyard

Example 16

An investment banker of the London City wants to "retire" in the Loire area of France and buy a Vineyard with *all* his accumulated savings. The wine is good and the winemaker wants to retire and the investment banker wants to cash out on his investments and learn how to make wine.

	3 yrs ago	2 yrs ago	last yr	
Revenues	**800**	**1'100**	**1'200**	operating at full capacity
Operating Lease	120	120	120	still 12 years to lease
Wages	180	200	200	the owner takes no salary
Materials	200	275	300	25% of revenue
Other OpEx	120	165	180	15% of revenue
Operating Income	**180**	**340**	**400**	
Tax	72	136	160	40% tax rate (τ)
Net Income	**108**	**204**	**240**	

All numbers are in thousands €

STEP 1

Determining the discount rate

CAPM is no help here:

- it assumes that the investor is well diversified and therefore uses β that is the risk that cannot be diversified
- it assumes that there is a market return, but this is a small business with may particular aspects

So . . .

- You find out that the β of large Vineyards is about 0.86. Though these are well known Vineyards with more professional distribution and better contracts in place. So, you estimate the unleveraged β to equal 1.18
- note that $\beta_{total} f_M = \beta_{Market}$ (with f_M the fraction of total risk that is market risk.
- approach this with $\beta_{total} = \frac{\beta_{Market}}{\sigma_M}$ (with σ_M the correlation with the market)
- assume we make a regression analysis, calculated R^2 and find that the total unleveraged beta equals

$$\begin{aligned}\beta_{total} &= \frac{\beta_M}{\sigma_M} \\ &= \frac{1.18}{0.5} \\ &= 2.36\end{aligned}$$

- re-leveraging the beta for public firms is done by using the market DE-ratio. For private firms one can choose one of the following methods:
  - assume that the DE-ratio is similar to the market average, or
  - use your estimates of debt and equity in the estimation — of course this gets circular because you're actually trying to calculate the value of the equity!
- for this exercise we assume that this vineyard has a DE-ratio of 14.3%, which is similar to the market average of the publicly traded peers.
- this allows us to calculate the leveraged beta:

$$\begin{aligned}\beta_{leveraged} &= \beta_{total}\left(1 + (1-\tau)DE\right)\right) \\ &= 2.36\left((1 + (1-0.4)0.1433)\right) \qquad \text{tax rate } \tau \text{ given} \\ &= 2.56\end{aligned}$$

- this finally defines the cost of equity:

$$\begin{aligned}K_e &= R_f + \beta \times RP \\ &= 0.0425 + 2.56 \times 0.04 \qquad \text{assuming that the risk premium is 4\%} \\ &= 0.145\end{aligned}$$

***Note**: Note that the CAPM is used to determine the cost of equity K_e. The CAPM states $E[R_k] = R_{rf} + \beta_k(E[R_M] - R_{rf})$, where of course $R_M - R_{rf} = R_{rf} + RP - R_{rf} = RP$ — see Chapter 10.7*

- So, now we have the cost of equity K_e. however, in order to calculate the cost of capital we still need first to determine the cost of debt (K_d). This can be done in the following steps:

- calculate the coverage ratio:

$$\begin{aligned} CoverageRatio &= \frac{OperatingIncome}{InterestExpense} \\ &= \frac{400'000}{120'000} \\ &= 3.33 \end{aligned}$$

- compare with the rating based coverage ratio (assume 3.25%)
- calculate the cost of debt:

$$\begin{aligned} K_d &= (R_{rf} + CoverageRatio)(1-\tau) \\ &= (0.0425 + 0.0325)(1 - 0.40) \\ &= 0.045 = 4.5\% \end{aligned}$$

- calculate the cost of capital ($WACC$)

$$\begin{aligned} WACC &= \frac{D}{D+E}K_d + \frac{E}{D+E}K_e \\ &= \frac{100}{114.33} \times 14.5\% + \frac{14.33}{114.33} \times 4.50\% \\ &= 13.25\% \end{aligned}$$

STEP 2

Clean up the Statements of Accounts

	stated	**future**	
Revenues	**1200**	**1'200.00**	
Operating Lease	120	0.00	leases are financial expenses
Wages	200	350.00	we will need an experienced manager
Materials	300	300.00	
Other OpEx	180	180.00	
Operating Income	**400**	**370.00**	
Financial Expenses	0	69.62	this is 7.5% of 928.23 (see note)
Taxable Income	**400**	**300.38**	
Tax	160	120.15	
Net Income	**240**	**180.23**	

***Note**: The debt is calculated as the present value of 120 million discounted at 7.5%*

STEP 3

Assess the impact of the key person

- The actual owner of the vineyard is an experienced person, that has all right contacts: with suppliers of bottles and labels, machines producers, seasonal labourers, and most important his personal sales network. Sales are likely to be impacted when he leaves.
- So, assume a 20% reduction of the operating income: from 370'000€to 296'000€.

STEP 4

Assess the expected growth rate

- we know that in long term we have $ReinvetmentRate = \frac{g}{ROC}$
- after considering the short history and the impact of the key person, we assume a growth rate g of 2% forever and a 20% ROC. This results in

$$ReinvestmentRate = \frac{g}{ROC} = \frac{0.02}{0.20} = 10\%$$

- even if the return would not grow, then still we would have to invest this amount for new machines, new vines, etc.

STEP 5

Do the maths

- Inputs:
  - tax rate: $\tau = 40\%$
  - adjusted EBIT: 296'000€
  - cost of capital: 13.25%
  - expected growth rate: 2%
  - Reinvestment Rate (RIR): 10%
- Valuation:

$$\begin{aligned} ValueVineyard &= \frac{E[FCF]}{WACC - g} \\ &= \frac{E[EBIT_{t+1}](1-\tau)(1-RIR)}{WAC - g} \\ &= \frac{E[EBIT_{t+1}](1-\tau)(1-RIR)}{WAC - g} \qquad \text{(assume } EBIT_{t+1} = (1+g)EBIT_t\text{)} \\ &= \frac{296'000€(1+0.02)(1-0.10)}{0.1325 - 0.20} \\ &= 1.449million\ € \end{aligned}$$

- Finally we have to reduce the value to the value of the equity by removing the present value of the leases

$$\begin{aligned} ValueOfEquityInVineyard &= 1.449million\ € - 0.928million\ € \\ &= 0.521million\ € \end{aligned}$$

STEP 6

Consider illiquidity effect

- In absence of a better theory: apply a discount of 20 to 30%
- Note that liquidity discount might depend on:
  - **the company itself**: larger companies and certainly companies that are partly quoted on the stock exchange are more liquid
  - **the buyer**: if the buyer is diversified then he might attach less value to liquidity (because he might sell other assets in time of need); some buyers are able to plan liquidity (pension funds); while others (such as people) can plan less efficiently and might need cash soon
  - **market sentiment**: when economy is doing good and markets are booming, people tend to forget about the liquidity

16.2 Microsoft: a Simplified Example

Microsoft on the Nasdaq

Figure 16.1: *A snapshot of Mircrosoft's information. Source: Yahoo Finance.*

Assumptions

- Assume you're a fund manager with as benchmark the SP500 (so you have an equity fund in USD)
- This means:
  - This is handy because the β given here is the beta relative to the S&P500 (using five years month-end data) – so it is your risk.
  - The 5-years horizon is appropriate for a fund manager.
  - A fund manager typical has a view
- Assume further
  - a constant growth rate of 10% (growth of the operational FCF)
  - that all future dividends will be 2.48% (the same as the dividend shown)
- Your fund size is 200 mln \$: this means that you have no influence in the management of a company that has a market cap of 492.84Bln. \$
- As "market" we will use the SP500. Its long term average return since its inception in 1928 is about 10% (this is our R_M)
- Microsoft is a specific company that has a lot of cash (137 Bln. Cash and Short Term Investments on a total of 158 Bln. total current assets). There are two issues related:

- this cash will not be part of the valuation that we find (ie. we have to add $\frac{137BlnUSD}{5.523Bln.shares} = 24.8USD$ to the price that we find and
- the income from this cash should be subtracted from the FCF. We estimate this income as 1% of the cash – so $ 1.37Bln. is financial income. Given that this is about 25% of its EBIT (see financial statements on Google Finance for example) we will reduce the dividend yield from 2.48% to 1.86% in case we consider only the dividend based on operations.

The solution

- Choose the DDModel because you have an outsiders view – you fund-size is much smaller than the market cap of the company
  - Look up long term interest rates: they are 3.00%

Date	1 Mo	3 Mo	6 Mo	1 Yr	2 Yr	3 Yr	5 Yr	7 Yr	10 Yr	20 Yr	30 Yr
01/03/17	0.52	0.53	0.65	0.89	1.22	1.50	1.94	2.26	2.45	2.78	3.04
01/04/17	0.49	0.53	0.63	0.87	1.24	1.50	1.94	2.26	2.46	2.78	3.05
01/05/17	0.51	0.52	0.62	0.83	1.17	1.43	1.86	2.18	2.37	2.69	2.96
01/06/17	0.50	0.53	0.61	0.85	1.22	1.50	1.92	2.23	2.42	2.73	3.00

Friday Jan 6, 2017

Figure 16.2: *Yield curves in USD — source: https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield*

- the growth-rate is given: $g = 9\%$ (given/estimated)
- the beta is given: $\beta = 1.32$ (given)
- the dividend that we will use is 2.00% (our estimation – a little higher than the dividend that was paid last year reduced with the financial income (ie. 1.86%))
- the required rate of return can be found via the CAPM:

$$\begin{aligned} R &= \beta(R_M - R_F) + R_F \\ &= 1.32(0.10 - 0.03) + 0.03 \\ &= 1.32 \times 0.07 + 0.03 \\ &= 12.24\% \end{aligned}$$

- apply the DDM for constant growth and constant dividends and only for the normal operations (which should be comparable to the market value without cash: $\$ 62.62 - \$24.8 = \$ 37.82$ per share):

$$\begin{aligned} V_{op} &= \frac{D_1}{R - g} \\ &= \frac{0.0200 \times \$ (62.62 - 24.8)}{0.1224 - 0.09} \\ &= \frac{\$ 0.7564}{0.0324} \\ &= \$ 23.35 \end{aligned}$$

- The value per share is now the sum of the cash and the operational value $\$\,23.35+\$\,24.8 = \$\,48.15$

Our valuation of Microsoft is lower than its actual share price, so –to us– it does not seem like a good buy.

A related question

What growth rate does the market assume – given the same assumptions – especially that the dividend on normal operations is 2.0%

Since $V = \frac{D_1}{R-g}$, we also have

$$\begin{aligned} g &= R - \frac{D_1}{V} \\ &= R - EPS \\ &= 12.24\% - 2.00\% \\ &= 10.24\% \end{aligned}$$

What do you think? Is that realistic?

PART V

Back Matter

Bibliography

Bertsimas, D., G. Lauprete, and A. Samarov (2004). Shortfall as a risk measure: properties, optimization and applications. *Journal of Economic Dynamics and Control 28*(7), 1353–1381.

Botev, Z. I., J. F. Grotowski, D. P. Kroese, et al. (2010). Kernel density estimation via diffusion. *The Annals of Statistics 38*(5), 2916–2957.

Bowman, A. W. (1984). An alternative method of cross-validation for the smoothing of density estimates. *Biometrika 71*(2), 353–360.

Chen, S. (2008). Nonparametric estimation of expected shortfall. *Journal of financial econometrics 6*(1), 87.

De Brouwer, P. (2016). Zarzadzania ryzykiem w podejsciu zintegrowanym. In M. Postuła and R. Cieślik (Eds.), *Projekty inwestycyjne finansowanie, budżetowanie, ocena efektywności*, Chapter 8, pp. 231–298. Warsaw: Difin SA.

De Brouwer, P. J. S. (2012). *Maslowian Portfolio Theory, a Coherent Approach to Strategic Asset Allocation*. Brussels: VUBPress.

Drury, C. M. (2013). *Management and cost accounting*. Springer.

Emmanuel Derman and Iraj Kani (1994, Jan). The volatility smile and its implied tree.

Epanechnikov, V. A. (1969). Non-parametric estimation of a multivariate probability density. *Theory of Probability & Its Applications 14*(1), 153–158.

Fermanian, J. and O. Scaillet (2005). Sensitivity analysis of var and expected shortfall for portfolios under netting agreements. *Journal of Banking & Finance 29*(4), 927–958.

Goldratt, E. M., J. Cox, and D. Whitford (1992). *The goal: a process of ongoing improvement*, Volume 2. North River Press Great Barrington, MA.

Hall, P., J. Marron, and B. U. Park (1992). Smoothed cross-validation. *Probability Theory and Related Fields 92*(1), 1–20.

Jones, C., J. Marron, and S. Sheather (1996a). Progress in data-based bandwidth selection for kernel density estimation. *Computational Statistics* (11), 337–381.

Jones, M. C., J. S. Marron, and S. J. Sheather (1996b). A brief survey of bandwidth selection for density estimation. *Journal of the American Statistical Association 91*(433), 401–407.

Kaplan, R. S. and D. P. Norton (2001a). Transforming the balanced scorecard from performance measurement to strategic management: Part i. *Accounting horizons 15*(1), 87–104.

Kaplan, R. S. and D. P. Norton (2001b). Transforming the balanced scorecard from performance measurement to strategic management: Part ii. *Accounting Horizons 15*(2), 147–160.

Kraut, R. (2002). Aristotle: political philosophy.

Lawrie, G. and I. Cobbold (2004). Third-generation balanced scorecard: evolution of an effective strategic control tool. *International Journal of Productivity and Performance Management 53*(7), 611–623.

Liker, J. and G. L. Convis (2011). *The Toyota way to lean leadership: Achieving and sustaining excellence through leadership development*. McGraw Hill Professional.

Mackay, C. (1841). *Memoirs of extraordinary Popular Delusions and the Madness of Crowds* (First ed.). New Burlington Street, London, UK: Richard Bentley.

Norreklit, H. (2000). The balance on the balanced scorecard a critical analysis of some of its assumptions. *Management accounting research 11*(1), 65–88.

Parzen, E. (1962). On estimation of a probability density function and mode. *The annals of mathematical statistics*, 1065–1076.

Reichheld, F. F. (2003). The one number you need to grow. *Harvard business review 81*(12), 46–55.

Rosenblatt, M. et al. (1956). Remarks on some nonparametric estimates of a density function. *The Annals of Mathematical Statistics 27*(3), 832–837.

Rudemo, M. (1982). Empirical choice of histograms and kernel density estimators. *Scandinavian Journal of Statistics*, 65–78.

Scaillet, O. (2004). Nonparametric estimation and sensitivity analysis of expected shortfall. *Mathematical Finance 14*(1), 115–129.

Scaillet, O. (2005). Nonparametric estimation of conditional expected shortfall. *Insurance and Risk Management Journal 74*(1), 639–660.

Scott, D. W. (1979). On optimal and data-based histograms. *Biometrika 66*(3), 605–610.

Scott, D. W. (2015). *Multivariate density estimation: theory, practice, and visualization*. John Wiley & Sons.

Sheather, S. J. and M. C. Jones (1991). A reliable data-based bandwidth selection method for kernel density estimation. *Journal of the Royal Statistical Society. Series B (Methodological)*, 683–690.

Simonoff, J. S. (2012). *Smoothing methods in statistics*. Springer Science & Business Media.

Smith, B. M. (2004). *A history of the global stock market: from ancient Rome to Silicon Valley*. University of Chicago press.

van der Merwe, A. and B. D. Clinton (2006). Management accounting-approaches, techniques, and management processes. *Journal of cost management 20*(3), 14–22.

Wand, M. P. and M. C. Jones (1994). *Kernel smoothing*. Crc Press.

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ROI, 103
ROIC, 103
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Nomenclature

σ the volatility of the returns of the underlying asset, page 37

τ the time to maturity, page 37

C_M the marginal cost, page 94

cf Cash Flow, page 13

D total debt expressed in currency, page 104

d_1 $:= \frac{\log\left(\frac{S}{X}\right)+\left(r+\frac{\sigma^2}{2}\right)(\tau)}{\sigma\sqrt{\tau}}$, page 37

d_2 $:= \frac{\log\left(\frac{S}{X}\right)+\left(r-\frac{\sigma^2}{2}\right)(\tau)}{\sigma\sqrt{\tau}} = d_1 - \sigma\sqrt{\tau}$, page 37

D_t the dividend paid in year t, page 119

D_t the dividend paid in year t, page 21

DPR $:= \frac{D}{E}$, dividend payout ratio, page 121

E earnings, page 121

E total equity expressed in currency, page 104

$f_{est}(x)$ the estimator for the probability density function, $f(x)$, page 150

$f_{est}(x;h)$ the estimator for the probability density function for a kernel density estimation with bandwidth h, page 150

FV Future Value, page 11

g Growth Rate, page 116

g the (dividend) growth rate, page 119

g the (dividend) growth rate, page 21

h the bandwidth or smoothing parameter in a kernel density estimation, page 150

I Interest payment (in monetary units), page 11

IV Intrinsic value, page 27

K Capital paid by investors, page 105

K_d cost of debt, page 104

K_e cost of equity, page 104

K_h the kernel (of a kernel density estimation) with bandwidth h, page 150

$log(x) := log_e(x)$, page 37

N a given natural number, page 11

$N(\cdot) := \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{z^2}{2}} dz$ the cumulative distribution function of the standard normal distribution, page 37

P the price of the product, page 94

P_t the (market) price of a stock at moment t, page 120

P_t the (market) price of a stock at moment t, page 22

$PBR := 1 - DPR$, plowback ratio, page 121

PV Present Value, page 11

Q the quantity produced, page 94

r Discount Rate, page 116

r capitalization rate, page 21

r interest rate, page 13

r is the capitalization rate and is the same as $E[R_k]$ in the CAPM, page 119

r the risk free rate (annual rate, expressed in terms of continuous compounding), page 37

r_1 the risk free interest rate over period 1, page 57

R_i the return of asset i, page 104

R_k the return of an arbitrary asset K, page 127

R_M the return of the market, page 127

R_{rf} The risk-free return (in calculations one generally uses an average of past risk-free returns and not the actual risk-free return), page 127

$ROE := \frac{E}{P}$, Return on Equity, page 121

S the spot price (of the underlying asset), page 27

t counter, page 13

V_0 the intrinsic value of the stock now, page 119

V_0 the intrinsic value of the stock now, page 21

V_0 the value of an asset at time zero (now) = the present value = PV, page 11

V_i the market value of asset i, page 104

V_t the value of an asset at time t, page 11

V_{market} Market Value (of a company), page 105

$VAR(X)$ the variance of the stochastic variable X, page 127

X the strike price, page 37

(i_n nominal interest rate, page 12

(i_r real interest rate, page 12

(p inflation rate, page 12

ABC Activity Based Costing, page 91

AER effective annual rate or annual equivalent rate, page 12

Altiplano a vanilla option is combined with a compensatory coupon payment if the underlying security never reaches its strike price during a given period, page 64

American an American option can be executed from the moment it is bought till its maturity date, page 26

Annapurna in which the option holder is rewarded if all securities in the basket never fall below a certain price during the relevant time period, page 64

APR annual percentage rate, page 12

Asian the strike or spot is determined by the average price of the underlying taken at different moments, page 64

Atlas in which the best and worst-performing securities are removed from the basket prior to execution of the option, page 64

ATM an option is in the money if its Intrinsic value is zero, page 27

AU Asset Utilisation, page 73

Barrier Option another word for Knock-in or Knock-Out options, page 65

Bermuda Option an option where the buyer has the right to exercise at a set (always discretely spaced) number of times, page 65

BSC Balanced Scorecard, page 96

CAL Capital Allocation Line, page 130

Call the right to buy an underlying asset at a pre-agreed price, page 25

Canary Option can be exercised at quarterly dates, but not before a set time period has elapsed, page 65

CapEx Capital Expenditure, page 74

CAPM Capital Asset Pricing Model, page 127

cash settlement pay out the profit to the option buyer in stead of deliver the underlying, page 26

CDO Collateral Debt Obligation, page 125

CF Cash Flow, page 116

CGDDM constant growth dividend discount model, page 119

CGDDM constant growth dividend discount model, page 21

CLV Customer Lifetime Value, page 98

CML Capital Market Line, page 130

CoGS Cost of Goods Sold, page 71

CoverageR Current Ratio, page 106

CR Current Ratio, page 74

CVM Customer Value Metric, page 98

DCF Discounted Cash Flow, page 115

DDM Dividend Discount Model, page 119

DDM Dividend Discount Model, page 21

DE Debt-to-Equity Ratio, page 108

deliver provide or accept the underlying from the option buyer, page 26

DPV Discounted Present Value, page 115

DSCR Debt Service Coverage Ratio, page 107

EA Environmental Accounting, page 93

EAT earnings after taxes, page 71

EBIT earnings before interest and taxes, page 71

EBITDA earnings before interest, taxes and depreciation, amortization, page 71

EBT earnings before taxes, page 71

European a European option can only be executed at its maturity date, page 26

EVA economic value added, page 105

Everest payoff based on the worst-performing securities in the basket, page 64

exercising sell or buy via the option contracts, page 26

expiry date the maturity date, page 25

FCF Free Cash Flow, page 113

FCFF Free Cash Flow to Firm, page 113

FV Future Value, page 115

GM Gross Margin, page 74

GPK Grenzplankostenrechnung, page 92

GR Rearing Ratio, page 108

Himalayan based on the performance of the best asset in the portfolio, page 64

Intrinsic value the value of the option at maturity, page 27

IPO Initial Pubic Offering, page 82

Israeli option callable by the option writer, page 64

ITM an option is in the money if its Intrinsic value is positive, page 27

KDE Kernel Density Estimation, page 148

Knock-In this option only becomes active when a certain level (up or down) is reached, page 65

Knock-Out a knock-out option becomes inactive after a certain level of the underlying is reached, page 65

KPI Key Performance Indicator, page 97

LBO Leveraged Buy Out, page 81

LCC Life Cycle Costing, page 93

LCV Lifetime Customer Value, page 98

long position the buyer of an option is said to have a long position on his books, page 28

look-back the spot is determined as the best price of some moments, page 64

LR Liquid Ratio, page 74

maturity or "maturity date" is the expiry date of an option, that is the last moment in time that it can change value because of the movement of the underlying, page 25

MIS Management Information System, page 89

MISE mean integrated squared error, page 151

MTM Marked-To-Market, page 27

MVA Market Value Added, page 105

NAV Net Asset Value, page 123

NOA Net Operating Assets, page 107

NOPAT Net Operating Income After Taxes, page 71

NPS Net Promoter Score, page 99

NPV Net Present Value, page 115

NPV Net Present Value, page 13

OA Operating Assets, page 107

OL Net Operating Assets, page 107

OpEx Operational Expenditure, page 75

OTC Over-The-Counter, page 28

OTM an option is in the money if its Intrinsic value is negative, page 27

P&L Profit and Loss, page 146

PM Profit Margin, page 73

premium here used as the equivalent for the "up front price of an option" or "actual price", page 36

PTB $= \frac{P}{BV} =$ price-to-book ratio with $BV = book\ value$, page 138

PTCF $= \frac{P}{CF} =$ price-to-cash-flow ratio, with $CF = (free)\ cash\ flow$, page 138

PTS $= \frac{P}{S} =$ price-to-sales ratio, with $S = sales$, page 138

Put the right to sell an underlying asset at a pre-agreed price, page 25

PVGO present value of growth opportunities, page 22

R&D research and development (costs), page 71

RCA Resource Consumption Accounting, page 91

ROCE Return on Total Capital Employed, page 103

ROE Return on Equity, page 106

ROI Return on Invested Capital, page 103

ROIC Return on Invested Capital, page 103

RP risk premium, $RP = R_x - R_f$, page 174

Russian lookback over the whole life time of the option, page 64

S Sales, page 92

SCA Standard Cost Accounting, page 90

SCL Security Characteristic Line, page 131

short position the seller of an option is said to have a short position on his books, page 28

SML Security Market Line, page 131

SML Security Market Line, page 127

spot price the actual value of the underlying asset, the price to be payed for the asset to buy it today and have it today, page 27

strike the "execution price", the price at which an option can be executed (e.g. for a call the price at which the underlying can be sold), page 25

T Throughput, page 92

TA Throughput Accounting, page 92

TC Target Costing, page 94

TC Total Capital, page 103

TCE Total Capital Employed, page 103

TVC Total Variable Costs, page 92

UCITS Undertaking for Collective Investments in Transferable Securities, page 124

VB Visual Basic, page 147

VC Venture Capitalist, page 83

Verde Option can be exercised at incremental dates(typically annually), but not before a set time period has elapsed, page 65

WACC weighted average cost of capital, page 104

WC Working Capital, page 108