

Black economic empowerment transactions and  
employee share options: Features of non-traded call  
options in the South African market

by

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## DECLARATION

I, the undersigned, declare that the dissertation, which I hereby submit for the degree Magister Scientiae at the University of Pretoria is my own work and has not previously been submitted by me for any degree at this or any other tertiary institution.

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## ABSTRACT

Employee share options and Black Economic Empowerment deals are financial instruments found in the South African market.

Employee share options (ESOs) are issued as a form of non-cash compensation to the employees of the company in addition to their salaries or bonuses. Its value is linked to the share price and since there is no downside risk for the employee his share option is similar to owning a call option on the stock of his employer.

Black economic empowerment (BEE) deals in this report refer to those types of transactions structured by listed South African companies to facilitate the transfer of a portion of their ordinary issued share capital to South African individuals or groups who qualify under the Broad-Based Black Economic Empowerment Act of 2003 (“the Act”). This Act requires a minimum percentage of the company to be black-owned in order to address the disproportionate distribution of wealth amongst racial groups in South Africa due to the legacy of Apartheid. These transactions are usually structured in such a way to allow the BEE partner to participate in the upside of the share price beyond a certain level but not in the downside which replicates a call option on the share price of the issuing company

The cost of both ESOs and BEE deals has to be accounted for on the balance sheet of the issuing company at its fair-value. Neither of these instruments can be traded and their extended option lifetimes are features that distinguish these deals significantly from regular traded options for which liquid markets exist. This makes pricing them a non-trivial exercise. A number of types of mathematical models have been developed to take the unique structure features into account to price them as accurately as possible.

Research by Huddart & Lang (1995 & 1996) has shown that option holders often exercise their vested options long before the maturity of the transactions but are unable to quantify a measure

that can be used. The wide variety of factors influencing option holders (recent stock price movements, market-to-strike ratio, proximity of vesting dates, time to maturity, share price volatility and wealth of option holder) as well as little exercise data publicly available prevents the options from being priced in a consistent manner. Various assumptions regarding the exercise behaviour of option holders are used that are not based on empirical observations even though the option prices are sensitive to this input.

This dissertation provides an overview of the models, inputs and exercise behaviour assumptions that are recognized in pricing both ESOs and BEE deals under IFRS 2 in South Africa. This puts the reader in a position to evaluate all pricing aspects of these deals. Furthermore, their structuring are also analysed in order to identify the general issues related to them.

A number of methods to manage the pricing issue surrounding exercise behaviour on ESOs have been considered for the South African market. The ESO Upper Bound-methodology showed that for each strike there is a threshold at which exercise will occur and the employee can invest the after-tax proceeds in a diversified portfolio with a higher expected return than that of the single equity option. This approach reduces the standard Black-Scholes option value without relying on assumptions about the employee's exercise behaviour and is a viable alternative for the South African market. The derived option value represents the cost of the option.

Seven large listed companies' BEE transactions are dissected and compared against one another using the fair-value of the transaction as a percentage of the market capitalization of the company. The author shows how this measure is a more equitable way of assigning BEE credits to companies than the current practice which is shareholding-based. The current approach does not reward the effort (read cost) that a company has undertaken to transfer shares to black South Africans but only focuses on the amount that is finally owned by the BEE participants. This leaves the transaction vulnerable to a volatile share price and leads to transactions with extended lock-in periods that do not provide much economic benefit to the BEE participants for many years.

Other inefficiencies in the type of BEE transactions that have emerged in reaction to the BEE codes that have been published by the South African government are also considered. Finally the funding model that is often used to facilitate these deals is assessed and the risks involved for the funder (bank) is reflected on.

Dedicated to all of those who work selflessly towards the people of South Africa, and to those who desperately need BEE to achieve what it set out to accomplish

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## GLOSSARY

### **Apartheid**

A system of legal racial segregation enforced by the National Party government in South Africa between 1948 and 1994, under which the rights of the majority black inhabitants of South Africa were curtailed and minority rule by whites was maintained.

### **Employee Share Option**

An employee share option (also referred to as an employee stock option) is a call option on the common stock of a company, issued as a form of non-cash compensation to the employees of the company. Restrictions on the option (such as vesting and limited transferability) attempt to align the holder's interest with those of the business' shareholders. If the company's stock rises, holders of options generally experience a direct financial benefit. This gives employees an incentive to behave in ways that will boost the company's stock price.

### **ESO**

Acronym used for Employee Share (or Stock) Option.

### **Black Economic Empowerment Deal**

Black economic empowerment deals, as it will be used in this report, refer to those types of transactions structured by listed South African companies to facilitate the transfer of a portion of their ordinary issued shares to South African individuals or groups who qualify under the Broad-Based Black Economic Empowerment Act of 2003. This Act requires a minimum percentage of the company to be black-owned in order to address the disproportionate distribution of wealth amongst racial groups in South Africa as part of the legacy of Apartheid.

### **BEE**

Acronym used for black economic empowerment.

### **Issuing Company**

The company that is doing the BEE deal to get the benefit in its BEE accreditation or the company that is issuing the ESO to its employees. In both cases the share price of the issuing company determines the value of the transaction when it is exercised by the holder.

## **Option Holders**

For the purpose of this report, option holders will refer to those groups or individual who are the beneficiaries of a BEE deal or those employees to whom ESO have been issued.

## **European Options**

Options that can only be exercised at maturity.

## **American Options**

Options that can be exercised anytime up to maturity.

## **Bermudan Options**

Options where exercise may only take place at certain time periods during the life of the option.

## **At-the-money**

When an option is at-the-money its spot price is such that it is equal to the strike of the option. For a call option, this would mean that the spot price is equal to the strike price. From here it can either go in-the-money or out-the-money.

## **In-the-money**

When a call option is in-the-money its spot price is higher than the strike price. Exercising the option would result in a positive value.

## **Out-the-money**

When a call option is out-the-money its spot price is lower than the strike price. Exercising the option would result in no value.

## **Over-the-counter**

Many financial instruments are traded on exchanges (JSE) where prices are made public. When two parties enter into a deal that does not happen on an exchange, this deal is said to be done over-the-counter (OTC).

## **Intrinsic value**

The intrinsic value of an option relates purely to the difference between the spot price and the strike price. Therefore, time value of money, pricing theory and structural issues of the option are not considered.



### **Fair-value**

The fair market value of financial instruments is not always apparent if the instrument is not trading on some exchange. The value refers to that price which a willing buyer and willing seller can agree on. It would require marking the instrument to the market by replicating it with instruments with known prices. This exercise produces a value that is referred to as fair-value.

Fair-value is the amount at which an equity instrument granted could be exchanged between knowledgeable, willing parties in an arm's length transaction. Market prices provide the best evidence of fair-value. Otherwise, a model is needed

### **Empowered**

A company that has taken the necessary steps to ensure that its level of black representation in a certain area of the company complies with the requirements is said to be empowered.

## LIST OF SYMBOLS

$S_t$	Underlying share price at time $t$
$K_t$	The strike at time $t$ . Since dividends may be used to repay the loan or interest may be charged on the outstanding loan amount, the strike could vary over the duration of the option.
$\sigma$	Annual volatility of the underlying share
$r$	The risk-free interest rate in the market on the valuation date. This rate will be obtained off the bond curve. It is assumed that this interest rate is compounded continuously (NACC).
$p$	The interest rate charged on the loan of the BEE deal. It is assumed that this interest rate is compounded continuously (NACC).
$q$	Dividend yield paid on the share. It is assumed that this is a NACC rate.
$T$	The term of the structure from its inception to the day on which any debt should be fully repaid.
$v$	Vesting term
$P_T$	Pay-off obtained when exercising an option at time $t$ .
$V(S,t)$	The value of an option on the underlying stock, $S$ , at time $t$ .
$\Pi$	The value of a hypothetical portfolio.
$N(x)$	The cumulative probability distribution function at $x$ of a standardised normal distribution.
$E[S_t]$	The expected value of the stock calculated at time $t$
$var(S_t)$	The variance of the stock calculated at time $t$
$\lambda$	The decay factor used in the exponentially weighted volatility calculation which expresses how much weight to give the new share price return in relation to the volatility up to that point
$\tau$	Marginal tax rate of the employee
$B_{us}$	Beta of the underlying asset. The beta refers to the degree by which the return on the underlying stock is correlated with the market.
$R_m$	Expected return of the market. The rate of return observed on a diversified portfolio.
$\sigma_m$	Risk of the market. The risk of the market is replicated by the volatility of the returns on the JSE All Share Index.

- $\sigma_T$  Total risk of the stock and more commonly known as the volatility of the stock.
- $\sigma_{us}$  Unsystematic risk of the stock. This is the portion of risk (volatility) on the underlying stock that can be diversified away by increasing the number of stocks in the portfolio

# CHAPTER 1

## 1 Introduction

In this chapter some background on Employee Share Options (ESOs) and Black Economic Empowerment (BEE) deals is provided and the need for uniquely tailored pricing models is established. The motivation for the research is discussed which relates to the extensive periods over which the deals are structured as well as the inefficient assignment of BEE credentials.

### 1.1 Background

Employee share options are issued as a form of non-cash compensation to the employees of the company in addition to their salaries or bonuses. The value is based on the difference between the level of the share price when the ESO is issued to the employee and when it is exercised some time thereafter. If the exercise price is less than the issue price, it has no value with no further obligation on the employee. Since there is not any downside risk for the employee his share option is similar to owning a call option on the stock of his employer. Restrictions on the option (such as vesting and limited transferability) attempt to align the holder's interest with those of the business' shareholders. If the company's stock rises, holders of options generally experience a direct financial benefit. This gives employees an incentive to behave in ways that will boost the company's stock price. There has been a substantial increase in the use of these instruments by corporations (Yermack (1994), Hall & Murphy (2003) & Van Zyl (2007)) over time and the focus it places on share price appreciation is sometimes criticised (Hall & Murphy (2002)).

Black economic empowerment (BEE) deals, as it will be discussed in this report, refer to those types of transactions structured by listed South African companies to facilitate the transfer of a portion of their ordinary issued share capital to South African individuals or groups who qualify under the Broad-Based Black Economic Empowerment Act of 2003 ("the Act"). This act requires a minimum percentage of the company to be black-owned in order to address the disproportionate distribution of wealth amongst racial groups in South Africa due to the legacy of Apartheid. These deals have emerged in the South African market after the Act came into effect as a way to expedite the sale of listed equities to black South Africans who do not have the capital to acquire it independently. Typical BEE transactions of listed companies also give

BEE partners a call option on the share price of the issuing company. They participate in the upside of the share beyond a certain level but not in the downside.

ESOs and BEE deals are similar in certain aspects:

- They can be classified as call options on the particular company's share price.
- The option lifetimes of both ESOs and BEE deals extend over several years.
- They cannot be traded freely as is the case with regular financial instruments since they are issued to very specific benefactors in order to achieve a particular objective for the issuing company. Therefore, they cannot be purchased by regular investors in the open market.
- The fair-values of these instruments cannot be obtained by calibrating them to similar traded options. Specific models are required to take the unique features into account to price them accurately.
- Apart from the fair-value, South African accounting rules also require companies to report additional details on their ESOs and BEE deals in their annual reports.

## 1.2 Objective

This report gives a comprehensive overview of the factors that influence BEE deals and ESOs from a South African perspective by looking at the fundamentals on which these instruments are based. The aim is to identify the critical issues regarding their structuring, valuation and use and to recommend enhancements for the South African market.

From an ESO point of view, the report specifically intends to use the extensive research that has been conducted on these instruments internationally to obtain a way of reducing the expense for South African firms and bring the cost incurred by the issuing companies more in line with the benefit that is derived from them by the employees.

Since BEE deals are a uniquely South African type of transaction which has only existed for a few years, the research on it is limited. The report sets out to establish the formal framework of these transactions from both a valuation and structural point of view. This will be used as basis to evaluate how the Act assigns BEE credits to companies who have initiated these deals and whether this process can be improved on.

Finally the information will be used to compare BEE deals and ESOs on a number of aspects.

### 1.3 Research outline

**Chapter 2** discusses the accounting framework that governs both BEE deals and ESOs. Since they are both classified as share-based payment transactions, their reporting needs to adhere to the requirements of IFRS 2.

IFRS 2 requires the fair-value of the relevant instrument to be expensed over the vesting period. To obtain the fair-value mathematical models are used for ESOs and BEE deals since there are not similar instruments that trade in the market. The similarities between ESOs and BEE deals suggest that they can be fair-valued with similar types of mathematical models. **Chapter 3** derives the commonly used models and looks at the appropriateness of each since the unique attributes of each transaction may lend itself towards a particular type of model.

In **Chapter 4** the inputs into pricing models are analysed. The sensitivity of the option value to these inputs is measured to assess how crucial any assumptions regarding the inputs are. Since BEE deals and ESOs are not traded, there is no standard with which to compare the prices produced by the models. This means that the correct use of the inputs is crucial.

The lack of conclusive research on the expected lifetime of these deals that span over several years requires a great deal of assumptions when pricing them. These are not done consistently and greatly affect the price. **Chapter 5** measures the impact of the details of the option structure as well as the specific assumption regarding the option holder's exercise behaviour on the price of the option.

The official use for the fair-value of the ESO and BEE transaction is illustrated in **Chapter 6** where the accounting expense is calculated over the vesting period.

The pricing framework being discussed in **Chapter 2** to **Chapter 6** covers both ESOs and BEE deals. The report turns its focus to ESOs specifically in **Chapter 7** and refers to its recent history, structure features and a few examples in the South African market of actual schemes.

Existing research on ESOs is extensive and covers all aspects of the field. The merits of a few solutions that have been suggested by other authors are considered in **Chapter 8** which looks at ways to incorporate the exercise behaviour of the employees into the ESO price.

**Chapter 9** views some of the structural shortcomings in existing ESOs and the alternatives that have been recommended. This is measured against whether the ESO scheme meets the objective it was set out to achieve.

In **Chapter 10** the focus turns to BEE deals looking at their background and examining the social-political environment that gave rise to their existence. It then turns to the deals of a few of the major listed South African companies and analyses how they have performed since their inception.

**Chapter 11** looks at some of the issues that have been raised with the current way in which ownership BEE credits are assigned to companies. The BEE credit assigning process does not consider the individual transactions but focuses on the latest level of black shareholding in the company.

In **Chapter 12** a potential alternative methodology to use in assigning BEE credits will be discussed. It is based on the fair-value of the deal and will be used as basis to compare individual BEE transactions.

**Chapter 13** focuses on a specific aspect of these deals when the purchase of the BEE shares is funded by a third party. Funding risk is discussed and establishing an adequate cover ratio examined.

Conclusions are highlighted in **Chapter 14** and BEE deals and ESOs compared on a number of key areas.

The aspects that are covered aim to bring the reader up to date with latest developments in the field.

## CHAPTER 2

### 2 IFRS 2

#### 2.1 Chapter Overview

This chapter gives a brief overview of the accounting framework that governs share-based payments and explains why ESOs and BEE deals need to be valued in the first place. It also states the accounting requirements for these types of transactions.

#### 2.2 Introduction

The International Financial Reporting Standards (IFRS) are principles-based Standards and Interpretations that have been adopted by the International Accounting Standards Board (IASB). In February 2004 it issued IFRS 2 *Share Based Payment*. This standard governs the accounting of share based financial instruments under which the following three types of transactions are identified (IFRS 2.2):

- equity-settled share-based payment transactions, in which the entity receives goods or services as consideration for equity instruments of the entity (including shares or share options);
- cash-settled share-based payment transactions, in which the entity acquires goods or services by incurring liabilities to the supplier of those goods or services for amounts that are based on the price (or value) of the entity's shares or other equity instruments of the entity. Transactions involving share appreciation rights (SARs) fall into this category; and
- transactions in which the entity receives or acquires goods or services and the terms of the arrangement provide either the entity or the supplier of those goods or services with a choice of whether the entity settles the transaction in cash (or other assets) or by issuing equity instruments.

IFRS 2 states that these instruments need to be accounted for at their fair market value in the audited financial statements. This is done in order to assign the associated cost (Bodie, Kaplan & Merton (2003)). The fair market value or fair-value refers to the price at which an instrument would reach a willing buyer and willing seller if the instrument had been tradable. For a liquid instrument that trades on an exchange, a recently concluded deal would imply the fair-value of



such an instrument. Many instruments that have value do however not trade on an exchange and the fair-value is far from apparent. These instruments need to be priced by appropriately qualified professionals (Financial Engineers) who are familiar with the relevant techniques that can be used to calculate a fair market value for the instrument.

The cost of the derivative (ESO or BEE deal) and its perceived value to the holder (employee or BEE participant) are generally not the same. The cost of the derivative is the amount of money needed to issue the eventual holder with a call option on the underlying share. This can also be interpreted as the compensation that a third party would require to take over the liability associated with the derivative. The value to the holder is his perceived discounted payoff. IAS 39 requires South African companies to account for the value of these instruments through the employees' eyes even though it is handled as a cost to the company. The reason for this is to bring the value of the incentive given to the holder in line with its cost.

In 1994 the Financial Accounting Standards Board (FASB) started to require that firms calculate and recognize as a cost the value of employee stock options at the time those options are granted. This was considered highly controversial at the time (Kulatilaka & Marcus (1994)). The requirement to indicate the intrinsic value of these options led to the use of issuing the option at-the-money to ensure that they will not have any accounting implication.

The dramatic fall (and rise) in technology stocks would surely not have been as severe had the expenses relating to ESOs been reported more conservatively and if investors had been aware which portion of companies' expenses were in the form of employee stock options. Aboody (1996) finds a negative correlation between the value of outstanding options and a firm's share price. In 2004 the International Accounting Standards Board (IASB) issued IFRS 2 which required more detailed reporting on derivatives and through this provides investors with a better picture of the companies they were investing in.

The publishing of *IFRS 2 Share-based Payments* in 2004 laid down specific guidelines on how the share based payment should be handled from an accounting point of view that was not apparent from the initial IFRS. The primary aim was to reflect the expenses associated with options accurately. Prior to it being published, companies reported a zero value for the ESOs. This happened when the share options were issued at-the-money (strike price equals spot price) with no intrinsic value. Only in applying option theory which recognized the potential value to the option holder, would the value in the share option have been indicated.

Black Economic Empowerment is a relatively new concept and has always been in existence with the more stringent requirements of IFRS 2. Since the value of such a transaction is determined by the performance of a reference asset it is also governed by the standard.

The essence of what IFRS 2 (International Accounting Standards Board (2004)) requires in terms of accounting for share-based payments is as follows:

- The fair-value of the derivative has to be determined as accurately as possible and expensed.
- Expensing of the instrument should take place over its vesting period.
- Equity settled instruments are to be fair-valued once at inception.
- Cash-settled instruments are to be valued each time the company publishes its results.
- All the models used in valuing the instruments and the inputs that are used in the models should aim to replicate the value of the instruments if they had been trading in the market.
- The results of this expense have to appear in the published results of the issuing company.

### **2.3 Conclusion**

IFRS 2 has governed the accounting requirements of all share-based payments under which ESOs and BEE deals fall since 2004. It requires the following:

- The fair-value of the derivative has to be expensed over its vesting period.
- Equity settled instruments must be priced once at inception while cash-settled instruments are to be valued each time the company publishes its results.
- All the models used in valuing the instruments and the inputs that are used in the models should aim to replicate the value of the instruments if they had been trading in the market.
- The results of this expense have to appear in the published results of the issuing company.

## CHAPTER 3

### 3 Pricing Models

#### 3.1 Chapter Overview

Chapter 2 established the need for ESOs and BEE deals to be priced. In this chapter the models that are used in the pricing of ESOs and BEE deals are considered. The following models are derived which illustrates the assumptions underlying them:

- Black-Scholes
- Binomial Model
- Finite Difference Method using the Crack-Nicholson approach
- Monte Carlo Simulation

For each model its applicability in valuing different kinds of options are discussed.

#### 3.2 Introduction

Under IFRS 2 (International Accounting Standards Board (2004)) ESOs and BEE deals need to be expensed in the financial statements of the issuing company at fair-value. Since they are not tradable and because there exists no tradable instruments that can be used to deduce a market-related fair-value for them in a straightforward manner, some work has to be put into calculating a price that could be viewed as fair. For this reason specific pricing models are required. These mathematical models aim to take all the aspects of the structures into consideration in estimating a fair market price. Considerable effort has gone into the development and subsequent refinement of these models. Due to the different features in the various models they may be more appropriate to price certain structures and less so for others. The similarities in most ESOs allow the use of standard models while the unique features of some BEE deals might require more customization.

Early option pricing methods were much more simplistic (before the Black & Scholes (1973) model become popular) compared to what is commonly used today. Smith & Zimmerman (1976) suggested that instead of recording the value of the option at the difference between the current stock price and the exercise price of the option, to value the option at the difference between the current stock price and the discounted exercise price. Such an approach does not account for the optionality-feature in ESOs which may contain significant value.

Rubinstein (1995) reports that there was a public outcry when American firms were initially forced to provide details of the value of their stock option plans through more sophisticated mathematical models. In some sectors (high-tech) firms would report a 25% reduction in earnings per share. This illustrates the significant increase in option values from using the more comprehensive mathematical methods.

The main inputs used by the models are as follows:

$S_t$	Underlying share price at time $t$
$K_t$	The strike at time $t$ . Since dividends may be used to repay the loan or interest may be charged on the outstanding loan amount, the strike could vary over the duration of the option.
$\sigma$	Annual volatility of the underlying share
$r$	The risk-free interest rate in the market on the valuation date. This rate will be obtained off the bond curve. It is assumed that this interest rate is compounded continuously (NACC).
$p$	The interest rate charged on the loan of the BEE deal. It is assumed that this interest rate is compounded continuously (NACC).
$q$	Dividend yield paid on the share. It is assumed that this is a NACC rate.
$T$	The term of the structure from its inception to the day on which any debt should be fully repaid.
$v$	Vesting term.

It is worth noting that since neither ESOs nor BEE deals can be traded, mispricing them will not lead directly to a loss as would be the case when quoting an incorrect price for an actively traded instrument. Prudent market participants would recognise such a mispriced instrument and quickly move to take advantage of the arbitrage opportunity. For ESOs and BEE deals a correct price ensures that these transactions are expensed correctly and that the information published in the annual statements of the company do indeed give an accurate reflection of the position of the company.

This chapter introduces the models most appropriate in the valuing of ESOs and BEE deals.

### 3.3 Black-Scholes

IFRS 2 recognises the Black-Scholes (Black & Scholes (1973)) model to obtain fair-values for share-based payments. It is a mathematical model for the price of an option on an equity, in which the underlying equity's price follows a stochastic process. This model is ideal for valuing European options and a solution is available in a closed form that makes the pricing of the derivative almost trivial (if the inputs can be obtained).

In this section (3.3) the work of Bjork (2004), Hull (2003) and Wilmott (2006) are combined and condensed in such a way to illustrate the fundamentals on which the Black-Scholes model is based.

#### 3.3.1 Nature of the Stock Price

It is assumed that the underlying stock's movement ( $X_t$ ) can be described by a Geometric Brownian motion process. Under this process, the stock has a drift of  $\mu$  and a volatility of  $\sigma$  driven by a Wiener process. The Wiener process has a probability density function

$$f_{W_t}(x) = \frac{1}{\sqrt{2\pi t}} e^{-\frac{x^2}{2t}} \quad (1)$$

and has the following normal distribution

$$W_t \sim N(0, t). \quad (2)$$

The stock is therefore described by the process

$$dX_t = \mu X_t dt + \sigma X_t dW_t. \quad (3)$$

We now set

$$F = Y_t = \ln X_t. \quad (4)$$

From Itô's lemma it can be deduced that

$$dF = \frac{\partial F}{\partial t} dt + \frac{\partial F}{\partial x} dX_t + \frac{1}{2} \cdot \frac{\partial^2 F}{\partial x^2} dX_t^2 \quad (5)$$

$$\therefore dY_t = \frac{\partial Y_t}{\partial t} dt + \frac{\partial Y_t}{\partial x} dX_t + \frac{1}{2} \cdot \frac{\partial^2 Y_t}{\partial x^2} dX_t^2 \quad (6)$$

$$dY_t = 0 dt + \frac{1}{X_t} dX_t + \frac{1}{2} \cdot \frac{-1}{X_t^2} dX_t^2 \quad (7)$$

$$dY_t = \frac{1}{X_t} (\mu X_t dt + \sigma X_t dW_t) - \frac{1}{2} \cdot \frac{1}{X_t^2} (\mu X_t dt + \sigma X_t dW_t)^2 \quad (8)$$

$$dY_t = \mu dt + \sigma dW_t - \frac{1}{2} \mu (dt)^2 - \mu \sigma dt \cdot dW_t - \frac{1}{2} \sigma^2 (dW_t)^2. \quad (9)$$

Since  $(dt)^2$  and  $dt \cdot dW_t$  are negligible compared to  $dt$  we have that

$$(dt)^2 = 0 \quad (10)$$

$$dt \cdot dW_t = 0. \quad (11)$$

Furthermore, in the limit

$$(dW_t)^2 = dt. \quad (12)$$

Which means that (9) becomes

$$dY_t = \mu dt + \sigma dW_t - \frac{1}{2} \sigma^2 dt \quad (13)$$

$$dY_t = \left( \mu - \frac{1}{2} \sigma^2 \right) dt + \sigma dW_t. \quad (14)$$

Since  $\mu$  and  $\sigma$  are constants it means that  $Y_t = \ln X_t$  follows a generalised Wiener process with a constant drift of  $\mu - \frac{1}{2} \sigma^2$  and a constant variance of  $\sigma$ . This means that

$$\ln S_T - \ln S_0 \sim \phi \left[ \left( \mu - \frac{1}{2} \sigma^2 \right) T, \sigma \sqrt{T} \right] \quad (15)$$

$$\ln S_T \sim \phi \left[ \ln S_0 + \left( \mu - \frac{1}{2} \sigma^2 \right) T, \sigma \sqrt{T} \right]. \quad (16)$$

Where  $\phi(m, s)$  represents a normal distribution with mean  $m$  and standard deviation  $s$ . Since  $\ln S_T$  is normally distributed,  $S_T$  is lognormally distributed. Note that  $\ln S_T - \ln S_0$  is merely  $\ln \frac{S_T}{S_0}$  which is the natural logarithm of the return on  $S$  over  $[0, T]$ .

Integrating (14) gives

$$Y_t = \int_0^t dY_s = \int_0^t \left( \left( \mu - \frac{1}{2} \sigma^2 \right) ds + \sigma dW_s \right) \quad (17)$$

$$Y_t = \int_0^t \left( \mu - \frac{1}{2} \sigma^2 \right) ds + \int_0^t \sigma dW_s \quad (18)$$

$$Y_t = Y_0 + \left( \mu - \frac{1}{2} \sigma^2 \right) t + \sigma W_t. \quad (19)$$

Substituting the result back into (4) gives

$$X_t = e^{Y_0 + \left( \mu - \frac{1}{2} \sigma^2 \right) t + \sigma W_t} \quad (20)$$

$$\therefore X_t = X_0 e^{\left( \mu - \frac{1}{2} \sigma^2 \right) t + \sigma W_t}. \quad (21)$$

Reverting back to the notation established at the start of this chapter, (21) becomes

$$S_t = S_0 e^{\left( \mu - \frac{1}{2} \sigma^2 \right) t + \sigma W_t}. \quad (22)$$

### 3.3.2 Risk-Neutral Portfolio

In order to use the result in equation 22 which describes the behaviour of the price of a stock, the framework needs to be expanded to simulate the portfolio of an investor. To do this, a few additional parameters are used:

- $V(S,t)$  The value of an option on the underlying stock,  $S$ , at time  $t$   
 $\Pi$  The value of a hypothetical portfolio

A portfolio,  $\Pi$ , is established in which an investor is long the option and short some quantity,  $\Delta$ , of the underlying stock,

$$\Pi = V(S, t) - \Delta S. \quad (23)$$

$S$ , the underlying stock, follows a log normal random walk process

$$dS_t = \mu S_t dt + \sigma S_t dW_t. \quad (24)$$

Since both the long position in the option and the short position in the stock are functions of the value of the price of the stock, the portfolio will be affected by a change in the stock price

$$d\Pi = dV(S, t) - \Delta dS. \quad (25)$$

Once again Itô's lemma is used to obtain  $d\Pi$  by differentiating  $V$ .

$$dV = \frac{\partial V}{\partial t} dt + \frac{\partial V}{\partial S} dS + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} dS^2 \quad (26)$$

This means that the change in the value of the portfolio becomes

$$d\Pi = \frac{\partial V}{\partial t} dt + \frac{\partial V}{\partial S} dS + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} dS^2 - \Delta dS \quad (27)$$

$$d\Pi = \frac{\partial V}{\partial t} dt + \left( \frac{\partial V}{\partial S} - \Delta \right) dS + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} dt. \quad (28)$$

By choosing the quantity of stock such that

$$\Delta = \frac{\partial V}{\partial S} \quad (29)$$

the middle term in (29) falls away and leaves

$$d\Pi = \frac{\partial V}{\partial t} dt + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} dt \quad (30)$$

$$d\Pi = \left( \frac{\partial V}{\partial t} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} \right) dt \quad (31)$$

By choosing  $\Delta$  as we have done, the portfolio has become completely riskless as  $d\Pi$  contains no random element. However, it assumes that any fraction of the stock can be traded. Since the portfolio is riskless, the return we would expect to make on it would be similar to investing the same amount of cash at the risk-free interest rate

$$\therefore d\Pi = r\Pi dt. \quad (32)$$

By substituting (29) in (23), this result together with (31) in (32), produces

$$\left( \frac{\partial V}{\partial t} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} \right) dt = r \left( V - \frac{\partial V}{\partial S} S \right) dt. \quad (33)$$

This can be simplified to

$$\frac{\partial V}{\partial t} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} - rV = 0. \quad (34)$$

This is the Black-Scholes partial differential equation (Black & Scholes (1973)). Obtaining the result required a number of assumptions:

- The price of the underlying instrument,  $S_t$ , follows a Wiener process,  $W_t$ , with constant drift  $\mu$  and volatility  $\sigma$ , and the price changes are log-normally distributed:

$$dS_t = \mu dS_t dt + \sigma dS_t W_t \quad (35)$$

- It is possible to short sell the underlying stock.
- There are no arbitrage opportunities in the market.
- Trading in the stock is continuous.
- There are no transaction costs or taxes.
- All securities are perfectly divisible (e.g. it is possible to buy any fraction of a share).
- It is possible to borrow and lend cash at a constant risk-free interest rate.
- The stock does not pay dividends

### 3.3.3 Adding Dividends

The assumption that the stock does not pay dividends is not very realistic. We now incorporate a continuous dividend yield,  $q$ , that is paid on the stock. Over a short time period,  $dt$ , dividends on the stock,  $D$ , will therefore be

$$D = qSdt. \quad (36)$$

Referring back to the initial portfolio in which we were short  $\Delta$  of the stock, means that the total dividends become

$$-\Delta D = -\Delta qSdt \quad (37)$$

If this is substituted back into the initial derivation (27) becomes

$$d\Pi = \frac{\partial V}{\partial t} dt + \frac{\partial V}{\partial S} dS + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} dS^2 - \Delta dS - \Delta qSdt. \quad (38)$$

Following the same process as before (33) now becomes



$$\left(\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2}\right) dt = r\left(V - \frac{\partial V}{\partial S} S\right) dt - q\left(\frac{\partial V}{\partial S} S\right) dt \quad (39)$$

which reduces to

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + (r - q)S \frac{\partial V}{\partial S} - rV = 0. \quad (40)$$

### 3.3.4 Solving the PDE

A number of techniques can be used to solve the PDE. In this instance the approach first introduced by Feynman & Kac (1959) will be considered. This method establishes a link between PDEs and stochastic processes. Consider a PDE of the form

$$\frac{\partial f}{\partial t} + \mu(x, t) \frac{\partial f}{\partial x} + \frac{1}{2}\sigma^2(x, t) \frac{\partial^2 f}{\partial x^2} = B(x, t)f \quad (41)$$

defined for all real  $x$  and  $t$  on the interval  $[0, T]$ , with a terminal condition

$$f(x, T) = \psi(x). \quad (42)$$

If  $\mu, \sigma, \psi$  and  $B$  are known functions and  $X$  satisfies the SDE

$$dX_\tau = \mu(X_\tau, \tau)d\tau + \sigma(X_\tau, \tau)dW_\tau \quad (43)$$

and

$$X_\tau = x \quad (44)$$

then the solution of the PDE can be written as an expectation of the form

$$f(x, t) = E \left[ e^{-\int_t^T B(X_\tau) d\tau} \psi(X_T) \middle| X_t = x \right]. \quad (45)$$

To solve the Black-Scholes PDE the formula in (40) is written in the same format as (41)

$$\frac{\partial V}{\partial t} + (r - q)S \frac{\partial V}{\partial S} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} = rV. \quad (46)$$

Since the underlying stock follows a lognormal random walk process, it is known that

$$dS_t = \mu_t S_t dt + \sigma_t S_t dW_t. \quad (47)$$

For a call option the pay-off at maturity is

$$V(S, T) = \psi(S) = \max(S - K, 0) \quad (48)$$

and

$$B(S, t) = r. \quad (49)$$

This means that Feynman-Kac gives the solution to the PDE as

$$V(S, t) = E_{S,t} [e^{-\int_t^T r d\tau} \psi(S_T)] \quad (50)$$

with

$$S_T = S_t e^{\left(r - q - \frac{1}{2}\sigma^2\right)(T-t) + \sigma(W_T - W_t)} \quad (51)$$

and

$$\ln S_T \sim \phi \left[ \left( r - q - \frac{1}{2} \sigma^2 \right) (T - t), \sigma \sqrt{(T - t)} \right]. \quad (52)$$

The formula in (50) can be reduced to

$$V(S, t) = e^{-(T-t)r} E_{S,t}[\psi(S_T)] \quad (53)$$

and then becomes

$$V(S, t) = e^{-(T-t)r} \int_{-\infty}^{\infty} \psi \left( S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)+\sigma z} \right) f(z) dz. \quad (54)$$

This is obtained by viewing  $f$  as the density function of  $Z$  and applying the rule for calculating expected values,

$$E_y[G(y)] = \int_{-\infty}^{\infty} G(y) f(y) dy. \quad (55)$$

Incorporating the pay-off function, (48), into (53) produces

$$E_{S,t}[\psi(S_T)] = E_{S,t}[\max(S - K, 0)]. \quad (56)$$

This means that

$$\psi(S_T) = S - K \text{ if } S \geq K \quad (57)$$

and

$$\psi(S_T) = 0 \text{ if } S < K. \quad (58)$$

Expanding  $S$ , (57) and (58) give

$$S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)+\sigma z} \geq K \text{ or } z \geq \frac{\ln \frac{K}{S_t} - (r-q-\frac{1}{2}\sigma^2)(T-t)}{\sigma} \quad (59)$$

and

$$S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)+\sigma z} < K \text{ or } z < \frac{\ln \frac{K}{S_t} - (r-q-\frac{1}{2}\sigma^2)(T-t)}{\sigma} \quad (60)$$

respectively. Let

$$\varphi = \frac{\ln \frac{K}{S_t} - (r-q-\frac{1}{2}\sigma^2)(T-t)}{\sigma}. \quad (61)$$

This causes the integral in (54) to become

$$\int_{\varphi}^{\infty} \left( S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)+\sigma z} - K \right) f(z) dz + \int_{-\infty}^{\varphi} 0 f(z) dz \quad (62)$$

which reduces to

$$\int_{\varphi}^{\infty} S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)+\sigma z} f(z) dz - \int_{\varphi}^{\infty} K f(z) dz. \quad (63)$$

Since  $Z$  is a Wiener process normally distributed as in (2) with the probability density function in (1), the **first term** in (63) can be written as

$$\int_{\varphi}^{\infty} S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)+\sigma z} \frac{1}{\sqrt{2\pi(T-t)}} e^{-\frac{z^2}{2(T-t)}} dz. \quad (64)$$

This is equal to

$$\frac{S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)}}{\sqrt{2\pi(T-t)}} \int_{\varphi}^{\infty} e^{\sigma z - \frac{z^2}{2(T-t)}} dz. \quad (65)$$

Using the substitution

$$y = \frac{z}{\sqrt{T-t}} \quad (66)$$

where

$$dy = \frac{dz}{\sqrt{T-t}} \quad (67)$$

the formula in (65) changes to

$$\frac{S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)}}{\sqrt{2\pi}} \int_{\frac{\varphi}{\sqrt{T-t}}}^{\infty} e^{\sigma y \sqrt{T-t} - \frac{y^2}{2}} dy. \quad (68)$$

By completing the square, (68) becomes

$$\frac{S_t e^{(r-q-\frac{1}{2}\sigma^2)(T-t)}}{\sqrt{2\pi}} \int_{\frac{\varphi}{\sqrt{T-t}}}^{\infty} e^{-\frac{1}{2}(y-\sigma\sqrt{T-t})^2 + \frac{1}{2}\sigma(T-t)} dy \quad (69)$$

which then reduces to

$$\frac{S_t e^{(r-q)(T-t)}}{\sqrt{2\pi}} \int_{\frac{\varphi}{\sqrt{T-t}}}^{\infty} e^{-\frac{1}{2}(y-\sigma\sqrt{T-t})^2} dy. \quad (70)$$

Applying another substitution of

$$v = y - \sigma\sqrt{T-t} \quad (71)$$

where

$$dv = dy, \quad (72)$$

gives

$$\frac{S_t e^{(r-q)(T-t)}}{\sqrt{2\pi}} \int_{\frac{\varphi}{\sqrt{T-t}} - \sigma\sqrt{T-t}}^{\infty} e^{-\frac{1}{2}v^2} dv \quad (73)$$

which can be recognised as

$$S_t e^{\mu(T-t)} \int_{-\infty}^{\frac{\varphi - \sigma(T-t)}{\sqrt{T-t}}} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}v^2} dv. \quad (74)$$

Since it is in the form of a standardised cumulative normal distribution function, (74) can be expressed as

$$S_t e^{(r-q)(T-t)} N\left(\frac{\sigma(T-t) - \varphi}{\sqrt{T-t}}\right). \quad (75)$$

Going back to the **second term** in (63) and using the characteristics of a Wiener process, the formula can be expanded to

$$\int_{\varphi}^{\infty} K \frac{1}{\sqrt{2\pi(T-t)}} e^{\frac{-z^2}{2(T-t)}} dz. \quad (76)$$

Using the same substitution as in (66), (76) now becomes

$$K \int_{\frac{\varphi}{\sqrt{T-t}}}^{\infty} \frac{1}{\sqrt{2\pi}} e^{\frac{-1}{2}y^2} dy. \quad (77)$$

This can be written as

$$K \int_{-\infty}^{\frac{-\varphi}{\sqrt{T-t}}} \frac{1}{\sqrt{2\pi}} e^{\frac{-1}{2}y^2} dy \quad (78)$$

which is equal to

$$KN\left(\frac{-\varphi}{\sqrt{T-t}}\right). \quad (79)$$

Substituting (75) and (79) into (63) and then into (54) gives

$$e^{-r(T-t)} \left( S_t e^{(r-q)(T-t)} N\left(\frac{\sigma(T-t) - \varphi}{\sqrt{T-t}}\right) - KN\left(\frac{-\varphi}{\sqrt{T-t}}\right) \right). \quad (80)$$

This becomes

$$S_t e^{-q(T-t)} N\left(\frac{\sigma(T-t) - \varphi}{\sqrt{T-t}}\right) - K e^{-r(T-t)} N\left(\frac{-\varphi}{\sqrt{T-t}}\right) \quad (81)$$

which is written as

$$V(S, t) = S_t e^{-q(T-t)} N(d_1) - K e^{-r(T-t)} N(d_2) \quad (82)$$

where

$$\begin{aligned} d_1 &= \frac{\sigma(T-t) - \varphi}{\sqrt{T-t}} = \frac{\sigma(T-t)}{\sqrt{T-t}} - \frac{\ln \frac{K}{S_t} - \left(r - q - \frac{1}{2}\sigma^2\right)(T-t)}{\sigma\sqrt{T-t}} \\ &= \frac{\sigma^2(T-t) + \ln \frac{S_t}{K} + (r-q)(T-t) - \frac{1}{2}\sigma^2(T-t)}{\sigma\sqrt{T-t}} \\ &= \frac{\left(r - q + \frac{1}{2}\sigma^2\right)(T-t) + \ln \frac{S_t}{K}}{\sigma\sqrt{T-t}} \end{aligned} \quad (83)$$

and

$$\begin{aligned}
 d_2 &= \frac{-\phi}{\sqrt{T-t}} = -\frac{\ln \frac{K}{S_t} - \left(r - q - \frac{1}{2}\sigma^2\right)(T-t)}{\sigma\sqrt{T-t}} \\
 &= \frac{\left(r - q - \frac{1}{2}\sigma^2\right)(T-t) + \ln \frac{S_t}{K}}{\sigma\sqrt{T-t}}.
 \end{aligned} \tag{84}$$

The Black-Scholes formula for a call option on a dividend paying stock has thus been derived as

$$C(S, t) = S_t e^{-q(T-t)} N(d_1) - K e^{-r(T-t)} N(d_2) \tag{85}$$

where

$$d_1 = \frac{\left(r - q + \frac{1}{2}\sigma^2\right)(T-t) + \ln \frac{S_t}{K}}{\sigma\sqrt{T-t}} \tag{86}$$

and

$$d_2 = \frac{\left(r - q - \frac{1}{2}\sigma^2\right)(T-t) + \ln \frac{S_t}{K}}{\sigma\sqrt{T-t}}. \tag{87}$$

This can be converted into the better known (but less generic) formula for non-dividing paying stocks by setting the dividend yield,  $q$ , to zero and produces

$$C_{q=0}(S, t) = S_t N(d_1) - K e^{-r(T-t)} N(d_2) \tag{88}$$

where

$$d_1 = \frac{\left(r + \frac{1}{2}\sigma^2\right)(T-t) + \ln \frac{S_t}{K}}{\sigma\sqrt{T-t}} \tag{89}$$

and

$$d_2 = \frac{\left(r - \frac{1}{2}\sigma^2\right)(T-t) + \ln \frac{S_t}{K}}{\sigma\sqrt{T-t}}. \tag{90}$$

where  $N(x)$  is the cumulative probability distribution function of a standardised normal distribution.

The Black–Scholes model revolutionised option trading as it made it possible for non-mathematicians to obtain a price for a vanilla option that is calibrated to the market. Its application has become widespread and the principles are used throughout the option pricing environment.

The assumptions underlying the model implicates that the price produced by the model cannot be used as it is. Some method of calibrating the price to the market is required. One such a method is to use an implied volatility<sup>1</sup> which forces the price obtained by the model to be in agreement with the price of a similar traded option in the market.

### **3.3.5 Pricing ESOs and BEE Deals**

The inputs used by the standard Black–Scholes model are not sufficient to describe the transactions extensively. An obvious missing parameter is the vesting period ( $v$ ), which refers to the period that the option holder must wait before s/he can start to exercise the option. When the assumption is made that the option will only be exercised close to the maturity of the deal, the impact of the vesting period is greatly reduced and the Black–Scholes model is often used when pricing ESOs under this assumption.

BEE deals are often complicated by the variable strike. Due to the strike being a function of the initial debt, dividends and interest on the loan, this model would not capture a crucial element of the fair-value of the option.

### **3.3.6 Pricing Suitability**

The issues highlighted with this model are significant but does not necessarily preclude the use of the model in pricing ESOs or BEE deals. There are cases where the details of the agreement are such that the price will not be adversely affected compared to other more complicated models. This will be the case when the option is effectively European by nature.

However, this does not preclude the use of the Black-Scholes model for valuing American call options as Cassimon, Engelen, Thomassen, & Van Wouwe, M. (2006), Roll (1977), Geske (1979a), Whaley (1981) and Geske (1981) showed.

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<sup>1</sup> See section 4.3.4.2

### 3.4 Binomial Tree

Binomial tree models first established by Cox, Ross & Rubinstein (1979) are versatile with respect to the range of options they can price. Options that can be exercised at any point in its lifetime compared with those that can only be exercised at maturity, offers more freedom to the option holder and should be priced accordingly. These options have an American-nature for which there often are no closed-form solutions and may be easily priced using the fundamentals of a binomial tree. The basics of the model are consistent with that of the Black–Scholes model which means that many of the assumptions relating to the Black–Scholes model also apply to the binomial tree method.

The binomial pricing model uses a "discrete-time framework" to trace the evolution of the option's key underlying variable via a binomial lattice (tree), for a given number of time steps between valuation date and option expiration. Each node in the lattice represents a possible value of the underlying reference asset, at a particular point in time. The model assumes that movements in the price follow a binomial distribution over a short period of time. For many time steps, this binomial distribution approaches the normal distribution assumed by Black-Scholes.

This price evolution forms the basis for the option valuation. In short, it works by developing a grid of share prices from the valuation date to the maturity date and then calculates option values backwards from the maturity of the option to the valuation date. The size of the grid is a function of the number of time steps used. Each step will represent a period equal to Term/Steps. Valuing the option in this way can be set out in three steps:

- Price tree generation;
- Calculation of option value at each final node;
- Progressive calculation of option value at each earlier node; the value at the first node is the value of the option.

In developing the binomial model of Cox, Ross & Rubenstein (1979) in the section that follows, selective segments of the literature published by Hull (2003), Wilmott (2006), Kerman (2002) and Swart (2007) are used.

### 3.4.1 Establishing the Model

In discussing the binomial model, the following symbols will be used:

- $p$  The probability of an upward movement of the share price
- $u$  The relative size of the upward movement in the share price
- $d$  The relative size of the downward movement in the share price

The formula in (22) shows that the stock price's behaviour over the period,  $[0,t]$ , has a deterministic portion,  $(\mu - \frac{1}{2}\sigma^2)t$ , as well as a random portion,  $\sigma W_t$ . The expected value of the stock,

$$E[S_t] = E[S_0 e^{(\mu - \frac{1}{2}\sigma^2)t + \sigma W_t}], \quad (91)$$

can be calculated by recognising that the Wiener process follows the normal distribution described in (2). This means that (91) can be expressed as

$$\int_{-\infty}^{\infty} S_0 e^{(\mu - \frac{1}{2}\sigma^2)t + \sigma x} \frac{1}{\sqrt{2\pi t}} e^{-\frac{x^2}{2t}} dx. \quad (92)$$

By following the same logic as was used in transforming (64) to (75), it can be shown that (92) is equivalent to

$$S_0 e^{\mu t} \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}y^2} dy \quad (93)$$

which reduces to

$$S_0 e^{\mu t}. \quad (94)$$

The expected share price at time  $t$  can be expressed in terms of the discrete binomial model as

$$E[S_t] = puS_0 + (1 - p)dS_0 \quad (95)$$

which means that

$$puS_0 + (1 - p)dS_0 = S_0 e^{\mu t}. \quad (96)$$

By rearranging (96)

$$p = \frac{e^{\mu t} - d}{u - d} \quad (97)$$

is obtained. The variance of  $S_t$  is obtained by recognizing that

$$\text{var}(S_t) = E[S_t^2] - E[S_t]^2. \quad (98)$$

Consider the first term on the right of equation (98) which can be expressed as

$$E[S_t^2] = p(uS_0)^2 + (1 - p)(dS_0)^2 = pu^2S_0^2 + (1 - p)d^2S_0^2 \quad (99)$$

in terms of the discrete model. Under the continuous model



$$E[S_t^2] = E\left[\left(S_0 e^{(\mu - \frac{1}{2}\sigma^2)t + \sigma W_t}\right)^2\right] \quad (100)$$

which can be shown to be equal to

$$S_0^2 e^{(2\mu + \sigma^2)t}. \quad (101)$$

By setting the discrete and continuous models for  $E[S_t^2]$  equal to each other,

$$pu^2 S_0^2 + (1-p)d^2 S_0^2 = S_0^2 e^{(2\mu + \sigma^2)t} \quad (102)$$

is obtained which reduces to

$$pu^2 + (1-p)d^2 = e^{(2\mu + \sigma^2)t} \quad (103)$$

and then to

$$p = \frac{e^{(2\mu + \sigma^2)t} - d^2}{u^2 - d^2}. \quad (104)$$

To solve the unknown variables in equations (97) and (104) the assumption is made that

$$ud = 1. \quad (105)$$

This implies that the share price in a binomial tree will converge to its original level if an up-movement is followed by a down movement or vice versa. By setting (97) and (104) equal to each other

$$\frac{e^{\mu t} - d}{u - d} = \frac{e^{(2\mu + \sigma^2)t} - d^2}{u^2 - d^2} = \frac{e^{(2\mu + \sigma^2)t} - d^2}{(u - d)(u + d)} \quad (106)$$

is produced which can be expressed as

$$e^{\mu t} u - du + e^{\mu t} d - d^2 = e^{(2\mu + \sigma^2)t} - d^2. \quad (107)$$

The  $d$ -variable can be removed from the (107) by substituting (105) to produce

$$e^{\mu t} u - 1 + \frac{e^{\mu t}}{u} = e^{(2\mu + \sigma^2)t}. \quad (108)$$

The equation in (108) can be converted into a quadratic function in  $u$  by multiplying it by

$$e^{-\mu t} u \quad (109)$$

and expressing it as

$$u^2 - (e^{(\mu + \sigma^2)t} + e^{-\mu t})u + 1 = 0. \quad (110)$$

The solution to  $u$  is simply

$$u = \frac{(e^{(\mu + \sigma^2)t} + e^{-\mu t}) \pm \sqrt{(e^{(\mu + \sigma^2)t} + e^{-\mu t})^2 - 4}}{2}. \quad (111)$$

The square root in (111) becomes

$$\sqrt{e^{2(\mu + \sigma^2)t} + 2e^{(\mu + \sigma^2)t - \mu t} + e^{-2\mu t} - 4} \quad (112)$$

which is equal to

$$\sqrt{e^{2(\mu+\sigma^2)t} + 2e^{\sigma^2t} + e^{-2\mu t} - 4}. \quad (113)$$

This can be simplified by using Taylor's theorem for expanding a function,

$$e^x = 1 + x + \frac{x^2}{2} + \dots \quad (114)$$

In this way (113) becomes

$$\sqrt{1 + 2(\mu + \sigma^2)t + \frac{(2(\mu + \sigma^2)t)^2}{2} + 2\left(1 + \sigma^2t + \frac{(\sigma^2t)^2}{2}\right) + 1 + (-2\mu t) + \frac{(-2\mu t)^2}{2} - 4}. \quad (115)$$

which reduces to

$$\sqrt{1 + 2\mu t + 2\sigma^2t + \frac{1}{2}(2\mu t + 2\sigma^2t)^2 + 2 + 2\sigma^2t + (\sigma^2t)^2 + 1 - 2\mu t + 2\mu^2t^2 - 4} \quad (116)$$

and then to

$$\sqrt{4\sigma^2t + \frac{1}{2}(2\mu + 2\sigma^2)^2t^2 + \sigma^2t^2 + 2\mu^2t^2}. \quad (117)$$

Recognizing that all the terms to the right of  $4\sigma^2t$  in (117) can be expressed as some function of  $\mu$  and  $\sigma$ ,

$$\sqrt{4\sigma^2t + g(\mu, \sigma)t^2} \quad (118)$$

is obtained which can be expressed as

$$2\sigma\sqrt{t} \sqrt{1 + \frac{g(\mu, \sigma)t}{4\sigma^2}}. \quad (119)$$

The square root in (119) has a Taylor expansion of

$$1 + h_1t + h_2t^2 + \dots \quad (120)$$

which changes (119) to

$$2\sigma\sqrt{t}(1 + h_1t + h_2t^2 + \dots). \quad (121)$$

Substituting Taylor's theorem for expanding a function and (121) into (111) produces

$$u = \frac{1 + (\mu + \sigma^2)t + \dots + 1 - \mu t + \dots \pm 2\sigma\sqrt{t}(1 + h_1t + h_2t^2 + \dots)}{2}. \quad (122)$$

If terms of the order higher than 1 in  $t$  is ignored (122) becomes

$$u = \frac{2 + \sigma^2t \pm 2\sigma\sqrt{t}}{2} \quad (123)$$

which is equal to

$$u = 1 \pm \sigma\sqrt{t} + \frac{1}{2}\sigma^2t. \quad (124)$$

Once again, recognizing (124) as the expansion of a function using Taylor's theorem, it becomes

$$u = e^{\pm\sigma\sqrt{t}}. \quad (125)$$

Since it was assumed that  $u > d$  it follows that

$$u = e^{\sigma\sqrt{t}} \quad (126)$$

and

$$d = e^{-\sigma\sqrt{t}}. \quad (127)$$

The probability of an upward move established in (97),

$$p_u = \frac{e^{\mu t} - d}{u - d}, \quad (128)$$

can be determined by substituting the values for  $u$  and  $d$  into (128). From this the probability of a downward move,

$$p_d = 1 - p_u \quad (129)$$

can also be calculated.

### 3.4.2 Application

The expression for the expected value of the option value over a single time step is used to generate the option-value grid

$$E[Value]_t = \left( p_u \cdot (Value_{t+1} | \text{Up}) - p_d \cdot (Value_{t+1} | \text{Down}) \right) \cdot df_{\Delta t}. \quad (130)$$

By starting from the maturity date where the option values are known, the option value at the preceding time step can be calculated. This expected value is discounted from  $t+1$  to  $t$  to obtain the node value at  $t$  using the discount factor,

$$df_{\Delta t} = e^{-r\Delta t}. \quad (131)$$

Performing this on all nodes over all the steps generates the cone-like grid of option values. The aim is to obtain the node value at time equal to zero which represents the value of the option on valuation date.

The following grid illustrates the workings of the binomial tree on a European call option with strike 70. In the last column ( $S_T$ ) the possible share prices at maturity are given. These have been calculated by applying (126) and (127) 20 times (number of steps) on the starting share price of 50. The pay-off at step 20 (maturity) can be determined for each corresponding share price by subtracting the strike of 70 and comparing the answer to zero. Working back the value



### 3.4.3 Pricing ESOs and BEE Deals

The binomial tree model is suited for valuing instruments that can only be exercised during certain periods since it incorporates the vesting period of the option. Since the option cannot be exercised during the vesting period and is then available to exercise any time between vesting and maturity date, the option is in fact of Bermudan style. It consists of a term during which exercise is not allowed combined with an American portion thereafter.



The binomial tree model can be customised to take account of a number of factors influencing the option price that the standard Black–Scholes model does not allow.

Hull & White (2004) suggest additional parameters to the Binomial model to value ESOs. It explicitly considers the possibility that the employee will leave the company after the vesting period and forfeits his ESOs. It requires the company to use employee turnover rates to estimate an employee exit rate that applies to both the pre-vesting period and the post-vesting period. Furthermore, it incorporates the employee's early exercise policy by assuming that early exercise happens when the stock price is a certain multiple of the exercise price (exercise multiple). Hull & White (2004) state that the employee exit rate,  $e$ , can be directly estimated from historical data on employee turnover rates for the category of option holders being considered. The early exercise multiple,  $M$ , is likely to be more difficult to estimate in many situations. Whenever sufficient data is available,  $M$  should be set equal to the average ratio of the stock price to the strike price when employees have made voluntarily early exercise decisions in the past and these decisions were not made immediately after the end of the vesting period. This method can be built into the binomial model as follow.

Suppose the tree has  $N$  time steps each of length  $\delta t$ . Suppose further that  $S_{ij}$  is the stock price at the  $j^{th}$  node of the tree at time  $i\delta t$  and that  $f_{ij}$  is the value of the option at this node. Define  $K$  as the strike price of the option and  $v$  as the time when the vesting period ends.

At maturity, the value of the option is as before,  $f_{N,j} = \max(S_{N,j} - K, 0)$ . Let  $r$  be equal to the risk-free rate and  $p$  equal to the probability of an up movement in the binomial tree. The value of the final option is represented by  $f_{00}$ .

When  $0 \leq i \leq N - 1$  (prior to maturity) then if  $i\delta t > v$  (the node has vested) and  $S_{i,j} \geq K \cdot M$  (the share price is a certain multiple of the strike price),  $f_{i,j} = S_{i,j} - K$ . If the share price has not increased sufficiently,  $S_{i,j} < K \cdot M$ , then exercise will not take place even though there is the possibility,  $e$ , that the employee will want to exercise his option and exit the company. This translates into a node value of

$$f_{i,j} = (1 - e\delta t) \cdot e^{-r\delta t} \cdot [pf_{i+1,j+1} + (1 - p) \cdot f_{i+1,j}] + e\delta t \cdot \max(S_{i,j} - K, 0).$$

If the option has not yet vested at,  $i\delta t < v$ , the value consists of only the term not representing exiting,

$$f_{i,j} = (1 - e\delta t) \cdot e^{-r\delta t} \cdot [pf_{i+1,j+1} + (1 - p) \cdot f_{i+1,j}].$$

By manipulating the way in which each node uses the 2 subsequent nodes, the impact of vesting periods, closed periods, the sub-optimal exercise rate, the exiting rate and the exercise multiple can be incorporated. This feature makes the binomial tree model ideally suited for pricing ESOs.

Binomial models are generally less suited to value BEE deals since there is often interest charged on the strike and dividends reduce the strike. The model can be adjusted to take account of known dividends which are not related to the share price (compared to using a dividend yield) but this is generally not used. The extended lifetimes of ESOs and BEE deals make it difficult to predict dividends independently of the share price.

### 3.4.4 Pricing Suitability

The Binomial tree pricing model is widely used as it is able to handle a variety of conditions which cannot be easily applied in some other models. Most significant is the fact that it includes the additional value in the option from being able to exercise the option at any point during its lifetime (after vesting). Rudkin (2006) showed that binomial models produce more accurate prices for ESOs than the Black-Scholes approach. The model is also relatively simple, mathematically, although it has no closed-form solution. It is considered more accurate, particularly for longer-dated options, and options on securities with varying dividend payments. For these reasons, various versions of the binomial model are widely used by practitioners in the options markets.

The binomial tree model cannot accurately cater for the path dependency inherent in many BEE deals.

### 3.5 Finite Difference Method

Finite difference models aim to obtain a solution for the value of a derivative by solving the differential equation (PDE) that satisfies the particular derivative. The differential equation is converted into its discrete difference equations which are solved iteratively. This section uses the work done by Crank & Nicolson (1947), Hull (2003), Wilmott (2006), Kerman (2002) and West (2008) to derive the Finite Difference Methodology.

The finite difference method is used to solve the Black-Scholes partial differential equation (PDE) derived in equation (34) in section 3.3.2

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} - rV = 0. \quad (132)$$

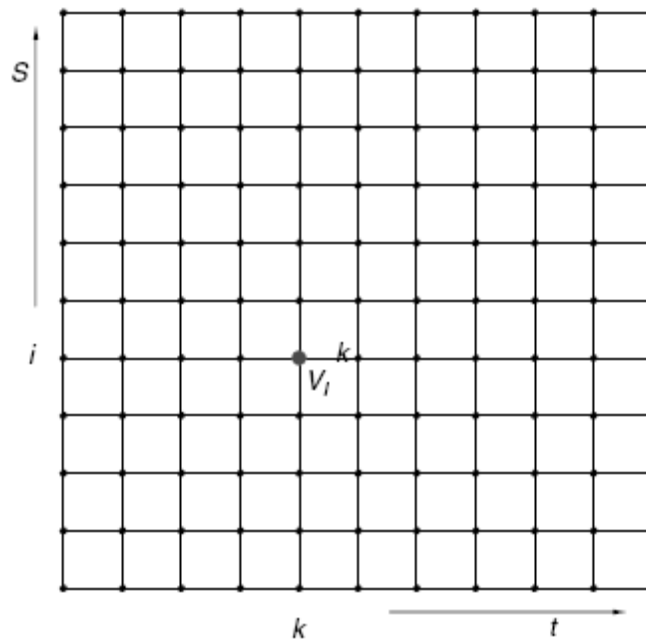
This can be written as

$$\frac{\partial V}{\partial t} = -\frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} - rS \frac{\partial V}{\partial S} + rV. \quad (133)$$

The definition of the 1<sup>st</sup> order derivative of V with respect to t is simply

$$\frac{\partial V}{\partial t} = \lim_{h \rightarrow 0} \frac{V(S, t+h) - V(S, t)}{h} \quad (134)$$

Finite difference uses a grid to evaluate the value of the option as a function of the spot price of the underlying asset ( $S_i$ ) and time ( $t_k$ ). Each point on the grid represents an option value node as a function of spot and time. Unlike the binomial (or trinomial) tree method, the grid is square.



Using the discrete grid over which the option is evaluation, (134) can be approximated using

$$\frac{\partial V}{\partial t}(S, t) \approx \frac{V_i^k - V_i^{k+1}}{\partial t}. \quad (135)$$

$\frac{\partial V}{\partial S}$  can be expressed in three ways:

- forward difference:  $\frac{V_{i+1}^k - V_i^k}{\partial S}$
- backward difference:  $\frac{V_i^k - V_{i-1}^k}{\partial S}$
- central difference:  $\frac{V_{i+1}^k - V_{i-1}^k}{2 \partial S}$

While the second order derivative is approximated by

$$\frac{\partial^2 V}{\partial S^2} \approx \frac{V_{i+1}^k - 2V_i^k + V_{i-1}^k}{\partial S^2}. \quad (136)$$

In this way the PDE (133) can be expressed discretely as

$$\frac{V_i^k - V_i^{k+1}}{\partial t} = -\frac{1}{2} \sigma^2 S^2 \frac{V_{i+1}^k - 2V_i^k + V_{i-1}^k}{\partial S^2} rS \frac{V_{i+1}^k - V_{i-1}^k}{2 \partial S} rV_i^k. \quad (137)$$

Since  $V_i^{k+1}$  is a function of  $V_{i+1}^k$ ,  $V_i^k$  and  $V_{i-1}^k$  it can be solved when working backwards from the known values at maturity. This is known as the **explicit method** which uses

$$\begin{aligned} V_i^{k+1} = & \left( \frac{1}{2} \frac{\partial t}{\partial S^2} \sigma^2 S^2 - \frac{1}{2} \frac{\partial t}{\partial S} rS \right) V_{i-1}^k + \left( 1 - \frac{\partial t}{\partial S^2} \sigma^2 S^2 - \partial tr \right) V_i^k \\ & + \left( \frac{1}{2} \frac{\partial t}{\partial S^2} \sigma^2 S^2 + \frac{1}{2} \frac{\partial t}{\partial S} rS \right) V_{i+1}^k \end{aligned} \quad (138)$$

or

$$V_i^{k+1} = A_i^k V_{i-1}^k + (1 + B_i^k) V_i^k + C_i^k V_{i+1}^k \quad (139)$$

where

$$A_i^k = \frac{1}{2} \frac{\partial t}{\partial S^2} \sigma^2 S^2 - \frac{1}{2} \frac{\partial t}{\partial S} rS \quad (140)$$

$$B_i^k = -\frac{\partial t}{\partial S^2} \sigma^2 S^2 - \partial tr \quad (141)$$

$$C_i^k = \frac{1}{2} \frac{\partial t}{\partial S^2} \sigma^2 S^2 + \frac{1}{2} \frac{\partial t}{\partial S} rS. \quad (142)$$



The **implicit equation** is obtained by writing  $V_i^k$  is a function of  $V_{i+1}^{k+1}$ ,  $V_i^{k+1}$  and  $V_{i-1}^{k+1}$  and transforms (137) to

$$V_i^k = A_i^{k+1}V_{i-1}^{k+1} + (1 + B_i^{k+1})V_i^{k+1} + C_i^{k+1}V_{i+1}^{k+1} \quad (143)$$

where

$$A_i^{k+1} = -\frac{1}{2} \frac{\partial t}{\partial S^2} \sigma^2 S^2 - \frac{1}{2} \frac{\partial t}{\partial S} rS \quad (144)$$

$$B_i^{k+1} = \frac{\partial t}{\partial S^2} \sigma^2 S^2 + \partial tr \quad (145)$$

$$C_i^{k+1} = -\frac{1}{2} \frac{\partial t}{\partial S^2} \sigma^2 S^2 + \frac{1}{2} \frac{\partial t}{\partial S} rS. \quad (146)$$

To solve the implicit equation, matrix calculus is required to solve the multiple equations. Finally the implicit and explicit methods are combined by **Crank & Nicolson** (1947) to produce

$$\begin{aligned} -A_i^{k+1}V_{i-1}^{k+1} + (1 - B_i^{k+1})V_i^{k+1} - C_i^{k+1}V_{i+1}^{k+1} \\ = A_i^kV_{i-1}^k + (1 + B_i^k)V_i^k + C_i^kV_{i+1}^k \end{aligned} \quad (147)$$

where

$$A_i^k = \frac{1}{4} (\sigma^2 i^2 - ri) \partial t \quad (148)$$

$$B_i^k = -\frac{1}{2} (\sigma^2 i^2 + r) \partial t \quad (149)$$

$$C_i^k = \frac{1}{4} (\sigma^2 i^2 + ri) \partial t. \quad (150)$$

If  $I$  is the number of steps, then at  $i=0$  and  $i=I$  the boundary conditions of the option determines the value at each of these nodes. For a call option,  $V_0^k = 0$  for all  $k \leq I$  since  $S_0$  will be equal to 0 (since  $S_0 - \text{Strike} \leq 0$ ). If the value chosen for  $S_{\max}$  is sufficient, then  $V_I^k = S_{\max} - \text{Strike}$  for all  $k \leq I$ . The boundary conditions eliminate the need for the two additional equations. This leaves  $I-1$  equations.

By setting up a set of equations with  $1 \leq i \leq I-1$  where the two boundary conditions (at Spot = 0 and spot max) supply the other two missing equations. By writing the method in matrix form,  $V_i^{k+1}$  can once again be solved iteratively:



$$\begin{pmatrix} -A_1^{k+1} & 1 - B_1^{k+1} & -C_1^{k+1} & 0 & \cdot & \cdot & \cdot \\ 0 & -A_2^{k+1} & 1 - B_2^{k+1} & \cdot & \cdot & \cdot & \cdot \\ \cdot & 0 & \cdot & \cdot & \cdot & 0 & \cdot \\ \cdot & \cdot & \cdot & \cdot & 1 - B_{I-2}^{k+1} & -C_{I-2}^{k+1} & 0 \\ \cdot & \cdot & \cdot & 0 & -A_{I-1}^{k+1} & 1 - B_{I-1}^{k+1} & -C_{I-1}^{k+1} \end{pmatrix} \begin{pmatrix} V_0^{k+1} \\ V_1^{k+1} \\ \cdot \\ \cdot \\ \cdot \\ V_{I-1}^{k+1} \\ V_I^{k+1} \end{pmatrix} = \begin{pmatrix} A_1^{k+1} & 1 + B_1^{k+1} & C_1^{k+1} & 0 & \cdot & \cdot & \cdot \\ 0 & A_2^{k+1} & 1 + B_2^{k+1} & \cdot & \cdot & \cdot & \cdot \\ \cdot & 0 & \cdot & \cdot & \cdot & 0 & \cdot \\ \cdot & \cdot & \cdot & \cdot & 1 + B_{I-2}^{k+1} & C_{I-2}^{k+1} & 0 \\ \cdot & \cdot & \cdot & 0 & A_{I-1}^{k+1} & 1 + B_{I-1}^{k+1} & C_{I-1}^{k+1} \end{pmatrix} \begin{pmatrix} V_0^k \\ V_1^k \\ \cdot \\ \cdot \\ \cdot \\ V_{I-1}^k \\ V_I^k \end{pmatrix} \quad (151)$$

The next section describes how the method is customized for use in pricing ESOs.

### 3.5.1 ESO Application

In order for the Finite Difference method to be useful as a tool to obtain the fair-value of an employee share option, a measure that quantifies the degree to which employees exercise their options before it is theoretically optimal for them to do so, is required. West (2008) introduces the suboptimal exercise rate,  $\lambda$ , into the Finite Difference model that states which percentage of his/her options the employee exercises annually when it is not optimal. West (2008) shows that the introduction of the sub-optimal exercise rate changes the PDE in (133) to

$$\frac{\partial V}{\partial t} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} - (r + \lambda)V + \lambda(S - K) = 0 \quad (152)$$

which transforms the matrix equations into

$$\begin{aligned} & \begin{pmatrix} -A_1^{k+1} & 1 - B_1^{k+1} & -C_1^{k+1} & 0 & \cdot & \cdot & \cdot \\ 0 & -A_2^{k+1} & 1 - B_2^{k+1} & \cdot & \cdot & \cdot & \cdot \\ \cdot & 0 & \cdot & \cdot & \cdot & 0 & \cdot \\ \cdot & \cdot & \cdot & \cdot & 1 - B_{I-2}^{k+1} & -C_{I-2}^{k+1} & 0 \\ \cdot & \cdot & \cdot & 0 & -A_{I-1}^{k+1} & 1 - B_{I-1}^{k+1} & -C_{I-1}^{k+1} \end{pmatrix} \begin{pmatrix} V_0^{k+1} \\ V_1^{k+1} \\ \cdot \\ \cdot \\ \cdot \\ V_{I-1}^{k+1} \\ V_I^{k+1} \end{pmatrix} \\ & = \begin{pmatrix} A_1^{k+1} & 1 + B_1^{k+1} & C_1^{k+1} & 0 & \cdot & \cdot & \cdot \\ 0 & A_2^{k+1} & 1 + B_2^{k+1} & \cdot & \cdot & \cdot & \cdot \\ \cdot & 0 & \cdot & \cdot & \cdot & 0 & \cdot \\ \cdot & \cdot & \cdot & \cdot & 1 + B_{I-2}^{k+1} & C_{I-2}^{k+1} & 0 \\ \cdot & \cdot & \cdot & 0 & A_{I-1}^{k+1} & 1 + B_{I-1}^{k+1} & C_{I-1}^{k+1} \end{pmatrix} \begin{pmatrix} V_0^k \\ V_1^k \\ \cdot \\ \cdot \\ \cdot \\ V_{I-1}^k \\ V_I^k \end{pmatrix} \quad (153) \\ & - \lambda \begin{pmatrix} S_0 - K \\ S_1 - K \\ \cdot \\ \cdot \\ \cdot \\ S_{I-1} - K \\ S_I - K \end{pmatrix} \end{aligned}$$

where

$$A_i^k = \frac{1}{4} (\sigma^2 i^2 - r_i) \partial t \quad (154)$$

$$B_i^k = -\frac{1}{2}(\sigma^2 i^2 + r + \lambda) \partial t \quad (155)$$

$$C_i^k = \frac{1}{4}(\sigma^2 i^2 + r i) \partial t. \quad (156)$$

West (2008) proposed that a logical choice for  $\lambda$  would be to have it as an increasing function of  $S$  to emulate the employee's greater likelihood to exercise if the pay-off increases while being zero if  $S < K$  or the option has not yet vested.

### 3.6 Monte Carlo Simulation

Monte Carlo Simulation is a procedure in which random numbers are generated according to probabilities assumed to be associated with a source of uncertainty. This method is a widely used technique for dealing with uncertainty in many aspects of business operations. It has been shown to be an accurate method of pricing options and particularly useful for path-dependent options and others for which no closed-form formula exists. This section uses the approach proposed by Hull (2003) to describe how to implement the Monte Carlo Simulation methodology into option pricing.

The assumptions of the Black-Scholes model imply that given a stock price at time  $t$ , simulated changes in the stock price at a future time  $t+\Delta t$  can be described by the following process:

$$\Delta S = \mu S \Delta t + \sigma S \varepsilon \sqrt{\Delta t} \quad (157)$$

The variable  $\varepsilon$ , is a random number generated from a standard normal probability distribution. This technique simulates a large number of scenarios and uses the various outcomes to obtain an average price for the option. Various share price-paths are simulated over the term of the option. For each path, the pay-off that would have occurred had the path realised, is calculated and discounted to the valuation day. The option price is obtained by calculating the average of all of these paths' option values. The price movement for each iteration is determined by the volatility of the underlying asset, interest rates as well as a random input. The inputs are used in the formula based on Geometric Brownian Motion to determine the asset movement from one step to the next. The process is applied in the model as:

$$S_{t+1} = S_t e^{(r-q-\frac{1}{2}\sigma^2)\Delta t + \sigma\varepsilon\sqrt{\Delta t}} \quad (158)$$

Where

$S_t$  is the known share price

$S_{t+1}$  is the simulation share price

$r$  is the continuously compounded risk-free interest rate in the market

$q$  is the dividend yield

$\sigma$  is the volatility of the underlying asset

$\Delta t$  is the time interval from  $t$  to  $t+1$

$\varepsilon$  is a random value drawn from the  $N(0,1)$  distribution

By allowing the share price to develop over the term of the option, the share price at any point during the term of the option is calculated. This allows specific aspects of the deal to be incorporated. As the number of iterations increase, the result stabilises.

### 3.6.1 Pricing ESOs and BEE Deals

Monte Carlo Simulation techniques are one of the few methods that can produce accurate path-dependent option values. As options become more and more complex (path dependency, multiple correlated underlying assets), Monte Carlo Simulation techniques are becoming more popular to value these options and in many cases are the only way to obtain mark-to-market values.

This model can incorporate most conditions in the structure in the pricing process (Van der Merwe (2010)). Since the debt (strike) associated with BEE deals is a function of the dividends paid throughout the life of the option as well as the interest accrued on the outstanding amount, the valuation of the deal is path-dependent. West (2009) illustrates this point and recommends the use of a Monte Carlo simulation when pricing BEE deals for IFRS 2 purposes. This method assumes that the return on the share price is log-normally distributed and uses this property to grow the share price ( $S_t$ ) over time until the maturity of the structure. Each time the share price is simulated, the associated dividends can be obtained. These figures may be needed if the strike (debt) earns interest at some rate ( $p$ ) while the dividends reduce the debt at that point. The share price can be grown from dividend payment date or at small steps. The larger the time steps, the more simulations should be run to ensure sufficient randomness in the model.

### 3.7 Model Comparison

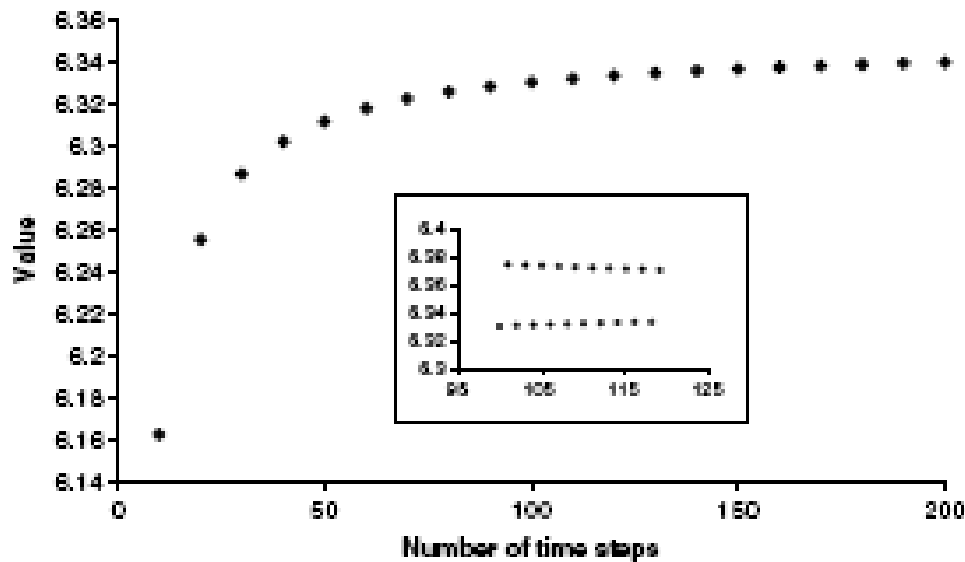
The table that follows illustrates the value of a standard European call option using the different models that were discussed.

Model	Black Scholes	Binomial Tree	Monte Carlo	Finite Difference
Spot	100	100	100	100
Strike	100	100	100	100
Term	6	6	6	6
Interest Rate	7.5%	7.5%	7.5%	7.5%
Volatility	30.0%	30.0%	30.0%	30.0%
Dividend Yield	3.0%	3.0%	3.0%	3.0%
Steps	-	1000	5000	200
Option Value	32.33	32.33	32.28	33.88

**Table 3.1 - Comparison of European call option values**

The option values obtained are similar in magnitude. This is in agreement with the findings of Ammann & Seiz (2004) who illustrated that ESOs priced with different models using similar input parameters, do not differ in value significantly. The prices will start to diverge as more detailed features are incorporated by the models differently.

Since the Black-Scholes model has a closed-form solution, the answer is constant. The other models all tend towards some value as more iteration or steps are included. Wilmot (2006) shows how the solution of the binomial model tends towards a fixed solution as more steps are added. This is illustrated in Figure 3.2.



**Figure 3.2 - Convergence of the Binomial tree model**

When comparing the explicit, implicit and Crank-Nicolson finite difference methods, Wilmot (2006) uses the natural logarithm of the standard error to compare the methods (see Figure 3.3).

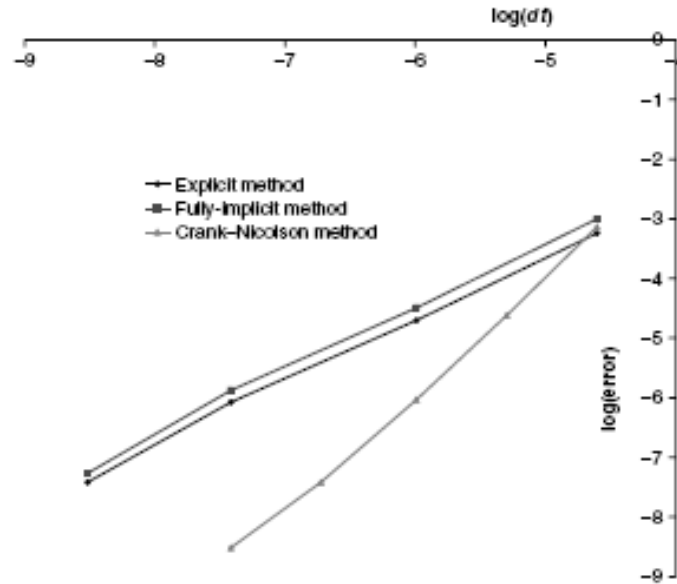


Figure 3.3 - Convergence of the three finite difference techniques.

The explicit and implicit methods have an error that decreases like  $\delta t$  but the Crank–Nicolson method is much better having an error that decreases like  $\delta t^2$ . The trinomial model is an extension of the binomial model which performs at least as well as the binomial model and sometimes better (Rubinstein (2000)). G. Ioffe, M. Ioffe (2007) show that even the implicit method converges better than the trinomial tree model (see Figure 3.4).

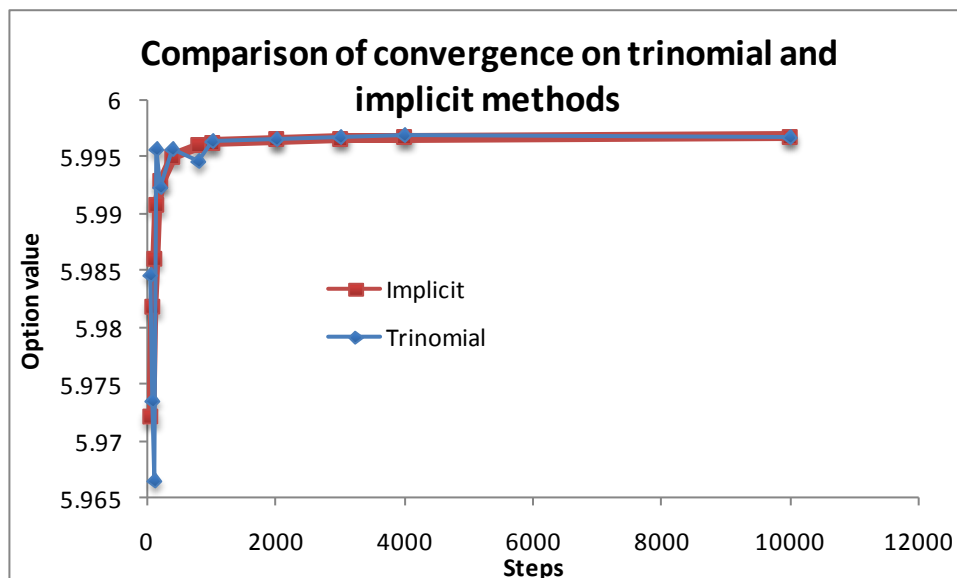
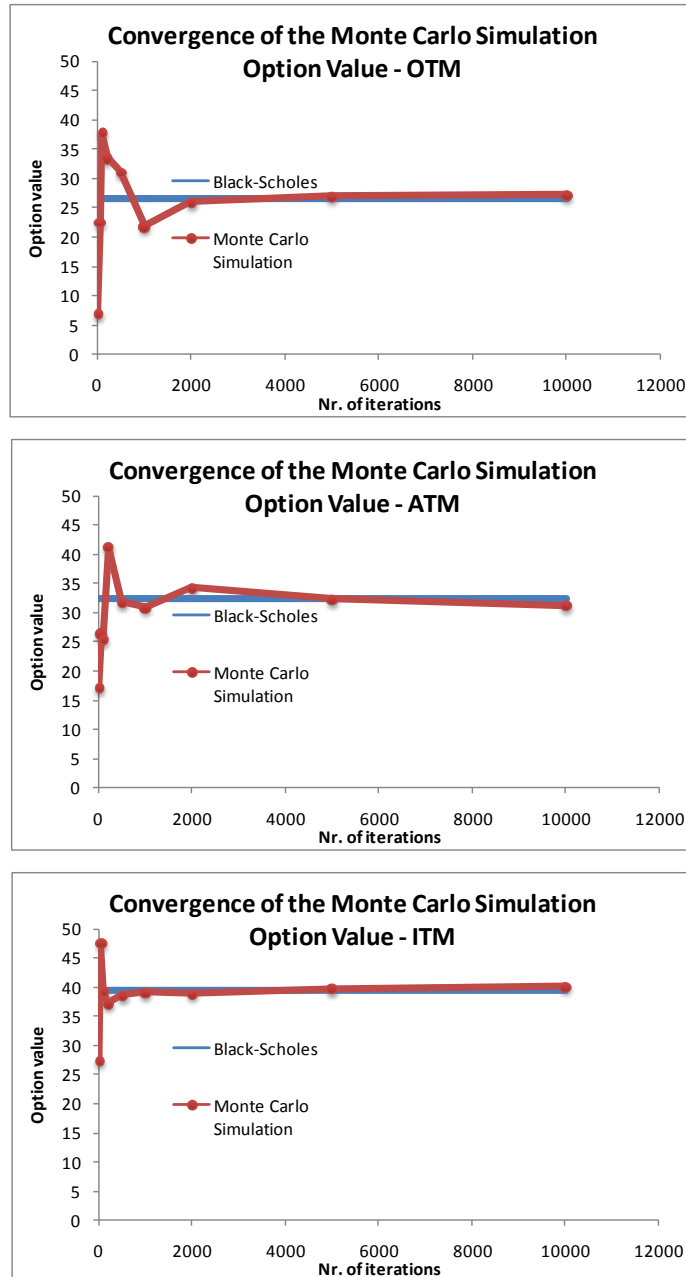


Figure 3.4 - Comparison of convergence on trinomial and implicit methods



The Monte Carlo simulation gives a new value each time it is run. As more iterations are used, the solution tends towards the Black-Scholes value.

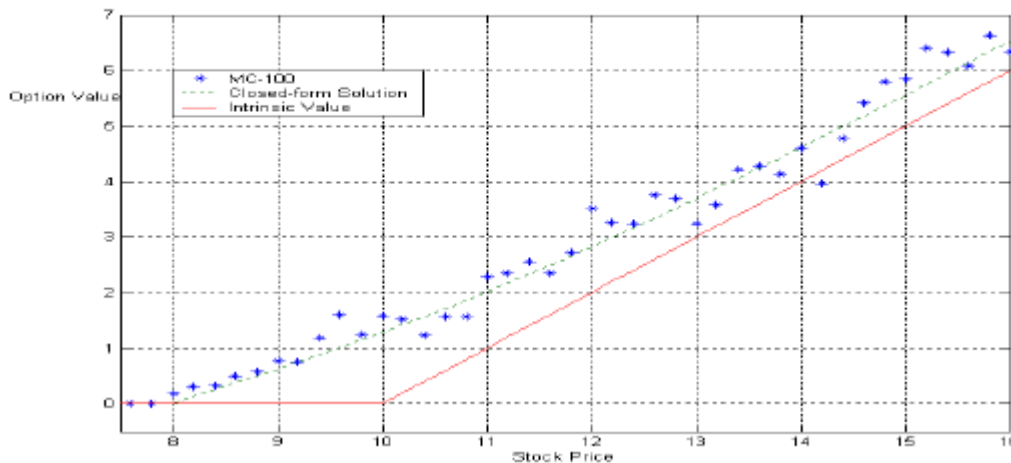


**Figure 3.5 - Convergence of the Monte Carlo simulation value for an out-the-money, at-the-money and in-the-money call option**

This comparison is useful to determine the number of steps to use in such a model. Ultimately, the Monte Carlo simulation will be used to price options for which a Black-Scholes model cannot be used.

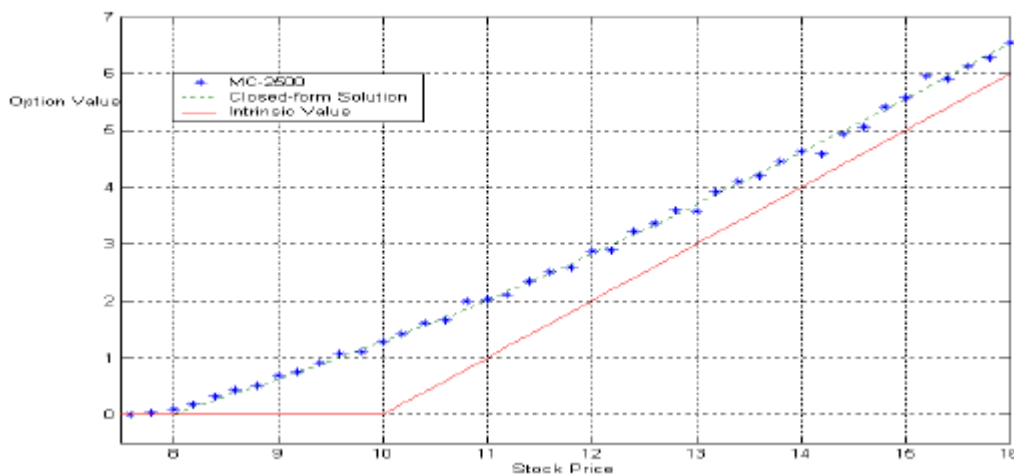
ESOs and BEE deals are priced for the purpose of expensing them on an annual basis. For this reason the calculation limitations that might be imposed on a bank's trading portfolio (re-pricing of the entire portfolio is done on a daily basis) do not apply to ESOs and BEE deals. Clewlow and Strickland (1998) and Hull (2000) argue that MCS are inefficient from a computational point of view since they generate high variances. But since the number of iterations is not limited by a time-constraint factor, it can be increased until the price stabilises to within an acceptable threshold. Jabbour & Liu (2005) argue that the estimated standard error of Monte Carlo simulation option prices are merely the sample standard deviation of the Monte Carlo simulation option prices divided by the square-root of the number of simulations. The impact on the option price of using an increased number of simulations is graphically illustrated in Figure 3.6 and Figure 3.7.

**Diagram A (Number of paths =100)**



**Figure 3.6 - Illustration of the standard error of a Monte Carlo simulation pricing model which uses 100 simulations**

**Diagram C (Number of paths =2500)**



**Figure 3.7 - Illustration of the standard error of a Monte Carlo simulation pricing model which uses 2500 simulations**

Figure 3.6 and Figure 3.7 show how the Monte Carlo simulation option prices (denoted by MC) of a European down-and-out call option stabilises as the number of simulations increase from 100 to 2500. By increasing the number of simulations by a factor of  $x$ , the standard error reduces by a factor of  $\sqrt{x}$ . Therefore, the standard error reduces by a factor of  $5 \left( \sqrt{\frac{2500}{100}} \right)$  when the number of simulations increase from 100 to 2500.

A 95% confidence interval for the Monte Carlo simulation option price,  $\mu$ , with a standard error of,  $\omega$ , can be obtained using

$$\left[ \mu + \frac{N^{-1}\left(\frac{5\%}{2}\right) \cdot \omega}{\sqrt{n}}; \mu + \frac{N^{-1}\left(1 - \frac{5\%}{2}\right) \cdot \omega}{\sqrt{n}} \right]. \quad (159)$$

In deciding the number of simulations when pricing the ESOs or BEE deals, one of two approaches is recommended. The number of simulations should either be increased to such a point where:

- the Rand-based price is stable to within 2 decimal places; or
- the 95% confidence interval for the Monte Carlo simulation option is less than a specified amount.

### 3.8 Conclusion

This chapter derived a number of mathematical models used in pricing ESOs and BEE deals.

These are:

- Black-Scholes
- Binomial Model
- Finite Difference Method using the Crack-Nicholson approach
- Monte Carlo Simulation

The models are all based on the following main assumptions:

- $S$ , the underlying stock, follows a Geometric Brownian motion process,

$$dS_t = \mu S_t dt + \sigma S_t dW_t,$$

which has a constant mean and volatility.

- This leads to the return on  $S_T$  being log normally distributed.
- It is possible to short sell the shares – something which is specifically difficult to justify when ESOs and BEE deals are priced.
- Any fraction of a share can be traded when hedging the portfolio. However, as Hall & Murphy (2000) indicates, since holders of these options are unable to hedge or diversify their portfolios, the risk neutrality assumption, which forms the basis of all the mentioned asset pricing models, does not hold. Therefore, even if all the inputs into the model were correct, the true value of these options is much lower. Since the options cannot be traded, the true discount ratio is very difficult to determine.
- There are no transaction costs – specifically when hedging.
- The initial assumption that the stock does not pay any dividends was addressed by generalizing the PDE-formula to include a dividend yield variable.
- Money can be borrowed or invested at a risk-free interest rate,  $r$ .

For each model its applicability in valuing different kinds of options are discussed.

Model	Option Characteristics
Black-Scholes	European
Binomial Model	American with exercise assumption
Finite Difference Method (Crack-Nicholson)	American with exercise assumption
Monte Carlo Simulation	Path dependency

It was shown that the models produce prices that are similar in magnitude for a standard call option. It is only when more specialized inputs are added to the models that the results could differ more significantly. The following table indicates which models to use depending on the instrument being priced.

<b>Transaction Type</b>	<b>Appropriate Model</b>
Basic ESO with no assumption on exercise behaviour or closed periods	Black-Scholes
Normal ESO in which an exercise assumption is used and closed periods are recognized.	Binomial Model Finite Difference Method (Crack-Nicholson)
Basic BEE deal with no assumption on exercise behaviour and no interest on the debt or the dividends	Black-Scholes
BEE deal with some assumption on exercise behaviour is used and interest is paid on the debt and/or the dividends	Monte Carlo Simulation

## CHAPTER 4

### 4 Model Inputs

#### 4.1 Chapter Overview

Chapter 3 introduced the mathematical models used in pricing BEE deals and ESOs. This chapter discusses the influence of the various inputs that are used in the pricing models. This includes the minimum inputs required to price the deals as well the additional exercise behaviour-related inputs that aim to recognise the impact of the option holders exercising before maturity of the deal. The sensitivity of the option price to each of these inputs is calculated which illustrates to what extent using a different input-value will affect the price. By the end of the chapter the impact of each input and the various forms in which it can be used, would have been covered.

#### 4.2 Introduction

Section 3 introduced the basic models that are often used when pricing ESOs and BEE deals. These models all require inputs that describe the contract for which a fair-value is required. Weygandt (1977) confirms that the factors that influence the value of ESOs have been agreed between market practitioners as the following:

#### 4.3 Minimum Inputs

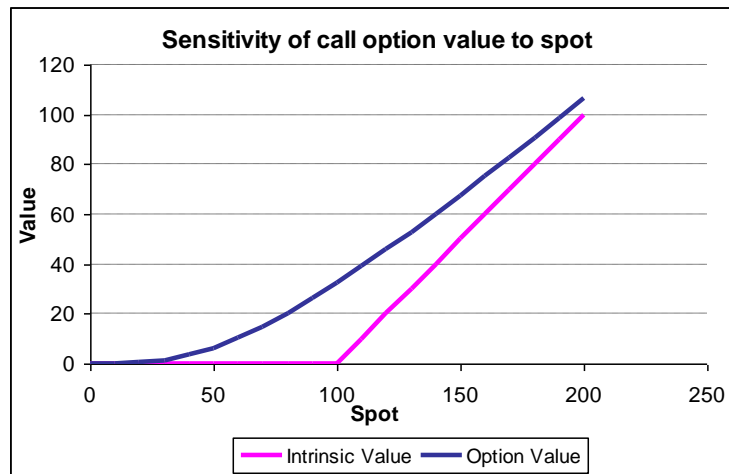
All the models will use a certain minimum level of inputs when assessing the fair-value for an option. They are either explicitly stated in the contract or can be deduced from data observed in the market. In order to analyse the sensitivity of the option to its input parameters, an option with the following basic features will be used:

<b>Input</b>	<b>Value</b>
Pricing model	Black Scholes
Spot price	100
Strike	100
Term	6 years
Interest Rate	7.5%
Volatility	30.0%
Dividend Yield	3.0%
<b>Option Value</b>	<b>32.33</b>

### 4.3.1 Spot Price

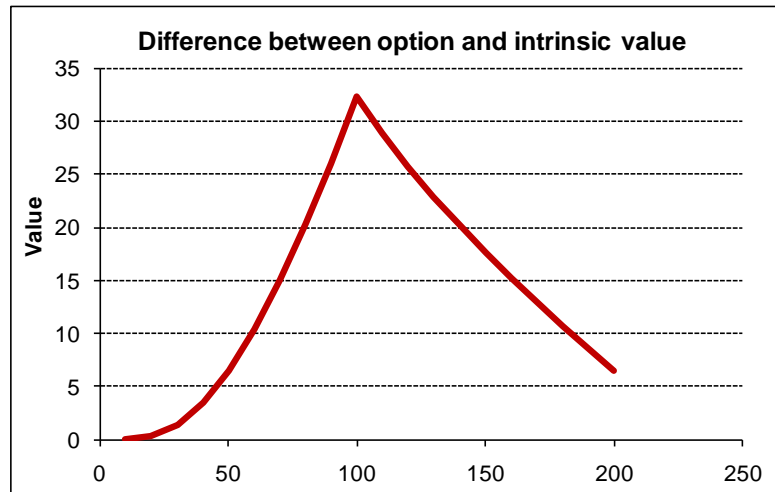
The spot price ( $S_0$ ) is the underlying equity price used when the valuation is done. This is either the last closing share price or the average of some recent period (last month) to remove some of the short term volatility

The sensitivity of the price of the option to the spot price is shown in Figure 4.1.



**Figure 4.1 - Sensitivity of a call option to spot price**

As the spot price increases, so does the option value. The intrinsic value (pay-off) is zero up to the point where the spot price exceeds the strike price. Where the spot is greater than the strike, there is a linear relationship. The option value however starts to increase long before the strike price is reached. This illustrates the value in having an option on an underlying asset even if the spot price is currently less than the strike. Option pricing captures the likelihood that the spot price can still change over the lifetime of the option.

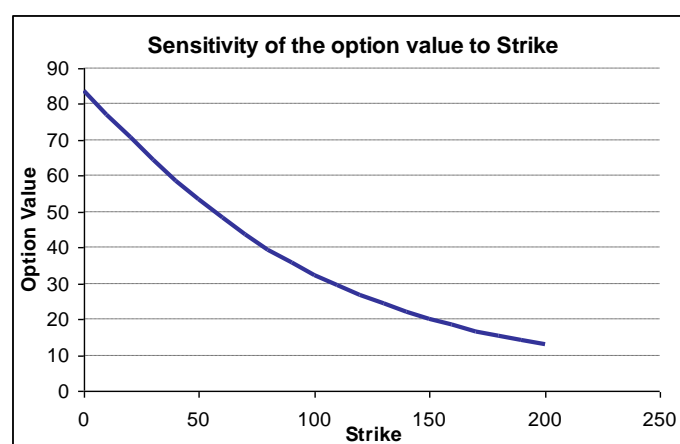


**Figure 4.2 - The difference between the option value and the intrinsic value**

The difference between the intrinsic value of a simple call option and its value derived from a model reaches a maximum when the spot price is equal to the strike price.

### 4.3.2 Strike Price

The strike ( $K_0$ ) price represents the threshold that will be used to compare the value of the underlying asset against when the option is exercised. It does not have to be constant over the term of the contract (see Section 7.5.3). The strike prices on ESOs are usually straightforward and simply the value of the spot price when the options were issued. Hall & Murphy (2000) report that 94% of option grants to S&P 500 CEOs were at-the-money. The strike on a BEE deal tends to be the remaining debt from the original purchase of the shares. This may change over time as interest accrues on the debt while dividends received on the underlying shares offsets the debt.



**Figure 4.3 - Sensitivity of the option to strike price**



As the strike price increases, it erodes the value of the option by reducing the intrinsic value.

### 4.3.3 Term to Maturity

The term of the transaction, (T), whether for ESOs or BEE deals, is specified in the contract. One problem with conventional models to value ESOs or BEE deals is that the term to maturity is usually a lot longer than with exchange-traded options. In South Africa, options traded on SAFEX seldom have maturities of more than four years while the more liquid options have much shorter maturity dates. ESOs can typically exist for 7 years while BEE deals have even longer lives. This means that very little of the extended research that has been done on option theory can be applied blindly to ESOs and BEE deals. We have no way of knowing whether the traditional option pricing models would have been used had there been an actively traded option market with maturities comparable with these long dated maturities. The prices of short-dated OTC options are kept in check because they can be compared to similar options on exchanges. This enables the calculation of the implied volatility (see Section 4.3.4.1). The prices for long-dated ESO and BEE deals have no natural instrument to be compared against.

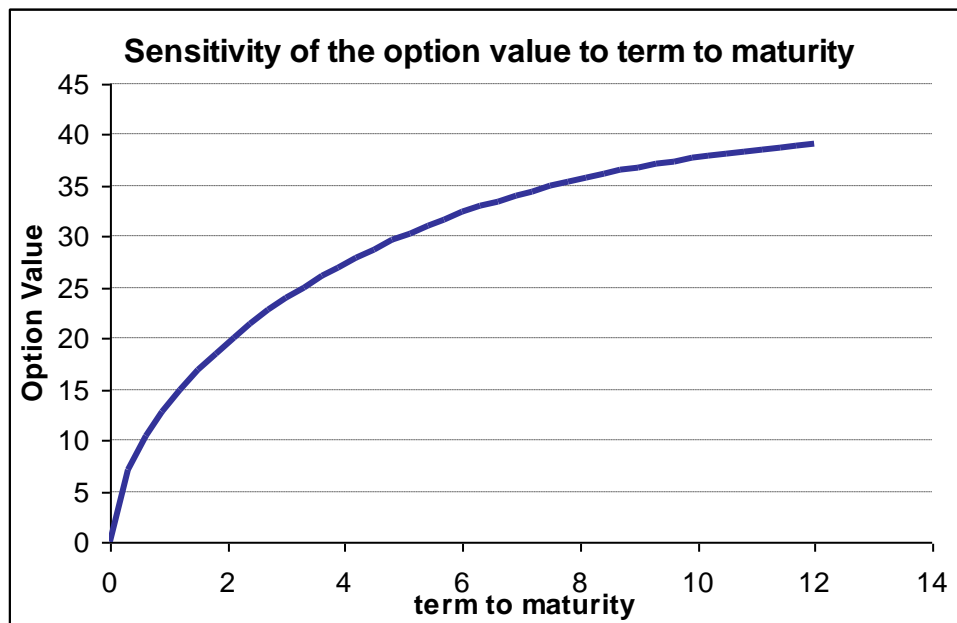


Figure 4.4 - Sensitivity of the option value to term to maturity

The value of a call option will tend to increase drastically as the option term is increased to allow more time for the spot to grow above the level of the strike price. However, this increase tends to flatten out as the term becomes exceedingly long.

### 4.3.4 Volatility of Underlying Stock

The stock volatility,  $\sigma$ , determines the variation of the share price in the model from the expected value over a certain period.

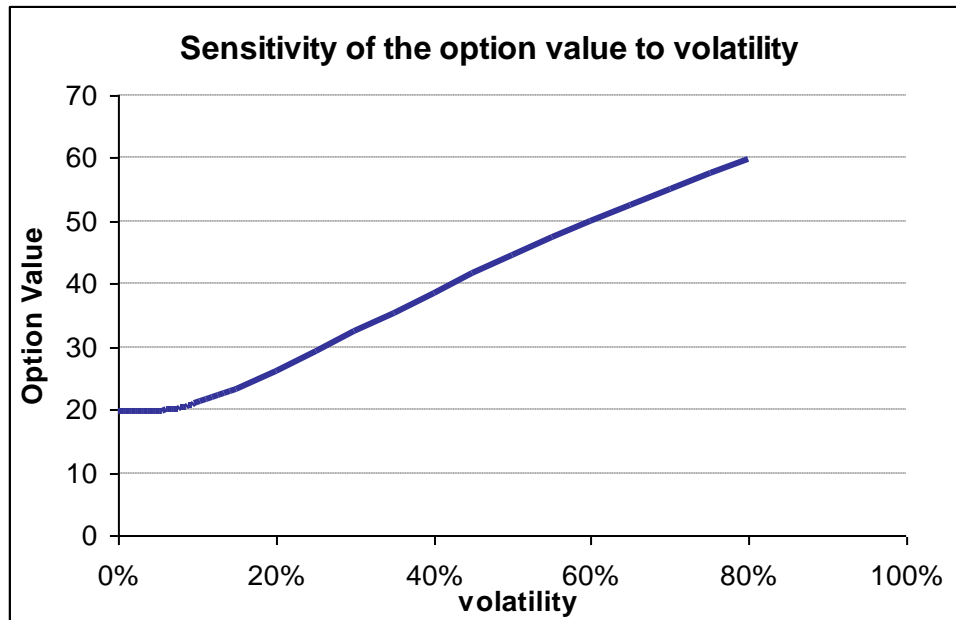


Figure 4.5 - Sensitivity of the option value to term to volatility

Figure 4.5 shows that as the volatility increases, the option value also increases. Various types of volatilities can be considered when pricing the option, each with its own properties.

#### 4.3.4.1 Historical Volatility

Historical volatility is often used as an input when pricing ESO and BEE deals. It provides a transparent way of obtaining an input to estimate the variability of the underlying reference asset over the option term.

##### 4.3.4.1.1 Simple Historical Volatility

This version of the volatility is a standard deviation calculation on the historical log-returns of the share price. This result is adjusted by an appropriate scaling factor (referred to as  $s$ ) to make it an annual volatility. The amount of historical data to include in the volatility calculation should be in agreement with the remaining term of the option. The volatility is calculated for ABSA bank on 2 February 2009.

Historical data	Standard deviation	Annual Volatility
1 year	3.0%	47.0%
2 years	2.5%	39.1%
3 years	2.3%	37.0%

Since the standard deviation was calculated on share prices published on each business day, the scaling factor used was the square root of 251. The decrease in volatility as more historical data is added indicates that the volatility has been increasing over the last 3 years.

#### 4.3.4.1.2 Exponentially Weighted Moving Average Volatility

The exponentially weighted moving average (EWMA) volatility (RiskMetrics (1996)) assigns a larger weight to more recent share price activity in the volatility estimation. The volatility is calculated by using each day's share price return to adjust the volatility up to that point. The decay factor,  $\lambda$ , expresses how much weight to give the new share price return in relation to the volatility up to that point. In this way the volatility at time  $t$ ,  $\sigma_t$ , can be expressed as a function of the volatility up to time  $t-1$ ,  $\sigma_{t-1}$ ,  $\lambda$  and the last share price change,

$$\sigma_t = \lambda \cdot \sigma_{t-1} + (1 - \lambda) \cdot \delta^2 \cdot s^2 \quad (160)$$

where  $\delta$  is the return between  $t$  and  $t-1$ ,  $\sigma_t$  is the volatility at time  $t$  and  $s$  the scaling factor.

Calculating the EWMA volatility for ABSA on 2 February 2009 gives the following result.

$\lambda$	EWMA Volatility
94%	51.2%
95%	50.8%
99%	48.5%

As  $\lambda$  increases, less weight is given to more recent share price returns (G. van Vuuren, M. Botha and P. Styger (2000)). Since the volatility decreases as the decay factor increases, the volatility has been increasing over time. This is in agreement with the trend seen in Section 4.3.4.1.1 even though the absolute values of the volatilities are different. Figure 4.6 shows how different versions of ABSA's volatility compare between 2001 and 2008.

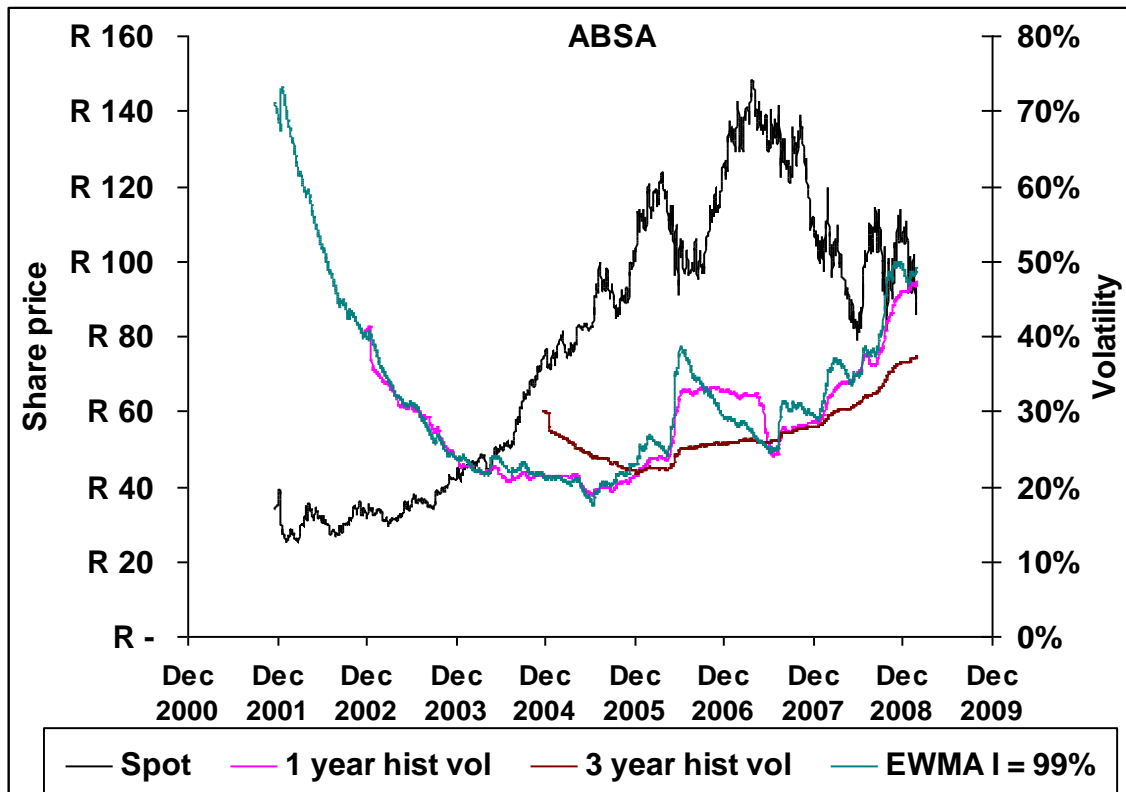


Figure 4.6 - Comparison of various volatility measures on the ABSA share price

The biggest argument against the use of historical volatility is that it cannot anticipate changes in the market that will have a direct effect on the share price. Structural changes to a company might change the company intrinsically causing a historical volatility measure to be inappropriate. An exponential weighted moving average (EWMA) model adds more weight to recent share price changes and does address this concern to some extent. However, historical volatility still is the preferred measure for long-dated ESOs and BEE deals.

Both the simple historical volatility and the exponentially weighted historical volatility are used in valuing BEE deals and ESOs.

#### 4.3.4.2 Implied Volatility

Implied volatility is another measure that is used to estimate the movement of the share price that is expected to realise over the term of an option (Beckers (1981)). In particular, it incorporates the impact that being in- or out-the-money would have on the option price. It is deduced from the price of a traded option in the market by solving the volatility-value that would result in the model pricing the option to the market.

When the prices of traded options are available, they, together with term-to-maturity, moneyness and the particular pricing model, can be used to establish the relevant volatility that would cause the theoretical value for the option equal to the current market price of that option. The use of implied volatility incorporates long-observed features which indicate that it does tend to vary with respect to strike price and expiry and leads to such observations as the volatility smile and skew.

The ‘volatility smile’ is a pattern that occurs for some instruments in which at-the-money options tend to have lower implied volatilities than in- or out-of-the-money options. When implied volatility is plotted against strike price, the resulting graph tends to rise in both the downside and upside directions indicating a higher volatility the more the option is out- or in-the-money. This can be interpreted as investors paying a premium on options that are not at-the-money.

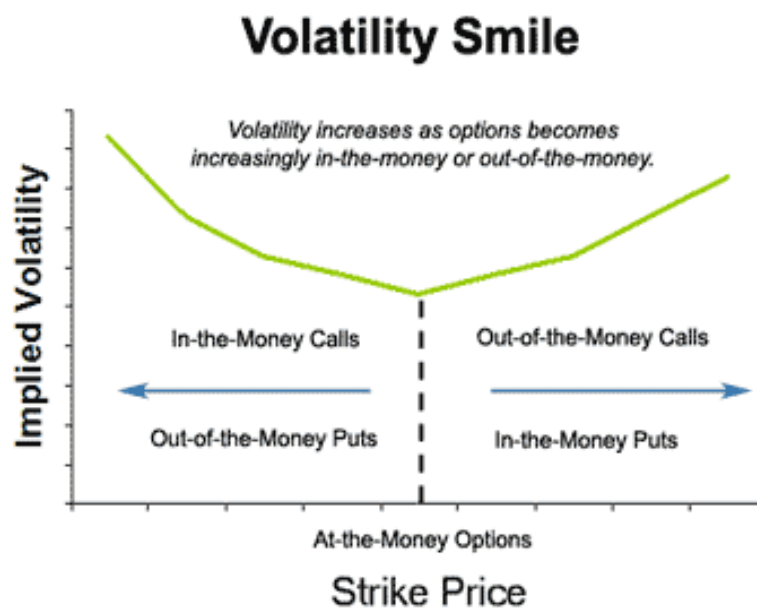


Figure 4.7 - Illustration of the volatility smile

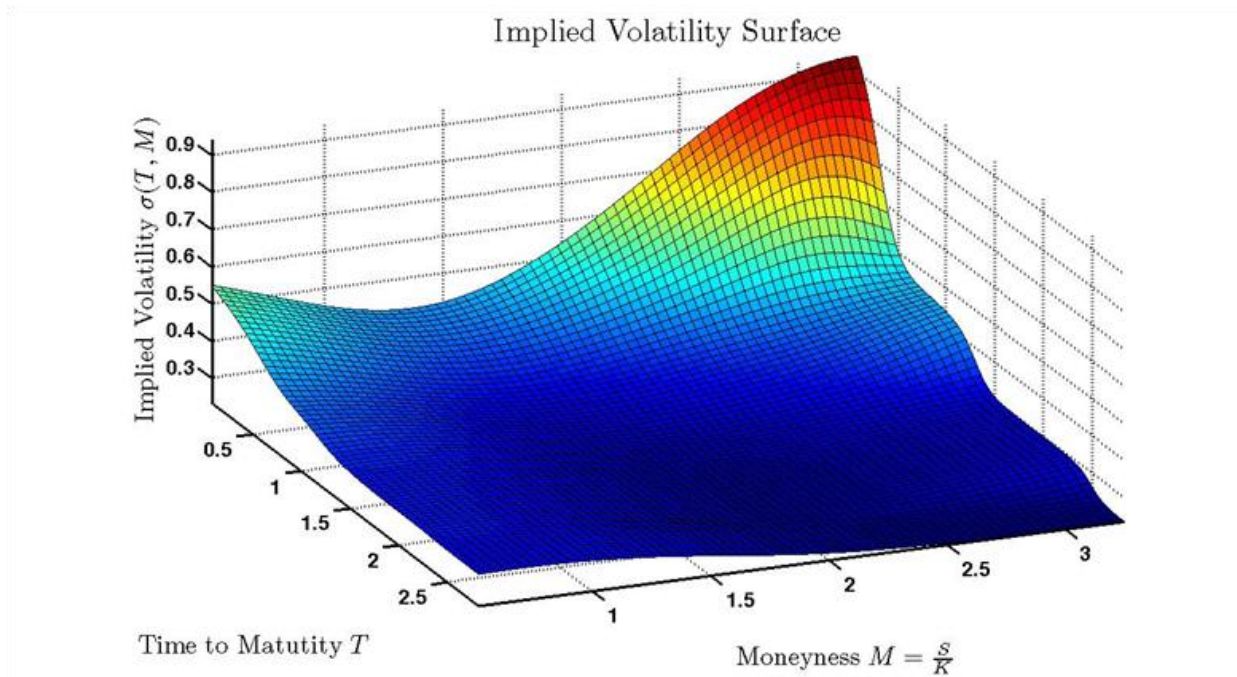
For markets where the graph in Figure 4.7 is downward sloping, such as equity options, the term ‘volatility skew’ is often used to describe its shape. This is shown on the right hand side as in Figure 4.8.



**Figure 4.8 - Volatility skew compared to volatility smile**

When the market prices of a number of options of different maturities and strikes on the same underlying asset are available it is possible to generate a volatility surface for the specific underlying asset that can be used when pricing options. This is common practice in ensuring that the option prices generated by the pricing models produce values that are in line with option prices in the market. For this reason implied volatility surfaces are used extensively in the industry when pricing liquid options.

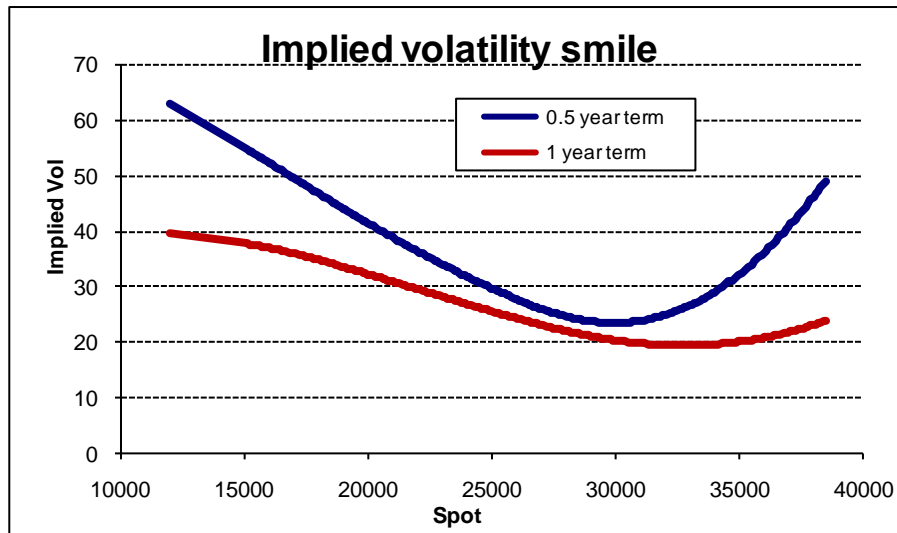
It should be noted that in South Africa volatility surfaces are frequently generated off the forward price of the underlying share price. To obtain the correct volatility-value from the volatility surface when pricing, this has to be taken into account. It is incorporated by calculating the forward price of the option at its maturity and using this value to determine the moneyness. The extended lifetimes of these transactions could cause the moneyness to differ substantially between the share price at inception and the forward price at maturity. The slope of the volatility-curve at the particular maturity would determine how much the increased moneyness changes the implied volatility.



**Figure 4.9 - Volatility surface**

Figure 4.9 illustrates a volatility surface which flattens out as the maturity increases. The volatility is considerably less sensitive to the moneyness as the maturity increases. The impact of the moneyness is significant at the shorter maturities (<0.5 years). For ESOs and BEE deals with longer maturities (>2 years) the moneyness becomes less of a factor as the volatility shows little differentiation along this axis.

In order to assess the applicability of the implied volatility in valuing ESOs or BEE deals it is important to realise the subtle difference in the meaning of an implied and historical volatility measure. Where the historical volatility directly refers to the change in the value of the underlying share price, the implied volatility uses the price of traded warrants to reverse-engineer an appropriate volatility. The price of a warrant and its underlying share should be highly correlated but is seldom perfectly correlated. It is also possible that there may be a more liquid market for the share than its warrant which will lead to different volatilities. This is confirmed by the volatility smile in Figure 4.10.



**Figure 4.10 - Implied volatilities for options with a strike of 31000**

The share price can only have single volatility over a fixed period, irrespective of the strike on an option. Since the implied volatility is used to bring the price of traded options in line with other traded options (where market forces on the option play a role), it is appropriate to use when pricing traded options. But since the volatility used for non-traded BEE deals and ESOs should primarily reflect the variability of the underlying share, it is not the first choice volatility measure. The reason for the difference is that the implied volatility incorporates the demand for options at different levels of moneyness.

When one transposes this notion unto the ESO world, it becomes clear why IFRS 2 suggests the use of historical volatility when pricing ESOs. The fact that ESOs cannot be traded means that their intrinsic value is solely driven by the level of the underlying stock and not by the demand for publicly traded options on the underlying share. However it is possible that holders of ESOs and BEE shares value at-the-money options lower than highly in- or out-the-money options. If this is the case, then the ‘smile’-formed volatility-curve would be more appropriate to use in pricing these deals.

Rubinstein (1994) investigated the alternative of including the volatility smile into option pricing directly. He showed that OTM put options have a significantly higher implied volatility than in ITM put options and that not including it would cause the Black-Scholes model to under value OTM options. This approach is simple to implement into an existing pricing model (Monte Carlo simulation) but is more suited for traded options than ESOs and BEE deals.

It is still worth mentioning the implications of implied volatility for two reasons:



- If an option starts trading that has similar properties to the untraded option for which volatility is required (long-dated, similar strike), the implied volatility could be considered.
- A case can be made that the volatility smile observed for traded options should also exist on non-traded options for which a price is estimated. An ESO or BEE deal that is far in or out of the money might be valued disproportionately less by its holder than an at-the-money option.

#### 4.3.4.3 Stochastic Volatility

Stochastic volatility refers to a model-based volatility that is driven by its own stochastic process when determining the option price and is therefore not constant over the life of the option. It is not commonly used in the valuing of ESOs or BEE deals where the historical or implied volatility measure has been favoured. Historical volatility is used when a lack of similarly traded options do not allow for the calculation of the implied volatility. The justification for using the historical volatility is that over the long term of the option the volatility will eventually revert back to its long-term average. However a much better approach would be to use a mean reverting stochastic volatility model which also allows for deviation away from the long-term volatility of the option which is recommended by Chang and Chang (1996).

The impact of using a stochastic measure in the volatility is now illustrated. Heston (1993) introduced a stochastic volatility model which assumes a mean-reverting volatility to describe the dynamics of the stock price as

$$dS_t = rS_t dt + \sqrt{V_t} S_t dW_1 \quad (161)$$

where the volatility at time  $t$ ,  $V_t$ , is driven by the process

$$dV_t = \kappa(\theta - V_t)dt + \sigma\sqrt{V_t}dW_2 \quad (162)$$

and the two Wiener processes are correlated such that

$$dW_1 \cdot dW_2 = \rho dt. \quad (163)$$

The additional stochastic volatility measures that the model uses are:

- $\kappa$       The rate at which the volatility returns to its mean
- $\theta$       The long run average of the volatility.
- $V_0$      The initial variance of the share price

- $\sigma$  Variance of the instantaneous volatility (vol of vol)
- $\rho$  Correlation parameter

This model implicates that the volatility is square root mean reverting with a long-run volatility of  $\theta$  and rate of reversion of  $\kappa$ .

It can be shown (but is out of the scope of this report) that the solution of the option price reduces to a complicated integral but is still in a closed-form solution.

The impact of using stochastic volatility is analysed by comparing the option value derived from the standard Black-Scholes model with one the uses Heston's approach. The standard model inputs are:

- Spot 45.24
- Strike 50.00
- Maturity 1 year
- Volatility 57.4%
- Interest rate 10%

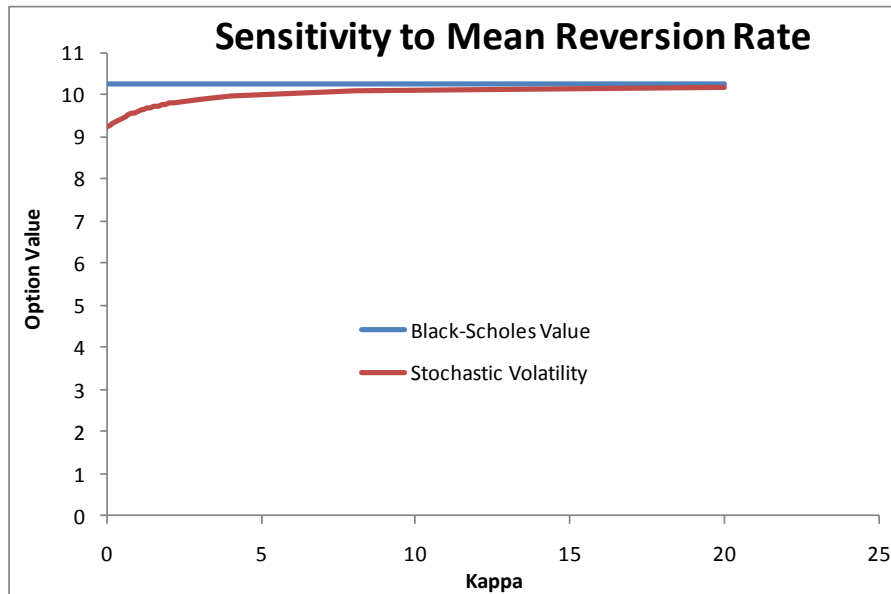
These inputs results in a call option-value of **10.23**. The following Heston stochastic volatility inputs are implemented:

- $\kappa$  1
- $\theta$  33%
- $V_0$  33%
- $\sigma$  64.8%
- $\rho$  -62.6%

The corresponding option-value changes to **10.61**. To understand the impact of each of the Heston model inputs fully, the option value's sensitivity to them are analysed. In each case the parameters as shown above are used except for the one being analysed.

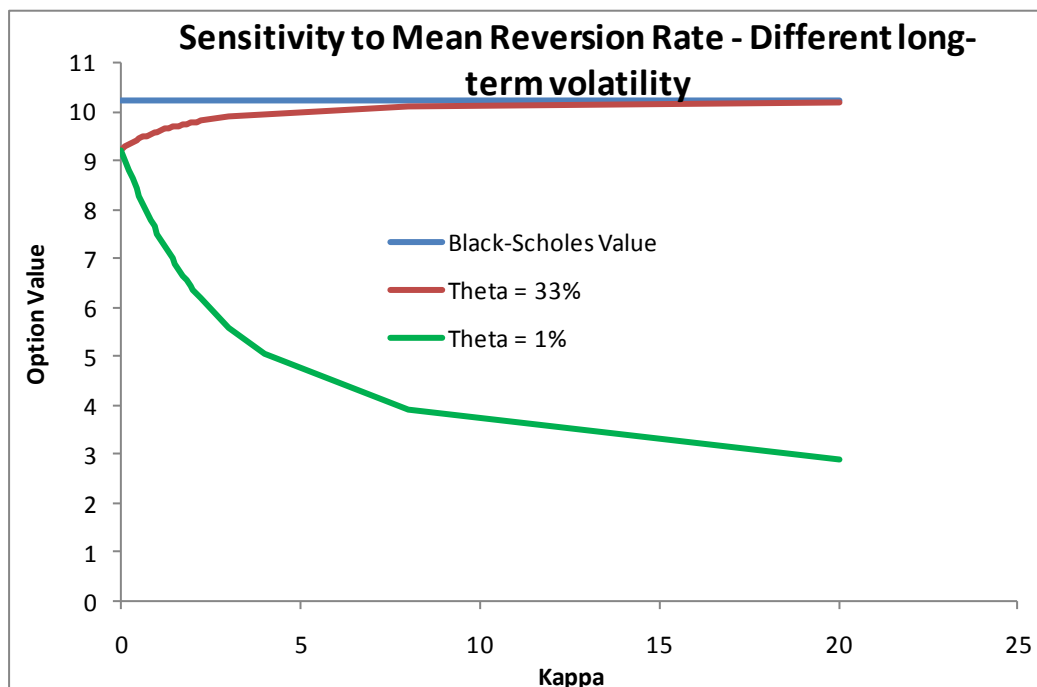
#### 4.3.4.3.1 Sensitivity to Mean Reversion Rate

The mean reversion rate,  $k$ , determines how fast the volatility returns to its long-term average when it has drifted away. It can be compared to the angular frequency of a sine wave which states how many oscillations occur within a specified time interval.



**Figure 4.11 - Option value sensitivity to the mean reversion rate of the stochastic volatility**

As the mean reversion rate increases, the volatility tends back to its long-term average in a shorter period of time but is also likely to diverge away from it faster. The impact on the option value is that the increasing rate of reversion increases it. However this is not always the case and depends on the other stochastic inputs as well. For instance, if the long-term average of the option was 1% instead of 33%, the impact is different.



**Figure 4.12 - Option value sensitivity to the mean reversion rate using different long-term volatility levels**

The lower long-term volatility causes the option value to decrease as the mean reversion rate increases since the volatility now tends towards a much lower level (1% vs. 33%).

#### 4.3.4.3.2 Sensitivity to the Variance of the Instantaneous Volatility

The variance of the instantaneous volatility (commonly referred to as volatility of volatility) measures the amplitude of the sine wave introduced in Section 4.3.4.3.1 and refers to the degree by which the instantaneous volatility can diverge from the long-term volatility.

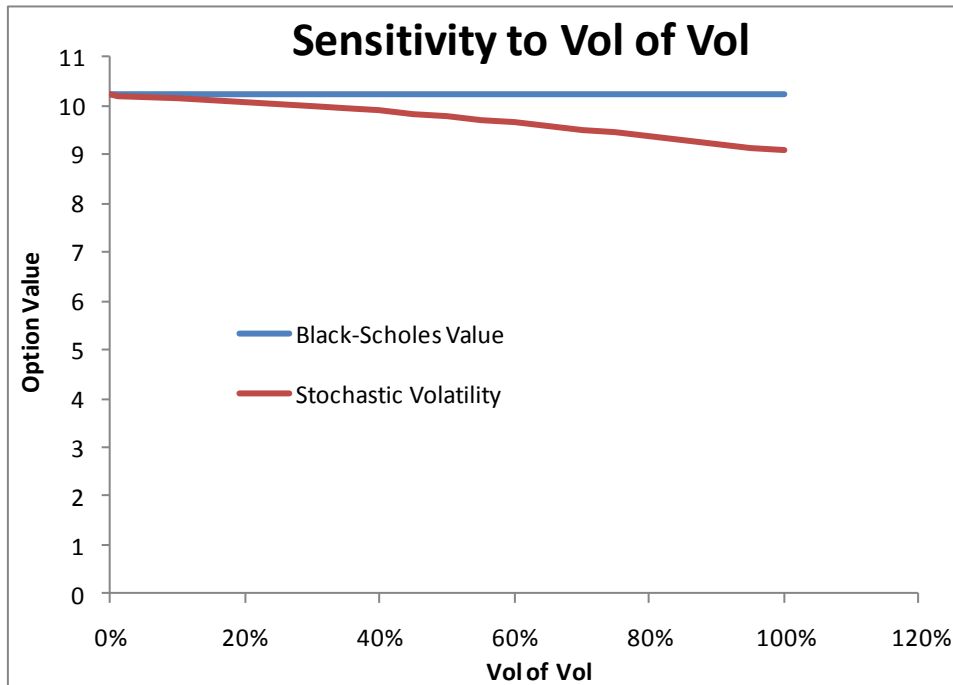


Figure 4.13 - Option value sensitivity to the volatility of the volatility

The increase in the *vol of vol*-measure reduces the option value. As with the mean reversion rate, its impact depends on that of other measures.

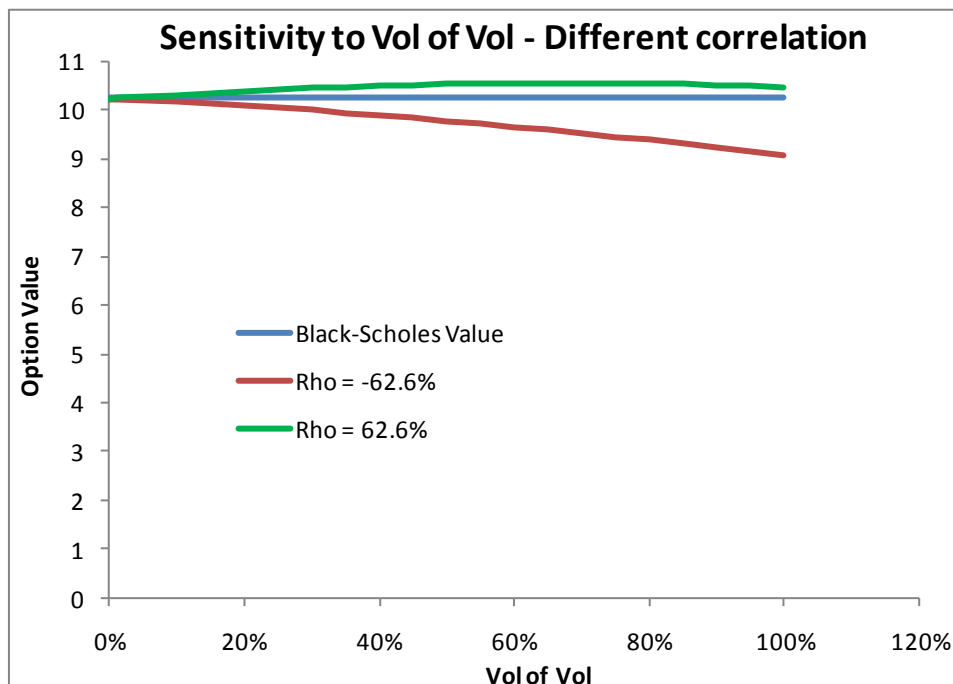


Figure 4.14 - Option value sensitivity to the volatility of the volatility using different correlation levels

When the correlation is changed from -62.6% to 62.6% the resulting variance of the volatility increases the option value.

#### 4.3.4.3.3 Sensitivity to the Long-term Variance

The long-term variance of the share price is the level around which the instantaneous volatility oscillates.

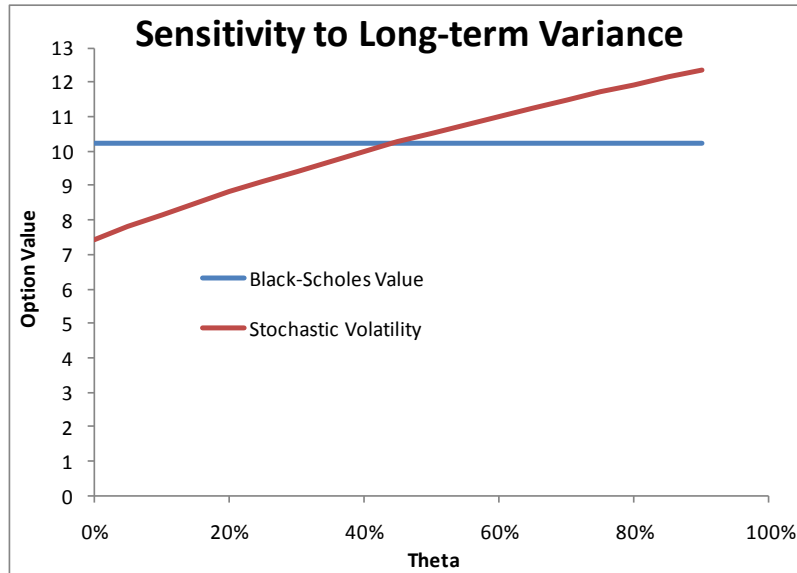


Figure 4.15 - Option value sensitivity to the long-term variance

As the long-term variance increases, so does the option value.

#### 4.3.4.3.4 Sensitivity to the Correlation

The correlation between the two Wiener processes describes what should happen to the volatility as the share price changes.

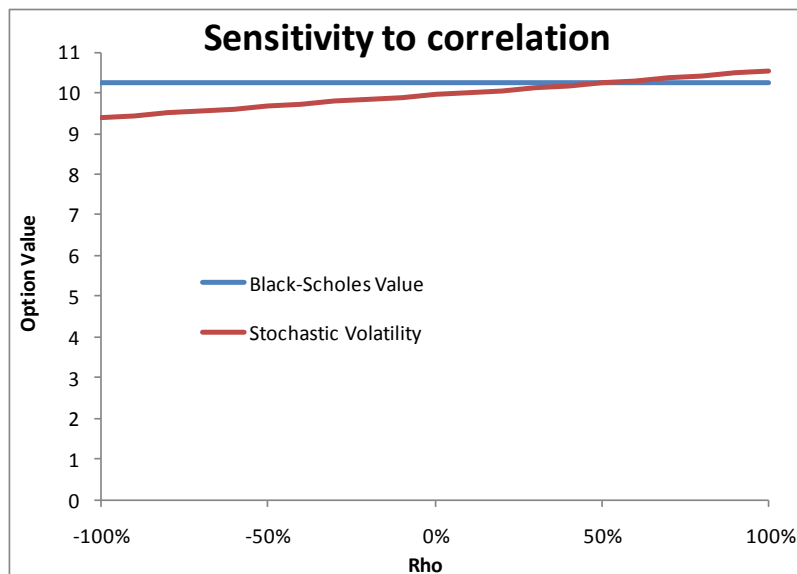


Figure 4.16 - Option value sensitivity

As the correlation increases, the option value increases and even exceeds the value produces by the Black-Scholes model.

#### 4.3.4.3.5 Conclusion

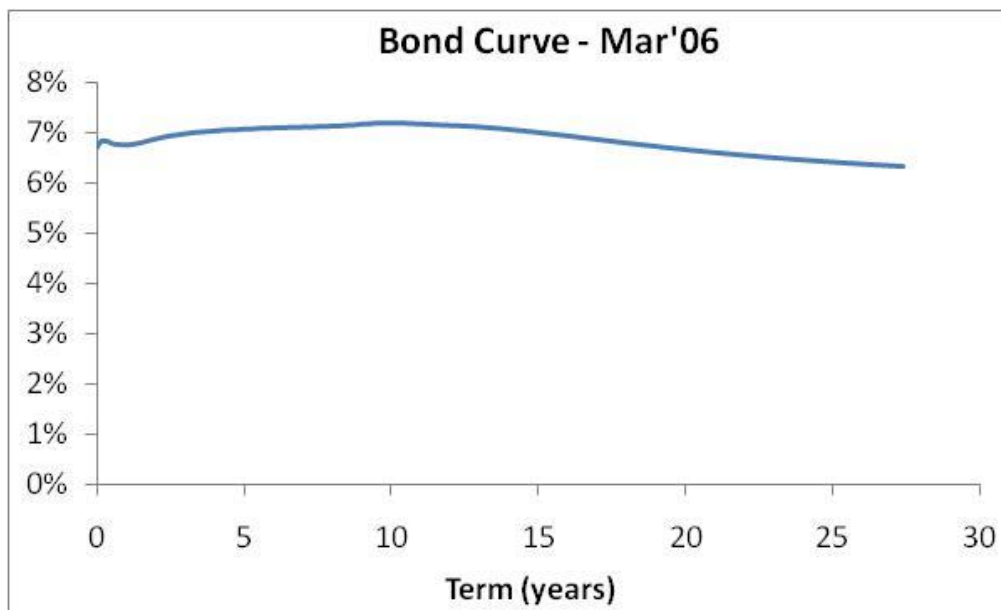
Using stochastic volatility in pricing ESOs and BEE deals would enable the use of a more sophisticated model to recognise that the volatility of a share may not stay constant over time (see Figure 4.6). This is especially true for ESOs and BEE deals with maturities much longer than regularly traded options. However, since it was illustrated that the inputs to the Heston model have a significant impact on the value of the option, calibrating these factors correctly is essential. Scott's (1997) analysis of the results of a stochastic volatility ESO pricing model also shows that when the important empirical characteristics of stock return variability are incorporated in pricing of ESOs, these additional features have a significant impact on option values, particularly on the values of longer term options.

However, the use of stochastic volatility models to price ESOs and BEE deals is not widely used in South Africa (see Section 7.6 & Section 10.6) with historical or implied volatility measures being preferred. The reason is believed to be related to the following:

- Historical and implied volatilities measures are recommended by IFRS 2 to be used in the pricing of ESOs and BEE deals.
- The use of a stochastic volatility pricing model adds significant complexity to the calculation of the option value. Since ESOs and BEE deals are not traded, there is no way of validating that the prices produced by a stochastic volatility model are realistic. A more robust model would therefore be preferred.
- Market practitioners responsible for pricing the deals often need to discuss them with management of the company. A simple model that is more transparent often takes preference.
- The availability of liquid options that are appropriate for the calibration of the parameters of a stochastic volatility model is often problematic.

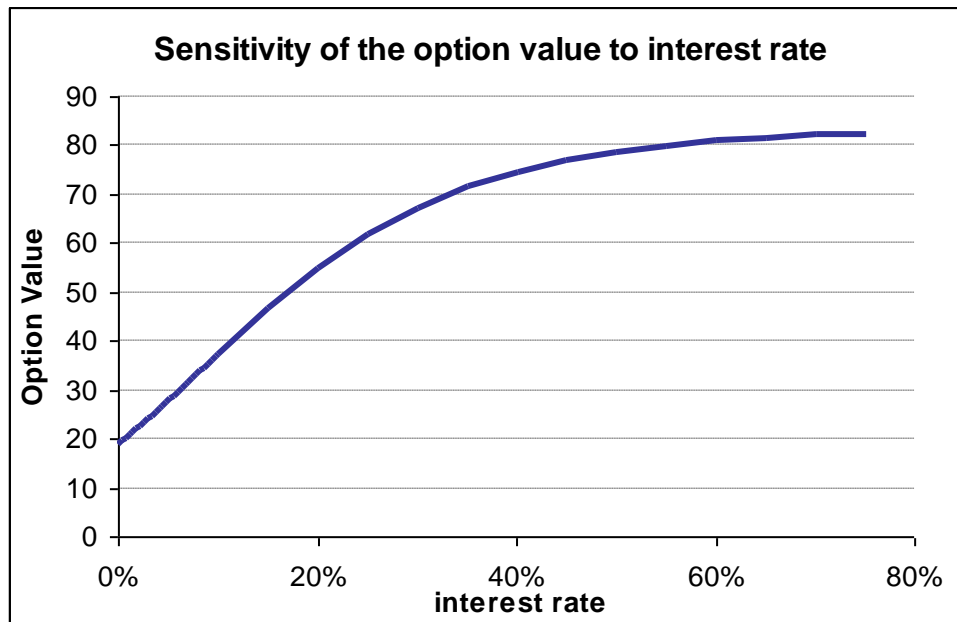
### 4.3.5 Interest Rate

The interest rate ( $r$ ) used in option pricing reflects the funding rate of the issuer who has to hedge the instrument. However, IFRS 2 stipulates that the rate used in pricing share-based payments (i.e. ESOs and BEE deals) should reflect the risk-free interest rate of the economy in whose currency the exercise price is expressed. For ZAR-based ESOs and BEE deals in South Africa the risk-free interest rate can be derived from market yield curves for zero-coupon South African government bonds.



**Figure 4.17 - Bond curve on 1 March 2006**

The risk-free interest rates on the bond curve in Figure 4.17 corresponding to the time to maturity of the option is used in pricing the ESOs and BEE deals.



**Figure 4.18 - Sensitivity of the option value to the interest rate**

The risk-free interest rate affects the price of an option in a less intuitive way than expected volatility or expected dividends do. As the interest rate increases so does the discount factor as well as the forward price at exercise. In the option in the example the net effect is that the option value increases.

Since IFRS 2 prescribes that the implied yield on government bonds should be used as the interest rate to price ESOs and BEE deals no adjustment is made for the company's own funding rate or even credit risk that might exist. If these factors were used it would increase the rate at which future payments are discounted at, thereby reducing the value of the option.

### **4.3.6 Dividends**

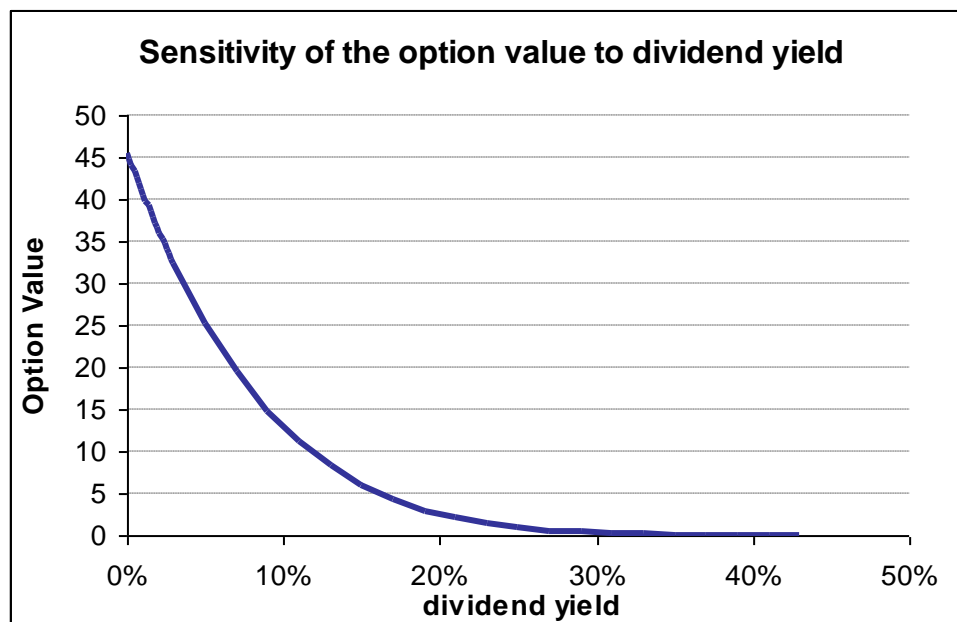
Dividends that are expected to be paid over the term of the option play a significant role in the fair-value of the instrument. In the case of ESOs the option holder only starts to receive the economic benefit of dividends when he exercises the option and takes ownership of the underlying shares. Up until that point the dividends included in the model only serves to reduce the share price at every dividend payment date by the size of the dividend. In BEE deals their application depends on the contract. If the holder of the option does not get the benefit of the dividends, they will merely reduce the expected future share price and reduce the value of the deal (similar to ESOs). However, when the proceeds of dividend payments do go to the holder they add to the value of the option. If the BEE partner can use the dividends to reduce the debt



on the BEE deal or keep it for himself, the benefits he receives should be included into the pricing model of the BEE transaction accordingly.

Dividends are often added into a model as dividend yield. In this case the annual dividend is expressed as a percentage of the share price on the dividend date. Discrete dividend payments can also be used if this gives a more accurate reflection of the company's dividend policy over the term of the option. If the share price is viewed as the present value of all future dividends (Gordon (1959)) then irrespective of how dividends are incorporated into pricing of ESOs or BEE deals, the present value of the estimated dividend payments cannot exceed the share price.

The historical dividend yield is often used as the input parameter.



**Figure 4.19 - Sensitivity of the option value to the dividend yield**

Figure 4.19 shows a negative relationship between the price of the option and its dividend yield. This would be the case for a simple European call option where the option holder is not entitled to proceeds from the dividends until he has exercised the option. In the model, dividends reduce the share price as they are paid. A BEE deal where there is often economic benefit to the holder even before he exercises options would not show this negative relationship.

As with volatility, there might be a reason that the historical data might not be applicable for pricing of the ESO or BEE deal. Consultation with senior management can assist in getting a sense of whether a similar dividend policy will be followed than what was used historically. The sensitivity of the option value to the dividend yield illustrates how critical this input is. In some case it might be more appropriate to use discrete dividends rather than a dividend yield rate.

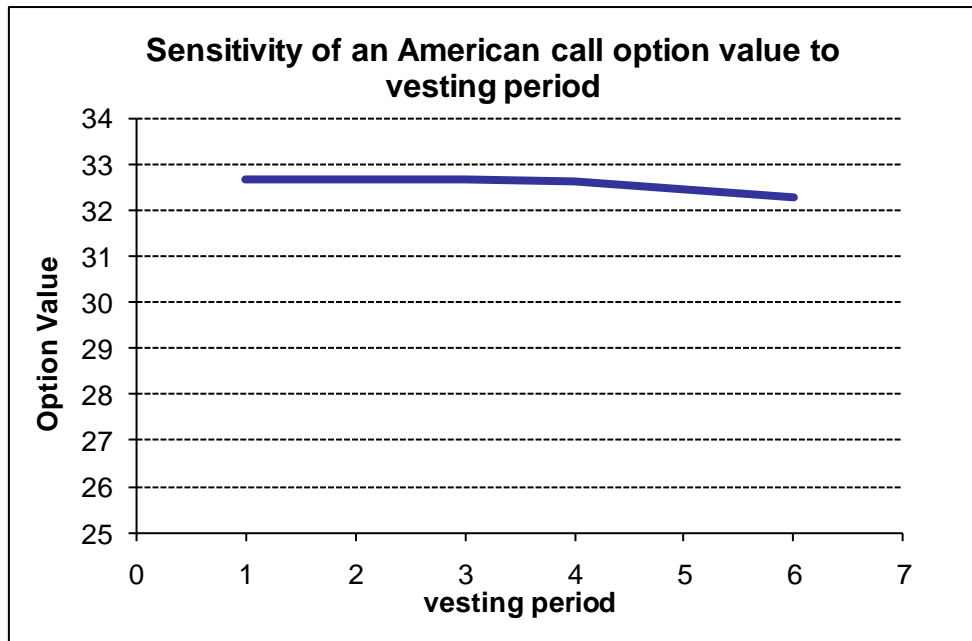
This might be the case if the management of the company has stated their intention to target a specific dividend amount. In such cases care should be taken to ensure that the share price still represents the present value of the dividends. A more comprehensive dividend framework can also be used by introducing a stochastic dividend model into the pricing model (Bjork (2004)).

### 4.3.7 Vesting Period

During the vesting period of a contract the holder is unable to sell his BEE shares or exercise his ESOs. To incorporate the effect of the vesting period on the price of an option a binomial tree pricing model can be used. The model acknowledges that the option holder can only exercise his option between the vesting date and the maturity date by not allowing exercise to take place at those nodes in the vesting period. The American nature of the option is now being accounted for.

Model	Binomial Tree / American
Spot	100
Strike	100
Term	6
<b>Vesting Period</b>	<b>3</b>
Interest Rate	7.5%
Volatility	30.0%
Dividend Yield	3.0%
Steps	300
<b>Option Value</b>	<b>32.74</b>

The option value of R 32.74 is slightly higher than the option value produced earlier by the European model in Section 4.3 of R 32.33. The earlier model assumed exercise occurs at maturity of the option while this one allows the holder to exercise any time after vesting. Looking at the instrument's sensitivity to the vesting period confirms the result.



**Figure 4.20 - Sensitivity of the option value to the vesting period**

As the vesting period increases, the option value reduces. The choice relating to when the option can be exercised becomes less and less. The relatively low sensitivity of the option value to the vesting period indicates that from a theoretical point of view little is lost by having to exercise at maturity. This is because a rational investor will still wait as long as possible before exercising. This happens at maturity when the share price has had an opportunity to grow. The limitation on exercise due to the vesting period therefore does not influence the value produced significantly.

#### **4.3.8 Closed Periods**

Holders of options who may have privileged information on the company's result that could affect the share price are often restricted from exercising their options during certain times of the year. This is typically when company results are to be published and the share price may be highly volatile. Many employees or BEE participants could have knowledge on how the results will cause the market to react and may be tempted to act upon this information by exercising some of their options or selling their BEE shares. This would however be illegal as it is a form of insider trading. Therefore, when results are finalised and published (interim and final) these holders are generally not allowed to trade their rights.

#### 4.4 Option Holder Related Inputs

Companies endeavour to have the cost relating to the ESOs or BEE deals as small as possible. As it is accounted for as an expense, it reduces the profit in the income statement. In most cases the standard valuation models overestimate the value of the option considerably according to Huddart & Lang (1996). This is due to the fact that both the standard Black-Scholes and Binomial Tree Models (excepted valuation models) assume that exercise will take place at maturity of the option (the time at which exercise takes place under the Black Binomial Tree model is very close to maturity). This is because these models assume that a rational investor will exercise the share options when it is optimum to do so from a valuation point of view. The regular way for utilising a Monte Carlo simulation model also calculates the fair-value based on exercise at maturity. However, in many cases there are long periods between the vesting and maturity dates. During this time employees may want to exercise their ESOs when they are of the opinion that the prevailing share price will result in a significant pay-off. Even senior executives cannot all be expected to hold on to the options until the optimal exercise time. Similarly, the partners in a BEE transaction may want to liquidate their positions before maturity of the deal. Option holders cannot hedge the risk on their portfolios (insiders are not allowed to short-sell the company shares) which implies that the risk-neutral principle underpinning the pricing models does not apply. Therefore, ESO holders cannot be expected to act 100% in line with other market participants.

The biggest issue relating to the valuation of these types of instruments is to quantify the fact that the option might be exercised before maturity. There is pressure on the issuing company to make assumptions that will lower the fair-value to reduce its associated expense. Prudent auditors will verify that the assumptions on which pricing is done, can be justified. Huddart & Lang (2005) state that failure to adjust the prices of ESOs for early exercise will introduce significant bias in its prices.

The question thus becomes how to view the exercise behaviour of employees with ESOs and BEE partners. Will they hold on to their options for as long as possible to give the share price time to grow or do they prefer cashing in as soon as a reasonable payoff is obtainable? In addition, the fact that employees leaving the company forfeit their unvested options also impacts the fair-value of ESOs. A number of different measures have emerged that aim to represent the exercise behaviour of the option holders.

#### 4.4.1 Exercise Multiple

In an attempt to align the exercise behaviour of option holders with the performance of the share price, the exercise multiple is often utilised. The exercise multiple, introduced by Hull & White (2004), refers to the degree by which the share price must exceed the strike price before the employee will exercise his options. For example, if the exercise multiple is 1.3, a share option with a strike of R100 will be exercised as soon as the share price is at least R130. The exercise multiple is often used and can be implemented into the Binomial Tree method or Monte Carlo model. Models built on this theory are freely available on the internet<sup>2</sup>.

The sensitivity of the ESO value to the exercise multiple requires a way of quantifying an exercise multiple value that can be justified. The obvious approach would be to analyse historical exercise behaviour to come up with a defensible input value. This approach has been tried by many scholars and practitioners but no conclusive method has yet been suggested – especially for South Africa. Research done on 40 American firms by J Carpenter (2004) observes exercise multiples between 1.68 and 3.33. No conclusion is drawn on a single exercise multiple that will be most appropriate. West (2005) suggests a method that uses two observed exercise multiples to construct an exercise multiple curve across a range of share prices. This curve is used by a binomial tree model to obtain an exercise multiple at each node. This methodology supplies an elegant way of incorporating observed exercise behaviour into the pricing of an ESO but is dependent on the existence of sufficient historical exercise data from which such a curve can be reliably constructed. Huddart & Lang (1996) showed that while early exercise occurs widespread, it is not uniform from one grant to the next. A number of factors play a role in the employee's decision to exercise early (recent stock price movements, in-the-money-ness, proximity of vesting dates, time to maturity and volatility) but the exact impact of each is unclear. Bettis, Bizjak & Lemmon (2005) who considered over 140,000 exercises confirmed the lack of uniformity in exercise behaviour.

In South Africa it has become common practice to use a combination of different exercise multiples<sup>3</sup> (1.3, 1.5 and infinite) when valuing ESOs. However, no research has been published to support the approach. It is also questionable whether a single set of exercise multiples can be used across different industries and level of employees.

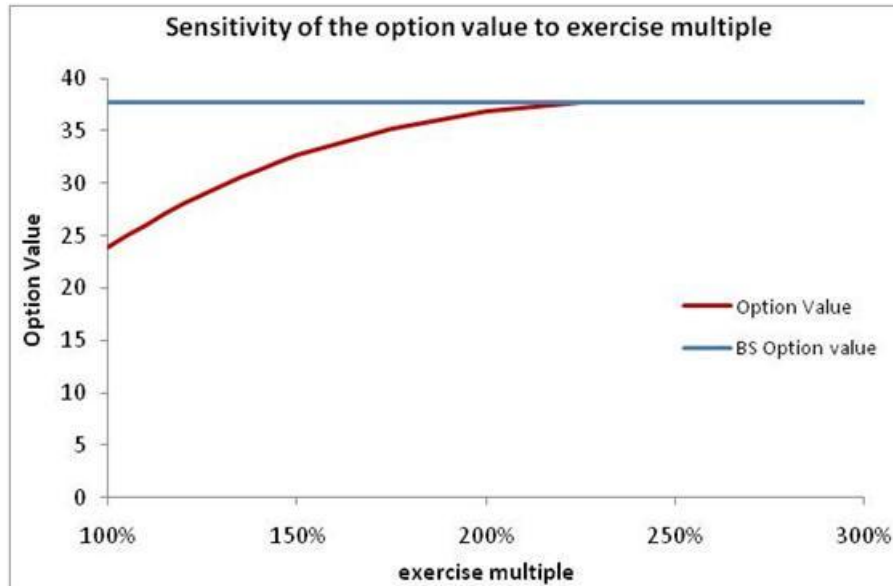
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<sup>2</sup> [www.exercisemultiple.com](http://www.exercisemultiple.com)

<sup>3</sup> See Section 7.6

Many BEE transactions are valued on the assumption that the BEE partners will not cash in their shares before maturity even though there is a great need for them to get access to the economic benefits of their shares before the deal matures.

In the following figure different exercise multiples are applied in a binomial tree model to the option in Section 3.7.



**Figure 4.21 - Sensitivity of the option value to the exercise multiple**

As the exercise multiple increases the option value does too. The value starts off at 24.38 when the exercise multiple is 100% and when it reaches 300% (spot is three times strike) the option value stabilises at 32.33. This is the same option value produced by the Black-Scholes model and standard binomial tree in Section 3.7. This is consistent with the view that those models calculate the option value based on exercise taking place at maturity.

Exercise data is difficult to obtain due to the sensitive nature of the information. Furthermore, trends that might be observed for a certain company might not be applicable to another due to the reasons outlined in Section 7.5.2. The following figure shows the historical exercise behaviour of 12,4m share options as it relates to the exercise multiple. These share options were issued between 1997 and 2004 to employees of a South African construction company.

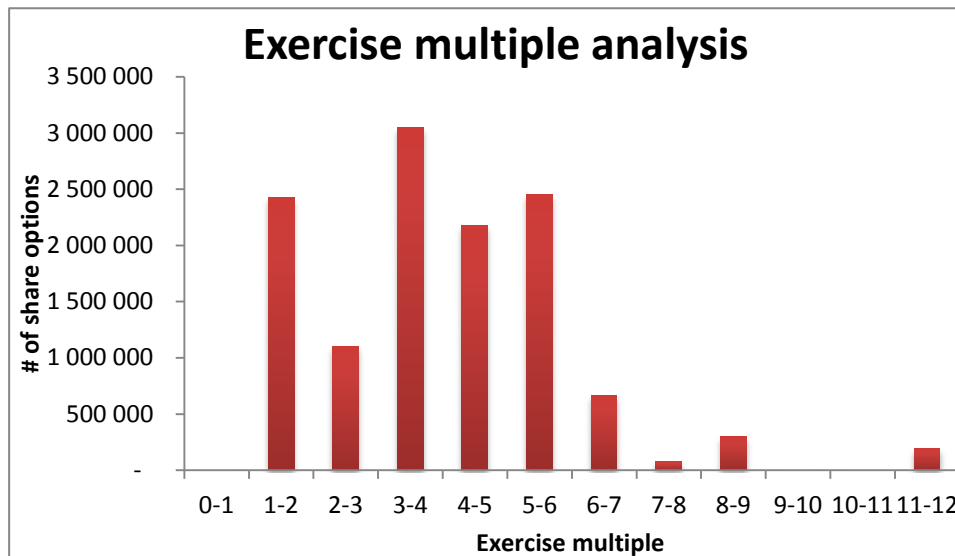


Figure 4.22 - Analysis of historical exercise multiples

All exercise multiples are larger than one since the options must be in-the-money (spot > strike) for it to be exercisable. 98% of the options were exercised when the multiple was between 1 and 9 with an average share weighted exercise multiple of 4.00. There is no distinguishable distribution to indicate whether there is a trend in the exercise behaviour of the employees.

#### 4.4.2 Expected Life

The expected life refers to the term from issue date until exercise is expected to take place. If the share price has grown substantially over the vesting period, many employees will exercise their options as soon as it is contractually allowed (option has vested). However, if the share price does not show much value when it vests, the holder is likely to hold on to it. When conventional option theory is applied to finding the expected life of the share option, the rational investor would only exercise shortly before maturity. However, this is very seldom the case and companies trying to minimise the expense, would argue this point. A typical approach would be to assume some holders exercise at vesting, some mid-way through the option term and the rest at maturity.

IFRS 2 encourages the use of an expected life input as long as a distinction is made between employees' level of seniority in the company. Alternatively, this approach can be used to validate values obtained through alternative methods.

Rudkin (2006) examines some of the most common features of ESOs. He points to a certain paradox within the commonly used models today. Since many options are exercised soon after they have vested, options with longer vesting periods will be exercised later and be valued

higher. This is of course not so for the employee who has less optionally if his ESO has a longer vesting period and was confirmed in Section 4.3.7. This observation emphasises that ESOs are valued from the point-of-view of the employer. The following figure looks at the time it took employees to exercise their options once it vested.

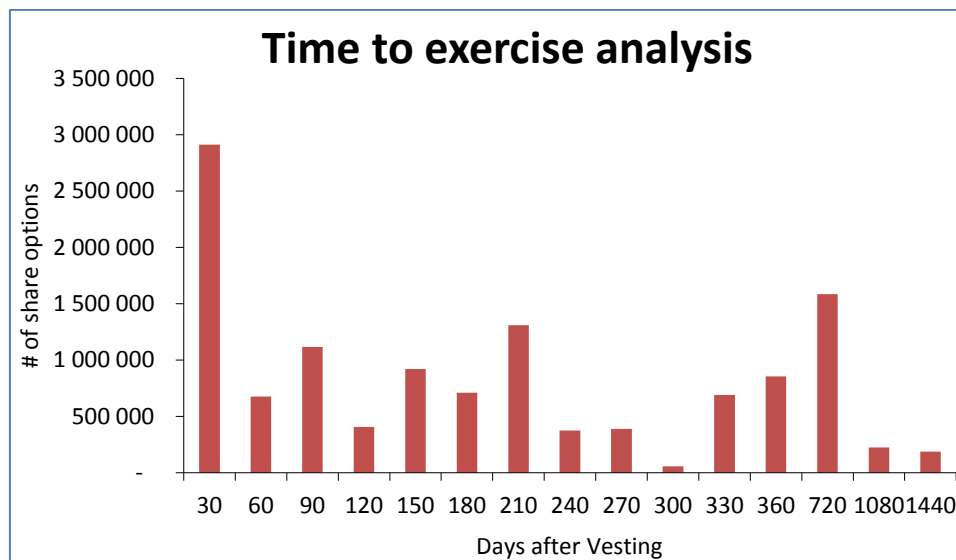


Figure 4.23 - Analysis of time to exercise

A large portion (24%) of the share options were exercised within a month of them vesting while the remaining was exercised over a period of four years. It is difficult to determine whether this was due to the preferences of the employees or whether the share price forced the behaviour. It is possible to look at subsections of the data but since the data includes options with different maturity dates, strike price, employee seniority and vesting conditions, the data reduces in size very quickly when it is sliced to show only a homogenous group.



Figure 4.24 - Exercise history superimposed on the share price history



Figure 4.24 shows how options were exercised as the share price grew. No statistical significant relationship between the share price performance and the exercising of the ESOs could be established.

#### **4.4.3 Sub-Optimal Exercise Rate**

This input can also be incorporated relatively simply into a Binomial Tree valuation model. The input states at what rate employees are expected to exercise their ESOs sub-optimally i.e. exercising their options when there is more value (from a pricing point of view) in holding on to them. The approach assumes that at every step in the tree, a small percentage of the vested options will be exercised if they are in-the-money. Although the concept might seem logical, it is very difficult to obtain historical exercise data that proves this idea or enables the calculation of the precise sub-optimal exercise rate. Practitioners will typically use an untested input of around 5%.

#### **4.4.4 Exiting Rate**

This rate refers to the expected rate at which employees will terminate their employment. If this happens before the shares have vested, they are forfeited. Those ESOs that have already vested when an employee leaves the service of his current employer will be exercised at the current share price. Termination of employment could be due to the option holder being tempted to go to another employer or when he is dismissed for some reason in which case he might forfeit all benefit from vested shares as well. In order to verify this input one needs to analyse the data of employees with share options who have left their employment.

This is not a crucial input from an expensing point of view. As the actual number of shares that vest each year becomes known, the expense will be adjusted accordingly. Over- or under expensing that occurred during the vesting period will be corrected at subsequent valuation dates after the vesting date.

## 4.5 Conclusion

In this chapter various inputs used in the pricing models were examined by considering their influence on the option value. Table 4.1 summarises the sensitivity of the option value to changes in these inputs as well as the ease with which they can be calculated.

Input	Method to Obtain Input	Impact on Option Value	Determining Input is Straightforward?
Spot Price	Direct	High	Yes
Strike Price	Direct	High	No but variable strike levels can be incorporated through a Monte Carlo model
Term to Maturity	Direct	High	Yes
Volatility	Calculation	High	Depends on type of volatility used
Simple Historical	Calculation	High	Yes but a constant volatility is questionable.
EWMA	Calculation	High	Yes but the decay factor has to be determined.
Implied	Calculation	High	No as volatility curve or surface is required.
Stochastic	Calculation	High	No since such a pricing model changes drastically and the parameters for the volatility still needs to be calibrated.
Interest Rate	Semi-calculation	Low	Yes
Dividends	Calculation	High	No since the historical dividend payment history has to be aligned with the current dividend policy. The choice of using discrete dividends or a dividend yield also needs to be explored.
Vesting Period	Direct	Medium	Yes
Closed Periods	Direct	Low	Yes
Exercise Behaviour-Related Inputs	Calculation	High	No as exercise behaviour data is limited
Exercise Multiple	Calculation	High	
Expected Life	Calculation	High	
Sub-optimal Exercise Rate	Calculation	High	
Exiting Rate	Calculation	High	

**Table 4.1 - Summary of input characteristics**

The volatility and exercise behaviour-related inputs are the most contentious inputs when ESOs and BEE deals are priced. Even though the option value is highly sensitive to changes in these inputs, there is a lot of scope in calculating the input-values used in the pricing models.

IFRS 2 recommends using either the historical volatility or an implied volatility even though neither of these measures account for future changes in the volatility over the period of the option. A stochastic volatility model caters specifically for this, but adds a great deal of complexity to the model and is not widely used.

Some research has been applied to quantifying exercise behaviour-related inputs. The methodologies are intuitive but suffer from a lack of data availability to calibrate them with. This leads to unstable results.

Since ESOs and BEE deals are not traded there are no prices to compare and calibrate the theoretical prices with. This makes it difficult to identify unrealistic model prices that are caused by incorrect input-values.

## CHAPTER 5

### 5 Other Pricing Factors

#### 5.1 Chapter Overview

In Section 4 the impact of input-values on the price of a standard call option was analysed. This chapter looks at the impact of the details of the option structure as well as the specific assumption regarding the option holder's exercise behaviour on the price of the option. While the majority of ESOs have a fairly standard structure, BEE deals may exhibit a great deal of variability especially in how dividends and interest on the debt are specified. However, there is no standard model that is used in either of the cases.

#### 5.2 Impact of Structure

In this section the prices of call options with different features will be compared. This is relevant to BEE deals in which a number of variations of the basic structure is seen. The options use the following basic inputs:

- Spot 100
- Strike 100
- Term 6 years
- Interest Rate 7.5%
- Volatility 30.0%
- Dividend Yield 3.0%
- Interest on strike / debt 9.0%
- Interest on dividends 8.0%

The structures differ in the following ways:

- Structure #1: Dividends are not paid on the share<sup>4</sup>. The debt does not accrue interest.
- Structure #2: Dividends are not paid on the share. The debt does accrue interest.
- Structure #3: Dividends are paid on the share. The option holder does not get the benefit of the dividends. The debt does not accrue interest. These features are typical of those of an ESO.

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<sup>4</sup> Technically the absence of dividends is not a structure feature since it is determined by the dividend policy of the company and not the BEE transaction. It is included in this analysis to illustrate the effect.

- Structure #4: Dividends are paid on the share. The option holder does not get the benefit of the dividends. The debt accrues interest.
- Structure #5: Dividends are paid on the share. The option holder gets the benefit of the dividends. Dividends are subtracted from the debt. The debt accrues interest.
- Structure #6: Dividends are paid on the share. The option holder gets the benefit of the dividends. Dividends are subtracted from the debt. The debt does not accrue interest.
- Structure #7: Dividends are paid on the share. The option holder gets the benefit of the dividends. Dividends are not subtracted from the debt. Dividends accrue interest. The debt accrues interest.
- Structure #8: Dividends are paid on the share. The option holder gets the benefit of the dividends. Dividends are not subtracted from the debt. Dividends accrue interest. The debt does not accrue interest.

BEE deals have a high degree of flexibility in the way they work but are generally contained in one of the eight alternatives listed while ESOs are mostly in the form of structure 3. These options are further illustrated in the flow diagram in Figure 5.1.

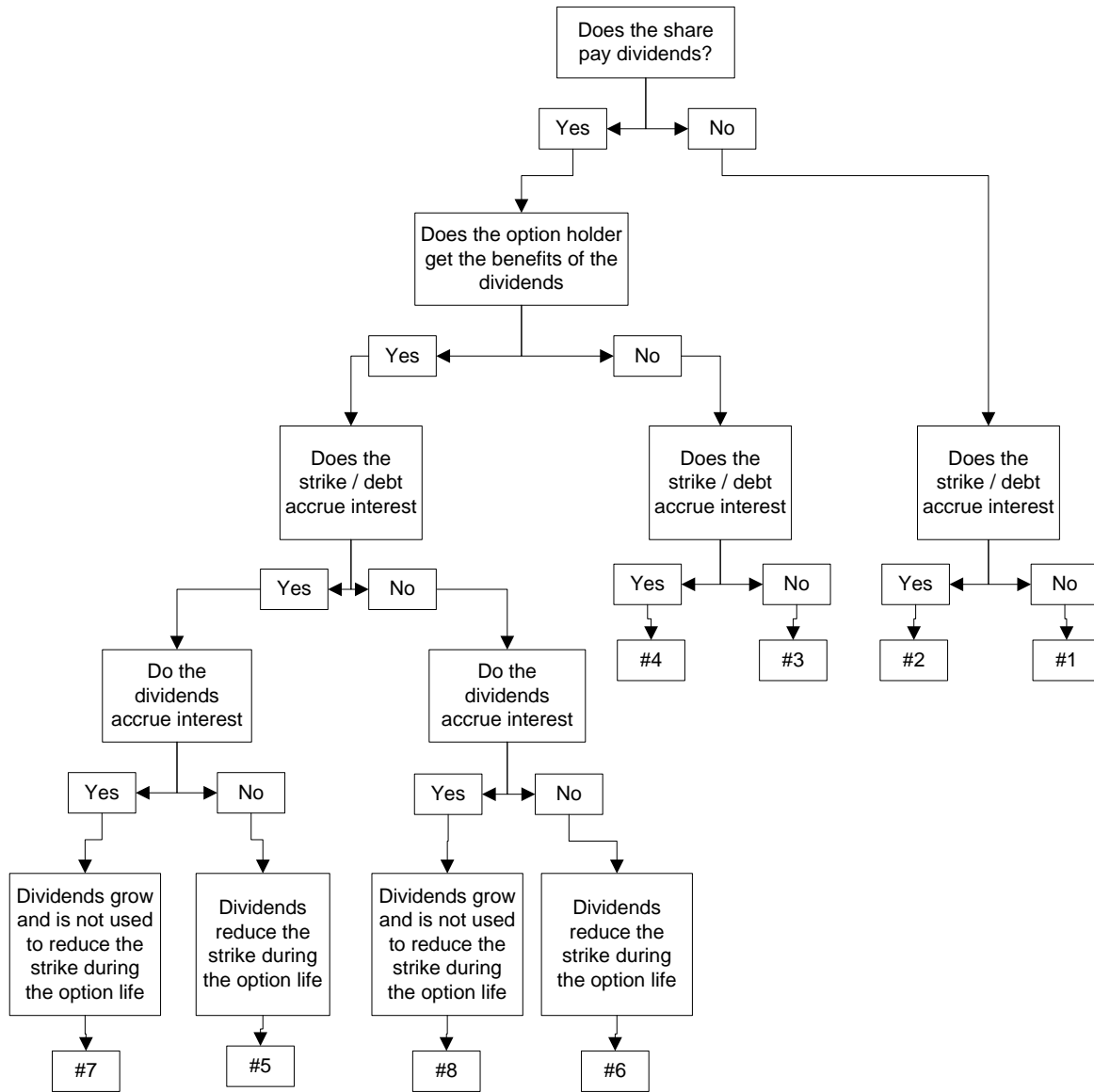
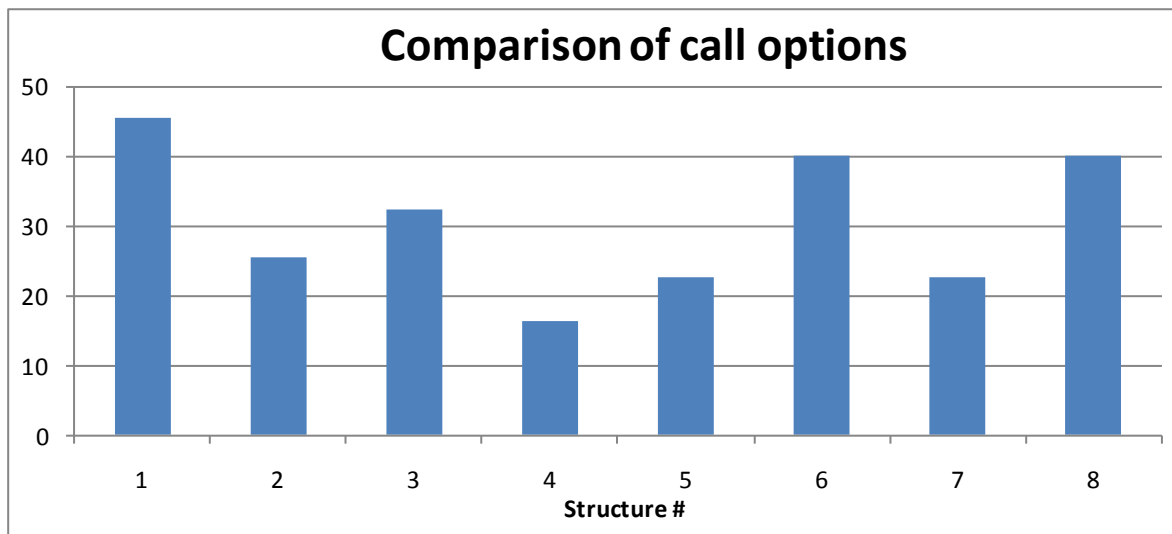


Figure 5.1 - Flow diagram of option choices

The fair-values calculated for the different call options are shown in Figure 5.2.



**Figure 5.2 - Comparison of call option fair-values**

This figure shows that structure 4 has the lowest value. Under this structure dividends are paid on the share but the holder does not get the benefit of the dividends while the debt also accrues interest. These factors collaborate to limit the payoff that the option holder will have once the restriction period has been lifted.

Structure 5 and 7 are structures in which dividends are paid on the shares while the holder gets the benefit of the dividends and the debt accrues interest. These two structures have similar values and are merely separated by the fact that while the dividends accrue interest at 8% in structure 7, they are subtracted from the debt in structure 5. From a valuation point of view there is no difference between the structures. However, some BEE deals pay out dividends to its partners while the option is still vesting to provide some form of economic benefit from the start of the deal. Such a condition will increase the value of the option.

Structure 1 has the highest value since the share price growth does not get reduced by dividend payments and there is no interest on the debt / strike.

The remaining structure values lie between the minimum and maximum values of the structures mentioned. By tweaking the features of the BEE structure, the value can be altered considerably which is indicated by the lowest structure (4) only having 36% of the value of the highest structure (1) (16.46 vs. 45.59). The underlying values can be viewed in Section 15.3 in the appendix.

### 5.3 Impact of Exercise Assumption

Having illustrated the impact of the specific features of the call option, the inputs into the pricing models will next be considered. This section illustrates the change in the value of an ESO as the assumptions relating to the option holder's exercise behaviour are changed. A similar option as in the previous section is considered with the same features as structure 3:

Spot	100
Strike	100
Term	6 years
Interest Rate	7.5%
Volatility	30.0%
Dividend Yield	3.0%
Vesting period	3 years

**Table 5.1 - Basic features of the ESO**

In the sections that follow, 12 options were priced in which the following assumptions regarding exercise behaviour were made in valuing the call options.

#### 5.3.1 Options A, B, C & D

These options do not use the vesting period as an input

- Option A: European call option valued with the Black-Scholes model.
- Option B: European call option valued with the Black-Scholes model. Exercise is expected to occur when the option vests.
- Option C: European call option valued with the Binomial tree. Exercise occurs at maturity.
- Option D: American call option valued with the Binomial tree. Exercise occurs when it is theoretically optimal.

#### 5.3.2 Options E

This approach uses the Binomial Tree method to value an American option. The vesting feature is included as well as an exercise multiple-input to align the exercise behaviour of option holders with the performance of the share price. The model will only allow exercise after vesting if the share price exceeds the strike price by the exercise multiple amount.

- Option E1: The exercise multiple is set to 5000. This forces exercise to maturity.
- Option E2: The exercise multiple is set to 1.0. Exercise occurs at the vesting date for nodes where the share price exceeds the strike.
- Option E3: The exercise multiple is set to 1.3.



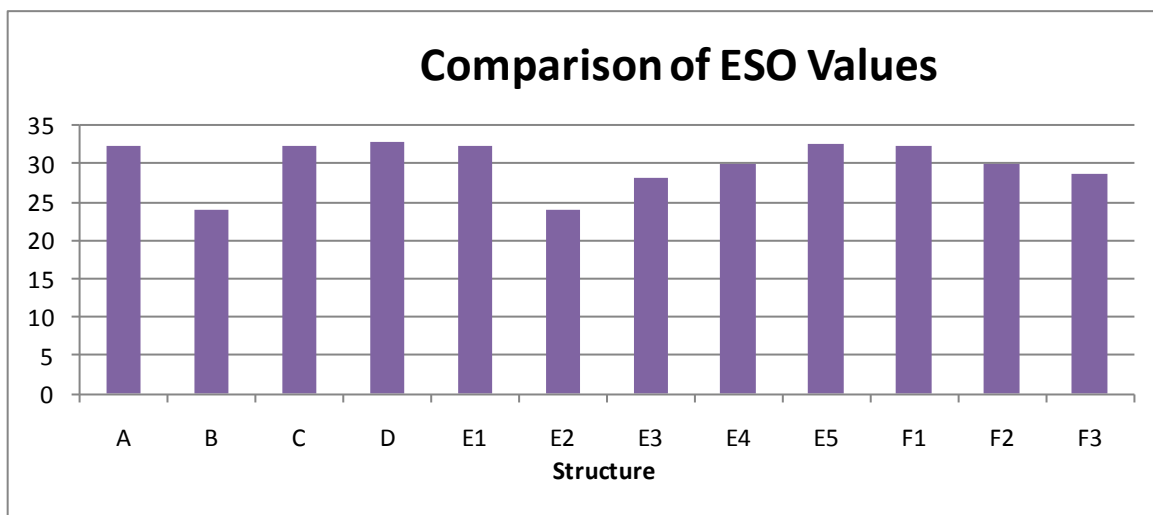
- Option E4: The exercise multiple is set to 1.5.
- Option E5: The exercise multiple is set to 5.

### 5.3.3 Options F

In this approach a sub-optimal exercise rate of 10% is included. This is an alternative way of recognising that employees or BEE participants may not wait until maturity to exercise their options. This input states at what rate the option holders are expected to exercise their ESOs sub-optimally i.e. exercising their options when theoretically it is better to hold on to them. The approach assumes that at every time period, a percentage of the vested options will be exercised if they are in-the-money. The extent that they are in-the-money is not considered. Although the concept might seem straightforward, it is very difficult to obtain historical exercise data that can be used to quantify the precise sub-optimal exercise rate.

- Option F1: The suboptimal exercise rate is set to 0%. This forces exercise to maturity.
- Option F2: The suboptimal exercise rate is set to 30%.
- Option F3: The suboptimal exercise rate is set to 60%.

### 5.3.4 Result Comparison



**Figure 5.3 - Comparison of ESO values under different exercise assumptions**

Figure 5.3 shows the option prices calculated by the various models (detailed results can be viewed in Appendix 15.4). The values for options A – F show how different assumptions regarding the employee’s exercise behaviour will affect the value of his option. The difference in value could become more dramatic as the specific input values get changed.

The structures in which it is implicated that exercise will take place close to expiry of the ESO (A, C, D, E1, E5, F1), have the highest values. While those options whose exercise assumptions indicate early exercise (B, E2, F3) have the lowest prices.

The sensitivity of option values to assumptions regarding exercise behaviour is clear. Prudent auditors will verify that the assumptions made in the valuation were valid.

## 5.4 Models for Other Types of ESOs

### 5.4.1 Option G

This approach uses a correlated Monte Carlo Simulation to include the fact that the underlying share price must out-perform a reference asset in order for it to be in the money. It has a strike that increases over time according to a reference asset. The reference asset has the following features:

Spot:	$I_0$	100
Volatility	$\sigma_I$	35%
Drift	$h$	2.50%
Correlation between spot and strike	$\rho_{SI}$	75%

In order to obtain two correlated random variables the following technique is used during each simulation:

1. Draw two independent random numbers from a standard normal distribution,  $\varepsilon_1$  and  $\varepsilon_2$ .
2. Determine two correlated random numbers,  $X_1$  and  $X_2$ , from the numbers obtained in step 1:

$$X_s = \varepsilon_1 \quad (164)$$

$$X_i = \rho_{SI} \cdot \varepsilon_1 + \varepsilon_2 \cdot \sqrt{1 - \rho_{SI}^2} \quad (165)$$

$X_s$  and  $X_i$  will be used as the random values needed to grow the share price and index respectively.

3. Calculate share price at t+1:

$$S_{t+1} = S_t e^{(r-q-\frac{1}{2}\sigma^2)\Delta t + \sigma_s X_s \sqrt{\Delta t}} \quad (166)$$

4. Calculate the correlated index level at t+1:

$$I_{t+1} = I_t e^{(r-h-\frac{1}{2}\sigma^2)\Delta t + \sigma_i X_i \sqrt{\Delta t}} \quad (167)$$

5. Repeat this process until  $S_T$  and  $I_T$  is obtained.
6. Calculate the pay-off at T.

If for example the contract stipulates that the option holder will be given the difference between the share price and the strike or debt inflated for the growth on the reference index, the payoff would be calculated by:

$$P_T = \text{Max}(S_T - \frac{I_T}{I_0} \cdot K, 0) \quad (168)$$

Using this methodology, a sufficient number of payoffs can be simulated to ensure that the average of these tend towards a constant number.

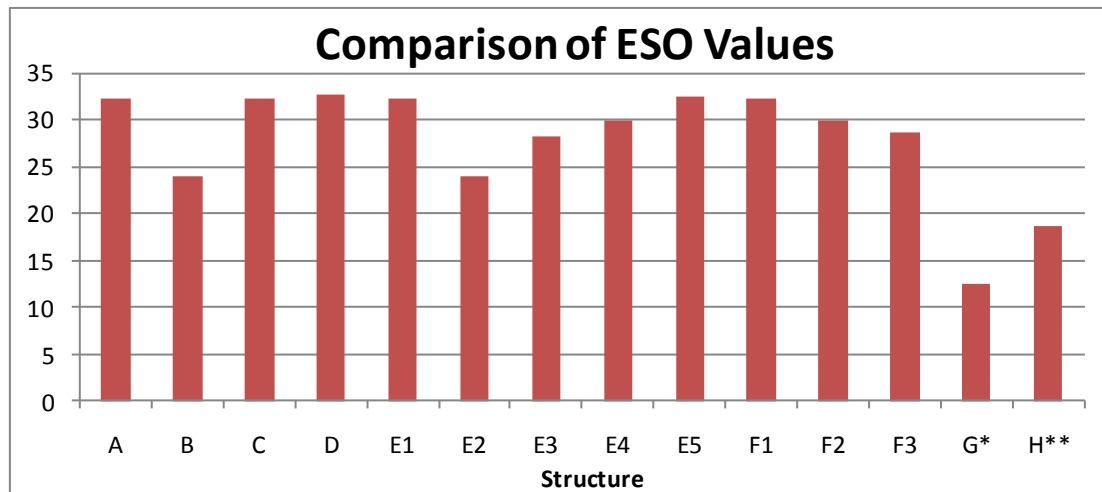
#### 5.4.1.1 Option H

This approach uses a correlated Binomial Tree to include the fact that the strike is in a different currency than the underlying share price. The pay-off is subject to the performance of the share price as well as the exchange rate. We make use of an extensive Binomial Tree model that has been modified to grow the value of a second correlated variable (Rubinstein 1994).

The reference asset has the following features:

Strike in Foreign Currency	\$14.71
Exchange rate Spot:	R6.80/\$
Exchange rate Volatility	35%
Foreign Risk-free	3.50%
Correlation with asset	77%
Number of Steps	100

## 5.4.2 Result Comparison



**Figure 5.4 - Comparison of ESO values under different exercise assumptions**

Adding the option prices of G and H to those in Section 5.3 produces the results in Figure 5.4. The index-linked share option has the lowest value. The high correlation (75%) between the share and the reference index (G) puts a severe strain on the option to get into the money. Even when assuming that exercise takes place at expiry of the option (6 years) the structure still has a considerably lower value than structure B where exercise takes place after 3 years (all things being equal, the longer the holder is expected to take to exercise, the higher the option value will be). Furthermore, option H has the second lowest value. This indicates the big impact of the hurdle index with which the share price of the option is “competing”.

## 5.5 Conclusion

It was illustrated how subtle differences in the structure of the deals (specifically BEE transactions) can make a significant impact on the option value.

The assumption regarding the exercise behaviour of the option holder was analysed and similarly indicated that the option value is greatly affected by it.

Finally the impact of having a strike that is in some way correlated to the reference asset also reduces the option value considerably.

This indicates that deals that at first glance appear to be similar could have vastly different prices when all things are considered. A pricing framework that incorporates all of the main differences as well as the subtle ones is imperative if transactions are compared.

## CHAPTER 6

### 6 Expensing

#### 6.1 Chapter Overview

Chapters 3 to 5 established the pricing framework by considering the models, inputs and structure features that all combine to determine the fair-value assigned to the ESOs or BEE deal. This chapter looks at how the fair-value which has been obtained by this process is used in expensing the option. The impact of having equity- or cash settled options are considered as well as how multiple tranches impact the expense value. A number of examples are used to illustrate how the different characteristics impact on each year's expense value.

#### 6.2 Introduction

The fair-values obtained from pricing the BEE deals and ESOs with the appropriate models are used to derive the cost that the company needs to account for annually. Bodie, Kaplan and Merton (2003) report that issuing ESOs have not always been viewed as attracting any cost but argue that it definitely does and that the fair-value is the best estimate of that cost.

The total cost can be expensed over the vesting period of the transaction. The expensing process can be summarised as follows:

- Obtain the fair-value for each tranche, i.e., a single transaction may have certain portions that vest over different periods.
- Assign each tranche's total cost proportionately over its vesting term
- Incorporate forfeited options
- Adjust each year's cost to the company's financial year-end date.

It should be noted that equity-settled payments and cash-based payments are treated slightly differently. Equity-settled payments are valued once at issue of the share-options, while cash-settled payments are valued each year.

### 6.3 Example 1

In this example an equity-settled ESO that vests over 3 years has been issued to 50 employees. Assume that 100 options have been assigned per employee and that the options were fair-valued at R10 an option at issue.

#### End of Year 1

$$\begin{aligned}
 \text{Value to be expensed} &= \text{Current cost} - \text{previous payments} \\
 &= \text{Fair-value} \times \# \text{ of options} \times \text{vesting term portion} \times \# \text{ of option holders} - 0 \\
 &= R10 \times 100 \times 1/3 \times 50 - 0 \\
 &= R 16,666.67
 \end{aligned}$$

Cost for year 1: R 16,666.67

#### End of Year 2

At the end of the 1<sup>st</sup> year 2 employees have forfeited their options by leaving the company.

$$\begin{aligned}
 \text{Value to be expensed} &= \text{Current cost} - \text{previous payments} \\
 &= \text{Fair-value} \times \# \text{ of options} \times \text{vesting term portion} \times \# \text{ of option holders} - R 16,666.67 \\
 &= 10 \times 100 \times 2/3 \times (50-2) - R 16,666.67 \\
 &= R 32,000 - R 16,666.67 \\
 &= R 15,333.33
 \end{aligned}$$

Cost for year 2: R 15,333.33

Cumulative value expensed: R 32,000

#### End of Year 3

At the end of the 3<sup>rd</sup> year another 4 employees have forfeited their options by leaving the company.

$$\begin{aligned}
 \text{Value to be expensed} &= \text{Current cost} - \text{previous payments} \\
 &= \text{Fair-value} \times \# \text{ of options} \times \text{vesting term portion} \times \# \text{ of option holders} - R 32,000 \\
 &= 10 \times 100 \times 3/3 \times (50-2-4) - R 32,000 \\
 &= R 44,000 - R 32,000 \\
 &= R 12,000
 \end{aligned}$$

Cost for year 3: R 12,000

Cumulative value expensed over the 3 years: R 44,000

## 6.4 Example 2

If the options had been cash-settled, the fair-value at each expense date would have been required. If this had been R12 at the end of the 1<sup>st</sup> year, R15 after two years and R22 after three years, the expense calculation would have looked as follows:

### End of Year 1

$$\begin{aligned} \text{Value to be expensed} &= \text{Current cost} - \text{previous payments} \\ &= \text{Fair-value} \times \# \text{ of options} \times \text{vesting term portion} \times \# \text{ of option holders} - \\ &\quad 0 \\ &= R12 \times 100 \times 1/3 \times 50 - 0 \\ &= R 20,000 \end{aligned}$$

Cost for year 1: R 20,000

Cumulative value expensed: R 20,000

### End of Year 2

At the end of the 1<sup>st</sup> year 2 employees have forfeited their options by leaving the company.

$$\begin{aligned} \text{Value to be expensed} &= \text{Current cost} - \text{previous payments} \\ &= \text{Fair-value} \times \# \text{ of options} \times \text{vesting term portion} \times \# \text{ of option holders} - \\ &\quad R 20,000 \\ &= R15 \times 100 \times 2/3 \times (50-2) - R 20,000 \\ &= R 48,000 - R 20,000 \\ &= R 28,000 \end{aligned}$$

Cost for year 2: R 28,000

Cumulative value expensed: R 48,000

### End of Year 3

At the end of the 3<sup>rd</sup> year another 4 employees have forfeited their options by leaving the company.

$$\begin{aligned} \text{Value to be expensed} &= \text{Current cost} - \text{previous payments} \\ &= \text{Fair-value} \times \# \text{ of options} \times \text{vesting term portion} \times \# \text{ of option holders} - \\ &\quad R 48,000 \\ &= R22 \times 100 \times 3/3 \times (50-2-4) - R 48,000 \\ &= R 96,800 - R 48,000 \\ &= R 48,800 \end{aligned}$$

Cost for year 3: R 48,800

Cumulative value expensed over the 3 years: R 96,800

## 6.5 Example 3

This example will expand on example 1 to incorporate multiple. The basic features of the issue are as follows:

<b>Scheme:</b>	Equity Settled
<b>Grant date</b>	01-Jan-06
<b># of employees</b>	100
<b># of options per employee</b>	900
<b>Tranches</b>	3
<b>Vesting structure</b>	
33.3%	1 year
33.3%	2 years
33.3%	3 years

The vesting of the shares is illustrated below.

Tranches	TOTAL	Year 1	Year 2	Year 3
		01-Jan-07	01-Jan-08	01-Jan-09
1 <sup>st</sup>	300	300		
2 <sup>nd</sup>	300	150	150	
3 <sup>rd</sup>	300	100	100	100
<b>Total</b>	<b>900</b>	<b>550</b>	<b>250</b>	<b>100</b>

On the inception date the three tranches have the following fair-values:

Tranches	Fair-value	Vesting period
1 <sup>st</sup>	8.00	1 year
2 <sup>nd</sup>	7.60	2 years
3 <sup>rd</sup>	7.30	3 years

The employees who have not forfeited their options are as follows:

	Issue	Year 1	Year 2	Year 3
	01-Jan-06	01-Jan-07	01-Jan-08	01-Jan-09
Employees left	100	95	92	88

### Year 1, 31 December 2006

Tranche	Fair-value	# of options	# of employees	Cost <sub>y1</sub>	Cost <sub>y0</sub>	Additional Cost	Cumm Cost
1 <sup>st</sup>	8.00	300	95	228,000	0	228,000	228,000
2 <sup>nd</sup>	7.60	150	95	108,300	0	108,300	108,300
3 <sup>rd</sup>	7.30	100	95	69,350	0	69,350	69,350
<b>TOTAL</b>		<b>550</b>		<b>405,650</b>	<b>0</b>	<b>405,650</b>	<b>405,650</b>



**Year 2, 31 December 2007**

Tranche	Fair-value	# of options	# of employees	Cost <sub>y2</sub>	Cost <sub>y1</sub>	Additional Cost	Cumm Cost
1st							228,000
2nd	7.60	300	92	209,760	108,300	101,460	209,760
3rd	7.30	200	92	134,320	69,350	64,970	134,320
<b>TOTAL</b>		<b>500</b>		<b>344,080</b>	<b>177,650</b>	<b>166,430</b>	<b>572,080</b>

**Year 3, 31 December 2008**

Tranche	Fair-value	# of options	# of employees	Cost <sub>y3</sub>	Cost <sub>y2</sub>	Additional Cost	Cumm Cost
1st							228,000
2nd							209,760
3rd	7.30	300	88	192,720	134,320	58,400	192,720
<b>TOTAL</b>		<b>300</b>		<b>192,720</b>	<b>134,320</b>	<b>58,400</b>	<b>630,480</b>

When the ESOs are first issued, it is unknown how many option holders will still be in the employment of the issuer when the various tranches vest. As this becomes known each year, the amount to expense is adjusted accordingly. At the end of the third year, the total amount expensed over the three years should tie back to the actual number of shares that vested.

Tranche	# of employees	Ultimate cost
1st	95	228,000
2nd	92	209,760
3rd	88	192,720
<b>Total</b>		<b>630,480</b>

The total amount expensed each year:

Year	Annual cost
1	405,650
2	166,430
3	58,400
<b>Total</b>	<b>630,480</b>

## 6.6 Example 4

If the ESO in example 3 was cash-settled, the expensing would change. The fair-value of the share options are recalculated on every expense date (year-end) whereas the equity settled cost used the issue date prices.

### Year 1, 31 December 2006

Tranche	Fair-value	# of options	# of employees	Cost <sub>y1</sub>	Cost <sub>y0</sub>	Additional Cost	Cumm Cost
1st	10.00	300	95	285,000	0	285,000	285,000
2nd	10.20	150	95	145,350	0	145,350	145,350
3rd	10.10	100	95	95,950	0	95,950	95,950
<b>TOTAL</b>		<b>550</b>		<b>526,300</b>	<b>0</b>	<b>526,300</b>	<b>526,300</b>

Since the 1<sup>st</sup> tranche vests at this point, the fair-value of R10.00 is merely the intrinsic value.

### Year 2, 31 December 2007

Tranche	Fair-value	# of options	# of employees	Cost <sub>y2</sub>	Cost <sub>y1</sub>	Additional Cost	Cumm Cost
1st							285,000
2nd	13.00	300	92	358,800	145,350	213,450	358,800
3rd	12.90	200	92	237,360	95,950	141,410	237,360
<b>TOTAL</b>		<b>500</b>		<b>596,160</b>	<b>241,300</b>	<b>354,860</b>	<b>881,160</b>

### Year 3, 31 December 2008

Tranche	Fair-value	# of options	# of employees	Cost <sub>y3</sub>	Cost <sub>y2</sub>	Additional Cost	Cumm Cost
1st							285,000
2nd							358,800
3rd	13.70	300	88	361,680	237,360	124,320	361,680
<b>TOTAL</b>		<b>300</b>		<b>361,680</b>	<b>237,360</b>	<b>124,320</b>	<b>1,005,480</b>

The amount ultimately paid on each tranche:

Tranche	# of employees	Ultimate cost
1st	95	285,000
2nd	92	358,800
3rd	88	361,680
<b>Total</b>		<b>1,005,480</b>

The total amount expensed each year is as follows:

<b>Year</b>	<b>Annual cost</b>
1	<b>526,300</b>
2	<b>354,860</b>
3	<b>124,320</b>
<b>Total</b>	<b>1,005,480</b>

### 6.7 Example 5

Finally, the cost can be accounted in the annual statements of the company. The issue date of the options and the financial year-end of the company might not be on the same day. The expensed associated with each year, has to be appropriated to the corresponding year-end. The costs at the 5 following financial year-ends in Example 4 are illustrated.

	<b>FYE 1</b>	<b>FYE 2</b>	<b>FYE 3</b>	<b>FYE 4</b>	<b>FYE 5</b>
<b>TOTAL</b>	<b>30-Jun-06</b>	<b>30-Jun-07</b>	<b>30-Jun-08</b>	<b>30-Jun-09</b>	<b>30-Jun-10</b>
1,005,480	259,545	441,754	241,341	62,839	0

Since the year-end date is halfway between consecutive cost dates, the cost for year is split over the two year-end dates to which it corresponds.

## 6.8 Conclusion

In this chapter the further use of the option price was illustrated. Five examples were used to illustrate how different factors impact on the value that is expensed each year for an option as it vests:

- Example 1: The expensing of a simple equity-settled ESO that vests over 3 years was discussed. The impact of option holders forfeiting their options over this period was shown.
- Example 2: The option in Example 1 was treated as if the options were cash-settled. This has the implication that the options have to be re-priced each year as well as the forfeited options need to be accounted for.
- Example 3: Takes the option in Example 1 and adds multiple tranches
- Example 4: Combined the cash-settled nature of the options in Example 2 with multiple tranches discussed in Example 3.
- Example 5: The expense assigned to each tranche that has to be accounted for at the end of the year was combined with a financial year end that does not correspond to that of the options.



## CHAPTER 7

### 7 Introduction to Employee Share Options

#### 7.1 Chapter Overview

This chapter looks at the basics of employee share options. Up until this point the focus has been on the pricing framework that covers both ESOs and BEE deals. This chapter focuses on ESOs and refers to its recent history, structure features and a few examples in the South African market of actual schemes.

#### 7.2 Introduction

Employee Share Options (ESOs) are financial transactions that are designed to facilitate the ownership of equity in a company to certain individuals or groups.

ESOs are granted to employees with the aim of motivating them to perform their tasks in such a manner that will lead to a sustainable increase in the share price of the company. ESOs fulfil this role because the strike of the option is usually the share price on issue date. The subsequent share price growth above the strike will then be available to the employee as the payoff when the option is exercised. It is a fairly simple way of rewarding employees and the reason for its popularity is mainly because it provides a simple way of quantifying the relationship between the reward gained by the employee (option payoff) and the benefit of the work done to justify the reward (increase in the share price).

However, a variety of issues have been raised on the effectiveness of ESOs. These relate to the cost involved in remunerating the employee that can be considerably more than the benefit he receives and the validity of issuing ESOs to employees who do not have a reasonable influence on the share price (Gordon (1952)).

They replicate call options on the relevant companies' share prices but have the limitation that they are not freely tradable in the market. This feature makes them difficult to fair-value accurately as is required by the International Financial Reporting Standard 2. This in turn affects the expensing of the transactions.



### 7.3 Background

There has been an increase in the use of Employee Share Options (ESOs) as a component of remuneration in recent years (Van Zyl (2007)). Hall & Murphy (2003) show that ESOs worth \$11 billion were granted to employees of companies on Standard & Poor's 500 index in 1995. By 2000 the increase in popularity of ESOs resulted in this number growing to \$119 billion. Apart from ESOs having become a significant portion of senior executives' overall package (up from 25% in 1992 to 40% in 1998 according to Hall & Murphy (2000)) and being the primary driver for increases in CEO pay during the 1990s (Murphy (2000)), there has also been a shift to combine the salaries of mid- and lower level employees with share options (Hall & Murphy (2000)).

### 7.4 IT Bubble

This trend in awarding ESOs took off during the late nineteen nineties when the information technology (IT) industry and internet companies witnessed an unprecedented growth. Many of the companies in these sectors had very little capital but managed to attract and retain talented staff by giving them share options. The demand for internet related services was so overwhelming during this time that many of these companies become overnight successes resulting in the share options becoming extremely valuable.

The atmosphere of the time can best be described by an article that appears at [www.stock-market-crash.net/nasdaq.htm](http://www.stock-market-crash.net/nasdaq.htm). It provides some insight into the forces at work during that time and how it colluded to change the way companies have to account for their share based payments today.

*"...Eventually, several of these start-up companies took the notice of serious venture capitalists, who were looking to finance these operations, take them public and reap massive profits. Soon the fledgling startups began to pay their hopeful employees with company shares. The premise was that when the company went public, the early shareholders would become instantly wealthy. The majority of the software companies were started in Silicon Valley, near San Francisco, which was a technology Mecca. The Nasdaq index of technology stocks was rising extremely fast, creating many millionaires."*



*“...As the internet moved from the hobbyist domain to a commercialized marketplace, online business owners became fantastically wealthy. Many technology companies were now selling stock in IPO’s. Most initial shareholders, including employees, became millionaires overnight. Companies continued to pay their employees in stock options, which profited greatly if the stock went up even slightly. By the late 1990’s, even secretaries had option portfolios valued in the millions! Many companies had BMW sign on bonuses! ....*

*“...Many of the technology stocks were listed on the Nasdaq exchange, which is an electronic marketplace. Every startup wanted to become “the Next Microsoft”. From 1996 to 2000, the NASDAQ went from 600 to 5,000. By early 2000, reality started to sink in. Investors soon realized that the dot-com dream was really a bubble. Within months, the NASDAQ crashed from 5,000 to 2,000. Hundreds of stocks such as Pet.com, which were each worth billions, were off the map as quickly as they appeared. Panic selling ensued as investors lost trillions of dollars. The stock market kept crashing down to 800 in 2002. One high flier, Microstrategy, slid from \$3500 per share to \$4! Numerous accounting scandals came to light, showing how many companies artificially inflated earnings. Shareholders were crippled. In 2001, the [US] economy entered a recession as the Fed repeatedly cut rates, trying to stop the bleeding. Millions of workers were now jobless and had lost their life savings.”*

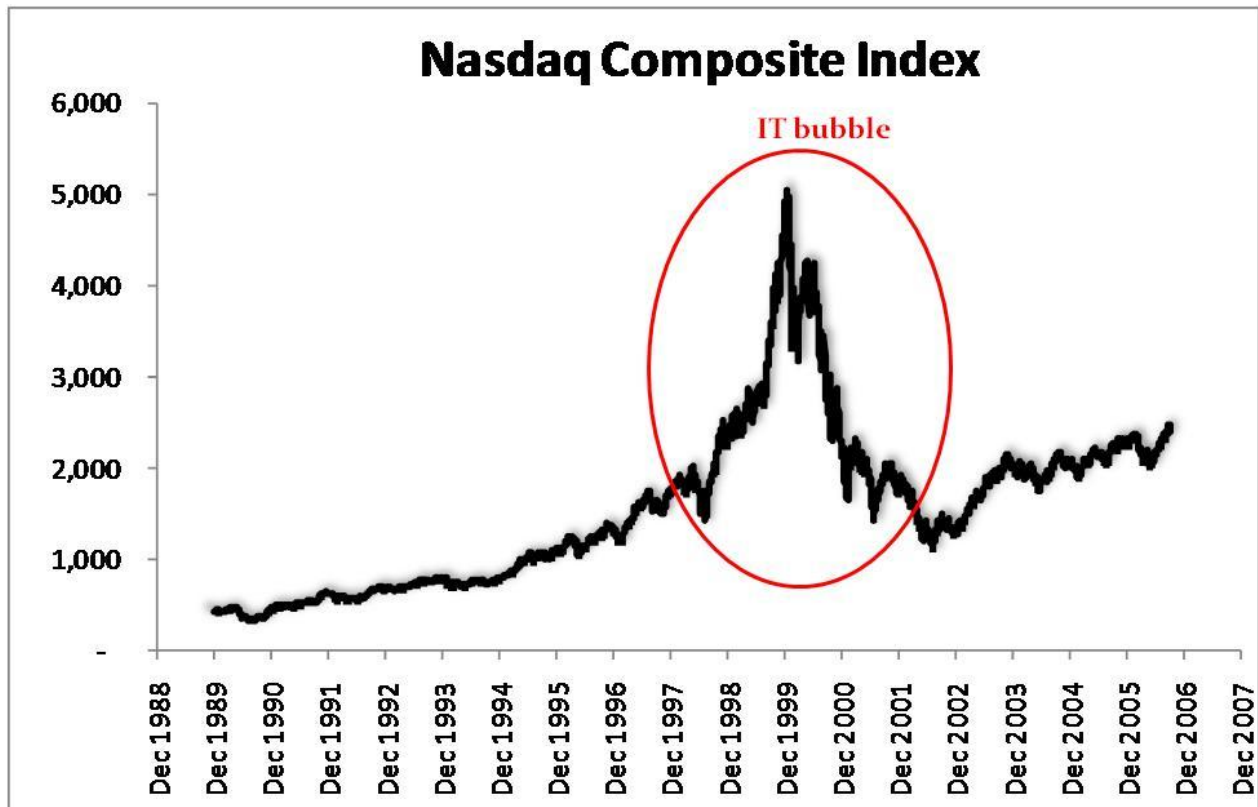


Figure 7.1 - NASDAQ Composite Index

The crash of the NASDAQ Information Technology Exchange wiped out billions of dollars all over the world and brought an end to the phenomenal growth in this sector that the market had become accustomed to. The IT bubble burst as it became more and more apparent that even though the internet had officially “arrived” and changed many things in business, making money out of it was not nearly as easy as originally anticipated. Even though the NASDAQ index has since returned to 1998 levels, the advantages of share options had become common knowledge. Here was an instrument with very little initial cost that could be used as incentives to attract the most talented people in the market. Hall & Murphy (2003) showed the impact on the value of employee share options on S&P 500 companies which crashed from a peak of \$119 billion in 2000 to \$71 billion in 2002. One thing that became clear was that the accounting rules for these instruments had to be changed. Bodie, Kaplan & Merton (2003) argue that the spate of corporate accounting scandals that was revealed after the collapse of the IT-sector showed just how unreal a picture of their economic performance many companies have been painting in their financial statements. Increasingly, investors and regulators have come to recognize that option-based compensation is a major distorting factor. They illustrate the point by mentioning that had AOL Time Warner in 2001 reported employee stock option expenses as recommended by SFAS 123,





it would have shown an operating loss of about \$1.7 billion rather than the \$700 million in operating income it actually reported.

Soon afterwards IFRS 2 (International Accounting Standards Board (2004)), was published to govern the accounting of share based financial instruments. Specifically, it states that all instruments with a derivative component had to be expensed at its fair-value which should incorporate all the option features.



## **7.5 ESO Structure Features**

The variety of structures that has emerged as vehicles to facilitate the transfer of shares to employees is limited. In this section we look at the common structure features.

### **7.5.1 Basic Structure**

In its most basic form, ESOs are call options on the share price of the issuing company. The option holder (employee) can exercise his right at certain times before the option matures. The term to maturity is usually several years, which is different to traded options that seldom have a life of longer than a year. When the option is exercised the share price at that time is compared against the strike – in whatever form it may be – and the payoff determined. The payoff can be share-based or in monetary terms.

### **7.5.2 Vesting Periods**

During the vesting period the options cannot be exercised. This period can be viewed as the time during which the issuing company obtains its compensation. The company issuing ESO sees this as time during which the individual should work for the company (with the resulting increase in share price) to be eligible for his option payoff. From an accounting point of view it will be seen as the time over which the employee earns the eventual payoff he will receive.

Typically, if an employee is given a fixed amount of ESOs that expires in a certain number of years' time, he can expect a portion to vest during the early part of the option term, another portion to vest halfway through and the remaining shares to vest shortly before the options expire. The reason for this is to enable the employee to have access to some of the money resulting from an increasing share price but to prevent him from cashing in all his options without the company gaining from any further employment. In this way the length and quality of his service are linked to his financial reward.

#### **7.5.2.1 Senior Management**

Senior management of large listed companies often receive a large part of their remuneration in the form of share options as these types of employees have a very direct influence on what happens to the share price. It is required by IFRS 2 to state the remuneration received by the CEO of the company which would include the value of his share options.



The structure of the ESOs received by senior management may differ from that given to regular employees. Apart from the fact that the number of options are much more than those received by others, the vesting periods may be altered. This would be to reflect the fact that senior management are less dependent on the cash-flows that may arise from the ESOs as they may already be very wealthy individuals. Longer vesting periods would therefore not be out of the ordinary.

The position that a CEO of share options finds himself in differs vastly from that of a regular worker when analysing his tendency to exercise his option.

- One would expect these high level employees to have a greater degree of wealth. Their liquidity needs should be lower than a regular employee's.
- The employer may pressure the CEO to hold his options longer than the contractual vesting period. Media reports of CEOs cashing in their share options are often not seen favourably by the market.

However, abnormal movements in the stock price will induce risk-averse holders to exercise their options to lock into their gains as showed by Hall and Murphy (2002). In this case the movement of the share, more than the absolute level thereof, triggers exercise.

Another interesting finding by Bettis, Bizjak and Lemmon (2004) was made when they analysed the change in volatility of the underlying share that followed share options being given to CEOs. They found that it is often the case that CEOs become more risk averse (reduction in volatility) after they have been given share options. It would of course be necessary to consider the manifesto given to the CEO but a reduction in the volatility seems to indicate that the CEO chooses a course of action after receiving share options that differs from his strategy prior to receiving them.

### **7.5.2.2 Regular Employees**

Regular employees would value the payoff on share options in the short term very highly and their schemes would reflect this by having vesting periods shorter than that of senior management. The schemes will be governed by a standard contract to ensure fairness among the many employees and to act as guide to ensure aboveboard management of the schemes. Relatively few people would be involved in the administration of the ESOs and due to the large volume involved, would want easy obtainable inputs.



### 7.5.3 Strike

The strike is the level against which the share price will be compared when the option gets exercised to determine the payoff to the option holder. Most employee share options are issued with a strike representing the share price of the company on issue date. These types of share options are by far the most widely used structures in South Africa currently<sup>5</sup>. They are simple and easy to administrate and provide a transparent way for employees to confirm the payoff on their share options.

There is no restriction on the way in which the eventual strike price can be calculated. Another way to obtain the strike is to have it increase at some rate over the term of the option<sup>6</sup>. For the option to be in-the-money when it is exercised, it will not only have to end up above the spot price at issue, but also have grown by more than this reference rate over the term. This is sometimes a hurdle rate on ESO. Such a reference rate can include, but is not restricted to:

- A fixed percentage rate that senior management believes should be exceeded by the growth in share price: Such a fixed rate will typically be comparable to historical growth.
- The Inflation rate: By having the inflation rate as the reference rate, the share options will only be in-the-money if the share price shows real growth.
- A market related index rate: Using a relevant index as reference, the employee knows that share price growth should outperform another market or industry related index.

In share options with strikes that include hurdle rates, it is much harder to obtain high pay-offs (see Section 5.4.2) since a rise in markets does not guarantee an in-the-money option at exercise and generally they are not very popular. The main reason for not using them is that it is not easy to attract talented employees with overly restrictive ESOs since they are essentially geared tools aimed at offering high returns to the employee. ESOs with strikes that accrue in this way are the exception to the rule at this stage in the South African market.

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<sup>5</sup> Liberty, Gold Fields and Discovery ESOs

<sup>6</sup> Lekana ESOs



## 7.6 Typical SA ESOs

Information on 12 employee share option schemes was sourced as it was reported in the relevant companies' annual statements. There are many similarities between ESOs from different companies with only the details differing.

### 7.6.1 Gold Fields

Year of Valuation	2005
Option Term	7 Years
Vesting Structure	
33.3%	2 years
33.3%	3 years
33.3%	4 years
Valuation Method	Black-Scholes
Exercise Assumption	Expected Life is 140% of vesting period
Type of Settlement	Equity Settled
MTM of Options considered	R 250 mil
Source	Gold Fields 2005 Annual Report
Source Location	<a href="http://www.goldfields.co.za/reports/annual_report_2005/pdfs/goldfields_annualreport2005.pdf">http://www.goldfields.co.za/reports/annual_report_2005/pdfs/goldfields_annualreport2005.pdf</a>

### 7.6.2 Discovery

Year of Valuation	2005
Option Term	4 Years
Vesting Structure	
33.3%	2 years
33.3%	3 years
33.3%	4 years
Valuation Method	Binomial Tree
Exercise Assumption	Employees exercise when it is optimum
Type of Settlement	Equity Settled
MTM of Options considered	R 62.3 mil
Source	Discovery 2005 Annual Report
Source Location	<a href="http://www.discovery.co.za/investor_relations/2005_annual/pdf/discovery2005_financials09.pdf">http://www.discovery.co.za/investor_relations/2005_annual/pdf/discovery2005_financials09.pdf</a>



### 7.6.3 Aspen Pharmacare

Year of Valuation	2005
Option Term	8 Years
Vesting Structure	
20%	2 years
20%	3 years
20%	4 years
20%	5 years
20%	6 years
Valuation Method	Binomial Tree
Exercise Assumption	
49%	0.5 years after vesting
37%	1.0 year after vesting
14%	At maturity
Type of Settlement	Equity Settled
MTM of Options considered	R 40 mil
Source	Aspen Pharmacare Holdings Limited 2005 Annual Report
Source Location	<a href="http://www.africanfinancials.com/Report.aspx?afr_year=2005&amp;CountryDOMAIN=za&amp;CshortName=APN">http://www.africanfinancials.com/Report.aspx?afr_year=2005&amp;CountryDOMAIN=za&amp;CshortName=APN</a>

### 7.6.4 Liberty Life

Year of Valuation	2004
Option Term	10 Years
Vesting Structure	
50%	3 years
25%	4 years
25%	5 years
Valuation Method	Binomial Tree
Exercise Assumption	Employees exercise when it is optimum
Type of Settlement	Equity Settled
MTM of Options considered	R 1,9 bil
Source	Liberty 2004 Annual Report
Source Location	<a href="http://www.africanfinancials.com/Report.aspx?afr_year=2005&amp;CountryDOMAIN=za&amp;CshortName=ARI">http://www.africanfinancials.com/Report.aspx?afr_year=2005&amp;CountryDOMAIN=za&amp;CshortName=ARI</a>



### 7.6.5 Africa Rainbow Minerals

Year of Valuation	2005
Option Term	10 Years
Vesting Structure	
33.3%	3 years
33.3%	4years
33.3%	5 years
Valuation Method	Binomial Tree
Exercise Assumption	
33.3%	120% exercise multiple
33.3%	150% exercise multiple
33.3%	Exercise when optimal
Type of Settlement	Equity Settled
MTM of Options considered	R 50 mil
Source	African Rainbow Minerals 2005 Annual Report
Source Location	<a href="http://www.goldfields.co.za/reports/annual_report_2005/pdfs/goldfields_annualreport2005.pdf">http://www.goldfields.co.za/reports/annual_report_2005/pdfs/goldfields_annualreport2005.pdf</a>

### 7.6.6 Impala Platinum

Year of Valuation	2005
Option Term	10 Years
Vesting Structure	
25%	2 years
25%	3 years
25%	4 years
25%	5 years
Valuation Method	Binomial Tree
Exercise Assumption	133% exercise multiple
Type of Settlement	Equity Settled                      Cash Settled
MTM of Options considered	R 12 mil                                  R 61 mil
Source	Impala Platinum Holdings Limited 2005 Annual Report
Source Location	<a href="http://www.implats.co.za/im/files/ar/2005/pdf/implats_ar2005.pdf">http://www.implats.co.za/im/files/ar/2005/pdf/implats_ar2005.pdf</a>



## 7.6.7 MTN

### Equity Settled ESOs

Year of Valuation	2005
Option Term	10 Years
Vesting Structure	
20%	2 years
20%	3 years
20%	4 years
20%	5 years
20%	6 years
Valuation Method	Binomial Tree
Exercise Assumption	
33.3%	120% exercise multiple
33.3%	150% exercise multiple
33.3%	Exercise when optimal
Type of Settlement	Equity Settled
MTM of Options considered	R 40 mil

### Cash Settled ESOs

Year of Valuation	2004
Option Term	10 Years
Vesting Structure	
20%	2 years
20%	3 years
20%	4 years
20%	5 years
20%	6 years
Valuation Method	Binomial Tree
Exercise Assumption	Exercise when optimal
Type of Settlement	Cash Settled
MTM of Options considered	R 340 mil

Source	MTN Holdings Limited 2005 Annual Report
Source Location	<a href="http://annualreport.mtn.com/pdfs/full_report_web.pdf">http://annualreport.mtn.com/pdfs/full_report_web.pdf</a>





### 7.6.8 Gold Reef Casino

Year of Valuation	2005
Option Term	10 Years
Vesting Structure	
33.3%	3 years
33.3%	4 years
33.3%	5 years
Valuation Method	Binomial Tree
Exercise Assumption	?
Type of Settlement	Equity Settled
MTM of Options considered	R 22 mil
Source	Gold Reef Resorts Limited 2005 Annual Report
Source Location	<a href="http://www.goldreefresorts.com/Downloads/AnnualReports/GRCR_AR2005.pdf">http://www.goldreefresorts.com/Downloads/AnnualReports/GRCR_AR2005.pdf</a>

### 7.6.9 Afrox

Year of Valuation	2006
Option Term	10 Years
Vesting Structure	
100%	4 years
Valuation Method	Black-Scholes
Exercise Assumption	1.0 year after vesting
Type of Settlement	Equity Settled
MTM of Options considered	R 180 mil
Source	Afrox Limited 2006 Annual Report
Source Location	<a href="http://www.afrox.co.za/downloads/annual_reports/AnnualReport_2006a.pdf">http://www.afrox.co.za/downloads/annual_reports/AnnualReport_2006a.pdf</a> <a href="http://www.afrox.co.za/downloads/annual_reports/AnnualReport_2006b.pdf">http://www.afrox.co.za/downloads/annual_reports/AnnualReport_2006b.pdf</a> <a href="http://www.afrox.co.za/downloads/annual_reports/AnnualReport_2006c.pdf">http://www.afrox.co.za/downloads/annual_reports/AnnualReport_2006c.pdf</a>



### 7.6.10 Standard Bank

Year of Valuation	2006
Option Term	10 Years
Vesting Structure	
A-type ESOs	
50%	3 years
25%	4 years
25%	5 years
B-type ESOs	
50%	5 years
25%	6 years
25%	7 years
Valuation Method	Black-Scholes
Exercise Assumption	
A-type ESOs	Exercised after 6.1 years
B-type ESOs	Exercised after 7.0 years
Type of Settlement	Equity Settled
MTM of Options considered	R 200 mil
Source	Standard Bank Limited 2006 Annual Report
Source Location	<a href="http://www.africanfinancials.com/Report.aspx?afr_year=2006&amp;CountryDOMAIN=za&amp;CshortName=SBK">http://www.africanfinancials.com/Report.aspx?afr_year=2006&amp;CountryDOMAIN=za&amp;CshortName=SBK</a>

### 7.6.11 Real Africa Holdings

Year of Valuation	2005
Option Term	10 Years
Vesting Structure	None
Valuation Method	Binomial Tree
Exercise Assumption	Exercise when optimal
Type of Settlement	Equity Settled
MTM of Options considered	R 2 mil
Source	Sun International Limited 2007 Annual Report
Source Location	<a href="http://suninternational.investoreports.com/sun_ar_2007/downloads/sun_ar_2007.pdf">http://suninternational.investoreports.com/sun_ar_2007/downloads/sun_ar_2007.pdf</a>



### 7.6.12 Comments

The share option schemes from various companies do not show a great degree of differentiation. The options are split into 3 or 4 tranches that vest at different times over the life of the option. Options are issued at-the-money with the vast majority having fixed strikes. They extend over a period of 7 to 10 years although a few of them are shorter.

All of these schemes were valued by either a Black-Scholes or Binomial model. The assumptions on exercise were more varied. Exercise can occur at maturity, the vesting date, spread between the vesting and maturity date, at a fixed point or any combination of these. No evidence was presented in support of the assumptions (if there was any) made with regards to the expected exercise behaviour.



## **7.7 Problems with Exercise Related Inputs**

The assumptions surrounding exercise in the sample of South African ESOs are not based on any fundamental research. Huddart & Lang (1995) who analysed the exercise behaviour of over 50,000 employees were unable to establish reliable relationships that could be used to estimate the exercise behaviour of the employee. The reasons are a combination of the following factors:

### **7.7.1 Limited Availability of Historical Data**

Since companies only have to report limited details on ESOs relating to senior management of the company, there is little data available in the market. Disclosure in the annual report is often limited to a general description of the ESOs, number of options outstanding, issued, exercised and surrendered in the reporting period as well as the ranges of strike prices (Huddart & Lang (1995)).

### **7.7.2 Homogenous Subgroups**

The problem of limited historical data is further affected by the fact that we cannot expect employees to act the same across all levels of seniority, industry and markets.

### **7.7.3 Information Influenced by the Vesting Period**

Another problem in analysing historical data is created by the vesting period. If the share price grows significantly over its vesting term, many of the options are exercised as soon as they vest. The truth may be that the holders would have exercised at a lower multiple had they not been restricted to do so. When using historical exercise data to determine the exercise multiple, the analysis will invariably bias the result to have an exercise multiple higher than what is the actual figure. For an option with a strike of R100, if it is observed that an employee has exercised at R130 when the options vested, it could be deduced that an exercise multiple of 1.3 is reasonable for other similar employees. However, the employee might have been happy to exercise at R120 or R110 but could not as it was still vesting. The truth about the employee's exercise preferences is therefore not shown in historical exercise data. Since exercise often occurs soon after the options have vested, much of the data contains this flaw.

ESOs without vesting periods are highly uncommon and there is therefore little data available that could be used to do the analysis on vesting-free data.



#### **7.7.4 Employee Preferences are Influenced by Market Conditions**

Carpenter (1998) states that there are two broad general factors that affect exercise. These are beliefs and values. Beliefs refer to what the options holders think will happen to the underlying share price. Research has shown that in some cases it is believed that the current trend will continue while in others, that the share price will revert back to some mean. Andreassen (1987, 1988) concluded that over the long run it is believed that a trend will continue based on the fundamentals of the share price while the share will revert back to its mean over the short run.

#### **7.7.5 Employees Do Not Function As Rational Investors**

Bowman, Minehart and Rabin (1997) have shown the existence of an S-shaped Value vs. Profit curve around the strike of the options. This means that investors are more severely affected by losses (share price being below the strike) than the value they derive from a profit (share price above the strike) the further they are out- or in-the-money. From the Huddart & Lang (1996) report it was found that early exercise leads to the forfeit of around 25% of the option value. Many other reports make similar claims. A rational investor would not forfeit such a significant portion if his investment which indicates that employees cannot be seen as such. This is further confirmed by Mozes (1995) who argues that since the employee is unable to hedge his portfolio, he cannot be seen as someone who will act like a true rational investor.

#### **7.7.6 Exercise Decisions are Influenced by Multiple Factors**

Huddart & Lang (1995) sites the following factors as significant in determining when an employee will exercise his share options:

- Recent stock price movements
- Market-to-strike ratio
- Proximity of vesting dates
- Time to maturity
- Volatility

In their report Heath, Huddart & Lang (1999) analyse a multitude of factors that could have an effect on the value of the options in their sample and uses regression analysis to quantify the importance of each of the factors. Factors included are:

- Fraction of options from a single grant exercised, available, will be cancelled and have vested recently;
- The difference between market and strike price;



- Return on the stock in the week prior to exercise, month 7 to 2 prior to exercise and month 13 to 8 prior to exercise;
- An indication variable to show whether stock price in the week of exercise exceeded the maximum in the preceding business year;
- Returns after exercise took place.

These factors are regressed against actual exercise history data and their relevance is determined. It is found that exercise is sensitive to positive short-term stock returns which is in accordance with the psychological factor theory. Unfortunately the relations obtained is not strong enough to ensure consistent predictability. If the share price has exceeded the annual maximum, exercise is very likely. This is, however, not a feature that can be used when having to value options with vesting periods typically of 3 years and longer. It can be used for cash settled options though that has to be revalued each year. The choice to exercise is a combination of the share price path as well as investors' risk aversion and preferences. This is probably the clearest indication that the inherent differences between ESOs and standard traded options are influenced by different factors.

### **7.7.7 Comments**

The Exercise multiple and Expected life inputs can both be defended from a logical point of view but cannot be quantified statistically. To do this, one needs to use historical exercise behaviour as a guide since the expected value of rational investors would produce the maximum expense that is seldom realised. Very few companies have exercise history data available and of the little analysis that has been done on it, no clear pattern could be determined. There are agreements among scholars however that traditional option pricing methods overstate the expense.

Exercise behaviour is the result of a combination of the influence that psychological factors (Heath, Huddart & Lang (1999)) have on already complex share price paths. This has resulted in no conclusive findings to quantify the exercise related inputs into the pricing models.



## 7.8 Conclusion

In this chapter the background of employee share options was considered and the role of at-the-money employee share options with no accounting impact illustrated during the IT bubble in the nineteen nineties. This assisted in convincing the regulators to change the accounting approach on share-based payments such that the potential value in these derivatives instead of the intrinsic value would be captured in its cost.

The basic structure of ESOs was discussed and the role of vesting periods as they relate to senior management and regular employees elaborated on. The different approaches that govern the strike price were also considered as well as the impact they have on the value of the options.

The ESO schemes of 11 South African companies were briefly analysed in terms of the basic structure and some of the pricing assumptions. It was found that there is little difference in the structures of the different ESOs and that they were all priced by either the Black-Scholes or Binomial models. Exercise behaviour was incorporated in a number of different ways with no evidence published to support these choices.

Finally, some of the general issues with exercise behaviour as it relates to the pricing of ESO schemes were highlighted. Looking for alternative ways to address these issues will be the subject of the next chapter.



## CHAPTER 8

### 8 Alternative Approaches to Exercise Behaviour

#### 8.1 Section Overview

Chapter 7 focussed on ESOs. One of the major obstacles encountered in their pricing is how to incorporate the exercise behaviour of the employees which significantly impacts on the ESO price (refer to Section 5.3). This chapter discusses three methods in which the issue of the exercise behaviour is addressed.

- The utility model: This approach considers the option holder's individual characteristics (initial wealth, risk aversion) to develop a framework in which the exercise behaviour can be simulated. The approach is discussed briefly and the logic on which it is based, is outlined.
- 90 day options: This approach proposes a different accounting treatment of options held by employees which is justified by being consistent with other types of employee remuneration. If the accounting treatment is allowed to be changed, the options have rolling maturity dates of only 90 days. Traded warrants have similar periods over which they can be exercised which greatly simplifies the task of obtaining a market price for the options.
- ESO upper bound: Assuming that a rational investor would rather have exposure to a diversified portfolio than a single asset, the Capital Asset Pricing Model is used to determine at what point the individual will exercise his options and invest the proceeds in a diversified portfolio. No assumptions about the option holder's behaviour are required which makes the method consistent with options having to reflect the cost to the issuer first and foremost. An example is done to illustrate the usefulness of the approach.

#### 8.2 Introduction

Van Horne (1969) analysed the price of traded warrants before the days of Black-Scholes and produced a regression analysis that priced the warrants. The formula obtained made use of all the inputs used in the pricing models we are familiar with today. This section considers some methods that have been proposed as alternatives due to the issues mentioned in Section 7.7 in order to quantify the early exercise of share options better.





### 8.3 Utility Model

The utility model, first introduced by Carpenter (1998), has become a way for quantifying non-share price related factors into the value of the options. Bettis, Bizjak and Lemmon (2004) also make use of it in their investigation into the drivers of option prices. In its most basic form it uses the employee's initial wealth and risk aversion and probability of exiting the firm to establish how much money the employee will be willing to exchange his option for. Since share options are non-tradable, some adjustment to standard option pricing methodology is required. Obtaining sensible inputs for employees is obviously crucial for this approach to have any use and they have to be segregated into homogeneous sub-groups. Historical exercise behaviour is then used to calibrate the utility model. The parameters are not solved empirically but rather a set of combinations of values are obtained from which the most appropriate can be chosen. Once the parameters have been obtained, it can be determined when exercise on existing options will happen as this occurs when the utility from early exercise is greater than the expected utility from continuing to hold the options.

Bettis, Bizjak and Lemmon (2004) compare the subjective option values (obtained from a calibrated utility based model) to the value of a regular American option. The utility based model determines the expected time until the options will be exercised. This number is then used in a standard pricing model instead of the contractual term.

Hall and Murphy (2000) also used the utility model in an attempt to bring non-tradable option pricing values and exercise behaviour into agreement. They show that the value derived by employees from the stock options is worth considerably less than the cost thereof (to the company). The report writers state that traditional option pricing methods clearly overstate the value of the options and attempt to increase the accuracy of these models. The reasoning behind this observation is that risk-averse employees do not have the options that are available to regular market participants to diversify or hedge their positions. They may sit with risk within their (limited) portfolio that would have been diversified away if not for the restrictions surrounding the options. Having these options available to market investors puts them in a position to be risk-neutral even if they have a similar outlook on investing to the employee.



## 8.4 90 Day Options

Bulow & Shoven (2004) proposes accounting for ESOs as 90 options that are extended every quarter. At the end of 90 days, they get revalued if the employee is still with the employer. This approach makes pricing an almost trivial exercise as publicly traded warrants should have similar features than the ESOs.

The justification for using such an unconventional approach is related to how employee salaries are viewed. Even though it can be assumed that employees' salaries will rise over time as long as they are in the employment of the company, this feature is not accounted for. Accountants have traditionally always showed what the historic cost of salaries was in the financial statements. Even bonuses that have similar features to call options are not accounted for before they have been earned. So using this approach, ESOs are seen as 90 day options.

The 90 option approach is further reinforced by the fact that an employee who is dismissed usually forfeits his vested ESOs. Even though the option may only expire at the end of 10 years. The employee cannot lay claim on the benefits at the end of the option term if he did not work until then. But the company is forced to price these options as if the employee will work for the whole period.

IFRS 2 does not view ESOs in this way and requires the price to capture all of the features stipulated in the ESO scheme agreement which includes the full term to maturity. Until such time as more freedom is allowed in the ESO pricing, the approach cannot be used.

## 8.5 ESO Upper Bound

Mozes (1995) points out that while Huddart (1994) and others illustrate that Black-Scholes overstate the value of ESOs, this is not quantified. Mozes' model (1995) presumes that there exists a share price ( $P_s$ ) at which the option holder would exercise his options and invest the proceeds into a diversified portfolio.

A binomial model is used to incorporate the probability of the share price reaching this level over different periods. These probabilities are combined with the Black-Scholes option value for each maturity to produce a probability weighted option value. This methodology is similar to what Meulbroek (2001) proposed which measures the cost of holding an employer's stock relative to holding a diversified market portfolio. Both of these models are based on the notion that without the ability to diversify fully, managers will always value their equity-based



compensation at less than its market value. Since employees cannot hedge their options, they have a certain amount of unsystematic risk for which they are not compensated by the market (the expected return on the asset has a higher risk). Thus an employee should exercise his in-the-money options and invest the proceeds in a diversified portfolio. The sooner s/he switches, the longer s/he will have exposure to the diversified portfolio. Mozes (1995) states that Black-Scholes option values are determined for each of the number of times at which the share price could reach  $P_s$ . The probability of reaching  $P_s$  at that time is multiplied by the Black-Scholes value for each time period and then added together. This gives the maximum option value.

The reasoning for increased accuracy in option valuation stems from the fact that if traditional models overvalue them, then accounting charges will be higher. Selling regular warrants in the market and giving the proceeds to the employees may be cheaper, but leads to an up-front cash outlay. For these reasons, obtaining a defensible and lower ESO value has merit.

### 8.5.1 Example 6

This example will calculate the upper bound of an ESO with similar properties as the one mentioned earlier. The ESO has the following basic features:

- Spot R 100.00
- Strike R 100.00
- Term 6.00 years
- Vesting Period 3.00 years
- Interest Rate 7.50%
- Volatility 30.00%
- Dividend Yield 2.70%

#### Step 1 – Determine $P_s$

The reasoning behind this approach is that a rational investor (employee with stock options) would rather have his money in a diversified portfolio than in a single stock according to the Capital Asset Pricing Model (CAPM) developed by Jack Treynor (1961, 1962), William Sharpe (1964), John Lintner (1965a,b) and Jan Mossin (1966). The reason for this is that the diversified portfolio enables him to be exposed to an asset with a larger expected return for the same amount of risk. To calculate this share price ( $P_s$ ) a number of inputs into the Capital Asset Pricing Model is needed.

The price is calculating using

$$P_s = \frac{X}{1 - \frac{E(G)}{E(DP)} \cdot (1 - \tau)} \quad (169)$$

where

- $X$  : Strike of the share option – R100.00  
 $\tau$  : Marginal tax rate of the employee – 40%  
 $E(G)$  : Expected return on the underlying stock  
 $E(DP)$  : Expected return on a diversified portfolio

and

$$\frac{E(G)}{E(DP)} = \frac{R_f + B_{us} \cdot (R_m - R_f)}{R_f + \sqrt{B_{us}^2 + \frac{\sigma_{us}^2}{\sigma_{Rm}^2}} \cdot (R_m - R_f)} \quad (170)$$

$R_f$  : Risk free rate in the market. This rate can be obtained off the zero coupon yield curve (ZCYC) on the valuation day of the ESO – 7.50%

$B_{us}$  : Beta of the underlying asset – 0.76. The beta refers to the degree by which the return on the underlying stock is correlated with the market. Betas can be calculated for South African firms using the methods suggested by Bradfield (2003).)

$R_m$  : Expected return of the market. The rate of return observed on a diversified portfolio. In this example we will be using the JSE All Share Index as the market – 12% (calculated over a period of 5 years on monthly returns).

$\sigma_m$  : Risk of the market. The risk of the market is replicated by the volatility of the returns on the JSE All Share Index – 15%.

$\sigma_T$  : Total risk of the stock and more commonly known as the volatility of the stock – 30%.

$\sigma_{us}$  : Unsystematic risk of the stock. This is the portion of risk (volatility) on the underlying stock that can be diversified away by increasing the number of stocks in the portfolio. It can be deduced from the beta and total risk of the stock according to the relation:

$$\sigma_{us}^2 = \sigma_T^2 - \beta_{us}^2 \cdot \sigma_M^2 \quad (171)$$

which means that for a stock with a total volatility of 30%, Beta of 76% and market risk of 15%

$$\sigma_{us} = 27.7\%$$

Substituting the values into (170) gives:

$$\frac{E(G)}{E(DP)} = 0.66$$

Using the formulas and inputs shown,  $P_s$  is determined from (169) as **R 165.86**. This means that as soon as the share price exceeds R 165.86, an option holder with a strike of R 100.00 on a stock with the CAPM values as indicated above, should be exercising his options and invest the proceeds in a diversified portfolio.

### Step 2 – Calculate expected term

A simple model can now be used to calculate the probability that the stock price will exceed  $P_s$  over the life of the option.

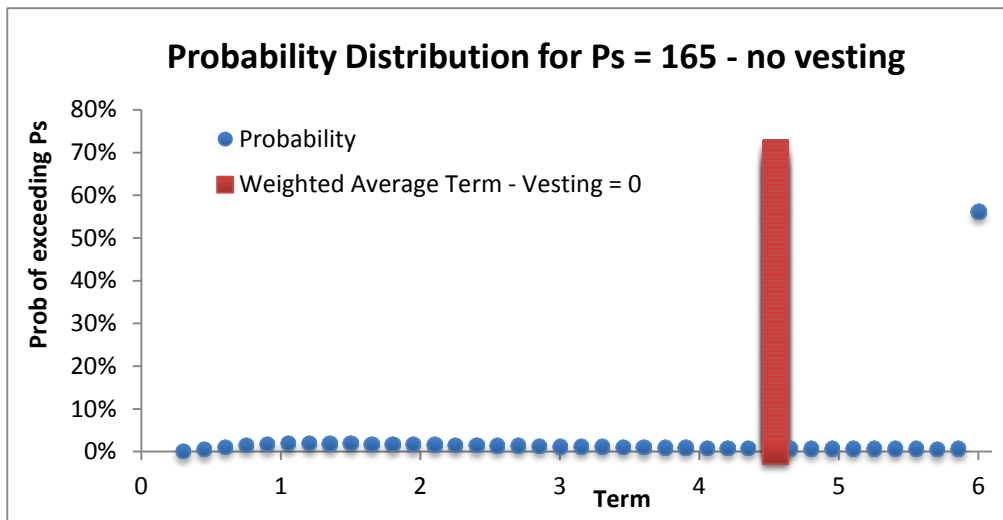


Figure 8.1 - Probability distribution of the share first exceeding  $P_s$

Figure 8.1 shows how the probability of exercising the option increases significantly at maturity. This is because the option holder who has not yet exercised before that will exercise his option at maturity irrespective of the share price. Prior to maturity the share price will have to exceed  $P_s$  for the option to be exercised. Incorporating the probability over the total term produces a probability weighted average term of 4.6 years.

However, the vesting period has not yet been incorporated. When we do this, the stock can be at any level during the vesting term. However, only when the option vests, it will be exercised if the stock is above  $P_s$ . If it is not, the employee holds on to his options until  $P_s$  is breached.

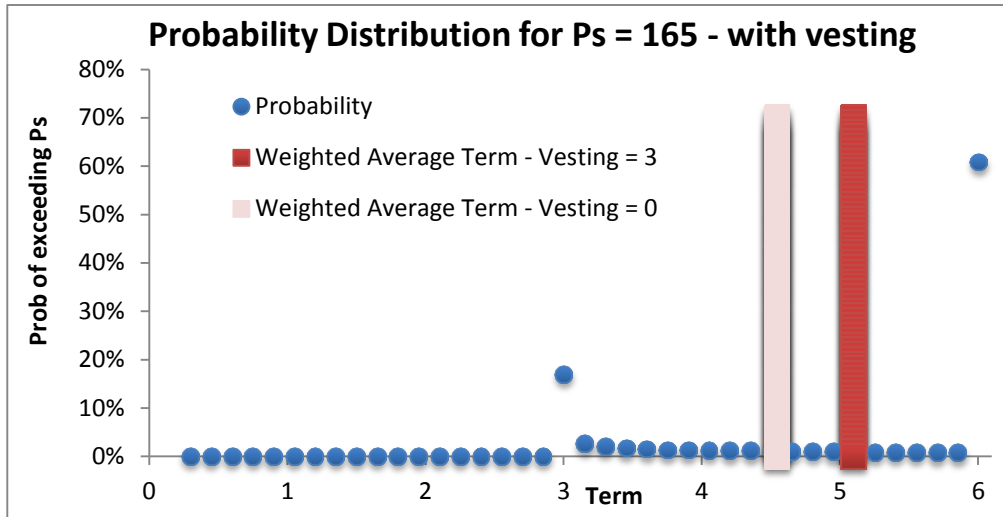


Figure 8.2 - Probability distribution of the share first exceeding  $P_s$  – with vesting

The probability of exceeding  $P_s$  when the option vests after three years is 16.9% while the chances of only reaching  $P_s$  after 3.2 years drops to 2.5%. The probability weighted average term when the vesting period of 3 years is included increases to 5.1 years. We can thus expect a share option value considerably lower than the standard Black-Scholes value of an option that uses the full term to maturity of 6 years as input which is **R 33.52**.

### Step 3 – Calculate ESO Upper Bound value

The ESO value can now be calculated by determining the standard Black-Scholes model at each term and multiplying it with the probability of the option being exercised at that point. In this way an option value of **R 30.98** is obtained. This approach was developed by Mozes (1995).

A slightly simpler way to go about this is to use the probability weighted maturity of 5.1 years in a single Black-Scholes model. This produces an option value of **R 31.32**.

Alternatively the value of  $P_s$ , R 165.86, can be converted into an exercise multiple (that is not linked to historical behaviour of option holders) and incorporated into a binomial pricing model. For the option concerned the exercise multiple would be 1.6586 and the price produced using a Binomial Model is **R 31.61**. This approach is fairly simple to implement once  $P_s$  has been calculated and produces a discount of 5.7% on the Black-Scholes model for this particular set of values.

The next two sections will investigate how the reduction in the Upper Bound method on the standard Black-Scholes model can vary.

### 8.5.1.1 Sensitivity to Strike

The impact of the *Upper Bound* on the option can be expressed in terms of its strike. Since  $P_s$  in equation (168) is a function of the strike and the CAPM inputs (which are specific to the company), the value of the option can be expressed in terms of a whole range of strike-values.

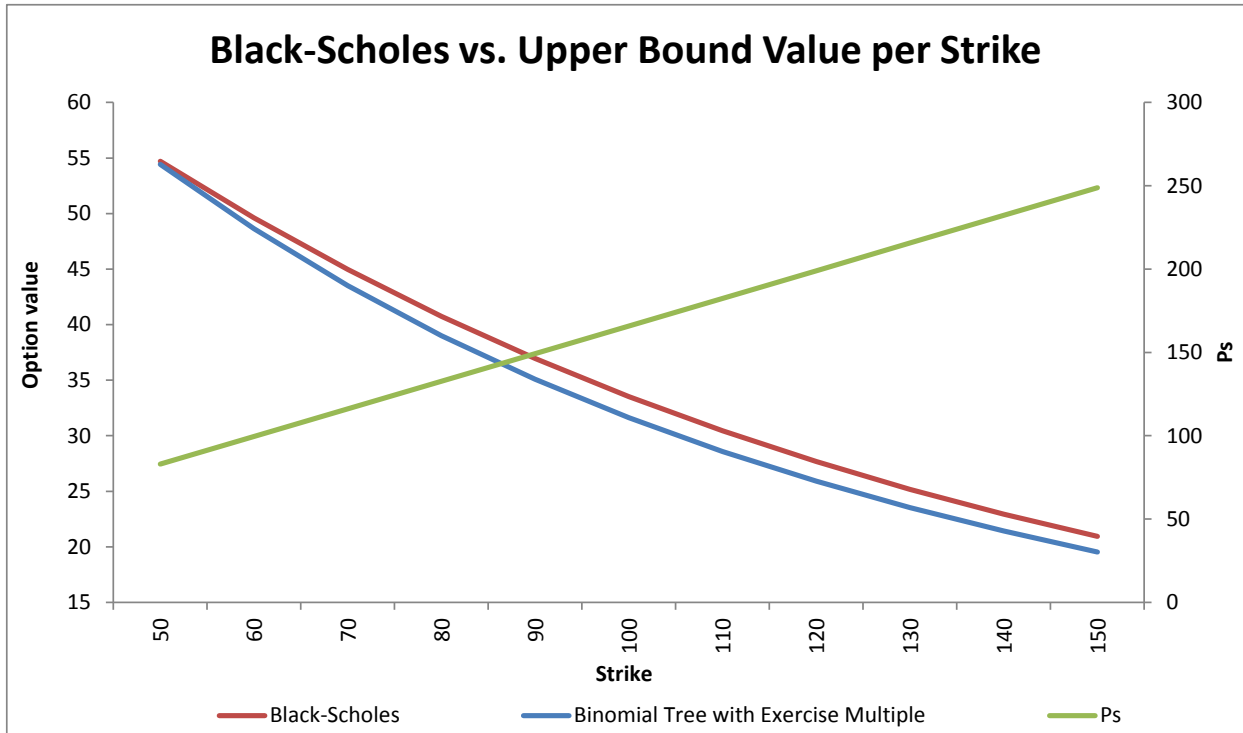
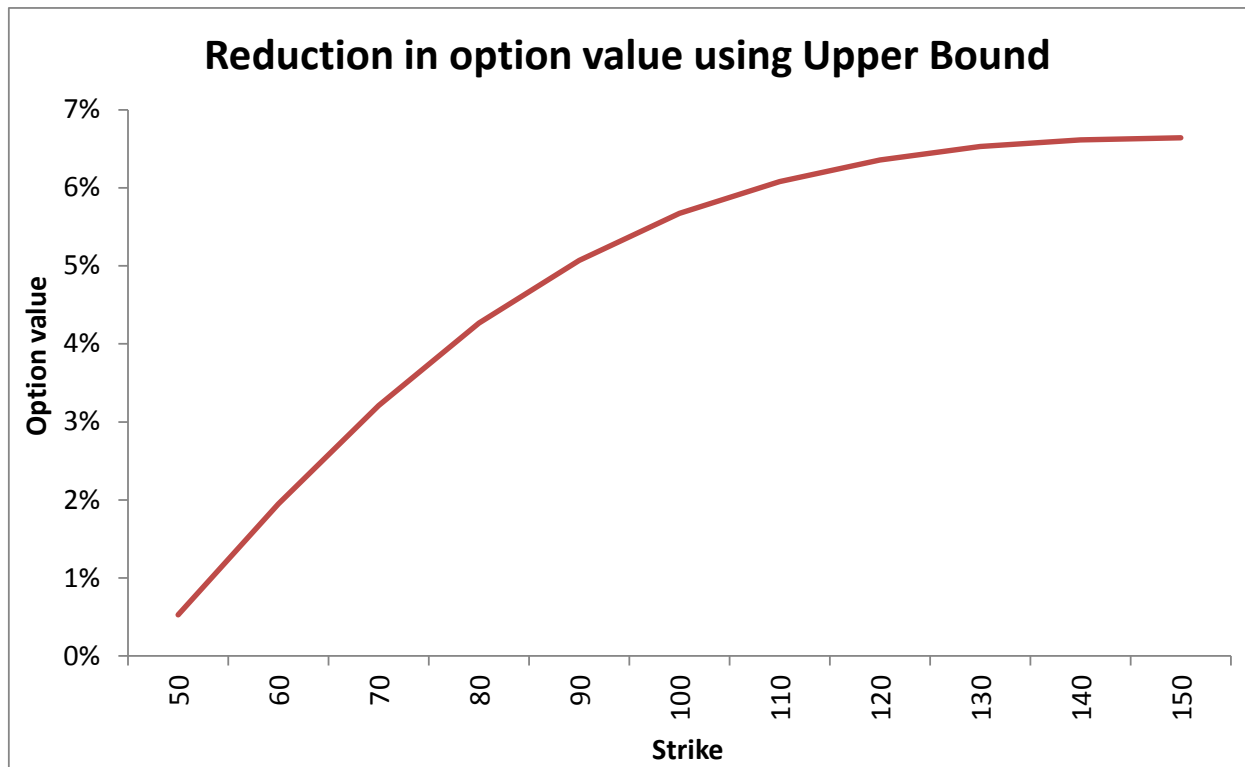


Figure 8.3 - Sensitivity of the option values to the strike

As the strike increases, the value of the call option reduces which causes the downward sloping option value curve in Figure 8.3. The Upper Bound option value (calculated using a binomial model with an exercise multiple derived from  $P_s$  and the strike) is less than that of the standard Black-Scholes model for all strikes since it incorporates the investor's preference to exercise his option at  $P_s$  instead of waiting for maturity of the transaction.



**Figure 8.4 - Reduction in Black-Scholes option value per Strike using the Upper Bound method**

The difference between the option value obtained using the standard Black-Scholes model and one which uses the Upper Bound-methodology is relatively small (<7%) for the range of strikes that were considered. This is linked to the specific beta-value (76%). As the Beta changes, so will the relative difference. This is analysed in the next section.



### 8.5.1.2 Sensitivity to Beta

The beta of a company refers to the degree by which the return on the underlying stock is correlated with the market. As the beta increases, so does the total volatility of the stock which is constructed from the volatility of the market and the systematic volatility of the stock

$$\sigma_T^2 = \sigma_{us}^2 + \beta_{us}^2 \cdot \sigma_M^2. \quad (172)$$

Keeping the volatility of the underlying stock,  $\sigma_{us}$ , and the volatility of the market,  $\sigma_M$ , constant, it is possible to calculate the total volatility as a function of beta using

$$\sigma_T = \sqrt{(27.7\%)^2 + \beta_{us}^2 \cdot (15\%)^2}. \quad (173)$$

While the option price is a function of the volatility ( $\sigma_T$ ), beta also impacts on  $P_s$ . Therefore, for an increasing beta, the volatility as well as  $P_s$  will increase.

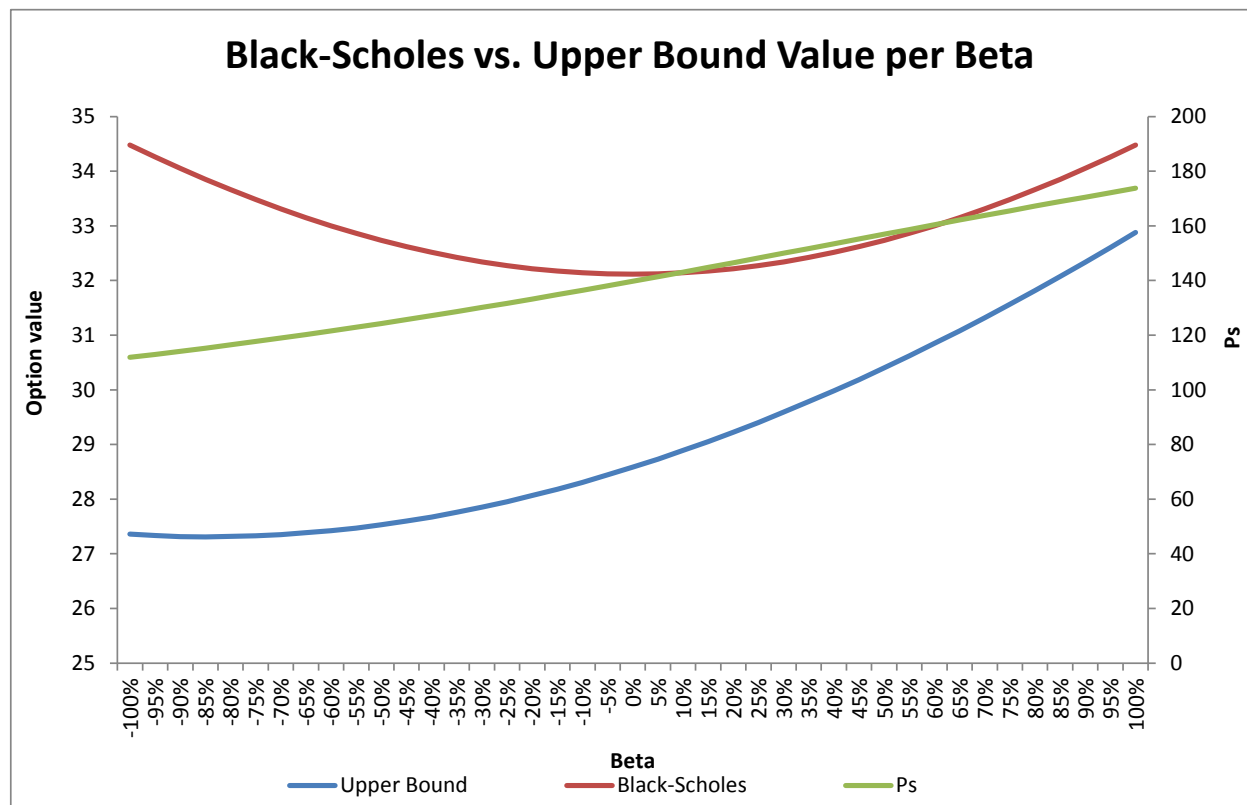
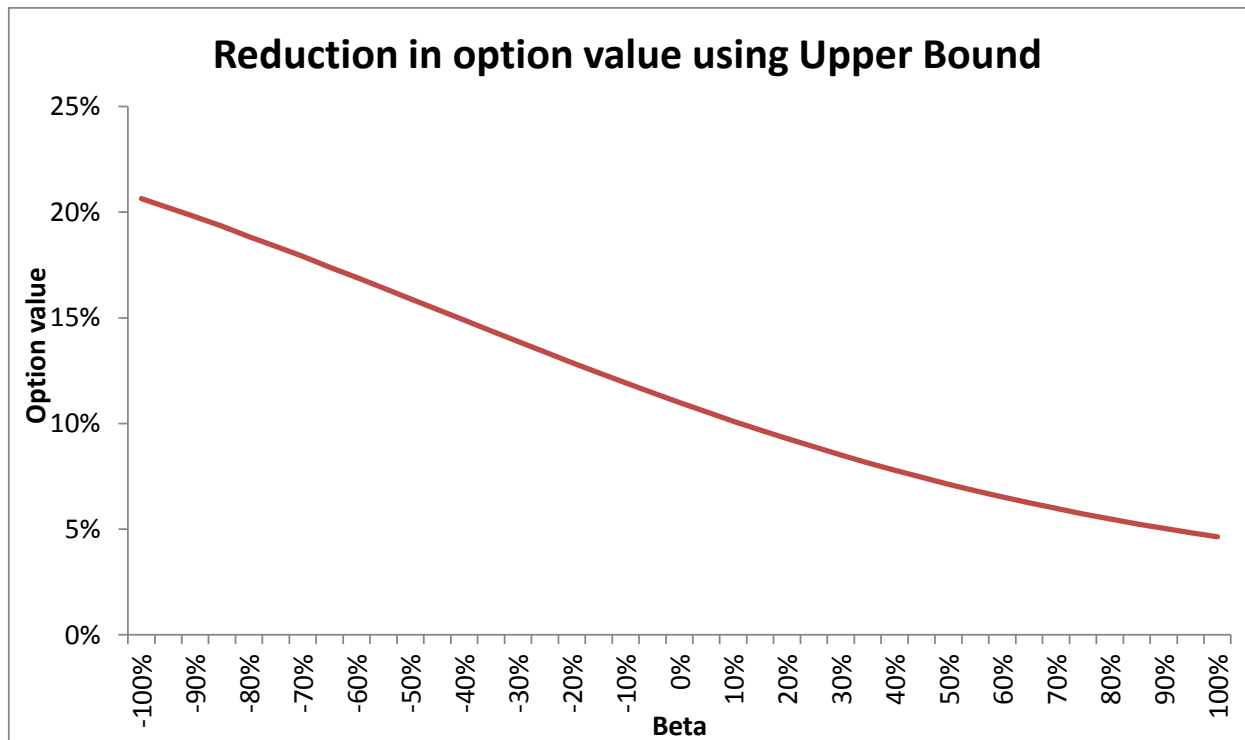


Figure 8.5 - Sensitivity of the option values to the beta

Figure 8.5 illustrates how the Black-Scholes and Upper Bound-value tend towards each other as Beta increases. The closer Beta gets to 100% the less difference there is in the risk of investing in the underlying company's stock or in a diversified portfolio.



**Figure 8.6 - Reduction in Black-Scholes option value per Beta using the Upper Bound method**

The impact of the beta-value in Figure 8.6 increases the reduction in Black-Scholes option value using the Upper Bound method to 20.6% when the beta is equal to -1. This is the case for an option on a share whose return is in direct disagreement with that of the market. As the beta increases, the stock behaves more and more like the market and with the result that the benefit of applying the Upper Bound method eventually reduces to 4.6% when beta is 100%.



## 8.6 Conclusion

The issues raised with respect to ESOs in chapter 7 relates to the implementation and impact of the input that describes the exercise behaviour of the option holders. This chapter discussed three methods to address these issues.

The utility model uses specific characteristics of individuals to determine when the benefit they get from exercising their options will be more than when they continue to hold onto them. The model confirms the believe that regular option pricing overstates the option value since these option holders do not have all the choices available to them that regular investors do (hedging or shorting the employer's shares). However, since it requires inputs that are specific to the investor, calibrating the model is difficult. Furthermore, it calculates the value of the option to the holder instead of the cost to the issuer which is what it is required by IFRS 2. For this reason the approach is not recommended for obtaining the option price for accounting purposes.

The 90 day options-approach is not a valuation methodology per se but rather the justification for revising the accounting treatment on employee share options. The authors of the approach (Bulow & Shoven (2004)) argue that other forms of remuneration such as salaries and bonuses are accounted for once they have been earned and paid out from one month to the next but the existing accounting treatment assumes the employee will still be employed by the time that the option matures when it is priced. This could be several years later. By allowing companies to consider a 90 day period for the option only, consistency between the different forms of remuneration is ensured and pricing the ESOs are considerably simplified as many traded options with known prices have similar life times.

The ESO upper bound-methodology recognises that at some point the option holder can exercise his options and invest the after-tax proceeds in a diversified portfolio with a higher expected return than that of the single equity option. By using the principles of the CAPM, it is possible to calculate a threshold level at which exercise will occur for each ESO of a specific issuing company, often prior to maturity of the option. Implementing this approach reduces the standard Black-Scholes option value without relying on assumptions about the specific employee's exercise behaviour. Instead, the behaviour of the option holder is viewed as that of a rational investor. This means that no assumption regarding the exercise behaviour or other characteristics of the employee is needed and that the derived option value represents the cost thereof.



The benefit in using the Upper Bound method is higher when the beta on the relevant stock is at its lowest as this implies that the stock does not mimic the market's behaviour and the value in switching to a diversified portfolio increases.

## CHAPTER 9

### 9 ESO Structure Issues

#### 9.1 Chapter Overview

In chapter 8 the pricing issue related to the exercise behaviour of employees was discussed and different ways were identified to address this issue. In this section we view some of the structural shortcomings in existing ESOs and the alternatives that have been recommended. This is measured against whether the ESO scheme meets the objective it was set out to obtain.

#### 9.2 General ESO Problems

The aim of ESOs is to:

- Give executives a greater incentive to act in the interest of the shareholders.
- Enable companies to retain the services of key employees without spending cash directly.
- Encourage executive risk taking.

Furthermore, it is in the best interest of the shareholders to have top calibre managers in their company and the high levels of compensation in some cases can be justified (Dean (1953)).

Core & Guay (2002) argue that the cost associated with compiling data on employee stock option portfolios is a substantial obstacle in investigating the impact of stock options on managerial incentives, financing decisions and the valuation of equity while Yermack (1994) concludes that CEO pay arrangements do not reflect the recommendations of compensation theorists. These reasons might explain why ESOs do not always achieve what they are supposed to accomplish. Some of the specific issues (some of which were observed by Hall & Murphy (2003)) are as follow:

- The cost of the ESOs to the issuing companies is much more than the value derived by employees (Hall & Murphy (2003)). The cost can be compared to what the company would have to pay an outside investor to take over the liabilities of the options granted to employees. Hall & Murphy (2003) found that employees value their options at about half of the price it cost the company to grant these options.

- The drawbacks of ESOs compared to other forms of compensation (bonuses & higher salaries) have not been adequately analysed to determine whether the popularity it has over these alternatives is justified.
- The ability of ESOs to retain employees is very low if the share price has dropped below the strike. This could even serve as an incentive for the employee to change employers in the hope of receiving new at-the-money options. Therefore, it could be argued that ESOs are only effective in a bull market.
- Cash bonuses are a more cost effective way than options to ensure continued employment. With the majority of share options being granted to employees below the top-executive level where the impact on the share price is limited, would the employee be best served by a compensation scheme that is tied to the share price of the company? Would a simple cash bonus that is connected to relevant tangible deliverables not make more sense?
- Even for top executives, the use of ESOs is questioned. ESOs with strikes that may increase are not popular with executives while the market scoffs at an executive who receives a huge payoff while he had not achieved much. The conclusion is that companies should be wary of blindly awarding stock options even though they have become popular in the market. It should analyse what it plans to achieve and whether ESOs are the best route to take. Most research indicates that ESOs are not the best route.
- The question gets asked why companies still use stock options to encourage employees when all the drawbacks and inefficiencies are known. No single reason is identified as the overriding reason for this. The hypothesis is put forward that the perceived low cost of ESOs might be the reason since they do not have an initial accounting cost or cash outlay. The company still bears an economic cost similar to what an outside investor would pay for the option even though the accounting charge is different – dependent on the pricing method, inputs and assumptions used. Thus, even though the economic cost of ESOs make them a poor way of retaining and motivating employees, it looks good from a perceived cost point of view.
- The popularity of ESOs during the latter part of the 1990's led to lower level of employees also wanting this form of compensation. The bull-run in many of the markets over this period caused total CEO pay to escalate significantly and at this point these employees also

wanted exposure to the market. The lack of a direct link between lower level employees and the share price was ignored. Whether hard working employees will see their ESOs in a bear market as incentives is questionable.

- Since ESOs are options held by investors who are employed by the company of the underlying stocks, insider trading can be a problem. Carpenter and Remmers (2001) acknowledge that traditional option pricing methods overstate the value of options when one considers the short time after vesting that exercise often occurs. However, employees do have more insight into the workings of the company and may even have significant influence on what happens to the share price. These factors could add to the value of the ESOs. The smaller the company or the more senior the employee, the higher the influence the employee can exert onto the share price would be, making the ESOs more valuable.

Carpenter and Remmers (2001) show very little evidence of insider trading. They came to this conclusion by analysing the post exercise return on two samples of exercise data. The data showed no sign that returns become negative after employees exercise their share options. Their reasoning for this is that this would be easily spotted and keeps employees in check. In fact, in one of the samples the returns on the underlying shares was abnormally positive. Any “rational insider trading investor” would have taken advantage of this.

- Unfortunately, in many cases, companies who aggressively pursue the services of a particular candidate to fill a senior position in their organization are willing to pay for it. They want to ensure that the candidate is lured to them and will ensure that the benefits in the remuneration package are tempting. This makes it difficult for them to have the candidate agree to a very restrictive performance clause in the structure of his ESO. If the candidate takes up the position but fails to have the desired positive influence on the share price, he can still be assured of a substantial value in his ESO. This problem will tend to repeat itself because even if the board gets rid of him, it will once again be desperately looking for someone who can swing the fortunes of the company. And again the next candidate will receive ESOs without strict performance related hurdles.

ESOs have in many cases become an expected part of the remuneration package for senior management. The degree to which it retains talent is questionable as a competitor would be likely to compensate the individual for any ESOs he might be forfeiting in moving to them. Middle management might be slightly less willing to give up their ESOs where the possibility of

being compensated for them is less. Loyalty is likely to be a function of a host of other factors such as the employee's history with the company and in particular to what degree he has been responsible for founding it.

### **9.3 Recommended ESO Methods**

Irrespective of the inherent inefficiencies of ESOs, there are still certain requirements that should be adhered to, to make the most of them. They should be structured and managed in such a way as to ensure that they perform the function they were intended for as closely as possible which is to provide an incentive for the employee to perform his role in such a way as to lead to a sustainable growth in the share price. There are, however, a number of ways in which this objective is misused. Misuse can be minimised by implementing the following structures:

#### **9.3.1 Cost Effective Options**

Having the cost of the issuing share options available (Black-Scholes), Hall and Murphy (2000) analyses which combination of cash, share and options utilises this cost most effectively. In other words, if the company is going to have to pay a certain amount for the incentives it is awarding the employee, it should give him such incentives that are valued by the employee as close to the cost as possible. The analysis shows that options issued at-the-money (ATM) are within one percentage of the maximum utility available which justifies the common use of this practice. However, for executives whose options make out only a small portion of their total wealth, in-the-money (ITM) options look to be higher valued and the report suggests that companies attempt to offer such options to the executives.

From an administrative point of view it may be easier to have a standard process where all options issued by the company are ATM. Questions surrounding the morality of providing executives with ITM options while regular employees' options are ATM could also be a situation that the company may want to avoid at all costs due to the intense public scrutiny executives packages are subjected to. However, it is still possible that a certain company may feel that this approach could be ideally suited to them. In such a scenario, the method developed by Hall and Murphy (2000) could add much value to the option issuing exercise. Also, the fact that executives do not value the options they receive as highly as it is reported and get criticised for in the media, could have a negative impact on the quality of work they produce if they feel that they are being too harshly judged. The result is a low incentive for an option that might be quite costly to the company.



### **9.3.2 Extended Vesting Periods**

It can happen that senior management makes decisions with the sole purpose of boosting the share price over the short-term (e.g. cutting back on maintenance expenses to save costs). The resulting action might boost profitability and thereby increase the traded share price in the short-term. Down the line, however, the lack of a necessary long-term view could have a severe negative impact on the business. By this time the employee has exercised his options and walked away with a substantial monetary reward. In effect he has been rewarded even though the basic functions were not performed. This can be avoided by having extensive vesting periods on the ESOs granted to senior management (even longer than their contract term) which has a direct influence on share prices in many cases. If these employees want a significant payoff on their ESOs, the share price has to keep growing for prolonged periods of time. This can only be the case if healthy business decisions are being made.

### **9.3.3 Hurdle Rates**

Much is published in the media about CEOs' share options – often reaching millions. Reasonable investors or shareholders will most probably not take offence at a CEO who received a large payoff on his ESOs if he has added value to the company or managed to guide it through a difficult period. Where the market does become concerned, is if it appears that the CEO walks away with a healthy pay-out even though the company is struggling. This can also be the case if the CEO did not do much but merely benefited from a rise in the market. It is for this reason that there is a strong drive towards including specific hurdle rates into the ESO structures of senior management. The market would like to see the CEO's action leading to an out-performance of the ALSI, his industry, competitor or inflation over the same period.

### **9.3.4 Detailed Disclosure**

Bulow & Shoven (2004) suggest that ESO disclosure by companies should be adequate to enable analysts and investors to do their own evaluation. Seeing the various approaches used to price ESOs, the ultimate solution may lie in providing this information to the market, for it to form its own opinion. The accounting standards may serve only as to how to summarise the raw data into a manageable form.

In essence, the report questions how much reliable information is presented to an investor when he sees option values that are based on the assumption that the employees will obtain huge pay-outs sometime in the distant future. These option values are seen within the context of a company with a significantly lower share price. If the pay-outs suggested by the traditional ESO pricing models are realised, the share price will also have grown and the company will have changed altogether. Many market observers believe that the share price is the best indication of what the market thinks the company is worth. With this in mind, even a company which is expected to do well is accurately valued by its current share price. There is, of course, nothing preventing companies from already providing such detailed disclosure.

### **9.3.5 Fixed Issue Dates**

Each company should have clear and simple rules as to when and how ESOs are issued. These rules should make the specific parameters of the employee's options predictable and transparent. If the company has a policy that determines who will receive options, the grants should take place on a fixed date. This measure will prevent the following from happening:

#### **9.3.5.1 Time Travel Grants**

The options are issued on a date in the past where the share price was lower than its current level. This means that the strike of the option is determined knowing what has happened to the share price since then. If the employee who receives the options is also involved in issuing them, he could fabricate a substantial intrinsic value into the option. Having a fixed annual issue date at which the strike is determined, would avoid this. Even if the administration of the options has fallen behind, such a policy will ensure that employees who are supposed to be granted the same ESOs will have the same strike on their share options. This could become a problem if administration delays occur during a volatile time for the share price.

#### **9.3.5.2 Spring Loaded Grants**

Spring Loaded grants occur when ESOs are granted just before favourable share price information becomes public or just after unfavourable information. The expected effect of the information can be anticipated to some degree and used to get exposure to a run in the share price or to avoid fixing the strike of the options before the share price drops. The link to insider trading is very strong in this regard.

## 9.4 Conclusion

This chapter looked at some of the problems inherent in ESOs and also how the most can be made from them despite these issues. The main issue is that their cost is less than the value derived by the option holders (Hall & Murphy (2003)) and that its use may be less effective than other types of incentives such as bonuses. Empirical proof of this is difficult to provide due to the subjectivity involved in employees' preferences. Utility models have been proposed by some authors (Carpenter (1998), Bettis, Bizjak & Lemmon (2004) and Hall & Murphy (2000)) but these have not been used extensively in the South African market.

With ESOs having been introduced and expanded on in the last two chapters, the report now turns to a detailed analysis of BEE deals.

## CHAPTER 10

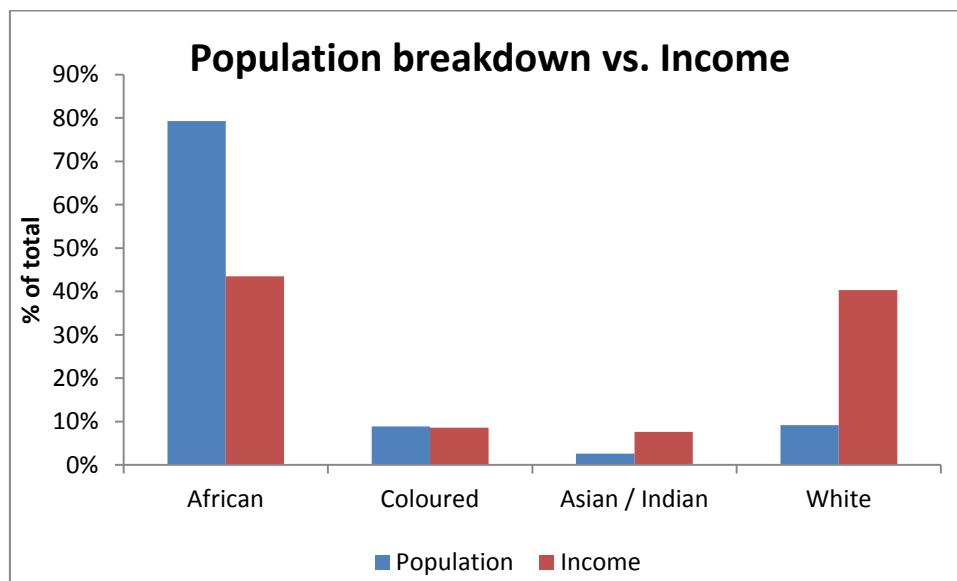
### 10 BEE Deals

#### 10.1 Chapter Overview

Having discussed ESOs in depth in the last two chapters, the focus now turns to BEE deals. This chapter looks at the background of these types of transactions and examines the social-political environment that gave rise to their existence as well as a few deals that have been done under this banner and how they have performed since inception.

#### 10.2 Background

One of the major legacies of Apartheid is the disproportionate distribution of wealth amongst racial groups in South Africa. The Institute for Justice and Reconciliation estimated that in 2008, Africans (41.8%) and Whites (40.3%) earned a similar proportion of the country's total income, even though there are eight times more Africans (79.3%) than Whites (9.2%) in South Africa.



**Figure 10.1 - Population breakdown vs. income earned by race**

To fast track the redistribution of wealth in the country after the democratic elections in 1994 the South African government proposed black economic empowerment (BEE) whereby black South Africans will be included in existing businesses in some form or another. During the latter part of the 1990s, companies sought out well placed black individuals for BEE deals who could assist them in some way. This usually meant acting as a go-between between the white company and the new black government or merely to pre-empt whatever BEE requirements will be called on from business. A handful of black entrepreneurs benefit economically from these

arrangements but there was growing criticism of these deals as it only helped to enrich a few well-placed individuals at the time. After the Asian crisis of the late 1990's when many of these deals collapsed, the government decided to specify in great detail the requirements of BEE for South African companies and the BEE codes were adopted in 2003.

These codes legislate the minimum requirements for black involvement in the various South African businesses across industry and business size. Failure to adhere to these codes could result in severe penalties at best and revoking of operating licenses at worst. Jenny Cargill [in her book *Trick or Treat – Rethinking Black Economic Empowerment*] (2010), indicates that the value of disclosed BEE deals between 1996 and 2003 of R90 billion increased to R350 billion between 2004 and 2008 after the adoption of the BEE codes.

### 10.3 Legislation

The government document, *Code 000: Broad-Based Black Economic Empowerment Framework* outlines the official rationale behind the BEE concept.

- 1. The Broad-Based Black Economic Empowerment Act no. 53 of 2003 and Government's Black Economic Empowerment Strategy aim to address inequalities resulting from the systematic exclusion of the majority of South Africans from meaningful participation in the economy.*
- 2. One of the defining features of Apartheid was the use of race to control and severely restrict black people from access to economic opportunities and resources.*
- 3. The under-development of black South Africans was characterised by the progressive destruction of productive assets; deliberate denial of access to skills and jobs; and the undermining of self-employment and entrepreneurship. In combination with one another, these policies restricted and suppressed wealth and skill endowments in black communities; thereby structurally inhibiting their participation in a de-racialised economy. It is a testimony to the vitality of black society that black people have managed to achieve what has been achieved.*
- 4. Government's strategy for broad-based black economic empowerment looks beyond the redress of past inequalities and aims to position BEE as a tool to broaden the country's economic base and accelerate growth, job creation and poverty eradication.*

According to the framework, BEE aims to alleviate the impact of the exclusion of so many citizens of the country under point 36 of this code:

*36. Broad-based black economic empowerment (Broad-Based BEE) means the economic empowerment of all black people including women, workers, youth, people with disabilities and people living in rural areas, through diverse but integrated socioeconomic strategies, that include, but are not limited to:*

*a) increasing the number of black people that manage, own and control enterprises and productive assets,*

*b) facilitating ownership and management of enterprises and productive assets by communities, workers, co-operatives and other collective enterprises,*

*c) human resource and skills development,*

*d) achieving equitable representation in all occupational categories and levels in the workforce,*

*e) preferential procurement, and*

*f) investment in enterprises that are owned or managed by black people.*

The components in which BEE are applicable are further defined in point 41 of the code:

*41. The three components of broad-based BEE each correspond to a specific beneficiary, namely:*

<b><i>Component</i></b>	<b><i>Beneficiary</i></b>
<i>a) Direct Empowerment</i>	<i>Equity holders, executives and other owners and managers of economic resources</i>
<i>b) Human Resource Development</i>	<i>Employees and job seekers</i>
<i>c) Indirect Empowerment</i>	<i>Suppliers, communities and other relevant external stakeholders</i>

Direct Empowerment is described in point 42:

*42. The direct empowerment component is comprised of the equity ownership and management element of the scorecard. The key focus of the direct empowerment component is its economic impact on the equity holders, executives and other owners*

*and managers of economic resources. The beneficiaries assume direct economic risk for their involvement and expect returns that are commensurate to that risk.*

**This report is concerned with *Direct Empowerment* and focuses specifically on the financial structures used today to facilitate the transfer of company shares to designated black citizens.**

#### **10.4 BEE Scorecard**

The South African government has taken a pro-active role in ensuring that the number of black South Africans that form part of the economic activities of the country increase over time. Companies are guided by a BEE charter for each economic industry that quantifies the requirements for empowerment in the various categories. Companies who fail to meet them are subject to a variety of penalties. These include financial fines, exclusion from government contract or revoking of operating licenses. Because of the serious consequences when failing to meet the BEE conditions, a formal way is needed to measure the level of empowerment of a company to ensure consistency. This led to the development of a scorecard system. Under this system companies will be given a score according to the degree they have managed to introduce black citizens to the three different areas (*Direct Empowerment, Human Resource Development and Indirect Empowerment*) throughout the company.

The act gives guidelines on how BEE in the various areas of the company should take place. In order to determine the degree to which a company has been “transformed”, a scorecard system is used. This system looks at how much black involvement and upliftment there is in the various areas throughout the company and assigns a weight to this percentage. By aggregating the various components, the company’s overall level of transformation is determined.

One of the major aspects in this regard, is the percentage of shares owned by black South Africans. Equity ownership falls in the *Direct Empowerment*-category. The BEE target is for black South Africans to control 25% + 1 vote of which 10% should be in the hands of black women.

An ownership scorecard (refer to Section 15.1 in the Appendix) determines the BEE credits. The scorecard counts out of a total of 20 points. Points can be gained in different areas. Each area is further divided into specific groups that the government wishes to target. Each of these sub-groups has a maximum number of points and target. If the company has reached the required

transformation target for the sub-group, it gets the associated number of points. According to this system the company is credited in three areas. Having less than the target will earn the company less points pro-rata. When the target is exceeded, the company still only gets the 100% point. This method is applied to all the sub-sections in the three main areas to determine an aggregated point out of 20. The three main areas are:

- Voting Rights

The target for unrestricted voting rights in the company in the hands of black people was set at 25% and 10% for black woman. Voting rights is obtained by owning shares (equity) in the company. Each share amounts to one vote. In this way the control of the company is determined by the party with the most votes. Some BEE initiatives do not grant voting rights to the BEE group while the vesting period is still underway. Therefore, depending on the specifics of the contract, the company does not have the benefit of scorecard-points while the shares are vesting.

- Economic Interest

The Economic interest refers to whether black people receive the financial benefit from owning the shares. As is the case with voting rights, since the structure used to transfer shares to the BEE group, may not be a simple process, financial gain is typically delayed. It is very typical for a BEE group to own the shares but not be eligible to receive the benefit of dividends on the shares while they are vesting. In such a case the company cannot score points for economic interest on the score card.

- Realization Points

In earlier versions of the BEE scorecard, eight of the 20 points in the ownership category were awarded when all outstanding funding on BEE transactions was fully repaid. This meant that the issuing company driving the share transfer would not receive credit for a large part of the deal, until the BEE partner had no more outstanding debt. This feature has subsequently been changed whereby seven of the eight points in the category will be awarded if the debt has been repaid to a certain degree as time goes on. The eighth point is awarded when the debt is paid-off.

- Bonus Points

One bonus point is available to companies who manage to transform in excess of the standard targets. This will happen when specific targets are met in the process of achieving the standard targets. The points gained in this section can be added to those obtained in the previous sections.



The Financial Mail magazine annually publishes a list of South Africa's best empowered companies. Details of how the companies are doing in the various areas as well as the overall score is provided (refer to Section 15.2 in the Appendix).

## 10.5 BEE and Equity

The BEE deals on which this report focuses are those that listed companies structure to increase the level black ownership in their share capital. They are broadly published and discussed in the media and have to be reported in the financial statements of the company. These deals aim to transfer equity of the company to designated black groups against the backdrop that share prices are extremely sensitive to market interference. In order to balance the pressure of simultaneously ensuring that a wider variety of South African citizens participate in the economy through equity ownership while honouring the existing ownership rights of equity holders, a unique framework has been developed. If shares were forcefully taken from existing owners and given to black citizens it could have caused share prices on the JSE to plummet with severe economic implications for the country as a whole. The shares would have been worthless to their new black owners with no winner in the end.

The sensitivity of share prices to political interference was clearly illustrated in October 2002 when a draft mining charter was leaked to the public. In it the South African Department of Minerals and Energy recommended that 50% of all mining shares be black owned within 10 years (by 2012). This was the first time that the government had indicated such drastic transformation targets and it came totally unexpected to the market. The market viewed this as an unrealistic target without radical government intervention. The result was an extreme decline in mining shares in South Africa with mining index losing R56 billion in two days and 33% of its value within 6 months. It was estimated that SA experienced a net foreign capital outflow of R11bn in this time. This contrasts with average foreign capital portfolio inflows of R19bn over the previous seven years<sup>7</sup>. This bill has since been amended to show more realistic targets of half those originally proposed (25%). This event highlighted the delicate nature of share transfer.

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<sup>7</sup> Financial Mail, 4 March 2005, *Reward or Risk?*, Jacqui Pile

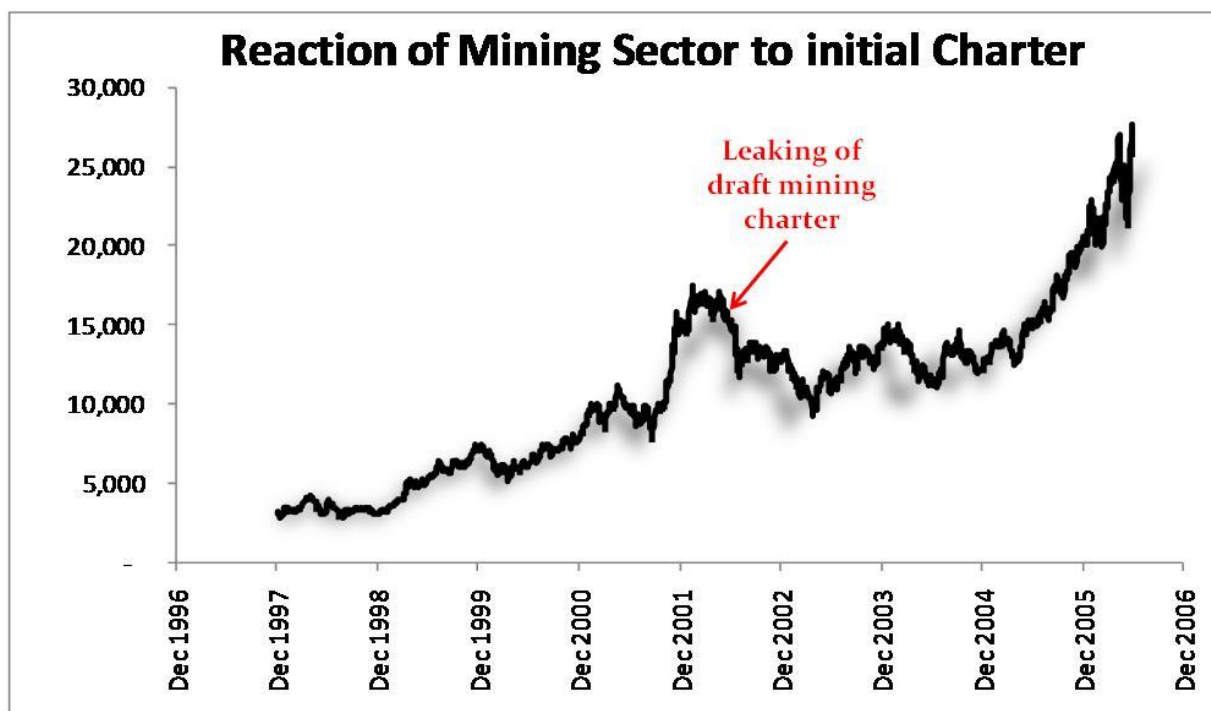


Figure 10.2 - Mining Sector reacts to Mining Charter

Instead of such a drastic approach, the SA government has given certain time horizons at which public companies' shareholding should have been transformed. This report will focus on the structure of a typical BEE deal that has emerged in the SA market to facilitate black shareholders in obtaining shares in South African companies.

New legislation introduced in 2004 requires all South African mining companies to convert mining licenses held under the previous laws to "new order" licenses. One of the conditions for conversion is compliance with the mining charter, which states that mining companies should have 15% black ownership by 2009 and 26% by 2014

The ability of listed companies to continue doing business depends on them having the necessary Black Economic Empowerment (BEE) credentials (Leonard (2007)). Apart from the direct threat of penalties and operating licenses being suspended, government and private contracts are increasingly being placed with empowered companies.

## 10.6 Existing BEE Transactions

In 2004 legislation that required companies to have a certain portion of their shares held by black South Africans came into effect. This gave rise to a situation where most large South African companies started structuring transactions to assist black investors in attaining equity ensuring the company's empowerment status. This section takes a look at the BEE transactions of some of the South Africa's leading companies. The features of the BEE transactions mimicked the understanding of the BEE legislation at that time. As new legislation was published certain aspects of the deal changed.

### 10.6.1 ABSA

#### 10.6.1.1 Transaction Details

- In April 2004 ABSA did a BEE transaction to transfer 10% of its issued ordinary shares (73,2m) to the Batho Bonke Consortium.
- The Batho Bonke Consortium is made up of Mvelaphanda Holdings (Proprietary) Limited, Leslie Maasdorp grouping, Nthobi Angel grouping, community trusts, business people, charities, regional groupings, regional community trusts, BEE companies, women's groupings, rural-based formations and business associations.
- Average share price at time of transaction: R43
- ABSA issued new redeemable preference shares (NRP) with a par value of R 2.00 each in which the consortium invested. These preference shares earn dividends at a rate of 72% of the prime overdraft rate and can be converted to ordinary ABSA shares at the option strike price between 3 and 5 years after issue (30 June 2007 and 30 June 2009) on a one-to-one basis. At least 50.1% of the ABSA shares obtained in this way are locked-in until 31 March 2011.
- The consortium uses its own funds to acquire the 73,2m redeemable preference shares at a cost of R 2.00 each:

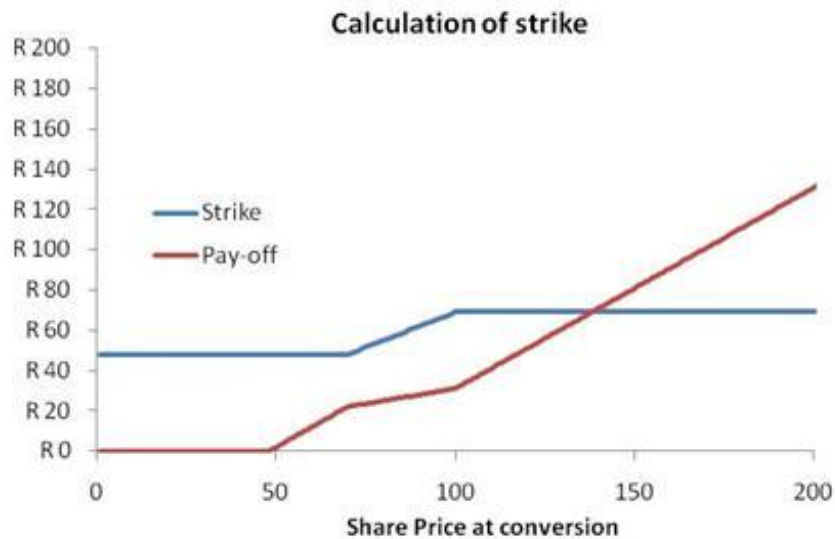
Total funds required by BEE consortium: R 146,4m

- The strike is determined when it is exercised according to the table.

Share Price	Strike
Less than R70	R48
Between R70 and R100	$R48 + 70\% \text{ of } (\text{Share Price} - R48)$
Greater than R100	R69

**Table 10.1 - Strike price on ABSA deal**

The strike as a function of the share price can be viewed in the graph below.

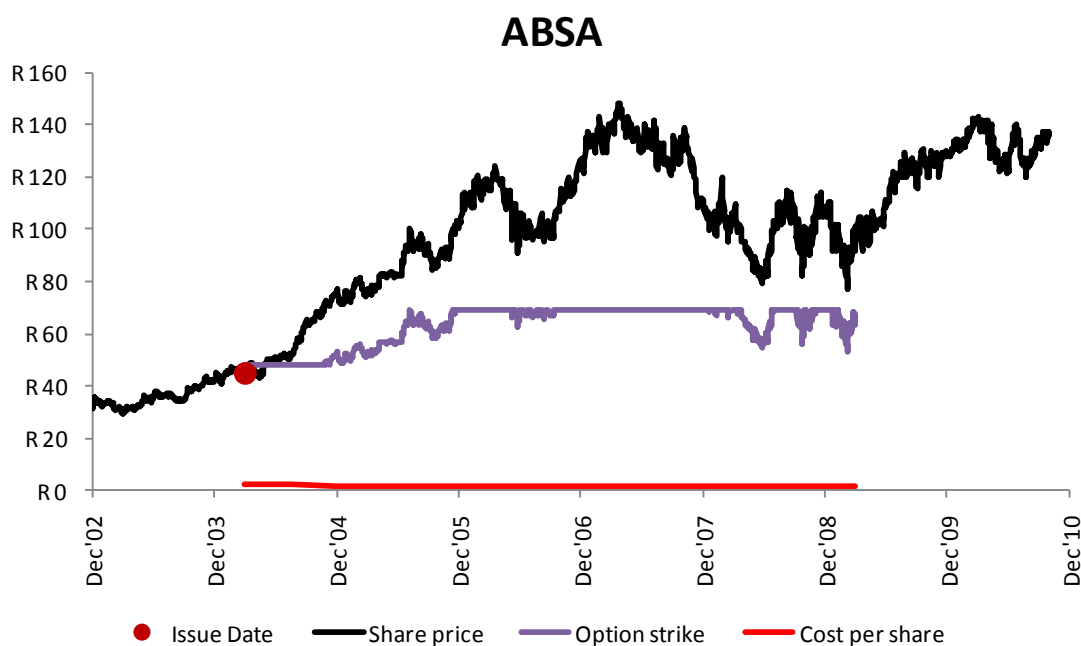


**Figure 10.3 - Strike price on ABSA BEE deal**

- Mr Tokyo Sexwale was elected to lead the empowerment transaction.
- The consortium becomes the largest single investor in ABSA apart from Barclays.
- Source of information:
  - URL: <http://www.absa.co.za>

Detailed sources of the transaction information can be viewed in Section 0 of the appendix.

### 10.6.1.2 Transaction Performance



**Figure 10.4 - ABSA share performance over life of BEE deal**

Figure 10.4 illustrates how the ABSA BEE deal has performed. Even though the cost of the preference shares was small in comparison with the share price at the time (R2.00 vs. R45.00), the strike on the options was larger than the share price (R48.00 vs. R45.00). This meant that even though on issue there was no intrinsic value for the BEE partners, the cost of having the exposure was also relatively small.

However, the strong share price growth has ensured that significant value has been obtained by the BEE partners.

Event	Issue	Exercise	Latest
Date	01 Apr 2004	27 Aug 2009	01 Nov 2010
Number of underlying shares	73,200,000	73,200,000	36,649,300
Share price	R 45.00	R 129.00	R 137.44
Strike	R 48.00	R 69.00	R 0.00
Debt per share	R 2.00	R 1.27	R 0.00
Intrinsic value per share	-R 2.00	R 58.73	R 137.44
Net structure value	-R 146,400,000	R 4,299,230,718	R 5,037,079,792

**Table 10.2 - Status of the ABSA BEE transaction**

On 27 August 2009 Batho Bonke exercised the options at an intrinsic value of R59. Through this action they were awarded 36,65 million unencumbered ordinary ABSA shares. The BEE partners cannot sell the shares until 2011 due to the lock-in period in the contract. Since conversion the share price has grown further from R129.00 to R137.44 bringing the net value to R5 bil.

## 10.6.2 MTN

MTN has conducted two BEE deals. The Asonge deal was done in 2007 and the Zakhele deal in 2010.

### 10.6.2.1 Asonge Deal Transaction Details

- In August 2007 MTN did a BEE transaction to transfer 6% of its issued ordinary shares (11.7m) to ordinary black South Africans.
- Black South Africans were invited to purchase MTN shares between 23 July 2007 and 16 August 2007 at a 20% discount to the market value of the 30 business day volume-weighted average traded price of the Shares on the JSE at 17h00 on Friday, 20 July 2007.
- Average share price at time of transaction: R 99.51
- Discounted purchase price: R 79.61
- Shares obtained in this way are subject to a 12 month (until August 2008) lock-in period during which they cannot be traded.
- Shares held for 24 months (until August 2009) gives the holder the right to an additional MTN share for each ten purchased under the terms of the transaction.
- All dividends accrue to the investor
- MTN's Asonge BEE deal is administered by the National Empowerment Fund.
- Source of information:
  - URL: <http://www.nefcorp.co.za>

Detailed sources of the transaction information can be viewed in Section 17.3.1 of the appendix.

### 10.6.2.2 Asonge Deal Transaction Performance

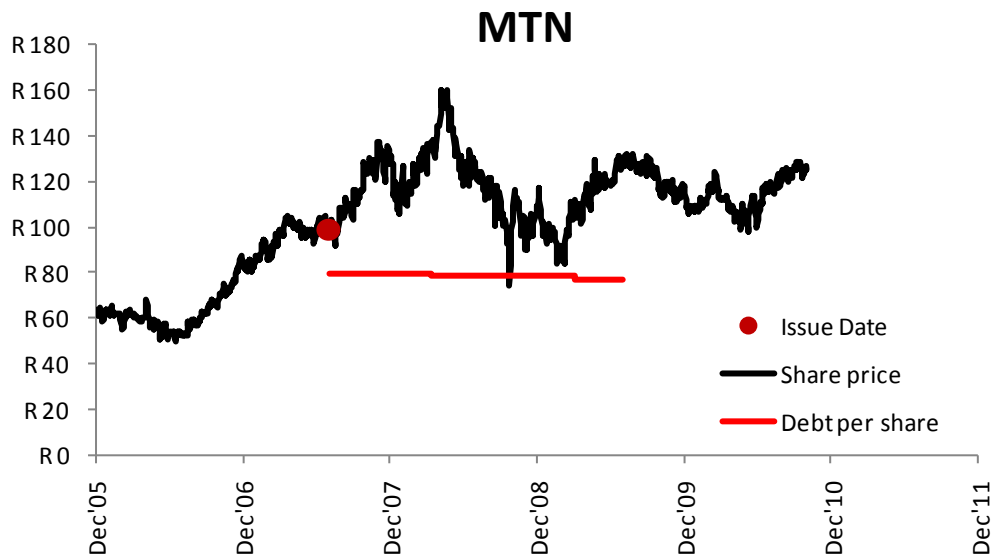


Figure 10.5 - MTN share performance over life of BEE deal

The MTN share price has been volatile over the lifetime of the transaction even going lower than the issue price at the end of 2008 and start of 2009. However, the discount at which the deal was done meant that it was only out-the-money for one day in October 2008.

Event	Issue	Maturity	Latest
Date	01 Aug 2007	03 Aug 2009	01 Nov 2010
Number of underlying shares	11,700,000	11,700,000	11,700,000
Debt per share	R 79.61	R 76.44	R 76.44
Share price	R 98.80	R 127.00	R 124.80
Intrinsic value per share	R 19.19	R 50.56	R 48.36
Net structure value	R 224,523,000	R 591,552,000	R 565,812,000
*Number of additional shares	0	1,170,000	1,170,000
Value of additional shares	R 0	R 148,590,000	R 146,016,000
Total value of transaction	R 224,523,000	R 740,142,000	R 711,828,000

\*Additional shares are granted to the option holders if the original shares are held until August 2009

Table 10.3 - Status of the MTN BEE transaction

In this analysis it was assumed that all the BEE shares were held until maturity to illustrate the maximum value that could have been derived by the BEE partners. At maturity (of the deal), it was worth R740 million which has subsequently reduced to R712 million.

The dividends cause a small reduction in the debt.

### 10.6.2.3 Zakhele Deal Transaction Details

- In August 2010 MTN did a BEE transaction to transfer an additional 4% of its issued ordinary shares (80.9m) to ordinary black South Africans.
- Black South Africans were invited to purchase MTN Zakhele shares between 30 August 2010 and 14 October 2010 at R20 a share.
- One MTN Zakhele share is worth 0.9315 ordinary MTN shares.
- Average MTN share price at time of transaction: R 116.50. Therefore, the MTN Zakhele share is worth R 108.52 (ignoring debt at this point).
- Investment required from black public: R 20.00 per share
- The shortfall is funded by debt and a donation by MTN. The break-down of the value of the Zakhele share can be summarised as follows:

Value of MTN share	R 116.50
Zakhele : MTN shares	0.9315
Value of Zakhele share	R 108.52
Investment required from public	R 20.00
Debt per share	R 66.43
MTN Donation	R 22.09

This results in a net value of the Zakhele share of R 42.09.

- The shortfall that is funded by debt looks as follows:

Source of debt	% of debt	Interest
A BIC Pref Share	26.8%	110% of the swap curve
B BIC Pref Share	13.4%	88% of Prime
Notional Vendor Finance	59.8%	85% of Prime

- Dividends paid on the MTN ordinary shares are used to reduce the debt on the MTN Zakhele shares.
- Shares obtained in this way cannot be traded during the first three years. At the end of this period restricted trading will be allowed during the fourth to sixth year, where the MTN Zakhele shares can be sold to other BEE investors.
- Black investors can lose their initial R 20 investment if the MTN share price does not perform adequately.
- This structure mimics a call option on the MTN shares in which the option holder paid R 20 to gain exposure to a MTN Zakhele share worth R 108.52 on which R 66.43 debt is owed.
- Source of information:
  - URL: <http://www.mtn.co.za>

Detailed sources of the transaction information can be viewed in Section 17.3.2 of the appendix.



#### 10.6.2.4 Zakhele Deal Transaction Performance

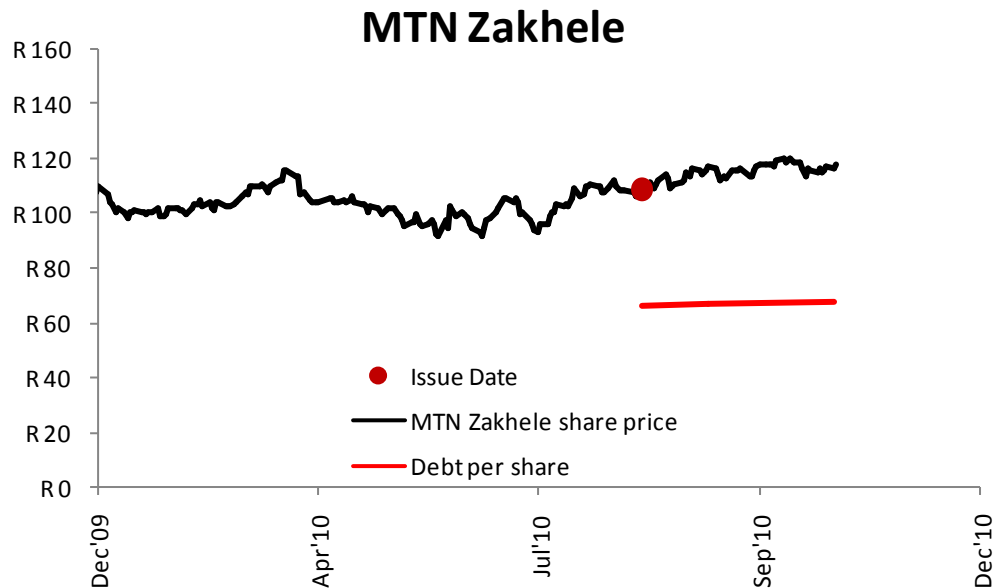


Figure 10.6 - MTN Zakhele share performance since inception of the BEE deal

The MTN share price has not shown a significant change since the deal's inception in August 2010. As with the MTN Asonge deal, the discount at which the deal was done means that it has been in-the-money from day one.

Event	Issue	Latest
Date	31 Aug 2010	01 Nov 2010
Nr of MTN Zakhele shares	80,900,000	80,900,000
Nr of ordinary MTN shares	75,359,856	75,359,856
Traded MTN Share price	R 116.50	R 124.80
Value of ordinary MTN shares	R 8,779,423,224	R 9,404,910,029
Total Debt	R 5,374,000,000	R 5,479,601,407
Net structure value	R 3,405,423,224	R 3,925,308,622
Value per MTN Zakhele share	R 42.09	R 48.52

Table 10.4 - Status of the MTN Zakhele BEE transaction

Currently the deal is worth R4 billion to the black public who invested in it compared to the R3.4 billion at its inception.

### 10.6.3 Sasol

#### 10.6.3.1 Transaction Details

- In June 2008 Sasol facilitated the Inzalo BEE deal to enable the transfer of 10% ordinary Sasol shares to black South Africans.
- The BEE participants are the general black public (3,0%), BEE groups selected by Sasol (1,5%), Sasol employees (4,0%) and the Sasol Inzalo Foundation (1,5%).
- Sasol offered to sell its shares between 2 June 2008 and 3 July 2008 in one of two ways to investors that meet the criteria, through a cash or funded option. The SASOL share price at the time of the deal was R465.
- The cash-option offered unlisted Sasol BEE shares at R366 per share when the listed shares traded at R465 on 2 June 2008, the day the offer opened. These shares cannot be sold for 2 years and for the next 8 years thereafter can only be sold to other BEE participants. After 10 years they revert to Sasol ordinary shares and can be traded normally.
- The funded option required small initial investment from the investor for each listed Sasol share required. The first 100 shares cost R18.30 while all shares above 100 costs R36.60. The shares cannot be sold for 3 years and for the next 7 years can only be sold to other BEE participants. After 10 years these shares can be traded as regular Sasol ordinary shares. Dividends on the shares are cumulated and set off against the remaining shortfall at maturity. The investor is entitled to the net amount of shares.
- The managing trust will be Fundco. The offer was four times oversubscribed. Sasol committed to follow a “bottoms-up” approach when awarding the available shares. This means that investors who applied for the lowest amount of shares will be awarded their shares first.
- Investors can lose the money they have invested. The funded option is only in the money if the share price at exercise is higher than the share price at issue. However, the significant portion of debt used to gain exposure to the shares, do not have to be repaid if they are out-the-money.
- Source of information:
  - URL: <http://www.sasol.com>Detailed sources of the transaction information can be viewed in Section 17.4 of the appendix.

### 10.6.3.2 Transaction Performance

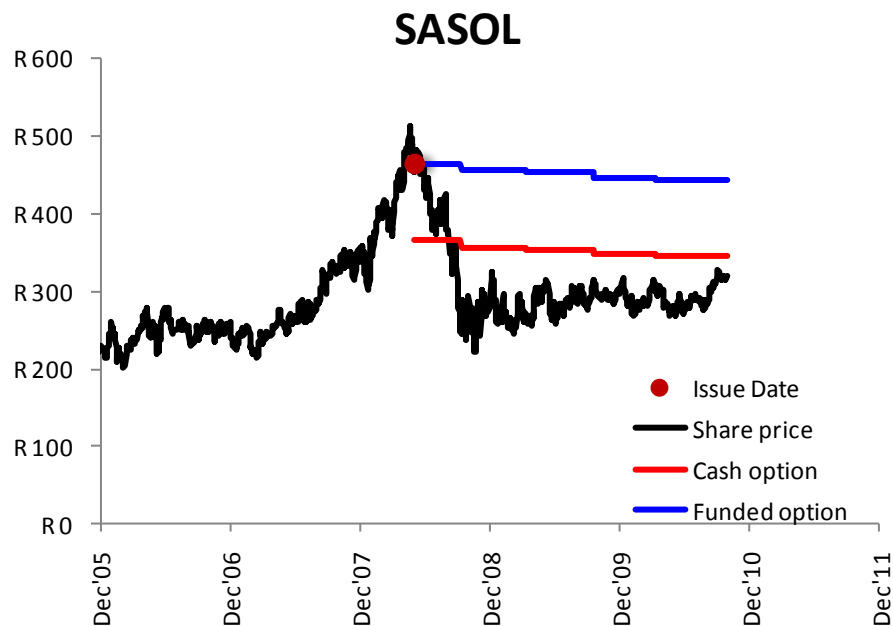


Figure 10.7 - SASOL share performance over life of BEE deal

Event	Issue	Low point	Latest
Date	02-Jun-08	24 Nov 2008	01 Nov 2010
Number of underlying shares	29,000,000,000	29,000,000,000	29,000,000,000
Share price	R 465.00	R 230.00	R 320.00
Cash option			
Strike	R 366.00	R 366.00	R 366.00
Intrinsic value per share	R 99.00	-R 136.00	-R 46.00
Funded option 1			
Strike on first 100 shares	R 18.30	R 18.30	R 18.30
Debt on first 100 shares	R 446.70	R 426.05	R 407.75
Intrinsic value per share	R 0.00	-R 196.05	-R 87.75
Funded option 2			
Strike on shares above 100	R 36.60	R 36.60	R 36.60
Debt on shares above 100	R 428.40	R 407.75	R 444.35
Intrinsic value per share	R 0.00	-R 177.75	-R 124.35

\*Since it is unknown how the many cash option-type shares and funded option-type shares were taken up by the public, the total values are unknown

Table 10.5 - Status of the SASOL BEE transaction

The funded option-type shares do not have an intrinsic value when they are issued. This is because the full share price of R465 still needs to be repaid whereas the cash-option has a R99 discount. However, by investing a fraction of the full share price in the funded options, exposure is obtained to a share trading at R465.

Figure 10.7 illustrates how the SASOL share price dropped drastically shortly after the deal was done in 2008 and that it has not recovered since. All the tranches are out-the-money and since there is no capital protection in place, the investors could lose their initial investments. Those

investors who chose the funded option did not get a discount on the purchase price and are worse off in terms of the value of their investment. However, since they had to pay only a portion of the share price to get exposure to it, the amount they could lose is much less.

The transaction has another eight years to go until it matures, which is adequate time for the share price to recover. However, it illustrates the risk involved in investing in equity with borrowed money.

The dividends cause a small reduction in the debt.

### 10.6.3.3 Standard Bank

#### 10.6.3.4 Transaction Details

- Transaction Date: October 2004
- Transaction Name: Tutuwa
- Value to be transferred: 10% of issued ordinary shares of Standard Bank
- Number of shares to be transferred: 100.5 mil ordinary Standard Bank shares
- Purchase price of shares: R40.50
- Transaction participants: Safika Holdings (Pty) Ltd, Shanduka Group Ltd, the Black Managers of Standard Bank Trust and the Tutuwa Community Trust.
- Tutuwa issues preference shares at a par value (with 8.5% dividend) equal to the cost of the Standard Bank Shares:

Preference shares @ par value                      R 5,2 bil

The funds obtained through the issue of the preference shares is effectively an 8.5% interest bearing loan used to buy the Standard Bank stake. Dividends on the Standard Bank share price are used to service the loan.

- Any outstanding amount has to be settled to Standard Bank.
- The deal has a maturity of 20 years but Tutuwa can start to trade its shares after 14 years.
- If the preference shares and the cumulative dividends had not been paid-off at this point, the deal collapses with no obligation to any party.
- This structure mimics that of a call option on Standard Bank shares with the initial preference share amount equal to the strike.
- Source of information:
  - URL: <http://www.standardbank.co.za>

Detailed sources of the transaction information can be viewed in Section 17.5 of the appendix.

### 10.6.3.5 Transaction Performance

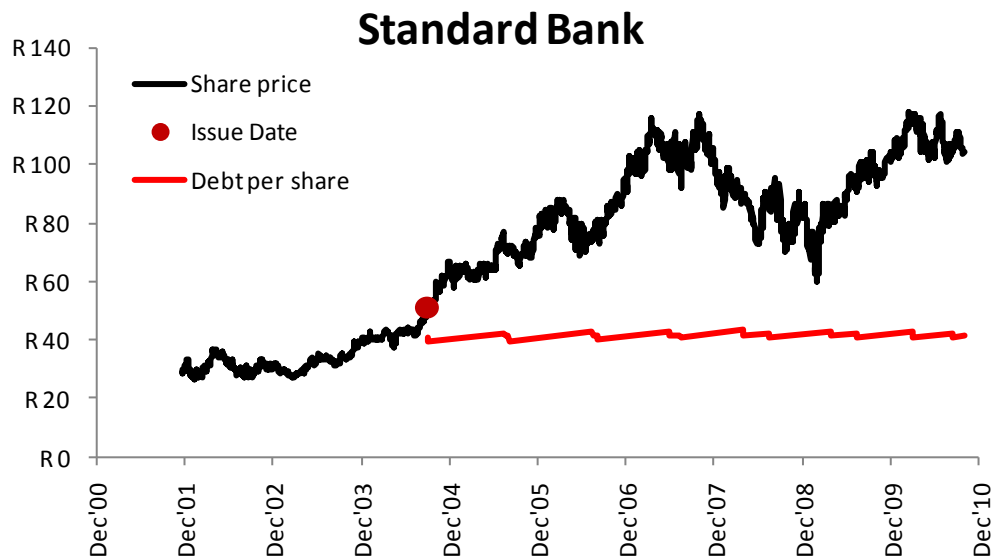


Figure 10.8 - Standard Bank share performance over life of BEE deal

Event	Issue	Low point	Latest
Date	01 Oct 2004	09 Mar 2009	01 Nov 2010
Number of underlying shares	100,500,000	100,500,000	100,500,001
Share price	R 51.00	R 62.85	R 104.50
Debt per share	R 40.50	R 43.07	R 41.16
Intrinsic value per share	R 10.50	R 19.78	R 63.34
Net structure value	R 1,055,250,000	R 1,987,869,715	R 6,366,019,698

Table 10.6 - Status of the Standard Bank BEE transaction

The discount given by Standard Bank to Tutuwa on the purchase price of the shares (purchase price of R40.50 when the shares were trading at R51 in October 2004) translated into immediate value for the BEE partner of more than R1 billion. This has since grown to R6.4 billion.

The dividends are just sufficient to service the interest on the debt but have no significant impact on the debt itself.

## 10.6.4 Murray & Roberts

### 10.6.4.1 Transaction Details

- Transaction Date: August 2005
- Transaction Name: Murray & Roberts BEE Transaction
- Value to be transferred: 10% of issued ordinary shares of Murray & Roberts
- Number of shares to be transferred: 33.2mil ordinary Murray & Roberts shares
- Lock-in Period: Shares obtained through this transaction cannot be sold for 10 years.
- Average share price at time of transaction: R14.87
- Transaction participants: Community Trust, Black Employee Trust, Black Executives Trust, General Staff Trust, i.e. the BEE partner
- Funding Structure: Murray & Roberts subscribes to preference shares of the BEE partner with a par value equal to that of the ordinary shares.  
33.2mil shares @ R14.87 per share: R 493,7 mil
- Preference Share dividend: 63.1% of the prime interest rate
- Other Information: The funds obtained by the BEE partner through the issue of the preference shares are effectively an interest bearing loan used obtained by the managing trust to buy the Murray & Roberts stake. Dividends on the Murray & Roberts share price are used to service the loan. Any outstanding amount has to be settled to Murray & Roberts.
- This structure mimics that of a call option on Murray & Roberts shares with the initial preference share amount equal to the strike.
- Source of information:
  - URL: <http://www.murrob.com>

Detailed sources of the transaction information can be viewed in Section 17.60 of the appendix.

### 10.6.4.2 Transaction Performance

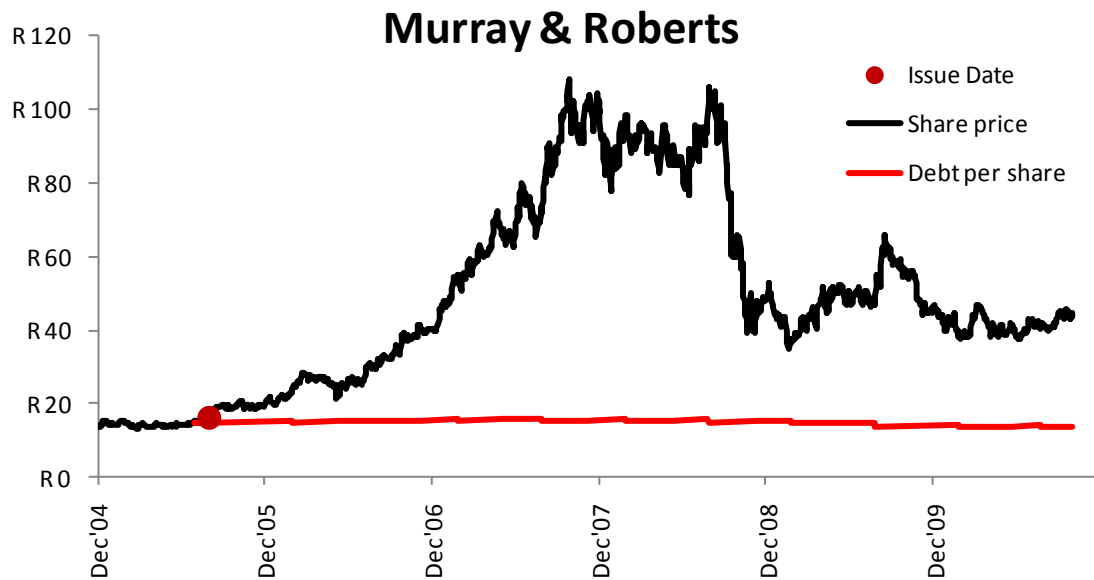


Figure 10.9 - Murray & Roberts share performance over life of BEE deal

Event	Issue	Pre-crash	Latest
Date	31-Aug-05	29-Oct-07	01-Nov-10
Number of underlying shares	33,200,000	33,200,000	33,200,000
Share price	R 15.99	R 108.25	R 43.69
Debt per share	14.87	R 15.38	R 13.66
Intrinsic value per share	R 1.12	R 92.87	R 30.03
Net structure value	R 37,184,000	R 3,083,173,100	R 997,019,782

Table 10.7 - Status of the Murray & Roberts BEE transaction

The growth in the share price since the inception of the deal led to considerable benefit for the option holders by the end of 2007 (R3.1 billion). The drastic fall in the share price after 2008 wiped out a considerable portion (R2.1 billion) of the value that the BEE partners had.

The Murray & Roberts deal illustrates the problem with BEE transactions having long lock-in periods. The BEE partners were unable to exercise the option when the share price was high and the subsequent fall in the price wiped out a significant portion of their value.



## 10.6.5 AngloGold Ashanti

### 10.6.5.1 Transaction Details

- Transaction Date: October 2006
- Transaction Name: Bokamoso Employee Share Ownership Plan
- Transaction Length: 7 years
- Transaction participants: 30,953 Black Employees
- Number of shares to be transferred: Each employee receives 120 AngloGold shares
- Lock-in Period: An equal amount of shares becomes tradable after 3, 4, 5, 6 and 7 years after receiving the shares.
- Managing Trust: Bokamoso Trust
- Average share price at time of transaction: R 300
- Funding Structure: 25% of the shares issued to each employee (30) are free while the remaining 75% (90) are funded through preference shares. These shares are acquired at a 10% discount to the market. AngloGold subscribes to preference shares with a par value equal to that of the 76% ordinary shares.
- Preference Share dividend: A dividend of 7% is paid on the preference shares.
- Dividend flow from ordinary shares: 50% of the dividends go to the employees while the remaining 50% is used to service the preference share debt.
- Source of information:
  - URL: <http://www.anglogold.co.za>

Detailed sources of the transaction information can be viewed in Section 17.7 of the appendix.

### 10.6.5.2 Transaction Performance

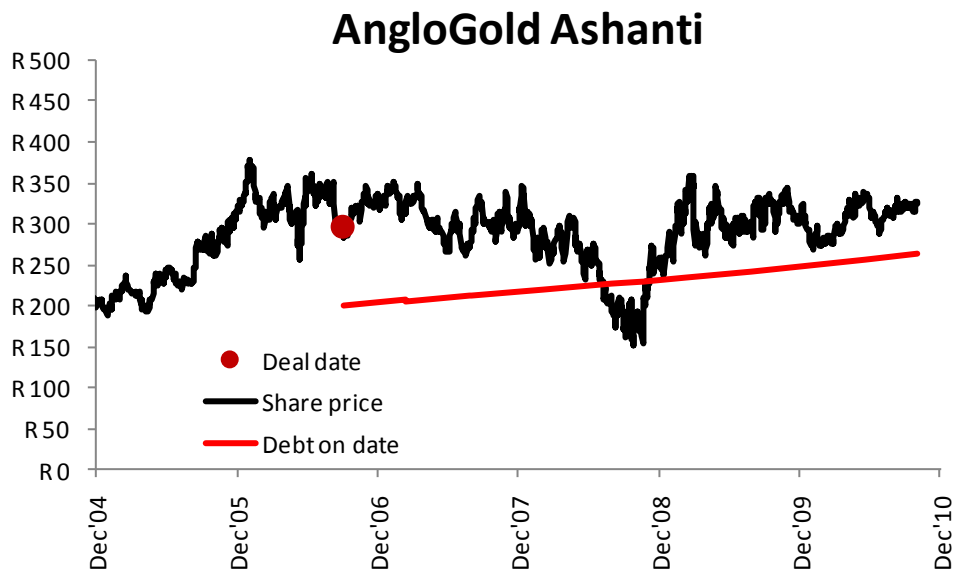


Figure 10.10 - AngloGold Ashanti share performance over life of BEE deal

Event	Issue	Low point	Latest
Date	02 Oct 2006	20 Nov 2008	01 Nov 2010
Number of underlying shares	3,714,360	3,714,360	3,714,360
Share price	R 296.90	R 154.99	R 326.57
Debt per share	R 200.41	R 230.27	R 263.20
Intrinsic value per share	R 96.49	-R 75.28	R 63.37
Net structure value	R 358,407,882	-R 279,621,412	R 235,375,375

Table 10.8 - Status of the AngloGold Ashanti BEE transaction

The shares were issued at a substantial discount resulting in a value of R358 million on day one. However, horizontal drifting of the share price has allowed the debt to cut into the initial value.

Only half of the dividends are used to service the interest on the preference shares. The rest flows to the employees. The outstanding amount has grown to such an extent that the debt per share is now considerably more than what it was on issue.

## 10.6.6 Anglo Platinum

### 10.6.6.1 Transaction Details

- Transaction Date: June 2008
- Transaction Name: Kotula BEE Transaction
- Transaction Length: 7 years
- Value to be transferred: 1.5% of issued ordinary shares of Anglo Platinum.
- Number of shares to be transferred: Each employee receives 500 Anglo Platinum shares for every year that he is employed during the 7 year period of the deal
- Lock-in Period: An equal amount of shares becomes tradable after 5, 6 and 7 years after receiving the shares.
- Managing Trust: Kotula Trust
- Average share price at time of transaction: R 1317.
- Transaction participants: 46,000 Black Employees
- Funding Structure: 40% of the shares issued to employees are free while the remaining 60% are funded through preference shares. Anglo Platinum subscribes to preference shares with a par value equal to that of the 60% ordinary shares.
- Preference Share dividend: No dividend is paid on the preference shares
- Dividend flow from ordinary shares: 50% of the dividends go to the employees while the remaining 50% is used to service the preference share debt.
- Any outstanding amount at the end of the transaction period has to be settled with Anglo Platinum resulting in the employee receiving the net capital amount.
- This structure is partly a call option on Anglo Platinum shares with the initial preference share amount equal to the strike and a normal share.
- Source of information:
  - URL: <http://www.angloplatinum.com>

Detailed sources of the transaction information can be viewed in Section 17.8 of the appendix.

### 10.6.6.2 Transaction Details

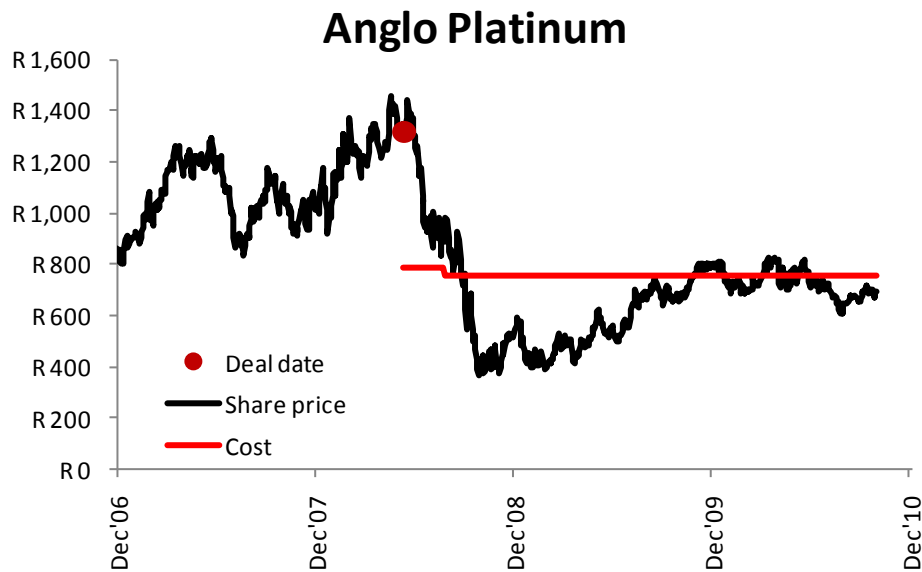


Figure 10.11 - Anglo Platinum share performance over life of BEE deal

Event	Issue	Low point	Latest
Date	11 Jun 2008	20 Nov 2008	01 Nov 2010
Number of underlying shares	3,947,310	3,947,310	3,947,310
Share price	R 1,317.00	R 390.00	R 695.00
Debt per share	R 790.20	R 755.20	R 755.20
Intrinsic value per share	R 526.80	-R 365.20	-R 60.20
Net structure value	R 2,079,442,908	-R 1,441,557,612	-R 237,628,062

Table 10.9 - Status of the Anglo Platinum BEE transaction

The Anglo Platinum BEE deal was issued at a massive discount to the participants with immediate value (R2.1 billion). However a sharp fall in the share price from when it was issued (R1,317) to six months later (R370), wiped out all of the value. Two years later the share price has recovered but the deal is still slightly out-the-money.

This illustrates the impact of the global recession that followed the credit crisis of 2008 and shows how easily a BEE deal could go from being in-the-money to out-the-money. The Anglo Platinum share price grew by 536% in the three and a half years leading up the BEE transaction and fell by 72% by December, six months later.

## 10.7 Conclusion

This chapter introduced the details of BEE transactions. The social-political environment in South Africa after the country became a democracy in 1994 required some intervention to redress the unequal participation in the economy across racial groups. As a result the BEE codes came into law in 2003 which specified the areas in which South African businesses would be required to involve black South Africans. The BEE transactions on which this report focuses relate to those that listed companies undertake to facilitate the transfer of share capital to blacks with limited funds to acquire the shares.

The BEE deals of seven major South African companies have been analysed. They show a great degree of variability across a number of structure features and value.

Issuing Company		Industry	Issued at discount?	Benefit for BEE participant	Interest on strike / debt	Current Status
ABSA		Banking	No but limited cost.	Option on share obtained at minimal cost	Interest on debt but not on strike	Highly ITM
MTN	Asonge	Telecoms	Yes	Get exposure to share price at discount	No	Highly ITM
	Zakhele	Telecoms	Yes	Get exposure to share price at discount	Yes	Slightly ITM, just kicked off
SASOL	Cash	Oil	Yes	Get exposure to share price at discount	No	Highly OTM
	Funded	Oil	No	Option on share obtained without any investment	No	Highly OTM
Standard Bank		Banking	Yes	Option on share obtained without any investment	Yes	Highly ITM
Murray & Roberts		Construction	No	Option on share obtained without any investment	Yes	ITM but less than in 2007
AngloGold Ashanti		Gold Mining	Yes	Option on share obtained without any investment	Yes	ITM but less than at issue
Anglo Platinum		Platinum Mining	Yes	Option on share obtained without any investment	No	OTM

When assigning BEE credits, the BEE codes do not judge each transaction separately, but rather looks at the companies' overall level of black shareholding.

## CHAPTER 11

### 11 Criticism of BEE Deals

#### 11.1 Section Overview

Chapter 10 introduced the concept of BEE deals, their origination and took a look at the transactions used by some of the major South African companies to facilitate their share transferral process. The deals investigated showed a large degree of divergence in terms of structure and value.

Despite the multitude of BEE deals that have been conducted, there have also been many detractors of the BEE initiative. The majority of criticisms have, however, been on the way in which it is being implemented, rather than whether it should be done at all. This chapter looks at some of the issues that have been raised with the current system.

#### 11.2 Shareholding as Measure

The Broad-Based Black Economic Empowerment Act no. 53 of 2003 requires a certain percentage of direct ownership in South African companies by black citizens. By forcing companies to comply with this requirement the aim is to involve previously disadvantaged people in the economy. This has led to the structuring of BEE deals that transfer shares to certain BEE participants. Using the shareholding of the company as measure for the degree to which it supports black citizens in obtaining a stake in the economy raises certain concerns.

- Very little value is created during the BEE process but instead it is transferred from one group to another. Jenny Cargill (2010) highlights this as the biggest flaw resulting from the BEE codes.
- The BEE codes aim to transfer wealth but do not use this to assign BEE credentials. Instead, it looks at the percentage of a company's equity being owned by black South Africans.

#### 11.3 BEE Participants

Criticism on the first tier of deals focused on the benefactors. A large majority of the deals that was made have resulted in only a few influential black citizens gaining financially through these deals. In the process they have become extremely rich. The ABSA and Standard Bank BEE deals have all been made with a consortium of BEE parties but still massive financial windfalls

to particular individuals (Tokyo Sexwale – ABSA, Saki Makhozama & Cyril Ramaphosa – both Standard Bank). These consortiums include a range of entities but were not open to the general black public. This has resulted in a feeling of discontent among many people in the country who see it as merely benefiting a few black people while leaving the vast majority unempowered.

Such arguments are hard to refute but there is a move towards structuring these deals in such a way as to ensure a more inclusive distribution of wealth. This has led to the evolution of Broad-Based Black Economic Empowerment (BBBEE) in which specific emphasis is placed on ensuring that larger groups of black people benefit from the deals. Repeated criticism in the media has forced companies to make the deals more broad-based. Recent BEE deals such as MTN Zakhele, Vodacom (unlisted) and Sasol have invited all black South Africans to take up shares under the various initiatives.

#### **11.4 Impact of Shares Being Traded**

An aspect that has historically not received much attention, is what will happen to the BEE credits of the issuing company when the shares become unencumbered at maturity of the deal. The BEE partner may want to liquidate his shares as soon as he is contractually allowed to do so. If he does sell, he receives the benefit, while the company shares may be taken up by a non-black shareholder. This will leave the company in the same position it was prior to the deal when it did not have the required level of black shareholding, even though it incurred the expense relating to the call option on the shares in its BEE transaction.

A similar problem arises if more shares are issued to the market and the BEE shares as percentage of total issued shares reduces. This happened to Standard Bank after the Industrial and Commercial Bank of China (ICBC) bought 20% of the shares. Should the issuing company lose his BEE credit if the percentage of black shareholders reduces or does the fact that it has already made an effort to have diversified shareholders be enough? On the other hand, since the empowerment requirements apply only to the bank's South African operations, having 20% owned by a Chinese organisation could increase the BEE level locally. It seems as if the BEE numbers are not just dependent on black people buying the company's shares.

BEE participants only really get the benefit of owning the shares, if they can sell them. It does not make sense to prohibit the sale of the publicly traded shares in a transaction aimed at uplifting people financially. But the company that is judged on the percentage of shares owned by black South Africans has no other choice than to restrict the trading of these shares.

## 11.5 Non-Performing Shares

If the share price does not perform according to expectations, the situation is just as severe. If the share price is insufficient to cover the outstanding debt on the BEE shares a variation of the following options is possible:

- Restructuring the terms of the BEE deal can take place where the maturity of the transaction is extended in order for the share price to recover. The cost of such a move can be determined by calculating the fair-value of the amended deal.
- The issuing company absorbs the loss on the BEE deal and the BEE partner keeps the shares. Depending on the size of the loss, it may be a significant item for the company. New restrictions may be placed on the sale of the BEE shares that will push out the date at which the shares are 100% unencumbered in the hands of the black shareholders even further. This option provides the BEE deal with another opportunity to meet its target but comes at a significant cost.
- Alternatively, the issuing company writes off the debt on the BEE deals and takes the shares back (transaction ends out-the-money). This option results in no real benefit for the BEE partner (might have received some dividends) and the issuing company still needs to find a way of increasing its BEE shareholding.

## 11.6 Impact of the Market

If two companies in different industries do the exact same BEE deal with similar fair-values, should they not be awarded similar BEE credits? If shares in the one industry start to increase significantly after the deal was done, the debt on the BEE shares are paid off quickly and the company achieves its BEE target. But equity in the other industry shows a decline preventing the debt to ever be repaid completely.

Did these two companies not make the same investment in their BEE transactions? The fair-value suggests they did and the deals were expensed equally. Should the one company be rewarded for its social upliftment program because there was a bull run in its share price? Current legislation does indeed reward and penalise in this way.

## 11.7 Lack of Communication

There is a general lack of clarity and guidance by the government regarding many of the uncertainties surrounding BEE according to Jenny Cargill (2010). The issue has largely been



sheltered due to the performance of South African shares between 2002 and 2008. When markets collapsed at the end of 2008 some deals were out-the-money (SASOL, AngloGold Ashanti and Anglo Platinum). If the deals had matured then, very little shares would have been transferred and the companies would be at risk of losing their operating licences due the insufficient BEE credits that it would have caused. Business wants some guarantees from the government that this will not happen. By removing some of the risk involved in the BEE transaction for the issuing company we could see many more deals being done.

## **11.8 Unrealistic Expectations**

Jenny Cargill (2010) refers to Malaysia as the best example of where some form of positive discrimination was used to transfer wealth to a certain population group. The Malaysian government introduced the Bumiputera policy in the 1970's which aimed to transfer the country's wealth to Malaysians. They did this by requiring that 30% of corporate shareholding be held by Malays. At that point Malays only controlled 2% of the country's wealth although they were in the majority. Today they own about 20% of the country's equity in part as a result of the policies. Cargill highlights that there appears to be a glass ceiling ( $\pm 20\%$ ) that such policies can attain which is probably due to the inefficiencies (not naturally market driven, corruption) inherent in these forced transactions. This is especially so if the policies are implemented without also focussing on developing a culture of entrepreneurship and skills development.

## 11.9 Trading Restrictions

The inability for BEE investors to trade the shares they gained through the transaction puts them at a distinct disadvantage against regular share owners since they are unable to hedge their portfolios or take advantage of short-term gains in the share price. Extensive vesting and lock-in periods have crept into the transactions as a way of preventing the loss of the BEE credits for which the deals were designed in the first place.

A small secondary market has already developed for those BEE shares that are allowed to be sold to fellow BEE investors. The discounts on these shares are rumoured to be between 30% and 60%. This illustrates the need that exists to liquidate the shares to gain access to the full economic benefits.

The JSE and SASOL is in the process of developing the necessary infrastructure that will allow more efficient trading of BEE shares between black South Africans and companies with the required BEE levels. This will make it easier for willing sellers to find willing buyers of their shares. This solution is a first step in addressing the issues surrounding the trade restrictions on BEE shares. When the platform has been established it is expected that all future BEE deals will allow this type of limited trading while existing deals may be amended to cater for it as well. Once this system is functional, there will develop a secondary market for the BEE shares whose value will start off at some discount and tend towards that of the unencumbered share price as they near the day when the lock-in period comes to an end.

## 11.10 Conclusion

This chapter looked at some of the main problems with BEE deals.

- Using black shareholding as the primary measure to assign ownership credits means that neither wealth creation nor wealth transfer is gauged.
- Initial deals allowed a significant portion of the shares involved in the BEE transaction to be allocated to certain black individuals. Fortunately more recent deals have tended to invite the general black public to participate in the transactions.
- Since BEE credits depend on the proportion of the share capital owned by black South Africans, companies are naturally reluctant to allow shares obtained through BEE transactions to be sold. This has caused extended lock-in periods to be placed on these shares which delays the economic benefit for several years.
- Share price appreciation is the main factor that determines whether the deal has any value. A deal in which the share price has not performed sufficiently to ensure that the transaction is in-the-money leaves the BEE participants with little gained and the issuing company having to do a new deal.
- Market volatility plays a significant role in determining the amount of BEE credits that a BEE transaction could generate.
- A number of unclear issues relating to BEE transactions are not being addressed by the South African government. Less uncertainty regarding these issues could see the number of deals increase.
- It has been proposed that there is a limit to the changes that BEE-type deals can make in balancing the wealth distribution in South Africa. This is due to the synthetic nature in which BEE deals aim to regulate the racial make-up of companies' shareholding. This leads to inefficiencies especially when there is no clear focus on developing a culture of entrepreneurship and skills development.



## CHAPTER 12

### 12 Proposed Methodology for Assigning BEE Credits

#### 12.1 Chapter Overview

A number of issues against BEE deals were discussed in the previous chapter. In this chapter the fair-value of a deal will be used as basis to compare individual transactions and this methodology will be discussed as a potential alternative to use in assigning BEE credits. An example will be done for three hypothetical companies to illustrate the methodology where after it will be applied to the deals discussed in Section 10.6. This will be followed by the advantages and potential implementation issues of the proposed methodology.

#### 12.2 Introduction

The BEE deals discussed in Section 10.6 vary greatly in their design and performance since inception. They are done at a great cost to the issuing company even though some may end up out-the-money. Issuing companies depend on the BEE credits they obtain through these deals to ensure that they comply with the requirements of the BEE codes. Any shares sold by the BEE partners causes the issuing company to forfeit the associated BEE credits. For this reason the contracts often include lock-in periods that do not allow the sale of these shares for a certain period of time. This delays the economic benefit that is coupled with the underlying shares.

In Section 4 the influence of the different model inputs on the fair-value was discussed. The value of a transaction is directly influenced by factors such as vesting period, discount on purchase price, interest on debt etc. If two companies have done very similar BEE deals to transfer 10% of the shares, the economic value in them should be similar. However, if the amount of shares that ends up in the hands of the BEE partners is different, the BEE credits will differ.

An alternative solution is to use the fair-value of the BEE transaction to determine the BEE credits that an issuing company can be awarded. This will align the cost involved for the issuing company with the credits rather than the number of shares that have been transferred. The existing framework awards points to the issuing company as more and more of the BEE shares become unencumbered which could take several years. If the BEE transaction is priced at inception, the credits can be awarded immediately and since it is not dependent on the actual



amount of shares that have been transferred, the credits will not reduce if the BEE participants sell their shares. This will greatly remove the need for having extended vesting or lock-in periods to protect the BEE credentials.

This approach will require that the fair-value of the BEE transaction is directly linked to the scorecard credits. This can be accomplished by giving a score according to the cost as a percentage of the market capitalisation that is involved in the original deal. The idea would be to acknowledge the difference in the structures used and to use an equitable and effective method in the crediting process. For instance, in the situation where a BEE partner has to pay interest on its debt while another BEE partner received his shares for free, the company giving the shares away surely has to be compensated for its increased cost. Section 10 illustrated the differences in the structure of current BEE deals. Although many of them aim to transfer 10% of the company's issued shares to black South Africans, the deals go about this in a variety of ways. Introducing the fair-value of the deal is an equitable way of awarding BEE credits and the fair-value is already being revealed by the IFRS cost that the issuing company has to account for.

### 12.3 Example 7

Comparing the following hypothetical BEE transactions will indicate how the fair-value should be used:

- Company A gives 5% of its equity to black South Africans and achieve the BEE goal. They get awarded all 7 BEE credits plus the bonus point as the deal brings the total black shareholding to 25%. The share price on the transaction date is R40.
- Company B whose current black shareholding is 5%, does a deal where they assist the BEE partner in buying 20% of the issued shares by allowing them to repay the purchase price of the share with the dividend proceeds of the share. Interest is charged on the outstanding debt and the shares may not be sold until maturity of the deal 10 years later. As more and more become debt free, the BEE credits are awarded according to the sliding scale in Section 15.1. The fair-value of the deal is R10 and the share price on the transaction date R85.
- Company C gives a 20% discount on 10% of its issued shares to qualifying black South Africans. These shares may be sold after 7 years. The full 10% is taken up by the market and the deal assists black South Africans in achieving a 25% shareholding in the company. The fair-value of the deal is R110 and the share price on the transaction date R170.



All three companies attained a level of 25% black shareholding through their BEE deals. While company A was generous enough to offer the shares for free, it was only done on 5% of its issued shares. Company B might have imposed a restrictive deal but has offered 20% of its shares. Company C provided a 20% discount on 10% of its issued shares. The two aspects to consider are what proportion of the share price is captured by the fair-value and what proportion of the issued shares were involved in the deal.

Company	Share Price on issue	Fair-value per share	Normalised Fair-value	Option value as a % of share price	Value of BEE deal as % of market cap
A	40	40	100%	5%	5.00%
B	85	10	12%	20%	2.35%
C	170	110	65%	10%	6.47%

**Table 12.1 - Comparing hypothetical BEE transactions**

The normalised fair-value is obtained by dividing the fair-value by the share price and the deal value as a percentage of market capitalisation (DVMC) by multiplying the normalised fair-value with the percentage of shares involved in the deal. Company C has the highest DVMC which means that it should get the highest reward in terms of BEE credits.

There is no single feature of the Company C transaction that accounts for its high rating but it fares well on most aspects. Using the DVMC brings all of the relevant aspects together in order to judge the transaction. It illustrates how deals with fundamental differences can be reduced to something which is comparable.

The limits within which the standardised fair-values fall are 0% and 100%. A 100% value will be obtained if the BEE-structure's option value is the same as the share price i.e. Share Give-Away scheme without any restrictions. The DVMC adjusts this value for the percentage of issued shares that are involved in the BEE transaction which reduces it considerably.

The DVMC is also the total cost (excluding administration expenses) of the BEE as a percentage of the total market capitalisation of the company.

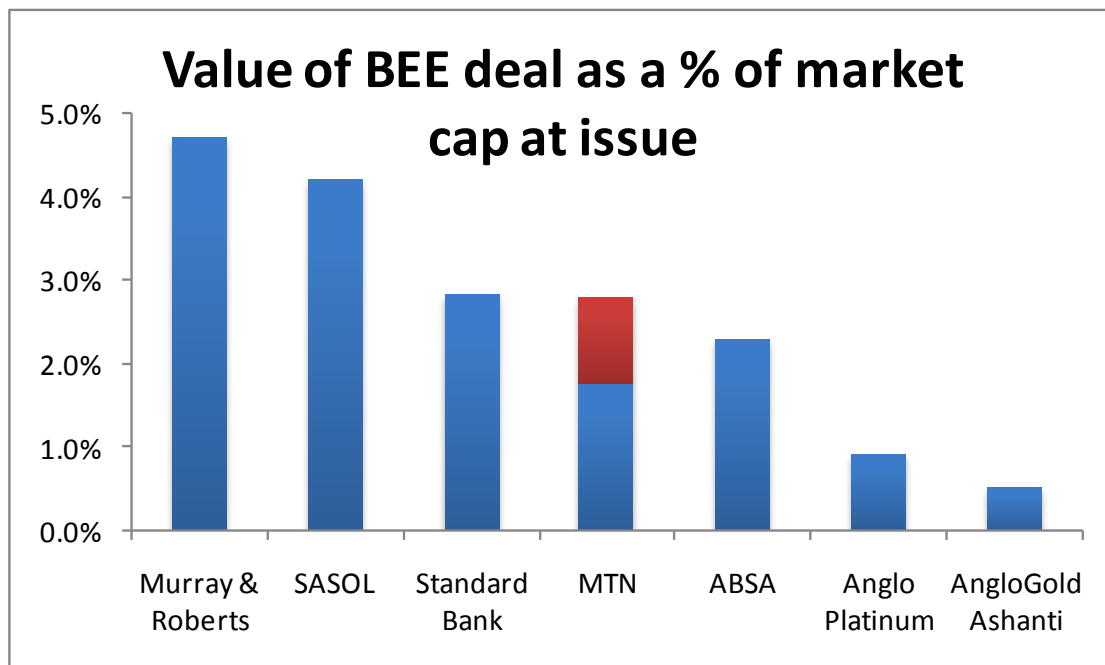
## 12.4 Comparing Actual Transactions

This section repeats the exercise performed in Section 12.3 for the actual BEE deals in Section 10.6.

Company	Share price on issue	Fair-value of 1 BEE option	Option value as a % of share price	# of shares	% of issued shares involved	Value of BEE deal as % of market cap
Murray & Roberts	R 15.99	R 7.53	47.1%	33,200,000	10.0%	4.71%
SASOL	R 465.00	196.1403	42.2%	63,100,000	10.0%	4.22%
Standard Bank	R 51.00	R 14.40	28.2%	100,500,000	10.0%	2.82%
MTN Asonge	R 98.80	R 29.07	29.4%	11,700,000	6.0%	1.77%
MTN Zakhele	R 116.50	R 26.89	23.1%	80,900,000	4.0%	0.99%
MTN TOTAL						2.76%
ABSA	R 45.00	R 10.12	22.5%	73,200,000	10.2%	2.29%
Anglo Platinum	R 1,317.00	R 811.58	61.6%	3,947,310	1.5%	0.92%
AngloGold Ashanti	R 296.90	R 153.06	51.6%	3,714,360	1.0%	0.53%

**Table 12.2 - Comparing actual BEE deals**

The deals in Table 12.2 were fair-valued using a Black-Scholes model and the details are available in Section 15.6 of the appendix. Using this approach the Murray & Roberts transaction ranks the highest with a deal value as percentage of market capitalisation of 4.7%. The normalised fair-values of Anglo Platinum and AngloGold Ashanti are relatively high but the small percentage of shares involved in the deal, gives Murray & Roberts a higher DVMC.



**Figure 12.1 - Comparison of normalised deal value as percentage of market capitalisation**



The details of the valuation inputs are available in Appendix 15.6. Even though the SASOL transaction is heavily out-the-money (Section 10.6.3.2), it still ranks second on the list. This is driven by the large discount on the cash option as well as the low cost of the funded options.

The cost of the BEE deal as percentage of the total market capitalisation of the company (DVCMC) can also be interpreted in another way. It is that portion of market capitalisation that could have been given to the BEE participant with the same accounting cost (fair-value). However, only a fraction of the structuring and administration costs would have been incurred. A traditional deal that has a cost of 4% of the total market capitalisation will take years to transfer the shares to the participants and could still fail or only manage to transfer a portion of the targeted 10%. If the company had given 4% of his share capital to the BEE participants, none of this would be an issue and it would be certain of having an additional 4% of its shares owned by BEE qualifying shareholders for the same price.

The current way in which BEE credits are assigned based on total black shareholding will always lead to transaction which boils down to an option on the underlying shares. These deals have the potential of transferring a lot more shares than the share give-away for the same price. However, this assumes a sustained growth in the share price which the 2008 global credit crisis has shown to be a very dangerous gamble to take.





## 12.5 Benefits and Issues

Implementing the approach that uses the cost of the BEE deal as a percentage of the market capitalisation to assign BEE credits has the following benefits:

- The issuing company is rewarded for a lenient structure and is not dependent on a volatile share price to obtain its BEE credits.
- The issuing company does not forfeit its BEE credits if the share price does not perform adequately. This means that the money invested in the transaction does not go to waste if the markets experience a downturn. If the initial transaction was comprehensive enough, a second transaction will not be required irrespective of the share price's performance.
- Extended lock-in periods are not needed which has two major advantages.
  - It frees up shares to be liquidated by the BEE participant and to realise the economic benefit of the underlying shares. The participants are also in a better position to take advantage of the share price rallying.
  - Limited secondary trading between investors that qualify as candidates has revealed extreme discounts at which these shares trade due to the limited number of investors who constitute the demand-side. This means that the true beneficiaries of a BEE deal receives less for his shares than the cost to the issuing company. The removal of the lock-in feature will mean that the shares can be traded normally on the Johannesburg Stock Exchange where their true market value can be liquidated.
- The approach is more equitable in assigning BEE credits in that those deals that have the highest probability (and cost) for transferring shares are rewarded.
- It is a trivial exercise to obtain the deal value as a percentage of market capitalisation since the fair-value of the deal is already being calculated as part of the reporting on share-base payments in the annual financial statements.

This approach cannot be implemented blindly as there are some factors that must be considered.

- If companies are unable to lose their BEE credits, it is possible that deals could emerge that aim to take advantage of this. The issuing company could merely provide a loan to the BEE partner to buy his shares, get his credits and then buy back the shares. No permanent transfer of wealth would have taken place and the BEE credentials would be a mockery of the system. Tracing the true source of the funding could turn into a nightmare as companies are often owned by a combination of other companies. To prevent this, transactions done to



obtain BEE credits, would have to be done according to certain minimum level of transparency.

- A transaction ending up out-the-money would not have brought economic empowerment to the BEE partners even though the issuing company has received its BEE credits. However this is also true for the current scenario with the only difference that the issuing company does not get its credits. In both cases the issuing company had to pay the cost of the initial deal.
- The pricing of the deals will be scrutinised much closer and the exercise behaviour-issue will have to be resolved. It could be agreed to use a consistent assumption (e.g. exercise at some fixed point between vesting and maturity) to remove any controversial influence that the exercise behaviour might introduce.
- If the issuing company cannot lose the BEE credits obtained from the BEE transaction, those credits must be recognised independently of credits from regular black shareholding (i.e. not as a result of the company's BEE deal). To resolve this the shareholding register would have to be updated to not only state whether a share is held by an investor that qualifies for BEE treatment but also whether it was obtained as a result of the company's BEE transactions. The BEE credits obtained for black shareholding from normal trading would change as the racial makeup of the shareholders change but there would also be fixed credits that were obtained as part of the BEE deals.

However, recent developments may soon significantly change the way in which BEE shares are valued. In the article *Sasol lists on JSE's new BEE trading facility*, The Mail & Guardian (1 Feb 2011) reported that on the 1<sup>st</sup> of February 2011 the new JSE BEE scheme share-trading facility went live. It allows shareholders to trade with only those compliant with the BEE listing requirements of the bourse. In this new BEE segment of the main board, the JSE will list only those shares which the companies indicate may only be held by people defined as 'BEE compliant' in the JSE listing requirements. Sasol Inzalo BEE ordinary shares will list on the BEE scheme share-trading facility from February 7. Since November 2010 shareholders of Sasol BEE ordinary shares were allowed to trade their shares with other black people or groups as defined by the Broad-Based Black Economic Empowerment Act. To date these shareholders have been able to trade shares via an over-the-counter (OTC) trading platform. The process was cumbersome for shareholders as they had to identify a qualified buyer for their shares and agree a price between themselves. The JSE's facility eliminates the need to find qualifying potential



buyers. This facility should ease the process in which BEE shares are traded and reduce the discounts compared to normal shares – thereby ensuring more value for the BEE shareholders.

## 12.6 Conclusion

This section proposed an alternative methodology for assigning BEE credits which is based on the fair-value of a BEE transaction. This is different to the current regime which only uses the total shareholding of investors qualifying for BEE treatment in the assigning process. The major advantages of this methodology is

- The issuing company is rewarded for a lenient structure and is not dependent on a volatile share price to obtain its BEE credits.
- The issuing company does not forfeit its BEE credits and the money invested in the deal if the share price does not perform adequately.
- Extended lock-in periods are not needed which frees up shares to be liquidated by the BEE participant to unlock the economic benefit. Since the shares can be traded on the JSE normally their true market values are obtained and not a discounted value.
- The approach is more equitable in assigning BEE credits in that those deals that have the highest probability (and cost) for transferring shares are rewarded.

Some administrative issues would have to be considered for the approach to work. This includes increased transparency of the funding of the BEE deal to prevent bogus deals and distinguishing between BEE credits from normal black shareholding and credits from a specific BEE transaction in the shareholding register.

The recently launched JSE BEE scheme share-trading facility allows for more effective trading between co-BEE compliant shareholders. Once this platform is becomes widely used significant information will be available on the impact that limited trading has on the value of listed shares. This new data opens the door for future research into valuing these types of shares.

## CHAPTER 13

### 13 Funding of BEE Transactions

#### 13.1 Chapter Overview

The general problems with BEE transactions were discussed in Section 11 and a method for comparing BEE deals and the credits they ensure in Section 12. This chapter focuses on a specific aspect of BEE deals when the purchase of the shares is funded by a third party (like a bank). The basic funding structure is explained which is followed up by a case study to illustrate the risk in using equity as security on a loan. The different factors that affect the funding risk are elaborated on and finally the impact of using different share cover ratios is analysed.

#### 13.2 Introduction

Figure 13.1 illustrates the basic structure of a funded BEE transaction.

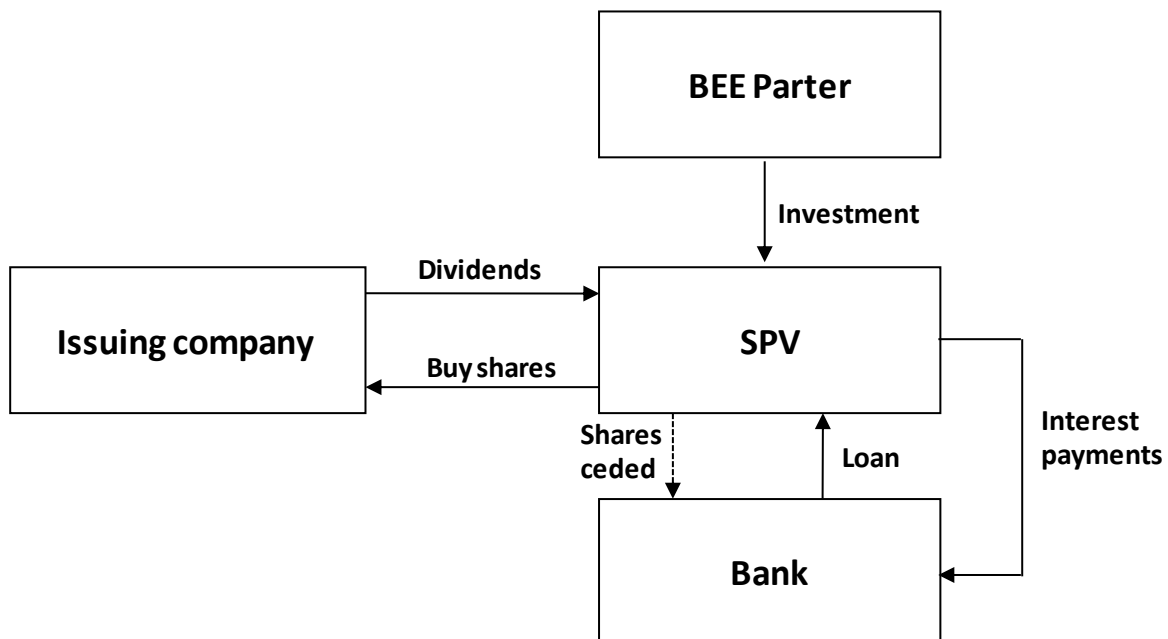


Figure 13.1 - Illustration of the funded BEE transaction structure

A special purpose vehicle (SPV) is established to facilitate the transaction which is owned by the BEE partner. The bank provides a loan to the SPV who uses the funds to purchase the shares from the issuing company. It is agreed to pay the interest on the loan is paid from the dividends earned on the purchased shares. The shares are ceded to the Bank in the event that the SPV cannot service the debt.

Financial institutions participate in BEE deals by providing funding to the BEE partner to acquire the shares. Even though many of them still make significant returns on their investments under such structures, they probably could have found other avenues to invest in with less risk involved. However, pressure from government to channel a portion of their capital into BEE funding means that they do get involved in deals with a higher risk. When the first BEE transactions were done during the 1990's, the issuing company was the main instigator for the transaction. Not only did it structure the deal but it also raised the necessary funds to allow the BEE participant to buy the required shares as part of the loan agreement (referred to as vendor funding). Even though some transactions are still funded in this way today, as some wealth has been transferred to investors with BEE status in the South African economy during the course of the new century, the buying power of black business people has become more substantial. This has had an impact on the features of deals which are showing a tendency to require a greater percentage of capital from the BEE participant (Sasol Inzalo & MTN Zakhele). Such a feature would not have been possible a few years ago. In addition legislation that sets out certain targets for financial institutions to meet with regards to their involvement in facilitating BEE deals, have caused banks to play a much more prominent role in the financing of BEE deals or portions thereof. Banks are now regularly involved in financing different tiers of a transaction and have to manage the risk involved as they would with any other transaction. This was never more evident than during 2009 when the impact of the global credit crisis caused markets to tumble worldwide and many blue-chip listed South African companies had share prices that depreciated severely. This had the effect that many BEE transactions were out-the-money. Banks who provided funding for these deals faced booking large losses if the loans they provided could not be repaid. The underlying shares that are purchased as part of the transaction usually serve as security for the loan from the bank. But with the drastic fall in equity markets, even deals which started off with very safe loan-to-value figures were threatened.

### 13.3 Case Study - Northam Ltd

In 2008 Nedbank assisted Mvelaphanda Resources in acquiring Northam shares by providing funding of R2.5bil of the total share value of R4bil. The underlying Northam shares were pledged to Nedbank.

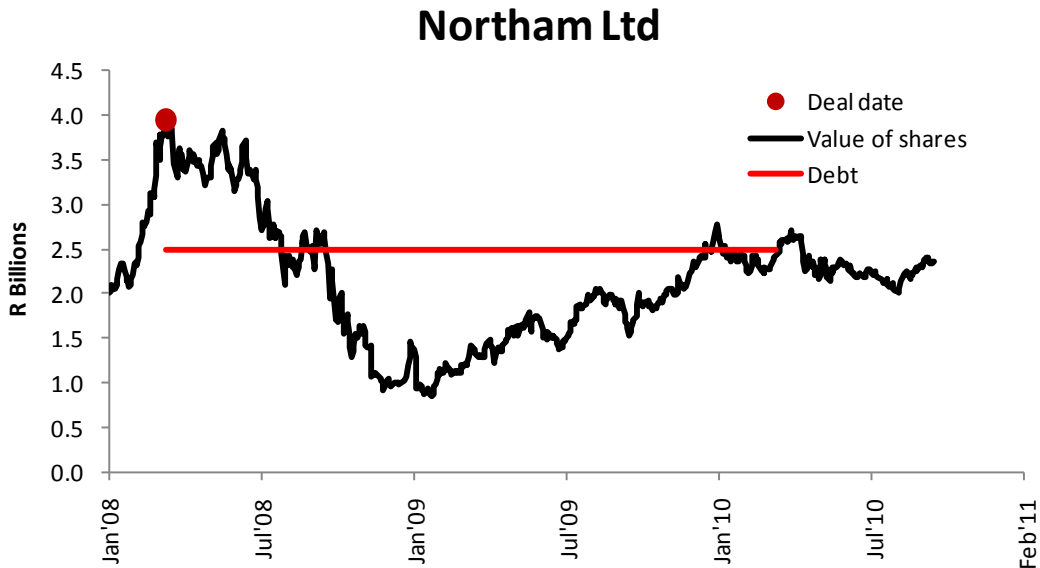


Figure 13.2 - Northam Ltd share price performance

The extreme drop in the Northam share price during the latter part of 2008 (Figure 13.2) from R79 to less than R20 meant that the shares were worth less than the loan for a substantial period of time. The Northam share price has subsequently recovered to some degree which enabled Mvelaphanda Resources to offload the shares and cancel the debt.

Event	Deal date	Low point	Sale
Date	11-Mar-08	14-Jan-09	15-Apr-10
Debt (R'bil)	2.5	2.5	2.5
Equity value (R'bil)	4.0	0.9	2.6
# of shares	50,000,000	50,000,000	50,000,000
Spot	R 79.00	R 18.70	R 52.50
Share cover ratio	1.6	0.4	1.1
Monthly average daily volume	954,028	528,981	932,061

Table 13.1 - Status of the Northam Ltd funding transaction

When the share price hit its lowest point of R18.70 at the end of 2008, the cover ratio was less than 0.4 from a level of 1.6 when the deal was done (Table 13.1). Fortunately Mvelaphanda Resources had other assets as well (mainly Goldfield shares) which it liquidated to free up some of the debt. Mvelaphanda Resources eventually sold 44mil Northam shares during April 2010 to cancel the Nedbank debt.

The additional Goldfield assets held by Mvelaphanda Resources meant that Nedbank was not solely dependent on the performance of the Northam Ltd shares. If these assets were not available, Nedbank would have called on the Northam shares. However, the difficulty in liquidating such a significant portion of shares and the speed at which the share price deteriorated would not have made it possible for Nedbank to recover the full amount it loaned to Mvelapanda Resources.

The next section looks more closely at the different factors to consider when assessing the funding risk.

## 13.4 Funding Risk

Institutions that participate in funding BEE deals have to consider the risks involved in them. Even though the underlying shares acquired by the BEE company are usually pledged to the funding entity or the issuing company guarantees the debt, this does not mean that the risks involved in these types of deals are necessarily mitigated.

- When the issuing company is acting as guarantor on the debt, its exposure to the bank is increased by the amount guaranteed. The fact that the company is listed does not mean it has an infinite supply of cash. The size of the BEE deal (around 10% of the market capitalisation) as well as other transactions that it may be involved with, should be aggregated and considered against the likelihood that the company may default. The rating from a rating agency can be used in this regard. The bank should satisfy itself that it is not too heavily exposed to the company when taking on the BEE debt.
- Banks favour a transaction in which the dividends earned by the BEE company on the shares it bought with the funds supplied by the bank in the first place, are ceded to the bank (or at least partially). The BEE participants might have very limited access to the economic benefits of the shares due the long lock-in periods that are typical of BEE deals. They may therefore have a strong motivation to use the dividends for something other than servicing the debt.
- An option with even less risk to the bank is one in which the BEE company buys preference shares from the issuing company that pay a fixed dividend and convert into ordinary shares at the end of the lock-in period (especially issued for the BEE transaction). By having such shares instead of ordinary shares, the payments to the bank are not subject to the volatile nature of ordinary dividends and ensure a fixed income stream to pay the funder. This preference share fixed dividend should furthermore take preference over the dividends on the ordinary share capital.
- In the case where the issuing company guarantees the debt, the seniority of the debt is to be considered. The issuing company may have many other creditors. A falling share price may coincide with many of them looking for additional security or to renegotiate the terms of their contracts. This may leave the company without the means to honour its agreement to guarantee the BEE debt. Agreeing on a sufficient seniority of these commitments up-front ensures that the company will first repay the funding debt.
- Since the BEE deals are heavily dependent on share price appreciation, the growth prospects of the company have to be analysed before deciding to fund a portion of the debt. The bank



would only as a last resort call on the shares pledged to it by the BEE partner since there is reputational risk involved in a failed BEE transaction. The prospects of the share is therefore important and is a function of some of the following:

- The audited financial results of the company describe its performance over its last financial year. It includes a number of measures (financial ratios) which can be used to analyse the health of the company.
- The prospects of the industry and the expected demand for the primary products and services in which the company operates can give an indication of the growth prospects.
- The existing customer order book indicates the amount of business that the company has signed.
- Some companies are highly dependent on commodity prices or the exchange rate. These measures are out of their control and can be highly volatile. A company such as SASOL has revenue which is closely linked to the international oil price and any information on the latter could help estimate what could happen to the share price. The expectation of these should be included in the analyses to determine the most likely share price outcome.
- This also ties in with the company's hedging strategy towards volatile factors with a direct impact on its profit. Companies with a conservative outlook on volatile factors could hedge a large part of this and be relatively unaffected by a sharp drop or rally. Companies who have a large portion of unhedged exposure towards these factors will be closely linked to the performance of the underlying factor.
- The geographical diversity of the markets in which the company operates could give an indication of how susceptible it is to a downturn in market conditions. Due to the recent global credit crisis record losses were recorded in highly developed markets (USA, UK, Europe) while many of the developing markets (China, India, Brazil) showed a relatively small impact.
- A similar role is played by the diversity of the industries in which the company operates. Some industries function in a more volatile cycle (automotive, commodities) while others are less so (pharmaceuticals, basic services).
- The degree to which the performance of the South African company is linked to the power supplied by ESKOM is another factor to consider. Companies whose primary revenue is obtained from mining or manufacturing are heavy users of electricity. Agreements that are reached between ESKOM and the company could remove some of

the uncertainty regarding how it will be affected when ESKOM's capacity comes under pressure. Since coal burning power stations, that are the biggest producers of electricity in the country, take several years to become operational the problem will persist for the foreseeable future.

- Companies whose fortunes are closely linked to government intervention will always be at risk when there is a change in the political landscape as can happen during elections.
- Granting of licences and business rights are also areas in which the government plays a role. Mining rights are awarded by the Department of Mineral Resources (DMR) and applicants can never be sure that they will receive the rights to mine a particular area.
- The increasing focus on environmental issues can possibly put severe pressure on companies seen as high polluters (manufacturing, mining). Developments in technology that can off-set these emissions such as carbon capture technology (CCT) will play a bigger and bigger role over the extensive periods that cover typical BEE deals. New regulation aimed at reducing the environmental impact of these types of operations could incur a significant cost.
- A stress testing framework is a crucial requirement in understanding the company's share price vulnerability to a combination of interlinked factors under various stress scenarios. Understanding some of the factors that play a role as well as analysing the probability of the BEE deal collapsing at some point over its lifetime will put the bank in a much better position when deciding whether to participate and to what extent in funding the transaction. The stress testing framework should enable the analyst to identify those circumstances under which the BEE partner will most likely not be able to repay its debt. Instead of trying to take a view on the share price, identifying the type of events that will lead to the defaulting of the loan, puts the bank in a better position to decide whether to participate in the funding of the debt.
- The spirit in which the BEE deal is done should be in accordance with the ideals for transformation. ArcelorMittal's planned BEE deal with Imperial Crown Trading (ICT) has been condemned from a number of corners due to a proposed deal that will see Duduzane Zuma (son of President Jacob Zuma) owning a significant part of ArcelorMittal. There are a number of questions being raised regarding how Mr Zuma had obtained the mining rights from the Department of Mineral Resources (DMR) and the reputational risk that could go

along if a bank had to get involved in the financing, might be severe. At present this case is being decided on by the courts.

- On the other side of the coin there is also reputational risk involved in not participating in BEE deals that enjoy a high profile and is broad based. The SASOL Inzalo BEE deal (2008) was the biggest BEE deal in South Africa at the time and impressed many market commentators with the degree to which it included ordinary black South Africans.
- The SASOL deal also illustrates that sometimes a BEE deal may be too large for a single bank to be doing all of the funding. The size and type of debt that the bank wants to get involved with need to be considered carefully. Although many banks might have wanted to be the sole provider of debt in a deal so popular, the total size of it would have left them with considerable concentration risk to SASOL. The degree to which other banks are willing to take-up portions of the debt indicates whether there is the potential for selling the debt in the future in the case that the bank no longer wants that particular exposure.
- Once a bank has done all the necessary research and analysis regarding a particular deal and decided to fund a portion of the debt, ongoing monitoring is crucial. Volatile markets and the length of time required to do the actual evaluation and analysis, could mean that the environment looks significantly different from the time analysis was kicked off to when the transaction finally takes place. The BEE partner might require considerably more or considerably less capital to buy the equity which could impact greatly on the terms that can be negotiated by the bank.
- The credit rating of the issuing company is an essential aspect of the deal. It describes the likelihood of the issuing company defaulting on its obligation. The bank should have a credit rating system in place that takes account of the major factors that play a role in the company's ability to service its debt (total debt, cash flow, industry outlook, quality of management, etc.). This should be in line with that of the major rating agencies (Moody's and Standard and Poor).
- Previous bond issues by the issuing company could say a lot about its ability to raise funds. The size of the issue, how good the take-up was as well the conditions of the market at the time will all indicate how the market views the credit worthiness of the company.
- In a deal where the underlying shares are pledged to the bank, it has to negotiate an appropriate threshold-level where the deal is at risk and the bank can take ownership of the underlying shares. This threshold will be expressed in terms of the degree by which the value of the shares exceeds the outstanding debt and is sometimes referred to as the share-

cover ratio. This ratio will almost always be significantly higher than 1 (where equity equals debt) to ensure that the bank still has time to liquidate the shares before they lose too much value.

- The liquidity of the shares becomes critical in a calculation like this. The large proportion of issued shares that might be involved in the funding transaction means that it is often required to sell the shares over time. The amount of shares traded daily should be small enough not to put downward pressure on the share price but large enough to allow for the all the shares to be sold timeously. A situation could arise where the market is aware that a bank is sitting with a significant proportion of the shares it got as security. Any attempt to sell the shares on the stock exchange will greatly reduce the value of the shares and could end up not being sufficient to cover the debt. Such a position is referred to as an overhang. To avoid this, the appropriate cover-ratios and procedures are needed.
- For these types of deals, mathematical models that estimate the likely loss that can be expected on these funding transactions could provide additional and on-going information in the assessment of the deal.
  - A simulation model can be used to estimate a large number of potential share price paths. This can be used to determine what the probability is that the value of the shares will drop below the predetermined threshold level when the shares will revert to the bank (technical default).
  - The loss-given-default (LGD) can be estimated by considering the degree to which the outstanding debt can be recovered if the shares are sold in the market at the simulated share prices.
  - An acceptable close-out period as well as the time that will elapse from when the transaction defaults to when the bank is in a position to start selling the shares. Furthermore, the confidence level at which the calculations are going to be made (between 95% and 99%) should be in line with the bank's overall risk management policy.
  - Banks will try to negotiate for as high a cover-ratio as possible. This will allow them to recover the outstanding debt even if their actions cause the share price to tumble. However, this is a highly undesirable position. Apart from the obvious repercussions that the BEE deal collapsed and the issuing company sits with a depleted share price, the reputational risk on the bank for playing a role in this could be just as severe.

- There should be some agreement by which the issuing company can remedy the situation if the threshold is breached. It could provide additional vendor funding to reduce the bank's exposure and bring the cover-ratio back to an acceptable level. This option is usually better than the deal collapsing.
- The relationship between the bank and the issuing company can play a big role determining whether the deal is done. A financial institution that is the official bank of the issuing company could be under pressure to fund at least some of the debt.
- Other issues that could play a role and should be evaluated:
  - The current or the prospect of litigation against either of the BEE partner or issuing company.
  - The issuing company should undertake not to delist as this could severely impact on both the share price and the liquidity of the shares.
  - Incurring significantly more debt.
  - Guarantees given.

This illustrates that there are a variety of factors that play a role in the risk associated with funding BEE debt. Furthermore, the BEE transactions take place against a political sensitive background and are highly visible in the media which makes it crucial to consider all factors.

## 13.5 Share Cover Ratio

In order to manage the volatile nature of shares that has been placed as security against a fixed liability, a combination of the share price, its volatility, the average traded volume and the total number of shares under consideration should be taken into account to determine whether the deal is sound.

The value of the security (shares) and the probability of repaying the loan are highly correlated since the shares could be the majority (or all) of the BEE partner's assets. When the share price drops the probability of default increases and the value of the security reduces. This is referred to as wrong-way risk (Le Roux (2008)).

The value of the shares pledged to the bank needs to exceed the loan value by a large enough margin at the outset of the deal to cater for drops in the share price that can occur. If the shares are called by the bank, it will want to sell them off as quickly as possible. However the large proportion of the total number of issued shares that might be involved in the deal might not make this a straight forward exercise. Selling too many shares at a time can push the share price down further and since the BEE deal has failed, the value of the underlying shares will in all likelihood not be very high to start off with. Cognisance of the average daily volume that can realistically be traded is therefore needed. This will however mean that to liquidate the shares may be a protracted process. During this time the share price can depreciate even further, leaving the bank in an undesirable position.

### 13.5.1 Example 8

- Suppose a BEE company enters into a deal to buy 10% of a listed company's shares worth R300 mil. It obtains its funds from a bank and has agreed to cede the underlying shares to the bank in the case that the deal is at risk of collapsing.
- It has been established that on average 1% of the issued shares are traded daily.
- To ensure conservatism, the bank will not trade more than 25% of the average daily traded volume when trying to liquidate the shares ensure it is not impacting negatively on the share price. Any significant increase in the volumes could signal to the market that there is an investor looking to offload a substantial number of shares. The South African market is so small that this may become an issue.
- This means that the shares will only be sold over a period of 40 (10%/1%/25%) days.

- A depreciating share price-curve is used to establish a safe level of initial security. The share price can be reduced daily by estimating its path with the volatility in a Geometric Brownian Motion process described in equation (158). In this case the 95% confidence level is used. This can be interpreted as using a share price path that is more conservative than what will occur in 95% of the cases.

### 13.5.2 Share Cover Ratio of 1

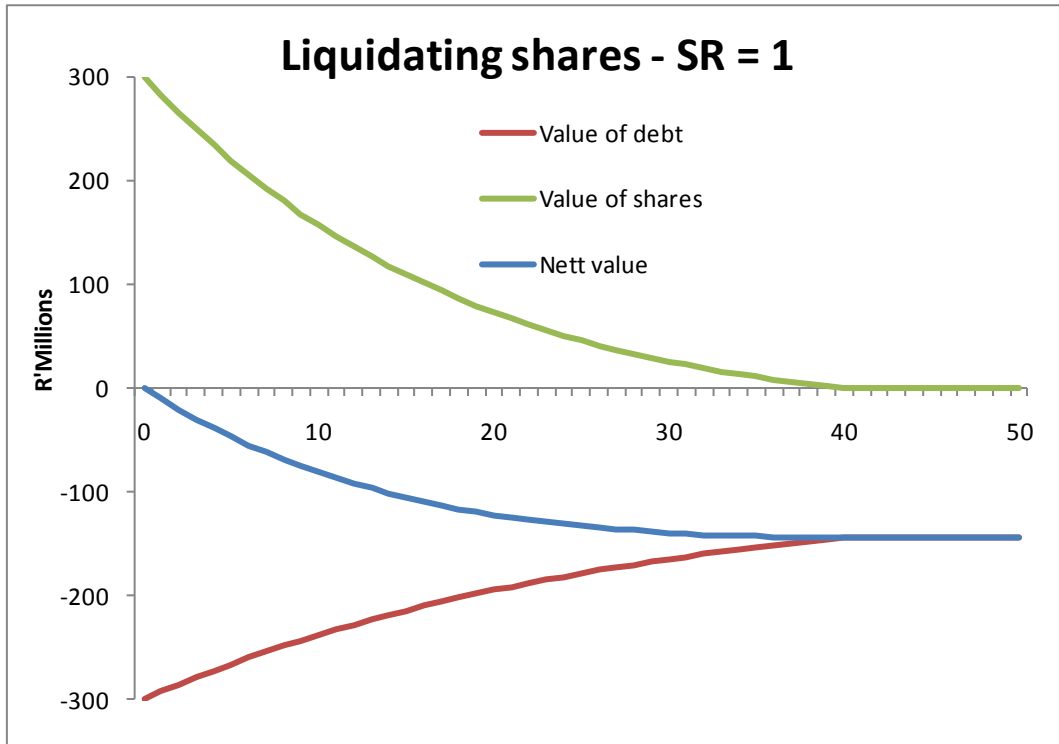


Figure 13.3 - Liquidating shares when the share cover ratio is 1

Figure 13.3 illustrates the net exposure of the bank as it tries to recover its loan by selling shares while the share price is falling. The debt was equal to the value of the shares at the point when selling started. Under these circumstances it is not possible to recover the initial debt and 48% is lost.

### 13.5.3 Share Cover Ratio of 1.5

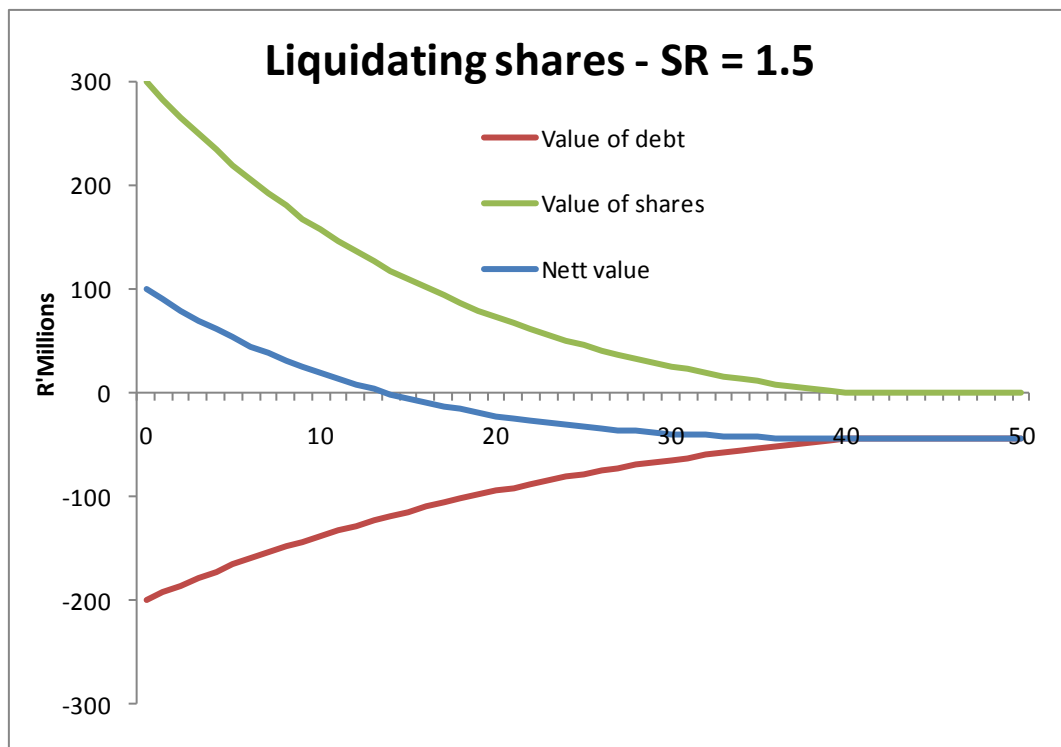


Figure 13.4 - Liquidating shares when the share cover ratio is 1.5

In Figure 13.4 the debt is reduced to R 200 million. By reducing the debt that needs to be covered by the shares (i.e. loaning less to the BEE partner while requiring the same amount of collateral) to only R200 mil, the value of the shares will exceed that of the loan by 50% initially which means that the share cover ratio is 1.5. R44.1 mil worth of debt cannot be recovered, bringing the loss ration down to 22% (down from 48% when the share cover ratio was 1).



### 13.5.4 Share Cover Ratio of 1.92

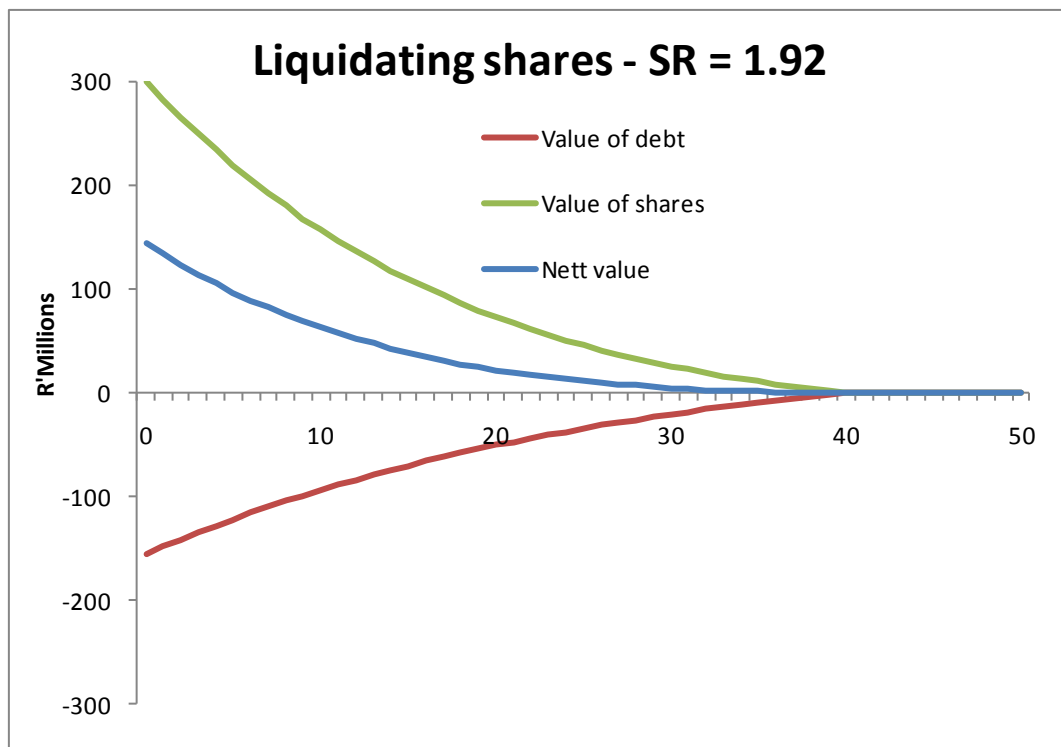


Figure 13.5 - Liquidating shares when the share cover ratio is 1.92

When the initial share cover ratio is increased further to 1.92 (debt equals only R 155,85 million), the reducing share price will be sufficient to cover the debt and no loss is made.

### 13.5.5 Comments

- The share cover ratio of 1.92 that was established estimates a share value to loan value at which it is safe to borrow. Banks will typically include a share cover ratio of 2 to indicate when the underlying shares will be called. In such deals the initial share cover ratio will be much higher with 2 being the trigger-level at which selling can start.
- If a trade sale agreement is in place, a third party (often the issuing company) has agreed to buy the shares from the bank at such a price that will cover the debt. This removes the risk for the bank to a large degree.
- The depreciating share price (calculated by 95% percentile Geometric Brownian Motion process) in the example has a significant impact on the value of the deal. This can be enhanced by the addition of intuitive share price barriers if the analyst believes that there are resistance levels through which the share price will not go.
- In addition, the maximum time that the bank is willing to take to trade out the shares can also be incorporated in determining an appropriate share cover ratio.

## 13.6 Conclusion

This chapter started off by describing the structure in which BEE deals are funded by third parties (usually banks). A case study on the Northam Ltd shares that Mvelapanda Recourses ceded to Nedbank illustrated the risk involved in using equity as security on a loan.

The different factors to consider in assessing the funding risk were discussed. There is a whole host of things to consider which includes the prospects of the share price, events that could lead the deal to collapse, the political sensitivity of these deals, reputational risk for the bank and the factors to take into account when establishing a healthy cover ratio.

An example was done to illustrate how to use the value and liquidity of the ceded shares to calculate an initial share cover ratio that should prevent any loss to the bank if the shares had to be called and liquidated. The share cover ratio should be adequate that if the share price is deteriorating during the time that bank is trying to sell them, it can still recover the original loan amount.

## CHAPTER 14

### 14 Conclusion

#### 14.1 Chapter Findings

**Chapter 1** introduced the concepts of ESOs and BEE deals and set out the objectives of the report and how the various aspects will be addressed in the chapters that follow.

**Chapter 2** showed that IFRS 2 has governed the accounting requirements of all share-based payments under which ESOs and BEE deals fall since 2004. It requires the following:

- The fair-value of the derivative has to be expensed over its vesting period.
- Equity settled instruments must be priced once at inception while cash-settled instruments are to be valued each time the company publishes its results.
- All the models used in valuing the instruments and the inputs that are used in the models should aim to replicate the value of the instruments if they had been trading in the market.
- The results of this expense have to appear in the published financial results of the issuing company.

In **Chapter 3** it was shown that marking the prices of ESOs and BEE deals to the market for accounting purposes can be done with a variety of mathematical models that calculate the probability weighted pay-off of the options. When calculating the fair-value the following mathematical models are proposed:

Transaction Type	Appropriate Model
Basic ESO with no assumption on exercise behaviour or closed periods	Black-Scholes
Normal ESO in which an exercise assumption is used and closed periods are recognized.	Binomial Model Finite Difference Method (Crack-Nicholson)
Basic BEE deal with no assumption on exercise behaviour and no interest on the debt or the dividends	Black-Scholes
BEE deal with some assumption on exercise behaviour is used and interest is paid on the debt and/or the dividends	Monte Carlo Simulation

All of these models make the following assumptions:

- $S$ , the underlying stock, follows a Geometric Brownian motion process,

$$dS_t = \mu S_t dt + \sigma S_t dW_t,$$

which has a constant mean and volatility.

- This leads to the return on  $S_T$  being log normally distributed.
- It is possible to short sell the shares – something which is specifically difficult to justify when ESOs and BEE deals are priced.
- Any fraction of a share can be traded when hedging the portfolio.
- There are no transaction costs – specifically when hedging.
- The initial assumption that the stock does not pay any dividends was addressed by generalizing the PDE-formula to include a dividend yield variable.
- Money can be borrowed or invested at a risk-free interest rate,  $r$ .

**Chapter 4** examined that since ESOs and BEE deals are not traded they do not have market prices with which to compare and calibrate the theoretical prices with. This together with the sensitivity of the option price to some of the inputs means that the correct use of the inputs is crucial.

Sensitivity analyses on the option values in **Chapter 5** showed that

- Subtle differences in the structure of the deals (specifically BEE transactions) can make a significant impact on the option value.
- The assumption regarding the exercise behaviour of the option holder greatly affects the option value. These assumptions are seldom based on empirical observations.
- Having a strike that is in some way correlated to the reference asset reduces the option value considerably.
- This indicates that deals that at first glance appear to be similar could have vastly different prices when all things are considered. A pricing framework that incorporates all of the main differences as well as the subtle ones is imperative if transactions are to be compared.

**Chapter 6** illustrated how to calculate the annual expense associated with ESOs and BEE deals once its fair-value has been obtained. A number of examples were used which started off at a very simple equity-settled instrument to which complexity was added on a step-by-step basis until it included multiple tranches and the financial year-end of the company on a cash-settled instrument.

**Chapter 7** analysed the ESO schemes of 11 South African companies. It was found that there is little difference in the structures of the different ESOs and that they were all priced by either the Black-Scholes or Binomial models. Exercise behaviour was incorporated in a number of different ways with no evidence published to support these choices.

In **Chapter 8** three methods were considered to address the issue relating to the early exercise of options in their pricing. Of these, the ESO Upper Bound-methodology is proposed as a practical way to reduce the option price produced by the Black-Scholes method without requiring additional information about the employee. It is based on the premise that there is a threshold level at which exercise will occur and the employee can invest the after-tax proceeds in a diversified portfolio with a higher expected return than that of the single equity option. This approach reduces the standard Black-Scholes option value without relying on assumptions about the specific employee's exercise behaviour. The derived option value represents the cost of the option.

The main issue with ESOs discussed in **Chapter 9** is that their cost is less than the value derived by the option holders and that the use of ESOs may be less effective than other types of monetary incentives such as bonuses.

The BEE deals of seven major South African companies showed a great degree of variability across a number of structure features and their values in **Chapter 10**. Even so, the BEE codes do not judge each transaction on its own merits, but rather looks at the companies' overall level of black shareholding when assigning BEE credits.

This was one of the main problems with BEE deals highlighted in **Chapter 11**. The others were:

- Using black shareholding as the primary measure to assign ownership credits means that neither wealth creation nor wealth transfer is gauged.
- Initial deals allowed a significant portion of the shares involved in the BEE transaction to be allocated to certain black individuals. Fortunately more recent deals have tended to invite the general black public to participate in the transactions.
- Most BEE deals have extended lock-in periods on these shares which delay the economic benefit for several years.
- BEE deals require a significant share price appreciation for the deal to have any value.

- Market volatility plays a significant role in determining the amount of BEE credits that a BEE transaction could generate.
- Uncertainty regarding some issues is preventing more deals of being conducted.
- It has been proposed that there is limit to the changes that BEE-type deals can make in balancing the wealth distribution in South Africa.

**Chapter 12** proposed an alternative methodology for assigning BEE credits which is based on the fair-value of a BEE transaction. The major advantages of this methodology are:

- The issuing company is rewarded for a lenient structure and is not dependent on a volatile share price to obtain its BEE credits.
- The issuing company does not forfeit its BEE credits and the money invested in the deal if the share price does not perform adequately.
- Extended lock-in periods are not needed which frees up shares to be liquidated by the BEE participant to unlock the economic benefit. Since the shares can be traded on the JSE normally their true market values are obtained and not a discounted value.
- The approach is more equitable in assigning BEE credits in that those deals that have the highest probability (and cost) for transferring shares are rewarded.

Some administrative issues would have to be considered for the approach to work. This includes increased transparency of the funding of the BEE deal to prevent bogus deals and distinguishing between BEE credits from normal black shareholding and credits from a specific BEE transaction.

The development of a secondary market for BEE shares that are traded among fellow BEE participants might in future assist in understanding how these option holders behave. The JSE has recently established a trading platform for these types of shares. Once trading has taken place for a time, research on the discount BEE shares obtained and how the values compare to ordinary shares, would greatly assist in quantifying the non-tradability feature of these shares.

**Chapter 13** discussed the different factors to consider in assessing the funding risk involved in BEE deals. An example was done to illustrate that the initial value of the equity that act as security should be significantly more than that of the loan (share cover ratio > 1) to ensure that the bank can still recover the original loan amount in the event of the transaction collapsing.

## 14.2 ESO and BEE Transaction Comparison

By considering a number of key areas, ESOs and BEE transactions can be compared to show the differences and similarities between these two types of instruments.

Nr	Area	ESO	BEE deals
1	Aim	To attract and retain talented employees. To encourage them to work in such a way as to increase the share price of the company over the long-term.	To increase the level of black ownership in listed SA companies.
2	Governing Accounting Standard	IFRS 2	IFRS 2
3	Pricing Models	Black-Scholes Binomial model Finite Difference Monte Carlo Simulation	Black-Scholes Binomial model Finite Difference Monte Carlo Simulation
4	Primary Model Inputs	Spot Strike Maturity Vesting Period Volatility Interest Rate Dividend Yield	Spot Strike Maturity Vesting Period Volatility Interest Rate Dividend Yield
5	Secondary Model Inputs	Exercise multiple Closed Periods	Interest on Strike Interest on Dividends
6	Customisation	Little differentiation between South African ESO schemes	Substantial differences between deals from different SA companies
7	Expensing	Fair-value is expensed over the vesting period, adjusted annually for forfeited options.	Fair-value is expensed over the vesting period, adjusted annually for forfeited shares.
8	Accounting History	Historically issued at the money to avoid any accounting charge	BEE deals have always been accounted for under IFRS 2
9	Strike	Determined at issue of the options and stays constant over the life of the option.	Represents the debt/cost at which the shares are sold to the BEE partner which changes over time as dividends reduce it.
10	Value When Exercised	Employees receive the monetary value between the strike and the share price at exercise	BEE partners receive the net amount of shares after debt/cost has been repaid.
11	Lock-in Periods	None	Extensive lock-in periods may exist to prevent the BEE partner from selling its shares

<b>Nr</b>	<b>Area</b>	<b>ESO</b>	<b>BEE deals</b>
12	Exercise Data	Little exercise data is publicly available. Studies have not been able to provide a conclusive framework to incorporate the exercise behaviour into the price.	Even fewer exercise data is available for BEE deals. The emergence of a secondary market for BEE shares might inform the level of discount that these investors are willing to take in the future.
13	Pricing Recommendations	Use the ESO upper bound methodology on SA companies to reduce the ESO charge.	Further research needed on secondary market for BEE shares to obtain a statistically sound discount for deals with extensive lock-in periods
14	Structure Issues	Many amendments have been proposed but the low level of differentiation between ESO schemes suggests that there is little scope for customised schemes.	The high degree of differentiation suggests that BEE deals could still be enhanced.
15	Legislative Influence	Issuing ESOs to employees are the domain of individual companies although disclosure rules require a minimum level of reporting on ESOs for senior management-level	The BEE Codes set out a comprehensive set of ownerships requirements to which SA companies need to adhere. This has led directly to the use of BEE deals to increase the level of black ownership in the share capital.
16	Effectiveness of SA schemes	No study has attempted to analyse to what degree South African ESOs reach their objective. International studies indicate that other forms of monetary incentives such as bonuses are a better instrument to use.	BEE deals only manage to transfer shares if a significant increase in the share price is achieved over the life of the deal. Extended lock-in periods delay the economic benefit in the shares.
17	Criticism of the Instruments	The cost of ESOs has been shown by many authors to be significantly more than the benefit derived by the employee.	A wide range of issues has been raised against BEE deals. The fact that wealth is only distributed if the share price rises and the long periods before the economic benefits are available to the BEE partners are two of the main problems.



Nr	Area	ESO	BEE deals
18	Risk Management	Limited risk management is required on ESOs as the number of shares involved is insignificant compared to the overall number of issued shares.	Banks who lend money to facilitate BEE deals are exposed to funding risk. This is based on the inherent problems with having equity as security on a fixed loan amount and the wrong-way risk involved.

Table 14.1 - Comparison of ESOs and BEE deals

### 14.3 Attaining Objectives

A number of objectives for this report were set in Section 1.2. Table 14.2 evaluates how those objectives have been addressed in the various sections of the report.

Objective	Relevant Section	How the Report Addresses the Objective
Overview of ESOs: Structural	7	The history of ESOs and their main features are discussed. The ESOs of 11 South African firms are briefly analysed.
	9.2	Problems that have been identified with the structuring of ESOs are discussed.
	9.3	Recommended ESO structure changes are considered.
Overview of ESOs: Valuation	3	The mathematical models used in the valuation of ESOs are derived and the applicability of each is discussed.
	4	Each of the inputs into the pricing models is discussed and their impact on the price analyzed.
	5.3	The impact of changes to the exercise assumption was considered by using the most appropriate pricing model.
	7.7	Includes the issues relating to the use of the exercise multiple
Overview of BEE deals: Structural	10	Background on BEE deals is provided with regards to the reason for their emergence and the role of the BEE Act. The BEE deals of six firms are discussed and their performance since inception analyzed.
	11	The main criticism against BEE deals are included and elaborated on.
	13	An in-depth analysis on the factors surrounding the risks involved in funding BEE deals is provided.
Overview of BEE deals: Valuation	3	The mathematical models used in the valuation of BEE deals are derived and the applicability of each discussed.
	4	Each of the inputs into the pricing models is discussed and their impact on the price analyzed.
	5.2	The effect of changes on BEE deals on their prices is analyzed.

Objective	Relevant Section	How the Report Addresses the Objective
Methodology for Reducing ESO Expense	8	The ESO Upper Bound methodology can be incorporated by SA firms. Implementing this approach reduces the standard Black-Scholes option value without relying on assumptions about the employee's exercise behaviour. This means that no assumption regarding the exercise behaviour or other characteristics of the employee is needed and that the derived option value represents the cost thereof.
Evaluation of BEE Act	11	A number of issues with the BEE Act have been identified.
	12.4	The report suggests using the cost of the BEE deal as percentage of the total market capitalisation of the company to assign BEE credits specific to the transaction. This approach is much more equitable and removes some of the major issues with the current deals (extended vesting periods). However, additional transparency will be required to identify the funds used to purchase the BEE shares and the administration on the shareholding register will have to be extended to include information on which shares have been obtained through BEE deals.
ESO vs. BEE Deal Comparison	14.2	ESOs and BEE deals are compared on 18 different levels.

Table 14.2 - Evaluating the report's content against the original objectives

## 15 Appendix

### 15.1 BEE Scorecard Details

Category	Detail	Points	Percentage
<b>Voting Rights</b>	Voting rights (black people)	3 pnts	25% + 1 vote
	Voting rights (black women)	2 pnts	10%
<b>Economic Interest</b>	Economic interest to which black people are entitled	4 pnts	25%
	Economic interest to which black women are entitled	2 pnts	10%
	Economic interest to which the following natural persons are entitled: <ul style="list-style-type: none"> <li>▪ black designated groups</li> <li>▪ black participants on distribution</li> <li>▪ employee schemes</li> <li>▪ black participants in cooperatives</li> </ul>	1 pnt	2.5%
<b>Realization Points</b>	Ownership fulfillment	1 pnt	No Restrictions
	Net Equity Interest  Achieved accordingly: <ul style="list-style-type: none"> <li>▪ 10% of the Target (Year 1)</li> <li>▪ 20% of the Target (Year 2)</li> <li>▪ 40% of the Target (Year 3-4)</li> <li>▪ 60% of the Target (Year 5-6)</li> <li>▪ 80% of the Target (Year 7-8)</li> <li>▪ 100% of the Target (Year 9-10)</li> </ul>	7 pnts	25%
<b>Bonus Points</b>	Ownership by: <ul style="list-style-type: none"> <li>▪ black new entrants</li> <li>▪ black participants in broad-based ownership schemes</li> <li>▪ black participants in cooperatives</li> </ul>	3 pnts	Bonus per each level of 5%

## 15.2 Financial Mail Top Empowerment Companies for 2008

TOP 188 COMPANIES																	
Rnk '08	Company	BEE Score (%)	Ownership (%)			Management (%) Gender adjusted			Employ equity (%)	Skills development (%)		Preferential procurement (%)		Enterprise development (%)		Socioeconomic development (%)	
			Voting rights	Economic interest	Score	Board participation	Black executive directors	Score		Score	Skills spend	Score	BEE spend	Score	Contributions	Score	Contributions
1	Adcorp Holdings	81,69	32,00	32,00	22,00	50,00	5,00	4,39	6,00	1,70	9,30	50,00	20,00	5,10	15,00	3,00	5,00
2	Merafe Resources	79,15	51,20	51,20	21,00	60,00	12,50	7,44	5,41	5,69	10,30	67,21	15,00	5,71	15,00	23,07	5,00
3	Hosken Consolidated	76,80	51,12	51,12	23,00	59,09	30,00	8,95	10,50	2,21	7,76	35,01	10,29	2,26	11,30	2,20	5,00
4	Tongaat Hulett	75,64	43,20	37,00	21,64	34,60	0,00	6,99	9,16	1,90	6,22	34,90	12,94	2,74	13,70	1,27	5,00
5	Metropolitan Holdings	73,01	30,70	30,70	17,63	46,43	37,50	9,53	10,16	1,08	6,72	39,67	9,52	4,06	15,00	0,89	4,45
6	Investec	72,32	25,10	25,10	20,07	31,25	0,00	3,08	5,04	1,83	11,11	49,40	15,53	92,46	15,00	0,49	2,50
7	Oceana Group	70,93	30,16	30,16	21,14	45,00	25,00	6,42	5,08	1,96	6,28	56,38	12,00	20,11	15,00	1,95	5,00
8	Super Group	70,70	34,30	34,30	17,09	41,00	21,50	5,06	9,95	0,90	7,80	20,00	10,80	3,10	15,00	1,20	5,00
9	Standard Bank	70,08	18,67	18,67	14,00	29,41	0,00	4,30	9,80	3,14	8,03	42,81	13,96	20,54	15,00	1,00	5,00
10	FirstRand	69,90	14,77	15,20	12,68	38,89	25,00	6,79	11,22	1,91	5,25	44,25	13,96	34,82	15,00	1,00	5,00
11	Coronation Fund Mgs	69,51	13,74	13,74	10,07	33,00	16,70	6,65	11,70	3,60	12,00	39,00	10,59	12,20	15,00	0,70	3,50
12	Paracon Holdings	69,11	33,74	33,74	20,00	38,89	12,50	4,13	3,96	0,94	7,88	55,01	15,19	3,00	15,00	0,59	2,95
13	Gijima AST Group	68,84	45,69	45,69	20,00	50,00	50,00	11,00	1,69	0,13	6,08	50,00	12,57	7,50	15,00	0,50	2,50
14	Glenrand MIB	68,53	29,40	29,40	20,00	37,50	25,00	5,38	2,57	4,00	7,20	58,40	15,38	2,60	13,00	2,70	5,00
15	Nedbank	67,81	17,87	17,45	12,77	33,33	0,00	6,68	7,02	1,89	5,68	53,10	15,65	27,95	15,00	1,04	5,00
16	Sun International	67,54	32,22	27,71	21,71	9,38	16,67	2,24	5,56	2,63	5,93	54,02	12,11	12,75	15,00	1,82	5,00
17	Dimension Data	67,21	25,42	25,42	19,17	53,85	53,85	9,14	5,05	0,83	7,66	19,10	6,19	3,80	15,00	4,30	5,00
18	InfoWave Holdings	66,41	23,99	23,99	18,47	22,22	30,00	6,78	9,00	1,02	7,50	21,25	6,06	7,99	15,00	0,72	3,60
19	Business Connexion	66,15	25,10	25,10	15,34	60,00	50,00	10,25	2,10	0,70	6,56	61,40	12,40	3,10	15,00	0,90	4,50
20	Aveng Group	65,59	55,93	55,93	23,00	10,00	7,14	2,40	1,99	0,58	7,17	32,53	11,03	9,06	15,00	2,51	5,00
21	Naspers	65,43	30,32	30,86	21,95	8,33	0,00	0,78	7,88	0,17	6,40	44,59	14,31	1,86	9,30	0,96	4,82
22	Phumelela	65,34	30,99	30,99	16,55	29,17	16,67	5,81	5,67	1,67	9,33	83,13	18,62	0,87	4,36	1,31	5,00
23	Cadiz Holdings	65,20	22,70	20,37	14,52	25,00	0,00	3,92	6,56	1,25	3,36	51,74	16,84	24,65	15,00	1,32	5,00
24	Santam	65,11	23,40	20,70	13,76	50,00	30,00	7,77	1,88	2,93	8,10	47,98	17,52	6,01	15,00	0,22	1,09
25	The Don Group	64,28	51,00	51,00	7,00	41,67	50,00	10,50	13,00	0,01	0,03	39,70	13,76	16,08	15,00	7,47	5,00
26	Discovery Holdings	63,89	21,40	21,00	14,01	33,33	0,00	4,00	8,24	6,41	8,00	53,50	15,22	1,88	9,42	3,30	5,00
27	Absa	63,35	14,00	14,00	10,56	34,21	12,50	6,40	8,00	1,09	3,86	64,89	15,00	21,15	15,00	0,91	4,54
28	Faritec Holdings	62,95	42,97	42,97	18,53	45,83	41,67	9,25	4,90	21,06	12,00	19,94	4,79	1,70	8,48	1,50	5,00
29	MTN Group	62,85	12,16	22,44	11,33	50,00	31,25	9,13	9,62	1,21	6,15	38,00	9,12	2,90	14,50	0,60	3,00
30	Telkom SA	62,38	12,44	12,44	11,97	61,36	50,00	10,60	4,05	2,74	11,60	69,41	20,00	0,26	1,29	0,58	2,89
31	Trans Hex Group	61,54	20,60	20,60	11,54	20,00	66,67	7,33	8,49	1,20	8,39	45,00	10,80	8,29	15,00	0,00	0,00
32	Mvelaphanda Group	61,52	53,80	53,80	23,00	46,67	50,00	8,20	8,21	0,00	4,29	30,00	12,96	0,00	3,95	0,00	0,91
33	Medi-Clinic	60,30	26,49	26,49	15,32	44,44	46,43	4,98	4,05	6,73	9,00	39,77	9,60	13,52	15,00	0,65	2,35
34	Barnard Jacobs	59,80	13,96	13,96	8,93	18,75	16,67	3,33	4,92	3,50	6,00	46,85	17,24	5,68	15,00	0,88	4,38



	Mel																
35	Raubex Group	59,60	28,68	28,68	21,35	21,43	0,00	1,29	1,68	0,87	7,75	58,01	16,47	1,98	9,90	0,24	1,18
36	Aspen Pharmacare	59,55	26,90	29,00	23,00	33,33	0,00	6,49	8,18	0,37	3,72	38,00	10,34	1,27	6,35	0,29	1,46
37	Network Healthcare	58,20	17,83	17,83	13,59	23,08	12,50	4,38	3,45	3,30	11,76	20,30	5,02	7,60	15,00	1,50	5,00
38	Kelly Group	57,56	37,64	37,64	15,03	19,23	20,00	4,29	8,95	1,00	7,11	85,84	17,18	0,00	0,00	1,04	5,00
39	Enviroserv Holdings	57,40	10,94	10,94	12,22	25,00	8,33	3,67	3,12	0,20	6,40	78,23	12,00	25,79	15,00	1,08	5,00
40	Sekunjalo	57,40	92,00	68,86	21,00	66,67	50,00	10,92	8,63	0,44	0,88	35,30	8,47	0,50	2,50	5,42	5,00
41	Petmin	56,87	37,00	36,00	20,00	25,00	37,50	5,61	2,12	2,37	10,74	20,60	7,66	1,15	5,74	6,20	5,00
42	Datacentrix Holdings	56,53	36,55	9,64	7,26	62,50	66,67	10,16	7,86	0,83	4,36	68,24	13,73	2,38	11,90	0,25	1,25
43	York Timber	56,27	26,00	26,00	19,00	25,00	33,30	5,08	6,96	3,50	6,00	3,00	0,72	4,00	15,00	0,70	3,50
44	Metrofile Holdings	56,00	27,10	27,10	18,00	20,00	0,00	2,20	4,70	0,40	0,80	60,00	16,30	2,40	12,00	0,40	2,00
45	Group Five	55,27	28,24	28,20	17,71	10,00	10,00	1,84	2,14	1,79	9,17	13,63	4,41	22,16	15,00	3,71	5,00
46	Sanlam	55,21	25,50	25,50	19,33	38,89	11,11	4,61	1,75	0,76	2,11	39,44	9,47	20,39	15,00	0,59	2,94
47	Bidvest Group	55,17	26,70	26,70	20,00	27,27	5,56	3,56	4,78	1,21	6,64	16,68	4,45	2,15	10,75	1,55	5,00
48	Argent Industrial	55,08	16,10	10,40	9,25	18,00	10,00	3,88	7,77	1,90	8,40	32,00	12,78	2,00	10,00	0,60	3,00
49	Allied Electronics	54,85	15,50	9,05	8,90	30,00	4,55	4,44	4,46	1,00	4,46	76,37	12,58	8,13	15,00	3,53	5,00
50	Hulamin	53,83	21,40	21,40	14,18	36,36	16,67	5,41	8,80	2,49	8,44	32,23	11,42	0,12	0,58	1,18	5,00
51	Mustek	53,67	26,84	2,73	4,54	11,54	0,00	1,69	5,51	2,42	10,29	41,68	11,63	96,20	15,00	13,23	5,00
52	Growthpoint Prop	52,75	14,71	14,71	10,06	14,29	12,50	2,48	4,11	31,71	6,00	42,09	10,10	29,83	15,00	100,00	5,00
53	Imperial Holdings	52,62	31,67	17,17	13,55	26,19	0,00	3,27	2,02	6,20	6,83	36,33	9,26	5,72	15,00	0,54	2,69
54	Omnia Holdings	51,91	20,11	20,11	12,66	20,00	20,00	4,00	0,15	0,70	5,74	39,00	9,36	3,26	15,00	2,01	5,00
55	Primeserv Group	51,62	80,80	80,80	12,00	21,43	0,00	2,50	10,05	0,54	7,07	0,00	0,00	10,29	15,00	3,55	5,00
56	Old Mutual Plc	50,45	13,83	13,83	9,17	28,20	0,00	4,04	5,25	3,80	8,52	45,40	12,97	1,30	6,50	0,80	4,00
57	Jasco Electronics	49,53	54,67	54,67	19,00	25,00	12,50	4,25	9,73	71,17	6,00	33,43	8,02	0,00	0,00	0,51	2,53
58	Massmart Holdings	49,44	8,10	2,00	4,35	35,70	0,00	5,35	10,98	1,50	5,16	15,00	3,60	11,17	15,00	1,56	5,00
59	AngloGold Ashanti	49,18	26,80	26,80	16,00	12,50	0,00	3,09	2,58	2,24	8,90	41,91	10,06	0,71	3,54	5,51	5,00
60	Purple Capital	48,52	19,90	13,50	11,31	33,33	0,00	3,25	3,96	0,00	0,00	54,10	15,00	6,27	15,00	0,00	0,00
61	Mutual & Federal	47,99	17,24	17,64	12,85	50,00	0,00	7,14	1,88	4,40	12,00	43,78	13,51	0,00	0,00	0,12	0,61
62	Cargo Carriers	47,83	5,00	5,00	4,00	8,33	0,00	1,33	0,00	0,75	10,50	25,00	12,00	18,90	15,00	1,00	5,00
63	WBHO	46,80	24,41	24,41	15,09	15,00	0,00	1,24	4,45	0,41	3,27	8,29	2,76	3,40	15,00	1,28	5,00
64	Lewis Group	46,54	0,00	4,00	3,93	40,00	0,00	3,82	4,50	2,06	10,12	17,37	4,17	3,41	15,00	1,29	5,00
65	Blue Label Telecoms	46,47	10,45	10,45	6,27	37,50	0,00	8,25	5,03	2,32	4,64	25,63	6,38	37,92	15,00	0,18	0,90
66	SABMiller Plc	46,36	0,00	0,00	1,12	0,00	0,00	6,74	7,40	0,00	8,15	0,00	10,99	0,00	7,86	0,00	4,10
67	Italtile	46,18	10,70	10,70	4,00	14,29	0,00	2,95	8,01	14,25	12,00	0,00	0,00	6,27	15,00	0,84	4,22
68	Foschini	45,77	0,00	16,93	4,95	18,18	0,00	3,05	6,02	2,65	10,50	40,49	13,71	0,51	2,55	2,40	5,00
69	African Rainbow	45,50	41,84	41,84	16,80	37,50	21,43	7,71	1,71	2,95	12,08	23,00	6,48	0,02	0,08	0,13	0,63
70	Exxaro Resources	43,95	53,00	53,00	20,00	50,00	16,67	6,22	3,55	2,43	9,80	3,46	1,87	0,00	0,00	0,50	2,51
71	African Bank Invest	43,21	6,60	6,60	6,04	21,43	10,00	5,81	5,98	2,95	11,90	45,17	10,84	0,00	0,00	0,53	2,64
72	Liberty Group	43,18	10,00	10,00	6,60	30,77	0,00	4,10	8,22	1,20	8,41	52,73	12,55	0,00	0,00	0,66	3,30
73	Woolworths Holdings	41,87	10,00	10,00	3,80	33,33	25,00	7,10	6,97	1,80	10,20	10,40	5,20	1,30	0,04	28,00	5,00
74	Remgro	41,00	21,21	21,42	15,40	6,25	0,00	1,20	0,00	3,50	6,00	29,20	9,50	0,90	4,30	0,90	4,60



75	Advtech	40,40	8,75	8,75	2,45	11,54	7,14	3,23	3,46	0,45	6,91	16,14	4,35	5,89	15,00	1,15	5,00
76	New Clicks Holdings	39,90	0,00	0,00	0,00	22,22	0,00	5,10	8,92	2,60	11,29	2,80	1,10	2,40	12,00	0,30	1,50
77	Sasol	39,49	16,67	16,67	10,34	48,33	62,50	6,90	4,07	0,36	6,72	30,00	10,20	0,07	0,34	0,18	0,92
78	PPC	39,30	1,74	1,74	1,17	40,00	10,00	4,11	2,45	2,61	11,49	47,22	16,10	0,00	0,00	0,80	3,98
79	Truworths Int	38,84	0,00	2,43	1,07	22,22	0,00	2,44	6,41	2,69	11,38	24,10	6,23	1,26	6,30	2,57	5,00
80	Harmony Gold	38,80	16,10	16,10	9,02	20,00	0,00	3,05	7,33	1,54	5,03	34,83	8,36	0,32	1,58	0,89	4,44
81	Rainbow Chicken	38,37	0,00	0,00	0,00	33,33	0,00	3,42	2,58	0,41	6,83	50,00	15,00	1,37	6,87	0,73	3,67
82	Kagiso Media	37,88	48,10	48,10	8,00	44,44	33,33	9,88	0,00	0,00	0,00	0,00	0,00	11,04	15,00	5,12	5,00
83	Sappi	37,55	0,00	0,00	0,00	19,23	0,00	2,82	1,91	1,84	5,56	24,16	7,61	3,22	15,00	0,93	4,65
84	Gold Fields	36,63	15,00	15,00	4,20	15,38	0,00	3,85	5,67	1,87	9,75	43,00	10,32	0,00	0,00	0,57	2,85
85	Dorbyl	36,14	0,00	0,00	0,00	20,00	0,00	3,45	1,79	0,50	7,10	42,00	13,35	1,50	7,50	0,59	2,95
86	Allied Technologies	35,89	25,10	25,10	15,00	20,83	0,00	2,25	0,00	1,00	2,00	36,00	11,64	0,00	0,00	1,00	5,00
87	Northam Platinum	35,85	30,91	30,91	15,18	38,89	0,00	3,75	2,81	2,87	10,23	11,19	2,69	0,00	0,00	0,24	1,21
88	Sasfin Holdings	34,21	10,00	10,00	5,60	22,22	0,00	3,21	3,45	0,47	6,93	11,37	6,02	1,40	7,00	0,40	2,00
89	Kumba Iron Ore	34,20	20,00	20,00	12,20	33,33	0,00	4,00	0,09	3,33	12,09	13,90	3,34	0,00	0,00	0,50	2,48
90	Pick n Pay Stores	33,73	0,00	4,48	1,91	20,83	0,00	3,15	9,26	5,78	6,26	20,26	5,30	0,57	2,86	1,45	5,00
91	Ambit Properties	32,79	39,00	39,00	7,00	50,00	0,00	5,83	7,96	0,00	0,00	50,00	12,00	0,00	0,00	0,00	0,00
92	DRD Gold	32,66	26,00	26,00	18,00	0,00	0,00	1,32	0,00	0,00	1,33	54,00	12,00	0,00	0,00	0,00	0,00
93	Distell Group	32,54	4,57	4,57	2,87	28,00	0,00	3,14	0,00	0,66	2,18	30,74	7,38	6,64	15,00	0,40	1,98
94	City Lodge Hotels	31,63	4,07	4,07	2,28	25,00	0,00	2,69	3,89	2,82	11,77	25,00	6,00	0,00	0,00	1,00	5,00
95	African Oxygen	30,86	28,42	14,18	9,45	22,73	0,00	3,82	1,85	1,45	4,63	31,12	7,47	0,05	0,25	0,68	3,40
96	Steinhoff Int	29,19	1,70	1,70	0,48	21,40	0,00	2,28	6,71	3,00	6,00	3,50	0,84	2,05	10,23	0,53	2,65
97	RMB Holdings	29,09	20,07	20,36	15,36	6,25	0,00	1,73	0,00	0,00	0,00	61,35	12,00	0,00	0,00	0,00	0,00
98	Nampak	29,02	0,80	0,80	1,65	23,08	50,00	6,38	2,83	0,75	2,09	59,31	13,28	0,00	0,00	0,56	2,79
99	Anglo American Plc	27,56	2,30	2,30	1,47	3,33	0,00	0,20	0,00	0,00	0,00	32,70	7,88	2,60	13,01	1,30	5,00
100	Transpaco	26,76	27,00	27,00	15,00	0,00	0,00	0,00	0,00	0,00	0,00	49,00	11,76	0,00	0,00	0,00	0,00
101	Afro-centric Invest	25,15	53,00	53,00	19,40	53,57	0,00	5,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
102	Cashbuild	25,13	10,00	10,00	3,80	22,22	0,00	1,33	0,00	0,00	0,00	0,00	0,00	38,18	15,00	13,25	5,00
103	Anooraq Resources	25,11	52,00	52,00	15,00	25,00	20,00	5,11	5,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
104	EOH Holdings	24,66	26,00	26,00	15,00	25,00	18,75	4,32	0,00	0,00	0,00	1,40	0,33	0,00	0,00	3,24	5,00
105	Makalani Holdings	23,63	25,00	25,00	15,00	43,75	50,00	8,63	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
106	Aquarius Platinum	22,76	26,00	26,00	17,00	11,11	0,00	2,85	2,91	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
107	Comair	22,38	16,10	16,10	9,02	7,14	0,00	1,05	0,00	4,00	7,31	0,00	0,00	0,00	0,00	1,83	5,00
108	Seardel Investment	22,19	44,30	44,30	9,00	0,00	0,00	0,45	12,74	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
109	ARB Holdings	21,78	19,24	19,24	5,39	9,25	0,00	0,56	2,88	0,36	0,73	51,80	12,00	0,04	0,20	0,01	0,03
110	Matodzi Resources	21,51	23,10	23,10	12,94	42,86	50,00	8,57	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
111	AVI	21,02	17,80	17,80	10,97	18,18	0,00	1,09	2,76	0,60	1,20	0,00	0,00	0,00	0,00	1,19	5,00
112	Mvela Resources	21,00	51,00	42,00	15,00	53,57	50,00	6,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
113	Mr Price Group	20,90	0,80	1,90	8,00	0,00	0,00	0,50	5,80	1,90	2,80	0,00	0,00	0,20	0,00	0,00	3,60
114	Anglo Platinum	20,75	6,00	6,00	4,36	21,43	7,14	2,20	1,66	1,39	2,87	25,40	6,56	0,17	0,84	0,45	2,26
115	Afgri	19,82	26,77	26,77	17,00	19,23	16,67	2,82	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
116	Spur Corporation	19,60	0,00	0,00	0,00	0,00	0,00	0,00	1,80	0,00	1,00	32,08	11,80	0,00	0,00	1,00	5,00
117	Astral Foods	19,10	1,20	1,20	0,98	20,00	0,00	1,65	1,84	0,97	2,50	9,26	2,66	1,83	9,16	0,04	0,20



118	Wesizwe Platinum	18,83	45,60	45,60	15,00	50,00	0,00	3,83	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
119	Pamodzi Gold	18,67	50,17	50,17	15,00	44,44	0,00	3,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
120	Aflease Gold	17,88	30,00	30,00	16,00	31,25	0,00	1,88	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
121	Astrapak	17,40	20,00	20,00	11,20	20,00	0,00	1,20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,21	5,00
122	Central Rand Gold	17,38	26,00	26,00	17,00	6,25	0,00	0,38	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
123	DigiCore Holdings	17,17	30,00	30,00	7,00	16,67	0,00	1,00	0,00	0,00	0,00	0,00	0,00	0,83	4,17	9,11	5,00
124	Wits Gold Resources	17,13	37,00	37,00	15,00	18,75	0,00	2,13	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
125	SA Coal Mining*	17,00	65,00	65,00	17,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
126	ConvergeNet Holdings	16,95	30,00	30,00	15,00	20,83	7,14	1,95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
127	Cullinan Holdings	16,93	2,54	2,54	1,42	6,25	0,00	0,79	4,93	0,16	0,80	31,20	7,49	0,00	0,00	0,30	1,50
128	Highveld Steel	16,81	0,00	0,00	0,00	11,76	0,00	1,94	1,98	1,37	7,54	18,00	4,32	0,00	0,00	0,21	1,03
129	Simmers & Jack	16,13	48,08	48,08	15,00	18,75	0,00	1,13	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
130	Set Point Technology	16,00	25,00	25,00	15,00	6,25	0,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
131	Datatec	15,69	45,00	45,00	15,00	5,56	0,00	0,69	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
132	Murray & Roberts	15,64	22,30	22,30	12,51	28,57	0,00	3,13	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
133	Thabex Exploration	15,60	27,59	27,59	15,00	10,00	0,00	0,60	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
134	Peregrine Holdings	15,50	25,66	25,66	7,00	28,57	0,00	2,71	0,00	0,00	0,79	0,00	0,00	0,00	0,00	1,00	5,00
135	Sallies	15,50	30,00	30,00	15,00	8,33	0,00	0,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
136	Great Basin Gold	15,30	26,00	26,00	15,00	5,00	0,00	0,30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
137	First Uranium Corp	15,23	29,90	29,90	15,00	3,85	0,00	0,23	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
138	Tawana Resources •	15,00	26,00	26,00	15,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
139	Illovo Sugar	14,69	8,15	8,15	4,56	10,00	20,00	2,61	0,00	0,00	0,00	10,49	2,52	0,00	0,00	17,44	5,00
140	Capitec Bank	14,68	15,73	15,73	8,81	16,67	0,00	1,00	0,00	2,43	4,87	0,00	0,00	0,00	0,00	0,00	0,00
141	Hudaco Industries	14,67	15,00	15,00	8,40	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,25	6,27	0,00	0,00
142	Miranda Mineral	14,17	19,24	19,24	10,77	40,00	0,00	3,40	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
143	GVM Metals #	13,96	10,06	10,06	6,71	37,50	50,00	7,25	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
144	Hyprop Investments	13,55	0,00	0,00	0,00	9,09	0,00	1,55	0,00	0,00	0,00	50,00	12,00	0,00	0,00	0,00	0,00
145	Tourism Investment	13,00	12,60	12,60	7,06	40,00	16,67	5,94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
146	Bell Equipment	12,80	22,50	22,50	12,60	3,33	0,00	0,20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
147	Assore	11,49	18,07	18,07	11,12	6,25	0,00	0,38	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
148	Brait SA	11,35	33,89	33,89	9,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,47	2,35
149	Invicta Holdings	11,20	20,00	20,00	11,20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
150	Palabora Mining †	10,83	0,00	0,00	0,00	18,75	0,00	3,38	0,00	0,73	7,46	0,00	0,00	0,00	0,00	0,00	0,00
151	Emira Property Fund	10,55	14,20	14,20	9,35	20,00	0,00	1,20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
152	Hospitality Property	10,17	30,40	30,40	7,00	27,78	12,50	3,17	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
153	Diamond Core	10,08	18,00	18,00	10,08	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
154	Sentula Mining	9,69	17,30	17,30	9,69	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
155	Square One Solutions	9,33	56,40	56,40	7,00	38,89	0,00	2,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00



156	Metair Investments	9,23	14,70	14,70	9,23	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
157	Combined Motor	9,08	40,00	40,00	7,00	6,25	0,00	0,38	1,70	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
158	Spescom	8,26	32,22	32,22	7,00	7,14	0,00	1,26	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
159	Shoprite Holdings	8,11	0,00	0,00	0,00	5,88	5,00	0,91	0,00	0,00	0,00	30,00	7,20	0,00	0,00	0,00	0,00
160	The Spar Group	8,00	0,00	0,00	0,00	25,00	0,00	3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3,25	5,00
161	Kairos Industrial	7,70	10,00	10,00	5,60	10,00	16,67	2,10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
162	Vukile Property Fund	7,67	25,00	25,00	7,00	11,11	0,00	0,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
163	UCS Group	7,60	25,10	25,10	7,00	10,00	0,00	0,60	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
164	Excellerate Holdings	7,30	25,00	25,00	7,00	5,00	0,00	0,30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
165	Avusa ‡	6,62	0,00	0,00	0,00	36,36	25,00	6,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,11	0,56
166	Acucap Properties	6,35	10,00	10,00	5,60	5,56	0,00	0,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
167	Siyathenga Property	5,70	15,00	15,00	4,20	11,11	0,00	1,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
168	SA Corp Real Estate	5,68	10,00	10,00	2,80	31,25	0,00	2,88	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
169	Verimark Holdings	5,55	10,00	10,00	3,80	12,50	0,00	1,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
170	Resilient Property	4,14	7,10	7,10	1,99	19,23	0,00	2,15	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
171	Command Holdings	4,00	0,00	0,00	0,00	50,00	25,00	4,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
172	Howden Africa	3,93	3,90	3,90	2,18	12,50	0,00	1,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
173	African Media Ent	3,00	0,00	0,00	0,00	50,00	0,00	3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
174	Basil Read Holdings	2,71	0,00	0,00	0,00	28,57	0,00	2,71	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
175	Kap International	2,67	0,00	0,00	0,00	27,78	0,00	2,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
176	Sabvest	2,13	0,00	0,00	0,00	18,75	0,00	2,13	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
177	Diversified Property	2,07	0,00	0,00	0,00	17,86	7,14	2,07	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
178	Capital Property Fund	1,63	0,00	0,00	0,00	16,67	0,00	1,63	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
179	Nu-World Holdings	1,60	0,00	0,00	0,00	10,00	0,00	1,60	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
180	Crookes Brothers	1,56	0,00	0,00	0,00	11,11	0,00	1,56	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
181	Ceramic Industries	1,56	0,00	0,00	0,00	6,25	0,00	1,56	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
182	Afrimat	1,50	0,00	0,00	0,00	25,00	0,00	1,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
183	Micromega Holdings	1,47	0,00	0,00	0,00	15,00	14,29	1,47	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
184	IFA Resorts & Hotels	1,10	0,00	0,00	0,00	7,14	16,67	1,10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
185	Mercantile Bank	1,00	0,00	0,00	0,00	6,25	0,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
186	Caxton & CTP	0,60	0,00	0,00	0,00	10,00	0,00	0,60	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
187	AECI	0,43	0,00	0,00	0,00	7,14	0,00	0,43	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
188	Distribution & Ware	0,43	0,00	0,00	0,00	7,14	0,00	0,43	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

▣ = Recently listed, waiting for submission.

\* = Recently listed after restructuring.

# = now called Coal of Africa. □ = Australian company. † = 72% owned by Rio Tinto. ‡ = Johnnic Communications.

Source: Empowerdex



### 15.3 Comparison of Fair-Values of Different Structures

Structure nr	Spot	Strike	Term	Interest Rate	Volatility	Dividend Yield	Interest on strike	Interest on Divs	Option Value	Share Pays Divs	Option holder gets the benefit of divs	Strike accrues interest	Subtract divs from strike	Divs accrue interest
1	100	100	6	7.5%	30.0%	0.0%	0.0%	0.0%	<b>45.59</b>	No	No	No	No	No
2	100	100	6	7.5%	30.0%	0.0%	9.0%	0.0%	<b>25.53</b>	No	No	Yes	No	No
3	100	100	6	7.5%	30.0%	3.0%	0.0%	0.0%	<b>32.33</b>	Yes	No	No	No	No
4	100	100	6	7.5%	30.0%	3.0%	9.0%	0.0%	<b>16.46</b>	Yes	No	Yes	No	No
5	100	100	6	7.5%	30.0%	3.0%	9.0%	8.0%	<b>22.66</b>	Yes	Yes	Yes	Yes	No
6	100	100	6	7.5%	30.0%	3.0%	9.0%	0.0%	<b>40.18</b>	Yes	Yes	No	Yes	No
7	100	100	6	7.5%	30.0%	3.0%	0.0%	8.0%	<b>22.66</b>	Yes	Yes	Yes	No	Yes
8	100	100	6	7.5%	30.0%	3.0%	0.0%	0.0%	<b>40.18</b>	Yes	Yes	No	No	Yes

## 15.4 Comparison of Exercise Related Assumptions

Option #	Model	Spot	Strike	Term	Vesting Period	Interest Rate	Volatility	Dividend Yield	Steps	Exercise Multiple	Expected Life	Exit Rate	Sub-Optimal Exercise Rate	Option Value
A	Black Scholes	100	100	6		7.5%	30.0%	3.0%						<b>32.33</b>
B	Black Scholes	100	100	6		7.5%	30.0%	3.0%			3			<b>23.90</b>
C	Biniomial Tree – European	100	100	6		7.5%	30.0%	3.0%	1000					<b>32.33</b>
D	Biniomial Tree – American	100	100	6	3	7.5%	30.0%	3.0%	1000					<b>32.75</b>
E.1	Biniomial Tree / American / Vesting	100	100	6	3	7.5%	30.0%	3.0%	1000	5000		0		<b>32.32</b>
E.2	Biniomial Tree / American / Vesting / Exercise Multiple	100	100	6	3	7.5%	30.0%	3.0%	1000	1.3		0		<b>28.25</b>
E.3	Biniomial Tree / American / Vesting / Exercise Multiple	100	100	6	3	7.5%	30.0%	3.0%	1000	1.5		0		<b>29.97</b>
E.4	Biniomial Tree / American / Vesting / Exercise Multiple	100	100	6	3	7.5%	30.0%	3.0%	1000	5		0		<b>32.53</b>
F	Biniomial Tree / American / Vesting / Exercise Multiple	100	100	6	3	7.5%	30.0%	3.0%	1000	5000		0%	10%	<b>31.33</b>
G*	MC / Expected Life, Index Linked strike	100	100	6	3	7.5%	30.0%	3.0%	1	1.5	6			<b>12.49</b>
H**	3D -Binomial Tree	100	14.71	6	3	7.5%	30.0%	3.0%	1000	1.5	6	-	-	<b>18.69</b>

### 15.5 South Africa's Wealth Distribution by Race

Race	Population	Income	Expenditure	Income per capita (R/pm)	Expenditure per capita (R/pm)
African	79.30%	43.50%	41.80%	934	775
Coloured	8.90%	8.60%	9.90%	1657	1633
Asian / Indian	2.60%	7.60%	7.40%	5057	4239
White	9.20%	40.30%	40.90%	7461	6572
Overall	100%	100%	100%	1705	1479

## 15.6 Comparison of BEE Deals at Inception

Company	MTN Asonge	MTN Zakhele	SASOL				Standard Bank	Murray & Roberts	Anglo Platinum	AngloGold Ashanti	ABSA
			Cash option	Funded option – 1st 99	Funded option – Thereafter	Combined					
Valuation Date	01-Aug-07	31-Aug-2010	02-Jun-08	02-Jun-08	02-Jun-08		01-Oct-04	01-Aug-05	11-Jun-08	02-Oct-06	01-Apr-04
Spot Price	R 98.80	R 116.50	R 465.00	R 465.00	R 465.00		R 51.00	R 15.99	R 1,317.00	R 296.90	R 45.00
Strike on Valuation Date	R 79.61	66.43	R 366.00	R 446.70	R 428.40		R 40.50	R 14.87	R 790.20	R 200.41	formula
Vesting period	1	3					14	10	5,6,7	3, 4, 5, 6 & 7	3
Maturity	-	3	10	10	10		20	10	7	7	5
Risk free rate to maturity	-	6.1%	-	10.16%	10.16%		8.19%	8.71%	9.38%	8.84%	11.17%
Volatility		45.3%		39.3%	39.3%		31.7%	42.5%	30.3%	39.4%	34.9%
Dividend Yield	0.61%	1.47%	3.94%	3.94%	3.94%		3.29%	4.17%	4.09%	4.26%	4.12%
Interest on Strike		8.7	0%	0%	0%		8.50%	63.1% of 11%	0%	7%	72% of 11.5%
Option fair-value	R 108.68	R 46.89	R 465.00	R 241.92	R 245.96		R 14.40	R 7.53	R 811.58	R 153.06	R 10.12
Cost of option	R 79.61	R 20.00	R 366.00	R 18.30	R 26.60		R 0.00	R 0.00	R 0.00	R 0.00	R 0.00
Net value of option	R 29.07	R 26.89	R 99.00	R 223.62	R 219.36	R 196.14	R 14.40	R 7.53	R 811.58	R 153.06	R 10.12
Option value as % spot	29%	23%	21%	48%	47%	42%	28%	47%	62%	52%	22%
Number of shares	11,700,000	80,900,000	12,620,000*	12,620,000*	37,860,000*	63,100,000	100,500,000	33,200,000	3,947,310	3,714,360	73,200,000
% of issued shares in deal	6.0%	4%	2.0%	2.0%	6.0%	10.0%		10.0%	1.5%	1.0%	10.2%
# of issued shares	195,000,000	1,883,076,857	13,362,200	13,362,200	40,086,600	668,110,000	1,560,507,000	331,893,000	263,154,000	362,614,000	718,210,000
Market Capitalisation (bil)	R 19.27	R 219,4	R 6.21	R 6.21	R 18.64	R 310.67	R 79.59	R 5.31	R 346.57	R 107.66	R 32.32
Total value of deal (bil)	R 0.34	R 2.2	R 5.87	R 3.05	R 9.31	R 12.38	R 1.45	R 0.25	R 3.20	R 0.57	R 0.74
% of market cap	1.77%	0.99%				3.98%	1.818%	4.710%	0.924%	0.528%	2.292%

\*The distribution between the different options for the Sasol scheme is unknown and is assumed to be 25%:25%:50% for cash:1<sup>st</sup> funded:2<sup>nd</sup> funded

## 15.7 Comparison of the Impact of the Share Cover Ratio

	<b>SR =1</b>	<b>SR = 1.5</b>	<b>SR = 1.92</b>
<b>Share price</b>	R 30.00	R 30.00	R 30.00
<b>Value of debt</b>	R 300,000,000	R 200,000,000	R 155,850,000
<b>Value of shares</b>	R 300,000,000	R 300,000,000	R 300,000,000
<b>Share cover ratio</b>	1.0	1.5	1.92
<b>Number of shares</b>	10,000,000	10,000,000	10,000,000
<b>Volatility</b>	35%	35%	35%
<b>Monthly average daily traded volume</b>	1,000,000	1,000,000	1,000,000
<b>% of average volume that can be traded</b>	25%	25%	25%
<b>Minimum # of days needed to liquidate</b>	40	40	40
<b>Share price minimum level</b>	7	7	7
<b>Interest rate</b>	10%	10%	10%
<b>Confidence interval</b>	95%	95%	95%
<b>Loss ratio</b>	48%	22%	0.00%

## 16 Programming Code

Visual Basic code used in the calculations and simulation to price the call options, are contained in this section

### 16.1 Black-Scholes

This code is used to determine the value of a simple call option using the Black-Scholes model and the primary option inputs.

```
Function EuropeanCall(Spot, Strike, Volatility, T, RF, q)
d1 = (Log(Spot / Strike) + ((RF - q) + (Volatility ^ 2) / 2) * T) / (Volatility * Sqr(T))
d2 = d1 - Volatility * Sqr(T)
Nd1 = Application.WorksheetFunction.NormSDist(d1)
Nd2 = Application.WorksheetFunction.NormSDist(d2)
EuropeanCall = Spot * Exp(-q * T) * Nd1 - Strike * Nd2 * Exp(-RF * T)
End Function
```

### 16.2 Binomial Model

This code is used to determine the value of a call option with the Binomial tree model while adding factors that simulate the exercise behaviour of the option holder.

```
Function ESOExerciseMult(S, K, T, vesttime, exiratereprevest, exiraterepostvest, exercisemultiple, SIG, r, q, n)
' This calculates the option value using the Enhanced FASB 123 procedures
Dim v(), timetoex()
Dim dt, u, d, a, p, price, exitval, var1, var2, pd, pu, pm, disc
Dim i, j, nval, ii, jj, IsInterp As Boolean
Dim ExMult1, ExMult2, ExMult_in, t1, t2, v1, v2
' This calculates the expected time to exercise conditional on vesting
' using the Enhanced FASB 123 model.
' This is similar to the model suggested in FASB 123 to estimate expected life
ReDim v(2 * n), timetoex(2 * n)
' Adjustment for continuous compounding
exiraterepostvest = Log(1 + exiraterepostvest)
' Calculate pu, pm, and pd for trinomial tree model
dt = T / n
nval = Int((Log(K * exercisemultiple) - Log(S)) / (SIG * Sqr(3 * dt)) + 0.5)
var1 = Log(K * exercisemultiple) - Log(S) - SIG * Sqr(dt)
IsInterp = False
If var1 <= 0# Then
IsInterp = True
var2 = (S / K) * Exp(SIG * Sqr(dt))
ExMult1 = 1#
ExMult2 = var2
ExMult_in = exercisemultiple
jj = 2
Else
ExMult1 = exercisemultiple
jj = 1
End If
For ii = 1 To jj
If ii = 1 Then
exercisemultiple = ExMult1
Else
exercisemultiple = ExMult2
```



```
End If
nval = Int((Log(K * exercisemultiple) - Log(S)) / (SIG * Sqr(3 * dt)) + 0.5)
If nval > 0 Then
    u = Exp((Log(K * exercisemultiple) - Log(S)) / nval)
Else
    u = Exp(SIG * Sqr(3 * dt))
End If
d = 1 / u
var1 = Exp((r - q) * dt)
var2 = Exp(2 * (r - q) * dt) + SIG * SIG * dt
disc = Exp(-r * dt)
pd = ((var1 - 1) * (u + 1) - var2 + 1) / ((u + 1) * (d - 1) - d * d + 1)
pu = ((var1 - 1) * (d + 1) - var2 + 1) / ((d + 1) * (u - 1) - u * u + 1)
pm = 1 - pu - pd
'Carry out rest of calculations for trinomial model
For i = 0 To 2 * n
    price = S * u ^ (i - n)
    v(i) = Application.Max(price - K, 0#)
    timetoex(i) = 0
Next i
For j = n - 1 To 0 Step -1
    For i = 0 To 2 * j
        If j * dt > vesttime - 0.001 Then ' if the ESO has vested
            price = S * u ^ (i - j)
            exitval = Application.Max(price - K, 0#) 'exitval is the intrinsic
            v(i) = (pu * v(i + 2) + pm * v(i + 1) + pd * v(i)) * disc
            timetoex(i) = (pu * timetoex(i + 2) + pm * timetoex(i + 1) + pd * timetoex(i) + dt) * (1 - exiraterepostvest *
dt)

            If price > exercisemultiple * K - 0.001 Then
                v(i) = exitval
                timetoex(i) = 0
            End If
            v(i) = exiraterepostvest * dt * exitval + (1 - exiraterepostvest * dt) * v(i)
        Else
            v(i) = (pu * v(i + 2) + pm * v(i + 1) + pd * v(i)) * disc
            timetoex(i) = (pu * timetoex(i + 2) + pm * timetoex(i + 1) + pd * timetoex(i)) + dt
        End If
    Next i
Next j
If ii = 1 Then
    t1 = timetoex(0)
    v1 = v(0) * (1 - exiratereprevest) ^ vesttime
Else
    t2 = timetoex(0)
    v2 = v(0) * (1 - exiratereprevest) ^ vesttime
End If
Next ii
If IsInterp Then
    t1 = t1 + (t2 - t1) * (ExMult_in - ExMult1) / (ExMult2 - ExMult1)
    v1 = v1 + (v2 - v1) * (ExMult_in - ExMult1) / (ExMult2 - ExMult1)
End If
ESOExerciseMult = v1
End Function
```

## 16.3 Monte Carlo Simulation

This code is used to determine the value of a call option with the Monte Carlo Simulation model in which the pay-off under different share price paths is determined.

```
Private Sub BinTree_Click()
Worksheets("Inputs").Range(Worksheets("Inputs").Cells(26, 2), Worksheets("Inputs").Cells(29, 2)).Select
Selection.ClearContents
Worksheets("Inputs").Cells(27, 1).Value = "Calculating..."
Application.ScreenUpdating = False
Dim S0 As Double, K, T, RF, sig, q, n, Random, df, CurrentDividends, CumDivs
Dim dt As Double, u, d, a, p, disc, g, S, i, j, Checker, ValuationDate, InceptionDate, ExerciseDate
Dim CallValue As Double, CallSum, CurrentStrike, NumberOfShares, FinalStrike, PVPayOffatMaturity
Dim Strike As Double, AveForwardValue, SumForwardValu, AveFinalStrike, SumFinalStrike
Dim Row As Boolean, CheckDivs
Dim steps As Integer, C, PlaceMarker, DivStartRow, DivEndRow, NumberOfDivLines, DivNumber, StrikesLessThanZero
Dim FinalSharePrice As Double, FinalDivs
Dim UpperDate As Date, LowerDate
Dim DividendDates() As Double, BonusValue
Dim eps As Double, drift, StepTerm
S0 = Worksheets("Inputs").Cells(8, 2).Value
K = Worksheets("Inputs").Cells(9, 2).Value
ValuationDate = Worksheets("Inputs").Cells(2, 2).Value
InceptionDate = Worksheets("Inputs").Cells(3, 2).Value
ExerciseDate = Worksheets("Inputs").Cells(4, 2).Value
RF = Worksheets("Inputs").Cells(12, 2).Value
sig = Worksheets("Inputs").Cells(13, 2).Value
q = Worksheets("Inputs").Cells(14, 2).Value
n = Worksheets("Inputs").Cells(18, 2).Value
iter = Worksheets("Inputs").Cells(17, 2).Value
NumberOfShares = Worksheets("Inputs").Cells(10, 2).Value
InterestOnDebt = Worksheets("Inputs").Cells(15, 2).Value
DivStartRow = Worksheets("Inputs").Cells(4, 11).Value
DivEndRow = Worksheets("Inputs").Cells(5, 11).Value
NumberOfDivLines = Worksheets("Inputs").Cells(5, 14).Value
'write all the dividends to an array
ReDim DividendDates(NumberOfDivLines)
For j = 1 To NumberOfDivLines
    DividendDates(j) = Worksheets("Inputs").Cells(DivStartRow + j - 1, 13).Value
    'Worksheets("Test").Cells(3 + j, 9).Value = DividendDates(j)
Next j
PlaceMarker = 3
Row = False
While Row = False
    Checker = Worksheets("Output").Cells(PlaceMarker, 1).Value
    If Checker = "" Then
        Row = True
    ElseIf Checker <> "" Then
        PlaceMarker = PlaceMarker + 1
    End If
Wend
Worksheets("Output").Activate
Worksheets("Output").Cells(PlaceMarker, 1).Value = PlaceMarker - 2
'write Start time to Output file
Worksheets("Output").Cells(PlaceMarker, 2).Select
ActiveCell.FormulaR1C1 = "=NOW()"
Worksheets("Output").Cells(PlaceMarker, 2).Select
Selection.Copy
Worksheets("Output").Cells(PlaceMarker, 2).Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= False, Transpose:=False
Worksheets("Inputs").Activate
Worksheets("Inputs").Cells(28, 2).Select
Application.ScreenUpdating = True
```





```
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
    False, Transpose:=False
Application.ScreenUpdating = False
Application.CutCopyMode = False
    T = (ExerciseDate - ValuationDate) / 365.25
    df = Exp(-RF * T)
    drift = (RF - (sig ^ 2) / 2)
    steps = n
    CallSum = 0
    SumForwardValue = 0
    SumFinalStrike = 0
    StrikesLessThanZero = 0
For i = 1 To iter
    S = S0
    Strike = K
    DivNumber = 1
    BonusValue = 0
    CumDivs = 0
    CheckDivs = True
    For j = 1 To NumberofDivLines
        StepTerm = DividendDates(j)
        Randomize
        Random = Rnd
        eps = WorksheetFunction.NormSInv(Random) 'random epsilon
        S = S * Exp((drift * StepTerm + (sig * eps * Sqr(StepTerm)))) 'werk vir S uit
        CurrentDividends = S * (Exp(q * StepTerm) - 1) 'semi-annual dividends
        S = S - CurrentDividends
        If Strike > 0 Then
            Strike = Strike * Exp(InterestOnDebt * StepTerm) - CurrentDividends
        ElseIf Strike < 0 Then
            BonusValue = (Strike * Exp(InterestOnDebt * StepTerm) - CurrentDividends) * -1
            Strike = 0
        Else
            BonusValue = BonusValue * Exp(RF * StepTerm) + CurrentDividends
        End If
    Next j
    FinalSharePrice = S
    FinalStrike = Strike
    If FinalStrike < 0 Then
        StrikesLessThanZero = StrikesLessThanZero + 1
    End If
    PVPayOffatMaturity = (IIf(FinalSharePrice - FinalStrike > 0, FinalSharePrice - FinalStrike, 0) + BonusValue) * df
    CallSum = CallSum + PVPayOffatMaturity
    SumForwardValue = SumForwardValue + FinalSharePrice
    SumFinalStrike = SumFinalStrike + FinalStrike
Next i
CallValue = CallSum / iter
AveForwardValue = SumForwardValue / iter
AveFinalStrike = SumFinalStrike / iter
'write to Output file
Worksheets("Output").Activate
'write End time to Output file
Worksheets("Output").Cells(PlaceMarker, 3).Select
ActiveCell.FormulaR1C1 = "=NOW()"
Worksheets("Output").Cells(PlaceMarker, 3).Select
Selection.Copy
Worksheets("Output").Cells(PlaceMarker, 3).Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= False, Transpose:=False
Worksheets("Inputs").Activate
Worksheets("Inputs").Cells(29, 2).Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= False, Transpose:=False
Worksheets("Inputs").Cells(30, 2).Value = Worksheets("Inputs").Cells(29, 2).Value - Worksheets("Inputs").Cells(28, 2).Value
Worksheets("Output").Activate
Application.CutCopyMode = False
```



```
Worksheets("Output").Cells(PlaceMarker, 4).Value = Worksheets("Output").Cells(PlaceMarker, 3).Value -  
Worksheets("Output").Cells(PlaceMarker, 2).Value  
Worksheets("Output").Cells(PlaceMarker, 5).Value = ValuationDate  
Worksheets("Output").Cells(PlaceMarker, 6).Value = InceptionDate  
Worksheets("Output").Cells(PlaceMarker, 7).Value = ExercisedDate  
Worksheets("Output").Cells(PlaceMarker, 8).Value = Worksheets("Inputs").Cells(4, 3).Value  
Worksheets("Output").Cells(PlaceMarker, 9).Value = NumberOfShares  
Worksheets("Output").Cells(PlaceMarker, 10).Value = NumberOfShares * K  
Worksheets("Output").Cells(PlaceMarker, 11).Value = S0  
Worksheets("Output").Cells(PlaceMarker, 12).Value = K  
Worksheets("Output").Cells(PlaceMarker, 13).Value = RF  
Worksheets("Output").Cells(PlaceMarker, 14).Value = sig  
Worksheets("Output").Cells(PlaceMarker, 15).Value = q  
Worksheets("Output").Cells(PlaceMarker, 16).Value = iter  
Worksheets("Output").Cells(PlaceMarker, 17).Value = n  
Worksheets("Output").Cells(PlaceMarker, 18).Value = CallValue  
Worksheets("Output").Cells(PlaceMarker, 19).Value = AveFinalStrike  
Worksheets("Output").Cells(PlaceMarker, 20).Value = AveForwardValue  
Worksheets("Output").Cells(PlaceMarker, 21).Value = StrikesLessThanZero  
Worksheets("Output").Cells(PlaceMarker, 24).Value = CallValue * NumberOfShares  
Worksheets("Inputs").Activate  
Application.ScreenUpdating = True  
Worksheets("Inputs").Cells(27, 1).Value = "System Ready"  
End Sub
```

## 16.4 Finite Difference

This code is used to determine the value of a call option with the Finite Difference model while incorporating the exercise multiple of the option holder.

```
Function CrankNicholsonFiniteDifAmCall_Vest_SubOptimalRate(Smax, S, M, dS, T, N, dt, X, sig, R, theta, SubOptimalExerciserRate,
Vestingperiod)
Dim j As Integer, i
Dim ZeroSpotValue As Double, MaxSpotValue, OptionValue, Spot
ZeroSpotValue = X
MaxSpotValue = 0
ReDim ABC(0 To M, 1 To 3) As Double
ReDim XYZ(0 To M, 1 To 3) As Double
ReDim ABC_Not_Vested(0 To M, 1 To 3) As Double
ReDim XYZ_Not_Vested(0 To M, 1 To 3) As Double
For j = 0 To M
    A = -0.5 * theta * (sig ^ 2 * j ^ 2 - R * j) * dt
    B = 1 + theta * (sig ^ 2 * j ^ 2 + (R + SubOptimalExerciserRate)) * dt
    C = -0.5 * theta * (sig ^ 2 * j ^ 2 + R * j) * dt
    ABC(j, 1) = A
    ABC(j, 2) = B
    ABC(j, 3) = C
    XYZ(j, 1) = 0.5 * (1 - theta) * (sig ^ 2 * j ^ 2 - R * j) * dt 'X
    XYZ(j, 2) = 1 - (1 - theta) * (sig ^ 2 * j ^ 2 + (R + SubOptimalExerciserRate)) * dt
    XYZ(j, 3) = 0.5 * (1 - theta) * (sig ^ 2 * j ^ 2 + R * j) * dt
    'For non-vested node, the suboptimal exercise rate is zero
    ABC_Not_Vested(j, 1) = A
    ABC_Not_Vested(j, 2) = 1 + theta * (sig ^ 2 * j ^ 2 + (R + 0)) * dt
    ABC_Not_Vested(j, 3) = C
    XYZ_Not_Vested(j, 1) = XYZ(j, 1)
    XYZ_Not_Vested(j, 2) = 1 - (1 - theta) * (sig ^ 2 * j ^ 2 + (R + 0)) * dt
    XYZ_Not_Vested(j, 3) = XYZ(j, 3)
Next j
'Construct Matrix A and B
ReDim MatrixA(0 To M, 0 To M)
ReDim InvMatrixA(1 To M - 1, 1 To M - 1)
ReDim MatrixB(0 To M, 0 To M)
For j = 0 To M
    For i = 0 To M
        MatrixA(i, j) = 0
        MatrixB(i, j) = 0
    Next i
Next j
For j = 1 To M - 1
    MatrixA(j, j - 1) = ABC(j, 1)
    MatrixA(j, j) = ABC(j, 2)
    MatrixA(j, j + 1) = ABC(j, 3)
    MatrixB(j, j - 1) = XYZ(j, 1)
    MatrixB(j, j) = XYZ(j, 2)
    MatrixB(j, j + 1) = XYZ(j, 3)
Next j
'Construct Matrix A and B for unvested periods
ReDim MatrixA_Unvested(0 To M, 0 To M)
ReDim InvMatrixA_Unvested(1 To M - 1, 1 To M - 1)
ReDim MatrixB_Unvested(0 To M, 0 To M)
For j = 0 To M
    For i = 0 To M
        MatrixA_Unvested(i, j) = 0
        MatrixB_Unvested(i, j) = 0
    Next i
Next j
For j = 1 To M - 1
```



```
MatrixA_Unvested(j, j - 1) = ABC_Not_Vested(j, 1)
MatrixA_Unvested(j, j) = ABC_Not_Vested(j, 2)
MatrixA_Unvested(j, j + 1) = ABC_Not_Vested(j, 3)
MatrixB_Unvested(j, j - 1) = XYZ_Not_Vested(j, 1)
MatrixB_Unvested(j, j) = XYZ_Not_Vested(j, 2)
MatrixB_Unvested(j, j + 1) = XYZ_Not_Vested(j, 3)
Next j
ReDim MInverseOfMatrixA(1 To M - 1, 1 To M - 1)
ReDim MInverseOfMatrixA_Unvested(1 To M - 1, 1 To M - 1)
ReDim aSpot(0 To M, 1 To 1)
For j = 1 To M - 1
    For i = 1 To M - 1
        MInverseOfMatrixA(i, j) = MatrixA(i, j)
        MInverseOfMatrixA_Unvested(i, j) = MatrixA_Unvested(i, j)
    Next i
Next j
MInverseOfMatrixA = Application.WorksheetFunction.MInverse(MInverseOfMatrixA)
MInverseOfMatrixA_Unvested = Application.WorksheetFunction.MInverse(MInverseOfMatrixA_Unvested)
ReDim PayoffArray(0 To M, 1 To 1)
For j = 0 To M
    Spot = j * dS
    OptionValue = IIf(Spot < X, 0, Spot - X)
    PayoffArray(j, 1) = OptionValue
    aSpot(j, 1) = Spot
Next j
ReDim MaxOfIntrinsic(0 To M, 1 To 1)
ReDim V_prior(0 To M, 1 To 1)
ReDim V_new(0 To M, 1 To 1)
ReDim ExplicitProduct(0 To M, 1 To 1)
ReDim ExplicitProduct2(0 To M, 1 To 1)
ReDim V_new_short(1 To M - 1, 1 To 1)
ReDim ExplicitProduct_short(1 To M - 1, 1 To 1)
ReDim EffectiveMatrixB(0 To M, 0 To M)
ReDim EffectiveMInverseOfMatrixAREDim(1 To M - 1, 1 To M - 1)
Dim TimePeriod As Double, EffectiveSubOptimalExerciserRate
V_prior = PayoffArray
For i = N To 1 Step -1
    TimePeriod = i * dt
    If TimePeriod >= Vestingperiod Then
        EffectiveSubOptimalExerciserRate = SubOptimalExerciserRate
        EffectiveMatrixB = MatrixB
    Else
        EffectiveSubOptimalExerciserRate = 0
        EffectiveMatrixB = MatrixB_Unvested
    End If
    ExplicitProduct = Application.WorksheetFunction.MMult(EffectiveMatrixB, V_prior)
    For j = 1 To M + 1
        ExplicitProduct2(j - 1, 1) = ExplicitProduct(j, 1)
    Next j
    For j = 0 To M
        ExplicitProduct2(j, 1) = ExplicitProduct2(j, 1) - EffectiveSubOptimalExerciserRate * PayoffArray(j, 1) * dt
    Next j
    For j = 1 To M - 1
        ExplicitProduct_short(j, 1) = ExplicitProduct2(j, 1)
    Next j
    If (TimePeriod - dt) >= Vestingperiod Then 'since Matrix A is being used 1 time step earlier
        EffectiveMInverseOfMatrixA = MInverseOfMatrixA
    Else
        EffectiveMInverseOfMatrixA = MInverseOfMatrixA_Unvested
    End If
    V_new_short = Application.WorksheetFunction.MMult(EffectiveMInverseOfMatrixA, ExplicitProduct_short)
    For j = 0 To M
        If j = 0 Or j = M Then
            V_new(j, 1) = PayoffArray(j, 1)
        Else
```



```
V_new(j, 1) = V_new_short(j, 1)
End If
Next j
For j = 0 To M
  If (TimePeriod - dt) >= Vestingperiod Then
    MaxOfIntrinsic(j, 1) = IIf(V_new(j, 1) > PayoffArray(j, 1), V_new(j, 1), PayoffArray(j, 1))
  Else
    MaxOfIntrinsic(j, 1) = V_new(j, 1)
  End If
Next j
V_prior = MaxOfIntrinsic
Next i
For j = 1 To M - 1
  If (aSpot(j, 1) + 0.5 * dS > S) And (aSpot(j, 1) - 0.5 * dS <= S) Then
    Position = j
  End If
Next j
FinalOptionValue = MaxOfIntrinsic(Position, 1)
CrankNicholsonFiniteDifAmCall_Vest_SubOptimalRate = FinalOptionValue
End Function
```



## 16.5 Upper Bound Approach

This code is used to determine the value of a call option with the Monte Carlo Simulation model in which the exercise behaviour of the holder is incorporated with the upper-bound approach.

```
Option Explicit
Private Sub BinTree_Click()
Dim S0 As Double, T, RF, SIG, q, h, Random, df, Ps, VestTerm, CumTerm, CumPayoff
Dim dt As Double, disc, S, i, j, Checker, teller
Dim CallValue As Double, CallSum, FinalStrike, PVPayOffatMaturity
Dim Strike As Double, ValuationDate, InceptionDate, ExerciseDate, VestingDate, MovingStrike
Dim steps As Integer, C, Counter, iter
Dim FinalSharePrice As Double, VestingTerm, CurrentTerm, dblRandomNumber
Dim eps1 As Double, drift, StepTerm, Term
Dim myRange As Range
' this macro determines the probability of exceeding the strike at various terms
Worksheets("Inputs").Cells(37, 3).Select
Range(Selection, ActiveCell.SpecialCells(xlLastCell)).Select
Selection.ClearContents
teller = 0
For MovingStrike = 5 To 200 Step 5
    teller = teller + 1
    Worksheets("Inputs").Cells(9, 2).Value = MovingStrike
    Worksheets("Inputs").Cells(21, 2).Value = ""
    Worksheets("Inputs").Cells(22, 2).Value = ""
    ValuationDate = Worksheets("Inputs").Cells(2, 2).Value
    InceptionDate = Worksheets("Inputs").Cells(3, 2).Value
    ExerciseDate = Worksheets("Inputs").Cells(4, 2).Value
    VestingDate = Worksheets("Inputs").Cells(5, 2).Value
    S0 = Worksheets("Inputs").Cells(8, 2).Value
    Strike = Worksheets("Inputs").Cells(9, 2).Value
    Ps = Worksheets("Inputs").Cells(10, 2).Value
    Term = Worksheets("Inputs").Cells(11, 2).Value
    RF = Worksheets("Inputs").Cells(12, 2).Value
    SIG = Worksheets("Inputs").Cells(13, 2).Value
    q = Worksheets("Inputs").Cells(14, 2).Value
    VestTerm = Worksheets("Inputs").Cells(15, 2).Value
    iter = Worksheets("Inputs").Cells(17, 2).Value
    steps = Worksheets("Inputs").Cells(18, 2).Value
    ' myRange = Worksheets("Inputs").Range(Worksheets("Inputs").Cells(22, 2), Worksheets("Inputs").Cells(23, 2)).Value
    T = (ExerciseDate - ValuationDate) / 365
    df = Exp(-RF * T)
    drift = RF - q - ((SIG ^ 2) / 2)
    StepTerm = T / steps
    VestingTerm = (VestingDate - ValuationDate) / 365
    CumTerm = 0
    CumPayoff = 0
    For j = 1 To iter
        S = S0
        For i = 1 To steps 'step through each day between VD and ED
            'generate a random number without using the worksheet function
            'The following four lines samples a random number from a N(0,1) distribution as in Hull
            dblRandomNumber = 0
            For Counter = 1 To 12
                dblRandomNumber = dblRandomNumber + Rnd()
            Next Counter
            dblRandomNumber = dblRandomNumber - 6
            S = S * Exp(((RF - q - ((SIG ^ 2) / 2)) * StepTerm + (SIG * dblRandomNumber * (Sqr(StepTerm))))) 'werk vir S uit
            CurrentTerm = i * StepTerm
            If CurrentTerm >= VestTerm Then
                If S >= Ps Then
                    i = steps
                End If
            End If
        Next i
    Next j
Next MovingStrike
Worksheets("Outputs").Cells(1, 2).Value = teller
End Sub
```



```
End If
Next i
CumTerm = CumTerm + CurrentTerm
CallValue = IIf(S - Strike > 0, S - Strike, 0)
CumPayoff = CumPayoff + CallValue * df
Next j
Worksheets("Inputs").Cells(21, 2).Value = CumTerm / iter
Worksheets("Inputs").Cells(22, 2).Value = CumPayoff / iter
'Results of this rounnd
Worksheets("Inputs").Cells(37, 2 + teller).Value = teller
Worksheets("Inputs").Cells(38, 2 + teller).Value = MovingStrike
Worksheets("Inputs").Cells(39, 2 + teller).Value = Ps
Worksheets("Inputs").Cells(40, 2 + teller).Value = Worksheets("Inputs").Cells(21, 2).Value
Worksheets("Inputs").Cells(41, 2 + teller).Value = Worksheets("Inputs").Cells(22, 2).Value
Worksheets("Inputs").Cells(42, 2 + teller).Value = Worksheets("Inputs").Cells(23, 2).Value
Next MovingStrike
End Sub
```

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