QUANTIFICATION OF THE DEFAULT PROBABILITY OF THE TOP 42 NON-FINANCIAL SOUTH AFRICAN FIRMS

by

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ABSTRACT

The focus of this dissertation is to quantify the probability of firm default focusing on the top 42 non-financial firms listed on the Johannesburg Stock Exchange. This paper follows the same methodology as outlined in the Moody's KMV white papers in implementing the Merton (1974) model. The model of default prediction builds upon option theory as pioneered by Black and Scholes and derives the probability of default predominately from the price and volatility of equity. In addition, BEE (Black Economic Empowerment) transactions currently being experienced within the South African corporate sector are further incorporated into the model. The results of this dissertation show that the Merton (1974) model may be used as a source of information of the underlying credit risk of publicly traded firms in South Africa.

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Introduction

All types of firms around the world are exposed to many different types of risks. These risks can be generally categorized as market, operational, liquidity, systemic and finally their associated credit risks. For banks and other lending institutions credit risk has always been the most subjective risk to measure since the first credit had been extended.

Credit risk can be defined as the risk of loss experienced due to the counterparty's failure to meet its obligations on a financial/non-financial contract or derivative transactions. Due to the wide range of counterparties (from individuals to firms and sovereign governments) and the many types of obligations (from consumer loans, bank loans, bonds to derivative transactions) credit risk can take on many different forms.

The first element of credit risk is the probability that such an event will occur; this event can be seen as the probability of default. In general, financial obligations require the service of interest and capital, and failure to service these obligations would constitute default.

In assessing credit risk with respect to firms, the focus of traditional credit analysis has been on fundamental accounting information, a general evaluation of the industrial environment, investment plans and balance sheet data. Management skills serve as a primary input for the assessment of the firm's likelihood of survival. This generally takes the form of whether the firm has the ability to generate sufficient cash flow to service its debt obligations over a certain time horizon, or over the life of the outstanding liabilities.

It is a well-known critique of this approach, that financial statement analysis may present a flawed picture of a firm's true financial condition and future prospects. Accounting principles are predominantly backward oriented and conservative in design. Moreover, accounting information does not include a precise concept of the future uncertainty and 'creative accounting' might even intend to disguise the firm's factual situation within certain legal limits. However, the adoption and implementation of International Financial Reporting Standards (IFRS) attempts to create a more transparent analysis regarding a firm's financial statements and thus the firm's financial circumstances.

However, prior to default, there is no sure way of identifying whether a firm would indeed default. Therefore, the purpose of traditional agency credit risk ratings is to categorize firms into various classes, each of which is homogenous in terms of its probability of default. These ratings thus provide an indication of the credit risk of the specific firm or obligor, but currently provide no quantification of the default probability within markets such as South Africa.

Historically default estimation is predominately tagged to the large corporate US listed debt market, and secondly the US market has in the past experienced actual defaults. These historical default rates provide a relatively robust, but aged dataset across many forms of firms and obligors thus enabling rating agencies in the US to assign a generic default probability per rating category.

The South African market presents a rather unique case with respect to default estimation. South African firms opt to obtain finance from banks and equity markets opposed to debt markets. The reason behind this is that the local corporate debt market is not only relatively new, but rather illiquid. Currently no firm has defaulted on their listed debt. Given this proposition, the effective probability of firm default is thus zero, however, this cannot be the case.

There currently exist a large number of methods used to assess the likelihood of firm default: the first formalized methods have been the scoring methods building on accounting and balance sheet data as pioneered by Altman and Ohlson in calculation of their Z and O scores respectively. Other, more recent methods, such as credit rating methods based on Value-at-Risk (VAR) such as 'CreditMetrics' or models built on macroeconomic variables such as 'CreditPortfolio View' have recently evolved.

The most popular and widespread method currently used today builds on the original Merton (1974) model. This model determines the default probability of an individual firm mainly from the market price and volatility of the firm's equity building on well-known option pricing theory as pioneered by Black and Scholes. The central idea of the Merton (1974) model to view the firm's equity as a call option on the firm's assets calculating an implied default probability from the value and volatility of the firm (inferred from the value and volatility of equity) in relation to a predetermined default barrier such as the face value of a zero-coupon bond or more practically the firm's total liabilities. This method of default estimation has become revolutionary within credit risk literature and is currently promoted by Moody's KMV [1] as a financial risk management product.

As the market for credit is currently expanding worldwide we can distinguish among certain key measures that are critical to the management of credit risk, however, none of these measures can be achieved without the most primary input - the default probability of the individual firm, making the probability the most important and subjective element to determine.

One factor to consider with firm default is the amount of money lost when such default occurs; this is generally referred to as the loss given default. This measure incorporates the fact that firm default can occur both with the first as well with the last repayment of the firm's obligations. Furthermore, as loss given default provides a measure of the monetary value lost due to default, migratory risk further incorporates the changes within the default probability and the associated value impact changes, and thus advances this measure to which is more commonly known as Value-at-Risk (VAR). A final element of effective credit risk management would be to incorporate default correlations, as these correlations consider the degree to which the default risks of individual borrowers or firms are related to each other.

It is important to bear in mind that credit risk of individual firms must be quantified and managed as a risk. The current trend is for all banks to contribute to an international body of knowledge to create a foundation for global banking best practice and to create

[1] Stephen Kealhofer, John McQuown and Oldrich Vasicek founded KMV in 1989. In 2002, KMV was acquired by Moody's and was renamed Moody's KMV.

a transparent methodology by which credit risks are effectively assessed and managed. The goal of all banks is to comply with the Capital Accord instituted by the Bank of International Settlements (BIS) in Basel, Switzerland [2].

The first Capital Accord as suggested by the BIS was first published in 1988 referred to as Basel I. Following on Basel I, the BIS released a new capital accord tilted Basel II which is scheduled to be adopted on 1 January 2008 [3]. The major difference between the two is that by quantifying the inherent risk of all firms and obligors from a credit risk point of view, banks would be able to change the amount of capital that is kept for reserve purposes and thus use this excess capital more productive means.

It should be noted that to comply with the BIS is not legally binding, and that complying with the Capital Accord has been suggested as 'global best banking practice'. However, in order to comply with the BIS, banks are required to manage their credit risk at both transaction level and portfolio level. One of the first steps that banks would need to take to adhere to the Basel II Capital Accord, is to implement one of the many model's for credit risk estimation, such as the implementation of the Merton (1974) model as discussed in this paper. The active calculation of default probabilities would enable banks to asses the underlying credit risk of each firm or obligor within their credit portfolios and adjust their capital reserves accordingly.

South African financial intuitions are currently implementing propriety credit risk models in order to comply with the Basel II Capital Accord. This research paper introduces the first formalised method of quantifying the probability of default by implementing the Merton (1974) model. The goal of this dissertation is to present a numerical analysis of the probability of default for the top 42 actively traded non-financial firms listed on the Johannesburg Stock Exchange.

The paper is structured as follows: The original Merton (1974) model assumptions and key inputs are presented. The paper then shows step for step how Merton adjusts the

[2] Basel Committee on Banking Supervision (2001) http://www.bis.org

[3] BIS (1996) – Amendment to the capital accord to incorporate market risks

Black and Scholes option pricing formula for a European call option to provide a measure of the default probability of an individual firm. The Merton (1974) model is further adjusted to incorporate asset-leakages, and a discussion is presented on how risk-neutral probabilities are transformed into 'real-world' probabilities by the inclusion of the asset-drift of the individual firm into the model. Furthermore, a brief history regarding Black Economic Empowerment (BEE) within South Africa is presented and shows how BEE will affect the model of default prediction. The methodology and assumptions made regarding the measurement and estimation procedures adopted for all the input variables used in the model is further presented.

The input variables are further separated in the model into a base-case and worst-case variable respectively. This scenario analysis enables the study to calculate the probability of firm default under current as well as severe market conditions and show's how the probabilities of default change with respect to changes in the input variables. Finally, a brief discussion of the Merton (1974) model is presented followed by a discussion on extensions of the Merton (1974) model by Moody's KMV.

The results section is outlined as follows: a brief discussion of the overall results is presented. The firms are subsequently ranked in terms of probability of default providing both the base-case as well as worst-case probability. Certain data outliers are discussed in detail with respect to the overall firm ranking. A further analysis is presented whereby the paper attempts to establish a relationship between the calculated default probabilities and firms that are currently rated by Moody's, Fitch and Standard and Poor. In Appendix B of this paper an in-depth analysis of each firm and their variables is presented.

The Merton (1974) Model

In his seminal article on credit risk management, Robert C. Merton proposed a method to price a public firms debt based on the equilibrium theory of option pricing by Black and Scholes. The original purpose of the Black-Scholes model was to value corporate liabilities based upon their contingency claim analysis, which has been recently extended to value and price nearly all forms of derivatives. It was Merton, who proposed in his 1974 paper on valuation of corporate debt "On The Pricing Of Corporate Debt: The Risk Structure Of Interest Rates" the extension and possible application of the Black-Scholes option pricing formula into the arena of default probability calculation. The Merton model was the first structural model to be published as it uses the evolution of the firms' capital structure, such as asset and debt values, to determine the time and probability of default by combining the movements of the firm's overall value relative to some pre-defined threshold or barrier, called the default point.

Merton noted that when a bank makes a loan, it is similar to writing a put option on the assets of the borrower's firm. In terms of standard option methodology, the payoff from equity mimics the payoff from a call option in the sense that if the value of the firm's assets were more than the value of the firm's debt the 'option' of holding the firm would be exercised and the value of the equity would thus be the difference between the value of the firms assets and the value of the debt. Thus, the equity of the firm is a call option on the assets, where the exercise price and the maturity are given by the face value and maturity of the debt. If the above notion did not hold (at least theoretically), the firm would have a high probability to default, since the equity would be worthless in an option theoretic approach.

Application of the put-call parity principle illustrates that debt can be viewed as a default risk-free loan less a put option sold to equity-holders by debt-holders. Put-call parity states that holding a call option with a specific exercise price is equivalent to owning the underlying asset, borrowing with a required repayment of the same value of the exercise price, and holding a put option with the same exercise price.

Translation of this into a capital structure paradigm would mean that the equity holders own the assets, have borrowed the debt amount, and also own the put option, which enables them to sell the asset for the borrowed amount. Thus, debt-holders, along with the debt, have also sold a put option to the equity-holders in recognition of the possibility of default.

In this paradigm, default may mean two things: exercise of the put option or non-exercise of the call option by the equity holders. This analogy between option pricing and capital structure builds the foundation of the Merton (1974) model.

Assumptions of the Merton (1974) Model

The model is a somewhat stylised structural asset-based model that requires a number of assumptions. Among other things, the model assumes that the underlying value of each firm follows a geometric Brownian motion and that each firm has issued one zero-coupon bond.

The model requires the value of the firm to be estimated, where the strike price of the call option is equal to the face value of debt (the zero-coupon bond). The model recognises that neither the underlying value of the firm nor its volatility is directly observable. However, under the model's assumptions both can be inferred from the value of equity, the volatility of equity and several other observable variables by solving two non-linear equations simultaneously. After inferring these values, the model specifies that the probability of default can be represented by the normal density function of a z-score depending on the firm's underlying value, the firm's volatility and the face value of the firm's debt.

Assumptions:

1. Markets are frictionless: There are no transaction costs, no taxes, no short-selling restrictions, no information asymmetries; assets are perfectly divisible and continuously traded; borrowing and lending rates are equal (i.e. absence of bid-ask spreads).

2. Market participants are price takers: There are sufficiently many investors with comparable wealth levels such that they can buy or sell as much of an asset as they want at the market price.

3. Constant risk-free interest rates: There is a risk-less asset whose rate of return per unit of time is known and constant, i.e. the term structure of interest rates is flat. Thus, the price of a risk-less discount bond paying R_x at maturity T is $R_t(T) = \exp(-rT)$ where r is the instantaneous risk-free interest rate.

4. Modigliani-Miller environment: The value of the firm V_t, is invariant to its capital structure; it is equal to the (market) value of equity E_t, plus the market value of a representative zero-coupon non-callable debt contract D_t, maturing at time T with face value D as:

$$V_t = E_t + D_t$$

Together with assumption (1) above, this implies that the value of the firm and the value of its assets are identical.

5. Itô dynamics of firm value: The value of the firm (i.e. the value of its assets). V_t, follows a geometric Brownian motion process as follows:

$$\frac{dV_t}{V_t} = \mu dt + \sigma_V dZ_{1,t}$$

Where μ, represents the instantaneous expected rate of return on the firm value with σ_V^2 representing the instantaneous variance of the return on the firm value per unit of time referred to as 'asset return volatility' or simply 'firm value volatility', and $dZ_{1,t} = \varepsilon_1 \sqrt{dt}$ is a standard Gauss-Wiener process.

6. Shareholder wealth maximization: Management acts to maximize shareholder wealth.

7. Perfect anti-dilution protection: There are neither cash flow payouts, nor issues of any new type of security during the life of the contract, nor bankruptcy costs. This implies that default can only occur at maturity if the firm cannot meet the repayment of the face value of the debt, D.

8. Perfect bankruptcy protection: Firms cannot file for bankruptcy except when they are unable to make the required cash payments. In this case, the absolute priority rule cannot be violated: shareholders obtain a positive payoff only if the debt holders are perfectly reimbursed.

Given these assumptions, the value of the equity of the firm E at time T (i.e. maturity) is presented by the following:

$$E_t = \max(0, V_t - D)$$

From the viewpoint of the payoff structure, the equity of the firm E is equivalent to a call option on the assets of the firm V.

Inputs of the Merton (1974) [4] Model

Merton defines the following variables:

V	Value of the firm's assets today
V_T	Value of the firm's assets at time T
E	Market value of the firm's equity
E_T	Value of the firm's equity at time T
D	Face value of debt due in one year
σ_V	Volatility of Assets
σ_E	Volatility of Equity
r	Instantaneous risk free rate

If $V_T < D$ (it is at least in theory) rational for the firm to default on the debt at time T as the value of equity would thus be zero. If $V_T > D$, the firm should make the debt repayments at time T and the value of equity would be the deference between $V_T - D$.

[4] Merton (1974)

Merton's model therefore shows that the value the firm's equity at time T is represented by:

$$E(V, D) = \max(0, V_T - D)$$

This shows that the equity is a call option on the value of the assets with a strike price equal to the face value of the firm's debt. The Black-Scholes [5] formulae for a European call option provides Merton with the value of equity as follows:

$$E(V, D) = V(d_1) - De^{-r(T-t)}N(d_2)$$

Where,

$$d_1 = \frac{\left[\ln\left(\frac{V}{D}\right) + \left(r + \frac{\sigma_V^2}{2}\right)(T-t)\right]}{\sigma_V\sqrt{T-t}} \qquad d_2 = d_1 - \sigma_V\sqrt{T-t}$$

Probability of Default [6]

The probability of default at time T is the probability that the market value of the firm's assets V_t will be less than the book value of the firm's outstanding debt D at time T. To put it formally, at time zero, the default probability (DP) is given by:

$DP = P(V_t \leq D)$ and in terms of natural logarithms,

$DP = P(\ln V_t \leq \ln D)$.

Following on this rationale of default, the following paragraphs show how the original Black and Scholes equations are adapted to the Merton model of default calculation.

5 Black, Fischer and Scholes (1973)

6 The mathematical derivations of this section are based on the works of Kulkarni et al. (2005), Crouhy et al. (2000), Vassalou and Xing (2004) and Crosbie and Bohn (2003)

In order to compute the value of equity (i.e. the call option on the firm's total assets), it is assumed that the firm's value process follows a geometric Brownian motion as follows:

$$dV_t = \mu V_t dt + \sigma V_t dW$$

or often written as:

$$\frac{dV_t}{V_t} = \mu dt + \sigma_V dW$$

V represents the value of firm's assets with μ representing the asset drift (i.e. the expected continuously compounded return on V). σ_V represents the volatility of the firm value and dW is seen to be a standard Gauss-Wiener process.

By applying the Itô's lemma [7] the following equation can be obtained:

$$dE_t = \left(\frac{\partial E}{\partial t} + rV_t \frac{\partial E}{\partial V} + \frac{1}{2}\sigma_V^2 V_t^2 \frac{\partial^2 E}{\partial V^2} \right) dt + \sigma_V V_t \frac{\partial E}{\partial V} dZ_t$$

After several steps, the following partial differential equation (below) for the value of equity emerges. This equation forms the key differential equation in the Black and Scholes option pricing formulae:

$$\left(\frac{\partial E}{\partial t} + rV_t \frac{\partial E}{\partial V} + \frac{1}{2}\sigma_V^2 V_t^2 \frac{\partial^2 E}{\partial V^2} - rE \right) = 0$$ [8]

Where t refers to time, r refers to the instantaneous risk-free interest rate and σ_V^2 refers to the volatility of the firm's assets.

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[7] For a discussion on the use of Ito's lemma see Hull (2002)

[8] Black, Fischer and Scholes (1973)

From the two equations above, the following relationship emerges:

$$d\ln V = \left(\mu - \frac{\sigma_V^2}{2}\right)dt + \sigma_V dW$$

It can be shown that incremental changes in $\ln V$ follows a generalized Gauss-Wiener process with a drift equal to $\left(\mu - \frac{\sigma_V^2}{2}\right)$ and a diffusion coefficient equal to σ_V. This equation follows from the use of an approximation (below) for the incremental change in $\ln V$ from $\ln V_t$ at time $(t = 0)$ to $\ln V_T$.

Where,

$$\ln V_T - \ln V_t \sim N\left[\left(\mu - \frac{\sigma_V^2}{2}\right)T, \sigma_V^2 T\right]$$ Or alternatively,

$$\ln V_T \sim N\left[\ln V_t + \left(\mu - \frac{\sigma_V^2}{2}\right)T, \sigma_V^2 T\right].$$

Since the logarithm of V_T as displayed above is normally distributed, the value of the firm at maturity V_T can be seen to be lognormal. Crouhy et al. (2000) claim, this assumption to be quite robust and the data actually confirms quite well to this hypothesis. Following on their study, the distribution of asset returns can be seen to be stable over time, i.e. the volatility of asset returns will remain relatively constant due to notion that the standard deviation of $\ln V_T$ is a linear function of $\sqrt{T}$, and thus, the uncertainty about the future development of the firm's asset value grows with the time-to-maturity.

From the properties of the lognormal distribution, the moments for the asset value of the firm can be derived.

The mean has the form: $E(V_T) = V_t e^{\mu T}$

And the variance: $Var(V_T) = V_t^2 e^{2\mu T}\left(e^{\sigma_V^2 T} - 1\right)$

As the value of assets follow the geometric Brownian process, Crouhy et al. (2000) show that the value of firm's assets at time T, V_T can be represented by the following equation:

$$V_T = V_t \exp\left[\left(\mu - \frac{\sigma_V^2}{2}\right)T + \sigma_V \sqrt{T} Z_T\right]$$

and after arranging,

$$\ln V_T = \ln V_t + \left[\left(\mu - \frac{\sigma_V^2}{2}\right)T + \sigma_V \sqrt{T} Z_T\right]$$

Where $\sqrt{T} Z_T = W_T - W_t$ is shown to be normally distributed with a zero mean and variance equal to T[9] and $Z_T = \frac{W_T - W_t}{\sqrt{T}}$[10] can be shown to represent the random components of the firm's return. The probability of default at time T is the probability that the market value of firm's assets will be less than the book value of the firm's outstanding debt at time T.

To describe this notion formally, at time zero, default probability (DP) is given by:

$DP = P(\ln V_T \leq \ln D)$, and after substituting the equation for $\ln V_T$ the default probability can be written as:

$DP = \Pr\left(\ln V_t + \left(\mu - \frac{\sigma_V^2}{2}\right)T + \sigma_V \sqrt{T} Z_T \leq \ln D\right)$ or alternatively after arranging,

[9] Crouhy et al. (2000)
[10] Vassalou and Xing (2004)

$$DP = \Pr\left(-\frac{\ln\left(\frac{V_t}{D_t}\right) + \left(\mu - \frac{\sigma_V^2}{2}\right)T}{\sigma_V\sqrt{T}} \geq Z_T \right)$$

As the random component of the firm's asset returns Z_t is seen to be lognormal, the default probability can be finally written as follows:

$$DP = N\left(-\frac{\ln\left(\frac{V}{D}\right) + \left(\mu - \frac{\sigma_V^2}{2}\right)T}{\sigma_V\sqrt{T}} \right)$$

This key equation provides us with the probability of default for a firm at the time of maturity T (e.g. the default probability within in one year with $T=1$). This equation shows that the probability of default is a function of the distance between the current value of the firm's assets and the face value of its liabilities adjusted for the expected growth in the firm's asset value relative to the firm's asset volatility [11].

This metric is known as the distance-to-default and thus, represents the number of standard deviations that the firm is away from default. The higher the distance-to-default metric, the better for the firm as a higher distance-to-default value implies being further away from the default barrier which is represented by the face value of the zero-coupon bond or more realistically the face value of the firms total liabilities. It is at this stage that the unrealistic assumption of a single zero coupon-bond is at its weakest. Firms usually have a schedule of debt due at various times, however, according to the distance-to-default metric, firms might be in default but still currently operating.

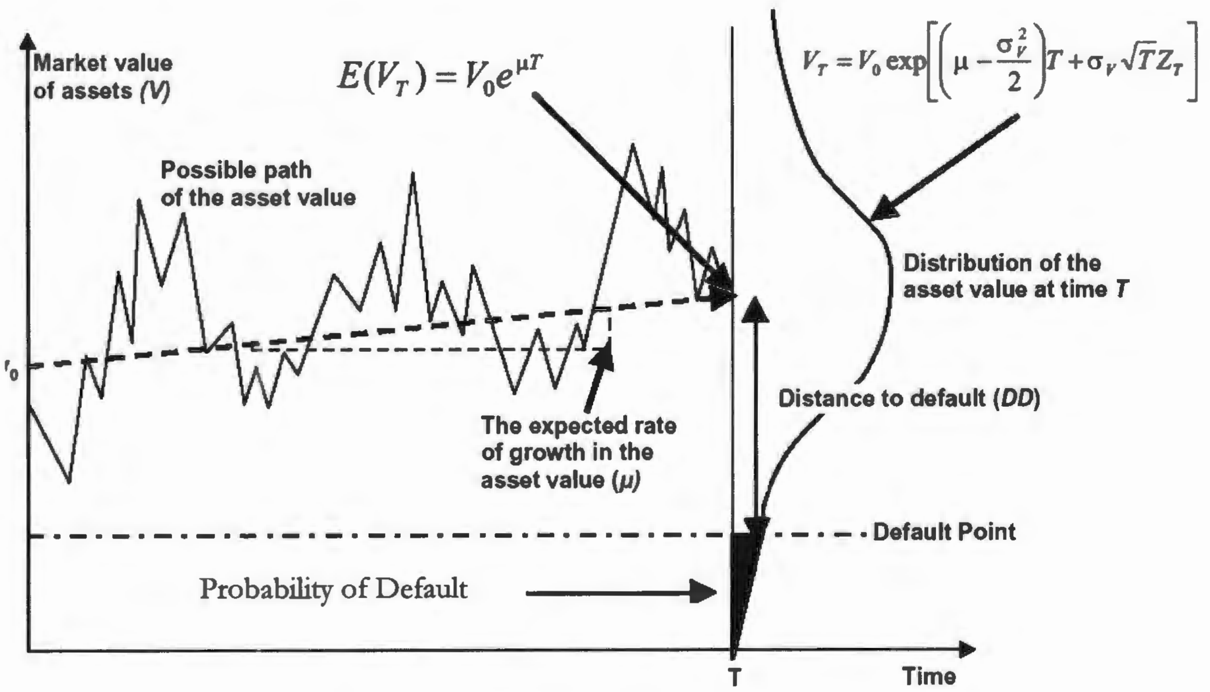
[11] Hillegeist et al. (2004)

The default probability thus combines the distance-to-default metric transformed into the cumulative normal distribution, which can be seen to be equivalent to the martingale probability in the original Black and Scholes equation as shown below:

$$DP = N\left(Z_t \leq -\frac{\ln\left(\frac{V_0}{D}\right) + \left(\mu - \frac{\sigma_V^2}{2}\right)T}{\sigma_V \sqrt{T}} \right) \equiv N(-d_2)$$

Figure 1 below summarizes the above section and schematically displays the development of the value of the firm in relation to the distribution of the future firms asset value process. In addition the figure displays the distant-to-default metric, the default point and how this metric is transformed into the associated probability of default. The expected growth rate in the firm's assets is discussed in more detail in the section to follow.

Figure 1: Distribution of the firm's asset value at maturity of the debt



Source: Moody's KMV and Crouhy et al. (2000)

Adjusting the model to include Asset-Payouts

One of the assumptions of the original Merton model is that there are no cash leakages from the firm. This assumption is highly unrealistic and the model has to be adjusted to include a form of leakage i.e. the asset pay out ratio of the firm. The previous equations are now modified to reflect this so called constant continuous asset-payout ratio. The value of equity today is thus represented by the following adjusted equation:

$$E(V,D) = Ve^{-\delta(T-t)}N(d_1) - De^{-r(T-t)}N(d_2) + (1-e^{-\delta T})V$$ [12]

Where, $$d_1 = \frac{\left[\ln\left(\frac{V}{D}\right) + \left(r - \delta + \frac{\sigma_V^2}{2}\right)(T-t)\right]}{\sigma_V\sqrt{T-t}} \qquad d_2 = d_1 - \sigma_V\sqrt{T-t}$$

The term δ represents the continuous asset payout ratio expressed in terms of V. The term δ appears twice in the equation above. The term $Ve^{-\delta T}$ accounts for the reduction of the value of the assets due to the cash dividends being paid out before the maturity and the term $(1-e^{-\delta T})V$, which doesn't appear in original Merton equation was added by (Hillegeist et al, 2004) to account for the fact that dividends are accrued to equity holders. This term is missing in the regular call option valuation equation for dividend paying stocks because dividends do not accrue to option holders. Given the inclusion of the asset leakage, this changes the distant-to-default metric and the default probability equation to the following:

$$DP = N\left[Z_t \leq -\frac{\left[\ln\left(\frac{V}{D}\right) + \left(r - \delta - \frac{\sigma_V^2}{2}\right)(T-t)\right]}{\sigma_V\sqrt{T}}\right] \equiv N(-d_2)$$ [13]

[12] For the derivation of the equation for equity, see e.g. Chartkou et al. (2006) and Hillegeist et al (2004)
[13] Crouchy et al (2000)

Calculation of the Risk Neutral Probability

To calculate the distance-to-default as well as the risk-neutral probability of default $N(-d_2)$, estimates of V and σ_V are required, neither of these, which are directly observable. The estimation procedure makes use of two important equations. The first being the Black-Scholes-Merton equation that expresses the value of a firm's equity as a function of the value of the firm and the second, relating the volatility of the firm's value to the volatility of its equity.

Since the firm is publicly traded, E can be observed, thus the equation below provides one condition that must be satisfied by V and σ_V.

$$E(V,D) = Ve^{-\delta(T-t)}N(d_1) - De^{-r(T-t)}N(d_2) + (1-e^{-\delta T})V$$ [14]

σ_V can be estimated from Itô's lemma. This follows Merton's assumptions that the value of equity is a function of the value of the firm and time, and from Itô's lemma the following relationship emerges:

$$\sigma_E = \left(\frac{V}{E}\right)\frac{\partial E}{\partial V}\sigma_V$$ [15]

In the Black-Scholes equation, it can be shown that $\frac{\partial E}{\partial V} = N(d_1)$ [16]. When combining this proposition into the equation above, the volatilities of the firm and its equity are thus related by:

$$\sigma_E = \left(\frac{V}{E}\right)N(d_1)\sigma_V$$

This provides another equation that must be satisfied by V and σ_V.

[14] Chartkou et al. (2006)

[15] Merton (1974)

[16] Black, Fischer and Scholes (1973)

However, this equation again assumes currently no asset payouts. This equation can easily be modified to incorporate a constant asset payout ratio as seen below:

$$\sigma_E = \left(\frac{V}{E}\right)\sigma_v e^{-\delta} N(d_1)\, V$$ [17]

Given this link, these two key non-linear equations below can be solved simultaneously for estimates of V and σ_V.

$$E(V,D) = Ve^{-\delta(T-t)}N(d_1) - De^{-r(T-t)}N(d_2) + (1-e^{-\delta T})V$$

$$E(V,D) = \frac{\sigma_v e^{-\delta} N(d_1)\, V}{\sigma_e}$$

Kealhoffer (2003) demonstrates that these equations illustrate for stable firm volatility, equity volatility increases with declining stock prices and thus equity volatility will reach very high levels for a company at the brink of default.

Hull (2002) suggests that the Newton Raphson [18] iterative algorithm can be used to solve the system of two non-linear equations in the form $F(x+y)=0$ and $G(x+y)=0$ to obtain the two unknown values of V and σ_V. In order to solve the equations, the solver routine function in Excel is used to minimize $[F(x+y)]^2 + [G(x+y)]^2 = 0$ with respect to V ,σ_V and subject to the constraints $V > 0, \sigma_V > 0$.

After solving, the market value of the firm's assets as well as the volatility of the firm's assets are obtained. T is set to 1 in the model, as the model is used to calculate a yearly default probability, or alternatively the probability of default within one year.

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[17] Suo and Wang (2006)

[18] Alternative procedures are discussed under the Assumption Section

Once this numerical solution is obtained, the distance-to-default metric can be calculated as follows:

$$d_2 = \frac{\left[\ln\left(\frac{V}{D}\right) + \left(r - \delta - \frac{\sigma_V^2}{2}\right)T\right]}{\sigma_V \sqrt{T}}$$ [19]

The risk-neutral distance-to-default metric is thus the difference between the estimated market value of the assets and the total liabilities scaled by the standard deviation of the firm's asset's market value.

According to the Black-Scholes-Merton formulation, the risk neutral probability of default at any time t is given by:

$$PD = P(V_T \leq D)$$

And summarising from the previous section the probability of default is transformed into a standard normal z-variable as follows:

$$PD = N\left[Z_t \leq -\frac{\ln V_0 / D + (r - \delta - \sigma_V^2 / 2)T}{\sigma_V \sqrt{T}}\right] \equiv N(-d_2)$$ [20]

[19] Crouchy et al (2000)

[20] Crouchy et al (2000)

Risk-Neutral Probabilities vs. 'Real-World' Probabilities

As the Merton (1974) model assumes that the value of the firm's assets grow at the risk free rate, the resultant probability of default would represent a risk-neutral probability opposed to a 'real-world' probability.

The difference between the 'real-world' probability and the risk-neutral probability stems from the systematic component of default risk [21]. The difference is determined from the expected return that is required for the systematic risk of the underlying firm. If the underlying firm had no systematic risk the expected return would simply be equal to the risk free rate and thus the two probabilities would be identical.

The risk-neutral probability can easily be converted into the 'real-world' probability and vice versa with the knowledge of the assets required return, mathematically this required return is referred to as the drift of the asset [22]. It should be noted here that the expected growth rate of the firm's assets over a specific horizon is required and not the equity drift.

The risk-neutral probability implies defaults are more likely to occur by assuming that the firm's assets will grow only at the risk free rate of interest in absence of allowing the firm's assets to grow at a rate equivalent to that of the market. Therefore, the risk-neutral probability overstates the default probability in a 'real-world' sense [23]. This notion holds generally, however, in certain specific firms this concept may not hold at all. However, It can be shown that the risk-neutral and risk adjusted distribution of a firm's asset value process have equivalent variances, and by incorporating the asset drift of the firm, shows that the risk-adjusted distribution of the asset value process would imply a mean greater than the risk free rate thus providing a 'real-world' probability of default.

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[21] For related discussion of 'real-world' versus risk-neutral probabilities, see Demchak (2000) and Crouhy et all (2000)

[22] Kealhoffer (2003)

[23] Deliandes and Geske (2003)

Following from literature [24], the use of a risk free rate of interest is highly unrealistic in the Merton (1974) model. The interest rate reflected in the model has to incorporate the markets perception of future financing rates. In implementation of the model, a one-year forward financing is used and it is assumed that firms will service their debt obligations at this rate in the future.

By integrating the asset drift and a forward financing rate enables the original Merton (1974) model to provide a more empirical measure of the default probability. The section to follow presents a methodology, which integrates the theoretical relationship between the expected return of the firm's assets and the expected return of equity.

[24] Kealhoffer et Al (1998) and Kealhoffer (2003)

Calculation of the Asset Drift [25]

The equation below relates equity to follow a stochastic differential process or alternatively an Itô's process.

$$dE_t = \mu E_t dt + \sigma_E E_t dZ_t$$

Where E_t, represents the value of equity and σ_E represents the equity volatility. It is assumed that at any time i.e. instantaneously, the following definition relations hold:

$$V_t = E_t + D_t \text{ and}$$

$$dV_t = dE_t + dD_t$$

That is, the value of the firm's asset must be equal to the value of debt and equity and the change in the value of the assets must be equal to the change in the values of equity and debt. By using Itô's lemma, the *process for equity* can be presented as follows:

$$dE_t = \left(\frac{\partial E}{\partial t} + \mu_v V_t \frac{\partial E}{\partial V} + \frac{1}{2}\sigma_V^2 V_t^2 \frac{\partial^2 E}{\partial V^2} \right) dt + \sigma_V V_t \frac{\partial E}{\partial V} dZ_t$$

By comparing the diffusion terms in the *process for equity* above the asset volatility and the equity volatility must satisfy the following equation as obtained from the previous section:

$$\sigma_E E_t \quad = \quad \sigma_V e^{-\delta} V_t \frac{\partial E}{\partial V} \quad = \quad \sigma_V e^{-\delta} N(d_1) V_t$$

Where $N(d_1)$ is referred to as the hedge ratio or the equity delta in standard option terminology and thus the 'option Greeks' are presented as follows and again adjusted for continuous asset leakages namely δ.

[25] This section is based on Kulkarni et al (2005) and Crouchy et al (2000)

- Equity Delta: $\Delta^E = e^{-\delta T} N(d_1)$

- Equity Gamma: $\Gamma^E = \dfrac{\partial^2 E}{\partial V^2} = \dfrac{n(d_1)e^{-\delta T}}{V\sigma_V\sqrt{T}}$

- Equity Theta: $\Theta^E = \dfrac{\partial E}{\partial t} = -\dfrac{Vn(d_1)\sigma_V e^{-\delta T}}{2\sqrt{T}} + \delta\, V\, N(d_1)e^{-\delta T} - rDe^{-rT}N(d_2)$

Therefore it can be shown that:

$$\frac{\partial N(d_1)}{\partial V} = n(d_1) = \frac{1}{\sqrt{2\pi}}e^{-d_1^2/2} \qquad \Theta\ N(x) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{x} e^{-\frac{1}{2}z^2}dz$$

Where, $N(x)$ denotes the probability distribution function of the standard normal variate.

By substituting the option Greeks into the *process for equity* the following equations [26] are obtained which can be used to solve for the drift of the firms assets μ_V.

$$\mu_E E = \left(\frac{\partial E}{\partial t} + (\mu_v - \delta)V_t\frac{\partial E}{\partial V} + \frac{1}{2}\sigma_V^2 V_t^2 \frac{\partial^2 E}{\partial V^2}\right)$$

$$\mu_E E = \Theta^E + (\mu_V - \delta)V\Delta^E + \frac{1}{2}\sigma_V^2 V^2\, \Gamma^E$$

$$\mu_V = \frac{\mu_E E - \Theta^E - \frac{1}{2}\sigma_V^2 V^2 \Gamma^E}{V\Delta^E} + \delta$$

[26] Kulkarni et al (2005)

The equity drift μ_E[27] can be estimated from the stock market by making use of the CAPM model as follows:

$$\mu_E - r = \beta\pi$$

Where π represents the market price of risk and r is assumed to be the one-year forward financing rate. The beta of equity with respect to the market portfolio is calculated as follows:

$$\beta = \frac{\operatorname{cov}(R_E, R_M)}{Var(R_M)} = \rho\frac{\sigma_E}{\sigma_M}$$

The market portfolio for the purpose of the calculation in South Africa can be represented by the JSE Top 40 Index or alternatively the ALSI (All Share) Index. It is assumed that the betas as calculated by Cadiz FSG [28] shall suffice for this purpose and are discussed under the section on model assumptions. Once β, π and r are obtained, the equity drift μ_E can be calculated as follows:

$$\mu_E - r = \beta\pi$$
$$\mu_M - r = \pi$$

The final step is to combine the equity drift along with the equity theta, delta and gamma in the equation below to obtain the asset drift μ_V.

$$\mu_V = \frac{\mu_E E - \Theta^E - \frac{1}{2}\sigma_V^2 V^2 \Gamma^E}{V\Delta^E} + \delta$$

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[27] Crouchy et al (2000)

[28] Cadiz Financial Services Group http://www.cadiz.co.za

Having found V and σ_V by solving the system of non-linear equations from the previous section, the asset drift μ_V is now combined to calculate the real-world default probability by substituting the risk-free rate with a rate to be equivalent to the growth of the firm's assets and thus the probability of default can be re-written as follows:

$$N(d_2) = N\left[-\frac{\ln V / D + (\mu_V - \delta - \sigma_V^2 / 2)T}{\sigma_V \sqrt{T}}\right]$$ [29]

It is worth noting that the impact of the asset payout ratio and the forward financing rates are inherently included in the calculation of the risk-neutral probability of default from the previous section. The risk-neutral probability of default is further adjusted to incorporate the asset drift as presented in this section. The financing rate and asset payout rates are further considered in the calculation of the option Greeks as presented in this section. A further discussion of the combination of interest rates and asset payouts can be read under the section of assumptions to follow shortly.

Prior to the implementation of the model and the assumptions regarding the inputs, it is necessary to give a brief history and discussion of Black Economic Empowerment (BEE) currently being experienced within the South African corporate sector, and the ultimate implication of BEE on the default model.

[29] Kulkarni et al (2005) and Crouchy et al (2000)

Black Economic Empowerment within South Africa

A Brief History

One of the most significant innovations in the Bill of Rights contained within South Africa's Constitution provides the general right to equality, allowing 'legislative' and other measures designed to protect or advance persons, or categories of persons disadvantaged by unfair discrimination in order to advance the equality of all citizens [30].

In recognizing the South African legacy of discrimination, the Bill of Rights clearly anticipated the government's pursuit of projects such as black economic empowerment (BEE). The government set a path of defining the key elements of BEE compliance. This compliance would need to be adhered to in respect of each and every sector of the South African economy. This approach of government was contained in a strategy document entitled 'South Africa's Economic Empowerment' released by the Department of Trade and Industry (DTI) in March 2003. However, by April 2004, this strategy had been supplemented with the Broad-Based Black Economic Empowerment Act of 2003 (the BEE Act), an enactment that finally moved the key elements of BEE compliance away from different sectoral initiatives and placed it firmly within the context of the law.

Funding Black Economic Empowerment Transactions

The challenge for South Africa is to facilitate a sustainable transfer of economic ownership to the political majority without destroying that which drives a market orientated economy, shareholder capitalism, free enterprise and especially free financial markets. A simple principle of wealth creation is one must have capital to create capital and unfortunately severe limitations have been previously placed on the economic activities of black South Africans. The new wave of BEE tries to pave this arena with a daunting task of facilitating rapid capital accumulation to the political majority. Most sectors of the economy have set a target of 25 per cent black equity within the next five to ten years, while the financial services sector, with more than R2 trillion in assets,[31] and

[30] Section 9(2) of the Constitution of the Republic of South Africa, Act 108 of 1996

[31] Business Map (2004)

a combined market capitalisation of over R500 billion, has set itself a target of 15 per cent black shareholding by 2014.

Types of Funding

Equity Finance

This type of finance is where firms are willing to take on the buyer's equity to facilitate the purchase of a potion of the assets or the entire firm. Firms or individuals must have equity or capital that can be used to purchase the required assets. Although this is the general idea, equity finance can take on many forms. One can borrow the cash needed from investors who, in turn take up equity in the business, or, the seller is willing to take on some of the buyer's equity (essentially a stake in the liquid assets that the buyer has) in return for selling a portion or the entire firm. This example is one of the more common forms of financing mergers and acquisitions. However, very few black individuals or groups are able to use this type of funding due the historical disadvantages placed on these designated groups in the past. These groups currently have inadequate capital, assets and/or collateral with which to lend with, and as thus, cannot use this form of finance.

Third-Party Debt

The second way of acquiring the asset is to borrow funds from a third-party financier, normally a bank. Usually this form of finance requires that the investor has some form security or collateral that can be provided in forms such as shares, property or some other liquid asset. The bank or financier will provide the empowerment partner with finance at some form of interest generally at a spread over the floating interest rate, JIBAR (The Johannesburg Inter-Bank Agreed Rate). This spread will take the viability of the asset that the empowerment partner is buying (the inherent risk of the investment as well as the cost of capital of the firm being provided the finance). In this scenario, the empowerment partner will ensure that the loan provided would be serviced from profits generated from the investment. Good management practices would entail that the empowerment partners must allow for working capital costs as well as for reinvestment initiatives to ensure adequate firm growth.

Vendor/Leveraged Finance

In general the owner of the assets provides finance to the buyer to acquire the same asset. Typically vendor financing in empowerment deals is through convertible instruments and equity derivatives. Most transactions entail providing share options to empowerment shareholders. It is becoming increasingly common to tie the deals to option schemes in which the partners gain immediate economic participation in the company, but have full ownership only when an option to buy shares matures and is exercised some years later.

A general structure essentially grants the stake to the empowerment party, thus ensuring full economic and voting rights, but with an option for the firm to acquire the stake back after a specific period if the empowerment firm does not or cannot pay for it. The advantage of this structure is that the empowerment firm is able to reinvest its dividends by continuously converting the money into the group's equity increasing the potential size of the final net equity.

There are concerns however of this type of structure, most notably section 38 of the South African Companies Act, 1973 (Act No. 69 of 1984) which prohibits companies from providing financial assistance in the acquisition of their own shares, except for employee share-incentive schemes and for share-buy backs. However, the Companies Bill of 2007 intents to repeal the Companies Act, be it enacted by the Parliament of the Republic of South Africa. This repeal states that Section 38 would not apply in instances relating specifically to BEE deals thus ultimately allowing companies to provide providing financial assistance in the acquisition of their own shares for BEE purposes.

In addition to the above motioned structure and derivative instruments used; leveraged finance is becoming increasingly common in empowerment deals. The biggest advantage is that it makes it easier to raise capital, since the funders are loading debt on to the target company rather than the empowerment entity. This financing provides risk or assets against which to lend, and is becoming increasingly popular because companies faced with BEE pressure are willing to ease access to operating assets and thus cash flows of these BEE created entities.

Leveraged finance only works when firms are acquiring assets rather than shares. Most companies are reluctant to go through this route, since they want empowerment to be a once-off transaction. Ironically, the codes of good practice to measure BEE compliance have made leveraged finance deals more viable, because they recognize empowerment ownership through the sale of equity at a holding level, and at enterprise level, through the sale of business units.

A big concern for most listed firms is that leveraged finance significantly increases the debt-to-equity ratio of enterprises and more importantly, there is concern that there will be pressure from banks for these firms to repay loans and as thus, these repayments could eventually tie up working capital and cash-flows. The ultimate implication is that vendor/leveraged finance has become so common in the South African corporate sector due to the fact that buyers have neither capital of their own nor the ability to raise traditional finance.

BEE and The Implication of Default

Funding empowerment stakes are legally becoming law and thus represents a challenge for the South African financial markets. Traditionally, financial markets by their very nature have been driven by one motive, profit. The market chooses winners, the businesses that have a high probability of returning an investment and an equal probability of success. Banks are now asked to play a role in empowerment deals. Banks have to find ways to lend money to more firms and to a broader range of individuals with higher risk.

South African banks currently face an additional burden of knowing that failure of empowerment may arise directly or indirectly, as the banks will be placed under pressure to facilitate empowerment until it has succeeded. The challenge of providing broad-based empowerment coupled with widespread lending is simply due to the implicit BEE demand of high sustainability and success, however, the reality of business is that many fail for the few that succeed.

The implicit result of BEE deals is that due to the very nature of the funding mechanisms there is an additional burden of debt on almost all listed firms books. This notion clearly states, that BEE and the associated debt costs increase the overall risk of firms, and more so for the banks providing this type of finance. However, this paper does not focus on any financial firms, but the implicit BEE demand would cause the rational thinker to infer that financial firms in South African are seen to be more risky.

Many of the funding structures typically require the BEE partner to service the debt obligations from the dividends that are currently received from the empowerment stake in the firm. In the US, historically, it can be shown that as a firm nears default the reaction of managers is to cut dividends in order to generate adequate cash for the service of outstanding debt obligations. However, in South Africa, due to the advent of BEE, it will not be possible for any firm to cut their dividends at they near default, and as thus, empowerment dividends can be seen to be implicit debt. This is due to the fact that the BEE partner would not be able to service the debt obligations without the associated dividend income stream.

This assumption regarding dividends has to be incorporated into the Merton (1974) model. These assumptions of dividends are incorporated into two scenarios, the base-case and worst-case scenario respectively. Under the base-case scenario, it is assumed that dividends are paid, and as thus, the empowerment structure has an income stream to service the debt obligations. In the worst-case scenario the dividends of the firm are able to drop to zero (as they currently do in the US). This would enable the results to display a very conservative worst-type of scenario. The notion of dividends not being paid would case an 'inferred' default to occur on the BEE structure, and as thus would cause the probability of default to increase under this scenario. The measurement of BEE debt and the associated dividends are discussed in the assumption section to follow.

Model Inputs and Assumptions

The Company Selection Process

For the purposes of this paper, only non-financial companies have been selected. This is due to the business nature of financial institutions being considerably different to that of industrialised firms. The nature of financial firms affects the model as such in the setting of the Default Point. The Default Point for financial firms would have to be adjusted, generating incomparable results with other firms. The FTSE JSE index series are currently reviewed quarterly with the latest index constituents being finalized on 31 March 2007. In order to obtain at least a short time series data for further comparison, only companies that have been incorporated into the index at least two years prior to March 2007 have been included in the sample. This is due to the fact that equity volatility remains a key input of default prediction model. The two-year window frame ensures that the stock has adequate daily stock price data and liquidity.

Where the company is dual listed and/or has multi-national operations the following assumptions shall prevail:

The company will be treated entirely as a South African entity, thereby, all outstanding debt will be assumed to be denominated in (ZAR). Where financial derivative instruments have been used for risk management purposes, it is assumed that all instruments such as currency and interest rate swaps are swapped back into the domestic currency (ZAR) and an equivalent domestic floating interest rate such as JIBAR (The Johannesburg Inter-bank Agreed Rate) has been used. This would ensure that a conservative approach would be used throughout the study. The assumption of only ZAR debt is rather restrictive as many firms obtain international finance and thus have interest payment and operations denominated in other currencies. However, if market conditions deteriorate rapidly, the emerging market and contagion nature would cause South African firms to default first.

Forecasting Time Horizon

Within credit risk literature and modelling, it is common to use a one-year $(T = 1)$ time horizon for debt maturity and subsequent estimation of default probability. As Kulkarni et al. (2005) argue, one year is perceived as being of sufficient length for a bank to raise additional capital on account of increases in portfolio credit risk (if any). The one-year convention may have arisen largely because, until recently, default probabilities and rating transition matrices were most easily available at a one-year horizon, with such data forming key inputs to conventional credit risk models.

Market Value of Equity

The value of equity E, is found simply as the number of shares outstanding at the time of the finalization of the index constituents and the share price on that day, namely 31 March 2007. The market capitalization, number of shares outstanding as well as the share price used are published in the FTSE JSE index review March 2007.

Setting the Default Point

The Default Point is defined as the threshold, which when crossed, triggers default. (In reality, the default point is also a random variable). In particular, firms will often adjust their liabilities as they near default. It is common to observe the liabilities of commercial and industrial firms increase as they near default while the liabilities of financial institutions often decrease as they approach default.

In the case where a firm's liabilities would consist only of a single, zero-coupon bond (i.e. the assumptions of the original Merton model), the Default Point would be the face value of this debt D. However, because this form of financing is highly unlikely to exist, some other measure of the Default Point has to be introduced. To be consistent with the theoretical Merton model from the previous section, this estimated Default Point is also labelled D.

Some authors of the credit risk literature [32] consider the Default Point D to be equal to the book value of total liabilities. Other authors however suggest that it is more rational to estimate D as $D = STL + LTL$ where STL is the book value of the companies' short-term liabilities (debt due in one year) and LTL is the book value of long-term debt. Both of these variables are easily obtainable from the annual reports of the companies.

This proxy is based on the observations of Moody's KMV, which has found from a sample of several hundred companies that firms default when the asset value reaches a level somewhere between the value of total liabilities and the value of short-term debt. Crosbie and Bohn (2003) show that the model is surprisingly robust to the precise level of the liabilities.

The South African case represents a rather unique proposition with respect to the measurement of the face value of firm debt. This relates to the fair value and discount treatment of BEE transactions in the financial statements of listed South African firms under IFRS 2 [33] (Share Based Payments). If the transaction was conducted at a discount, the transaction will be treated as being part of the debt of the firm, this is due to the fact that an expense is recognized in the income statement immediately due to the associated costs of the transaction. This cost shall be reversed from the income statement and thus form part of the face value of short-term debt. The fair value approach assumes that there will be no erosion to the equity structure of the firm, thus causing neither an increase in debt or liability with respect to the transaction.

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[32] e.g. Hillegeist et al. (2004)

[33] International Financial Reporting Standards

Aggregate Measure of Debt

All long-term and short-term interest bearing borrowings will be included, specifically interest bearing debt due within the following year. Preference share capital is assumed to redeem within the redeemable portion due within the following year. If the firm has any convertible loans outstanding, the option to conversion has been taken into account within the next year. If the firm has conducted a BEE transaction at discount, the expense, which was recognized in the Income Statement in prior years, will form part of the face value of debt. For simplicity purposes liabilities that do not bear an implicit interest charge, such as deferred tax liabilities and pension liabilities will not be taken into account.

The liabilities of subsidiaries are not adjusted, which are currently consolidated at 100 percent on a consolidated balance sheet even though the parent company may not own 100 percent of the subsidiary. Joint Ventures are incorporated on a line-by-line basis in the actual percentage of participation. Associate companies merely represent an investment by the parent and thus liabilities of the Associate are accounted for within the parent.

This study further assumes that at any time between the publication of two annual reports, market participants behave as if the actual debt level were the one reported in the most recent annual report.

Setting the Interest Rate

The original Merton model assumes a risk free rate of interest as the model computes risk-neutral probabilities of default. A one-year forward financing rate is used for the calculation of the 'real-world' probabilities of default. The one-year forward rate has been calculated from the 1YR and 2YR swap rates from value date 10 June 2007, directly after the latest 50bps increase in interest rates. The Repo rate increased from 12.5% to 13.0% on this day.

I YR Swap	9.21%
2 YR Swap	9.00%
1YR Forward Swap Rate	8.79%

This rate has been assumed to be the short-term financing rate applicable within one-year. The rationale is that the swap curve is seen to be the most reliable perception of the markets feelings towards floating short-term interest rates namely, JIBAR (Johannesburg Inter-bank Agreed Rate) in the future. JIBAR can be seen as the AAA corporate yield as quoted in the domestic inter-bank market. Some corporate firms are currently rated by rating agencies and have certain listed debt (if any), which has in addition, been rated independently. Independent ratings on corporate debt would be the ascent of listed securitisation tranches by firms who securitize their books.

For the purposes of the study the following spreads over the 1YR forward financing rate will be applicable for the following rating categories. This paper further provides a base-case and a worst-case scenario over which the default probabilities will be calculated.

It must be noted that firms do not follow homogenous financing and capital structures and the table below would be used as reasonability check as to rates used in the default prediction model. Each firm has to provide details of their financing in the notes to the annual financial statements under the notes Interest Bearing Borrowings and Risk Management. Generally details of the average interest rates applicable on current finance are provided if the rates are fixed. Where there is no indication of rates and the firm is currently being financed at JIBAR, the following spreads and rates below will prevail and used as a reasonability check.

Base Case			**Worst Case**		
Forward	**Spread**	**Rate**	**Forward**	**Spread**	**Rate**
9.62%	0.68%	10.30%	9.62%	2.68%	12.30%
AAA	0.68%	10.30%	**AAA**	2.68%	12.30%
AA	1.35%	10.97%	AA	3.35%	12.97%
A+	2.03%	11.65%	A+	4.03%	13.65%
A-	2.70%	12.32%	A-	4.70%	14.32%
BBB	3.38%	13.00%	BBB	5.38%	15.00%
BB+	4.06%	13.68%	BB+	6.06%	15.68%
BB	4.73%	14.35%	BB	6.73%	16.35%
B+	5.41%	15.03%	B+	7.41%	17.03%
B-	6.08%	15.70%	B-	8.08%	17.70%
CCC	6.76%	16.38%	CCC	8.76%	18.38%
CC	7.44%	17.06%	CC	9.44%	19.06%
C	8.11%	17.73%	C	10.11%	19.73%
D	8.79%	18.41%	D	10.79%	20.41%

The spread difference between the base and worst-case results in a differential of 200bps. Thus, it is assumed that over the next year, the Repo [34] rate will on average increase by 200bps. This 200bps would be indicative of only the worst case-scenario. It should be noted that the move from the base-case to the worst-case is about 3 notches in the table above.

The monetary policy committee of the South African Reserve Bank (SARB) 'the central bank' meets eight times throughout the year, and thus, on average raises interest rates by 50bps if need be. This would entail that four rate rises are assumed throughout the year in this paper. The general reason for the 50bps increment opposed a 100bps increment, is due to the fact that a 100bps hike would generally 'shock' the South African markets in an event of crisis. Being conservative in the worst-case market scenario, the paper assumes two rate hikes of 100bps each. It is further assumed that all AAA firms will be able to obtain finance at the short-term forward financing rate plus a marginal spread of 68bps and 268bps under the base and worst-case scenario respectively.

The rationale behind the construction of the spreads is that all ratings below BBB are assumed to be financed at Prime. Historically the resultant spread between 3M JIBAR and prime is assumed to be on average 3.5%. It is further assumed that the one-year forward financing rate would be an equivalent short-term rate such as 3M JIBAR in the future. This assumption provides a spread of 3.38% over the financing rate for all BBB firms as seen highlighted in the table above.

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[34] The South African Repurchase Rate - See: The South African Reserve Bank

Computing The Asset Pay-Out Rate

The asset payout rate, δ, is a combination of the financing rate paid on the firms current borrowings combined with the rate of common and preferred dividends.

It is assumed that the most recently reported dividend yield would be constant and applicable over the following year. This assumption is based on the idea that management tries to maintain a constant dividend payment over time. If the firm has preference shares currently outstanding, the preference share rate will be used, however scaled down by the preference share weighting in the overall capital structure.

Due to the advent of BEE transactions in South Africa, two scenarios are assumed with respect to the asset payout ratio. Most firms will not able to cut their dividend to zero due to the various BEE financing structures as well as general market sentiment towards the firms share price. However, if the firm is on the brink of default, the model allows under the worst-case scenario that the dividend portion of the payout rate to drop to zero.

Computing The Equity Drift

The market return on assets μ_E, can be calculated based on the actual return on assets for the entire year. However, the actual return on assets over the last year may be negative. This contradicts financial theory where the expected returns cannot be negative and cannot be lower than the risk-free rate. One way of dealing with this problem is to set the growth rate equal to the risk-free rate of return in the cases, where μ_E, would be otherwise negative or lower than the riskless rate [35]. The risk free rate is assumed to be the forward financing rate as discussed above.

Thus, $\mu_E(t)$ is calculated as follows:

$$\mu_E(t) = Max\left[\frac{S(t) + Dividends - S(t-1)}{S(t-1)},\quad r\right]$$

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35 Hillegeist et al (2004)

Alternatively, μ_E, could be calculated from the CAPM model, assuming the risk free rate is represented by the forward financing rate of 9.62% coupled with a South African domestic equity risk premium of 300bps.

It is assumed that 300bps would be indicative of the market risk premium for South Africa. The rationale is that if the firm has a beta of 1, combined with the financing rate of 9.62%, the resultant equity drift would equate to 12.62%. Thus, the firm's assets will grow at a rate marginally higher than the current Prime rate of 12.5% [36] within a discrete framework, or alternatively 11.88% in a continuous a framework.

The betas of all firms used in the sample are provided by Cadiz FSG. In order to be consistent with the sample selection, the betas have been used to coincide with the latest FTSE JSE Top 40 index constituents, which were finalized on March 2007.

For the purposes of the study, the expected return will be calculated using the CAPM model. Under the two scenarios, the base case expected return would simply represent current market conditions as calculated by the CAPM model, whilst the expected return under the worst-case scenario would simply be represented by the forward financing rate of 9.62%. It is important to err on the conservative side under the worst-case scenario in terms of the equity drift/expected return.

[36] Prime Rate as at June 2007 – See: The South African Reserve Bank

Computing The Asset Drift

The asset drift of the firm is calculated from the theoretical relationship between the expected return on assets μ_V and the expected return on equity μ_E. By combing the option Greeks with the stochastic process for equity the following relationship emerges for μ_V, where μ_E is calculated from the CAPM model with δ being the asset payout of the firm.

$$\mu_V = \frac{\mu_E E - \Theta^E - \frac{1}{2}\sigma_V^2 V^2 \Gamma^E}{V\Delta^E} + \delta$$

Θ *Equity Theta*
Γ *Equity Gamma*
Δ *EquityDelta*

Computing Equity Volatility

The volatility of equity σ_E can be estimated from historical stock return data. σ_E is computed as an annualised standard deviation of daily returns over one year, with the returns being expressed using continuous compounding. Stock price data is obtained over the last 252 observations for the period March 2006 to March 2007. The period will ensure that the study matches the calculated volatility with the latest index constituents as well as the market capitalization on that day. It is assumed that an annualisation factor of 252 will be applied to the daily volatility calculations.

The appropriate size of T in calculating volatility with daily data has to be considered. Hull (2002) suggests T between 90 and 180 trading days (in order to take account of the fact that volatility is time varying. It is assumed for the purposes of this study that 252 points of daily data would be sufficient in calculating equity volatility.

An alternative approach in estimating equity volatility would be to use implied volatility. The implied volatility of equity can be extracted from the market prices of options currently traded. The implied volatility is simply the volatility calculated using the Black-Scholes formulae that equates the value of the option equal to the current market value of the option. These volatilities can be calculated using the Newton-Raphson algorithm, however, the listed option market in South Africa has still to be developed for meaningful data to be used.

CADIZ in association with the Johannesburg Stock exchange has recently released a market wide volatility indicator known as the SAVI [37] (The South African Volatility Index). This measure has been calculated using the implied volatility of options currently listed on the Top 40 firms that are currently actively traded. This measure represents a forward-looking 90-day measure of future market volatility. The obvious disadvantage of using this measure is that it represents a holistic market measure as opposed to individual firm implied volatility. As of yet, there are not enough actively traded listed options on all firms in our sample to use the implied volatility measure. To combat this problem we turn to the GARCH (Generalised Autoregressive Conditional Heteroscedasticity) approach as a composite measure of volatility.

GARCH Approach To Measure Volatility

The GARCH (1,1) model has been implemented as a reasonability check to the volatility as calculated above. The GARCH model simply states, that the forecast of tomorrow's volatility is dependant on today's volatility and today's shock.

$$\sigma_{t+1}^2 = \varpi + \alpha\varepsilon_t^2 + \beta\sigma_t^2$$

The GARCH model recognizes that in practice variance tends to get pulled back to a long-run average level and thus incorporates mean reversion. The same time horizon and annualisation factor is used as above. For the implementation of the GARCH model, it is assumed that returns are unpredictable. The Steps in estimating the parameters involve maximum likelihood methods. The MLM process involves choosing values for the parameters that maximize the chance (or likelihood) of the data actually recurring.

[37] See the Johannesburg Stock Exchange for the latest figure currently published on the SAFEX website

The steps in estimating the GARCH parameters are outlined below:

1. It is assumed that the probability distribution of returns conditional on the variance is normal.
2. Equity returns are computed, where $r(t) = \ln(S_t) - \ln(S_t - 1)$.
3. The variance for the first observation is set to the unconditional variance:

$$S_1^2 = \sum_{i=1}^{252} Var(rt)$$

4. The initial values of the parameters of the model are set as follows:

$$\alpha = 0.1 \qquad \beta = 0.85 \qquad \omega = \frac{\sum_{i=1}^{252} Var(rt)}{(1-\alpha-\beta)}$$

5. The conditional variance for the second and third observations and so forth for the time horizon are constructed according the formulae below:

$$\sigma_{t+1}^2 = \varpi + \alpha\varepsilon_t^2 + \beta\sigma_t^2$$

6. The log-likelihood of each observation is computed by the following formula below:

$$L_t = \frac{1}{\sqrt{2\Pi\sigma_t^2}} \exp\left\{\frac{1}{2}\frac{\varepsilon_t^2}{\sigma_t^2}\right\}$$

This can be interpreted as a measure of the relative probability that the GARCH model with the parameters specified generate the data that is actually observed.

7. The final step in implementing the GARCH model would be to maximize the sum of the daily calculated log-likelihood function with respect to the parameters α and β respectively.

For the base-case scenario it is assumed that the current market conditions that prevailed over the last year will continue to prevail over the following year, thus, the volatility of equity is set equal to the unconditional variance as calculated above.

To incorporate possible market conditions as the firm nears default incorporating one and two sigma events, the standard deviation of the daily volatility measure is calculated. The volatility measure is therefore increased by one or two standard deviations for the worst-case scenario measure of volatility respectively.

Value of the Firms Assets and the Volatility of the Assets

This paper assumes that the Newton Raphson iterative algorithm will be used in solving the system of two non-liner equations simultaneously. In order to solve these equations, initial estimates of the value of the firm's assets as well as the volatility of the firm's asset process is required. An approximate of V is obtained where $V = E + D$ and for σ_V, Moody's KMV propose an initial value for $\sigma_V = \sigma_E\left(\frac{E}{E+D}\right)$. After the initial estimates have been set, the systems of non-linear equations (as seen below) are solved for the variables V and σ_V subject to the constraints $V > 0, \sigma_V > 0$.

$$E(V,D) = Ve^{-\delta(T-t)}N(d_1) - De^{-r(T-t)}N(d_2) + (1 - e^{-\delta T})V$$

$$E(V,D) = \frac{\sigma_v e^{-\delta} N(d_1) V}{\sigma_e}$$

Alternative Estimation Procedures

From the perspective of the estimation procedures and the methodology as outlined so far in this paper, there are however, alternative approaches that have been employed in the past to deal with variants of the Merton (1974) model, specifically with respect to solving the system of non-linear equations and estimates of the firm's asset volatility process.

This paper assumes and employs the same methodology as Moody's KMV in setting the initial firm asset volatility. However, alternative and suggested approach, is to estimate the initial value of the assets or the initial leverage ratio which can be used to calculate the firms asset volatility. This procedure is currently employed by earlier studies such as Jones et al. (1984), and Delianedis and Geske (2003), among others.

Following on their studies, Eom et al. (2004) suggest that firm asset volatility can be derived by computing the annualised volatility of the firm's assets from annual balance sheet data. Although, this seems intuitively appealing, this would cause the sample of firms to drop significantly, as Eom et al. (2004) suggest approximately 5 to 10 years of balance sheet data is required for an adequate measurement of firm asset volatility.

Furthermore, this paper assumes that the Newton Raphson iterative algorithm as suggested in Hull (2002) shall be used in solving the system of two non-linear equations. A critique of this of this methodology as outlined in Crosbie and Bohn (2003), is that two key equations;

$$E(V,D) = Ve^{-\delta(T-t)}N(d_1) - De^{-r(T-t)}N(d_2) + (1-e^{-\delta T})V$$

$$E(V,D) = \frac{\sigma_v e^{-\delta} N(d_1) V}{\sigma_e}$$

hold only instantaneously, since in reality both the leverage ratio and the hedge ratio, $N(d_1)$, of individual firms are not adequately stable for the algorithm to provide meaningful estimates. The algorithm forces a stochastic variable to be constant. To combat this problem Crosbie and Bohn (2003), suggest a more complicated iterative procedure for solving the system of non-linear equations. This iterative procedure [38] follows in setting the initial value of $\sigma_V = \sigma_E \left(\frac{E}{E+D} \right)$ as proposed by Moody's KMV. The value of σ_V and the equation as seen below:

$$E(V,D) = Ve^{-\delta(T-t)}N(d_1) - De^{-r(T-t)}N(d_2) + (1 - e^{-\delta T})V$$

are used to infer the market value of firm's assets for every day of the previous year. The implied log return of the firm's assets for each day is calculated and these returns series are used to generate new estimates of σ_V which is used for the next round of iteration. The iteration on σ_V is repeated in this manner until the values of σ_V from two consecutive iterations converge.

Once the converged value of σ_V is obtained, it is used to back out V throughout the equation: $E(V,D) = Ve^{-\delta(T-t)}N(d_1) - De^{-r(T-t)}N(d_2) + (1 - e^{-\delta T})V$.

For the purposes of this paper, it is assumed that the Newton Raphson method shall be an adequate algorithm in solving for the unknown variables of V and σ_V in spite of the argument against this method as outlined in Crosbie and Bohn (2003).

There remains a wealth of other methodologies currently employed to deal with variants of the Merton (1974) model, however these methods base their variable estimates from the key factors as outlined in this section.

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[38] See Bharath and Shumway (2004) and Vassalou and Xing (2004) for further discussion

Results

The implementation of the Merton (1974) structural model has so far received little attention within South African academic literature. This paper attempts to implement the adjusted Merton (1974) model by incorporating all methodologies as published by Moody's KMV. The firm sample currently excludes all financial firms; the notion behind this is that the default barrier defining industrial and financial firms would have to be adjusted generating incomparable results among the sample of firms.

The probabilities of default are calculated for the top 42 non-financial firms currently listed on the JSE. The notion behind the choice of these firms is that equity volatility remains one of the key inputs in the Merton (1974) model. These firms represent the most liquid and actively traded stocks on the JSE and as thus it is assumed that the equity volatility of individual firms would be directly comparable.

The probabilities of default are considered under two scenarios, the base-case and the worst-case respectively. For the base-case scenario it is assumed that the input variables that prevailed over the last year will continue to prevail over the following year, thus all the variables in the model are set to current market conditions/estimates. The worst-case scenario assumes a more stringent set of input variables as it is assumed that in an event of a market crisis, these variables would be more applicable.

Table 1 to follow ranks the sample of firms analysed in terms of their probability of default, from Rank 1 (most likely to default) to Rank 42 (least likely to default.). In addition, Table 1 provides the current rank of the firm on the JSE.

Table 1: Firm Rank according to the Probability of Default

Ticker	JSE Rank	Defualt Rank	Probability of Default (Bps) Base	Worst
NTC	34	1	65.3141220286	202.9391945941
SAP	35	2	38.2810273339	137.0560246012
ANG	14	3	0.2748151766	8.1630729029
IPL	30	4	0.1748030430	9.7636485862
BAW	29	5	0.0870744702	0.1331957475
SOL	7	6	0.0312686589	0.4838321481
SHF	32	7	0.0131680034	0.7863865459
MTN	6	8	0.0027506730	0.1649722740
WHL	39	9	0.0021388954	0.0962981071
HAR	26	10	0.0018816367	0.0915411257
ARI	38	11	0.0012399078	0.0076534113
KIO	28	12	0.0007534043	0.0169206564
NPN	20	13	0.0002658222	0.0659630746
BVT	24	14	0.0002244741	0.1359622098
NPK	52	15	0.0001703643	0.1415990752
BIL	2	16	0.0000754204	0.0055929324
SHP	51	17	0.0000314772	0.3314965994
ILV	74	18	0.0000197142	0.0017327245
TRU	42	19	0.0000154004	0.0350558637
JDG	44	20	0.0000109306	0.0095971039
GFI	15	21	0.0000059586	0.0275876123
MUR	40	22	0.0000051475	0.0600656867
AVI	83	23	0.0000033409	0.0003687128
IMP	11	24	0.0000020230	0.0003784676
MLA	23	25	0.0000014655	0.0000762889
FOS	46	26	0.0000009182	0.0015290487
SUI	47	27	0.0000008423	0.0000193092
TKG	13	28	0.0000007587	0.0000833082
MPC	73	29	0.0000005237	0.0000106647
TBS	31	30	0.0000002947	0.0007966025
LON	17	31	0.0000000402	0.0000409606
NCL	93	32	0.0000000333	0.0000278718
MSM	43	33	0.0000000014	0.0000045576
AGL	1	34	0.0000000005	0.0000345855
PPC	36	35	0.0000000002	0.0000003569
SAB	3	36	0.0000000000	0.0000000652
SPP	71	37	0.0000000000	0.0000006452
ECO	33	38	0.0000000000	0.0000000635
RCH	5	39	0.0000000000	0.0000000215
PIK	45	40	0.0000000000	0.0000000000
AMS	4	41	0.0000000000	0.0000000000
REM	16	42	0.0000000000	0.0000000000

It can be seen that the overall default probabilities under both scenarios are less than one basis point (1bp) bar firms NTC and SAP. It can also be seen that firms included in the lower part of the JSE raking are seen to exhibit higher probabilities of default. The probabilities of default can be seen to drop significantly for the rest of the sample firms after NTC and SAP. It would be plausible to discuss these two firms in detail and show how each firm is analysed and presented in Appendix B prior to a discussion of the overall results. Table 2 below represents an extract from Appendix B showing the variables used for the base-case scenario for NTC and SAP respectively:

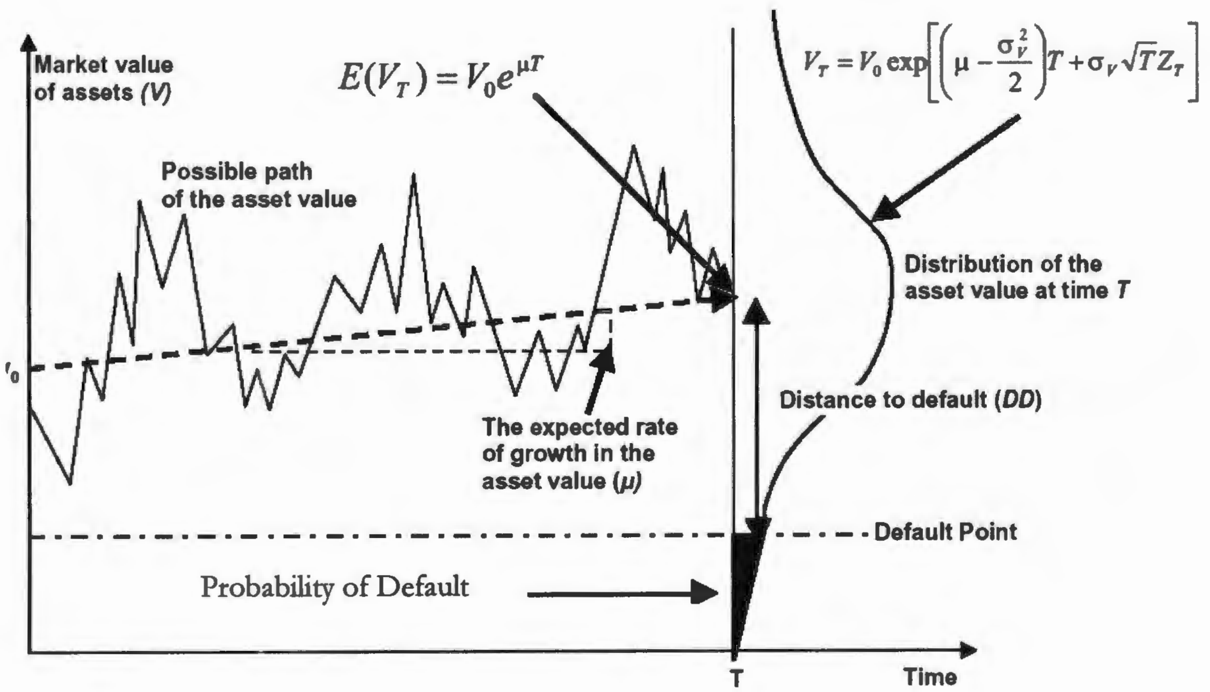
Table 2: NTC and SAP Model Inputs

NTC		SAP	
Rating	N/R	Rating	Ba1
	Rbn		Rbn
Market value of Equity	24.78	Market value of Equity	24.50
Face value of Debt	29.22	Face value of Debt	18.17
D/E	118%	D/E	74%
Forward JIBAR	9.62%	Forward JIBAR	9.62%
Spread	1.35%	Spread	3.38%
Interest Rate	10.97%	Interest Rate	13.00%
Dividend Yield	3.44%	Dividend Yield	2.47%
Payout Ratio	13.85%	Payout Ratio	14.69%
Financing Rate	10.41%	Financing Rate	12.22%
Equity Volatility	30.45%	Equity Volatility	35.23%
Time	1.00	Time	1.00
Equity Drift	11.00%	Equity Drift	12.47%
Beta	0.46	Beta	0.95
Risk Premium	3.00%	Risk Premium	3.00%
Equity Delta	0.87	Equity Delta	0.86
Equity Gamma	0.37	Equity Gamma	0.32
Equity Theta	-5.14	Equity Theta	-8.95
Asset Drift	-0.796%	Asset Drift	3.122%
Adjusted Drift	1.556%	Adjusted Drift	N/A
Value of Assets	51.08	Value of Assets	40.57
Asset Volatility	17.00%	Asset Volatility	24.60%
Market Vlaue of Debt	26.3	Market Vlaue of Debt	16.06
Debt to Assets	51%	Debt to Assets	40%
Probability of Default	0.65314122%	Probability of Default	0.38281027%

The firms SAP and NTC both exhibit very leveraged capital structures in relation to the sample with resultant debt-to-equity ratios of 118% and 74% respectively, furthermore the financial statements of these firms state that finance is generally obtained at Prime (SAP), however, NTC obtains finance at Prime less 200bps. For the purposes of this paper the interest rate coupled with the spreads used in the table above are assumed to be indicative of the forward Prime rate applicable for NTC and SAP over the next year within a continuous framework. The payout rate can further be seen to be a combination of the forward financing rate combined with the asset leakages of the firm's in the form of dividends and interest payments.

It is common knowledge that volatility greatly affects the value of an option, and thus, in the Merton (1974) model, the volatility of the firm asset's σ_V would greatly affect the default probability in the very short-term. The intuition behind this notion is that as asset volatility is sharply increased, there is a higher possibility of the asset value process crossing the threshold barrier triggering default. This notion can schematically be represented and further explained by Figure 2 and Table 3 below.

Figure 2: Value of the firms Assets and the Default Point



Source: Moody's KMV and Crouhy et al. (2000

Figure 2 shows the random possible asset value path of the firm over the horizon period with the development of the firm's asset value at the end of year-one. The expected growth in the asset value of the firm is commonly referred to as the asset drift and is also schematically represented. It can be seen that the market value of the firm's assets can fluctuate (as measured by asset volatility) above the default threshold labelled the default point. The distant-to-default measure is simply the standard deviation of the firm's asset volatility i.e. how many standard deviations the firm's asset value process is away from the default point.

Table 3: Value of the NTC and SAP Assets

NTC

Value of Assets	51.08
Asset Volatility	17.0%
Market Value of Debt	26.30
Debt to Assets	51%
Probability of default	0.65314122%

SAP

Value of Assets	40.57
Asset Volatility	24.6%
Market Value of Debt	16.06
Debt to Assets	40%
Probability of default	0.38281027%

Table 3 shows the Merton (1974) model's output in calculating the asset volatility and the implied market value of the firm and its debt. The market value of debt is simply the difference between the implied firm value less the firm's market capitalisation. These values are obtained by solving the two key non-linear equations simultaneously for variables V and σ_V.

With respect to Table 3, it can be seen that the Debt to Asset ratio for NTC and SAP is calculated to be 51% and 40% respectively. This shows that 51% and 40% of these firms' assets are currently financed by debt.

These ratios clearly show the large amount of debt drawn in the capital structures. This leverage thus implies that the values of NTC's and SAP's assets are far closer to the default threshold than the reaming firms in the sample. The reason behind this is that NTC and SAP both obtain finance at high rates of interest and have higher leakages from their market values. These high leakages cause the possible path of the firm's market value to decrease more rapidly over time i.e. until $t = 1$ (one-year) in the model. When combining the asset volatilities of 17% and 24.6% for NTC and SAP with the possible path of their lower market values, the fluctuation of these assets can be seen to cross the default threshold more often thus triggering default.

The option Greeks, or specifically the equity delta can provide further indication of the equity value of the firm. As equity is seen to be a call option on the firm's assets with the strike price equal to the face value of debt; the delta in this framework shows that as the value of equity rises, the value of firm's assets increases. The deltas for both NTC and SAP are seen to be highly positive indicating that as debt is increased in the capital structure, the delta would decreases, implying a lower equity value in relation to the firm's total assets. This shows that the model of default prediction, and thus the default probability is greatly sensitive for the firms NTC and SAP with respect to the value of the firm assets and their associated volatilities. This notion can further be seen in the sensitivity of delta when measured by the positive gamma. The high sensitivities can be explained by the leverage employed in the capital structures. When combining the theoretical relationship between the expected return on assets and the expected return on equity the asset drift can be calculated and will further be explained below.

Following on Figure 2, the possible path of the market value of the firm includes the expected growth in asset value or asset drift. When considering the asset drifts, the drifts for NTC and SAP are seen to be negative 0.796% and 3.112% respectively. The negative drift contradicts financial theory where expected returns cannot be negative and cannot be lower than the risk-free rate. A way of dealing with this problem is to set the growth rate of assets equal to the risk-free rate, or more applicable in this study, the forward financing rate. NTC is the only firm to exhibit a negative asset drift in the sample of firms. The asset drift for NTC is set to a marginal rate of 1.556% and 0.778% under the base-case and worst-case scenario respectively. The 1.566% represents the difference between the equity drift and the asset-payout percentage of the firm. This rate assumes that due to the large leverage and high payouts in this firm there would be 1.556% of capital for reinvestment purposes.

It can be seen that NTC's and SAP's asset drifts are substantially lower than when compared to the sample mean of 7.6%. These low asset drifts in conjunction with high leakages cause the possible path of the market value to decrease substantially quicker over time (when compared to the sample) causing the probability of reaching the default threshold to increase.

NTC and SAP exhibit debt-to-equity ratios of 118% and 74% respectively; and when compared to the sample mean of 14.26%. These firms can be seen to remain the most leveraged. The high probabilities of default for NTC and SAP as seen in Table 1 stem from the combination of their leverage with higher payout's and their low standard deviation of asset volatility measure. Furthermore, a decreasing market value process caused by higher payouts and low asset drifts for these firms cause the probability to further be increased when compared to the sample.

The probabilities of default for NTC and SAP as calculated by the Merton (1974) model cause these firms to be seen as the most risky over the next year. However, no consideration has been made for cession/security on NTC's and SAP's leverage. Property and fixtures totalling 90% of the total debt amount outstanding secure NTC's debt. This property is considered to be highly marketable thus enabling NTC to use leverage in the capital structure. SAP on the other hand has 80% of its debt in the form of unsecured bank loans with the remaining 20% in the form of publicly traded bonds with specific financial covenants and pledged cession/security.

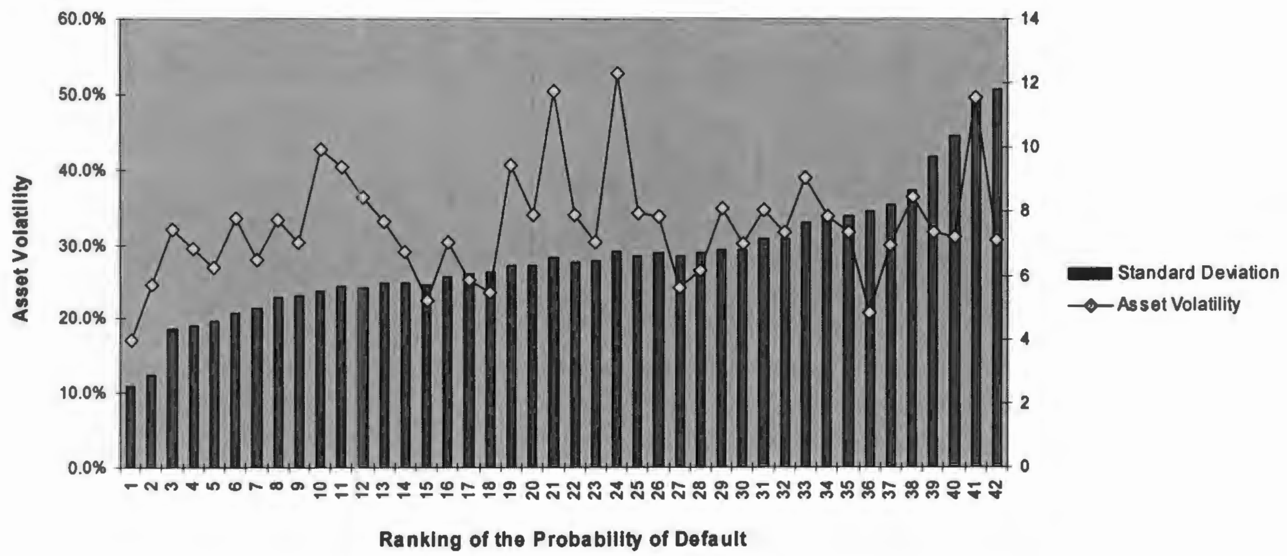
When comparing NTC and SAP to their associated probabilities of default, knowledge of NTC's cession/security clearly contradicts the notion of NTC being the most risky firm as calculated by the Merton (1974) model. A rational thinker would thus infer SAP being more risky than NTC due to the presence of only 20% cession/security for bonds outstanding.

The bias in probabilities calculated is unfortunately a flaw in the model, as security/cession is unfortunately not taken into account. The Merton (1974) model is therefore not an extension or a generalization of traditional credit analysis but raises the question of whether one should take a trade-off between the errors owing to a purely quantitative assessment opposed to a biased judgmental analysis of a firm's soft facts.

Combing back to the overall ranking of the firms in Table 1, the remaining firms in the sample are seen to have probabilities of less than 1bps. These firms can be seen to have an asset value process that will hardly trigger the default barrier even if the asset volatility is seen to be high. The idea behind this result is that most of these firms exhibit relatively higher asset drifts and have market capitalisations in excess of their serviced debt amount. These factors when combined, enable the default threshold to be further away from the value of the firm's assets, thus causing the low probabilities as seen in Table 1.

Following on the notion above, the overall ranking of the firms in Table 1 can be analyzed in terms of the standard deviation of asset volatility and the amount of serviced debt. The Merton (1974) model states that a higher distant-to-default or asset volatility standard deviation would imply being further from the default threshold (the serviced debt amount) thus implying, a lower probability of default. To test if this notion in fact holds in the sample of the firms analysed, the variables standard deviation and the asset volatilities are graphically represented below in Figure 3.

Figure 3: Standard Deviation of Asset Volatility



The hypothesis of the Merton (1974) model conforms to the sample of the firms analysed. As seen in Figure 3 above, the standard deviation of the asset volatility increases as the probability of default declines as measured from the ranking in Table 1 (rank 1-most likely to default, to rank 42-least likely). Figure 3 shows clearly why firms NTC and SAP (ranked 1 and 2 respectively) have the highest default probabilities. These firms have the lowest standard deviations and thus are seen to be closer to their default threshold when compared to the sample.

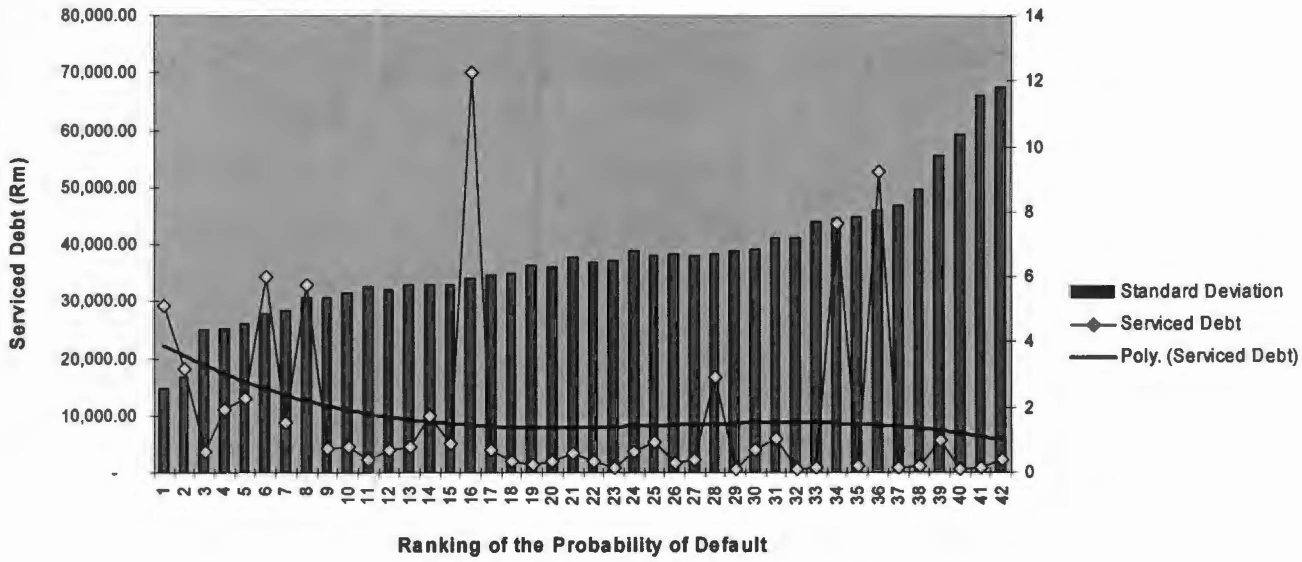
When considering the relationship between the asset volatility and its standard deviation, the relationship seems to be somewhat mixed. Crosbie and Bohn (2003) show that for a sharp decrease in market leverage for a firm trending upwards and whose stock prices are growing rapidly will lead to an overestimation of the asset volatility and subsequently imply a higher probability of default. Crosbie and Bohn (2003) further state that the Merton (1974) model biases the probability in exactly the opposite direction. The intuition behind their notion is that as asset volatility is sharply increased, there is a higher possibility of the asset value process crossing the threshold barrier triggering default.

This notion is true, however, in the South African case, the firm's asset values (bar NTC and SAP) would have to drop severely before any of the firm's possible asset value processes (as measured by asset volatility) would breach the default threshold. This is due to the fact that most of the firms in the sample have market capitalisations far in excess of their serviced debt amount. The Firms ranked 19-24 in the sample exhibit asset volatilities in excess of 40%, however, are seen to have probabilities again of less than 1bps. This provides further evidence that an increase in asset volatility, combined with the lower debt-to-equity ratios would hardly cause the default threshold to be breached.

The asset volatility measure is further exacerbated and can ultimately be seen to be incomparable among firms. This is due to the fact that this measure is calculated from firm specific variables in the Merton (1974) model. It would be impossible to quantify an asset volatility relationship, as firms do not follow homogenous capital structures and payout policies.

A further test to confirm the hypothesis that the standard deviation of asset volatility increases as the serviced debt of the firm is decreased will be presented graphically below in Figure 4. The idea is that as the debt amount decreases in the capital structure, the standard deviation of asset volatility should increase, as the firm's possible asset value process will be further away from the default threshold.

Figure 4: Serviced Debt and the Standard Deviation of Asset volatility



The sample firms analysed can be seen to confirm to the notion that as debt is decreased, the standard deviation of asset volatility is increased. Figure 4 follows the same ranking as can be seen in Table 1 (1-most likely to default, and 42-least likely). A polynomial trend line has been added to the data to graphically display the general trend of the serviced debt data in absence of outliers. It can be seen that most of the firms analysed are relatively un-leveraged, which thus caused the higher standard deviation measure, and as thus, lowers the probabilities of default. The major outliers as seen in Figure 4 are summarized in Table 4 below.

Table 4: Analysis of Data Outliers

Stock	JSE Rank	Market Cap (Rm)	Serviced Debt (Rm)	D/E	Std Deviation	Default Probability (bps)
NTC	34	24,776.61	29,224.00	118%	2.65	65.314122
SOL	7	143,705.41	34,328.00	24%	4.85	0.031269
MTN	6	160,038.40	32,979.00	21%	5.34	0.002751
BIL	2	353,562.12	70,124.00	20%	5.96	0.000075
AGL	1	530,461.10	43,736.00	8%	7.77	0.000000
SAB	3	238,969.43	52,714.00	22%	8.04	0.000000

The outliers as seen in Table 4 above are discussed below to show why these firms exhibit debt amounts in excess of the sample mean (R10, 054.65m) coupled with lower probabilities of default.

This can simply be explained by the market capitalization of the outliers. As seen in Table 4 above, these firms have market values far in excess of their serviced debt amount with debt-to-equity ratios marginally higher than the sample average of 14.26%. These under leveraged structures cause the standard deviation to be higher thus showing that the possible asset value path will hardly reach the default threshold. However, when comparing the results, these outliers seem to have excess debt; however, this debt has to be seen analysed in the context of the entire capital structure.

The higher standard deviation measures for the rest of the sample firm's results from the fact that South African firms can be seen to have relatively un-leveraged capital structures. This implies that firms in South Africa opt to rely ultimately on equity opposed to debt financing. Further evidence of this notion can be seen in Table 4 in the sense that the probability of default decreases with higher market capitalisations.

Independently Rated Firms

It should be noted that most South African firms are not currently rated by rating agencies and in addition, have little, if any, corporately traded debt on the South African Bond Exchange. There remain to be a few firms that are currently rated and are further analysed in the paragraphs to follow.

The ratings of these firms are obtained from Bloomberg [39] and are provided by Moody's and Fitch. Standard and Poor currently provide ratings for the firm's in the sample, however these ratings have been previously obtained either from Moody's or Fitch. This enables the analysis to provide the most robust data set of rated firms within the total sample.

In reality the subsidiary or the parent firm are only rated and therefore it is assumed that firm analysed shall carry the same rating as the subsidiary or parent where applicable. This section seeks to explain some, if any anomalies of the probabilities of default as calculated by the Merton (1974) model and the associated rating as provided from the rating agencies.

It should be noted that most of the rated firms have multi-national operations and are dual listed on other exchanges. In addition, there remain to be a few corporate firms that are also currently rated in the firm sample; this can be seen as the accent of the listed securitizations currently being experienced in the South African debt markets.

For the purposes of this section is necessary to give a brief outline of the hierarchy of the rating categories as assigned by Moody's and Fitch. This hierarchy can be seen in Table 5 below.

Table 5: Rating Categories

Moody's	Fitch	
Aaa	AAA	
Aa	AA	
A	A	
Baa	BBB	
Ba	BB	Below Investment Grade Quality
B	B	Below Investment Grade Quality
Caa	CCC	Below Investment Grade Quality
Ca	CC	Below Investment Grade Quality
C - Default	C - Default	Below Investment Grade Quality

[39] Ratings obtained on 1 August 2007

Moody's appends numerical modifiers 1, 2, and 3 to each generic rating classification from Aa through to Caa. The modifier 1 indicates that the obligation ranks in the higher end of its generic rating category; the modifier 2 indicates a mid-range ranking; and the modifier 3 indicates a ranking in the lower end of that generic rating category. Fitch uses the modifiers + or – to be appended to a rating to denote a relative status within major rating categories.

Firms that are rated at and below Baa3 and BBB- for Moody's and Fitch respectively indicate that that the firm can be considered below investment grade and as such may possess certain speculative characteristics. The capacity for payment of financial commitments is considered adequate but adverse changes in circumstances and economic conditions are more likely to impair the firm's capacity.

The rated firms are displayed graphically in Figure 5, 6 and 7 below as follows: The firm's default rank and the associated base-case probability of default are displaced as represented in Table 1 (Firm Rank according to the Probability of Default). It should be reminded that Rank 1 represents the most likely to default. Figure 5 displays the firms currently rated by Moody's. Figure 6 displays the firms currently rated by Fitch. These figures attempt to establish a relationship between ratings and the associated probability of default.

Figure 5: Moody's Ratings

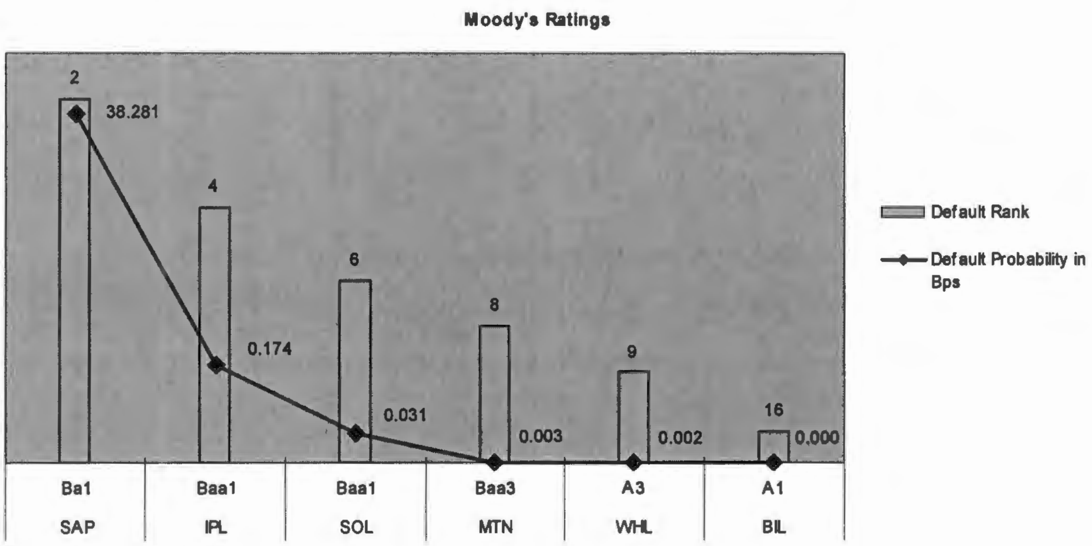
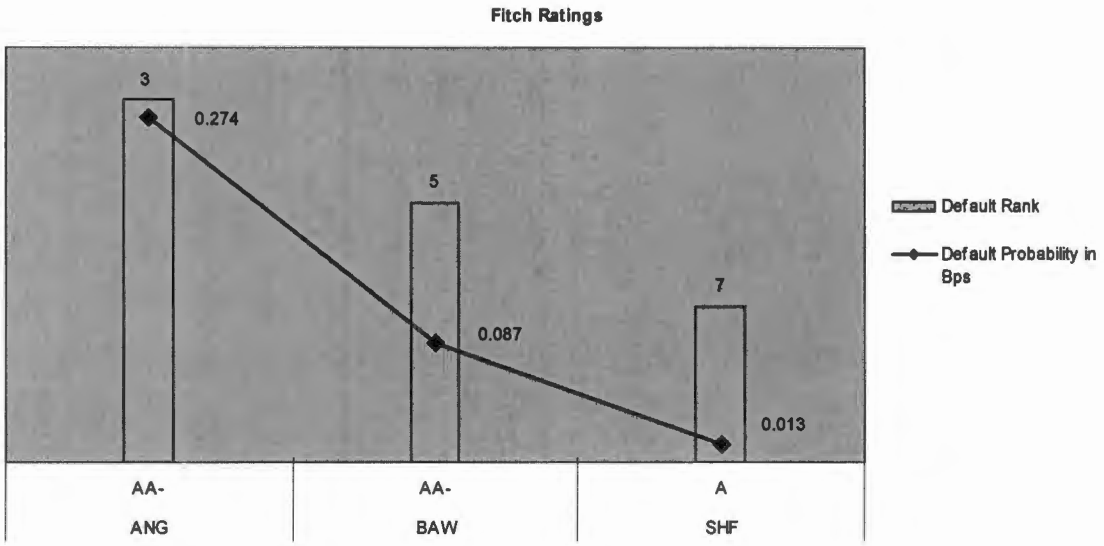


Figure 6: Fitch Ratings



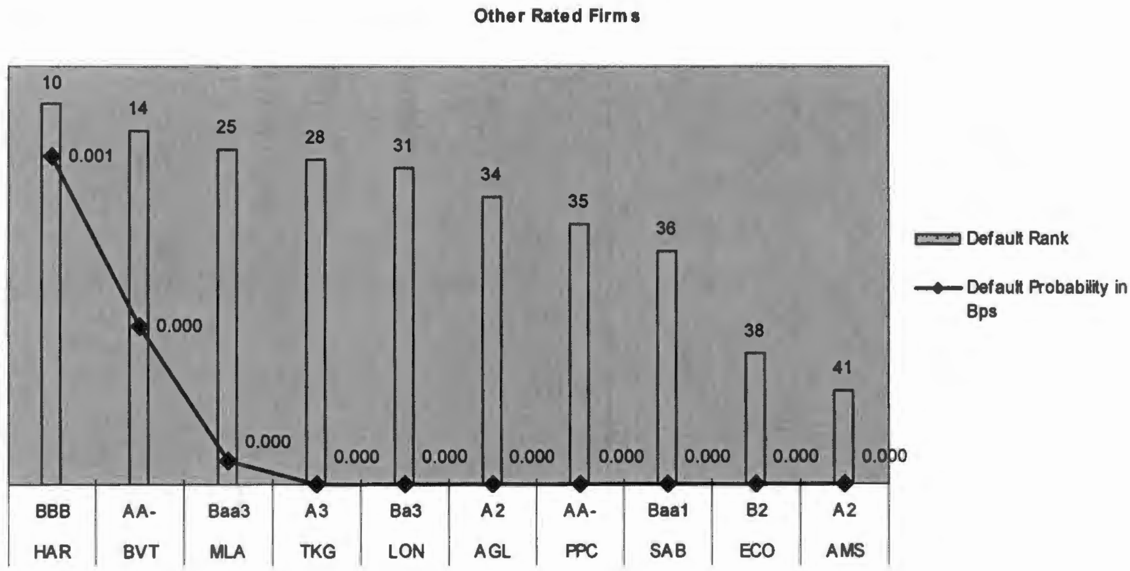
It is assumed that lower default probabilities are associated with higher rating categories. When looking at Figure 5 - the firms rated by Moody's seem to follow a decreasing probability of default with an acceding order of quality i.e. from medium-grade (Ba1) to investment grade (A1) quality. Similarly, Figure 6 - ratings provided by Fitch, can be seen to follow the same trend (AA- to A). Thus, this analysis clearly shows that the Merton (1974) model can be seen as an indicator of the underlining credit risk associated with listed firms. The model is able to quantify lower probabilities of default that are inherent in firms associated with higher ratings.

However, there seems to be discrepancy between ratings provided by Moody's and Fitch. Moody's firm ratings seem to fall in the lower part of the investment grade category while the ratings as provided by Fitch seem to fall in the higher part of the investment grate category. This discrepancy can seem to stem from the fact that rating agencies are slow to upgrade or downgrade ratings with respect to credit events. The data would suggest that Moody's have currently revised their ratings while Fitch is still endeavouring to do so.

Therefore given the results thus far, the purpose of agency ratings is to categorize firms into homogenous groups of default; however, this is not the case in markets such as South Africa. Ratings agencies base their probabilities of default from an international perspective; therefore, assuming that each rating category in South Africa would equate to a homogenous probability would be implausible. The probabilities of default inherent in each rating category are seen to be relative probabilities from an international perspective. This is due to the notion that currently no firm whether listed on the equity or debt markets in South Africa has currently defaulted on its debt and in essence there remains to be limited, if any, historical default data with respect to the South African markets to empirically test this notion.

This concept can be illustrated in Figure7 below; whereby all remaining rated firms and their default rank and associated base-case probabilities are displayed.

Figure 7: Other Rated Firms



It can be seen in Figure 7 above that the remaining rated firms, although ranked in terms of decreasing probabilities of default, seem to have ratings that are not in ascending order of rating quality. HAR and MLA can be seen to be the data outliers in this case. These firms are currently placed in the lowest investment grade category (Baa3 for Moody's and BBB- for Fitch), whilst the other firms tend to be placed within the higher part of the investment grade category, however the probabilities of these firms, despite their different agency ratings tend to remain the same. Figure 7 above shows that the Merton (1974) model does not adequately capture the relationship of a decreasing probability with an associated increase in rating quality. This result can stem from the fact that these default probabilities are so small that the Merton (1974) model cannot effectively distinguish between default probabilities and associated ratings within the investment grade category. Another plausible reason as mentioned earlier is that rating agencies are slow to upgrade or downgrade ratings with respect to changes in credit quality.

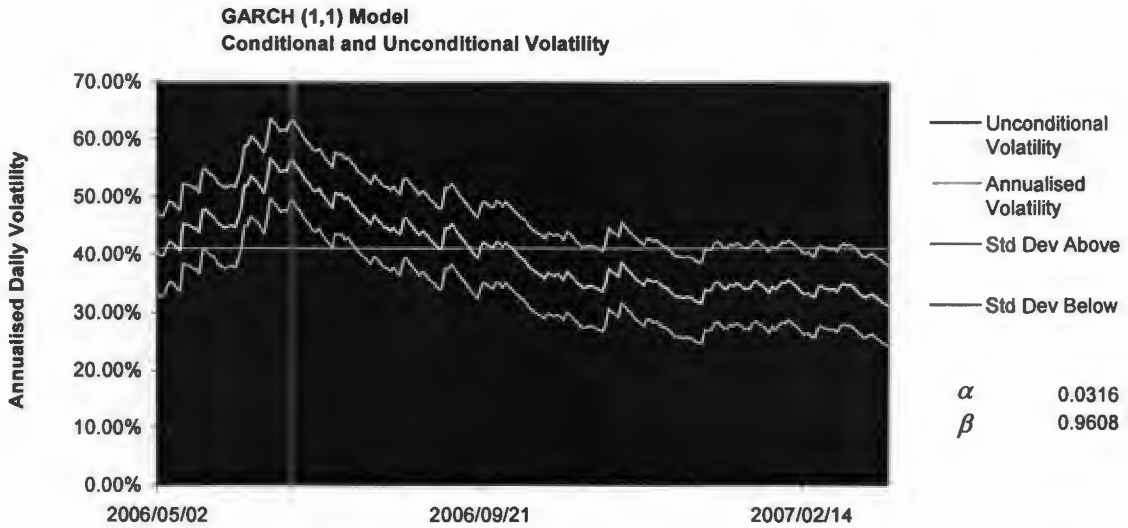
The section to follows attempts to explain why HAR and MLA exhibit probabilities of default equivalent to those of high investment grated rated firms, while being rated BBB and Baa3 respectively. It would be plausible to discuss these data outliers in terms of their equity volatility and their associated probabilities of default under the base-case and worst-case scenario respectively.

Data Outliers: HAR and MLA

The probability of default as calculated by the Merton (1974) model does not adequately distinguish these two firms from the remaining rated firms as presented in the previous section. These firms will be further analysed in terms of their equity volatility as calculated by the GARCH (1,1) model. An output of each firms GARCH (1,1) model is presented in the detailed firm analysis within Appendix B.

The Merton (1974) model assumes that the volatility of individual firms stock prices (on efficient markets) takes into account the inherent volatility of precious metal prices. For HAR and MLA, the respective metal prices that would greatly affect these firms associated probabilities of default are that of gold and steel respectively. Figure 8 and 9 below graphically represent the equity volatility of HAR and MLA over the last year.

Figure 8: HAR Equity Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
39.67%	48.06%	34.11%	41.09%	6.98%

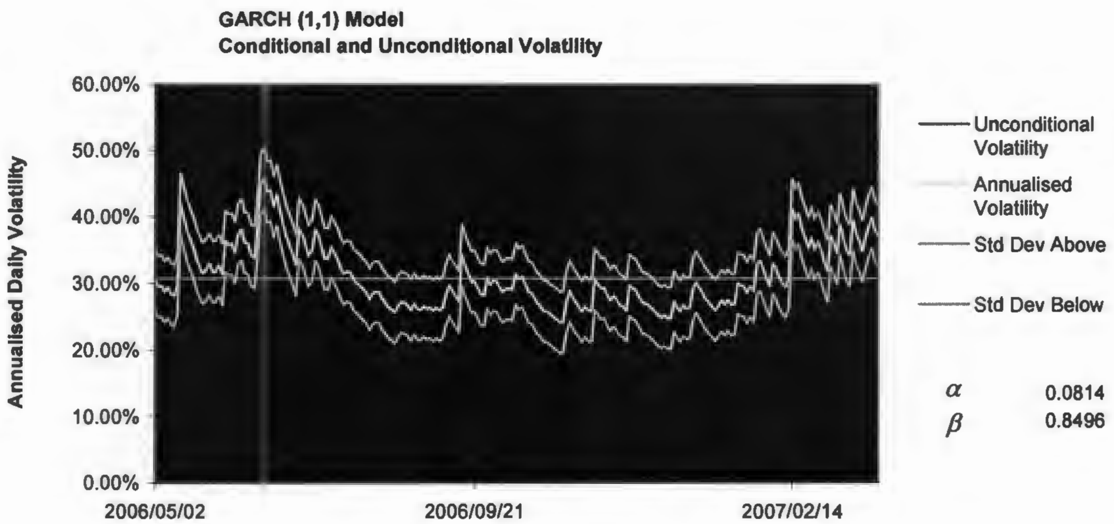
Base Case

Asset Volatility	42.8%
Probability of Default	0.00001882%

Worst Case

Asset Volatility	49.3%
Probability of Default	0.000915411%

Figure 9: MLA Equity Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
31.08%	35.31%	26.12%	30.72%	4.60%

Base Case

Asset Volatility	34.1%
Probability of Default	0.00000001%

Worst Case

Asset Volatility	37.7%
Probability of Default	0.000000763%

It can be seen that the average volatility of HAR and MLA is 39.67% and 31.08% respectively. In addition, these figures clearly show how volatile the HAR and MLA stock price is when considering the standard deviation of volatility of 6.98% and 4.6% respectively. HAR can be seen to be more volatile than MLA, as the volatility breaches the 50% band for most of the sample period. This can be explained by the volatile gold price currently experienced over the last year on world-markets being reflected in HAR's stock price. In contrast to HAR, MLA's volatility breaches only the 40% band in the earlier and later part sample period, while remaining in the 35% band generally. This can be seen in the steel price being not as volatile as the gold price over the period analysed.

When considering the implied asset volatility calculations from the Merton (1974), these seem to follow the general trend of increased equity volatility. Unfortunately, the asset volatility cannot graphically be represented over the last year as equity volatility. This is due to the fact the this measure is an implied output from the Merton (1974) model as calculated from the last year's equity volatility, the value of the firm's assets and its associated liabilities. However, the asset volatility for these two firms remain higher when compared to the sample mean of 32%.

As equity volatility remains one of the key inputs in the Merton (1974) model, it can be shown how the probabilities of default increase substantially from the base-case to the worst-case scenario. This is due to the fact that the worst-case scenario uses a one standard deviation plus input of equity volatility, and as thus, the implied asset volatility can be seen to increase with the associated increase in equity volatility. The increase of these input variables cause the large deviation of default probabilities between the two probabilities under the two scenarios respectively. It should be noted that even with the increased asset volatility, these firm's asset value processes (as discussed for NTC and SAP previously) would hardly trigger the default threshold, as the market capitalizations of these firms' remain well in excess of their serviced debt amount. This clearly shows why the probabilities for HAR and MLA as seen in the base-case and worst-case are far below 1bps respectively.

Crosbie and Bohn (2003) show that the probabilities of default as calculated by the Merton (1974) model are biased precisely in the wrong direction for firms with sharp decreases in market leverage and whose stock prices are growing rapidly. This notion clearly explains the results obtained in the previous section when comparing the rating of HAR and MLA to their associated probabilities of default. These probabilities intuitively should be higher for the firms HAR and MLA, as these firms are rated BBB and Baa3 respectively when compared to the high investment grade rating of the remaining rated firms in Figure 7 previously. The firms HAR and MLA have equity prices that are seen to be bolstered by higher metal prices over the last year. The impact of these higher metal prices causes the stocks of these two firms to grow rapidly and affect the equity volatility calculations as seen in Figures 8 and Figure 9 respectively.

'The impact of higher equity volatility with rapidly growing stock prices in conjunction with low leverage tends to overestimate the asset volatility as implied in the Merton (1974) model' [40]. This overestimation causes the standard deviation of asset volatility to be higher for the firms HAR and MLA respectively. This higher standard deviation measures implies being further away from the default threshold, thus lowering the probability of default, and in this case, biasing the probabilities of default in precisely the wrong direction. This factor can be seen as one reason as to why the firms HAR and MLA are seen to have equivalent probabilities to the remaining high investment grade rated firms, while being rated BBB and Baa3 respectively.

Unfortunately due to the few firms that are rated in the sample further analysis of this kind could not be conducted, and in addition HAR and MLA are seen to be the only data outliers while all other rated firms tend to follow a general trend. A conclusion drawn from this analysis is that the Merton (1974) model cannot effectively distinguish between default probabilities and the associated ratings within the investment grade category. This notion can further be seen in that the remaining rated firms tend to hover within the investment grade-rating category hierarchy displaying similar probabilities of default.

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[40] See Crosbie and Bohn (2002)

Discussion of the Original Merton (1974) Model

The Merton model is able to compensate for a number of deficiencies of traditional credit analysis if correctly specified. The model provides a methodology to effectively include the market's perception of a firm into credit analysis by combing the markets view of forward financing rates, equity values and their associated volatilities.

The basic idea of Merton's structural approach is to relate the default probability of a certain firm to its asset value and volatility. This makes the Merton (1974) model very intuitive with calculations being not prohibitively difficult to calculate. The main advantage of the asset value-based approaches is that the information that will be incorporated into the model is inherently future orientated because equity prices (on efficient markets) reflect the future prospects of firms.

Unlike accounting-based models (such as the Altman Z-score's and Olhson O-score's), the structural model incorporates the measure of asset volatility, which is a crucial variable in bankruptcy prediction. The Merton (1974) model instantly reflects the actual credit risk of the firm because the share prices change almost continuously. Therefore, the probability of default can be estimated at any point in time for any publicly traded firm regardless of the time period and industry.

If default probabilities were published and actively calculated, firms could be individually assessed on a day-to-day basis enabling risk profiles to be evaluated without the associated balance sheet time lags. It would be possible to anticipate possible deteriorations in credit quality quickly within in a reasonable margin of error. This would enable a firms risk profile to be compared on a 'cardinal scale' of a firms relative default risk, instead of the more conventional 'ordinal' ranking proposed by rating agencies by grouping firms of potentially differing credit risks into homogenous rating categories. A common critique of rating agencies is that it takes a substantial amount of time for these agencies to make changes to the credit ratings of firms, and in addition, it costs a firm to be rated. Using equity values and volatilities to infer default probabilities allows the asset-based models such as the Merton (1974) model to reflect information faster than credit ratings and ultimately assess credit quality in absence of such a rating.

Although this argument is theoretically appeasing, this is not necessarily the case because the amount of debt drawn by a company is not published on a day-to-day basis but rather parallel to the accounting periods. In reality there might be unknown undrawn lines of credit that could be used to honor payments and avert a default prior to the market receiving this information.

In Merton (1974) model, each issuer is specific and is characterized by its own asset return distribution, its own capital structure and its own default probability. Therefore, the default probabilities obtained from the Merton (1974) model are unique numbers that are firm specific and directly comparable.

Merton (1974) Model Assumptions

The assumption that the firm has issued one zero-coupon bond maturing at a specific time in the future is highly unrealistic, however an approximate of the face value of this zero coupon bond is assumed to be the face value of all liabilities currently outstanding and due within a specific time (i.e. one-year). In addition to the measurement of the this so called face value of debt, the model is further deteriorated by the fact that Merton considers the concept of default to be only when the total amount of assets is less than the total amount of debt at a certain point in time and thus excludes other reasons of possible bankruptcy such as temporary liquidity problems, law suits and criminal acts.

Furthermore, the firm value and firm value volatility would not be justified if the differential equation defining the equity value process did not include the expected return on the firm value. Merton, therefore, assumes the existence of arbitrageurs who imply that the self-financed portfolio consisting of the firm, equity, and risk-less debt earn the same risk-free rate as other risk-free securities, independent of the expected return. If the portfolio earned more than this return, arbitrageurs could make a risk-less profit by shorting the risk-free securities using the proceeds to buy the portfolio; and if the portfolio earned less, arbitrages could make a risk-less profit by doing the opposite, i.e. by shorting the portfolio and buying risk-free securities.

This deficiency is taken into account by calculating a 'real-world' probability by using forward financing rates opposed to risk-free rates. The study follows literature [41] concerning the Merton model, that the expected return can be calculated from the theoretical relationship between the differential equation defining the process of equity combined with 'option Greeks' and the CAPM model.

Another deficiency of the model stems from the put-call parity principle translated into the capital structure paradigm. As equity is seen as a long call option on the value of the firm, the firm's creditors can be considered to hold the short position of the same option. This situation between creditors and equity owners is slightly different from the short and long position of an ordinary call option because equity holders remain the owners and the managers of the firm in addition to their long option position. This gives the equity holders the opportunity to dispose relatively freely of the firm's assets as it serves their interests. Creditors, on the other hand, as holders of the short position can do little to prevent this until after a default has occurred, however, Merton assumes the original option relationship for simplicity opposed to economic realism.

The application of Itô's Lemma will continue to remain problematical in the model, as Merton assumes that the value of equity is assumed to be solely determined from a function of the firm's asset value and time. It has been shown that equity values are not only influenced by firm's fundamental economic facts, but are also severely affected by speculative tendencies and market imperfections. This would lead to the price of equity containing inefficient information of the firm causing inaccurate estimates of default probabilities.

The assessment of the firms creditworthiness based solely upon the performance of its stock price is further deteriorated by the assumption that the value of the firm follows an autoregressive process. There are many other exogenous factors that could change the characteristics of the firm's value. These factors include amongst others; country risk, general fluctuations within the economic environment, industry business cycle effects and productivity shocks which are currently ignored in the model.

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[41] Hillegeist et Al (2004)

Having completely tied down default analysis to a purely quantitative analysis of the firm value process, all errors attributable to judgmental analyses could be avoided, however judgmental analysis could not be completely ignored but supplemented by the advent of a market implied default metric. Merton's model is therefore not an extension or a generalization of traditional credit analysis.

Extensions of the Merton (1974) Model by Moody's KMV

The many technical assumptions of the Merton model greatly diminished its practicability for assessing default probabilities. This led the KMV Corporation (now Moody's KMV) in the early 1980's to extend the Merton model to a variant, the Vasicek-Kealhofer model.

The Vasicek-Kealhofer model has the same conceptual architecture as the Merton approach, but above all tries to weaken and adapt the technical assumptions. While Merton assumes the firm's liabilities to only consist of two classes, a debt issue maturing on a specific date and equity, Moody's KMV allows liabilities to include current liabilities, short-term debt, long-term debt, convertible debt, preferred stock, convertible preferred stock, and common equity.

Moody's KMV takes account of dividend payments and cash payments of interest prior to the maturity of the debt and in essence Moody's KMV generalizes the concept of default. In the Merton (1974) model, default was equivalent to the firm value being lower than the debt at the moment when the debt had to be repaid. In the Vasicek-Kealhofer model default can happen even before the maturity of a particular debt issue. Equity, in this context, has no expiration date, but is modelled as a perpetual option or a barrier option [42].

In the Moody's KMV model, the firm value process is only modelled as a geometric Brownian motion for the purpose of calculation of the unknown input variables and the standard deviation of asset volatility or referred to as the distant-to-default. It had turned

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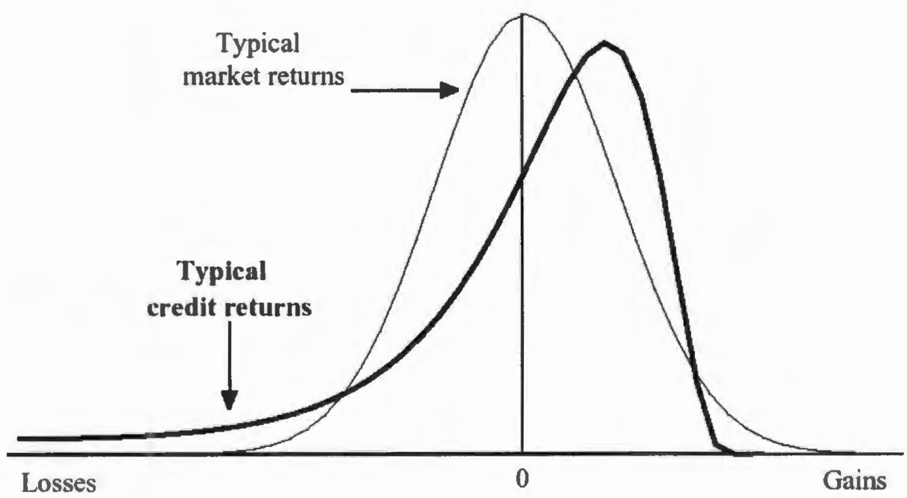
42 See Hull (2002) for a further discussion on exotic options.

out that the mapping of the distance to default measure to default probabilities via the lognormal law implied by the geometric Brownian motion led to implausible results.

The main difference between the classical Merton (1974) model and the Moody's KMV model is that the original Merton (1974) model uses the cumulative Normal distribution to convert the distances-to-default into default probabilities. However, Moody's KMV rightly argues that the probability of default implied from the Normal distribution is far too low for adequate measurement, and in addition, the credit curve can be seen to be Non-Normal but highly skewed and fat-tailed. This can be seen in Figure 10 below.

Figure 10: Market Returns vs. Credit Returns



Source: Credit Metrics (1997) JP Morgan Technical Document

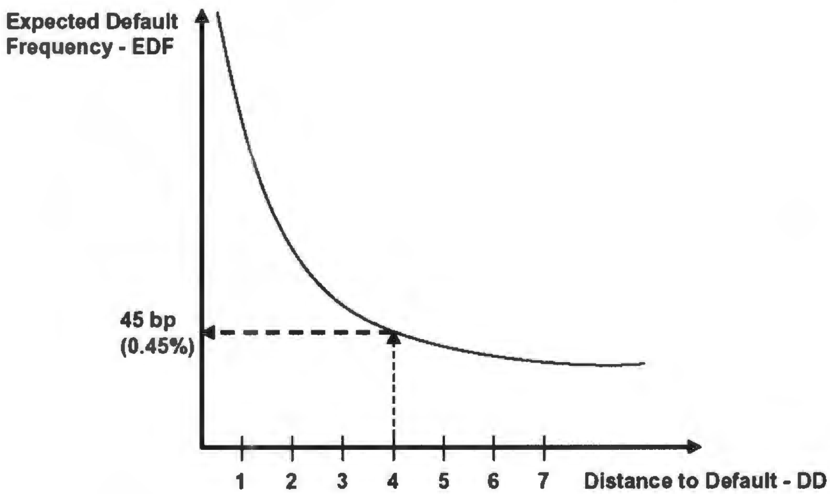
The resulting distribution of typical credit returns can be seen to have much wider tails than the Normal distribution and furthermore, when considering the Normal distribution, firms that represent a distant-to-default of more than 3.49 equate to probabilities of effectively zero. However, Moody's KMV have shown that firms with standard deviations of 4-6 have indeed defaulted [43].

[43] Measuring & Managing Credit Risk: Understanding the EDF Credit Measure for Public Firms (2004) – Moody's KMV

Moody's KMV therefore uses its wide historical company database (since 1973) to estimate the empirical distribution of distances-to-default and thus calculates default probabilities based on this propriety distribution.

Moody's KMV refers to their default probability as the Expected Default Frequency). The distance-to-default is therefore mapped into the Expected Default Frequency for a given time horizon. This mapping can be seen in Figure 11 below.

Figure 11: Mapping the distant-to-default into the Expected Default Frequencies



Source: Crosbie and Bohn (2003)

Referring to Figure 11 above, a distance-to-default of 4 (4 standard deviations away from default) would from the Normal distribution imply a zero probability of default, however, Moody's KMV maps this distance-to-default of 4 to a default rate of around 45 bps (0.45%).

According to the researchers employed by Moody's KMV; they show that the Moody's KMV model outperforms the original Merton (1974) model significantly [44]. However, the possibility to use the Moody's KMV model and the EDF measures in South Africa is questionable.

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[44] See: Sobehart and Keenan (1999)

The distance-to-default should capture most of the relevant inter-country differences in default risk [45] however the different economic prospects for countries are already captured by the individual equity and asset valuations. Furthermore, the Moody's KMV empirical propriety default distribution is built on publicly listed firms in the United States and, as a result, translation to other countries is uncertain. However, Moody's KMV claims that their experience internationally has been very good and that over half of their customers operate outside of the US. This fact can further be the fact that one of the prominent four banks in South Africa – Nedbank, has currently implemented the Moody's KMV model for credit risk estimation.

The Moody's KMV model is valuable because it rendered the Merton (1974) model operational and turned it into a useful tool for practitioners. The model enables risk managers to monitor public companies on a day-to-day basis and use the estimated default probability as an early warning signal providing information that is entirely based on automated and purely quantitative analysis, and once in operation, the model is unlikely to fail due to human misinterpretation of the actual economic situation.

However, being an extension of the Merton (1974) model, the Moody's KMV model inherits all its severe structural problems. Moreover, Moody's KMV has so far refused to publish the precise methodology and the data upon which the empirical distributions are calculated.

This cannot be compensated by the fact that Moody's KMV asserts to have done detailed research that has proved all results. The lack of a publicly available test is critical because the exponential relationship between distance to default and estimated probability of default is so sensitive that small errors in the measuring of the distance to default or in the mapping between both quantities may lead to significant errors in the resulting default probability.

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[45] Crosbie and Bohn (2003)

Conclusion

This paper attempts to incorporate all the published methodologies as proposed by Moody's KMV in implementation of the Merton (1974) model, however certain methodologies will remain propriety to Moody's KMV. The implementation of the Merton (1974) model on the Johannesburg Stock exchange in South Africa has yielded some interesting results. Firstly, South African firms are seen to be un-leveraged and tend to rely on equity financing as opposed to debt financing. NTC and SAP are the only two firms in the sample where relatively high degrees of leverage have been used in the capital structure. Further evidence of this notion can be seen in the probabilities of default being below 1bps for all firms bar NTC and SAP in the sample. In addition, a relationship between the default probabilities as calculated by the Merton (1974) model and firms rated in the lower part of the investment-grade category has been established, however, the Merton (1974) model cannot adequately distinguish firms in terms of their probability of default within the higher part of the investment-grade category. Unfortunately due to the few firms that are currently rated in the sample, further analysis of this kind could not be conducted. The overall result of this paper is that the Merton (1974) model when correctly specified can provide information of the underlying credit risk of publicly traded firms in South Africa.

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Appendix A: Data Tables

				R Millions				
Security	**JSE Rank**	**Index**	**Ticker**	**Mkt Cap (ZAR)**	**Serviced Debt (ZAR)**	**D/E**	**Shares**	**Price (Cent)**
Network Healthcare Ltd	34	Top 40	NTC	24,776.61	29,224.00	117.95%	1,782,490,221.00	1,390.00
Sappi Ltd	35	Top 40	SAP	24,504.88	18,167.00	74.14%	239,072,000.00	10,250.00
Anglogold Ashanti Ltd	14	Top 40	ANG	87,431.39	3,720.00	4.25%	275,114,519.00	31,780.00
Imperial Holdings Ltd	30	Top 40	IPL	32,949.51	11,088.00	33.65%	207,896,450.00	15,849.00
Barloworld Ltd	29	Top 40	BAW	35,097.81	13,000.00	37.04%	200,558,926.00	17,500.00
Sasol Ltd	7	Top 40	SOL	143,705.41	34,328.00	23.89%	624,806,148.00	23,000.00
Steinhoff International Holdings Ltd	32	Top 40	SHF	28,286.26	8,838.10	31.25%	1,140,575,014.00	2,480.00
MTN Group Ltd	6	Top 40	MTN	160,038.40	32,979.00	20.61%	1,850,154,903.00	8,650.00
Woolworths Holdings Ltd	39	Mid Cap	WHL	17,969.51	4,253.80	23.67%	883,022,422.00	2,035.00
Harmony G M Co Ltd	26	Top 40	HAR	39,635.42	4,500.00	11.35%	398,345,944.00	9,950.00
African Rainbow Minerals Ltd	38	Mid Cap	ARI	19,663.98	2,252.00	11.45%	206,554,429.00	9,520.00
Kumba Iron Ore Ltd	28	Top 40	KIO	39,202.44	4,019.00	10.25%	313,594,471.00	12,501.00
Naspers Ltd	20	Top 40	NPN	55,302.40	4,444.00	8.04%	321,058,936.00	17,225.00
Bidvest Ltd	24	Top 40	BVT	44,665.31	9,800.00	21.94%	324,815,015.00	13,751.00
Nampak Ltd	52	Mid Cap	NPK	14,389.05	4,971.60	34.55%	650,793,627.00	2,211.00
Bhp Billiton Plc	2	Top 40	BIL	353,562.12	70,124.00	19.83%	2,468,147,415.00	14,325.00
Shoprite Holdings Ltd	51	Mid Cap	SHP	14,657.64	3,917.00	26.72%	543,479,460.00	2,697.00
Illovo Sugar Ltd	74	Mid Cap	ILV	6,929.57	1,960.00	28.28%	348,745,100.00	1,987.00
Truworths International Ltd	42	Mid Cap	TRU	16,468.73	1,430.20	8.68%	487,240,507.00	3,380.00
JD Group Ltd	44	Mid Cap	JDG	15,904.35	2,113.00	13.29%	178,500,000.00	8,910.00
Gold Fields Ltd	15	Top 40	GFI	80,773.02	3,422.60	4.24%	650,346,416.00	12,420.00
Murray And Roberts Ltd	40	Mid Cap	MUR	17,357.98	2,074.10	11.95%	331,892,619.00	5,230.00
Avi Ltd	83	Mid Cap	AVI	5,582.34	888.00	15.91%	315,386,460.00	1,770.00
Impala Platinum Holdings Ltd	11	Top 40	IMP	110,221.51	3,590.30	3.26%	553,876,920.00	19,900.00
Mittal Steel SA Ltd	23	Top 40	MLA	49,032.73	5,527.00	11.27%	445,752,132.00	11,000.00
Foschini Ltd	46	Mid Cap	FOS	15,259.61	1,779.40	11.66%	240,498,241.00	6,345.00
Sun International Ltd	47	Mid Cap	SUI	15,203.93	2,325.60	15.30%	117,859,947.00	12,900.00
Telkom SA Ltd	13	Top 40	TKG	88,553.55	16,754.00	18.92%	544,944,899.00	16,250.00
Mr Price Group Ltd	73	Mid Cap	MPC	6,949.61	700.00	10.07%	233,993,604.00	2,970.00
Tiger Brands Ltd	31	Top 40	TBS	28,789.76	3,977.10	13.81%	170,605,986.00	16,875.00
Lonmin Plc	17	Top 40	LON	62,354.68	6,075.00	9.74%	142,884,228.00	43,640.00
New Clicks Holdings Ltd	93	Mid Cap	NCL	4,521.29	500.00	11.06%	353,226,015.00	1,280.00
Massmart Holdings Ltd	43	Mid Cap	MSM	16,433.23	900.00	5.48%	199,190,697.00	8,250.00
Anglo American Plc	1	Top 40	AGL	530,791.10	43,736.00	8.24%	1,517,413,104.00	34,980.00
Pretoria Port Cement Ltd	36	Top 40	PPC	22,595.34	1,065.60	4.72%	53,670,631.00	42,100.00
Sabmiller Plc	3	Top 40	SAB	238,969.43	52,714.00	22.06%	1,496,364,622.00	15,970.00
The Spar Group Ltd	71	Mid Cap	SPP	7,705.75	716.00	9.29%	168,505,420.00	4,573.00
Edgars Cons Stores Ltd	33	Top 40	ECO	25,091.05	1,168.00	4.66%	566,133,829.00	4,432.00
Richemont Securities Ltd	5	Top 40	RCH	206,190.00	5,551.00	2.69%	5,220,000,000.00	3,950.00
Pik N Pay Stores Ltd	45	Top 40	PIK	15,346.25	646.23	4.21%	485,948,357.00	3,158.00
Anglo Platinum Ltd	4	Top 40	AMS	215,594.67	835.60	0.39%	218,877,839.00	98,500.00
Remgro Ltd	16	Top 40	REM	78,531.41	2,221.21	2.83%	448,802,207.00	17,498.00
Average				71,833.07	10,054.65	14.26%	664,789,040.00	14,128.14

Ticker	JSE Rank	Defualt Rank	Probability of Default (Bps) Base	Probability of Default (Bps) Worst	Std Deviation Base	Std Deviation Worst	Asset Volatility Base	Asset Volatility Worst	Asset Drift Base	Asset Drift Worst
NTC	34	1	65.3141220286	202.9391945941	2.65	2.25	17.0%	20.2%	1.556%	0.778%
SAP	35	2	38.2810273339	137.0560246012	2.91	2.49	24.6%	28.1%	3.112%	0.450%
ANG	14	3	0.2748151766	8.1630729029	4.35	3.54	32.0%	39.2%	8.464%	5.279%
IPL	30	4	0.1748030430	9.7636485862	4.43	3.48	29.5%	38.4%	7.240%	5.019%
BAW	29	5	0.0870744702	0.1331957475	4.56	4.47	26.9%	27.3%	7.135%	4.562%
SOL	7	6	0.0312686589	0.4838321481	4.85	4.28	33.5%	38.0%	10.123%	6.453%
SHF	32	7	0.0131680034	0.7863865459	4.96	4.10	28.0%	33.8%	8.696%	5.939%
MTN	6	8	0.0027506730	0.1649722740	5.34	4.54	33.4%	39.0%	9.256%	7.066%
WHL	39	9	0.0021388954	0.0962981071	5.36	4.63	30.3%	35.6%	8.339%	6.684%
HAR	26	10	0.0018816367	0.0915411257	5.51	4.78	42.8%	49.3%	13.940%	8.617%
ARI	38	11	0.0012399078	0.0076534113	5.69	5.52	40.4%	43.8%	12.090%	8.608%
KIO	28	12	0.0007534043	0.0169206564	5.62	5.05	36.4%	40.3%	12.295%	7.910%
NPN	20	13	0.0002658222	0.0659630746	5.77	4.76	33.0%	39.8%	10.126%	7.459%
BVT	24	14	0.0002244741	0.1359622098	5.76	4.57	29.0%	37.1%	8.526%	6.763%
NPK	52	15	0.0001703643	0.1415990752	5.74	4.48	22.4%	29.4%	6.820%	5.269%
BIL	2	16	0.0000754204	0.0055929324	5.96	5.21	30.3%	34.2%	10.920%	7.148%
SHP	51	17	0.0000314772	0.3314965994	6.06	4.35	25.2%	35.6%	7.144%	6.262%
ILV	74	18	0.0000197142	0.0017327245	6.12	5.36	23.5%	26.7%	11.750%	5.693%
TRU	42	19	0.0000154004	0.0350558637	6.33	5.02	40.6%	52.4%	10.158%	9.093%
JDG	44	20	0.0000109306	0.0095971039	6.32	5.18	34.0%	42.2%	9.046%	8.286%
GFI	15	21	0.0000059586	0.0275876123	6.58	5.19	50.3%	64.9%	13.991%	10.099%
MUR	40	22	0.0000051475	0.0600656867	6.45	4.85	34.0%	47.0%	9.911%	8.509%
AVI	83	23	0.0000033409	0.0003687128	6.48	5.73	30.3%	34.4%	8.933%	7.785%
IMP	11	24	0.0000020230	0.0003784676	6.78	5.98	52.7%	60.2%	16.150%	10.307%
MLA	23	25	0.0000014655	0.0000762889	6.64	6.04	34.1%	37.7%	12.991%	8.652%
FOS	46	26	0.0000009182	0.0015290487	6.71	5.53	33.7%	41.3%	10.086%	8.564%
SUI	47	27	0.0000008423	0.0000193092	6.63	6.15	24.1%	25.9%	8.959%	6.486%
TKG	13	28	0.0000007587	0.0000833082	6.71	5.94	26.5%	30.1%	8.748%	7.196%
MPC	73	29	0.0000005237	0.0000106647	6.81	6.36	34.9%	37.6%	10.871%	8.887%
TBS	31	30	0.0000002947	0.0007966025	6.85	5.61	30.1%	37.2%	10.141%	8.135%
LON	17	31	0.0000000402	0.0000409606	7.18	6.16	34.6%	40.0%	12.914%	8.901%
NCL	93	32	0.0000000333	0.0000278718	7.18	6.20	31.6%	36.9%	10.342%	8.697%
MSM	43	33	0.0000000014	0.0000045576	7.69	6.59	38.9%	46.1%	10.864%	9.730%
AGL	1	34	0.0000000005	0.0000345855	7.77	6.21	33.8%	42.0%	13.750%	9.230%
PPC	36	35	0.0000000002	0.0000003569	7.85	6.88	31.6%	36.5%	10.801%	9.140%
SAB	3	36	0.0000000000	0.0000000652	8.04	7.01	20.8%	23.7%	11.840%	6.792%
SPP	71	37	0.0000000000	0.0000006452	8.20	6.79	30.0%	36.3%	10.746%	9.047%
ECO	33	38	0.0000000000	0.0000000635	8.69	7.21	36.3%	44.2%	11.619%	9.855%
RCH	5	39	0.0000000000	0.0000000215	9.73	7.35	31.7%	42.0%	13.094%	9.765%
PIK	45	40	0.0000000000	0.0000000000	10.37	8.48	31.0%	38.4%	11.327%	9.991%
AMS	4	41	0.0000000000	0.0000000000	11.55	9.53	49.5%	60.1%	16.444%	10.721%
REM	16	42	0.0000000000	0.0000000000	11.82	9.27	30.6%	39.4%	12.080%	10.266%

Average					Std Deviation Base	Std Deviation Worst	Asset Volatility Base	Asset Volatility Worst	Asset Drift Base	Asset Drift Worst
Average					6.60	5.55	32.5%	38.9%	10.3%	7.6%

Merton (1974) Model Outputs

Beta Calculations as provided by Cadiz FSG

Ticker	Beta	Annualised Alpha	Std Error(β)	Annualised Total Risk	Annualised Unique Risk	R2	% Days Traded	No of Months
NTC	0.46	-6.88	0.10	33.49	15.88	77.520	99.440	60.000
SAP	0.95	3.70	0.11	31.24	17.28	69.410	99.440	60.000
ANG	1.04	4.92	0.10	22.09	15.55	50.420	99.440	60.000
IPL	0.63	-8.76	0.17	45.39	27.56	63.130	99.440	60.000
BAW	0.77	-5.58	0.12	28.63	18.69	57.400	99.440	60.000
SOL	1.12	17.13	0.21	37.55	34.38	16.160	99.440	60.000
SHF	0.84	8.77	0.14	33.11	22.66	53.190	99.440	60.000
MTN	0.70	6.45	0.18	44.58	28.82	58.220	99.440	60.000
WHL	0.40	63.06	0.28	29.02	29.01	0.020	99.090	36.000
HAR	1.44	7.23	0.18	37.34	29.56	37.320	99.440	60.000
ARI	1.54	16.94	0.24	45.48	38.42	28.630	99.440	60.000
KIO	1.31	14.08	0.10	18.32	15.45	28.890	99.440	60.000
NPN	0.84	-0.58	0.17	38.37	26.99	50.500	83.267	60.000
BVT	0.47	24.19	0.25	44.91	40.90	17.050	99.440	60.000
NPK	0.36	37.46	0.30	49.88	43.07	25.430	99.724	52.000
BIL	1.21	12.20	0.12	21.72	19.30	21.020	99.440	60.000
SHP	0.20	4.25	0.30	59.2	48.62	32.530	99.440	60.000
ILV	0.71	14.97	0.22	41.64	31.11	44.170	99.263	52.000
TRU	0.25	6.46	0.12	25.05	18.79	43.720	99.440	60.000
JDG	0.14	12.37	0.15	27.25	23.74	24.100	99.359	60.000
GFI	1.09	16.69	0.11	21.2	18.26	25.860	99.440	60.000
MUR	0.42	13.66	0.14	28.73	22.42	39.090	99.359	60.000
AVI	0.28	57.12	0.22	37.52	36.31	6.360	98.879	60.000
IMP	1.55	31.60	0.14	24.91	22.89	15.540	99.440	60.000
MLA	1.15	-6.45	0.15	32.22	24.74	41.040	99.520	60.000
FOS	0.40	34.38	0.16	27.08	25.88	8.640	97.198	60.000
SUI	0.72	-42.92	0.28	36.51	22.24	62.910	96.708	23.000
TKG	0.04	28.21	0.13	22.02	20.33	14.790	99.359	60.000
MPC	0.49	31.30	0.18	29.61	28.30	8.670	99.279	60.000
TBS	0.51	35.90	0.15	25.4	24.88	4.040	99.359	60.000
LON	1.25	38.35	0.18	28.96	28.47	3.350	96.958	60.000
NCL	0.41	24.72	0.22	35.66	35.59	0.430	99.279	60.000
MSM	0.26	15.68	0.15	25.57	24.76	6.250	99.359	60.000
AGL	1.38	46.12	0.15	25.08	23.66	10.980	99.039	60.000
PPC	0.37	24.11	0.36	28.38	24.89	23.120	98.913	17.000
SAB	0.74	24.96	0.16	26.24	25.96	2.160	99.279	60.000
SPP	0.45	3.43	0.10	17.84	16.16	17.950	99.440	60.000
ECO	0.45	9.90	0.31	51.49	50.14	5.200	77.287	60.000
RCH	1.01	28.22	0.25	18.99	17.25	17.480	99.176	17.000
PIK	0.31	36.78	0.19	32.55	30.87	10.060	98.559	60.000
AMS	1.64	15.56	0.15	28.49	24.07	28.610	99.359	60.000
REM	0.47	13.30	0.17	28.42	27.84	4.050	99.440	60.000
	0.73	16.98	0.18	32.07	26.71	27.51	98.26	56.12

Network Healthcare Holdings Ltd:
AFS Date: 20 Sep 2006
Rating: N/R

Appendix B: Individual Analysis of Firm Variables

NTC

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	1.35%
Interest Rate	10.97%
Continuous	10.41%
Dividend Yield	3.50%
Continuous DY	3.44%
Asset Payout	13.85%

	Rbn
Market value of Equity	24.78
Face value of Debt	29.22
Payout Ratio	13.85%
Interest Rate	10.41%
Equity Volatility	30.45%
Time	1.00

Equity Drift	11.00%
Beta	0.46
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.37
Equity Theta	-5.14
Asset Drift	-0.796%

Adjusted Asset Drift 1.556%

Worst Case

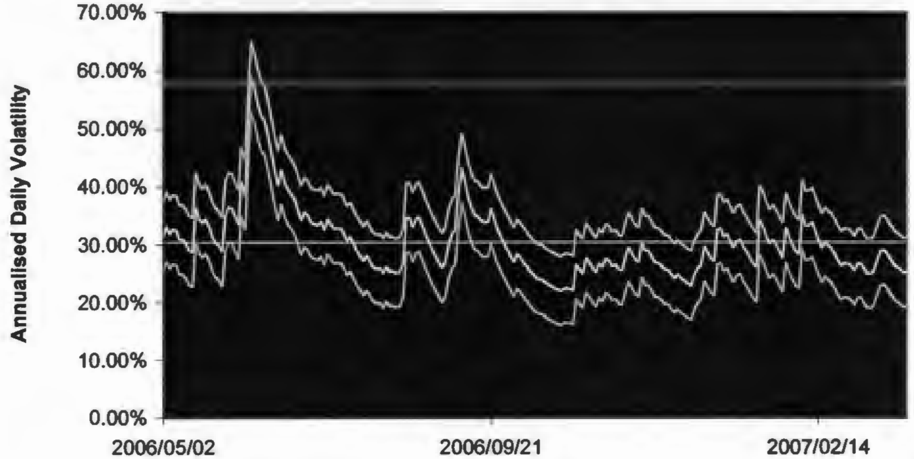
1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.35%
Interest Rate	12.97%
Continuous	12.20%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.20%

	Rbn
Market value of Equity	24.78
Face value of Debt	29.22
Payout Ratio	12.20%
Interest Rate	12.20%
Equity Volatility	36.42%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.32
Equity Theta	-8.19
Asset Drift	-1.693%

Adjusted Asset Drift 0.778%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0853
β	0.8497

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
30.17%	36.42%	24.48%	30.45%	5.97%

Base Case

	Rbn
Value of Assets	51.08
Asset Volatility	17.0%
Market value of debt	26.30
Probability of default	0.65314122%

Worst Case

	Rbn
Value of Assets	50.53
Asset Volatility	20.2%
Market value of debt	25.76
Probability of default	2.029391946%

Sappi Ltd

AFS Date: 20 Sep 2006

Rating: Ba1

SAP

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.38%
Interest Rate	13.00%
Continuous	12.22%
Dividend Yield	2.50%
Continuous DY	2.47%
Asset Payout	14.69%

Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.38%
Interest Rate	15.00%
Continuous	13.98%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.98%

Base Case

	Rbn
Market value of Equity	24.50
Face value of Debt	18.17
Payout Ratio	14.69%
Interest Rate	12.22%
Equity Volatility	35.23%
Time	1.00

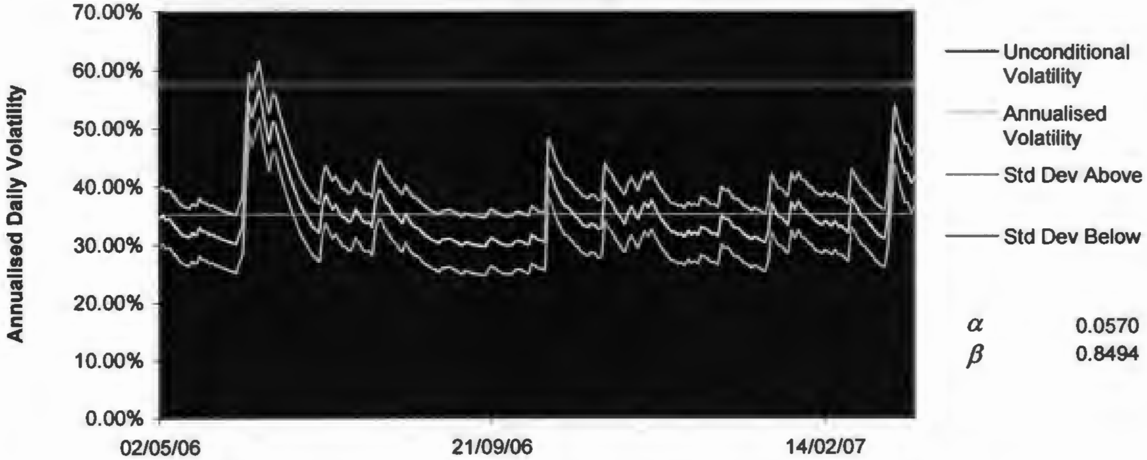
Equity Drift	12.47%
Beta	0.95
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.32
Equity Theta	-8.95
Asset Drift	3.122%

Worst Case

	Rbn
Market value of Equity	24.50
Face value of Debt	18.17
Payout Ratio	13.98%
Interest Rate	13.98%
Equity Volatility	40.18%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.29
Equity Theta	-11.22
Asset Drift	0.450%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0570
β	0.8494

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
35.13%	40.18%	30.27%	35.23%	4.96%

Base Case

	Rbn
Value of Assets	40.57
Asset Volatility	24.6%
Market value of debt	16.06
Probability of default	0.38281027%

Worst Case

	Rbn
Value of Assets	40.25
Asset Volatility	28.1%
Market value of debt	15.74
Probability of default	1.370560246%

Anglogold Ashanti Ltd
AFS Date: 31 Dec 2006
Rating: AA-

ANG

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	2.27%
Continuous DY	2.24%
Asset Payout	13.86%

	Rbn
Market value of Equity	87.43
Face value of Debt	27.78
Payout Ratio	13.86%
Interest Rate	11.62%
Equity Volatility	35.73%
Time	1.00

Equity Drift	12.74%
Beta	1.04
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.09
Equity Theta	-41.69
Asset Drift	8.464%

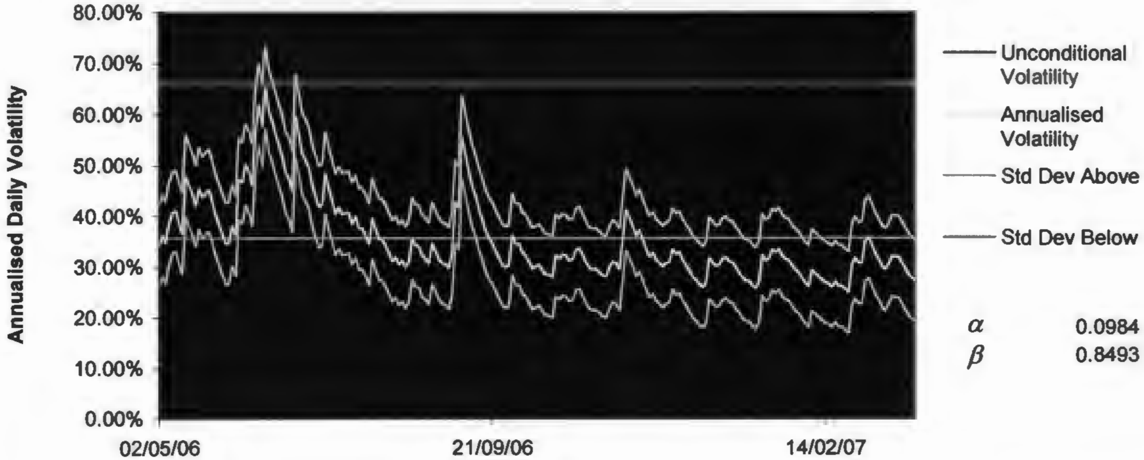
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	87.43
Face value of Debt	27.78
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	43.79%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.07
Equity Theta	-54.87
Asset Drift	5.279%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0984
β	0.8493

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
34.94%	43.79%	27.68%	35.73%	8.06%

Base Case

	Rbn
Value of Assets	112.18
Asset Volatility	32.0%
Market value of debt	24.75
Probability of default	0.00274815%

Worst Case

	Rbn
Value of Assets	111.74
Asset Volatility	39.2%
Market value of debt	24.31
Probability of default	0.081630729%

Imperial Holdings Ltd
AFS Date: 25 Jun 2006
Rating: Baa1

IPL

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	4.33%
Continuous DY	4.24%
Asset Payout	15.86%

	Rbn
Market value of Equity	32.95
Face value of Debt	11.09
Payout Ratio	15.86%
Interest Rate	11.62%
Equity Volatility	32.74%
Time	1.00

Equity Drift	11.51%
Beta	0.63
Risk Premium	3.00%
Equity Delta	0.85
Equity Gamma	0.25
Equity Theta	-13.12
Asset Drift	7.240%

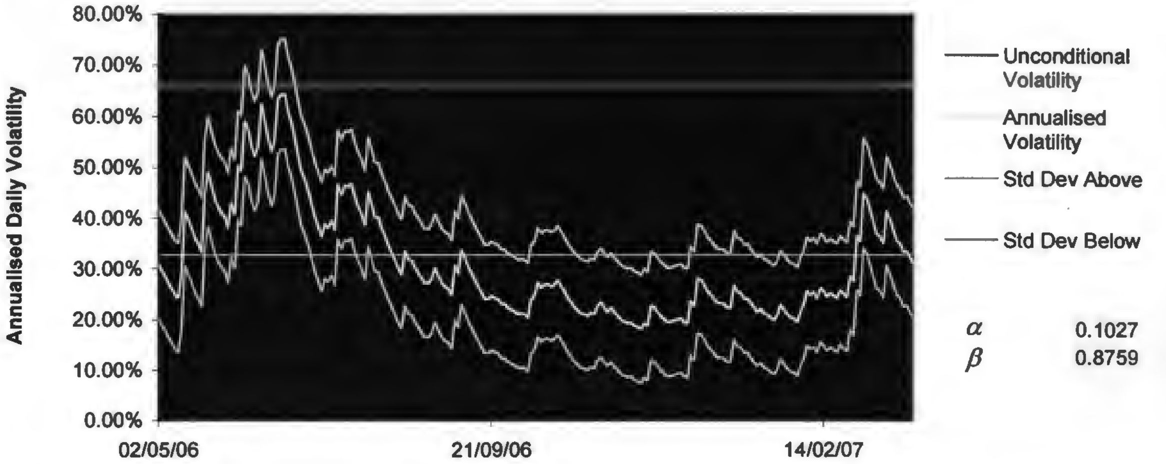
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	32.95
Face value of Debt	11.09
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	43.49%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.20
Equity Theta	-20.36
Asset Drift	5.019%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1027
β	0.8759

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
31.00%	43.49%	22.00%	32.74%	10.74%

Base Case

	Rbn
Value of Assets	42.83
Asset Volatility	29.5%
Market value of debt	9.88
Probability of default	0.00174803%

Worst Case

	Rbn
Value of Assets	42.65
Asset Volatility	38.4%
Market value of debt	9.70
Probability of default	0.097636486%

Barloworld Ltd
AFS Date: 30 Sep 2006
Rating: AA-

BAW

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	4.30%
Continuous DY	4.21%
Asset Payout	15.83%

	Rbn
Market value of Equity	35.10
Face value of Debt	13.00
Payout Ratio	15.83%
Interest Rate	11.62%
Equity Volatility	30.52%
Time	1.00

Equity Drift	11.93%
Beta	0.77
Risk Premium	3.00%
Equity Delta	0.85
Equity Gamma	0.25
Equity Theta	-12.27
Asset Drift	7.135%

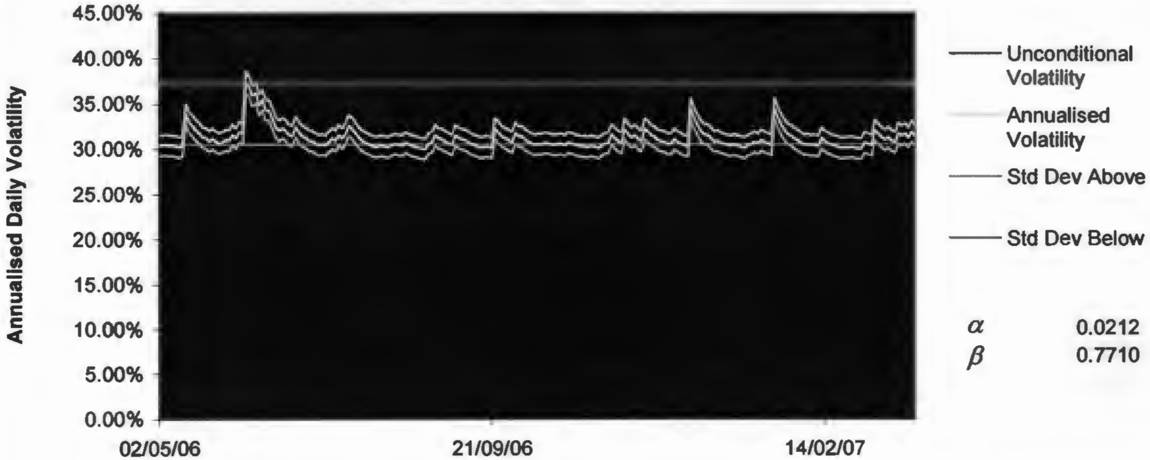
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	35.10
Face value of Debt	13.00
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	31.66%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.26
Equity Theta	-13.71
Asset Drift	4.562%

GARCH (1,1) Model
Conditional and Unconditional Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
31.12%	31.66%	29.39%	30.52%	1.14%

Base Case

	Rbn
Value of Assets	46.68
Asset Volatility	26.9%
Market value of debt	11.58
Probability of default	0.00087074%

Worst Case

	Rbn
Value of Assets	46.47
Asset Volatility	27.3%
Market value of debt	11.38
Probability of default	0.001331957%

Sasol Ltd
AFS Date: 30 Jun 2006
Rating: Baa1

SOL

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	4.00%
Continuous DY	3.92%
Asset Payout	15.54%

	Rbn
Market value of Equity	143.71
Face value of Debt	34.33
Payout Ratio	15.54%
Interest Rate	11.62%
Equity Volatility	34.80%
Time	1.00

Equity Drift	12.98%
Beta	1.12
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.05
Equity Theta	-66.27
Asset Drift	10.123%

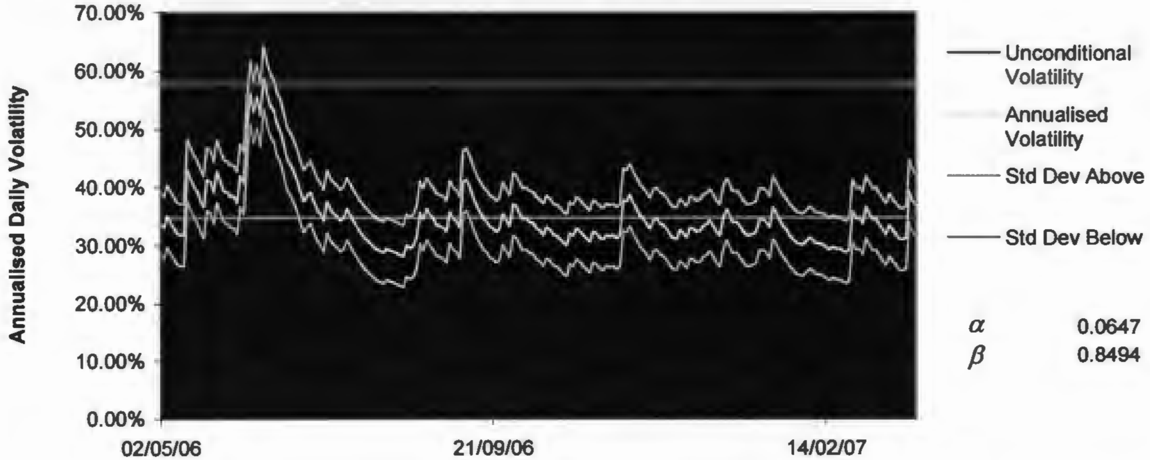
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	143.71
Face value of Debt	34.33
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	40.15%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.05
Equity Theta	-82.96
Asset Drift	6.453%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0647
β	0.8494

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
34.77%	40.15%	29.44%	34.80%	5.35%

Base Case

	Rbn
Value of Assets	174.28
Asset Volatility	33.5%
Market value of debt	30.58
Probability of default	0.0003127%

Worst Case

	Rbn
Value of Assets	173.75
Asset Volatility	0.38
Market value of debt	30.04
Probability of default	0.00483832%

Steinhoff International Holdings Ltd

AFS Date: 30 Jun 2006

Rating: A

SHF

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.03%
Interest Rate	11.65%
Continuous	11.02%
Dividend Yield	2.50%
Continuous DY	2.47%
Asset Payout	13.49%

	Rbn
Market value of Equity	28.29
Face value of Debt	8.84
Payout Ratio	13.49%
Interest Rate	11.02%
Equity Volatility	31.36%
Time	1.00

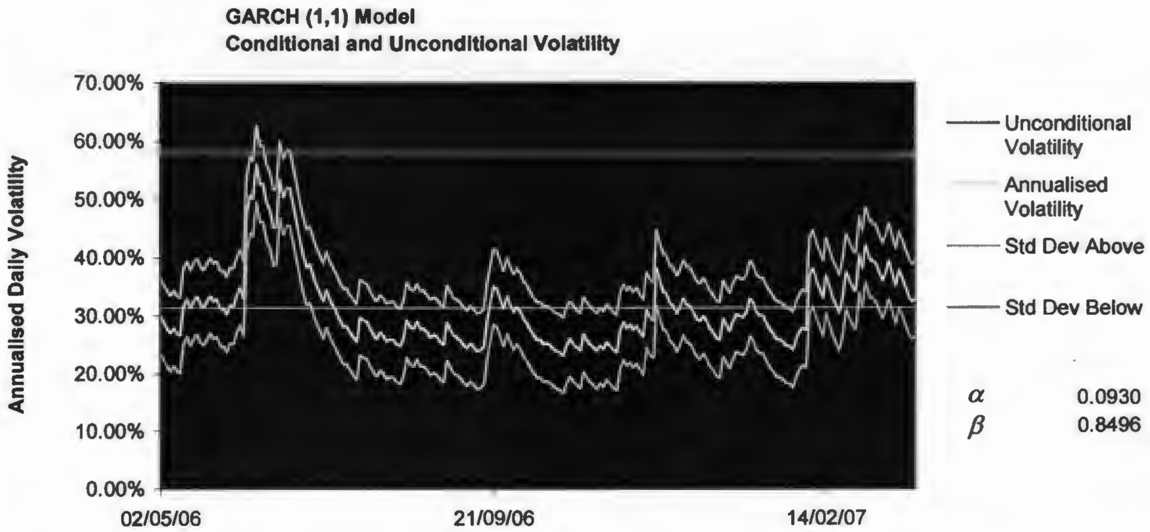
Equity Drift	12.14%
Beta	0.84
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.32
Equity Theta	-11.35
Asset Drift	8.098%

Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.03%
Interest Rate	13.65%
Continuous	12.80%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.80%

	Rbn
Market value of Equity	28.29
Face value of Debt	8.84
Payout Ratio	12.80%
Interest Rate	12.80%
Equity Volatility	37.88%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.88
Equity Gamma	0.27
Equity Theta	-14.87
Asset Drift	5.440%



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
31.08%	37.88%	24.84%	31.36%	6.52%

Base Case

	Rbn
Value of Assets	36.21
Asset Volatility	28.0%
Market value of debt	7.92
Probability of default	0.00013168%

Worst Case

	Rbn
Value of Assets	36.07
Asset Volatility	33.8%
Market value of debt	7.78
Probability of default	0.007863865%

MTN Group Ltd
AFS Date: 30 Dec 2006
Rating: Baa3

MTN

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	1.35%
Interest Rate	10.07%
Continuous	10.41%
Dividend Yield	1.05%
Continuous DY	1.04%
Asset Payout	11.45%

	Rbn
Market value of Equity	160.04
Face value of Debt	32.98
Payout Ratio	11.45%
Interest Rate	10.41%
Equity Volatility	35.31%
Time	1.00

Equity Drift	11.72%
Beta	0.70
Risk Premium	3.00%
Equity Delta	0.89
Equity Gamma	0.05
Equity Theta	-82.61
Asset Drift	9.256%

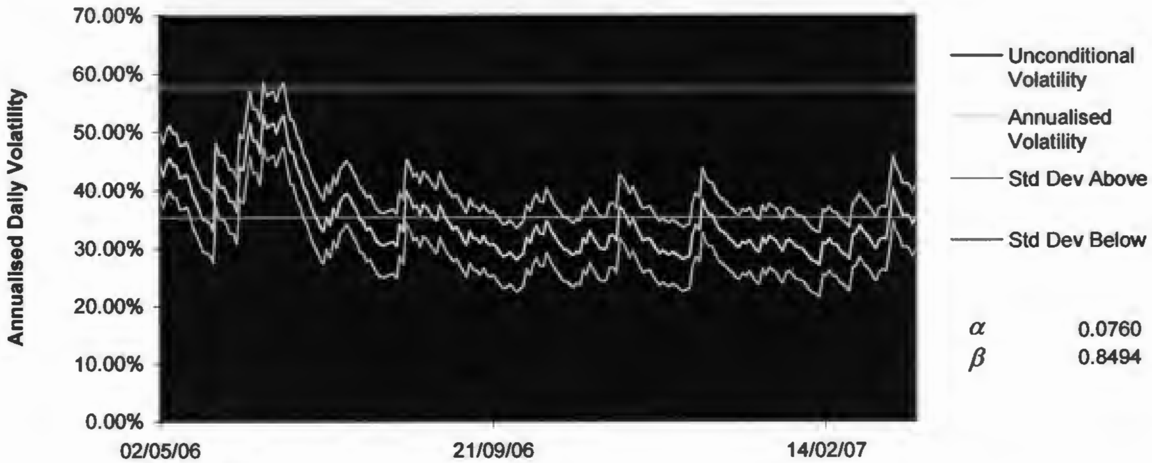
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.35%
Interest Rate	12.97%
Continuous	12.20%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.20%

	Rbn
Market value of Equity	160.04
Face value of Debt	32.98
Payout Ratio	12.20%
Interest Rate	12.20%
Equity Volatility	40.83%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.04
Equity Theta	-97.56
Asset Drift	7.066%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0760
β	0.8494

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
34.46%	40.83%	29.78%	35.31%	5.53%

Base Case

	Rbn
Value of Assets	189.77
Asset Volatility	33.4%
Market value of debt	29.74
Probability of default	0.0000275%

Worst Case

	Rbn
Value of Assets	189.25
Asset Volatility	39.0%
Market value of debt	29.21
Probability of default	0.00164972%

Woolworths Holdings Ltd
AFS Date: 31 Jun 2006
Rating: N/R

WHL

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.33%
Interest Rate	9.95%
Continuous	9.49%
Dividend Yield	5.00%
Continuous DY	4.88%
Asset Payout	14.36%

	Rbn
Market value of Equity	17.97
Face value of Debt	4.25
Payout Ratio	14.36%
Interest Rate	9.49%
Equity Volatility	31.85%
Time	1.00

Equity Drift	10.82%
Beta	0.40
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.49
Equity Theta	-7.56
Asset Drift	8.339%

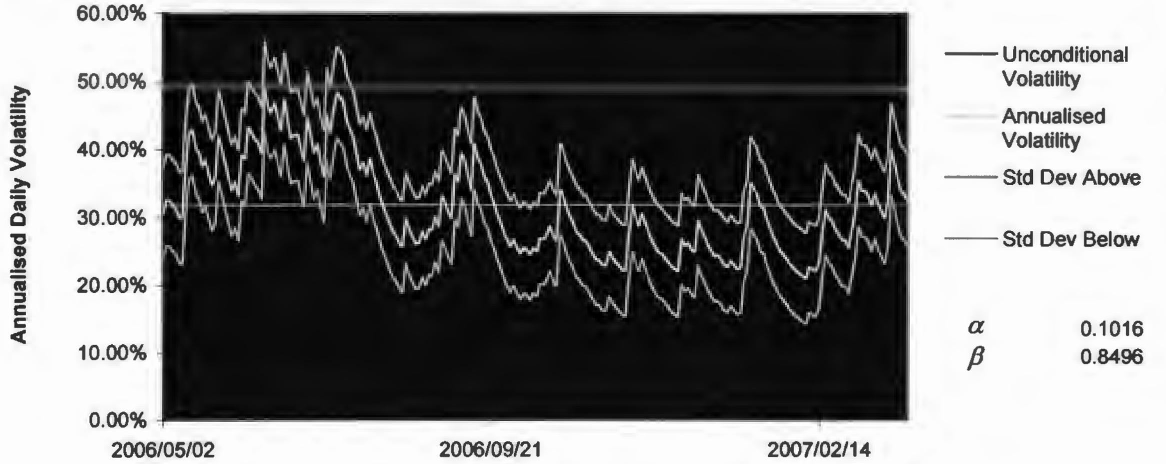
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.33%
Interest Rate	11.95%
Continuous	11.29%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.29%

	Rbn
Market value of Equity	17.97
Face value of Debt	4.25
Payout Ratio	11.29%
Interest Rate	11.29%
Equity Volatility	38.58%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.43
Equity Theta	-10.27
Asset Drift	6.684%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1016
β	0.8496

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
31.46%	38.58%	25.13%	31.85%	6.72%

Base Case

	Rbn
Value of Assets	21.84
Asset Volatility	30.3%
Market value of debt	3.87
Probability of default	0.00002139%

Worst Case

	Rbn
Value of Assets	21.77
Asset Volatility	35.6%
Market value of debt	3.80
Probability of default	0.000962981%

Harmony G M Co Ltd

AFS Date: 30 Jun 2006

Rating: N/R

HAR

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	1.35%
Interest Rate	10.97%
Continuous	10.41%
Dividend Yield	3.57%
Continuous DY	3.51%
Asset Payout	13.92%

	Rbn
Market value of Equity	39.64
Face value of Debt	4.50
Payout Ratio	13.92%
Interest Rate	10.41%
Equity Volatility	41.09%
Time	1.00

Equity Drift	13.94%
Beta	1.44
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.17
Equity Theta	-24.57
Asset Drift	13.424%

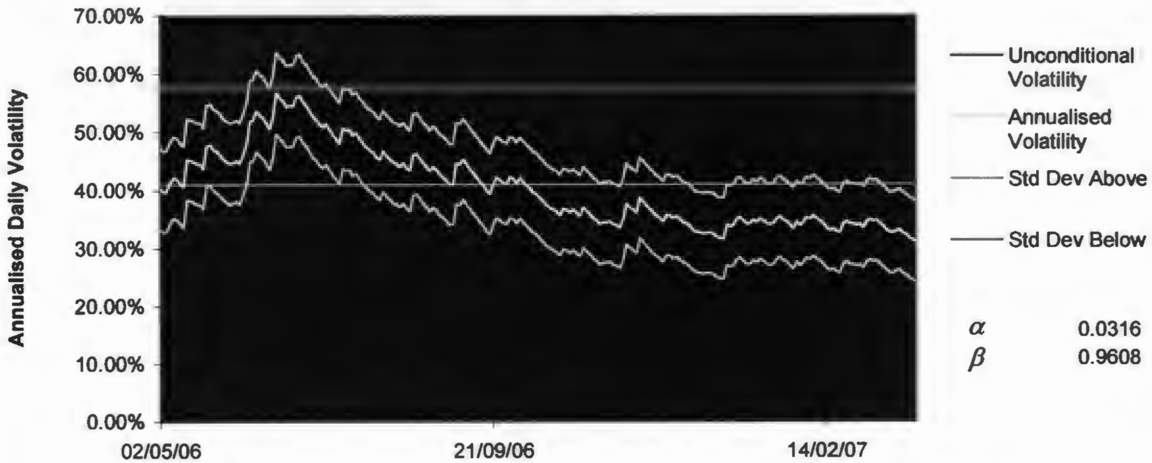
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.35%
Interest Rate	12.97%
Continuous	12.20%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.20%

	Rbn
Market value of Equity	39.64
Face value of Debt	4.50
Payout Ratio	12.20%
Interest Rate	12.20%
Equity Volatility	48.06%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.15
Equity Theta	-30.24
Asset Drift	8.617%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α 0.0316

β 0.9608

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
39.67%	48.06%	34.11%	41.09%	6.98%

Base Case

	Rbn
Value of Assets	43.69
Asset Volatility	42.8%
Market value of debt	4.06
Probability of default	0.00001882%

Worst Case

	Rbn
Value of Assets	43.62
Asset Volatility	49.3%
Market value of debt	3.99
Probability of default	0.000915411%

African Rainbow Minerals Ltd
AFS Date: 30 Jun 2006
Rating: N/R

ARI

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.00%
Interest Rate	14.62%
Continuous	13.65%
Dividend Yield	5.00%
Continuous DY	4.88%
Asset Payout	18.52%

	Rbn
Market value of Equity	19.66
Face value of Debt	2.25
Payout Ratio	18.52%
Interest Rate	13.65%
Equity Volatility	36.95%
Time	1.00

Equity Drift	14.24%
Beta	1.54
Risk Premium	3.00%
Equity Delta	0.83
Equity Gamma	0.35
Equity Theta	-9.91
Asset Drift	9.034%

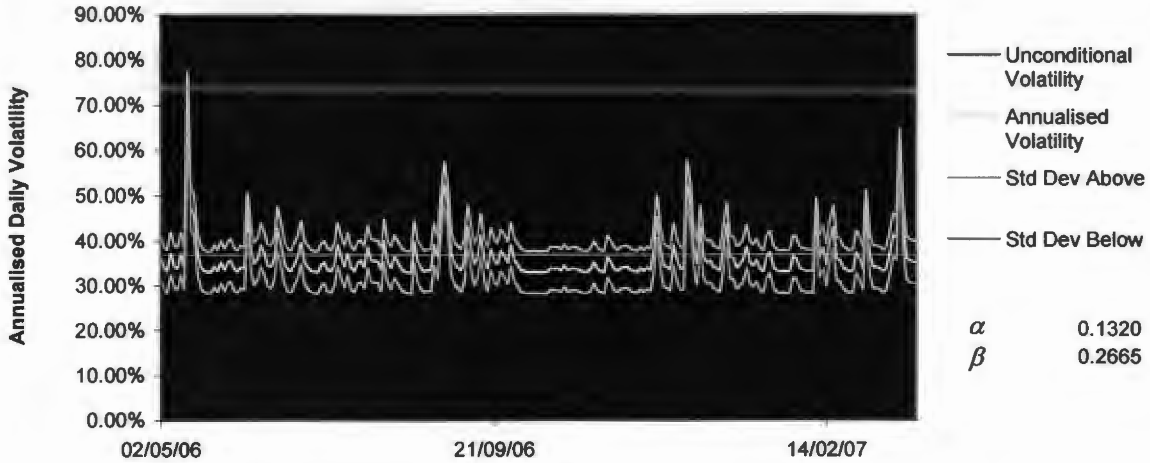
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	6.00%
Interest Rate	15.62%
Continuous	14.51%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	14.51%

	Rbn
Market value of Equity	19.66
Face value of Debt	2.25
Payout Ratio	14.51%
Interest Rate	14.51%
Equity Volatility	41.65%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.86
Equity Gamma	0.34
Equity Theta	-12.24
Asset Drift	8.608%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1320
β	0.2665

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
36.26%	41.65%	32.24%	36.95%	4.71%

Base Case

	Rbn
Value of Assets	21.63
Asset Volatility	40.4%
Market value of debt	1.97
Probability of default	0.00001240%

Worst Case

	Rbn
Value of Assets	21.61
Asset Volatility	43.8%
Market value of debt	1.95
Probability of default	0.000076534%

Kumba Iron Ore Ltd
AFS Date: 30 Jun 2006
Rating: N/R

KIO

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.03%
Interest Rate	11.65%
Continuous	11.02%
Dividend Yield	4.00%
Continuous DY	3.92%
Asset Payout	14.94%

Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.03%
Interest Rate	13.65%
Continuous	12.80%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.80%

Base Case

	Rbn
Market value of Equity	39.20
Face value of Debt	6.00
Payout Ratio	14.94%
Interest Rate	11.02%
Equity Volatility	35.67%
Time	1.00

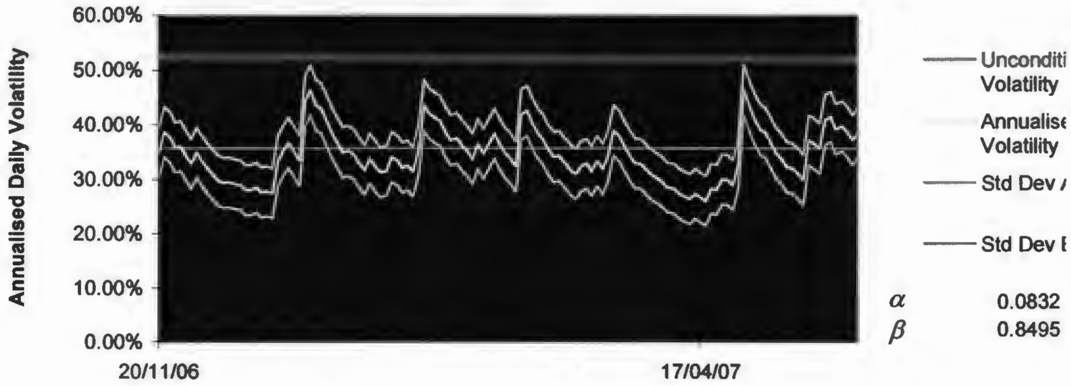
Equity Drift	13.55%
Beta	1.31
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.20
Equity Theta	-19.67
Asset Drift	12.295%

Worst Case

	Rbn
Market value of Equity	39.20
Face value of Debt	6.00
Payout Ratio	12.80%
Interest Rate	12.80%
Equity Volatility	40.26%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.88
Equity Gamma	0.18
Equity Theta	-23.67
Asset Drift	7.910%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0832
β	0.8495

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
34.47%	40.26%	31.07%	35.67%	4.59%

Base Case

	Rbn
Value of Assets	44.58
Asset Volatility	36.4%
Market value of debt	5.38
Probability of default	0.00000753%

Worst Case

	Rbn
Value of Assets	44.49
Asset Volatility	40.3%
Market value of debt	5.28
Probability of default	0.000169207%

Naspers Ltd
AFS Date: 31 Mar 2006
Rating: N/R

NPN

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.38%
Interest Rate	13.00%
Continuous	12.22%
Dividend Yield	1.20%
Continuous DY	1.19%
Asset Payout	13.41%

	Rbn
Market value of Equity	55.30
Face value of Debt	9.74
Payout Ratio	13.41%
Interest Rate	12.22%
Equity Volatility	33.33%
Time	1.00

Equity Drift	12.14%
Beta	0.84
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.15
Equity Theta	-25.73
Asset Drift	10.126%

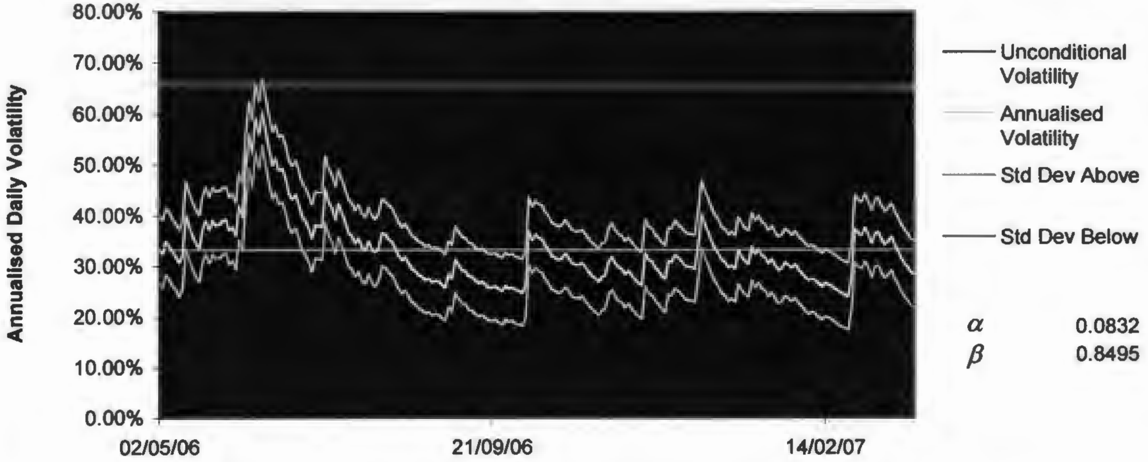
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.38%
Interest Rate	15.00%
Continuous	13.98%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.98%

	Rbn
Market value of Equity	55.30
Face value of Debt	9.74
Payout Ratio	13.98%
Interest Rate	13.98%
Equity Volatility	39.93%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.13
Equity Theta	-32.13
Asset Drift	7.459%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0832
β	0.8495

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
32.80%	39.93%	26.74%	33.33%	6.59%

Base Case

	Rbn
Value of Assets	63.93
Asset Volatility	33.0%
Market value of debt	8.63
Probability of default	0.00000266%

Worst Case

	Rbn
Value of Assets	63.78
Asset Volatility	39.8%
Market value of debt	8.48
Probability of default	0.000659631%

Bidvest Ltd

AFS Date: 30 Jun 2006

Rating: AA-

BVT

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	3.57%
Continuous DY	3.51%
Asset Payout	15.13%

	Rbn
Market value of Equity	44.67
Face value of Debt	9.80
Payout Ratio	15.13%
Interest Rate	11.62%
Equity Volatility	29.82%
Time	1.00

Equity Drift	11.03%
Beta	0.47
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.21
Equity Theta	-16.81
Asset Drift	8.526%

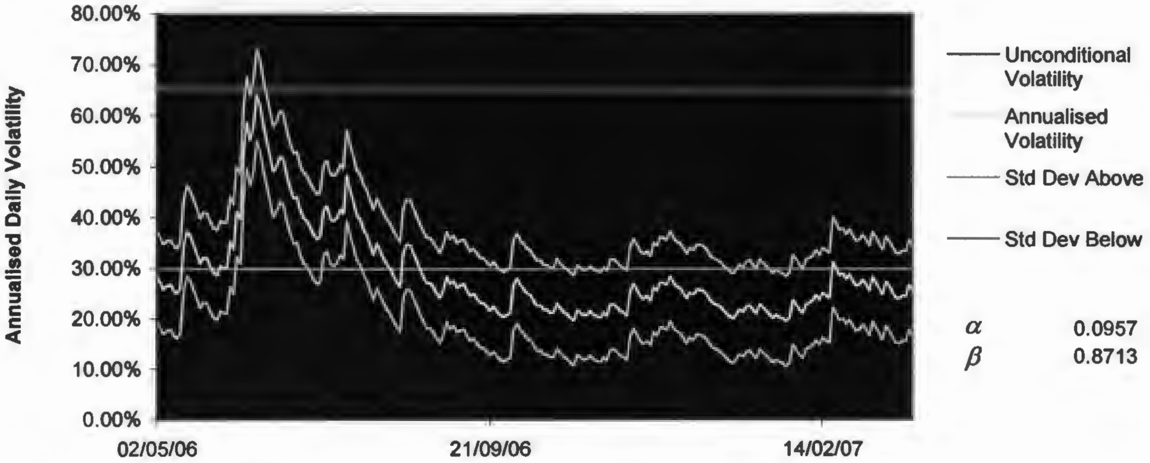
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	44.67
Face value of Debt	9.80
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	38.70%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.16
Equity Theta	-24.77
Asset Drift	6.763%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0957
β	0.8713

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
28.43%	38.70%	20.93%	29.82%	8.89%

Base Case

	Rbn
Value of Assets	53.40
Asset Volatility	29.0%
Market value of debt	8.73
Probability of default	0.00000224%

Worst Case

	Rbn
Value of Assets	53.24
Asset Volatility	37.1%
Market value of debt	8.58
Probability of default	0.001359622%

Nampak Ltd
AFS Date: 30 Sep 2006
Rating: N/R

NPK

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.20%
Interest Rate	9.82%
Continuous	9.37%
Dividend Yield	5.30%
Continuous DY	5.16%
Asset Payout	14.53%

	Rbn
Market value of Equity	14.39
Face value of Debt	4.97
Payout Ratio	14.53%
Interest Rate	9.37%
Equity Volatility	25.42%
Time	1.00

Equity Drift	10.70%
Beta	0.36
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.76
Equity Theta	-4.00
Asset Drift	6.820%

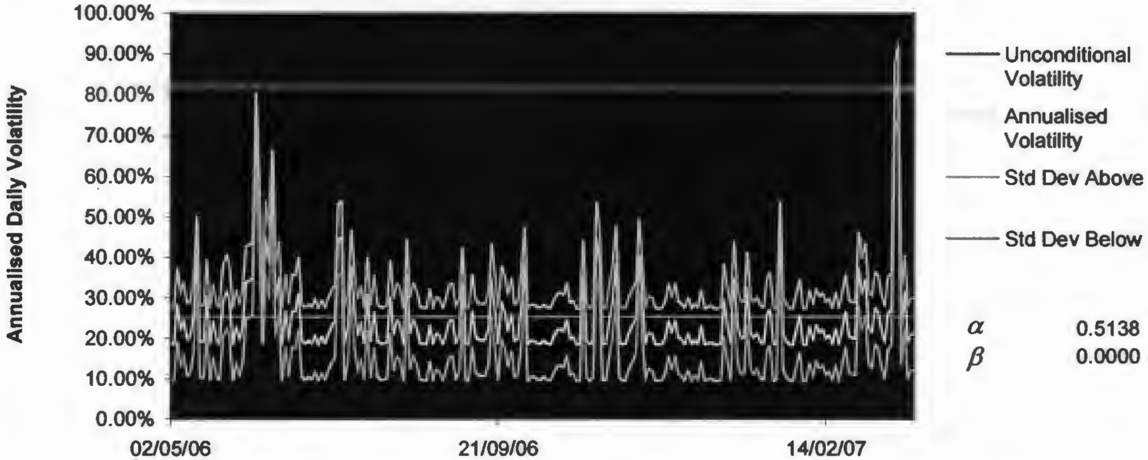
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.20%
Interest Rate	11.82%
Continuous	11.17%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.17%

	Rbn
Market value of Equity	14.39
Face value of Debt	4.97
Payout Ratio	11.17%
Interest Rate	11.17%
Equity Volatility	34.40%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.60
Equity Theta	-6.82
Asset Drift	5.269%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.5138
β	0.0000

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
24.41%	34.40%	16.45%	25.42%	8.97%

Base Case

	Rbn
Value of Assets	18.92
Asset Volatility	22.4%
Market value of debt	4.53
Probability of default	0.00000170%

Worst Case

	Rbn
Value of Assets	18.84
Asset Volatility	29.4%
Market value of debt	4.45
Probability of default	0.001415991%

BHP Billiton PLC
AFS Date: 30 Jun 2006
Rating: A1

BIL

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.03%
Interest Rate	11.65%
Continuous	11.02%
Dividend Yield	2.00%
Continuous DY	1.98%
Asset Payout	13.00%

	Rbn
Market value of Equity	353.56
Face value of Debt	70.12
Payout Ratio	13.00%
Interest Rate	11.02%
Equity Volatility	31.32%
Time	1.00

Equity Drift	13.25%
Beta	1.21
Risk Premium	3.00%
Equity Delta	0.88
Equity Gamma	0.03
Equity Theta	-151.52
Asset Drift	10.920%

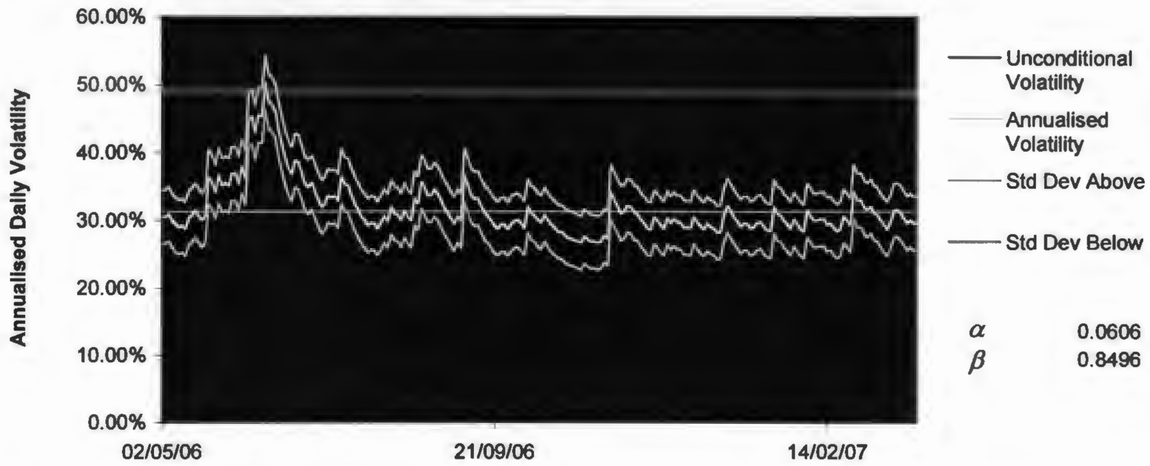
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.03%
Interest Rate	13.65%
Continuous	12.80%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.80%

	Rbn
Market value of Equity	353.56
Face value of Debt	70.12
Payout Ratio	12.80%
Interest Rate	12.80%
Equity Volatility	35.31%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.88
Equity Gamma	0.02
Equity Theta	-177.55
Asset Drift	7.148%

GARCH (1,1) Model
Conditional and Unconditional Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
31.43%	35.31%	27.33%	31.32%	3.99%

Base Case

	Rbn
Value of Assets	416.41
Asset Volatility	30.3%
Market value of debt	62.84
Probability of default	0.0000008%

Worst Case

	Rbn
Value of Assets	415.30
Asset Volatility	34.2%
Market value of debt	61.74
Probability of default	0.00005593%

Shoprite Holdings Ltd
AFS Date: 30 Jun 2006
Rating: N/R

SHP

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.30%
Interest Rate	9.92%
Continuous	9.46%
Dividend Yield	2.00%
Continuous DY	1.98%
Asset Payout	11.44%

	Rbn
Market value of Equity	14.66
Face value of Debt	3.92
Payout Ratio	11.44%
Interest Rate	9.46%
Equity Volatility	27.92%
Time	1.00

Equity Drift	10.22%
Beta	0.20
Risk Premium	3.00%
Equity Delta	0.89
Equity Gamma	0.72
Equity Theta	-5.41
Asset Drift	7.144%

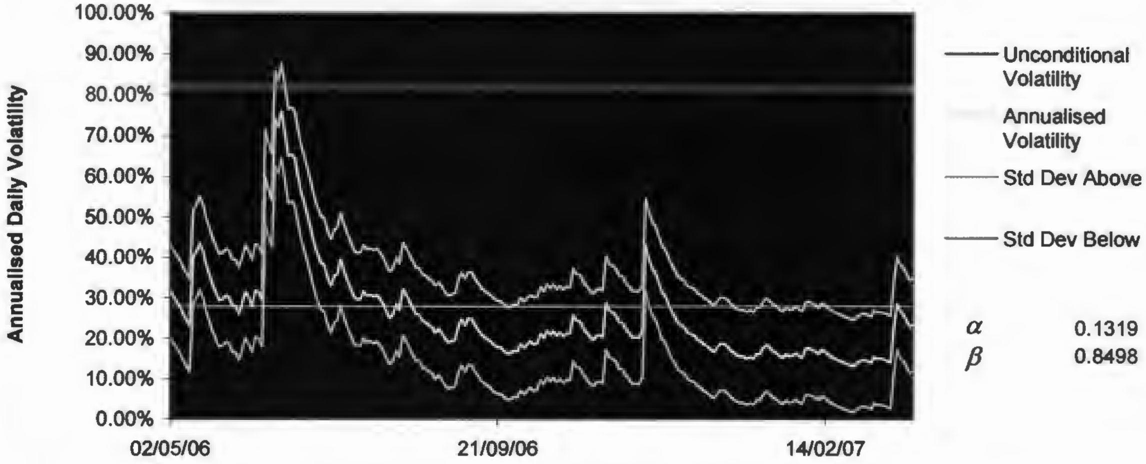
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.30%
Interest Rate	11.92%
Continuous	11.26%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.26%

	Rbn
Market value of Equity	14.66
Face value of Debt	3.92
Payout Ratio	11.26%
Interest Rate	11.26%
Equity Volatility	39.42%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.51
Equity Theta	-8.52
Asset Drift	6.262%

GARCH (1,1) Model
Conditional and Unconditional Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
25.85%	39.42%	16.42%	27.92%	11.50%

Base Case

	Rbn
Value of Assets	18.22
Asset Volatility	25.2%
Market value of debt	3.57
Probability of default	0.00000031%

Worst Case

	Rbn
Value of Assets	18.16
Asset Volatility	35.6%
Market value of debt	3.50
Probability of default	0.003314966%

Illovo Sugar Ltd
AFS Date: 31 Mar 2006
Rating: N/R

ILV

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.50%
Interest Rate	13.12%
Continuous	12.33%
Dividend Yield	3.40%
Continuous DY	3.34%
Asset Payout	15.67%

Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.50%
Interest Rate	15.12%
Continuous	14.08%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	14.08%

Base Case

	Rbn
Market value of Equity	6.93
Face value of Debt	1.96
Payout Ratio	15.67%
Interest Rate	12.33%
Equity Volatility	25.11%
Time	1.00

Worst Case

	Rbn
Market value of Equity	6.93
Face value of Debt	1.96
Payout Ratio	14.08%
Interest Rate	14.08%
Equity Volatility	28.95%
Time	1.00

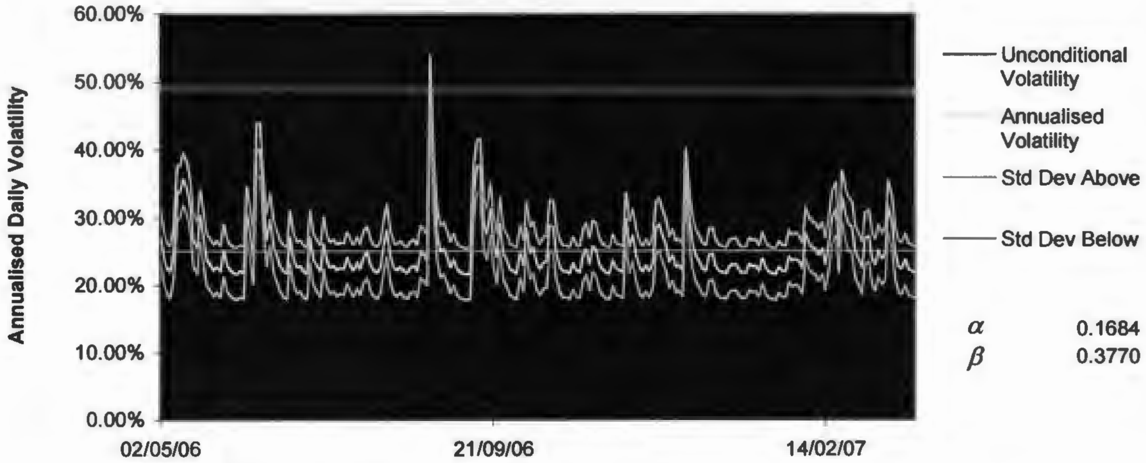
Base Case

Equity Drift	11.75%
Beta	0.71
Risk Premium	3.00%
Equity Delta	0.85
Equity Gamma	1.56
Equity Theta	-1.86
Asset Drift	8.110%

Worst Case

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	1.40
Equity Theta	-2.43
Asset Drift	5.693%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1684
β	0.3770

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
24.88%	28.95%	21.27%	25.11%	3.84%

Base Case

	Rbn
Value of Assets	8.66
Asset Volatility	23.5%
Market value of debt	1.73
Probability of default	0.00000020%

Worst Case

	Rbn
Value of Assets	8.63
Asset Volatility	26.7%
Market value of debt	1.70
Probability of default	0.000017327%

Truworths International Ltd
AFS Date: 25 Jun 2006
Rating: N/R

TRU

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.68%
Interest Rate	10.30%
Continuous	9.80%
Dividend Yield	3.50%
Continuous DY	3.44%
Asset Payout	13.24%

	Rbn
Market value of Equity	16.47
Face value of Debt	1.43
Payout Ratio	13.24%
Interest Rate	9.80%
Equity Volatility	38.38%
Time	1.00

Equity Drift	10.37%
Beta	0.25
Risk Premium	3.00%
Equity Delta	0.88
Equity Gamma	0.45
Equity Theta	-9.56
Asset Drift	10.158%

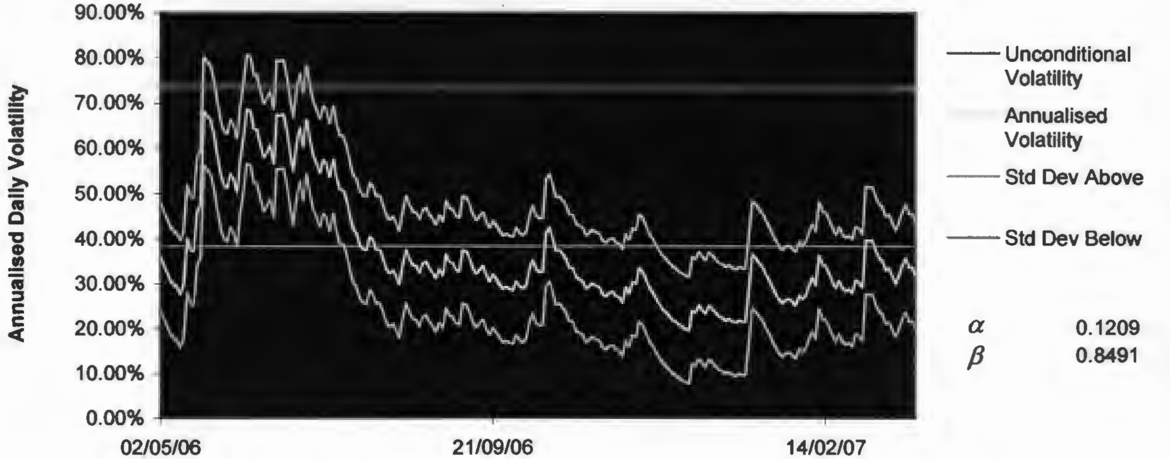
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.68%
Interest Rate	12.30%
Continuous	11.60%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.60%

	Rbn
Market value of Equity	16.47
Face value of Debt	1.43
Payout Ratio	11.60%
Interest Rate	11.60%
Equity Volatility	50.29%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.36
Equity Theta	-13.42
Asset Drift	9.093%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1209
β	0.8491

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
36.56%	50.29%	26.46%	38.38%	11.92%

Base Case

	Rbn
Value of Assets	17.77
Asset Volatility	40.6%
Market value of debt	1.30
Probability of default	0.00000015%

Worst Case

	Rbn
Value of Assets	17.74
Asset Volatility	52.4%
Market value of debt	1.28
Probability of default	0.000350559%

JD Group Ltd

AFS Date: 31 Aug 2006

Rating: N/R

JDG

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.40%
Interest Rate	10.02%
Continuous	9.55%
Dividend Yield	3.69%
Continuous DY	3.62%
Asset Payout	13.17%

	Rbn
Market value of Equity	15.90
Face value of Debt	2.11
Payout Ratio	13.17%
Interest Rate	9.55%
Equity Volatility	33.39%
Time	1.00

Equity Drift	10.04%
Beta	0.14
Risk Premium	3.00%
Equity Delta	0.88
Equity Gamma	0.54
Equity Theta	-7.63
Asset Drift	9.046%

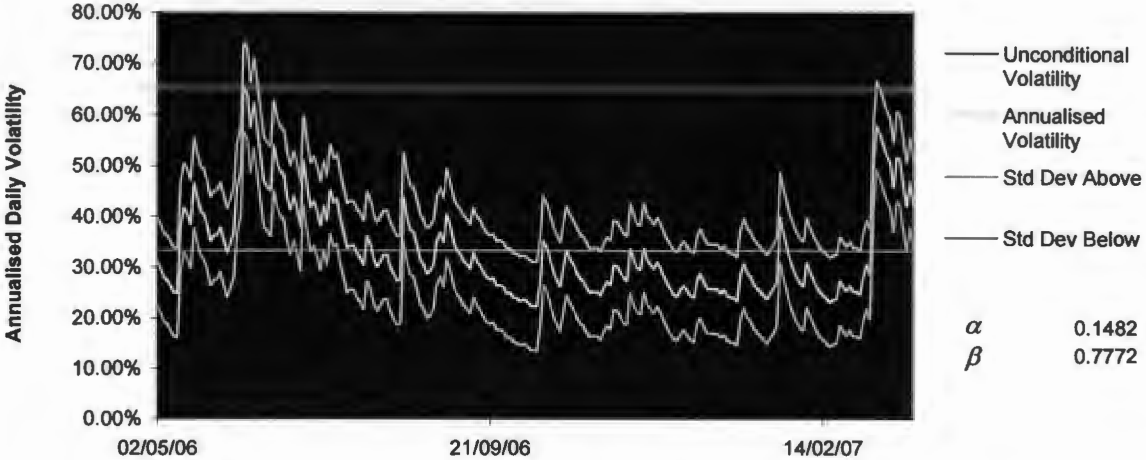
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.40%
Interest Rate	12.02%
Continuous	11.35%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.35%

	Rbn
Market value of Equity	15.90
Face value of Debt	2.11
Payout Ratio	11.35%
Interest Rate	11.35%
Equity Volatility	42.17%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.44
Equity Theta	-10.46
Asset Drift	8.286%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1482
β	0.7772

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
32.99%	42.17%	24.61%	33.39%	8.78%

Base Case

	Rbn
Value of Assets	17.83
Asset Volatility	34.0%
Market value of debt	1.92
Probability of default	0.00000011%

Worst Case

	Rbn
Value of Assets	17.79
Asset Volatility	42.2%
Market value of debt	1.89
Probability of default	0.000095971%

Gold Fields Ltd
AFS Date: 30 Jun 2006
Rating: N/R

GFI

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.38%
Interest Rate	13.00%
Continuous	12.22%
Dividend Yield	3.33%
Continuous DY	3.28%
Asset Payout	15.50%

	Rbn
Market value of Equity	80.77
Face value of Debt	3.42
Payout Ratio	15.50%
Interest Rate	12.22%
Equity Volatility	44.66%
Time	1.00

Equity Drift	12.89%
Beta	1.09
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.08
Equity Theta	-55.60
Asset Drift	13.991%

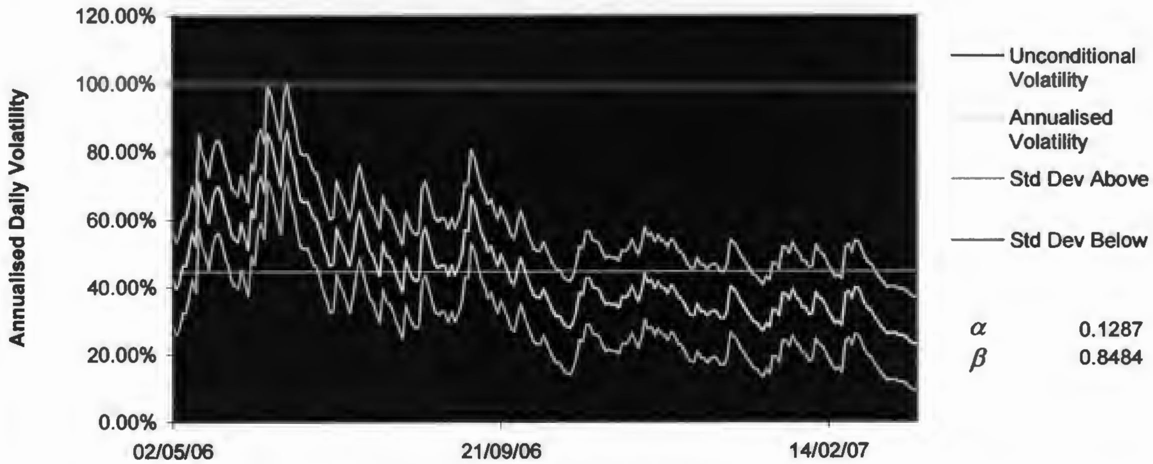
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.38%
Interest Rate	15.00%
Continuous	13.98%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.98%

	Rbn
Market value of Equity	80.77
Face value of Debt	3.42
Payout Ratio	13.98%
Interest Rate	13.98%
Equity Volatility	58.50%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.06
Equity Theta	-77.28
Asset Drift	10.099%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1287
β	0.8484

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
42.89%	58.50%	30.82%	44.66%	13.84%

Base Case

	Rbn
Value of Assets	83.81
Asset Volatility	50.3%
Market value of debt	3.04
Probability of default	0.0000001%

Worst Case

	Rbn
Value of Assets	83.76
Asset Volatility	64.9%
Market value of debt	2.98
Probability of default	0.00027588%

Murray And Roberts Ltd
AFS Date: 30 Jun 2006
Rating: N/R

MUR

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.38%
Interest Rate	13.00%
Continuous	12.22%
Dividend Yield	1.15%
Continuous DY	1.14%
Asset Payout	13.37%

Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.38%
Interest Rate	15.00%
Continuous	13.98%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.98%

Base Case

	Rbn
Market value of Equity	17.36
Face value of Debt	2.07
Payout Ratio	13.37%
Interest Rate	12.22%
Equity Volatility	33.75%
Time	1.00

Worst Case

	Rbn
Market value of Equity	17.36
Face value of Debt	2.07
Payout Ratio	13.98%
Interest Rate	13.98%
Equity Volatility	45.14%
Time	1.00

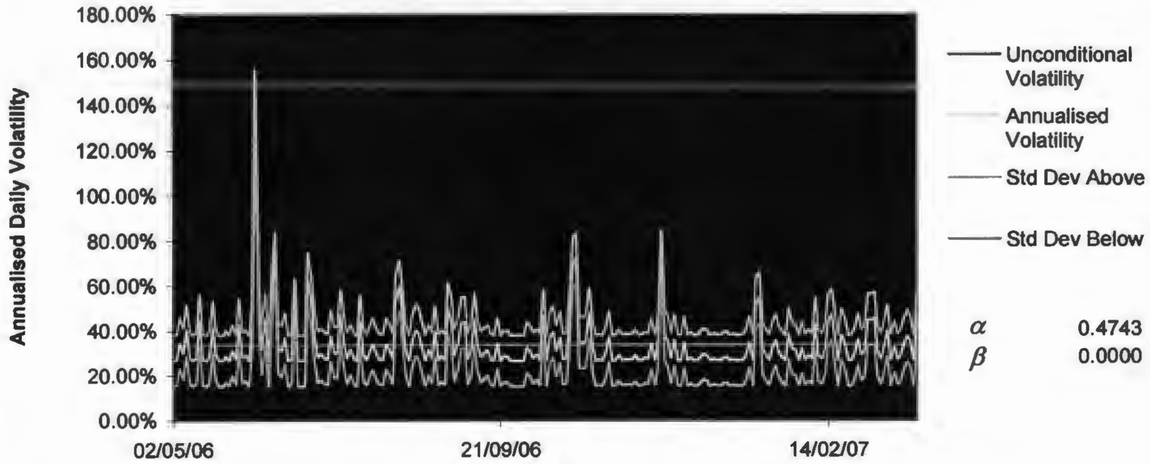
Base Case

Equity Drift	10.88%
Beta	0.42
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.49
Equity Theta	-8.43
Asset Drift	9.911%

Worst Case

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.36
Equity Theta	-11.99
Asset Drift	8.509%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.4743
β	0.0000

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
33.62%	45.14%	22.36%	33.75%	11.39%

Base Case

	Rbn
Value of Assets	19.20
Asset Volatility	34.9%
Market value of debt	1.84
Probability of default	0.00000005%

Worst Case

	Rbn
Value of Assets	19.16
Asset Volatility	47.0%
Market value of debt	1.81
Probability of default	0.000600657%

Avi Ltd

AFS Date: 30 Jun 2006

Rating: N/R

AVI

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	3.00%
Continuous DY	2.96%
Asset Payout	14.57%

	Rbn
Market value of Equity	5.58
Face value of Debt	0.89
Payout Ratio	14.57%
Interest Rate	11.62%
Equity Volatility	29.90%
Time	1.00

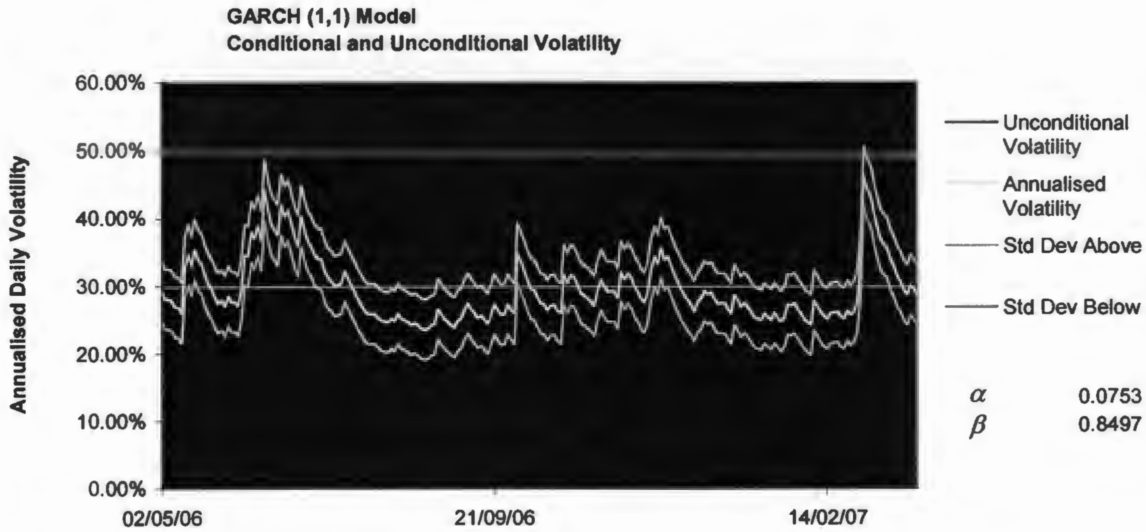
Equity Drift	10.46%
Beta	0.28
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	1.67
Equity Theta	-2.21
Asset Drift	8.933%

Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	5.58
Face value of Debt	0.89
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	34.36%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	1.49
Equity Theta	-2.71
Asset Drift	7.785%



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
29.57%	34.36%	25.44%	29.90%	4.46%

Base Case

	Rbn
Value of Assets	6.37
Asset Volatility	30.3%
Market value of debt	0.79
Probability of default	0.00000003%

Worst Case

	Rbn
Value of Assets	6.36
Asset Volatility	34.4%
Market value of debt	0.78
Probability of default	0.000003687%

Impala Platinum Holdings Ltd
AFS Date: 30 Jun 2006
Rating: N/R

IMP

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.25%
Interest Rate	12.87%
Continuous	12.11%
Dividend Yield	5.75%
Continuous DY	5.59%
Asset Payout	17.70%

	Rbn
Market value of Equity	110.22
Face value of Debt	3.59
Payout Ratio	17.70%
Interest Rate	12.11%
Equity Volatility	45.47%
Time	1.00

Equity Drift	14.27%
Beta	1.55
Risk Premium	3.00%
Equity Delta	0.84
Equity Gamma	0.05
Equity Theta	-76.01
Asset Drift	16.150%

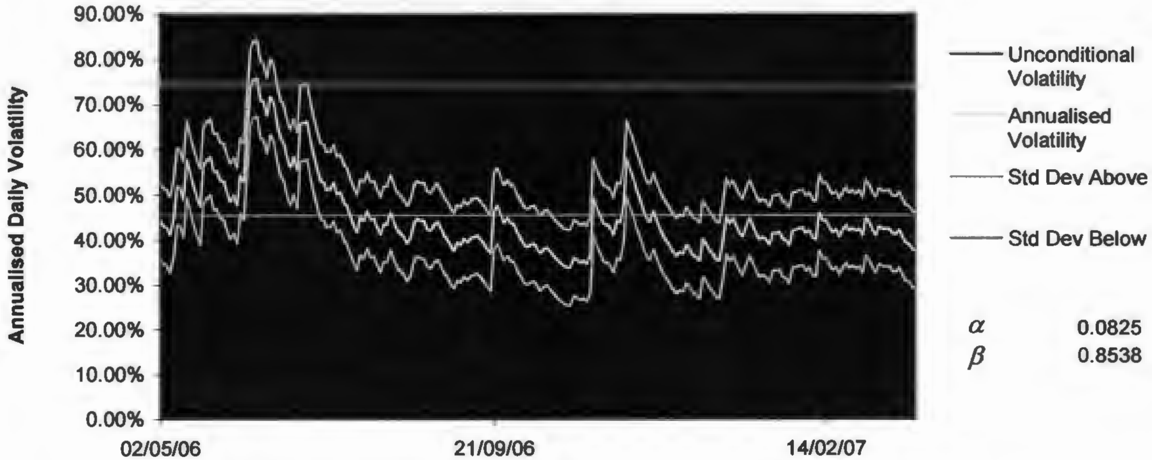
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.25%
Interest Rate	14.87%
Continuous	13.86%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.86%

	Rbn
Market value of Equity	110.22
Face value of Debt	3.59
Payout Ratio	13.86%
Interest Rate	13.86%
Equity Volatility	53.87%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.05
Equity Theta	-96.32
Asset Drift	10.307%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0825
β	0.8538

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
44.55%	53.87%	37.07%	45.47%	8.40%

Base Case

	Rbn
Value of Assets	113.41
Asset Volatility	52.7%
Market value of debt	3.19
Probability of default	0.0000000%

Worst Case

	Rbn
Value of Assets	113.36
Asset Volatility	60.2%
Market value of debt	3.14
Probability of default	0.00000378%

Mittal Steel SA Ltd
AFS Date: 31 Dec 2006
Rating: Baa3

MLA

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.41%
Interest Rate	15.03%
Continuous	14.00%
Dividend Yield	6.00%
Continuous DY	5.83%
Asset Payout	19.83%

	Rbn
Market value of Equity	49.03
Face value of Debt	5.53
Payout Ratio	19.83%
Interest Rate	14.00%
Equity Volatility	30.72%
Time	1.00

Equity Drift	13.07%
Beta	1.15
Risk Premium	3.00%
Equity Delta	0.82
Equity Gamma	0.17
Equity Theta	-18.58
Asset Drift	12.991%

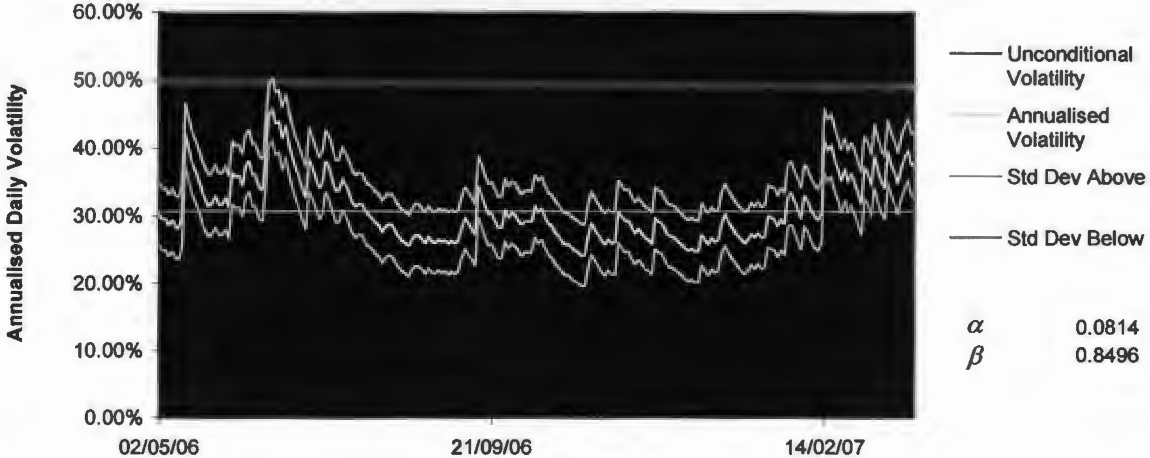
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	7.41%
Interest Rate	17.03%
Continuous	15.73%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	15.73%

	Rbn
Market value of Equity	49.03
Face value of Debt	5.53
Payout Ratio	15.73%
Interest Rate	15.73%
Equity Volatility	35.31%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.85
Equity Gamma	0.16
Equity Theta	-24.24
Asset Drift	8.652%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0814
β	0.8496

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
31.08%	35.31%	26.12%	30.72%	4.60%

Base Case

	Rbn
Value of Assets	53.84
Asset Volatility	34.1%
Market value of debt	4.81
Probability of default	0.00000001%

Worst Case

	Rbn
Value of Assets	53.76
Asset Volatility	37.7%
Market value of debt	4.73
Probability of default	0.000000763%

Foschini Ltd
AFS Date: 31 Mar 2006
Rating: N/R

FOS

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	3.10%
Continuous DY	3.05%
Asset Payout	14.67%

	Rbn
Market value of Equity	15.26
Face value of Debt	1.78
Payout Ratio	14.67%
Interest Rate	11.62%
Equity Volatility	32.08%
Time	1.00

Equity Drift	10.62%
Beta	0.40
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.57
Equity Theta	-6.79
Asset Drift	10.086%

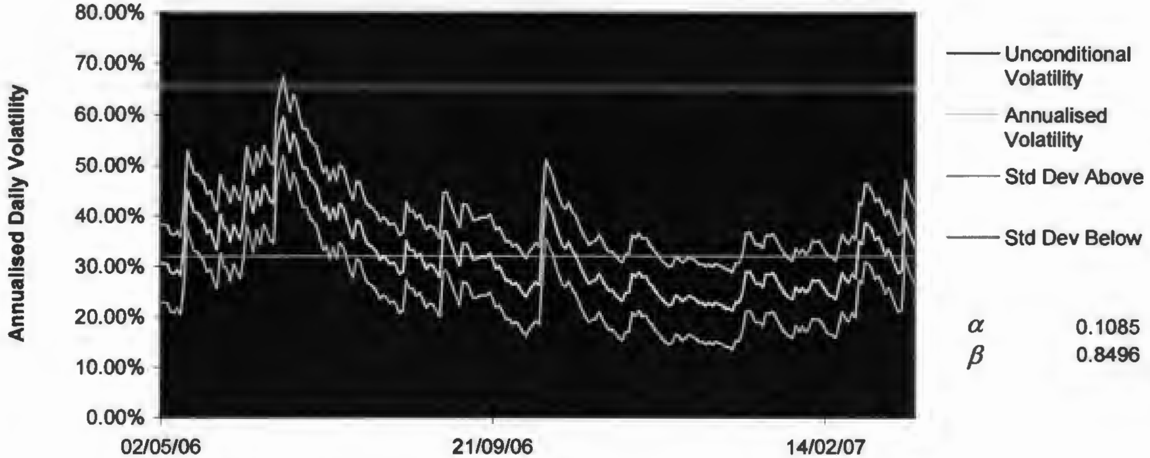
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	15.26
Face value of Debt	1.78
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	39.78%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.47
Equity Theta	-9.11
Asset Drift	8.564%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1085
β	0.8496

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
31.68%	39.78%	24.38%	32.08%	7.70%

Base Case

	Rbn
Value of Assets	16.85
Asset Volatility	33.7%
Market value of debt	1.59
Probability of default	0.00000001%

Worst Case

	Rbn
Value of Assets	16.82
Asset Volatility	41.3%
Market value of debt	1.56
Probability of default	0.000015290%

Sun International Ltd
AFS Date: 30 Jun 2006
Rating: N/R

SUI

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	3.50%
Continuous DY	3.44%
Asset Payout	15.06%

	Rbn
Market value of Equity	15.20
Face value of Debt	3.60
Payout Ratio	15.06%
Interest Rate	11.62%
Equity Volatility	25.14%
Time	1.00

Equity Drift	11.78%
Beta	0.72
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.72
Equity Theta	-4.35
Asset Drift	8.959%

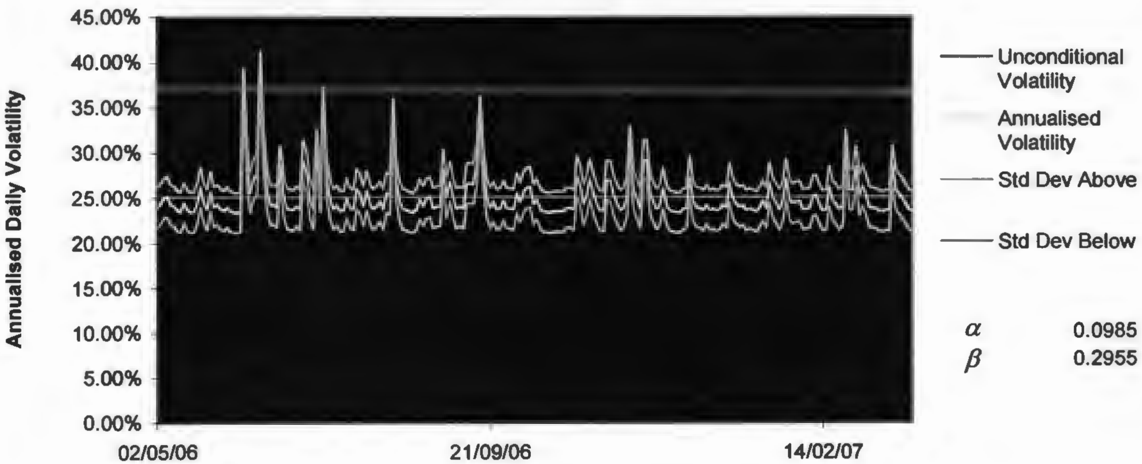
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	15.20
Face value of Debt	3.60
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	27.37%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.68
Equity Theta	-5.17
Asset Drift	6.486%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0985
β	0.2955

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
25.10%	27.37%	22.92%	25.14%	2.22%

Base Case

	Rbn
Value of Assets	18.41
Asset Volatility	24.1%
Market value of debt	3.21
Probability of default	0.00000001%

Worst Case

	Rbn
Value of Assets	18.35
Asset Volatility	25.9%
Market value of debt	3.15
Probability of default	0.000000193%

Telkom SA Ltd
AFS Date: 31 Mar 2006
Rating: A3

TKG

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.06%
Interest Rate	13.68%
Continuous	12.82%
Dividend Yield	3.33%
Continuous DY	3.28%
Asset Payout	16.10%

Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	6.06%
Interest Rate	15.68%
Continuous	14.57%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	14.57%

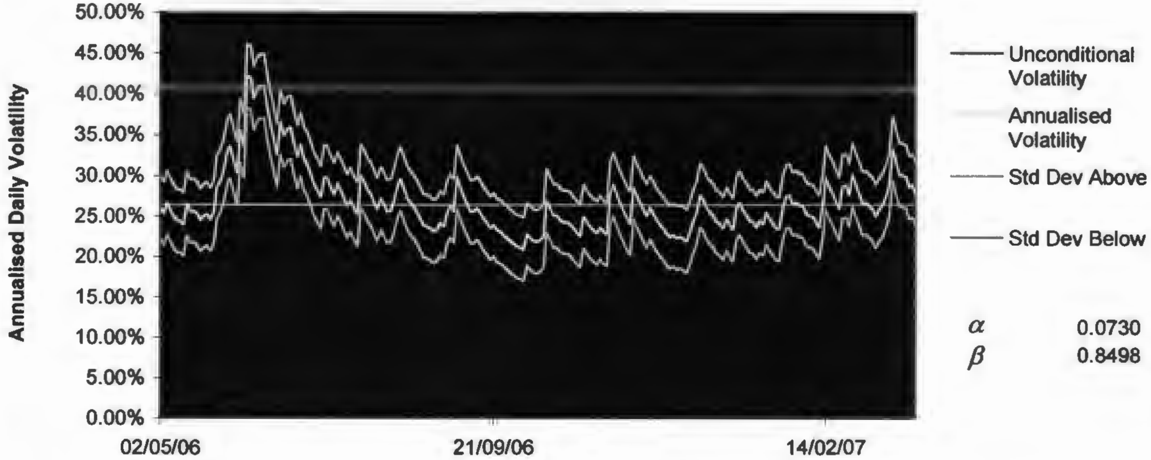
Base Case

	Rbn
Market value of Equity	88.55
Face value of Debt	16.75
Payout Ratio	16.10%
Interest Rate	12.82%
Equity Volatility	26.35%
Time	1.00
Equity Drift	9.74%
Beta	0.04
Risk Premium	3.00%
Equity Delta	0.85
Equity Gamma	0.12
Equity Theta	-27.35
Asset Drift	7.660%

Worst Case

	Rbn
Market value of Equity	88.55
Face value of Debt	16.75
Payout Ratio	14.57%
Interest Rate	14.57%
Equity Volatility	30.25%
Time	1.00
Equity Drift	9.62%
Equity Delta	0.86
Equity Gamma	0.10
Equity Theta	-34.74
Asset Drift	7.196%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0730
β	0.8498

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
26.54%	30.25%	22.45%	26.35%	3.90%

Base Case

	Rbn
Value of Assets	103.30
Asset Volatility	26.5%
Market value of debt	14.75
Probability of default	0.0000000%

Worst Case

	Rbn
Value of Assets	103.05
Asset Volatility	30.1%
Market value of debt	14.49
Probability of default	0.00000083%

Mr Price Group Ltd
AFS Date: 31 Mar 2006
Rating: N/R

MPC

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.00%
Interest Rate	13.62%
Continuous	12.77%
Dividend Yield	4.60%
Continuous DY	4.50%
Asset Payout	17.27%

	Rbn
Market value of Equity	6.95
Face value of Debt	0.70
Payout Ratio	17.27%
Interest Rate	12.77%
Equity Volatility	32.01%
Time	1.00

Equity Drift	11.09%
Beta	0.49
Risk Premium	3.00%
Equity Delta	0.84
Equity Gamma	1.18
Equity Theta	-2.96
Asset Drift	10.871%

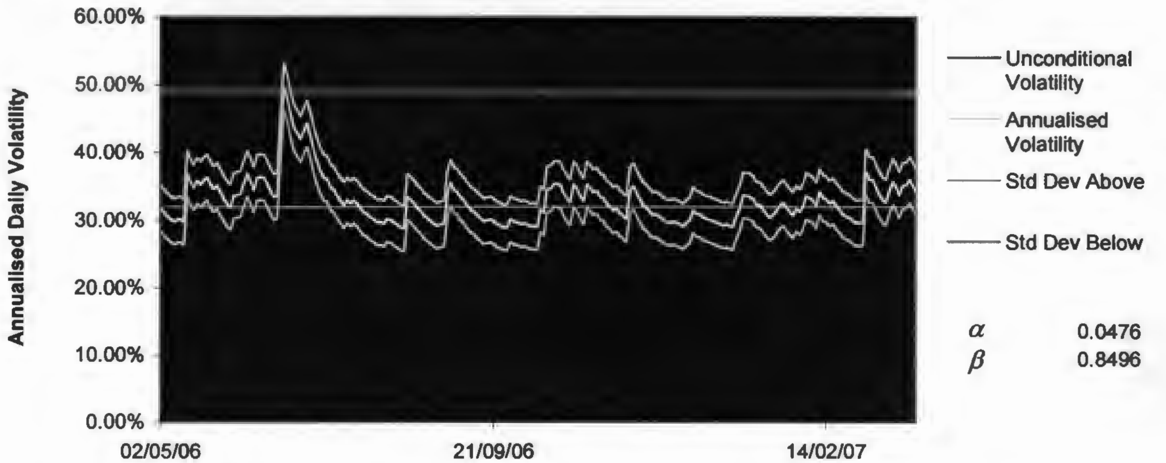
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	6.00%
Interest Rate	15.62%
Continuous	14.51%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	14.51%

	Rbn
Market value of Equity	6.95
Face value of Debt	0.70
Payout Ratio	14.51%
Interest Rate	14.51%
Equity Volatility	35.39%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.86
Equity Gamma	1.13
Equity Theta	-3.53
Asset Drift	8.887%

GARCH (1,1) Model
Conditional and Unconditional Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
32.58%	35.39%	28.62%	32.01%	3.39%

Base Case

	Rbn
Value of Assets	7.57
Asset Volatility	34.9%
Market value of debt	0.62
Probability of default	0.00000001%

Worst Case

	Rbn
Value of Assets	7.56
Asset Volatility	37.6%
Market value of debt	0.61
Probability of default	0.000000107%

Tiger Brands Ltd
AFS Date: 30 Sep 2006
Rating: N/R

TBS

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.73%
Interest Rate	14.35%
Continuous	13.41%
Dividend Yield	4.30%
Continuous DY	4.21%
Asset Payout	17.62%

	Rbn
Market value of Equity	28.79
Face value of Debt	3.98
Payout Ratio	17.62%
Interest Rate	13.41%
Equity Volatility	28.33%
Time	1.00

Equity Drift	11.15%
Beta	0.51
Risk Premium	3.00%
Equity Delta	0.84
Equity Gamma	0.32
Equity Theta	-9.93
Asset Drift	10.141%

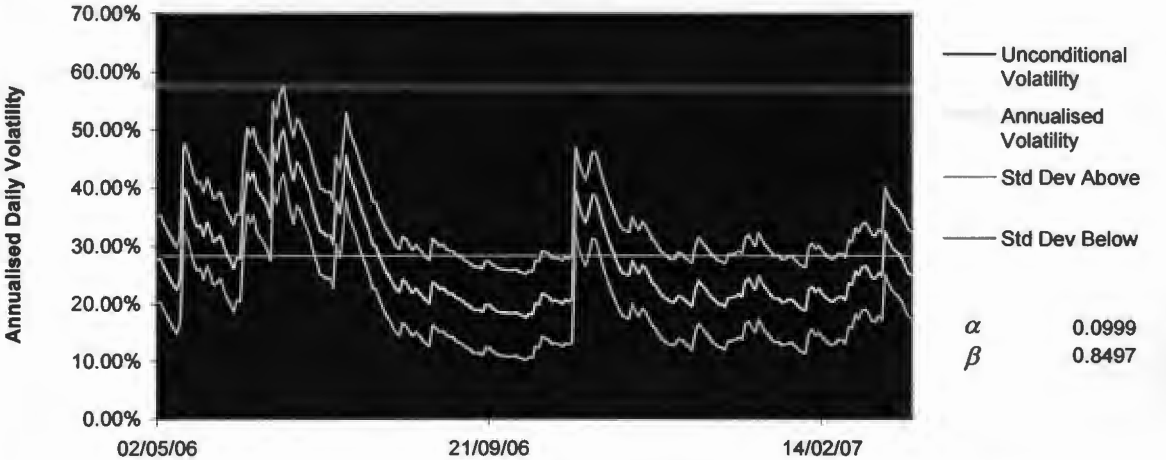
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	6.73%
Interest Rate	16.35%
Continuous	15.14%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	15.14%

	Rbn
Market value of Equity	28.79
Face value of Debt	3.98
Payout Ratio	15.14%
Interest Rate	15.14%
Equity Volatility	35.82%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.86
Equity Gamma	0.27
Equity Theta	-14.47
Asset Drift	8.135%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0999
β	0.8497

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
26.97%	35.82%	20.84%	28.33%	7.49%

Base Case

	Rbn
Value of Assets	32.27
Asset Volatility	30.1%
Market value of debt	3.48
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	32.21
Asset Volatility	37.2%
Market value of debt	3.42
Probability of default	0.000007966%

Lonmin PLC

AFS Date: 30 Sep 2006

Rating: Ba3

LON

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.68%
Interest Rate	10.30%
Continuous	9.80%
Dividend Yield	1.90%
Continuous DY	1.88%
Asset Payout	11.69%

	Rbn
Market value of Equity	62.35
Face value of Debt	6.08
Payout Ratio	11.69%
Interest Rate	9.80%
Equity Volatility	33.50%
Time	1.00

Equity Drift	13.37%
Beta	1.25
Risk Premium	3.00%
Equity Delta	0.89
Equity Gamma	0.14
Equity Theta	-31.25
Asset Drift	12.914%

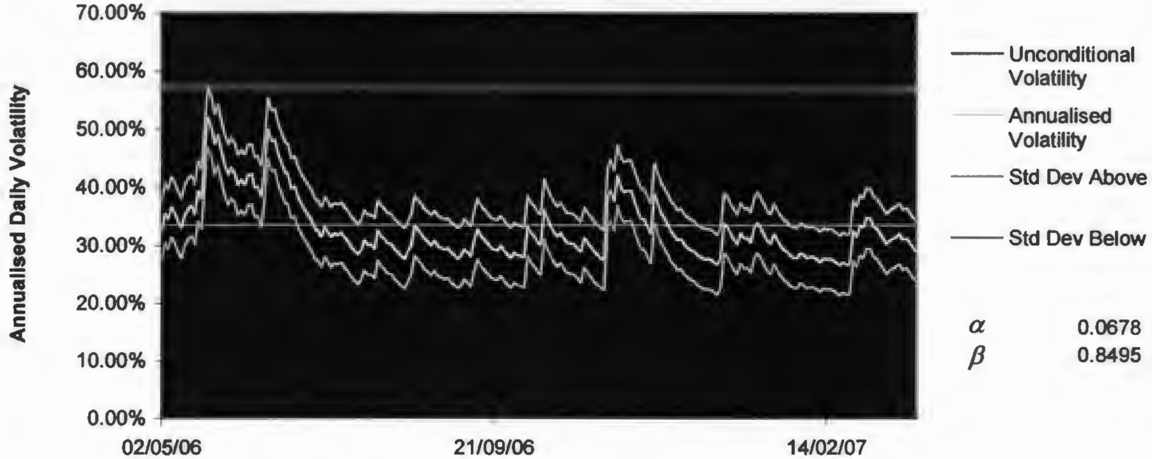
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.68%
Interest Rate	12.30%
Continuous	11.60%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.60%

	Rbn
Market value of Equity	62.35
Face value of Debt	6.08
Payout Ratio	11.60%
Interest Rate	11.60%
Equity Volatility	38.69%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.12
Equity Theta	-37.25
Asset Drift	8.901%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α 0.0678

β 0.8495

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
32.55%	38.69%	28.30%	33.50%	5.19%

Base Case

	Rbn
Value of Assets	67.87
Asset Volatility	34.6%
Market value of debt	5.51
Probability of default	0.0000000%

Worst Case

	Rbn
Value of Assets	67.77
Asset Volatility	40.0%
Market value of debt	5.42
Probability of default	0.00000041%

New Clicks Holdings Ltd

AFS Date: 31 Aug 2006

Rating: N/R

NCL

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	5.41%
Interest Rate	15.03%
Continuous	14.00%
Dividend Yield	3.70%
Continuous DY	3.63%
Asset Payout	17.64%

	Rbn
Market value of Equity	4.52
Face value of Debt	0.50
Payout Ratio	17.64%
Interest Rate	14.00%
Equity Volatility	29.12%
Time	1.00

Equity Drift	10.85%
Beta	0.41
Risk Premium	3.00%
Equity Delta	0.84
Equity Gamma	1.99
Equity Theta	-1.65
Asset Drift	10.342%

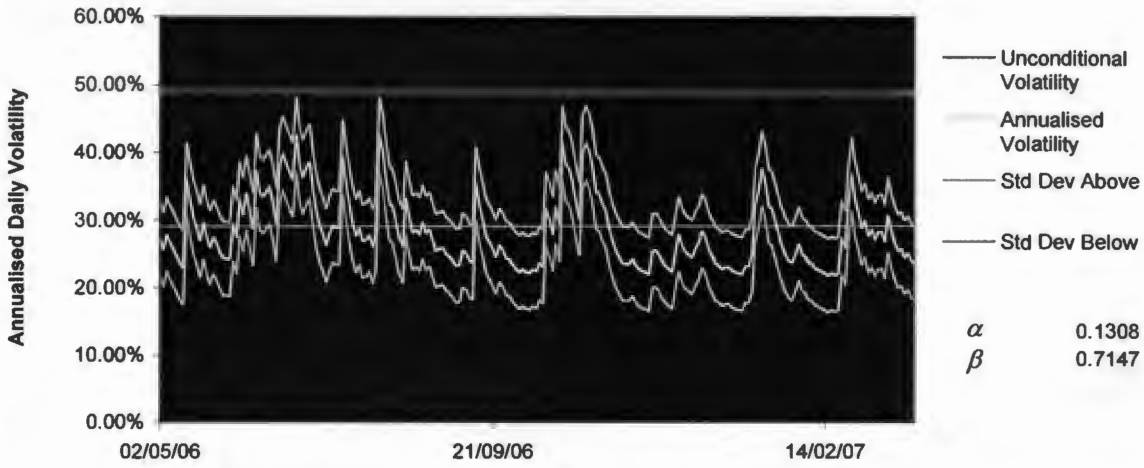
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	7.41%
Interest Rate	17.03%
Continuous	15.73%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	15.73%

	Rbn
Market value of Equity	4.52
Face value of Debt	0.50
Payout Ratio	15.73%
Interest Rate	15.73%
Equity Volatility	34.59%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.85
Equity Gamma	1.74
Equity Theta	-2.17
Asset Drift	8.697%

GARCH (1,1) Model
Conditional and Unconditional Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
28.50%	34.59%	23.65%	29.12%	5.47%

Base Case

	Rbn
Value of Assets	4.96
Asset Volatility	31.6%
Market value of debt	0.44
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	4.95
Asset Volatility	36.9%
Market value of debt	0.43
Probability of default	0.000000279%

Massmart Holdings Ltd
AFS Date: 30 Jun 2006
Rating: N/R

MSM

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	1.38%
Interest Rate	11.00%
Continuous	10.44%
Dividend Yield	3.90%
Continuous DY	3.83%
Asset Payout	14.26%

	Rbn
Market value of Equity	16.43
Face value of Debt	0.90
Payout Ratio	14.26%
Interest Rate	10.44%
Equity Volatility	35.44%
Time	1.00

Equity Drift	10.40%
Beta	0.26
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.48
Equity Theta	-8.61
Asset Drift	10.864%

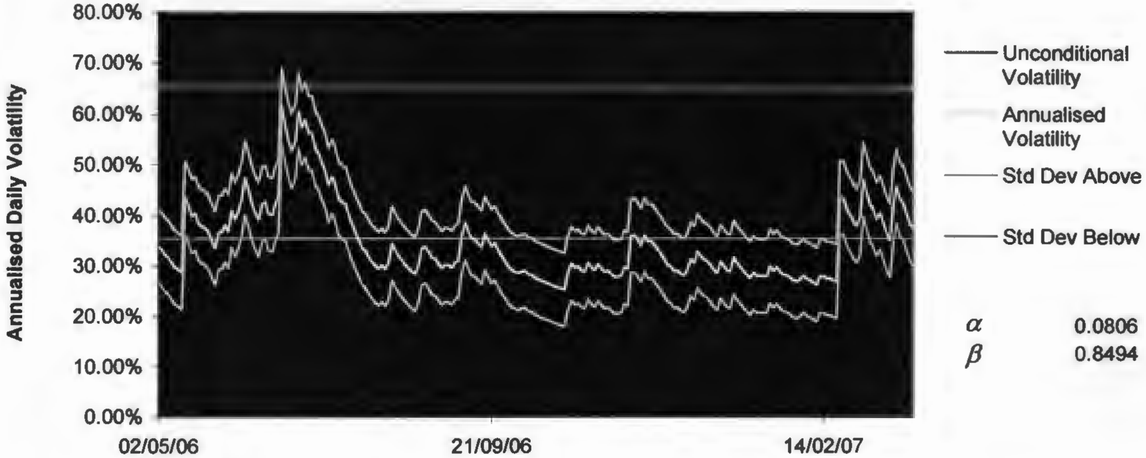
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.38%
Interest Rate	13.00%
Continuous	12.22%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.22%

	Rbn
Market value of Equity	16.43
Face value of Debt	0.90
Payout Ratio	12.22%
Interest Rate	12.22%
Equity Volatility	42.75%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.88
Equity Gamma	0.41
Equity Theta	-11.10
Asset Drift	9.730%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0806
β	0.8494

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
34.46%	42.75%	28.14%	35.44%	7.31%

Base Case

	Rbn
Value of Assets	17.25
Asset Volatility	38.9%
Market value of debt	0.81
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	17.23
Asset Volatility	46.1%
Market value of debt	0.80
Probability of default	0.000000046%

Anglo American PLC

AFS Date: 31 Dec 2006

Rating: A2

AGL

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.70%
Interest Rate	12.32%
Continuous	11.62%
Dividend Yield	1.80%
Continuous DY	1.78%
Asset Payout	13.40%

	Rbn
Market value of Equity	530.79
Face value of Debt	43.74
Payout Ratio	13.40%
Interest Rate	11.62%
Equity Volatility	31.73%
Time	1.00

Equity Drift	13.76%
Beta	1.38
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.02
Equity Theta	-241.99
Asset Drift	13.750%

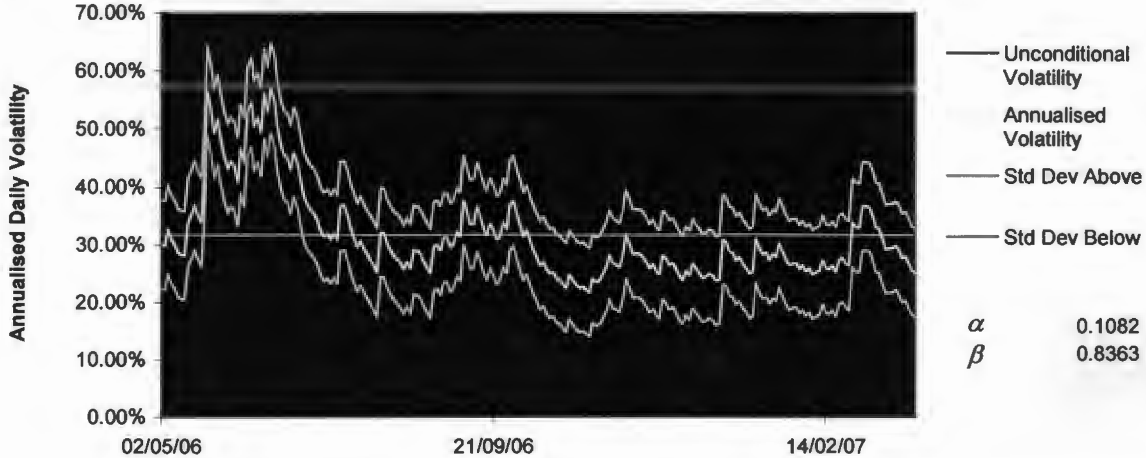
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.70%
Interest Rate	14.32%
Continuous	13.38%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	13.38%

	Rbn
Market value of Equity	530.79
Face value of Debt	43.74
Payout Ratio	13.38%
Interest Rate	13.38%
Equity Volatility	39.43%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.87
Equity Gamma	0.01
Equity Theta	-317.53
Asset Drift	9.230%

GARCH (1,1) Model
Conditional and Unconditional Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
30.80%	39.43%	24.04%	31.73%	7.70%

Base Case

	Rbn
Value of Assets	569.78
Asset Volatility	33.8%
Market value of debt	38.99
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	569.10
Asset Volatility	42.0%
Market value of debt	38.31
Probability of default	0.00000035%

Pretoria Port Cement Ltd
AFS Date: 30 Sep 2006
Rating: AA-

PPC

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.06%
Interest Rate	13.68%
Continuous	12.82%
Dividend Yield	5.23%
Continuous DY	5.10%
Asset Payout	17.92%

	Rbn
Market value of Equity	22.60
Face value of Debt	2.00
Payout Ratio	17.92%
Interest Rate	12.82%
Equity Volatility	28.43%
Time	1.00

Equity Drift	10.73%
Beta	0.37
Risk Premium	3.00%
Equity Delta	0.84
Equity Gamma	0.40
Equity Theta	-8.08
Asset Drift	10.801%

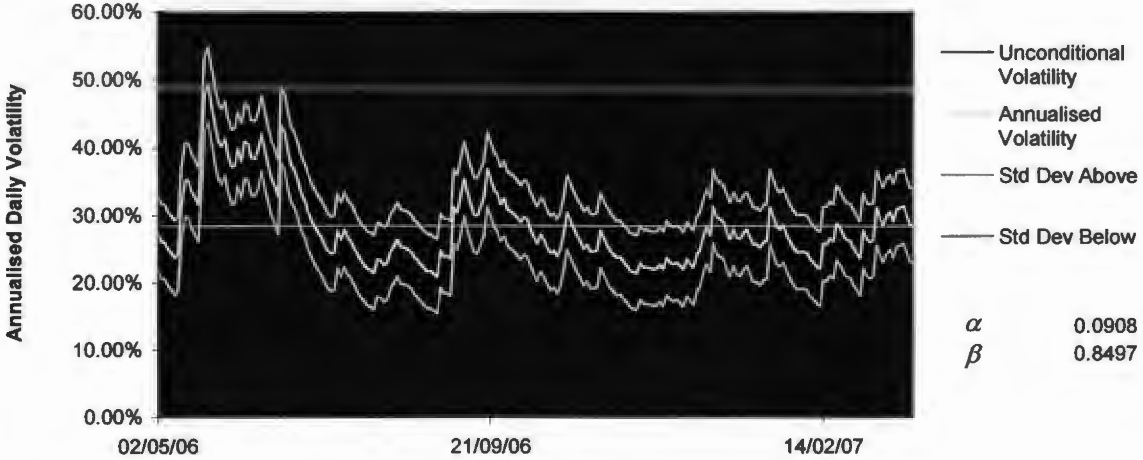
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	6.06%
Interest Rate	15.68%
Continuous	14.57%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	14.57%

	Rbn
Market value of Equity	22.60
Face value of Debt	2.00
Payout Ratio	14.57%
Interest Rate	14.57%
Equity Volatility	33.94%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.86
Equity Gamma	0.36
Equity Theta	-10.95
Asset Drift	9.140%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0908
β	0.8497

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
28.13%	33.94%	22.92%	28.43%	5.51%

Base Case

	Rbn
Value of Assets	24.36
Asset Volatility	31.6%
Market value of debt	1.76
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	24.33
Asset Volatility	36.5%
Market value of debt	1.73
Probability of default	0.000000004%

Sabmiller PLC

AFS Date: 31 Mar 2006

Rating: Baa1

SAB

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.03%
Interest Rate	11.65%
Continuous	11.02%
Dividend Yield	2.40%
Continuous DY	2.37%
Asset Payout	13.39%

	Rbn
Market value of Equity	238.97
Face value of Debt	52.71
Payout Ratio	13.39%
Interest Rate	11.02%
Equity Volatility	21.78%
Time	1.00

Equity Drift	11.64%
Beta	0.74
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.05
Equity Theta	-58.10
Asset Drift	9.225%

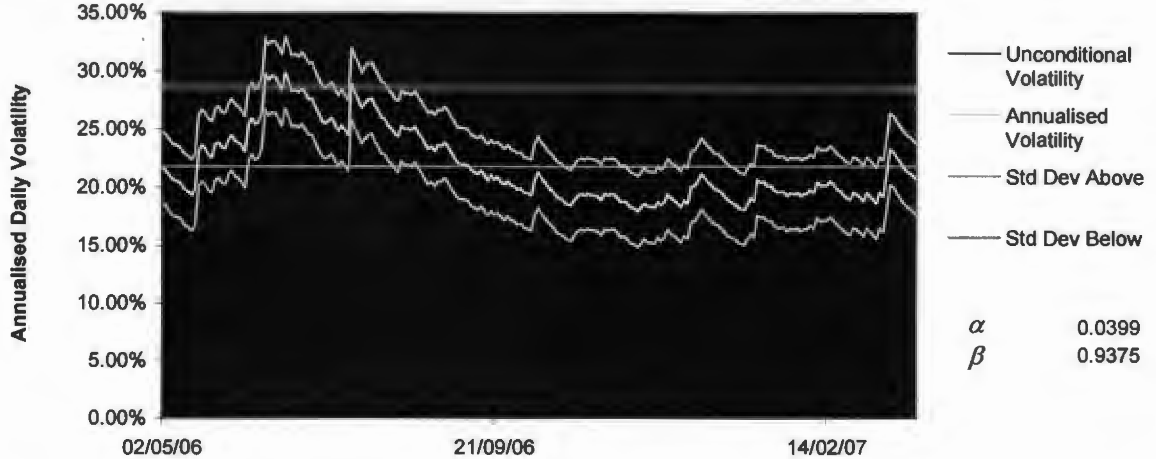
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	4.03%
Interest Rate	13.65%
Continuous	12.80%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.80%

	Rbn
Market value of Equity	238.97
Face value of Debt	52.71
Payout Ratio	12.80%
Interest Rate	12.80%
Equity Volatility	24.85%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.88
Equity Gamma	0.05
Equity Theta	-72.39
Asset Drift	6.792%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0399
β	0.9375

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
21.64%	24.85%	18.72%	21.78%	3.07%

Base Case

	Rbn
Value of Assets	286.21
Asset Volatility	20.8%
Market value of debt	47.24
Probability of default	0.0000000%

Worst Case

	Rbn
Value of Assets	285.38
Asset Volatility	23.7%
Market value of debt	46.41
Probability of default	0.00000000%

The Spar Group Ltd
AFS Date: 30 Sep 2006
Rating: N/R

SPP

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.00%
Interest Rate	12.62%
Continuous	11.88%
Dividend Yield	3.40%
Continuous DY	3.34%
Asset Payout	15.23%

Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	6.00%
Interest Rate	15.62%
Continuous	14.51%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	14.51%

Base Case

	Rbn
Market value of Equity	7.71
Face value of Debt	0.72
Payout Ratio	15.23%
Interest Rate	11.88%
Equity Volatility	27.89%
Time	1.00

Worst Case

	Rbn
Market value of Equity	7.71
Face value of Debt	0.72
Payout Ratio	14.51%
Interest Rate	14.51%
Equity Volatility	33.94%
Time	1.00

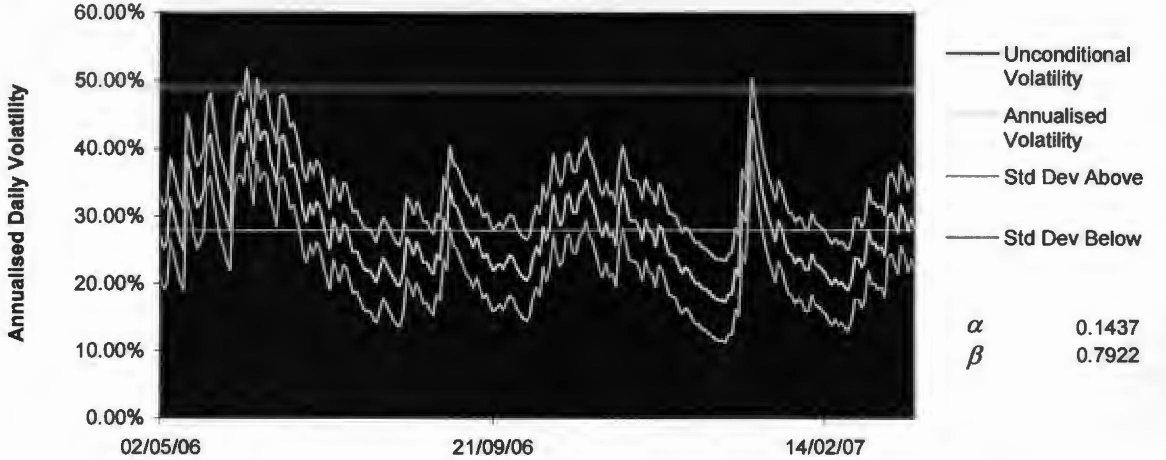
Base Case

Equity Drift	10.97%
Beta	0.45
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	1.28
Equity Theta	-2.83
Asset Drift	10.746%

Worst Case

Equity Drift	9.62%
Equity Delta	0.86
Equity Gamma	1.06
Equity Theta	-3.72
Asset Drift	9.047%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1437
β	0.7922

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
27.79%	33.94%	21.85%	27.89%	6.04%

Base Case

	Rbn
Value of Assets	8.34
Asset Volatility	30.0%
Market value of debt	0.64
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	8.33
Asset Volatility	36.3%
Market value of debt	0.62
Probability of default	0.000000006%

Edgars Consolidated Stores Ltd

AFS Date: 31 Mar 2006

Rating: B2

ECO

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.68%
Interest Rate	10.30%
Continuous	9.80%
Dividend Yield	4.00%
Continuous DY	3.92%
Asset Payout	13.73%

	Rbn
Market value of Equity	25.09
Face value of Debt	1.17
Payout Ratio	13.73%
Interest Rate	9.80%
Equity Volatility	33.00%
Time	1.00

Equity Drift	10.97%
Beta	0.45
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.34
Equity Theta	-12.16
Asset Drift	11.619%

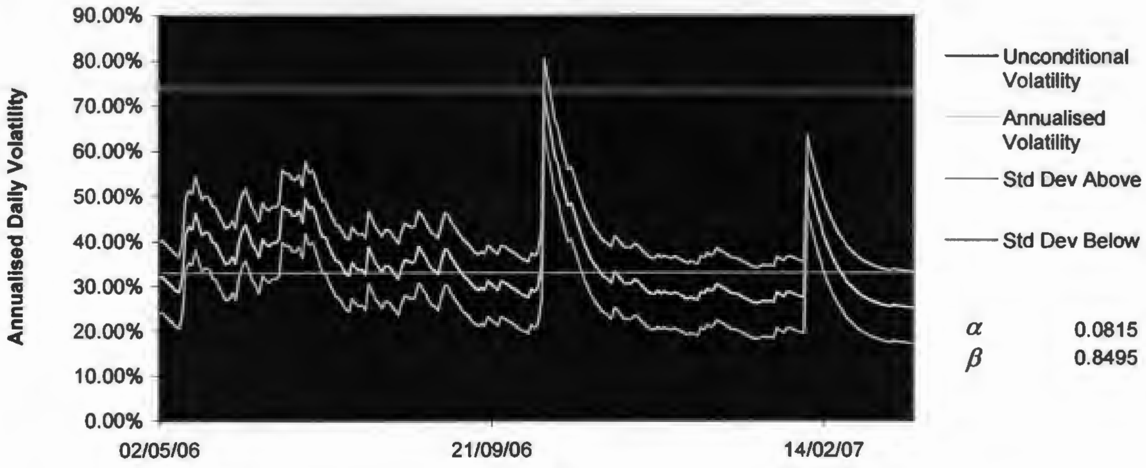
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.68%
Interest Rate	12.30%
Continuous	11.60%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.60%

	Rbn
Market value of Equity	25.09
Face value of Debt	1.17
Payout Ratio	11.60%
Interest Rate	11.60%
Equity Volatility	40.99%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.29
Equity Theta	-16.30
Asset Drift	9.855%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.0815
β	0.8495

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
33.82%	40.99%	25.00%	33.00%	7.99%

Base Case

	Rbn
Value of Assets	26.15
Asset Volatility	36.3%
Market value of debt	1.06
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	26.13
Asset Volatility	44.2%
Market value of debt	1.04
Probability of default	0.000000001%

Richemont Securities Ltd
AFS Date: 31 Mar 2006
Rating: N/R

RCH

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.68%
Interest Rate	10.30%
Continuous	9.80%
Dividend Yield	1.86%
Continuous DY	1.84%
Asset Payout	11.65%

	Rbn
Market value of Equity	206.19
Face value of Debt	10.55
Payout Ratio	11.65%
Interest Rate	9.80%
Equity Volatility	29.50%
Time	1.00

Equity Drift	12.65%
Beta	1.01
Risk Premium	3.00%
Equity Delta	0.89
Equity Gamma	0.05
Equity Theta	-89.84
Asset Drift	13.094%

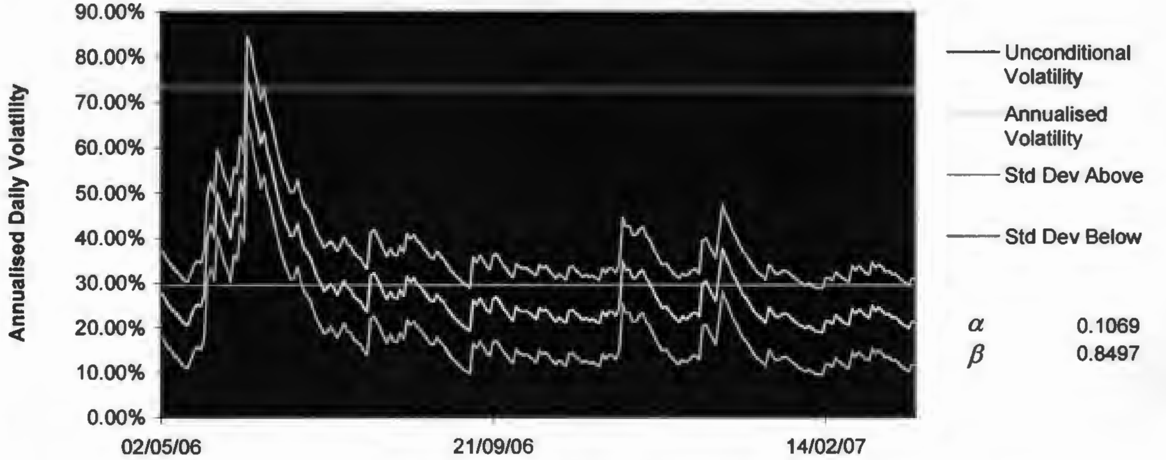
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.68%
Interest Rate	12.30%
Continuous	11.60%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.60%

	Rbn
Market value of Equity	206.19
Face value of Debt	10.55
Payout Ratio	11.60%
Interest Rate	11.60%
Equity Volatility	39.12%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.04
Equity Theta	-126.65
Asset Drift	9.765%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α 0.1069
β 0.8497

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
27.90%	39.12%	19.89%	29.50%	9.62%

Base Case

	Rbn
Value of Assets	215.77
Asset Volatility	31.7%
Market value of debt	9.58
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	215.60
Asset Volatility	42.0%
Market value of debt	9.41
Probability of default	0.000000000%

Pik N Pay Stores Ltd
AFS Date: 28 Feb 2006
Rating: N/R

PIK

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	1.50%
Interest Rate	11.12%
Continuous	10.54%
Dividend Yield	4.23%
Continuous DY	4.14%
Asset Payout	14.69%

	Rbn
Market value of Equity	15.35
Face value of Debt	0.65
Payout Ratio	14.69%
Interest Rate	10.54%
Equity Volatility	27.83%
Time	1.00

Equity Drift	10.55%
Beta	0.31
Risk Premium	3.00%
Equity Delta	0.86
Equity Gamma	0.65
Equity Theta	-5.86
Asset Drift	11.327%

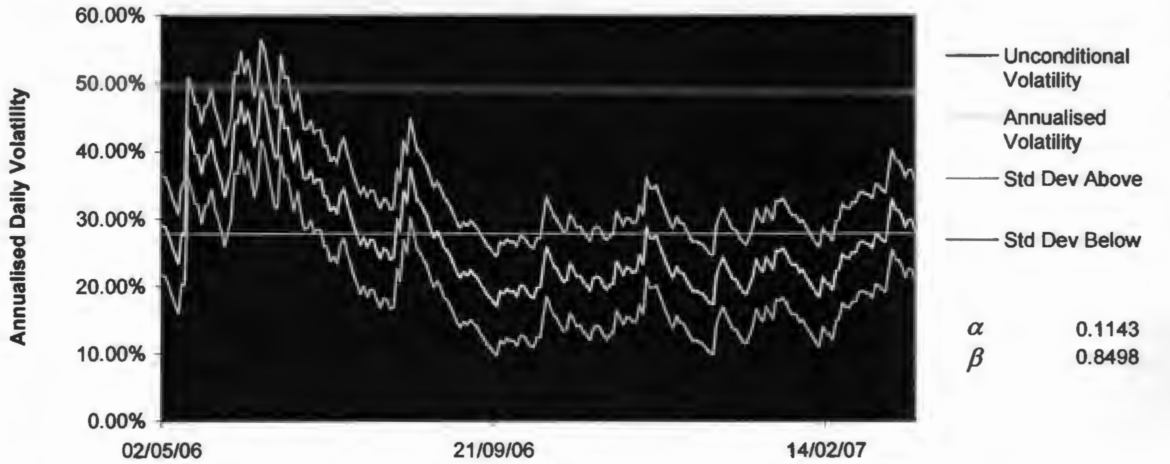
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.50%
Interest Rate	13.12%
Continuous	12.33%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.33%

	Rbn
Market value of Equity	15.35
Face value of Debt	0.65
Payout Ratio	12.33%
Interest Rate	12.33%
Equity Volatility	35.20%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.88
Equity Gamma	0.54
Equity Theta	-8.24
Asset Drift	9.991%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1143
β	0.8498

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
26.86%	35.20%	20.47%	27.83%	7.37%

Base Case

	Rbn
Value of Assets	15.93
Asset Volatility	31.0%
Market value of debt	0.58
Probability of default	0.00000000%

Worst Case

	Rbn
Value of Assets	15.92
Asset Volatility	38.4%
Market value of debt	0.57
Probability of default	0.000000000%

Anglo Platinum Ltd
AFS Date: 31 Dec 2006
Rating: A2

AMS

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	0.68%
Interest Rate	10.30%
Continuous	9.80%
Dividend Yield	3.14%
Continuous DY	3.09%
Asset Payout	12.90%

	Rbn
Market value of Equity	215.59
Face value of Debt	0.84
Payout Ratio	12.90%
Interest Rate	9.80%
Equity Volatility	43.66%
Time	1.00

Equity Drift	14.54%
Beta	1.64
Risk Premium	3.00%
Equity Delta	0.88
Equity Gamma	0.03
Equity Theta	-150.46
Asset Drift	16.444%

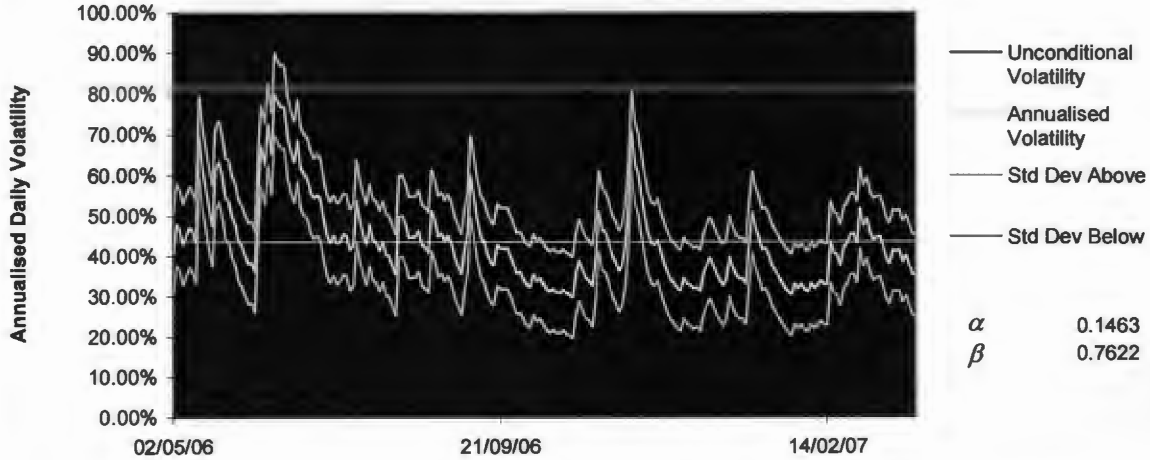
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	2.68%
Interest Rate	12.30%
Continuous	11.60%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	11.60%

	Rbn
Market value of Equity	215.59
Face value of Debt	0.84
Payout Ratio	11.60%
Interest Rate	11.60%
Equity Volatility	53.69%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.03
Equity Theta	-192.86
Asset Drift	10.721%

GARCH (1,1) Model
Conditional and Unconditional Volatility



α	0.1463
β	0.7622

Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
42.93%	53.69%	33.62%	43.66%	10.04%

Base Case

	Rbn
Value of Assets	216.37
Asset Volatility	49.5%
Market value of debt	0.78
Probability of default	0.0000000%

Worst Case

	Rbn
Value of Assets	216.36
Asset Volatility	60.1%
Market value of debt	0.76
Probability of default	0.00000000%

Remgro Ltd
AFS Date: 31 Mar 2006
Rating: N/R

REM

Base Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	1.35%
Interest Rate	10.97%
Continuous	10.41%
Dividend Yield	3.70%
Continuous DY	3.63%
Asset Payout	14.04%

	Rbn
Market value of Equity	78.53
Face value of Debt	2.22
Payout Ratio	14.04%
Interest Rate	10.41%
Equity Volatility	27.28%
Time	1.00

Equity Drift	11.03%
Beta	0.47
Risk Premium	3.00%
Equity Delta	0.87
Equity Gamma	0.13
Equity Theta	-29.80
Asset Drift	12.080%

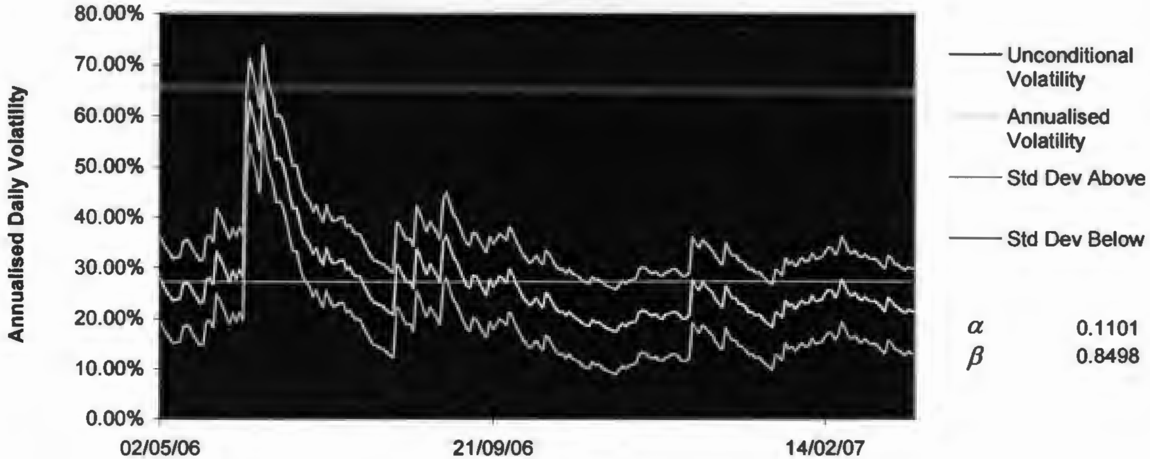
Worst Case

1 YR Swap	9.78%
2 YR Swap	9.70%
1YR forward Swap Rate	9.62%
Spread	3.35%
Interest Rate	12.97%
Continuous	12.20%
Dividend Yield	0.00%
Continuous DY	0.00%
Asset Payout	12.20%

	Rbn
Market value of Equity	78.53
Face value of Debt	2.22
Payout Ratio	12.20%
Interest Rate	12.20%
Equity Volatility	35.71%
Time	1.00

Equity Drift	9.62%
Equity Delta	0.89
Equity Gamma	0.10
Equity Theta	-43.23
Asset Drift	10.266%

GARCH (1,1) Model
Conditional and Unconditional Volatility



Ave Volatility	1 Std Above	1 Std Below	Unconditional	Std Dev of Volatility
26.38%	35.71%	18.84%	27.28%	8.43%

Base Case

	Rbn
Value of Assets	80.54
Asset Volatility	30.6%
Market value of debt	2.01
Probability of default	0.0000000%

Worst Case

	Rbn
Value of Assets	80.50
Asset Volatility	39.4%
Market value of debt	1.97
Probability of default	0.00000000%