

AN INVESTIGATION INTO THE REASONS FOR THE PRICING DIFFERENCES BETWEEN A WARRANT AND AN OPTION ON THE SAME STOCK IN THE SOUTH AFRICAN DERIVATIVES MARKET

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Abstract

This study set out to draw a pricing comparison between two similar contracts in the South African derivatives market. These contracts, a normal option and a warrant on the same underlying stock are considered. The research shows that although the two derivatives are the same in all respects, the premiums differ substantially when priced with the Black-Scholes-Merton model. It is clear that pricing has to take place over the same calendar period due to market changes when comparing the instruments. The Black-Scholes-Merton model was the proposed model to be used. However, due to certain limitations the Modified Black model was used as the best suited model. It was shown that warrant contracts always have a higher implied volatility and a higher premium than a comparable normal option per share of the same stock. These results were compared with similar studies conducted in the European markets.

Keywords: Black-Scholes-Merton model, "Historic volatility", "Implied volatility", "Premium", "Option", "Modified Black model", "Warrant."

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Introduction

Internationally, as well as in South Africa, institutional and private investors are faced with trading decisions with volatile stocks in an unpredictable market. Fluctuations in the stock price of a company can be due to changing fundamental factors in the company and the influence of market factors. Over the years more instruments have been made available for trading and investment. The Global financial crisis accentuates the fact that corporate managers require even better risk management skills and tools.

Risk in this context refers to the possible loss due to the change in the stock price of a company. Two similar derivative instruments, namely options and warrants are expected to provide the same price on the same underlying. However, these two similar derivative instruments do not always provide similar prices on the same stock, which is also the case in the South African derivatives market. This is shown in the study conducted by Galai & Schneller (1978:1333). To date, insufficient studies had been conducted in the South African derivatives market, comparing these instruments. In this paper a similar stock of a company will be used as the underlying.

Explaining the reasons for the differences between the prices of these two derivative instruments, may contribute to the more efficient use of these instruments, better risk management decisions and more appropriate investment decisions. Numerous questions arise when option and warrant prices are

compared. This paper is aimed at further clarifying this issue.

The aim of this research is to determine the reasons for the difference between the price of an option on a share and the price of a warrant on the same underlying share in the South African derivatives market. The price of these two instruments should agree as these two instruments are essentially similar in many respects. However, there are differences in the prices of these instruments that need to be explained

Although these instruments are in a way difficult to compare due to their terms being so different, a comparison will be attempted in this study.

Option Pricing Theory and Warrant Prices

Option pricing theory has been regarded as one of the most important contributions made to business society. This break-through has been adopted by practitioners worldwide and the end result has been the improvement in the efficiency of financial markets (Kaufman, 1999:77).

Bodie, Kane and Marcus (2007:505) mention that there are at least six factors that should have an effect on the value of a call option on stock, namely: the stock price, the exercise price, the volatility of the stock price, the time to expiration, the interest rate, and the dividend yield of the stock.

Hull (2006:611) provides an illustration of Fisher Black's model which is an extension of the

Black-Scholes-Merton model which is used for pricing options on futures. The Black-Scholes-Merton model assumes that interest rates are stochastic, while Black's model is best used when interest rates are assumed to be constant. The Black model also uses the dividend yield and risk free interest rate as two of the variables used to price the future.

Although most of the assumptions mentioned by the various authors with regard to the Black-Scholes-Merton model may not hold in practice it is important to note that this model still provides an excellent approximation of option prices in the real world business environment.

Reilly and Brown (2009, 75) define a warrant as an option issued by a corporation (in this research Sasol) the gives the holder the right to acquire the stock from the company at a specified price for a specified time period. A warrant can also be defined as an instrument that is based on an underlying similarly to a normal option and may also be priced using the Black-Scholes-Merton model. In South Africa, warrants are issued on the Johannesburg Stock Exchange by independent financial institutions as well as banks. Koorts and Smit (2002:31) argue that investors are able to purchase these instruments as they would a share, and are able to gain a leveraged exposure in the market. Investors do not require a significant amount of capital to take a position and even small investors can include an entire basket of warrants in their portfolio.

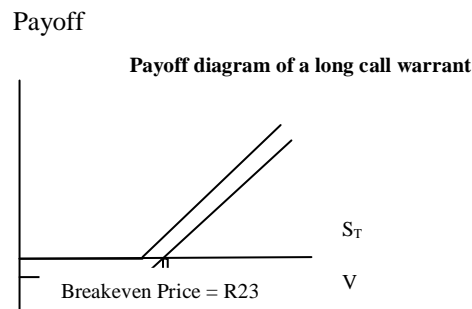
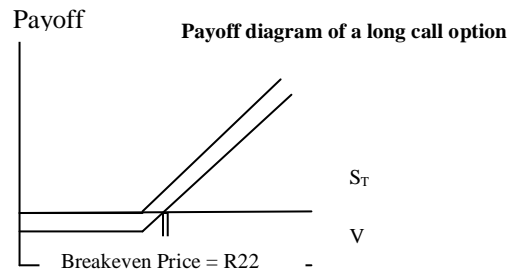
A warrant is an instrument that allows the holder to purchase a stock at a fixed price at a certain date in the future. A warrant can, thus, be seen as a call option issued by a company on its own stock to generate funds. Logically, warrants should be valued differently due to the fact that exercising a call warrant will increase the issued shares of a company which will have a direct impact on the value of the underlying stock. Exercising a warrant results in an increase in the number of shares outstanding and also brings new cash into the company. Both of these factors have an effect on the stock price. Koorts & Smith (2002:31) state that the "*the expected negative impact (dilution) of an exercise makes the warrants less valuable than otherwise similar call options*". Warrants are independent derivative instruments in the South African, German and Australian financial markets, which are issued by financial institutions. Warrants trade over-the-counter, as well through an exchange where the underlying asset is listed (Koorts & Smith, 2002:31).

Implied volatility as a measure of volatility is widely believed to be superior to historical volatility when valuing options and can be seen as the market's prediction of future volatility. In option markets the Black-Scholes-Merton model provides different implied volatilities for different strikes and time to maturity. This change in the implied volatility for different times to maturity is known as a volatility smile. For most warrants implied volatility can be

seen as a poor measure of future volatility. The reason for this is due to the methodology used to calculate this measure.

Schwartz (1970:87) compared the price behaviour of warrants with the price behaviour of options showing normal trading patterns. He firstly compared the warrant price to common option price and then compared the warrant premium to common option price, with the premium expressed as a percentage of exercise price. In his opinion, warrants that are structured with a hundred percent premium, can be regarded as having an advantage over other warrants and are also practical for the issuing company. The investing public would favour these warrants due to the price being lower. He also regards the high premium warrant as an excellent case for corporate takeover schemes (Schwartz, 1970:95).

Example: Assume stock price is R20 with R20 strike price. The call option premium is R2 and a call warrants premium is R3.



Although call options and call warrants may have the same payoff diagram, a call warrant has a higher premium and thus requires a higher breakeven price.

As stated by Kotze (2009) "If the stock price moves to R25. This may not seem like much, but consider this in percentage terms:

- R3 Profit / Cost for the option (R2) = 150%
- R2 Profit / Cost of the warrant (R3) = 66.7%"

The stock price must move more for a warrant than a comparable option contract. This example is based on the assumption that the long party will immediately sell the stock received upon exercise of the option/warrant contract.

Modelling and Comparison of Option and Warrant Prices

Multitudes of different perspectives have been introduced to reach a valid conclusion as to the reasons for the pricing differences between an option and a warrant on the same stock in the South African market.

From the research done by Veld & Verboven (1995:1128) it was concluded that "...no important (principle) differences exist between warrants and long term call options, which could explain the substantial price differentials found in the Philips example".

Kremer & Roenfeldt (1992:225) mention that "...the pricing of corporate warrants constitutes a natural application for option pricing models because of the many similarities between call options and warrants." They also maintain that although there are many studies on the pricing of options, there are very few available on warrants. Most scholars agree that comparing warrants with normal options on the same stock is complicated by the difference in terms that apply to the two instruments. Warrants, by their very nature are long term instruments.

Many different models exist that attempt to model the pricing of warrants. An example is the Jump-Diffusion model which Kremer & Roenfeldt (1992) proved is the best model for the pricing of warrants. Kriesel (2002) defends the use of nonparametric statistical methods, while Beckers (1980) is positive about the results obtained using the Constant Elasticity of Variance model that he says that if the tests for a larger sample hold true, could replace the Black-Scholes-Merton model. Lauterbach & Schultz (1990) also maintain that the Constant Elasticity of Variance model prices warrants more accurately. Galai & Schneller (1978) focused their analysis on the value of the stock of firms that issue warrants.

Data analysis

This section illustrates the pricing method used to compute the premium of a call option on Sasol shares as quoted on the equity derivatives market in South Africa. Secondly, it illustrates the computation of the premium of a call warrant also on Sasol (SOL) similar in all respects except the maturity date. Both premiums will be calculated on a per share basis for an American style option but with European style characteristics. Thirdly, the premiums will be recalculated for at-the-money comparison option and warrant.⁵

Tick data obtained from the Johannesburg Securities Exchange (JSE) was used to compute the premium of about a 6 month long call option for the

period from 27/01/2009 to 18/06/2009. Due to the American style of options traded in South Africa, the modified Black model was used to compute the premium. This is the model used to price options on futures referred to before. As the underlying is a single stock future (SSF), the spot price is the prevailing futures price at that time and is usually close to the JSE mark-to-market value and is therefore used as a proxy for the price of the share on that date. Note that in the comparison that follows the terms of the option/warrant are the same but the expiry dates are different.

⁵ $S_T = K$.

Table 1. Spot Price of futures and options on 27/01/2009

Futures Price Specifics, allow for acquisition of 100 shares						
Contract Type	Closing Price/ Volatility	Bid	Offer	M-t-M	First	Last
Expiry June 09 Code SOLQ	278.00	284.84	284.84	284.84	274.37	274.37
Call option Strike 302.18	59% ⁶	284.84	284.84	3472.00 ⁷	0.00	0.00
Call option Strike 379.31	59%	284.84	284.84	1496.00	12.35	12.35

Source: Extract from South African Futures Exchange (2009) daily price data, adjusted

⁶ The volatility quoted on similar futures contracts expiring on March 2009.

⁷ This is the premium of an American call option on 100 futures contracts using the implied volatility of 59%, which is provided by SAFEX for all strike prices within a certain range.

The modified Black model is used together with the inputs from Table 1 to produce the following output:

Table 2. JSE Modified Black Calculator

Calculate:	Premium
Spot price:	284.84
Strike price:	302.18
Risk Free rate:	0.00%
Dividend yield:	0.00%
From Date:	27/01/2009
Expiry Date:	18/06/2009
Call or Put:	Call ⁸
Nominal	100
Volatility:	⁹ 62.01%
Result:	3 685.59

As shown above, the Sasol futures price of R284.84, expiring in March 2009 is used as the spot price for the option contract on 27/01/2009. The reason for the use of the future's price is that it converges to the spot price over time for which the Black model caters. The risk free interest rate and dividend yield is not used in the calculation as it is already worked into futures price. Otherwise, the present value of the futures price or spot price (together with the risk-free interest rate and dividend yield) should be used in the Black & Scholes model. This price differs from the market price of R3 459.68 for the basket due to market changes and marking-to-market. The spot price that will give the quoted basket price of R3 459.68 can be found iteratively through a trial and error process. This results in a new share spot price of R280.39, which is the spot price used by the issuer of the option. As the futures contract allows for the acquisition of 100 shares, the call premium per share therefore is:

$$\frac{3\,459.68}{100} = \text{R}34.60 \text{ per share.}$$

In order to calculate the premium of a warrant on the same Sasol share price with strike of R300, the implied volatility of the share must first be determined. This is done by using the modified Black model. Note that the comparable warrant contract expires in August 2009, where options on futures

contracts expire every three months, namely June and September. Thus, to compare the warrant with option for the same time to maturity, an interpolated futures spot price for August must be derived as illustrated below.

Table 3. Interpolated futures spot price for August

June options on futures spot	August options on futures spot	September options on futures spot
284.15	288.59	290.07

Source: Safex (2009), adjusted

For a South African Futures Exchange (SAFEX) closing price on date of valuation of R282.63, a strike price of R300 and a premium of R4 160.00 (for a 100 shares or R41.60 per share) for the call option contract, a volatility of 59.17% is derived.

Table 4. JSE Modified Black Calculator

Calculate:	Implied Volatility
Spot price:	288.59
Strike price:	300.00
Risk Free rate:	0.00%
Dividend yield:	0.00%
From Date:	12/02/2009
Expiry Date:	01/08/2009
Call or Put:	Call
Nominal:	100
Premium:	¹⁰ 4 160.00
Result:	59.17%

If the warrant is compared to a SAFEX option contract (similar in all respects) a substantial price difference can be observed. Table 5 below illustrates how large the difference between a traditional option and warrant contract on the same underlying can be. As mentioned before, no adjustment for the expiry date is made and the instruments are also not at-the-money but are similar in all other respects. If the volatility of the normal option should drop to 59,17%, the difference would be even greater. A further difference is due the conversion ratio and the volatility of the call option and the warrant. This conversion ratio refers to the rate at which the warrants may be exercised by the holders relative to one share or a basket of shares. Put differently, it is the number of warrants that need to be exercised to convert into one unit of the underlying asset. This has an effect on the unit price of the shares as the number

⁸Two fundamental types of options are traded in the South African derivatives market, namely call and put options. By definition warrants are similar to long call options. Thus, in this study only call options have been considered in relation to call warrants in order to validate the comparison.

⁹ Boardman (2009) stated that the 62.01% represents the implied volatility used by the issuer of the option contract.

¹⁰ Comparable premium of a warrant is calculated as 0.32 x 130 (Cover ratio) x 100 (1 futures contract is on 100 shares) = 4160. This allows for comparison of the warrant premium with the premium of an option contract on the share.

of issued shares will increase which will dilute the unit price of the share after conversion.

Table 5. Comparison of the option and warrant contract volatility

	Call option contract	Warrant contract (conversion ratio = 130)
Implied volatilities	62.01%	59.17%
Premiums	R34.60 ¹¹	R41.60 ¹²

Table 7 below further illustrates the effect of the conversion ratio on the price of a warrant. The calculation was done for different conversion ratios. The price ascertained using the 63.30% implied volatility, together with the Sasol spot price of R282.63 (28263c), provides a premium of 32.0455. This is consistent with the 32c quoted in the market.

¹¹ Similar option premium per share is $3459.68/100 = R2.84$.

¹² Warrant premium per share is $0.32 \times 130 = 41.60$.

Table 6. Warrant price calculation, including conversion ratio¹³

Valuation Date	12/02/2009	Volatility	59.17%
Expiry Date	01/08/2009	Conversion ratio	130:1
Spot price	28859	Style	American call
Dividend yield	0%	Delta	0.5426
Exercise price	30000	Premium	32.0059

Source: Adapted from Standard Bank (2009)

The warrant calculator provides the following premiums for different conversion ratios:

Table 7. Warrant prices with different cover ratio's

Conversion ratio	Delta	Premium (cents)
20:1	0.5316	208.2955
40:1	0.5316	104.1478
60:1	0.5316	69.4318
80:1	0.5316	52.0739
100:1	0.5316	41.6591
120:1	0.5316	34.7159
130:1	0.5316	32.0455

Table 8. At-the-money warrant valuation for different conversion ratios

Conversion ratio	Delta	At-the-money Premium (cents)
20:1	0.5860	256.8297
40:1	0.5860	128.4149
60:1	0.5860	85.6099
80:1	0.5860	64.2074
100:1	0.5860	51.3659
120:1	0.5860	42.8050
130:1	0.5860	39.5123

¹³ Warrant calculator contains a built in "dilution factor". This calculator is provided on the Standard Bank website.

Refer to the List of References.

It is important to understand the effect of the conversion ratio. For different warrants on the same underlying and with very similar terms, it is not unusual to see different levels of responsiveness. This is due to the different conversion ratios. Warrants with a lower conversion ratio usually have the advantage of being more responsive to a smaller change in the underlying. The conversion ratio is therefore an important variable to consider when investing in warrants.

If the valuation process is repeated for at-the-money options on futures with a price of R302.18, the from date is once again 27 January 2009, expiry date 18 June 2009 as before and volatility of 62.01 percent, the premium for a basket of 100 shares comes to R4 633.78 or R46,34 per share. If the pricing process for the valuation of the warrant is also repeated with a stock strike price of R300 (30000c), similar expiry date and volatility of 59.17%¹⁴, the new warrant price comes to R48.06¹⁵.

For the sake of clarity, the table with the conversion ratios for the at-the-money warrant valuation with the different conversion ratios is given again.

The above table is the result of the calculation of firstly, the premium of an American long call option. This was held consistent with the premium quoted in the market. The premium was calculated using the modified Black model provided by the JSE.

A point worth mentioning here is that the volatility as quoted in the market is an implied volatility contrary to the volatility used by the issuer (short party) of the option contract which is more subjective. The spot price of R280.30 was found iteratively to provide the premium of R34.60 per share. The goal-seek method (demonstrated above) for the spot price can only be used if the volatility and the premium are quoted in the market. If the premium is not quoted, the volatility is usually calculated using a flat volatility curve.

For an example, all options with the Strike price of 100 to 500 are priced at 59% volatility for a certain time to maturity. (In the discussion above, a skew volatility assumption was used by the issuer, thus pricing it far left on the volatility curve at 62.01%¹⁶ (see Figure 1 below).

¹⁴ Since no comparable at-the-money options existed for the specific time to maturity, it was approximated by using the implied volatility (63.30%) of a similar out-the-money option.

¹⁵ $36.9705c \times 130$ (Conversion ratio) \times (1 futures contract = 100 shares) = 4 806.17, thus 1 share of stock = R48.06.

¹⁶ Refer to the literature review. This is also referred to as a volatility smile.

Figure 1: Relationship between the implied volatility used by SAFEX and the issuer

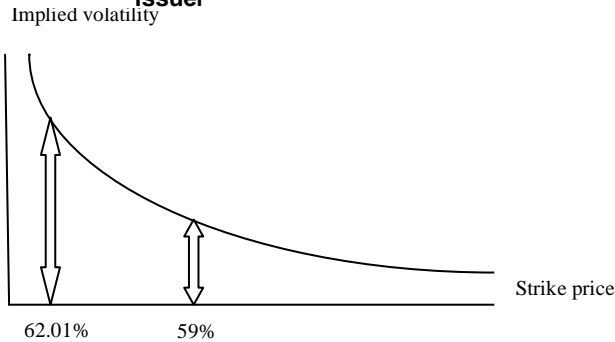
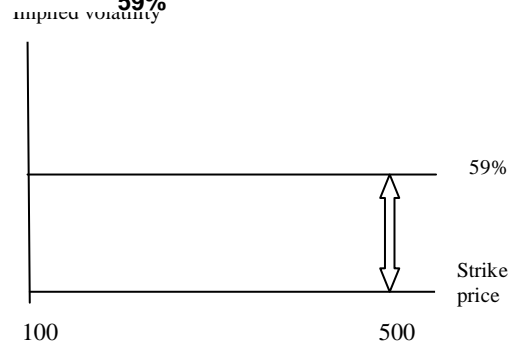


Figure 2: All option contracts with a strike between 100 and R500 quoted at 59%



A Different Valuation Approach

As stated by Kotze (2009) and other equity derivative specialists and dealers, it is preferable to compare warrants and options with not only similar time to maturity¹⁷ (term) but also expiry date. Although an identical period has been applied, the different exercise prices resulted in fallacious results.

Since volatility, as it relates to option contracts, is actually what is traded in the market place, volatilities of the two instruments should be compared rather than the prices.

A warrant from date should be selected and the warrant price should be determined (see Table 8 below). The price of 42 cents for the warrant should be converted to the single stock equivalent taking into account the conversion ratio and number of shares. This comes to:

$$42 \text{ cent} \times 160 \times 100 = R6\ 720$$

Of course, in order to logically compare the two instruments, they should be as close as possible to each other in all respects. The exercise price and time to maturity should be identical. An interpolated futures price should be determined and be used as the spot price for both the option and warrant contracts.¹⁸

The approach would then be to find a Sasol futures contract price for the same period using SAFEX end-of-day data. The information for a Sasol

warrant that expires on the 3rd of November 2009 is listed in Table 9.

The interpolated fair value of the SSF also expiring on the 3rd of November must be determined. To do this, the closest expiring future, before and after the warrant expiry date is used for interpolation. Also the volatility closest to the SSF is used. The interpolated SAFEX value of R306 (see Table 10) below was obtained from the Standard Bank web site. It can also be calculated, however there are some issues that need to be considered that may complicate the calculation. Of the utmost importance is, secondly, to be aware that the SAFEX division of the JSE uses different yield curves to discount different dividends from different companies. The yield curves can be constructed from a process known as “bootstrapping.” Although alternative yield curves can be constructed, to match the yield curve that is constructed with the yield curve used by SAFEX, is a complex task.

¹⁷ It is better to compare a warrant (01/12/2008 to 01/06/2009) to an identical option for a similar date (01/12/2008 to 01/06/2009) than to an option with a similar +/- 6 months time to expiration (16/09/2008 to 19/03/2009). The reason is due to the fact that the market has shifted, namely more dividends have been declared, interest rates have changed. The new mark to market price will not allow for a reasonable comparison. Example: A home loan taken out in 1980 will differ from a home loan taken out in 1990.

¹⁸ Refer to steps proposed by Boardman (2009) for the complete steps that should be followed.

Table 9. Dates for a warrant contract

From Date	Alpha name	Contract Name	Closing Price (cent)
04/06/2009	SOLSBF	SB SOL Strike R270 Call on Future Conversion ratio 160:1 Expiry date: November, 09	42

Adapted from SAFEX

Table 10. Data to compute the interpolated futures price for November

Futures price expiring in September	Comparable implied volatility	Futures price expiring in November (interpolated price between September and December)
318.06 C	45%	306.23

Adapted from <http://www.safex.co.za/pub/EdmStats/Fullstats20090604.xls>

An option with expiry date of 3 November, strike of R270 and futures price of R306 was retrieved from the Standard Bank web site. For this the volatility can also be determined with the Modified Black Model. The premium of the warrant in SSF terms is R6 720 and the volatility is 63.96% when determined on a trial and error basis using the Black

Model. The price of the call option with the same expiry date, strike and volatility of 45% (which was determined from the SAFEX end of day data) as in Table 9 above, gives a premium of R5 426,32. Table 11 below finally compares the two instruments on the basis of volatility and premiums. Once again substantial differences can be observed.

Table 11. Comparison of an identical option and warrant contract on the same underlying stock

	identical option contract	Warrant contract
Implied volatilities	45%	63.96%
Premiums	R54.26	R67.2

This comparison shows that a warrant contract in this case has a *higher implied volatility* and a *higher premium* than a comparable option on a per share basis. Although the above calculation was carried out only for a single Sasol share, the findings were further confirmed by discussion with market participants.

Generally, warrants provide one major advantage over traditional options. Warrants contain an element of market making. The “onscreen market maker” is responsible for providing a “narrow double” throughout a trading day. For example, assuming the market remained constant, if an investor purchases a warrant for 37 cents in the market, he/she is allowed to exit that position at 35 or even 36 cents (Kotze, 2009).

According to Kotze (2009), warrants generally trade in the market at a higher volatility than comparable options. This is confirmed by Table 11. In the above case the warrant traded at an implied volatility of 63.96%, whereas an identical call option traded at an implied volatility of 45%. Due to the “onscreen market maker,” investors can move in and

out of a warrant position at minimal cost. This is confirmed by Boardman (2009) who stated that warrant volatilities are often 20% or more higher than our Single Stock Options wholesale market prices. The higher implied volatilities of warrants results in a higher premium than comparable traditional options.

The motivation for the lower option premium may be due to the fact that it is easier to start earning a return investing in traditional options due the lower breakeven price (strike plus premium) as opposed to warrants with the higher premiums.

Furthermore any investor can write an option, or trade an option, with any available counterparty. This tends to reduce the risk for the investor. Boardman (2009) also confirms that this helps keep the volatility of normal options lower as investors can:

- Short options if they feel volatilities are too high.
- Or long options if they feel the volatility is too low.

This provides a wider range of option trading strategies that also involves writing options. Thus the major difference between options and warrants is that

the warrants cannot be shorted, only longed. It is also the cause of the difference in the prices of an options and identical warrants. As the investor is paying more in volatility terms, these investors cannot expect the issuer to buy back this high volatility. Although both at-the-money call option and at-the-money call warrant premiums were determined, numerous derivative specialists are of the opinion that it is more sensible to compare these instruments out-the-money than in-the-money because this ignores the intrinsic value (Boardman, 2009).

Although premiums were calculated for a long American call option and a long American call warrant, the American style options traded in the South African derivatives market have the underlying characteristics of European options. Thus, the Black-Scholes-Merton model could also have been used to calculate the premium of a warrant, provided a volatility premium was taken into account of +/- 1% (Kotze, 2009). Although the American style options contain European style characteristics, early exercise of these options prior to maturity were not favourable. By exercising these options early, investors would lose dividends that they would have received if they held their options till the maturity date. As mentioned before, the lower the cover ratio, the greater the warrant premium due to the smaller number of warrants that are exercised into one share of stock resulting in a lower dilution factor.

Conclusion

The results of this research are in contrast to the findings of Sithole (2003) who stated that options and warrants produce equivalent premiums. Results of this research are similar to those of Koorts & Smith (2003:31) and Veld & Verboven (1995). Koorts & Smith (2003:31) states "the price difference presents itself in the volatility, which is the only uncertain parameter". This is true as stated previously, that the warrant's volatility is always greater than that of the comparable option, provided that the option and warrant being compared are both either in- or out-the money. Crouchy (1991:89) argued that a call option and call warrant with similar maturity and exercise price should have the same premium. This is, however, not the case in the South African market as they should have an identical time to maturity and exercise price.

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