OPTIONS AND THE PRICING PITFALLS

START WITH THE RIGHT INFORMATION

By JOHN CAMPBELL, NEIL COCKS and DON HAMSON

The increasing popularity and convenience of equity options trading should not blind market participants to the possibility of drawbacks in their pricing models

Over the past decade the trading volume in Australian listed equity options has grown substantially. Many individuals and institutions who previously regarded these markets with extreme caution now use them as an integral part of their risk-management and investment strategy. In a general sense, this rise in popularity is due to the increasing sophistication of the Australian capital markets. For example, the share price index futures contract and its associated options contracts have become more popular since their successful use by some portfolio managers to mitigate losses in the October 1987 stockmarket crash.

Unlike that of a share, the price of an equity option can be established with substantial accuracy. The Black-Scholes option-pricing model[1] prices equity options by incorporating only five variables:

- the risk-free interest rate;
- the current price of the underlying share the option is written on;
- the expected volatility of the share price;
- the time to option expiration; and
- the exercise price of the option.

It has been shown that increases in the first four variables will increase the value of a call option, while an increase in the last variable reduces the value of a call, all other things being equal. Professional option traders use highly refined versions of the model to increase its accuracy. For example, these models account for dividends during the life of the option, the possibility of early exercise of the option, or the extent to which the option is in-the-money.

The acceptance of the Black-Scholes option-pricing model and its various refinements, as well as the blossoming of interest in options, has led to the proliferation of computer software packages which price options. This software, mostly drawn from the US, is being used by portfolio managers, banks, brokers and individual investors. Many users of these packages, however, may be inputting erroneous parameters into their pricing models.

The risk-free rate of interest

One of the five main inputs into the Black-Scholes model is the risk-free rate of interest. In practice, this is expressed as some form of a rate per annum. The most commonly used indicator of this is the Treasury Note yield. The use of this rate will, however, produce an incorrect price.

The Black-Scholes model requires a special formulation of the risk-free interest rate — a continuously compounded form. Most interest rates are quoted in nominal annual terms, but pay interest more frequently, such as at monthly or quarterly intervals. Where interest can be earned on interest, the effective return earned by investing for a full year is greater than the nominal rate

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quoted. When expressed in continuously compounded form, interest rates appear lower than when expressed in other forms such as effective terms. For instance, the continuous rate which is equivalent to an effective rate of 15 per cent per annum is only 13.98 per cent per annum. Using an effective or a nominal rate can seriously affect the values of certain options. As would be expected, the error leads to overvaluation of call options and undervaluation of put options.

As indicated in Table 1, the use of an incorrect effective rate overvalues call options by up to 5.5 per cent and undervalues puts by up to 8.4 per cent. In other words, on a parcel of only 20 option contracts, calls can be overpriced by up to $492, and puts underpriced by $510. Where a strategy requires the purchase of calls and sale of puts to produce the desired combination, the effect of the error is magnified. As Table 1 shows, the problem is exacerbated by low volatility and greater time to maturity, and has a greater dollar effect for in-the-money options.

The procedure to convert normal interest rates to continuously compounded ones is straightforward. The continuously compounded rate is the natural logarithm of 1 plus the effective rate of interest:

Continuous interest rate = ln(1 + effective rate)

eg, .1398 = ln(1 +.15)

Unfortunately, the rate of return of most money market instruments is quoted in yield terms rather than as an effective rate. *(See Figure 1)*

This yield is a nominal interest rate. Unless the instrument is of 365 days' maturity, the yield must first be converted to an effective rate:[2] *(See figure 2)*

Current share price

Measuring the current share price is not always as simple as it seems. Some time may have elapsed since the last sale has occurred.[3] Opinion about the worth of a share can alter greatly without any shares actually being sold. This can easily be seen by comparing "buy-sell" or "bid-ask" quotes with last-sale prices for shares. The last-sale price is often outside the buy-sell range.

Probably the best way to estimate the current price of a share which has not recently traded is to use the mid-point of the buy-sell quotes. The use of outdated last-sale prices may lead to significant inaccuracies in pricing an option.

Once the earnings announcement is made, the market quickly digests any information contained in the earnings figure, and uncertainty is reduced

Share volatility

Another possible misconception with option-pricing models surrounds the appropriate measure of volatility to use. The measure used should reflect the expected future volatility of the share price over the future life of the option. This volatility is not necessarily constant through time. Uncertainty about company or market-wide factors may affect share price volatility.

Current research that we are undertaking indicates that share price volatility, as reflected in option values, increases in the period preceding the announcement of preliminary and interim earnings, and rapidly decreases after the announcement. The increase in volatility appears to be due to uncertainty and speculation about a company's imminent earnings announcement. Once the earnings announcement is made, the market quickly digests any information contained in the earnings figure, and uncertainty is reduced.

The effect of changes in volatility can be significant, as shown by Table 1. A doubling of the standard deviation, a measure of volatility, can greatly increase the value of both put and call options, particularly out-of-the-money options.

Further confusion surrounds the two types of options found in the Australian capital markets. Options to buy or sell shares are traded on the listed equity options market. These options are written on shares which have already been issued. However, some companies issue options to subscribe for unissued shares, and these options are traded on the Australian Stock Exchange. In the US these options are referred to as warrants.

As warrants are exercised, the exercise price is paid to the company, and the number of shares on issue by the company is increased. The increase in the number of shares on issue dilutes the share price of the company in much the same way as a rights issue; the value of the company is spread across a larger share base.

For a normal option, the exercise of a listed BHP call option does not increase the number of BHP shares in the market. One can price warrants using the normal option pricing model after adjusting for the dilution factor *q (See figure 3)*.

As can been seen, the value of a warrant, or an option on unissued shares, is always less than the value of a normal option with the same terms because of the dilution factor.

Summary

A significant number of the computations made to price Australian options may employ incorrect parameters. One common mistake may be the use of an inappropriate estimate of the risk-free rate of interest. If effective interest rates or market yields are directly input into the

Fig 1: $$\% \text{ yield} = \frac{\text{Face value} - \text{current price}}{\text{Current price}} \times \frac{36500}{\text{Days to maturity}}$$

Fig 2: $$\text{Effective rate} = 1 + \left[\frac{\text{Yield}}{36500 \times \text{Days to maturity}}\right]\left(\frac{365}{\text{Days to maturity}}\right) + 1$$

Fig 3: $$\text{Value of warrant} = \frac{1}{1+q} \text{ Value of call}$$

where q= ratio of warrants to shares outstanding

eg, Normal call value = 50c

Number of warrants = 1 million

Number of shares = 4 million

Warrant value = $\frac{1}{1 + 1/4}$ x 50 = 40 cents

Black-Scholes option pricing model, the resulting option prices will be wrong. The size of these errors may be significant. To overcome this misspecification, quoted interest rates should be converted to continuously compounded rates. This conversion process generally involves an intermediate conversion of quoted market rates or yields into effective interest rates.

The estimate of the future volatility of the underlying share on which the option is written is also crucial in determining the value of an option, particularly since it is the least observable of the factors affecting the option's value.

The use of an outdated last-sale price for the current share price in an option pricing model will also distort the computed option value. When no recent sale has occurred, it is preferable to use the mid-point of the buy-sell quotes.

Option participants should also be aware of whether the option is a listed equity option or a warrant. Given identical terms, warrants are worth less. □

Table 1: Example put and call option values

(figures show value in dollars for 20 contracts based on current share price of $6.50 for a non-dividend-paying stock)

Series	Type	Contract value using Effective rate	Contract value using Continuously compounded rate	Error in pricing $	Error in pricing %
Dec 5.50	Call	25834	25612	222	0.87
	Put	1838	1886	-48	-2.55
SD=.4 Dec 6.50	Call	12632	12464	168	1.35
	Put	7910	8060	-150	-1.86
Dec 7.50	Call	5092	4994	98	-1.96
	Put	19642	19914	-272	-1.37
Dec 5.50	Call	24080	23818	262	-6.52
SD=.2 Dec 6.50	Call	7762	7564	198	2.62
	Put	3040	30160	-120	-3.80
Dec 7.50	Call	994	946	48	5.07
	Put	15544	15864	-320	-2.02
Mar 5.50	Call	31334	30938	396	1.28
	Put	3488	3612	-124	-3.43
SD=.4 Mar 6.50	Call	19118	18784	334	1.78
	Put	9846	10126	-280	-2.77
Mar 7.50	Call	10840	10594	246	2.32
	Put	20140	20604	-464	-2.25
Mar 5.50	Call	28130	27638	492	1.78
	Put	284	310	-26	-8.39
SD=.2 Mar 6.50	Call	12606	12194	412	3.38
	Put	3332	3536	-204	-5.77
Mar 7.50	Call	3780	3582	198	5.53
	Put	13082	13592	-510	-3.75

SD = standard deviation (volatility) of the underlying stock.

NOTES

1. F. Black and M. Scholes, "The Value of Option/Contracts and Corporate Liabilities," *Journal of Political Economy* 1973.

2. The shorter period of compounding for the nominal rate, or the shorter the period of quotation for the yield, the smaller is the difference between the quoted rate and the continuously compounded rate.

3. This is possible even though the shares on which traded options exist have a high trading volume. The problem is more acute for warrants, which are often issued over thinly traded shares.

DIRECTORS' DUTIES

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jailed for up to seven years unless they can prove that:

- the breach of the legislation took place without their actual or imputed knowledge;
- they were not in a position to influence the company's action; and
- if they were in such a position, they used all due diligence to prevent the breach.

It is a basic feature of Australian law that the onus of proof should be on the prosecution. This new approach to law-making is tantamount to an assumption of guilt. The nature of the activity involved does not warrant such a break with this feature of our legal system.

I believe directors must obtain adequate insurance cover to protect them and third parties from the results of commercial misjudgment or misfortune. It is appropriate to consider changing the Companies Code to permit premiums to be met by directors' companies. It may even have to become compulsory for directors to be insured, analagous to third party motor vehicle insurance.

The advent of a single body to represent company directors and to support their interests is timely. I would like to set out four specific goals that I believe the Institute of Company Directors and its members should pursue:

- To work towards having company law simplified to remove the risk of directors inadvertently breaching the law through the sheer complexity and volume of the law with which they have to be familiar.
- To encourage and assist directors to be better educated about their role and their responsibilities.
- To encourage improved structuring of boards; eg, through use audit and other committees and, if necessary, appointment of more appropriately qualified independent non-executive directors;
- As individuals and through the institute strive to publicise at every opportunity the fact that the vast majority of directors are honest and diligent and their companies efficiently and well run. □