Options Trading - Art or Science?
Danny Roberts.
Junior Sophister

As international trade and capital mobility have increased, the markets for financial derivatives, like options, have become more important. Danny Roberts, who has worked as an options trader, first introduces options, and then analyses their trading under the dichotomy of art or science.

"Great deeds are usually wrought at great risk" (Herodotus 485-425 BC\(^1\)).

In this essay I intend to discuss the nature of options markets, with particular emphasis on the area of stock-index options. I will explore the contribution of 'quantitative methods' in applied options trading.

What is an Option?
An option gives the holder the right, but not the obligation to either buy or sell some stated underlying asset at an agreed exercise price ('strike price'), either before or at some fixed date. In a legal sense an option can be categorised as a 'contingent claim' contract.\(^2\) The seller of an option (also known as a 'writer') grants the purchaser this right (option) in return for the payment of an option 'premium'. The buyer of an option has a risk limited to the premium money paid, with a theoretically unlimited profit in the case of a call and in the case of a put, the value of the option price minus 0, at the maximum. Likewise, the seller has a limited profit (in both cases, the premium monies) and an unlimited risk in the case of an uncovered written call, uncovered being where an option writer does not own the underlying stock. In the case of a put the loss is limited to \{strike price minus 0\} again.

Two broad types of option contract exist - the option to buy the underlying asset and the option to sell it, known respectively as 'calls' and 'puts'. Options may be further categorised in terms of so-called 'European' or 'American' style contracts. In the former case, exercise of the option is only permitted upon expiration of the contract term, whereas, in the latter this may occur (by the issuance of an 'assignment notice' on behalf of the buyer) at any time during the options' life. At expiration the value of a call is equal to max. \{0, index minus strike price\}, and the value of a put is equal to max. \{0, strike price minus index value\}.

\(^1\) Readings in Investment, p. 39.
\(^2\) Options, Futures and other Derivatives, p. 1.
In the case of stock-index options the underlying instrument on which the option is based is a stock-market index. The more popular indexes include the S&P (traded on the Chicago Mercantile Exchange - The ‘Merc’) and the FTSE (‘Footsie’- traded on the London International Financial Futures Exchange-LIFFE). Most stock-index options are ‘cash’ settled options, in the sense that upon expiration all outstanding positions are settled for cash at the prevailing ‘spot’ price. (Unlike, for example, many other option contracts where at expiry the buyer automatically exercises ‘as a result of option’, and so either ‘calls’ or ‘puts’ the underlying asset at the ‘strike’ set out in the contract).

Option Strategies
Option market participants can be divided into two categories -‘speculators’ and ‘hedgers’. The speculator attempts, by forming a view on the market, to earn excess returns to compensate for risk-bearing, whilst the ‘hedger’ utilises option strategies as a risk-management tool. The specific option strategies available to correctly match the required risk/reward and payoff profile sought by the option trader have developed a colourful terminology of its own. Some examples are: spreads, straddles, barriers, strips and straps, strangles, swaps, asians and binaries.

Illustration of all these is not practicable, so, we will consider one example for illustrative purposes using the Butterfly Spread with a common stock option. This example draws heavily on Macmillan.

Current Prices:
IBM Common: 60 - IBM is trading at 60p.
IBM July 50 Call: 12 - The investor pays 12p for the right to buy IBM stock at 50p at/before expiry of the option in July.
IBM July 60 Call: 6 - The investor pays 6p for the right to buy IBM stock at 60p at/before expiry of an option in July.
IBM July 70 Call: 3 - same model as above.

Butterfly Spread:

<table>
<thead>
<tr>
<th>Action</th>
<th>Options Price</th>
<th>Shares</th>
</tr>
</thead>
<tbody>
<tr>
<td>buy 1 contract: July 50 Call</td>
<td>1200 dr.</td>
<td>100</td>
</tr>
<tr>
<td>sell 2 contract: July 60 Call</td>
<td>1200 cr.</td>
<td>200</td>
</tr>
<tr>
<td>buy 1 contract: July 70 Call</td>
<td>300 dr.</td>
<td>100</td>
</tr>
<tr>
<td>net debit</td>
<td>300 (plus commissions)</td>
<td></td>
</tr>
</tbody>
</table>

We are now able to compute the payoff matrix for this strategy - please note that we will ignore commission costs, and we are implicitly assuming that the

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3 Options as strategic investment, p. 181.

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Illustrative prices quoted are tradable in the sense that that our purchases to 'open' are executed at 'ask/offer' prices, and our opening sales at 'bid' prices.

Results of Butterfly Spread Trade at Expiration

<table>
<thead>
<tr>
<th>Contract:</th>
<th>1 dr.</th>
<th>2 cr.</th>
<th>1 dr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM Price at Expiration</td>
<td>July 50 Profit</td>
<td>July 60 Profit</td>
<td>July 70 Profit</td>
</tr>
<tr>
<td>40</td>
<td>-1200</td>
<td>+1200</td>
<td>-300</td>
</tr>
<tr>
<td>50</td>
<td>-1200</td>
<td>+1200</td>
<td>-300</td>
</tr>
<tr>
<td>53</td>
<td>-900</td>
<td>+1200</td>
<td>-300</td>
</tr>
<tr>
<td>56</td>
<td>-600</td>
<td>+1200</td>
<td>-300</td>
</tr>
<tr>
<td>60</td>
<td>-200</td>
<td>+1200</td>
<td>-300</td>
</tr>
<tr>
<td>64</td>
<td>+200</td>
<td>+400</td>
<td>-300</td>
</tr>
<tr>
<td>67</td>
<td>+500</td>
<td>-200</td>
<td>-300</td>
</tr>
<tr>
<td>70</td>
<td>+800</td>
<td>-800</td>
<td>-300</td>
</tr>
<tr>
<td>80</td>
<td>+1800</td>
<td>-2800</td>
<td>+700</td>
</tr>
</tbody>
</table>

This strategy would suit a trader who believes the stock price will be close to its current price at expiration, or when he wants to exercise it. This example illustrates a combination strategy, though, a very real consideration in 'putting-on' these types of trades will be their expense/payoff ratio, as different classes of trader will have quite different dealing costs. In addition to varying commission charges, the expense of dealing in terms of quote spreads can be high, especially in the case of 'out of the money' options. This will often mean that certain types of transactions are really only suitable for options market-makers and/or institutional investors.

In the context of stock-index options, strategies will often include a combination of an option position and stock-index futures. Arbitrage related trading may additionally involve trading in index constituent stocks ('spot') to complete the triangle arbitrage conditions (in conjunction with a risk-free instrument).

Of crucial importance to understanding stock-index options is the so-called theory of 'one price', which underlies the arbitrage principal linking the pricing mechanism of the respective asset classes. Although stock-indexes are not an example of a 'pure arbitrage market' (like, for example foreign exchange markets), and certain characteristics make riskless arbitrage difficult, techniques such as 'program trading' do exist, and 'fair value' of futures/cash and 'put-call parity' are standard analytic tools in options brokerage research (with 'fair values' generally computed for both 'gross' and 'net' funds).
Options - Efficiency and Pricing

There is huge literature in this field and the best we can hope for in the space allotted is a brief synopsis of the more important issues. In stock-index options markets the trader essentially faces two issues in relation to market efficiency. He/She must consider the efficiency of both the market and the option strategy. In relation to the stock market, approaches include Sharpe-Lintner's Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory and Chaos Theory.

CAPM is based on concepts developed by Markowitz in relation to the Variance/Covariance Matrix. The approach posits that return is a function of the undiversifiable risk an investor bears. This is defined as 'market risk', as the matrix shows that the unsystematic risk (variance) can be diversified away using a portfolio approach. This concept is important both in terms of the market itself, where the benefits of diversification are illustrated, and, in the options. The implication of this perspective is that stock-indexes should display less variability in expected return, and hence lower pricing relative to equivalent individual stock options.

The model introduces the popular 'beta coefficient' which measures the standardised covariance with respect to the market. Excess expected returns can be achieved for individual stocks or asset classes only by the assumption of greater risk. The Stock Market Line (SML) illustrates a linear relationship in expected return-beta space.

An 'efficient frontier' maximises return subject to expected risk. It can be shown that the tangent of the loci of these points with a line representing the cost of riskless borrowing/lending (under an assumption of homogenous expectations) produces an 'optimal' portfolio for each investor. This represents a weighted market portfolio with borrowing or lending changing the gearing, and, consequently the risk profile of each individual investor.

This approach provides many important insights to portfolio management. The utilisation of this framework as a forecasting tool has been less impressive. Indeed, the model was designed as a general equilibrium model for all asset classes. The lack of predictive power, despite much research effort aimed at calculating the correct 'risk premium', shows the complexity of the subject matter. The Multi-Factor Arbitrage Pricing Theory, does, I feel, merit considerable interest. Elaine Gazzarelli, the Analyst, who enjoyed some success in relation to forecasting at the time of the 1987 Crash (though, less so later) utilised such methodology in an eleven variable model. I am not sure whether the model is in the public domain although one of the factors was percentage liquidity in Institutional Portfolios, which had sunk to the low level of 3% at the time. The approach utilises econometric multiple regression methodology. Elton and
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Gruber\(^4\) cite Chen, Roll and Ross, and suggest a four factor model including the following variables: inflation, yield curve, risk premia and industrial production. This approach undoubtedly can make some contribution to the scientific methodology of securities markets. However, various issues may cause problems including the following:

- Model Specification - likely to be extremely complex
- Lag Issues - stock markets are themselves regarded as 'lead indicators'
- Data Mining - if models are formulated, for example in a bull market (irrespective of duration), how reliable will they be in bear markets?
- Stability - if causality is itself not stable, how are we to model this?

George Soros suggested, when interviewed by Byron Wien for 'Soros on Soros', that what concerned him most about mathematical methods was "...those methods work 99% of the time, but they break down 1% of the time. I am more concerned with that 1%."\(^5\)

To take an example from the 1987 Stock Market Crash - the low on the nearby futures at this time was 1350, relative to a Cash low of 1511 on the FTSE 100 Index, implying a huge futures - cash discount. This represents an incredible theoretical arbitrage opportunity. However, due to such factors as the existence of 'fast markets', lack of liquidity in the futures and cash markets, and a high degree of even very short-term uncertainty, such trades posed considerable difficulty. In such a situation prices are not 'firm'. Trading in the underlying options was sometimes close to impossible. For example, certain FTSE 100 Index options with out of the money strikes were quoted at prices like: Offered at 80; Bid at 1. It is difficult to imagine a theoretical framework that can cope with markets like these. Incidentally, the 'uptick' rule and the existence of 'circuit breakers' post the Brady report on U.S. markets, continues to make efficient arbitrage there difficult in certain circumstances. A technical analytical framework was of limited use. For example Dr. Jerry, who favours monitoring the market for his 'Trend Analysis' newsletter, at the time noted that on the Friday BEFORE the Crash the Market was at its most oversold in terms of the 10 Day Rate of Change Indicator (ROC) since 1962. Probably the best suggestion at the time came from a computer-based trading system which concluded that the markets were too dangerous to do anything at all.

This is possibly an appropriate juncture to discuss the contribution of chaos theory, from which we have borrowed concepts from sub-atomic Physics in an

\(^4\) Modern Portfolio Theory and Investment Analysis, p.383.  
\(^5\) Soros on Soros, p. 6.
attempt to formulate the stochastic processes inherent in stock prices. Some valuation models in options pricing utilise geometric brownian motion (which describe the path of a particle subject to a large number of small molecular shocks), to attempt an optimal valuation of the volatility input to pricing models. De Grauwe\textsuperscript{6} illustrates the concept of stable equilibria in three-dimensional space with examples from fractal geometry. The existence or otherwise of ‘stable’ equilibria often displays a high degree of ‘sensitivity to initial conditions’, and even the type of computer used in modelling can produce differing regimes, especially with larger iterative processes. We still understand very little about this, but these models may well imply, as suggested by Baumol\textsuperscript{7}, that in reality stock patterns are more complex than generally appreciated.

Having discussed the state of theory in relation to stock market efficiency I should now like to focus on the efficiency aspects of options themselves. In many cases this will be a secondary consideration to the trader, who may consider merely the characteristics of the option trade in terms of his/her view on the underlying market. The ‘hedger’ may not consider the option pricing beyond perhaps the ‘delta’, ‘gamma’ and perhaps generalised ‘time decay’ characteristics, and the speculator likewise may take a position commensurate with a view on the underlying market. In both cases they are happy to rely on the general efficiency characteristics of the market. Nevertheless, it is important to be familiar with pricing theory at some level to successfully participate. Although the mathematics involved can be foreboding, one ought certainly to understand the determinants of option pricing. In addition to movements in the value of the underlying instrument itself, factors such as imputed volatility and time decay can have very important impacts in and of themselves, and to a lesser extent the other characteristics in the valuation process (such as the risk-free rate and dividend).

Real aficionados will be intimately familiar with not only the delta (first derivative of option with respect to the underlying security) and gamma (second derivative) but, also its theta (ROC with respect to time), vega(w.r.t. imputed volatility) and rho (w.r.t. interest rate). These concepts are particularly important in the context of constructing ‘hedge ratios’.

In order to appreciate aspects of option pricing more clearly, we will consider perhaps the best-known option model - The Black-Scholes model (based on the work of Fischer Black and Myron Scholes in the early 70s).

This model can be expressed in the following form:

\textsuperscript{6}Exchange Rate Theory - Chaotic models of Foreign Exchange Markets, p. 17.
\textsuperscript{7}W.F. Baumol in Readings in Investment, S. Lofthouse (Editor).
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\[ w(x,t) = x \Phi(d_1) - ce^{-r(t*-t)} N(d_2) \]

where \( d_1 = \frac{\ln(x/c) + r + 1/2 \sigma^2 (t*-t)}{\sigma \sqrt{t*-t}} \)

and \( d_2 = \frac{\ln(x/c) + (r-1/2 \sigma^2 (t*-t))}{\sigma \sqrt{t*-t}} \)

w= value of call option or warrant on the stock, \( t= \) today’s date, \( x= \) Stock Price, \( c= \) Strike Price, \( r= \) Interest Rate, \( t*= \) Maturity Date, \( \ln= \) Natural Log, \( e= 2.718 \ldots \)

\( \sigma= \) Standard Deviation of Stock Return, \( N= \) Cumulative Normal Density Function,

The above formulation can be utilised in the sense that knowledge of any six variables will give the seventh. It can be used in applied work (utilising a model including a rate of dividend payment) in order to either obtain a theoretical options price, or where this is known, the ‘imputed volatility’. These are closely monitored, and are quoted on the basis of ‘at the money’ strikes. By utilising the range of strike prices one can construct the ‘volatility smile’ i.e. by graphing the strike/implied volatility. Analysts also sometimes plot implied volatility against time series. I carried out this exercise in respect of the Euro-FTSE contracts quoted on LIFFE at the Market close on 1 November 1996, and interestingly, the imputed volatility varied from around 7% for far out of the money strikes to around 14% ‘at the money’. This is, I suspect, related to the dealing spread characteristics.

The Black-Scholes model can be used to value European-style options in terms of continuous time. An iterative approach utilising the ‘tree’ model can simulate valuation of the exercise prior to expiry feature of American-style contracts, utilising discrete-time Mathematics. This ‘tree’ analysis underlies a lot of option mathematics, and indeed, Black-Scholes can be approximated by a simpler binomial approach.

One of the more important issues I wish to stress, however, is that despite their mathematical complexity many valuation models are really quite imperfect. Fischer Black concedes in his paper ‘Using the holes in Black-Scholes’ (5) that his model is unrealistic in at least ten of its assumptions. These are that:

- The stock’s volatility is known, and it does not change over the life of the option.
- The stock price changes smoothly: it never jumps up or down a large amount in a short time.
• The short-term interest rate never changes.
• Anyone can borrow or lend as much as they want at a single and universal rate.
• An investor who sells the stock or the option short will have the use of all the proceeds of the sale, and receive any returns from investing these proceeds.
• There are no trading costs for either the stock or the option.
• An investor's trades do not affect the taxes he pays.
• The stock pays no dividend.
• An investor can exercise the option only on expiration.
• There are no take-overs or other events that can end the option’s life early.

Many of these shortcomings have been adjusted for substantially in subsequent models, for example, in the Cox-Ross approach. In other respects, the effects of changes in specification probably would not warrant the resultant increased complexity (especially, where the variable concerned had a small effect on pricing). Perhaps, the only area where improved insight could help considerably is in relation to the volatility measure and, in terms of the underlying market processes. Volatility is particularly important in an options framework as options represent an opportunity to trade volatility in its own right. One could, for example, either simultaneously buy calls and puts, or combine a strategy in both options and cash markets.

This appears to have been the thrust of more recent work with the development of models by Markov (consistent with 'weak-form' efficiency in terms of the Efficient Market Hypothesis) and so-called 'Jump' Models (based on discontinuous Stochastic processes).

Since 1987 options seems to have been systematically overprice. This raises the issue more generally as to the existence of what might be termed 'memory' effects in markets. A strategy that would suggest itself in these circumstances would be a combination of writing in, or at the money options (both calls and puts) and buying out of the money strikes, combined with volatility arbitrage in the cash market. This takes the form of combining a written option position, and a hedge with an opposite position in the cash market. It is widely used in the 'traditional options' market in London, for example. The writer accepts the option premium money and institutes the respective cash position. The ongoing exposure of the position is then 'managed' in the sense that the cash position is maintained whilst the option remains 'in the money'. Provided that the volatility has been correctly priced, any losses incurred in the cash market should be at least covered by the option premium money received. My suggested strategy is a variant of this, where the written 'double' position is hedged by either 'long' or 'short' positions in the cash market, depending on the quote vis a vis the option 'strikes'. The out of the money positions are discretionary, but protect against 'reversal' gaps.
Conclusions
The derivatives markets continue to grow apace. We are growing accustomed to seeing an ever more bewildering array of instruments of ever increasing complexity. Within the options field alone we have seen the recent development of ‘Caps’, ‘Leaps’, ‘Percs’ and Index Warrants. This is not to mention the developments in ‘Exotic’ options. Derivatives are very important hedging tools, and the only tools available to produce perfect negative covariance in stock markets. For the technical trader these markets provide a further plethora of data in his/her attempt to ‘play the players’ (which I believe may be a sensible methodological approach). One of their more important practical applications is their use in combination with futures positions as a ‘stop-loss’. They can avoid some of the psychological difficulties the trader faces in ‘rationalising’ losing trades. It should always be remembered that there is no such thing as a ‘free lunch’, and that options represent a ‘zero sum’ game. On this theme, certain of Nick Leeson’s remarks in ‘Rogue Trader’ are of interest in the theoretical options debate. For example, he comments as follows, “But then I had to sell more and more. This drove down the volatility, since whenever there was a buyer, I’d hit him. Soon I was the main seller in the market, and I was forcing options down the market’s throat.” Clearly, this raises the issue of causality, or what is sometimes referred to as fungibility, i.e. money ‘mixes’. Sometimes the pricing of the option will lead the cash market. Often arbitrageurs will absorb all the liquidity in the option or convertible before trading in the more visible cash market, as a type of ‘front-running’ exercise. This type of issue alone ought presumably to leave many concerned at applying option pricing as a ‘black box’ system.

Two further issues of importance in relation to market efficiency in stock markets are, the generally higher level of volatility in the futures relative to cash markets, and, volatility generally in relation to exogenous shocks. In terms of the former issue, some explanation can be provided by such characteristics such as bid/ask ‘bounce’, and lower dealing costs in futures. However, some participants (see Haigh for example) suggest that ‘taking out the stops’ may be at least partially responsible. The volatility relative to ‘news’ has been tested in a number of ways. It manifests itself most obviously in terms of intra as opposed to inter-day volatility. Likewise, these characteristics are difficult to encapsulate in a model framework.

To return to the essay title, it is my contention that option models should be utilised as an aide to trading, and not a prescriptive tool in their own right. In this sense I would contend that option trading remains both art and science.

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8 Rogue Trader, p. 116.
Bibliography.


