APPENDIX 6.2
(referred to in paragraphs 5.66 and 6.27)

Notes provided by the London Investment Banking Association

LIBA Note 1

Why is Professor Marsh's analysis wrong?

Professor Marsh's analysis is based on the following assumptions:

(i) Underwriting a rights issue is akin to selling a put option over the shares underwritten, and

(ii) The fair price of such a put option can be calculated by applying the Black and Scholes model.

On this basis Marsh analyses the sub-underwriting commissions on rights issues and concludes that they are too high. (*Note:* Marsh does not comment on the commission charged by the primary underwriter; furthermore his analysis applies only to rights issues and not to other forms of capital-raising.)

The defects in Marsh's analysis are as follows:

1. His analysis assumes that the fair price for the option implicit in underwriting a rights issue is the same as the fair price for an option over the marginal share. A typical rights issue involves the issue of a significant proportion of a company's share capital (a 25 per cent increase in the capital would be quite normal). No market exists in anything like this depth for options over shares. It is clear that if a market did exist the price for an option over a quarter of a company's capital would not be the same as the price for an option over the marginal share.

2. Marsh not only ignores the fact that no market exists for an option of the scale implicit in underwriting but also assumes that such an option would be fairly priced in accordance with Black and Scholes. This is wrong because:

    (i) Black and Scholes uses a measure of historic volatility which cannot reasonably be projected in the circumstances of a rights issue, the news of which is itself likely to impact the share price volatility.

    (ii) Black and Scholes assumes that the probabilities attaching to future prices of the underlying shares are lognormally distributed. Where a material, price-influencing event such as a rights issue occurs the assumption of such a distribution is wholly inappropriate. If the market price falls below the underwritten price at the key time a substantial part of the issue is likely to be left with the underwriters. In expectation that the underwriters will want to sell, the price is immediately likely to fall further. Thus, the circumstances of the issue make it more likely that there will be, for example, discontinuity in the price.

    (iii) The fair price of an option implied by applying Black and Scholes is the price which yields neither profit nor loss in the long run to the regular investor in this and similar options. Sub-underwriters would clearly not put their capital at risk merely to break-even and it would be imprudent for them to do so.

3. Marsh's analysis makes no allowance for the transaction cost of any hedge. If a hedge of such a large proportion of a company's capital were available it would plainly attract a significant transaction cost. If, therefore, sub-underwriters were fully and successfully to hedge in the manner

implied by Black and Scholes they would be guaranteed a loss if they underwrote on Marsh's terms.

4. In considering what would be an appropriate underwriting profit Marsh makes no attempt to compare the returns from sub-underwriting with the capital necessary to support the activity.

LIBA note 2

Pricing an Underwriting Commitment as a Put Option

Introduction

The following paper has been prepared in response to the OFT paper of November 1994 named "Underwriting of Rights Issues". The paper seeks to price underwriting commitments as put options but ignores significant costs and impediments in doing so. This note attempts to quantify those costs and details some practical constraints to hedging underwriting commitments as such. The conclusion reached is that the costs are significant enough to have a major bearing on the conclusions reached within the OFT paper and that the practical constraints are so massive that the use of the method is, at best, questionable.

Method

The analysis below estimates, by means of stochastic computer simulation, the "real world" costs and risks associated with hedging a put option. This method mimics what a trader would do across a range of randomly generated, but realistic, scenarios. In each scenario, the computer can apply predefined hedging rules and calculate precisely, the costs, risks and returns of having done so—including all the constraints and friction which apply in the market. The method not only generates an expected return from a hedged option position but provides a measure of the variability of profits—ie the risk to the hedger.

Case

To demonstrate, the following fictional case has been used;

Company:	Unigate
Share price:	100
Option type:	European Put
Duration:	1 month
Interest Rates:	6%
Dividend:	0% (over the duration of the option)
Stock Borrowing:	3% (including costs for collateralising)
Trading spread:	2% (including spread, impact, commission, and tax)
Strike price:	88.5
Premium:	1.45
Historic Vol:	28.75%
Implied Vol:	50%
B/S Fair Value:	0.23
No. Runs:	500

The strike price of 88.5 was chosen such that the premium was 1.45%, as is the norm with sub underwritings, and the implied volatility was 1.75 times the historic, as was evidenced in the OFT paper.

Summary of results

The position made a profit of 0.54% on average. This implies that the cost of hedging is 0.91% (1.45–0.54). Of that 0.91% cost, 0.62% is spent on spread and transaction costs. Of 500 runs, 64 made losses (12.8%). The maximum loss was 4.91%. The maximum profit 2.13%. The standard deviation of profit was 0.83%.

Observations

The most telling observations are;

The transaction costs are nearly 3 times the Black Scholes fair value.

The worst case is 9 times the expected profit whilst the best is only 4 times the expected profit.

The expected profit is only 0.65 standard deviations above zero.

There is a 1 in 8 chance of losing money.

It is not surprising that the transaction costs are a multiple of the Black Scholes fair value as the fair value is so small relative to the stock price and the transaction costs are proportional to the stock price—not the option price.

This analysis supplies the two vital components missing from the OFT paper—the cost (0.61%) and the risk (0.83%). To achieve a 1 standard deviation profit from hedging after covering trading costs, in this example, the required premium is 1.74.

Practical Constraints

Anyone actually attempting to implement such a trade would face a number of practical constraints. Assuming that the rights issue was on 10% of the outstanding capital of Unigate, the number of options sold by the underwriter would be 23.4 million. Based on an initial delta of –0.1292, the trader would sell 3,023,280 shares to set up the hedge. Thereafter, if he chose to rehedge every 5% move in his exposure, he would need to sell or buy 1,170,000 shares. The market size in Unigate is 25,000 shares at a spread of 5p (1.4%). On request, a market maker may make a wider spread in, say, 100,000 shares. This would still only amount to less than 10% required for a single rebalancing trade.

Conclusion

Using the Black Scholes model to value underwriting commitments is unrealistic on two fronts. Firstly, the model does not take trading costs into account—for out of the money put options these are particularly significant and can amount to a multiple of the fair value. Secondly, practical constraints make it impossible to implement the required hedging strategy. The Black Scholes model is only valid if the hedging strategy can be implemented hence its use in this context cannot be justified.

LIBA note 3

Critical Examination of [the study by Professor Marsh of] The London Business School on The Current Sub-Underwriting Fee Structure for UK Rights Issues

We want to focus in this short note on the problems we see in the method applied by [Professor Marsh] for valuing the "put" option which is effectively sold by the sub-underwriters to the issuer in a UK rights issue. In general, we identified two key problem areas in pricing such a "put" option with a pure Black-Scholes model approach:

- Choice of volatility measure
- Hedging costs

Choice of Volatility Measure

The volatility measure is a critical input variable for the pricing of options. Prof. Marsh decided to use in his study a long-run volatility measure based on five year historic volatility of returns on the stocks in his sample. In the paper he stated as major reasons for taking long-run rather than short-run volatilities that the latter are measured with considerable estimate error and are less stable than long-run volatilities. However, we find a series of problems associated with his choice of volatility measure.

Firstly, short-term volatility is in practice viewed by the market as a much better indicator of future volatility over the next month or so than five year old data. This can be seen by analysing the "implied volatility" (the level of volatility reflected in the actual price of a traded option) in the listed options market. Such an analysis shows that implied volatility trades close to one month historical volatility.

Secondly, Prof. Marsh decided not to look at the listed options market and specifically analyse the relationship between historical and implied volatilities at the time of the announcement of a rights issue and in the underwriting period. Our review showed that, on or just before the announcement of a rights issue, the implied volatility of the stock in question increases to a higher level and remains there until the end of the underwriting period. If the rights issue appears to be fully subscribed, the implied volatility tends to tail off again towards the end of the underwriting period. The higher level of uncertainty in the options market at the time of announcement of a rights issue and in the subscription period increases the level of implied volatility by approximately 5% above the one month historical volatility. Consequently, a seller of a "put" would price an option for the underwriting period by using one month historical volatility and make an adjustment for the increased level of uncertainty due to the "new" information. In our view, the one month historical volatility plus an added 5% adjustment for "new" information would yield a volatility figure that is more realistic than the one used by Prof. Marsh.

Thirdly, Prof. Marsh prices out-of-the-money options at the same volatility levels as at-the-money options. However, in observing the equity options market we see that in practice out-of-the-money put options trade at higher implied volatilities than out-of-the-money call options and at-the-money options. This phenomenon is called volatility "skew" and can be explained through the higher probability of equities gapping down than jumping up. During the rights underwriting period there is a higher chance of the stock gapping down, particularly if the rights issue is initially badly received or it appears that a large portion of the issue may not be taken up towards the end of the underwriting period. This volatility "skew" would be factored into the pricing of any "put" option.

Hedging costs

The Black and Scholes model assumes that the hedging process is frictionless. This, however, is a theoretical assumption and not the case in practice. The implied volatilities in the listed options market reflect very small underlying values. This does not apply for rights issues where the underwritten amount is often equivalent to issuing a "put" option for a large percentage of the company's shares representing several hundred million pounds. In order to remain fully hedged the seller of an option has to sell or buy the underlying shares when the stock price moves against him. For instance, if the price of a stock is 400p and moves down 10p, in order to avoid further losses the seller of a put option would have to rehedge by selling shares at 390p. The quoted price in the market will, however, only be good for a normal market trade in volume terms. The impact, therefore, of selling large amounts of shares in such a situation will be to further depress the market price. The effective cost of rehedging will obviously increase. This phenomenon is called "market impact" and increases proportionately with the size of the position to be hedged. In view of the illiquidity of many UK stocks this is a very important factor in determining the "true" cost of the hedge and, therefore, the "put" option. Whether a sub-underwriter chooses to hedge the "put" option is not in our opinion relevant to this aspect of our analysis. The writer of the "put" needs to be reimbursed in full for the risk he is taking independent of his hedging decision.

Summary

We believe that the right starting point for pricing a "put" option sold by the sub-underwriters to the issuer is the use of one month historical volatility instead of five year historical volatility. In our view, the use of long-run volatilities, which generally tend to be lower than short-run volatilities, understates the price of the "put" option. Furthermore, in order to determine a realistic price for the option, additional cost elements for the volatility jump at the time of the rights issue and during the underwriting period, the volatility "skew" for out-of-the-money put options and the effects of the "market impact" have to be factored in. The seller of a "put" option would take account of these factors by adding "extra" implied volatility. According to our market experience, we would add 5% "extra" volatility for the increase in volatility during the underwriting period, 5% for the volatility "skew" associated with out-of-money put options, and 15% for the "market impact" when hedging a very large underlying position. Since Prof. Marsh did not account for any of these cost elements in his study, he consequently underestimated the fair price of the "put" option sold by the sub-underwriters.

In order to use the Black-Scholes approach to option pricing in a UK rights issue, it is clear that it is necessary to price each underwriting on an individual basis to take account of the out-of-the-money level where the "put" is struck, the recent volatility level of the stock and the degree of risk that the rights issue will be badly received or unsuccessful.

LIBA Note 4

Black-Scholes and equity underwriting

Introduction

The statement in the MMC's issues letter (Appendix 2.1) that the ex-ante returns depend on the Black-Scholes value and on the five inputs listed is subject to a major qualification. Black-Scholes made explicit that their model assumed the existence of seven "ideal conditions". To the extent that any of these conditions do not pertain in the equity underwriting market, appropriate allowance needs to be made for the consequence of their relaxation. Black himself in 'The holes in Black-Scholes', *Risk*, September 1988 considers the allowance to be made for the relaxation in some cases.

In practice more than one of the "ideal conditions" probably do not apply to the market for underwriting share issues, but this note concentrates on Black-Scholes' condition (c), which reads:

> "There are no transaction costs in buying or selling the stock or option."

LIBA has explained the critical consequences of the adjustments necessary to take account of the relaxation of this assumption. This note pulls together those explanations in order to provide a full explanation of this principal reason why LIBA considers that Professor Marsh's findings are not correct.

The Black-Scholes Model

The heart of the Black-Scholes model is the statement:

> "Thus it is possible to create a hedged position, consisting of a long position in the stock and a short position in the option, whose value will not depend on the price of the stock, but will depend only on time and the values of known constants."

It is the cost of this hedged position which Professor Marsh treats as the "fair value" of underwriting. For simplicity Black-Scholes assumed the absence of transactions costs, but to apply their model to a real world case it is necessary to allow for the costs that actually arise. The inclusion of an allowance for transactions costs is one of the adjustments which Breedon and Twinn made, and is the largest part of the reason why they come to a higher estimate of sub-underwriting costs than Professor Marsh, and an estimate of excess returns less than half as high as he did. (In this context it should be noted that the MMC reference to Breedon and Twinn's work as "sensitivity analyses" in the issues letter is not quite accurate: in its treatment of transaction costs their paper is a refinement of Professor Marsh's analysis, which is clearly necessary to allow for the relaxation of this simplifying assumption.)

Breedon and Twinn did not make allowance for one aspect of transactions cost which would arise in hedging an option of the size of a rights issue—the extent to which short sales of the share to construct the hedge would have to be at a price below the normal market spread, and thereby add to the cost of the hedge. The critical point is that to hedge a characteristic rights issue the short sales would be of very large size, such that a reduction of the share price would be almost inevitable.

The Magnitude of the Short Hedging Position

The size of the short sale required is illustrated in LIBA Note 2 above, which included a worked example of the cost of constructing a hedge for a rather small—1 for 10—rights issue. For the share chosen in that example the hedge would require a sale of over 3 million shares, more than 1% of the company's issued equity, and 120 times larger than the Normal Market Size for transactions in the company's shares. To assume as Breedon and Twinn do that a sale of this size could be made at a price within the normal dealing spread is implausible. In the case analysed, an allowance is made for this and as a result the cost of the hedge is three times the size of the Black-Scholes fair value.

If instead of the small rights issue analysed, one took an issue of, say 1 for 4, which would be more characteristic of a rights issue, the size of required short sale would be multiplied accordingly. If allowance is made for a plausible share price movement associated with a short sale of this magnitude the costs of constructing a Black-Scholes hedged position rise to an extent that the cost of the option would be uncompetitive with the pricing of a conventional rights issue.

LIBA suggests that the MMC tests the strength of this argument by conducting for themselves this type of analysis for issues of a size characteristic of rights issues. The analysis would generate an estimate of the size of the short sale needed to construct the hedge. The MMC could then seek quotations for a short sale of this magnitude and see whether a price is available and if so how the price compares with the then market price.

Conclusion

If Professor Marsh's findings were correct a question would arise why it is that, despite the very large profit which he argues would be available from using a put option to hedge a rights issue instead of conventional underwriting, nobody seems to have applied that strategy. This paper suggests that one reason is likely to be that the cost of constructing a Black-Scholes hedge would be very much larger than appears from Professor Marsh's analysis—and also larger than appears from Breedon and Twinn's paper which attempts to allow for transaction costs but does not do so fully. Discussions with individuals engaged in equity option writing have all given the strong impression that equity option market professionals do not—and would not—price equity options of the magnitude involved in a rights issue on the basis of Black-Scholes' model. While these discussions have elicited a range of additional explanations of why, the above analysis explains objectively one reason why attempting to do so would be unwise.