Options Arbitrage in Imperfect Markets

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ABSTRACT

Option valuation models are based on an arbitrage strategy—hedging the option against the underlying asset and rebalancing continuously until expiration—that is only possible in a frictionless market. This paper simulates the impact of market imperfections and other problems with the "standard" arbitrage trade, including uncertain volatility, transactions costs, indivisibilities, and rebalancing only at discrete intervals. We find that, in an actual market such as that for stock index options, the standard arbitrage is exposed to such large risk and transactions costs that it can only establish very wide bounds on equilibrium options prices. This has important implications for price determination in options markets, as well as for testing of valuation models.

Among all theories in finance, the Black-Scholes option pricing model has perhaps had the biggest impact on the real world of securities trading. Virtually all market participants are aware of the model and use it in their decision making. Academics regularly test the model's valuation on actual market prices and typically conclude that, while not every feature is accounted for, the model works very well in explaining observed option prices.¹

Most option valuation models are based on an arbitrage argument. Under the assumptions of the model, the option can be combined with the underlying asset into a hedged position that is riskless for local changes in the asset's price and in time and must therefore earn the riskless interest rate. This leads to a theoretical value for the option such that profitable arbitrage is ruled out.

However, while virtually all options traders are aware of option pricing theory and most use it in some way, the arbitrage mechanism assumed in deriving the theory cannot work in a real options market in the same way that it does in a frictionless market. The disparity between options arbitrage in theory and in practice is the subject of this paper.

Some of the important assumptions made in deriving the Black-Scholes model are the following.

- The price of the underlying asset follows a logarithmic diffusion process that can be written

\[ \frac{dP}{P} = R \, dt + \nu \, dz, \]  

where \( R \) is the drift of the price per unit time, \( dt \) denotes an infinitesimal

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¹ Empirical studies of the option pricing model include Black and Scholes (1972), Galai (1977), and Macbeth and Merville (1979), among many others. Galai (1983b) provides a review of the literature on testing option models.

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