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Option Pricing and Replication with Transaction Costs and Dividends

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Abstract:
This paper derives optimal perfect hedging portfolios in the presence of transaction costs within the binomial model of stock returns, for a market maker that establishes bid and ask prices for American call options on stocks paying dividends prior to expiration. It is shown that, while the option holder's optimal exercise policy at the ex-dividend date varies according to the stock price, there are intervals of values for such a price where the optimal policy would depend on the holder's preferences. Nonetheless, the perfect hedging assumption still allows the derivation of optimal hedging portfolios for both long and short positions of a market maker on the option.

Executive Summary:
In a market where market makers must quote bid and ask prices, like the SOFFEX, it is important to be able to determine the bid and ask prices of the traded assets. This is also true for negociated option contracts when the bid and ask prices must take transaction costs into account. The methodology developed in this paper allows us to derive bid and ask prices for American options on dividend-paying stocks under the assumption that the market makers hedge themselves perfectly against all possible investor decisions. Since the derived prices are independent from the market makers' preferences, including their taste for risk, the perfect hedging assumption increases the theoretical bid/ask spread. In fact, all possible spreads that may depend on market makers' risk aversion must lie within the perfectly hedged bid/ask spread.

In an empirical study using daily data on the SOFFEX we found that the average observed

bid/ask spreads were smaller than the theoretical spreads derived by the algorithms presented in this article when there are dividends prior to option expiration, contrary to options on stocks without such dividends. From this it may be inferred that during the period under study the market makers did not necessarily try to hedge themselves perfectly.

Nonetheless, the data show that the observed spreads were on average biased downwards and the quoted bid prices were lower than those corresponding to perfect hedging. Given that the theoretical prices assume that the underlying asset's price follows the binomial model, the bid/ask spread tends to increase with the number of times the market makers' portfolios are restructured. This increases the theoretical spread because of the transaction costs incurred in each restructuring. In order to counterbalance this effect, which is unavoidable in the binomial model under perfect hedging, we have adopted an ad hoc procedure of adjustment of the transaction costs. This assumes that these costs increase at a rate that decreases in proportion to the number of times the portfolios are restructured, as specified in this article. With this adjustment the average theoretical bid/ask spreads become comparable to those observed on the SOFFEX. Thus, with this ad hoc adjustment of the transaction costs and with the perfect hedging hypothesis it is possible to derive bid/ask spreads comparable to those observed on the SOFFEX, thus yielding bounds within which the market makers' spreads should lie whether or not they use perfect hedging.

The proposed algorithms allow a quick estimation of the theoretical bid and ask prices and may thus be used by market makers on the SOFFEX. They are, to our knowledge, the only ones that produce such prices under the perfect hedging hypothesis. The authors have also extended their procedure to American put options and to options on stock indices.