An examination of the Australian Stock Exchange and Australian Financial Review's Fair Values

Steve Easton and Irena Ivanovic

Abstract

The Australian Stock Exchange (ASX) provides so-called fair values for exchange-traded options listed on ASX Derivatives - values reported daily in the *Australian Financial Review*. An examination of all fair values reported in the *Australian Financial Review* from 4 January 2005 to 31 March 2005 documents that between 1 and 2 per cent violate the most fundamental option relationships, specifically the requirement for call and put option values to increase as term to expiry increases, and for call (put) option values to increase (decrease) as exercise price decreases. As these are modelled prices, the systematic incorrect values may not be explained by transaction costs. They are, nevertheless, consistent with staleness. Further, in nearly 30 per cent of cases these fair values violate the basic put-call parity relationship. The type of these violations is also consistent with these values being stale. Simple screens could be included to remove fair values that breach the most basic relationships.

Key Words: Fair Values, Stale Prices, Parity Relationships

Contact Details

Steve Easton, Newcastle Business School, University of Newcastle, Callaghan, NSW, 2305 steve.easton@newcastle.edu.au and Irena Ivanovic, Newcastle Business School, University of Newcastle, Callaghan, NSW, 2305.

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Introduction

The Australian Stock Exchange (ASX) provides so-called fair values for exchange-traded options listed on ASX Derivatives. These values are reported daily in Australia's leading financial newspaper – the *Australian Financial Review.* As detailed on the ASX website (www.asx.com.au/investor/options/getting_started/pricing_models.htm), they are calculated using standard option pricing models with the standard six parameter inputs, namely share price, exercise price, term to expiry, volatility, the risk-free interest rate and expected dividends. But irrespective of what model is used and what parameter inputs are used, the usefulness of these values will be reduced if they are stale by the time they are reported in the *Australian Financial Review.* In this paper the staleness of these values is assessed in terms of whether they obey fundamental pricing relationships.

We first examine whether the fair values reported in the *Australian Financial Review* obey the basic requirements identified by Merton (1973) for call and put option values to increase as term to expiry increases, and for call (put) option values to decrease (increase) as exercise price increases.

We then examine whether the fair values obey the simple well-known put-call parity relation. Following the format of Cox and Rubinstein (1985), put-call parity consists of two inequalities:

$$C - S + PV_e(K) \leq P \leq C - S + K + PV_p(D), \qquad (1)$$

where: P = American put option price; C = American call option price; S = share price; K = exercise price; $PV_e(.)$ = present value, at the risk-free rate, for the period to the expiry of the option; D = amount of a dividend to be paid pursuant to an ex-dividend date falling within the life of the option; and $PV_p(.)$ = present value, at the risk-free rate, for the period to the dividend payment date.

If the price of the put option is less than the lower bound in Equation 1 this gives rise to an arbitrage strategy involving buying the put and the share, selling the call and borrowing the present value of the exercise price. However, if the price of the put option is greater than the upper bound in Equation 1 the resultant arbitrage strategy involves selling the put and the share, buying the call and lending the present value of the exercise price and the dividends due on the share.

Tests of this parity relationship may be undertaken in terms of "violation rates". That is, each put price may be classified either as a "non-violation" if it falls between the boundaries specified in Equation 1, or as a lower (upper) boundary violation if it is less (greater) than the lower (upper) boundary.

It should be noted that irrespective of the model used, provided that the parameter estimates used for the put and call options are the same, fair values should not violate the parity relationship.

Studies of this parity theorem have included those undertaken by Nisbet (1992), Kamara and Miller (1995), Lamont and Thaler (2003) and Ofek, Richardson and Whitelaw (2004). Results of these studies are consistent in showing that put options are overvalued relative to call options and the underlying share. The most detailed study is that of Ofek, Richardson and Whitelaw that found that *put options were relatively over valued and that the overvaluation increased with the term to maturity of the options*. They concluded that this result was consistent with a behavioural finance theory of over-optimistic investors and costs of short selling shares.

Studies of the Australian market have been undertaken by Loudon (1988), Gray (1989) and Brown and Easton (1992). The general finding of these studies is of *relatively under valued put options, especially for short-term options*. These results are in stark contrast to those from overseas studies. They are, however, the violations that are expected when prices are stale. For example, Easton (1994) demonstrated using simulation analysis that for at-the-money options, violations of the lower boundary of Equation 1 (implying apparent relative under valuation of put options) may exceed 20% for short-term options,

even with a lag between the options being traded and the share being traded of only fifteen minutes.

Data

We collected all fair values and last sale prices reported in the *Australian Financial Review* from 4 January 2005 to 31 March 2005 inclusive. This procedure resulted in a sample of 39 275 put options and 43 961 call options for a total of 110 companies. Dividend data for these companies was obtained from the Australian Stock Exchange website www.asx.com.au/options. Interest rate data were collected from the IRESS database. For options with terms to maturity of less than or equal to 135 days, the 90-day bank bill rate was used to proxy for the risk free interest rate, while for options with terms to maturity of greater than 135 days, the 180-day bank bill rate was used.

Results

As reported in Table 1, of the sample of 43 961 call options, 40496 had non-zero fair values. Of these, 1452 *distinct* matched pairs of option values were found where an increase in term to expiry was associated with a decrease in reported fair value. For these matched pairs, the only difference was the term to expiry. As these are modelled values, transaction costs cannot explain the finding. *At least* one of the fair values for each distinct matched pair or 726 fair values must be incorrect. A further 562 distinct matched pairs were found where an increase in exercise price was associated with an increase in reported fair value where for these matched pairs, the only difference was the exercise price. Again, at least one of the fair values for each of these matched pairs or 281 fair values must be incorrect. Some incorrect option values were identified using both screens. However, 1746 *distinct* matched pairs of options were found where an increase in term to expiry was associated with a decrease in reported fair value, or where an increase in exercise price was associated with an increase in reported fair value. Therefore, at least 873 or 2.2 per cent of the reported call option fair values must be incorrect.

As shown in Table 1, the results for put options were similar to those for call options. Using the same matching technique as for call options, at least 425 put option fair values were identified as incorrect because an increase in term to expiry was associated with a

decrease in fair value. A further 206 values were identified as incorrect because an increase in exercise price was associated with a decrease in fair value. In total 512 distinct matched pairs of options were found where an increase in term to expiry was associated with a decrease in reported fair value, or where an increase in exercise price was associated with a decrease in fair value. Therefore, as least 206 or 1.5 per cent of the reported put option fair values must be incorrect.[1]

Given breaches of these most basic relationships, we also tested for violations of the put-call parity relationship. Put and call options were matched where a non-zero fair value was reported for both. This procedure resulted in 14 655 matched pairs. The results are reported in Panel A of Table 2. It may be seen that in 29.9 per cent of cases, the fair values did not obey the put-call parity relationship, with the violation exceeding $0.01 in 21.0 per cent of cases. Moreover, these violations are of the type that is to be expected in the presence of stale values. Lower boundary violations occur more frequently than upper boundary violations with approximately three quarters of all violations being of the lower bound. Violations are greater for short-term options. For options with terms to maturity of less than 80 days, the fair values did not obey the parity relationship in 41.7 per cent of cases, while for options with terms of 80 or more days, the fair values failed to obey the parity relationship in only 7.3 per cent of cases.

Sensitivity analysis was undertaken to examine whether assumptions with respect to interest rates may explain the violations of the parity relationship. However, changing interest rates by as much as 2 per cent was not sufficient to prevent violations. Decreasing (increasing) interest rates by 2 per cent per annum resulted in total violations increasing (falling) to 51.9 per cent (20.2 per cent) of cases, with the number of upper bound violations remaining virtually unchanged. Further misestimation of dividends will cause upper bound violations and is not a possible explanation for the prevalence of lower bound violations.

[1]Before the exclusion of doubling counting, there were 2502 (1524) matched pairs of call (put) option fair values where an increase in term to expiry was associated with a decrease in reported fair value, or where an increase in exercise price was associated with a decrease in fair value. Similar analyses were conducted on last sale prices for call and put options, with the results showing, as is to be expected with stale prices, a high percentage of violations of these relationships,. For call (put) options, there were 9636 (4528) matched pairs. While violations are less for fair values than last sale prices, it remains unclear as to why fair values that are stale are reported.

To compare these findings with those using last sale prices, put and call options were also matched where a non-zero last sale was reported for both. This procedure resulted in 17 267 matched pairs. The results are reported in Panel B of Table 2. Violation rates are consistently higher than those found using fair values. In 44.8 per cent of cases, the last sale prices did not obey the put-call parity relationship, with the violation exceeding $0.01 in 36.5 per cent of cases. These violations are also of the type that is to be expected in the presence of stale values. Lower boundary violations occur more frequently than upper boundary violations with 29.5 per cent of observations showing lower bound violations and 15.3 per cent upper bound violations. Violations are again greater for short-term options. For options with terms to maturity of less than 80 days, last sale prices did not obey the parity relationship in 52.4 per cent of cases, while for options with terms of 80 or more days, last sale prices failed to obey the parity relationship in 26.3 per cent of cases.

Conclusion

The ASX provides so-called fair values for exchange-traded options listed on ASX Derivatives - values reported daily in the *Australian Financial Review.* An examination of all fair values reported in the *Australian Financial Review* from 4 January 2005 to 31 March 2005 documents that between 1 and 2 per cent violate the most fundamental option relationships, specifically the requirement for call and put option values to increase as term to expiry increases, and for call (put) option values to increase (decrease) as exercise price decreases. As these are modelled prices, the systematic incorrect values may not be explained by transaction costs. They are, nevertheless, consistent with staleness. Further, in nearly 30 per cent of cases these fair values violate the basic put-call parity relationship. The type of these violations is also consistent with these values being stale. While the use of fair values may be superior to the use of last sale prices, simple screens could be included to remove fair values that breach this basic relationship.

As a minimum, screens could be included to omit those fair values that breach fundamental relationships based on term to expiry or exercise price.

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Table 1: Violations of Option Pricing Conditions

	Call Options	Put Options
Sample of non-zero Fair Values	40496	36150
Breach of Term to Expiry Condition:		
Number	726	425
Rate (%)	1.8	1.2
Breach of Exercise Price Condition:		
Number	281	206
Rate (%)	0.7	0.6
Breach of either Term to Expiry or Exercise Price Condition:		
Number	873	531
Rate (%)	2.2	1.5

Table 2: Put-Call Parity Using Fair Values and Last Sale Prices

Panel A			Fair Values		
	Total Sample	t < 80 days	t ≥ 80 days	S ≤ X	S > X
Sample Size:	14655	9612	5043	6050	8605
Non-violations:					
Number	10278	5603	4675	3968	6310
Rate (%)	70.1	58.3	92.7	65.6	73.3
Lower-violations:					
Number	3371	3060	311	1655	1716
Rate (%)	23.0	31.8	6.2	27.4	19.9
Lower-violations > $0.01:					
Number	2280	2096	184	1139	1141
Rate (%)	15.6	21.8	3.6	18.8	13.3
Upper-violations:					
Number	1006	949	57	427	579
Rate (%)	6.9	9.9	1.1	7.1	6.7
Upper-violations > $0.01:					
Number	797	752	45	348	449
Rate (%)	5.4	7.8	0.9	5.8	5.2
Panel B			Last Sale		
	Total Sample	t < 80 days	t ≥ 80 days	S ≤ X	S > X
Sample Size:	17267	12272	4995	7008	10259
Non-violations:					
Number	9523	5843	3680	3797	5726
Rate (%)	55.2	47.6	73.7	54.2	55.8
Lower-violations:					
Number	5095	4343	752	2309	2786
Rate (%)	29.5	35.4	15.1	32.9	27.2
Lower-violations > $0.01:					
Number	4086	3425	661	1872	2214
Rate (%)	23.7	27.9	13.2	26.7	21.6
Upper-violations:					
Number	2649	2086	563	902	1747
Rate (%)	15.3	17.0	11.3	12.9	17.0
Upper-violations > $0.01:					
Number	2224	1716	508	728	1496
Rate (%)	12.9	14.0	10.2	10.4	14.6