



Market Structure and its Effects on the Pricing of Derivative Securities in Australia

by

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ABSTRACT

This paper examines whether two securities that have identical payoffs, the equity warrant and the exchange traded option, are priced differently when they are subject to different microstructure issues. The results show that different trading processes, the behaviour of market makers and short-selling restrictions seem to have an effect on relative pricing. This study indicates that, on average, a warrant is priced higher relative to an equivalent option. It appears that this pricing difference may be related to greater liquidity in the warrant market as compared to the option market.

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1. Introduction

There have been numerous studies that have examined the effect of different market microstructures on the price formation process. Various studies that have used U.S data have found that different trading processes between markets can affect security prices [see for example Stoll and Whaley (1990), Bollerslev and Domowitz (1991), Fishman and Longstaff (1992) and Madhavan (1992)]. Other overseas papers, using non-US data, have also examined the effect of differences in trading processes on the price formation process [see Grunbichler, Longstaff and Schwartz (1994), Shyy and Lee (1995), Chow, Lee and Shyy (1996) and Pirrong (1996)].

In Australia, a unique opportunity has arisen to investigate the effect of the trading process on security prices and to analyse how different market microstructures affect the price formation process. Since 1991, the Australian Stock Exchange (ASX) has permitted the trading of equity warrants issued by parties other than the company upon whose shares the warrants are issued. Although the contracts are referred to as warrants, the fact that there is no effect on the capitalisation of the company if the warrants are exercised, implies that the securities are in fact long-dated options rather than bona-fide warrants¹. Because equity warrants and exchange-traded options are securities with identical payoffs, but are subject to different trading processes, there is an opportunity to examine the effect of these different trading processes on the price formation process.

The purpose of this paper is to determine whether the market values these two types of security identically, and if not, to examine what may be the cause of any dissimilarities in pricing. Section 2 of the paper discusses the characteristics of the securities and the markets in which they are traded and suggests the way in which any differences may be expected to affect their relative pricing. Section 3 outlines the nature and source of the

¹ Traditionally, a warrant is a security issued by a company that permits the holder to convert the warrant into shares in the company at the holder's option, according to the terms of the warrant contract. If the warrant is exercised, additional shares are issued by the company resulting in a dilution in the ownership of existing shareholders. The equity warrants considered in this paper are not issued by the company upon whose share the warrants are written, but are instead issued by a third party. If these warrants are exercised, no additional shares are issued and hence there will be no dilution of the value of existing shares.

data and research methods used. Section 4 sets out the results of the testing and Section 5 presents the conclusions.

2. Characteristics of Equity Warrants and Exchange Traded Options and their Markets

2.1 Method of Trading

Exchange traded options are traded on an open outcry basis on the ASX's option trading floor in Sydney, whilst warrants are traded electronically on the Stock Exchange Automated Trading System (SEATS). Various researchers have examined the impact of this microstructure difference on security trading. For example, Grunbichler, Longstaff and Schwartz (1994) and Economides and Schwartz (1995) have argued that electronic trading will reduce the cost of running an exchange.

Another advantage provided by electronic screen-trading is that orders can be physically processed much faster than on floor-trading and there are fewer errors in recording trades [see Grossman (1990)² and Pirrong (1996)]. Screen-trading also permits participants to see all the orders, including price and volume, on the screen which can provide more information about the state of the true market price to participants than on a floor based trading system where there may be fragmentation of order flows in the pits as the volume of trades increases [see Pirrong (1996)]³. Finally, various United States studies [for example Fishman and Longstaff (1992) and Madhavan (1992)] have suggested that screen based trading provides anonymity to informed traders which may enable them to be more aggressive as compared to floor-trading where the identity of the trader on the floor would be known.⁴

² As cited on pp170-171 of Grunbichler, Longstaff and Schwartz (1994).

³ Bid and ask prices can be seen on the screen. Once an order is keyed in and executed on a screen based system then the trade is matched instantaneously. Conversely, for a floor based trading system, such as the Australian Options Market, a bid or ask offer is required to be sent to the floor where a party willing to take an opposite position must be found and negotiated with.

⁴ This statement is not necessarily true as the trader may be acting on behalf of a third party. In Australia, SEATS trading permits any broker to identify the broker making the bid or ask offer and possibly the client on whose behalf that they are acting.

In the options market, Registered Independent Options Traders (RIOTs) act as market makers and they are obliged to be in the market to provide a firm bid or offer.⁵ The bid or offer is valid only if it is taken immediately. In the United States, Stoll (1978) and Grossman and Miller (1988) have argued that market liquidity is aided by the presence of market makers. They argued that market makers supply immediacy by their willingness to bear the risk of any changes in the equilibrium price during the time between the final buyer or seller.⁶ However, liquidity is not necessarily a consequence of the market maker being willing to supply immediacy as indicated by the size of the bid ask spreads in the Australian option market. This may be explained by the reluctance of the few market makers in the Australian options market to take an open position in such a thinly-traded market.⁷ The illiquidity of the market is especially pronounced for options with a term-to-maturity greater than three months. In the last month before maturity, the market becomes much more liquid. Possible reasons for this difference are inadequate risk-return payoffs for market makers combined with the thinness of the Australian market for longer term-to-maturity.

For the warrants market, the Australian Stock Exchange (ASX) has a policy that for an issuer of a warrant to be granted trading status it must undertake to make a market in the warrants.⁸ This is similar to but not exactly the same as the options market because trading on SEATS requires a market maker to explicitly withdraw a bid/offer from the SEATS system while in an open outcry system a market maker need not explicitly withdraw their bid/offer.

⁵ RIOTs are prepared to do this because they are subject to lower transaction costs than other traders and will quote a lower (higher) bid (sell) price for parties requiring immediacy.

⁶ The market makers are not taking a position in the market. They are there as an intermediary. That is, they are only there as a temporary buyer (seller) and will sell (buy) when the eventual buyer (seller) seeking a position in the market appears.

⁷ An example of the relative scarcity of market makers is that as of October 1997 there are only ten RIOTs responsible for all options traded on BHP shares. Over the sample period, BHP shares and options were the most frequently traded in Australia.

⁸ This undertaking is similar to the obligation of RIOT to make a market. However, it is not clear whether this undertaking does provide a genuine safety net for a buyer/seller who has concerns about the liquidity of the market.

2.2 Implications of Third-Party Issuer

Exchange traded option contracts are issued and maintained by the Options Clearing House Pty Ltd (OCH). Investors themselves are not direct parties to option contracts, but are represented by an approved Clearing Member throughout the transaction. In essence, the OCH takes the position of seller to every buyer and the buyer to every seller. Therefore, the risk of any traders in options is limited to that of the OCH. However, the OCH reduces its risk exposure through a system of margining. For a trader in options, any losses through non-performance of the opposite party to the transaction is automatically covered by the OCH and the National Guarantee Fund.

Warrants, however, are issued by third parties, predominantly by merchant banks. Non-performance of the issuer at expiry of the warrant does not attract the protection of the National Guarantee Fund. Furthermore, certain circumstances or conditions may be specified in a warrant contract, known as "extraordinary events", that may lead to the issuer cancelling any outstanding warrants or deferring any payment obligations, leaving the holder of the warrant without any form of recourse. These circumstances may include events such as delistings and trading suspensions.

These differences contribute to greater credit risk associated with the purchase of a warrant. This increased credit risk could be expected to result in warrants being priced at a discount to comparable classes of options.⁹

2.3 Impediments to Short-Selling

Investors in the options market are able to take and write options in the market with few impediments, and hence are able to act on any perceived overpricing or underpricing of an options contract. Warrants, however, are issued securities that are not simply able to be written in the same way as options. The short-selling of warrants is subject to the same short-selling restrictions that apply to all shares. That is, unless the security has been designated by the ASX as an Approved Security it is not able to be short-sold¹⁰.

⁹ Though warrants may have a higher credit risk, issuers of warrants have a vested interest to market the advantages of warrants compared to options, such as greater liquidity, which they have done quite successfully. This is reflected in the increased volumes of warrants being traded.

¹⁰ ASX Business Rule 2.18

There were no warrants designated as such as of October 1997. The inability to short-sell warrants implies that an investor who believes that a warrant is overpriced would not be able to exploit this belief by short-selling the security.¹¹

2.4 Liquidity Premium

Liquidity is of value to those who transact in financial markets as there exists price penalties for illiquidity in markets.¹² For example, in a liquid market an investor who is going long will be willing to pay more for their opening purchase as they will be able to make a closing sale without having to sell at an artificially low price. Correspondingly, an investor making an opening sale (short-selling) will be willing to sell at a lower price as they know that in a closing purchase they will not have to pay an artificially high price. In the equity warrants market, short-selling is not permitted and it is the buyer who will pay for this liquidity premium as the investor knows that in a liquid market the closing sale would not be at an artificially low price. Conversely, sellers in the warrants market will always be closing their position in the market. They do not need to consider the liquidity of the market and its impact on the future purchase price required to close their position. In the options market, where short-selling is permitted it is not clear who pays for the advantage of liquidity.

If the warrant market is more liquid as compared to an equivalent option market, and there is a short-selling prohibition, it would be expected that a warrant would be priced more than an equivalent option.

2.5 Other Considerations

Equity warrants are typically issued with a term to expiry of around two years, whereas standard exchange traded options are usually issued with nine months until expiry. However, there are a small number of exchange-traded options that have a term-to-maturity of up to three years. As this study compares prices of options and warrants

¹¹ The fact that the equity warrants are issued by merchant banks, combined with the prohibition on short selling, could lead to a systematic overpricing of the warrants as the arbitrageurs are unable to profit from this opportunity.

¹² For a discussion of the importance of liquidity to the market see Grossman and Miller (1988) and Hosking (1997).

with the same underlying characteristics, the warrants and the exchange-traded option will be matched so that they will have identical remaining term-to-maturity.

Stamp duty is not levied on either warrant or option transactions, except where a transfer of shares has taken place pursuant to the exercise of the security. Brokerage costs for trading in exchange-traded options as compared to trading on SEATS are only marginally lower.

Both the equity warrants and options market require physical delivery at maturity date as there are generally no cash settlement procedures. As a result, this should not have any effect on the relative pricing of these derivative securities.

In summary, the main advantage of screen trading in warrants as compared to the floor-based trading in the options market is that it provides fewer frictions to trading, it allows investors to process orders much faster and it permits them to observe the complete order book. In addition, RIOTs on the options market do not appear to be performing their role of providing immediacy to the market especially for longer terms-to-maturity. These factors can combine to generate greater liquidity and pricing advantages in the warrants market. The disadvantages of trading in warrants are credit risk and marginally higher transaction costs. It appears that there are factors to support warrants being priced greater than options as well as being priced less than options. Consequently, the question of warrants being overpriced (underpriced) relative to a matched exchange-traded option is indeterminate. Therefore, the null hypothesis to be tested is that there is no systematic difference in the pricing of equity warrants with comparable exchange-traded options.

3. Data and Research Method

Equity warrants data and exchange-traded options data were taken from the IRESS database for the period from 1 January 1997 to the 31 October 1997. Companies with warrant and option securities with identical exercise price, maturity date, call

characteristics and that were American in nature were chosen.¹³ A record was obtained of all equity warrant data with respect to the security code, date of trade, time of trade to the minute, volume and the price of the trade. A similar record was obtained for the exchange-traded option. These two sets of data were matched initially to the same day. They were then matched to the nearest minute with the maximum time allowed between the trade of a warrant and its corresponding option being fifteen minutes. With respect to two warrant (option) trades having the same time period to the nearest option (warrant) trade, the trade which was chosen to be matched was based upon the volume of the warrant (option) which matched most closely the volume in the option (warrant).

As a result of this selection criteria and sample period, there were 478 equity warrant and option trades that were able to be matched to the same day. This initial sample was then filtered to remove all trades that took place at a price that could not be regarded as market determined such as cancelled trades, crossings, and specials. This reduced the sample to 359 trades. Any matched trades taking place in the first ten minutes of the trading day (before ten past ten) were excluded due to the staggered opening procedure of Stock Exchange Automated Trading System (SEATS). This criterion reduced the sample to 350 trades. This sample of matched trades was then reduced so that only those matched trades that took place within fifteen minutes of each other remained. The final sample contained 190 matched trades. Table 1 summarises the way in which this sample of matched trades was obtained. Concurrently an analysis of whether the warrant is overpriced or underpriced relative to the matched option was recorded and the time between the warrant and option trade was noted.

¹³ Equity warrants can be either calls or puts. However, most of the equity put warrants are European-style options. In order to make valid comparisons with the options market only American-style warrants were considered in this analysis.

**TABLE 1 : SUMMARY STATISTICS OF EQUITY WARRANTS AND EXCHANGE
TRADED OPTIONS**

Total no. of trades for	
(A) Equity Warrants	14424
(B) Exchange-traded options	520
No. of matched trades to the day	478
No. of matched trades to the day after removing cancelled trades, crossings and specials	359
No. of matched trades after excluding those that occurred in the first ten minutes of trading	350
No. of matched trades within fifteen minutes	190
No. of companies in initial matched sample	6
No. of companies in final sample with trades matched within fifteen minutes	5
No. of matched warrant and option series in final sample matched within fifteen minutes	6
Minimum no. of days to maturity for sample with total no. of trades	27
Maximum no. of days to maturity for sample with total no. of trades	602

4. Results

Table 2 shows the final sample of warrant and option trades allowing for differing degrees of non-simultaneity between the trades. A binomial test of whether there is any

statistical difference between the number of occasions where the options are priced less than the equivalent warrant and the number of occasions where the options are priced greater than the equivalent warrant was performed at each level. It shows that the null hypothesis of no statistically significant difference in the number of relative overpricings and underpricings is rejected at the one per cent level of significance.¹⁴ This result is insensitive to whether the trades were matched to the same minute or whether they were matched to within fifteen minutes of each other, indicating that the finding is not likely to be the result of non-simultaneity in the matched trades.

TABLE 2 : RESULTS OF THE NUMBER OF WARRANTS AND OPTIONS TRADES MATCHED WITHIN ZERO TO FIFTEEN MINUTES

TIME BETWEEN TRADES	OPTION PRICE < WARRANT PRICE	OPTION PRICE > WARRANT PRICE	OPTION PRICE EQUAL TO WARRANT PRICE
0 min*	32	6	2
≤ 5 min*	84	32	12
≤ 10 min*	109	42	15
≤ 15 min*	127	46	17

* Denotes significance at the 1% level for the two-tailed binomial test.

One possible reason that the option could be priced at a discount to the matched warrant, as outlined in Section 2, is that the warrant price may incorporate a liquidity premium. In order to test this, we need to identify when the options market is especially illiquid relative to the warrants market, as it is for this set of transactions that we would expect the greatest relative mispricing to occur. It has already been noted that RIOTs in the options market are reluctant to make a true market in options with longer terms-to-maturity. This suggests that there may be a significant difference in liquidity for matched securities with longer terms-to-maturity.

Table 3A shows the total number of warrant and option trades for various terms-to-maturity. From the table, the number of trades in the warrants as compared to the

¹⁴ For our sample of matched warrants and options, the minimum tick size was the same for both the option and warrant.

number of option trades increases as the term-to-maturity increases. In addition, it appears that the number of trades in the options only increases substantially for remaining terms-to-maturity less than 100 days. This is best illustrated by the trend in the ratio of option trades to warrant trades over the 5 terms-to-maturity. The ratio is 0.013 for the longest term-to-maturity and 0.326 for the quintile relating to those matched trades with the shortest term-to-maturity. These data appear to support the view that the warrant market is relatively more liquid than the options market for longer terms-to-maturity.

TABLE 3A: TOTAL NUMBER OF TRADES IN WARRANTS AND OPTIONS ACCORDING TO TERM-TO-MATURITY			
TERM-TO-MATURITY (No. of Days)	WARRANTS	OPTIONS	RATIO OF OPTION TRADES TO WARRANT TRADES
≤100	494	161	0.326
101 - 154	945	92	0.097
155 - 247	2327	129	0.055
248 - 321	4515	58	0.013
> 321	6143	80	0.013
TOTAL	14424	520	0.036

In Table 3B, the volume data for the warrants and options market are converted so that they are equivalent in terms of the number of underlying shares. Table 3B shows that for the longer term-to-maturity quintiles the total volume of underlying shares traded in the warrant market is much greater than the option market, as indicated by the ratio of option volume to warrant volume. For example, the longest term-to-maturity quintile had a ratio of 0.050. For the term-to-maturity quintile less than 100 days, the volume in the options market actually overtakes the volume traded in the warrants market, as shown by the ratio of 2.499, though it does have a fewer number of trades.¹⁵ These tables support the view that the warrant market is much more liquid for longer terms-to-maturity but in the last three months before maturity it is not clear whether either market has greater liquidity.

¹⁵ A larger volume could simply indicate a single trade with a very large volume traded.

TABLE 3B: TOTAL VOLUME IN TERMS OF UNDERLYING SHARES FOR WARRANTS AND OPTIONS ACCORDING TO TERM-TO-MATURITY*

TERM-TO-MATURITY (No. of Days)	WARRANTS	OPTIONS	RATIO OF OPTION VOLUME TO WARRANT VOLUME
≤100	5,409,162	13,517,000	2.499
101 - 154	12,943,000	6,519,000	0.504
155 - 247	33,607,652	9,931,000	0.295
248 - 321	42,012,004	3,363,000	0.080
> 321	72,709,457	3,669,000	0.050
TOTAL	166,681,275	36,999,000	0.222

* Both the warrant and option trades were converted to an equivalent number of underlying shares.

If the systematic mispricing is the result of a liquidity premium then, given the greater apparent liquidity in the warrants market for longer terms-to-maturity, we would expect the systematic mispricing to be prevalent for matched securities with a longer term-to-maturity. To test this, the sample of matched trades is divided in two: those in which the option price is greater than the warrant price and those in which the option price is less than the warrant price. The mean and median term-to-maturity of both groups matched within fifteen minutes is calculated. Table 4 shows that the mean (median) term-to-maturity when the option price exceeds the warrant price is approximately 169 days (121 days) while the mean term-to-maturity for occasions when the warrant price exceeds the option price is approximately 235 days (246 days). A Mann-Whitney test of whether the two groups are drawn from the same population was rejected at the 1% level of significance with a z -statistic of -3.94.

TABLE 4: MEAN AND MEDIAN TERM-TO-MATURITY FOR THE SAMPLE SEPERATED ON THE BASIS OF DIRECTION OF RELATIVE MISPRICING

	MEAN	MEDIAN	Mann-Whitney statistic
Option > Warrant (X_1)	169	121	-3.94*
Option < Warrant (X_2)	235	246	

* Denotes significance at the 1% level.

The above results suggest that term-to-maturity is related to the pricing difference between warrants and options. In order to investigate this further, the matched observations were arranged according to term-to-maturity quintiles.

Table 5 shows the results of the number of matched trades within fifteen minutes where the option price is less than the warrant price and where the warrant price is greater than the option price based on term-to-maturity. A Chi-Square test was performed on the null hypothesis that the proportion of under/overpricing is independent of the term-to-maturity. This hypothesis is rejected at the 1% level of significance. Furthermore, a binomial test was performed on the null hypothesis that there is no statistically significant difference in the number of relative overpricings and underpricings for each quintile. The results show that for the term-to-maturity quintiles greater than 154 days the null hypothesis of no statistical difference can be rejected at the 1% level. For the shorter term-to-maturity quintiles the null hypothesis of no systematic difference in pricing cannot be rejected.

TABLE 5: QUINTILES BASED ON TERM-TO-MATURITY FOR THE SAMPLE SEPERATED ON THE BASIS OF THE DIRECTION OF RELATIVE MISPRICING*

TERM-TO-MATURITY QUINTILES (No. of Days)	OPTION < WARRANT	OPTION > WARRANT	BINOMIAL TEST PROBABILITY
≤ 100	17	19	0.434
101 - 154	21	14	0.155
155 - 247	30	5	0.000***
248 -321	33	2	0.000***
> 321	25	7	0.002***
Chi-Square test statistic	26.38**		

* The total number of trades in the five quintiles is one hundred and seventy-three. The reason is that of the one hundred and ninety trades matched within fifteen minutes, seventeen of these trades had the option price equal to the warrant price.

** Denotes significance at the 1% level for the Chi-Square test with 4 degrees of freedom.

*** Denotes significance at the 1% level for the two-tailed binomial test.

The mean pricing differences in dollar amount and percent are shown in Table 6A. The aggregate sample of matched trades within fifteen minutes shows that when the options are priced less than the equivalent warrant, the mean pricing difference is 15.22%. This can be compared with a mean pricing difference of 4.56% when an option trades at a price in excess of a matched warrant. A mean pricing difference of the magnitude of 15.22% (4.56%) may initially suggest that the relative mispricing of warrants and options is economically significant but this will depend on the size of the bid-ask spread in the options and warrants market ¹⁶. If participants are forced to trade at the maximum bid-ask spread in the option and the warrant market, then this systematic mispricing may not represent an arbitrage opportunity as they may face costs of 15-20% when they are forced to sell at the bid price and and buy at the ask price.¹⁷

TABLE 6A: MEAN PRICING DIFFERENCE FOR THE SAMPLE SEPERATED ON THE BASIS OF THE DIRECTION OF RELATIVE MISPRICING.

	DOLLAR AMOUNT (\$)	PERCENTAGE AMOUNT (%)
Option < Warrant	0.0455	15.22
Option >Warrant	0.0650	4.56

Table 6B shows that median pricing differences are 12% when the option is less than the warrant and 3.82% when the option is greater than the warrant, suggesting that this result is not driven by the presence of outliers.

TABLE 6B: MEDIAN PRICING DIFFERENCE FOR THE SAMPLE SEPERATED ON THE BASIS OF THE DIRECTION OF RELATIVE MISPRICING

	DOLLAR AMOUNT (\$)	PERCENTAGE AMOUNT (%)
MEDIAN		
Option < Warrant	0.0400	12.00
Option > Warrant	0.0200	3.82

¹⁶ All analyses performed on the final sample were repeated at the individual company level. In general, these results are similar to those presented in this study.

¹⁷ ASX Business Rule 7.6.1.3 shows that for options with a price range of 35 to 60 cents, the maximum spread allowed for category 1 companies is 5 cents while for category 2 companies it is 6 cents. Our sample of companies are predominately category 1 with one company in category 2.

5. Conclusion

Equity warrants and exchange-traded options which have identical characteristics should trade at the same price in a competitive and frictionless market. In Australia, equity warrants and exchange-traded options are traded in the context of different microstructures and frictions as outlined in section two of this study. We believe that market structures, in particular the type of trading mechanisms and the role played by market makers, affect both the liquidity and the relative pricing in these markets. Our results show that the null hypothesis that there is equal likelihood of the warrant being overpriced relative to the option, as being relatively underpriced would be strongly rejected at the 1% level of significance. Specifically, we found that options seemed to be underpriced relative to the equivalent warrants and this underpricing is related to longer terms-to-maturity and the relative liquidity in both markets. For shorter terms-to-maturity, when there does not seem to be a clear liquidity advantage for either one of the two markets, there is no evidence of a systematic pricing difference.

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