“Why Do the Market Impacts of Derivative Warrant Differ from Those of Standard Options? Evidence from an Emerging Market”

WHY DO THE MARKET IMPACTS OF DERIVATIVE WARRANT DIFFER FROM THOSE OF STANDARD OPTIONS? EVIDENCE FROM AN EMERGING MARKET

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Abstract

This paper examines various impacts arising from the introduction of derivative warrants on the risks, returns and trading activity of the underlying assets. The results reveal many features of the impacts of derivative warrants that distinguish them from standard options. We find that there is a discernible post-issue underperformance of the underlying stocks. The results suggest that investment banks demonstrate the ability for the selection of overvalued stocks as the underlying assets for derivative call warrants. We also find that investment banks tend to issue warrants on stocks that have demonstrated recent increase in volatility. The empirical results show that whilst trading volume, systemic risk and liquidity are unaffected, variance of the underlying asset decreases in response to the introduction of derivative warrants.

Key words: Derivative warrants; Hedging effect; IPO; Market timing; Investor overreaction.
JEL Classification: C15; G13.

1. Introduction

Derivative warrants are long-term options issued by financial institutions. The issuing of warrants has recently gained considerable popularity as a means of repackaging securities into smaller units which are then more accessible to smaller investors. With recent developments, it suggests that derivative warrants market is a lucrative area for investment banks[2]. This paper attempts to examine the effects of the introduction of warrants on the underlying assets.

The impacts on underlying assets arising from the introduction of derivative warrants may differ from those of standard options, since they have distinctive inherent features that distinguish them from exchange-traded options. First of all, the underlying assets of derivative warrants are selected by the issuing financial institutions and the IPO announcements of the warrants are unexpected (Chan and Wei, 2001). Since derivative warrants are initiated by profit-maximizing financial institutions, a useful call warrant writing strategy is to select the individual stock that has short-run price momentum but its price will tend to be depressed when the warrant expires[3]. Secondly, as in the case of an issuing firm's equity IPO announcement, investment banks may be very selective in the timing of warrant IPOs; thus, clustering of IPOs may also be observable in the case of derivative warrants. The likelihood of such clustering of warrant issuances may precipitate hedging demand in the underlying assets, which, in turn, may result in bidding up the underlying asset price. Both Chan and Wei (2001), and Chen and Wu (2001) find that the introduction of warrants leads to a significantly positive price effect on the underlying securities in Hong Kong, and price change is positively associated with trading volume. The former finds that the effects are only associated with the issuance dates instead of the listing dates of the warrants, however, the latter sets the listing date rather than issuance date as an event date. Although Aitken and Segara (2005) find significant negative abnormal returns on the announcement day, they support the view that banks trade profitability from warrants issue.

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[2] Warrants have been successfully traded in many markets, such as those of Australia, Germany, Hong Kong, Switzerland and Taiwan.

[3] A similar argument can also be applied to the case of derivative put warrants.

The paper contributes to a better understanding of the timing of IPO announcements in respect of derivative warrants. Our results reveal, *inter alia*, that: (i) investment banks display a good sense of timing in the issuing of warrants, which leads to evidence of IPO clustering in warrant markets, and which in turn suggests a high correlation between the number of call warrants issued and stock market performance; (ii) our findings suggesting that there are positive abnormal returns at the announcement day, but these returns decline thereafter; (iii) when the consecutive issuance of a popular underlying asset is observed, the effects of hedging demand on the underlying asset prices are more significant; (iv) financial institutions demonstrate an ability to select overvalued growth stocks as the underlying assets for derivative call warrants; post-issue underperformance by the underlying asset is observed; and (v) there is evidence to suggest that financial institutions will tend to issue derivative warrants on high volatility stocks; nevertheless, the volatility of the underlying asset decreases after the introduction of warrants. Our results are particularly informative for small investors who consider derivative warrants as an alternative high leveraged trading vehicle to individual stocks.

The remainder of this paper is set out as follows. In the next section, we discuss the institutional settings that can affect the risks and returns involved in the writing of derivative warrants. This is followed by presentation of the research methodology for this study, with the empirical results provided in the penultimate section. The final section presents the conclusions drawn from this study.

2. The Different Impacts of Warrants and Options

Wide ranging empirical evidence exists on the effects of options listing on the underlying market (see for example, Conrad, 1989; Detemple and Jorion, 1990; and Damodaran and Lim, 1991). Within the UK markets, Watt, Yadav and Draper (1992) found evidence of positive excess returns, which was later supported by Stucki and Wasserfallen's (1994) examination of the Swiss markets. Thus, an association between the listing of call options and positive excess returns seemed evident. However, Sorescu (2000) questioned this association with findings that positive abnormal returns were apparent during the period of 1973-1980, whilst negative abnormal returns were found after 1980. He argued that possible causes included the implementation of regulatory changes in 1981, and the introduction of index futures in 1982. The recent study by Hamill, Opong and McGregor (2002) went on to show that the equity options listing effect within the UK markets had become diminished over time. Mayhew and Mihov (2005) find the price level effects largely vanish when a comparison is made to an appropriate set of control firms.

The impacts on the underlying assets, arising from the introduction of derivative warrants, may in many respects differ from those of standard options, for a number of reasons. Following Chan and Wei (2001), we briefly summarize them as follows. First of all, the underlying assets for warrants are selected by the issuing financial institution, with the timing of the derivative warrant's IPO announcement being totally unexpected. As in the case of an issuing firm's equity IPO announcement, investment banks may be very selective in the timing of the announcement of a warrant's IPO; thus, clustering of IPOs may also be observable in the case of derivative warrants. Furthermore, under certain market conditions, the flexibility available to investment banks in their design of the contract features of derivative warrants, such as moneyness, the choice of underlying assets and the expiry date, can all serve to enhance the attractiveness of derivative warrants[1].

Chan and Wei (2001) and Chen and Wu (2001) examined the impacts on both price and trading volume of underlying securities, arising from the introduction of derivative equity warrants in Hong Kong. Both studies demonstrated the existence of a positive price effect, and that price changes were positively associated with trading volume. The former finds that the effects are only associated with the issuance dates instead of the listing dates of the warrants, however, the latter sets the listing date rather than issuance date as an event date. Although Aitken and Segara (2005) find significant negative abnormal returns on the announcement day, they support the view that banks trade profitability from warrants issue. As for expiration effects, Chen and Wu (2001) find

[1] In the early stage, there were some occasions that the financial analysts of the issuing investment bank made recommendation for the underlying stocks when they issue the warrants. But since 2001, the Taiwan SFC had totally banned the simultaneously analyst coverage during the primary market process.

that the expiration of warrants causes a positive price effect on the expiration day and a negative price effect after expiration for in-the-money warrants, and a negative price effect prior to expiration for out-of-the-money warrants, respectively. The change in trading volumes corresponds closely with the change in price impacts. There are no reported arguments on the warrant expiration day effect in Taiwan, while Chung and Hseu (2005) find that there is no expiration day effect on Taiwan Futures Exchange (TAIFEX) Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) futures.

Secondly, prior to the issuance of new derivative warrants, investment banks are required to cover (hedge) their writing positions with spot positions[1]. The propensity towards clustering of warrant issuances may precipitate hedging demand in the underlying assets, which can in turn result in the bidding up of the underlying asset price; this may give rise to hedging pressure effect on the underlying asset at the time of issuance.

Thirdly, the effect of the announcement of the issue of a derivative warrant can be enhanced considerably if public investors believe that the announcement carries with it positive information content on the expected future performance of the underlying stock. For example, as reported by Reuters on 23 August 2001, when Merrill Lynch announced that it had decided not to issue a derivative warrant on Taiwan Semiconductor Manufacturing Company (TSMC), which had earlier been proposed for issue in Luxembourg, TSMC's American Depositary Receipts (ADRs) plunged overnight by 10.79 percent, followed immediately by a sharp fall in its TSEC listed shares.

Fourthly, since investment banks initiate warrants based on a profit-making purpose, a useful call warrant writing strategy is to select the individual stock that has short-run price momentum but in a longer period its price will tend to be depressed. Short-run price momentum will help to succeed in the primary market process, while overreaction in a longer period will increase the probability of warrants expiring out of money. The higher the ability that warrant issuers can time these opportunities, the higher their warrant writing profits. This also implies that a post-issue underperformance by the underlying asset will be observed. If financial institutions have the ability to select overvalued growth stocks as the underlying asset, the protracted post-issuance underperformance of the underlying assets will be observed.

Finally, there is evidence to show that financial institutions tend to issue derivative warrants on high volatility stocks, and as such, the volatility of the underlying assets may well increase, which could precipitate investors' interest in trading warrants. In addition, volatility markup has always been observed in the pricing of warrants, since higher markup enhances the profits from warrant writing (Green and Figlewski, 1999) and represents an important strategy for overcoming market imperfections, such as transaction costs (Chung, Lee and Wu, 2002). It is possible then that financial institutions can promote both the trading and volatility of the potential underlying assets of warrants in order to achieve successful primary market sales[2].

As a result of these institutional differences, the impacts on the market arising from the introduction of derivative warrants may well differ from those of standard exchange-traded options. We explain in the next section the methodology adopted in investigating the various issues concerning the impacts of derivative warrant introductions.

3. Institutional Arrangements and Data

Derivative warrants provide the holder with the right to buy or sell a specified number of shares in an unrelated company. The exercising of warrants has no effect on a company's capitalization. Whilst most of the derivative warrants issued relate to individually-listed companies, some are issued as a basket of listed equities. The issuance of these warrants in Taiwan has been undertaken independently by the island's financial institutions ever since they were first traded in the Taiwan Stock Exchange Corporation (TSEC) in 1997. Every three months, the TSEC undertakes an evaluation of each individual stock and publishes a qualified stock list from which investment

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[1] During the life of the warrant, issuers are required to conduct dynamic hedging and to submit a hedging proposal plan in order to maintain their ability to meet their obligations.

[2] Some institutional differences exist between derivative warrants and standard options, such as short-selling restrictions and credit risk (for a more detailed description see: Chung, Lee and Wu, 2002).

bankers choose their underlying assets[1]. Since Taiwanese derivative warrants are non-collateralized, issuers are required to conduct dynamic hedging during the life of the warrant, in order to maintain their ability to meet their obligations.

An important feature of the Taiwan derivative warrants market is that in contrast to the issuing of standard options, the lifetime of a warrant involves two separate processes, the issuing process and the listing process. At day 0, the application day, issuing financial institution is required to complete the registration process and submit all the relevant documents to the SFC. The following day (day 1) is the issuing date. From this point onwards, within ten working days, the issuer must sell at least 80% of the warrants in the primary market, whilst the remaining 20% may be retained as an inventory for market making purposes; usually, both public offering and private placement are employed. If, prior to day 10, the required number of shares is sold, the issuer then consults with the TSEC for allocation of a listing date, which is usually 3 days later (day 13). There is, therefore, often a 10-14 day lag between registration and listing.

Following the regulatory reforms by the Securities and Futures Commission (SFC)[2] has given rise to discernible growth in the warrants market[3]. The time series of quarterly TAIEX and the number of American-style call warrants issued relate to individually-listed companies from the third quarter of 1997 to the fourth quarter of 2004 are presented in Table 1, Figures 1a and lb[4]. Evidences show that there is evidence of IPO clustering in warrants markets, the higher issuance level occurred when the TAIEX is local high, both the periods before (Figure 1a) and after 2001 (Figure 1b). Meeting the preference of Taiwan investors, most of qualified stocks belonging to the electronic sector. For example, among 33 and 132 derivative warrants issued in the first quarter of 2000 and in the third quarter of 2003, there are 13 and 65 underlying stocks of warrants belong to the electronic sector, respectively. Responding to the recovery of the Taiwan stock market and the merger wave of Taiwan's financial holding companies, there were 35 warrants issued in the third quarter of 2003. It is worth noting that investment bankers do demonstrate good timing in their issuing of warrants. Among 906 American-style warrants call of individual stock, there are 723 warrants that are out-of-the-money at expiration. The *p*-value is significantly different from 0.5 at the 5 per cent significance level.

Table 1

Taiwan Stock Exchange market index and warrants issued, 3Q1997-4Q2004

Quarter	TAIEX	Number of Warrants Issued	Quarterly Index Return	No. of Out-of-Money Warrants
3Q1997	8708.83	5	-0.04	0
4Q1997	8187.27	4	-0.06	0
1Q1998	9091.16	8	0.11	0
2Q1998	7548.81	2	-0.17	0
3Q1998	6833.95	1	-0.09	0
4Q1998	6418.43	2	-0.06	0
1Q1999	6881.72	3	0.07	0
2Q1999	8467.37	10	0.23	0
3Q1999	7598.79	11	-0.10	0
4Q1999	8448.84	30	0.11	6

[1] The SFC places restrictions on the market value, liquidity and market holdings of the underlying asset.

[2] Chiang, Lee and Hsieh (2000) provide an insight into the Taiwanese warrants market, documenting the background to the general market situation, along with a detailed examination of the reform and modification of the regulatory rules by the Securities and Futures Commission (SFC).

[3] Taiwan put warrant was introduced in 2003, up to the end of 2004, there have been 997 warrants issued and thereafter listed in TSEC, which include 35 basket and 962 individual stocks warrants (906 American-style call, 44 American-style put, 13 European-style call and 2 European-style put, respectively). Furthermore, Taiwanese warrants have been listed in the over the counter (OTC) since 2004.

[4] We would like to thank an anonymous referee' suggestion to include the issuing data of Taiwan warrants after 2000 in the paper, in order that the results should be stronger.

Table 1 (continuous)

Quarter	TAIEX	Number of Warrants Issued	Quarterly Index Return	No. of Out-of-Money Warrants
1Q2000	9854.95	33	0.17	29
2Q2000	8265.09	7	-0.16	6
3Q2000	6185.14	4	-0.25	1
4Q2000	4739.09	6	-0.23	6
1Q2001	5797.92	15	0.22	12
2Q2001	4883.43	4	-0.16	4
3Q2001	3636.94	12	-0.26	6
4Q2001	5551.24	34	0.53	33
1Q2002	6167.47	44	0.11	41
2Q2002	5153.71	6	-0.16	5
3Q2002	4191.81	21	-0.19	19
4Q2002	4452.45	29	0.06	27
1Q2003	4321.22	26	-0.03	16
2Q2003	4872.15	19	0.13	15
3Q2003	5611.41	132	0.15	109
4Q2003	5890.69	91	0.05	85
1Q2004	6522.19	131	0.11	126
2Q2004	5839.44	76	-0.10	75
3Q2004	5845.69	24	0.00	24
4Q2004	6139.69	143	0.05	141

Note: The number includes both the warrants on individual stocks and basket warrants.

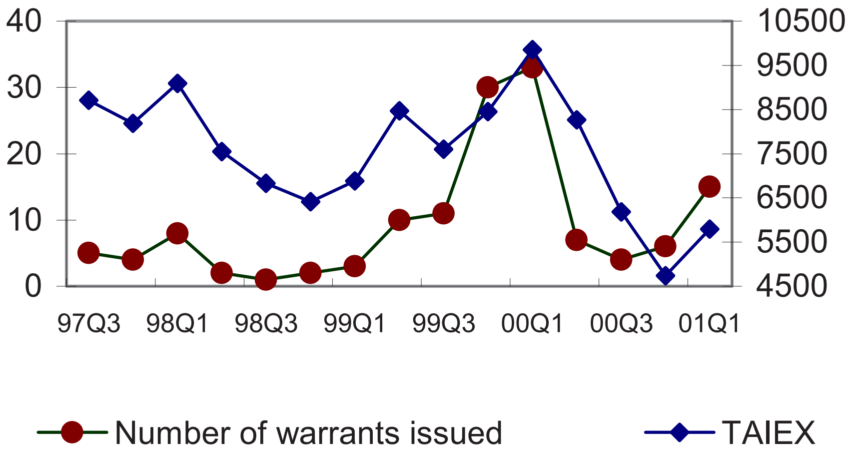


Fig. 1a. The number of call warrants issued per quarter and the TAIEX from the third quarter of 1997 to the first quarter of 2001

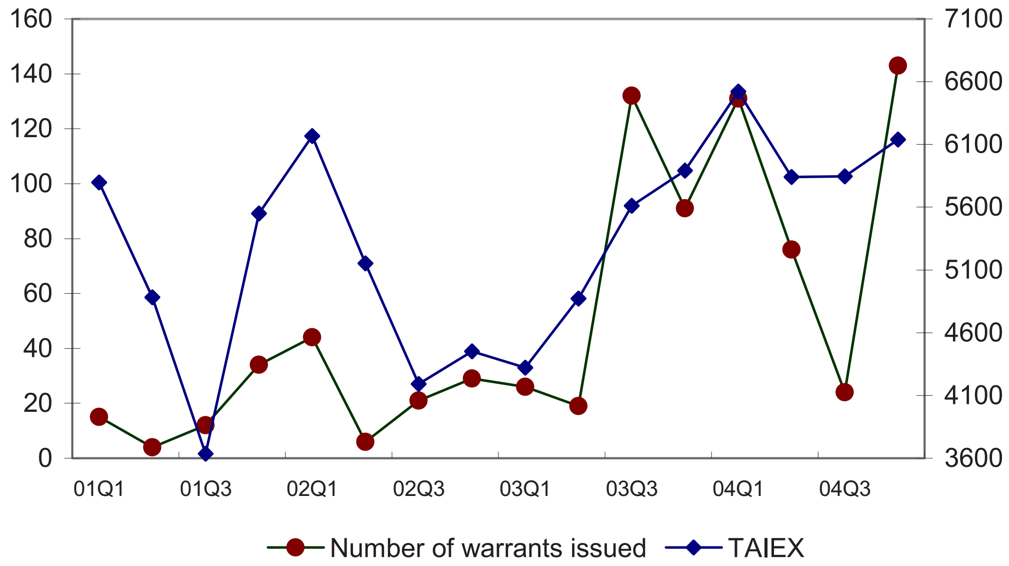


Fig. 1b. The number of call warrants issued per quarter and the TAIEX from 2001 to 2004

The data analyzed in this study includes a sample of 97 individual derivative call warrants listed in TSEC from August 1997 to June 2000, 56 of which are 'in-the-money' and 41 of which are 'out-of-the-money'. Our analysis employs intra-day trading data on the underlying stocks and issue data of derivatives call warrants obtained from the Taiwan Economic Journal (TEJ) databank.

4. Methodology and Empirical Results

4.1. The Impact on Systematic Risk and Volatility

An abiding concern with regard to the introduction of derivatives has been that speculation in the options market might lead to increased volatility in the underlying stock market. However, the underlying assets of warrants are selected by the issuing financial institution and the IPO announcement of derivative warrant is unexpected, and as such, investment banks may choose a volatile stock as the underlying asset of a warrant, since the value of options increases with an increase in volatility and investors therefore have a greater interest in these stocks. A typical pricing strategy within the option writing industry is to seek to boost volatility by a certain percentage in order to enhance the available profits from warrant writing (Green and Figlewski, 1999) and to overcome market imperfections, such as transaction costs (Chung, Lee and Wu, 2002).

In order to avoid any possible bias in examining the impact on volatility due to investment banks' selection activities, we test the impact on volatility by comparing the volatility of underlying stocks during three stages. The first stage involves the period from -120 to -31 days prior to issuance; the second stage is the 30-day period immediately before issuance; and the third stage is the 90-day period after issuance.

Table 2 presents the test results of the adjusted volatility ratios for the underlying stocks both before and after warrant introductions. The adjusted volatility ratios are computed by dividing the standard deviation for stock *i,* by the standard deviation of market return. For a comparison, the analysis is also conducted for the control sample of stocks that are eligible for issuance but are not selected by financial institutions[1].

[1] A stock from the same industrial group, with similar company size, is chosen as the comparable stock.

Table 2

Wilcoxon rank-sum tests for changes in adjusted volatility for different periods

	Underlying stocks of warrants		Control sample	
Period	Median Volatility Ratio	Wilcoxson tests	Median Volatility Ratio	Wilcoxson tests
t=-120 ~-31	1.82		1.19	
t=-30 ~ -1	2.02	-2.66[1] (<0.01)	1.25	-0.16 (0.44)
t=1 ~ 90	1.69	2.65[2] (<0.01)	1.11	0.35 (0.58)

Notes:

[a] refer to the test of equality of variance ratio between period t=-120 ~-31 and t=-30 ~ -1.

[b] refer to the test of equality of variance ratio between period t=-30 ~ -1 and period t=1 ~ 90. Initial values refer to Z-statistics (p-values are given in parentheses).

The median volatility ratios of the underlying stocks for the periods t = -120 to -31 and t = -30 to-1 are respectively, 1.82 and 2.02, whilst the ratio for the post-announcement period is 1.69. That is, the volatility for the 30-day period prior to issuance was highest, with a general decrease in volatility after issuance. The Wilcoxson rank-sum test results in Table 2 show that during the 30-day period prior to issuance, volatility was higher than in the other two periods. The Wilcoxson test results also demonstrate a significant decrease in volatility following the announcement day, as compared to the period t = -120 to -31, results which concur with those reported by Conrad (1989), Detemple and Jorion (1990) and Damodaran and Lim (1991). Our results are also consistent with the theoretical models, such as Ross (1976), which propose that stock prices in incomplete markets are generally affected by the introduction of new options.

The results from the control sample show that there is no significant change in volatility and their volatility ratios appear to be lower than those of the underlying stocks, thus confirming the tendency for financial institutions to select highly volatile stocks as the underlying asset.

The results of our study are generally congruent with those of Mayhew (2000b), which surveyed the effects of stock options listing on volatility, finding a decline in the overall volatility of the underlying stock, with no significant change in beta. Nevertheless we find evidence that there is a tendency amongst financial institutions to select stocks of high volatility as the underlying asset.

4.2. Hedging and Announcement Effects

Hedging effect refers to the hedging pressure of buying underlying securities prior to the issuance of new derivative warrants. As the issuers of derivative warrants initially adopt a short position in warrants, they are thus exposed to an upside potential loss if the warrants become 'in-the-money'. In order to hedge against the price risk associated with warrant issuance, a delta-hedging strategy is usually applied. The delta measures the sensitivity of the derivative warrant price to instantaneous changes in underlying stock prices; thus, buying pressure on the underlying stocks is anticipated whenever new warrants are issued, and the clustering of warrant issues with the same underlying asset may precipitate a price increase induced by hedging demand.

We employ an event-study methodology to examine whether the introduction of derivative warrants has any association with price effects that can in turn, be associated with hedging. Since most of the warrant issuers in Taiwan conduct their hedge in the two-week period before sending their application for issuance, we test the cumulative abnormal return (CAR) in this period to investigate the possible hedging effects.

The event day is defined as the point at which the derivative warrant is announced. For each stock *i*, the abnormal return is calculated as follows:

$$AR_{i\tau} = r_{i\tau} - \alpha_i - \beta_i r_{m\tau}, \quad i=1..N,$$

where $r_{i\tau}$ and $r_{m\tau}$ are the rate of return on stock *i* and the return of the TAIEX on day τ, respectively. Coefficients α_i and β_i are the intercept and slope of the market model estimated over a 200-day period prior to the event window. The average abnormal returns on day τ for the N stocks, AAR_τ and the CAR are estimated by

$$AAR_\tau = N^{-1}\sum_i^N AR_{i\tau} \ .$$

$$CAR_T = \sum_{t1}^{t2} AAR_t \ ,$$

where T= $t_2 - t_1 + 1$. Since volatility might be changed, as earlier studies on stock option introduction have shown, the t-statistics based on the cross sectional standard deviation is used.

In order to investigate the CAR, both before and after the announcement day, we conduct a CAR analysis of two issuance samples. The first sample of 76 stocks was collected by excluding those warrants with underlying assets that had been issued during the previous two months, whilst the second sample included all 97 warrants. This research design allows for the examination of the impact of consecutive issuances of the same underlying stocks, upon which the hedging pressure effects are expected to be more significant. Furthermore, we calculate the CAR for the period from the 40th day before issuance to the 120th day after issuance. Using such a longer post-issuance period in the CAR analysis provides us with an opportunity to examine whether financial institutions may be taking advantage of windows of opportunity by issuing warrants on overvalued equities.

If investors believe that the announcement carries an element of positive information content about how the parties involved perceive the future performance of the underlying stock, the announcement of the warrant issuance may induce a positive price reaction. The results of the analysis of the CAR, both before and after the announcement day, are presented in Table 3. In general, we find a significant price increase in the underlying stocks, with the abnormal return at the announcement day being, on average, 1.2%. The CAR appears to peak at the announcement day, after which it demonstrates a decline. We also find that the CAR from all samples during the pre-announcement period was larger than those of the sample excluding multiple issuances. This result is consistent with the theory of hedging pressure effect, which argues that extra buying pressure prior to the introduction of warrants will have positive price effects on the underlying assets.

Table 3

Cumulative abnormal returns (CAR) of underlying stocks, before and after warrant introduction

Day	76 stocks			97 stocks		
	AAR (%)	t-AAR	CAR (%)	AAR (%)	t-AAR	CAR (%)
-40	-0.117	-1.007	-0.168	-0.268	-0.486	-0.160
-30	0.523	1.009	0.104	0.268	2.182	0.633
-20	0.196	0.590	1.047	0.157	0.818	2.368
-10	0.093	0.022	1.702	0.006	0.390	3.326
-9	0.121	0.380	1.803	0.101	0.505	3.447
-8	0.204	1.256	2.137	0.334	0.853	3.652
-7	0.078	0.326	2.224	0.087	0.326	3.730
-6	-0.106	-0.230	2.163	-0.061	-0.442	3.624
-5	-0.188	-1.318	1.813	-0.350	-0.784	3.436
-4	0.327	1.703	2.265	0.452	1.367	3.763
-3	0.098	-0.384	2.163	-0.102	0.407	3.861
-2	0.222	0.886	2.399	0.236	0.928	4.083

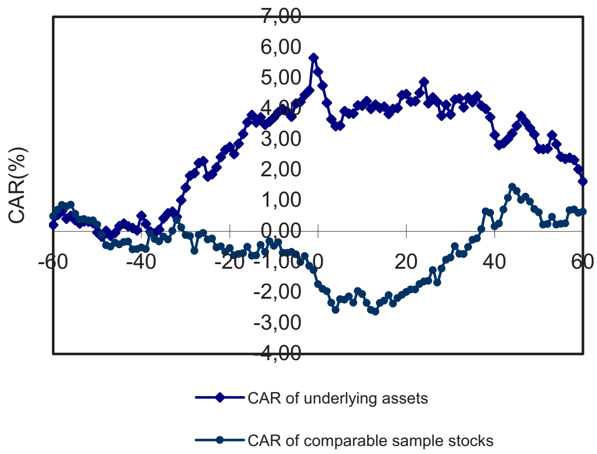
Table 3 (continuous)

Day	76 stocks			97 stocks		
	AAR (%)	t-AAR	CAR (%)	AAR (%)	t-AAR	CAR (%)
-1	0.213	0.394	2.503	0.105	0.889	4.296
0	1.125	4.445	3.686	1.182	4.693	5.421
1	-0.526	-1.375	3.320	-0.365	-2.195	4.895
2	-0.436	-1.781	2.847	-0.474	-1.818	4.460
3	-0.622	-2.707	2.128	-0.719	-2.597	3.838
4	-0.519	-2.054	1.582	-0.546	-2.166	3.319
5	-0.344	-0.846	1.357	-0.225	-1.438	2.975
6	0.086	0.035	1.366	0.009	0.360	3.061
7	0.450	1.493	1.763	0.397	1.877	3.511
8	-0.040	0.016	1.767	0.004	-0.167	3.471
9	0.017	0.299	1.847	0.080	0.071	3.488
10	0.214	0.498	1.979	0.132	0.895	3.702
20	0.425	1.521	2.080	0.404	1.773	3.879
30	0.310	0.865	1.329	0.231	1.289	3.223
40	-0.333	-1.395	0.369	-0.371	-1.387	2.529
50	-0.329	-1.455	-0.438	-0.387	-1.368	1.862
60	-0.277	-0.948	-1.101	-0.252	-1.155	0.937
80	0.094	0.124	-1.776	0.033	0.390	0.610
100	0.108	0.370	-3.027	0.098	0.448	-0.886
120	-0.053	-0.293	-3.040	-0.078	-0.221	-0.897

Notes:

1.The first sample of 76 stocks was collected by excluding those warrants whose underlying assets were issued in the previous two months, whilst the second sample includes all 97 warrants listed on the TAIEX from August 1997 to June 2000.

2. AAR represents the average abnormal return. The null hypothesis of the t test is that AAR is equal to zero.



Note: The matched sample stocks are selected from the eligible stocks for each underlying asset and represent the stocks that are eligible for writing but are not selected by any investment banks. A stock from the same industrial group, with similar company size, is chosen as the comparable stock.

Fig. 2. Cumulative abnormal returns of underlying assets and comparable sample stocks

Figure 2 presents a comparison of the cumulative abnormal returns of the underlying stocks and the matched sample stocks, in order to provide a further insight into hedging effects. It can be readily seen that the price effect associated with the issuance of warrants no longer exists for those control sample stocks.

4.3. Primary Market Effect

Primary market effect refers to the possible impacts on the risk and return due to the issuers' manipulation of underlying asset price during the issuing process. Since the market close price of the underlying asset directly affects investors' perception of the warrant's value, warrant issuers might manipulate the underlying asset price during the issuing process. We investigate the primary market effect by using the standard CAR method and microstructure models based on five-minute interval data. The first method is to test whether there is any possible CAR during the primary market process (CAR(1,10)). If the test results of CAR(1,10) are not significant, it might suggest that there is no evidence of positive price impact during the primary market process and no support for the price manipulation hypothesis.

The possible impacts on the risk and return at the market close of the underlying assets are further explored by using the following models. The sample data includes the 60-day period before day -30 (t = -90 ... -31) and the 10 days issuing period (t=1…10). Specifically, for each stock, we estimate the following two regression models by using the GMM method.

$$r_{j,t} = \mu_0 + \mu_0^{ISS} \mathrm{D}_t^{ISS} + \sum_{k=1}^{12} \mu_k D_{k,t} + \mu_{CLS} D_{12,t} D_t^{ISS} + \varepsilon_{j,t}, \quad (1)$$

$$| r_{j,t} | = h_0 + h_0^{ISS} \mathrm{D}_t^{ISS} + \sum_{k=1}^{12} h_k D_{k,t} + h_{CLS} D_{12,t} D_t^{ISS} + \varepsilon_{j,t}, \quad (2)$$

where $r_{j,t}$ and $| r_{j,t} |$ are the five-minute intraday return and absolute return for the underlying asset at interval *j* of day *t,* respectively; D_t^{ISS} is a (0,1) dummy variable to control for the effects of the primary market process, hence, it is equal to 1 if day *t* is in the issuance period, otherwise 0; and $D_{k,t}$ for k = 1…12 are dummy variables controlling for intraday interval effects[1]. Since the peak and trough periods occur either at the beginning or at the end of a trading day, we set up the dummy variable for only the opening thirty minutes and the closing thirty minutes. Following Foster and Viswanathan (1993), we use absolute return as a measure of intraday volatility. If μ_k and h_k for all *k* is equal to zero, this would indicate that the intraday volatilities are all constant and no intraday seasonality in volatility exists. μ_0^{ISS} and h_0^{ISS} measures the average intraday price and volatility effect, respectively. μ_{CLS} and h_{CLS} measures the possible day-end (11:55-12:00) price and volatility effect.

As depicted in Figure 2, there is no evidence of increase in daily excess return during the primary market process (t=1..10). Furthermore, the estimated *t* statistic for testing the first 10-days CAR being zero is -1.18. The results do not seem to find any evidence of positive price impact during the primary market process. Hence, the empirical evidence from the daily data finds no support for the price manipulation hypothesis.

Table 4 presents further regression results of possible price effects during the primary market period by using intraday returns. We examine whether there is any day-end return increase

[1] The twelve intraday intervals are: (1) 9:00-9:05; (2) 9:05-9:10; (3) 9:10-915; (4) 9:15-9:20; (5) 9:20-925; (6) 9:25-9:30; (7) 11:30-11:35; (8) 11:35-11:40; (9) 11:40-11:45; (10) 11:45-11:50; (11) 11:50-11:55; and (12) 11:55-12:00 during the period before 2001. Hence, D_1 is 1 if *j* = 9:00-9:05 interval, otherwise 0; D_2 is 1 if $| r_{j,t} |$ is the absolute return for interval 9:05-9:10 (*j* = 9:05-9:10), otherwise 0, and so on.

during primary market process. The model is estimated using GMM method for each of the 97 underlying stocks based on 5 minutes interval. To save space we only report the average values of estimated parameters and the numbers of coefficients that are significantly positive at 5% level. The results show that average value of change in 11:55-12:00 interval, μ_{CLS}, is -0.00106 and only 7 out of the 97 underlying stocks have a positive effect. There is little evidence that the last five minutes returns during the issuing period of warrants are higher than those of the regular period.

Table 4

Regression results of changes in intraday return behavior of the underlying stocks during the primary market process

Parameter		Average value	Average t value	No. of significant value
Intercept	μ_0	0.00003	(0.1671)	[0]
1st interval (09:00-09:05)	μ_1	0.00304	(5.6099)	[85]
2nd interval (09:05-09:10)	μ_2	-0.00107	(-1.9332)	[0]
3rd interval (09:10-09:15)	μ_3	0.00049	(0.9453)	[17]
4th interval (09:15-09:20)	μ_4	-0.00004	(-0.1064)	[0]
5th interval (09:20-09:25)	μ_5	-0.00010	(-0.1537)	[0]
6th interval (09:25-09:30)	μ_6	-0.00008	(-0.1806)	[0]
7th interval (11:30-11:35)	μ_7	0.00015	(0.1716)	[0]
8th interval (11:35-11:40)	μ_8	0.00014	(0.3460)	[2]
9th interval (11:40-11:45)	μ_9	-0.00029	(-0.5981)	[0]
10th interval (11:45-11:50)	μ_{10}	-0.00025	(-0.5096)	[0]
11th interval (11:50-11:55)	μ_{11}	-0.00033	(-0.5653)	[0]
12th interval (11:55-12:00)	μ_{12}	-0.00001	(-0.0134)	[12]
Change in intercept	μ_o^{ISS}	0.00000	(-0.0008)	[0]
Change in 11:55-12:00 interval	μ_{CLS}	**-0.00106**	**(-0.3187)**	**[7]**

Notes:

1. The GMM estimates of each of the 97 underlying stocks based on 5 minutes interval. The regression model is: $r_{j,t} = \mu_0 + \mu_0^{ISS} D_t^{ISS} + \sum_{k=1}^{12} \mu_k D_{k,t} + \mu_{CLS} D_{12,t} D_t^{ISS} + \varepsilon_{j,t}$, where $r_{j,t}$ is the five-minute intraday return for the underlying asset at interval j of day t ; D_t^{ISS} is a (0,1) dummy variable to control for the effects of the primary market process, hence, it is equal to 1 if day t is in the issuance period, otherwise 0; and $D_{k,t}$ for k = 1…12 are dummy variables controlling for intraday interval effects. If μ_k for all k is equal to zero, this would indicate that the intraday volatility is all constant and no intraday seasonality in volatility exists. μ_0^{ISS} measures the average intraday price effect. μ_{CLS} measures the possible day-end price effect.

2. The average t statistics are in the parentheses.

3. Numbers in brackets are those of coefficients that are significantly positive at 5% level.

Table 5 presents the test results of possible changes in the intraday volatility during the primary market process. The results indicate an apparent basic U-shape pattern in the intraday volatility for almost every underlying stock. The intraday volatility apparently is highest for the opening and closing five-minute intervals. Most importantly, only 14 stocks demonstrate that h_{CLS} is significantly positive at 5% level. The result indicates that there is little evidence that the last five minutes volatility during the issuing period of warrants is higher than those of the regular period.

Table 5

Regression results of changes in intraday volatility of underlying stocks during the primary market process

Parameter		Average value	Average *t* value	No. of significant
Intercept	h_0	0.00326	(46.406)	[97]
1st interval (09:00-09:05)	h_1	0.00692	(22.031)	[95]
2nd interval (09:05-09:10)	h_2	0.00284	(6.577)	[92]
3rd interval (09:10-09:15)	h_3	0.00196	(5.151)	[92]
4th interval (09:15-09:20)	h_4	0.00097	(2.587)	[73]
5th interval (09:20-09:25)	h_5	0.00096	(2.636)	[66]
6th interval (09:25-09:30)	h_6	0.00050	(1.548)	[35]
7th interval (11:30-11:35)	h_7	-0.00007	(-0.216)	[2]
8th interval (11:35-11:40)	h_8	0.00006	(0.168)	[2]
9th interval (11:40-11:45)	h_9	0.00045	(1.124)	[19]
10th interval (11:45-11:50)	h_{10}	0.00052	(1.411)	[28]
11th interval (11:50-11:55)	h_{11}	0.00089	(2.255)	[59]
12th interval (11:55-12:00)	h_{12}	0.00156	(3.602)	[88]
Change in intercept	h_o^{ISS}	0.00002	(0.078)	[19]
Change in 11:55-12:00 interval	h_{CLS}	**0.00022**	**(0.108)**	**[14]**

Notes:

1. The GMM estimates of each of the 97 underlying stocks based on 5 minutes interval. The regression model is: $|r_{j,t}| = h_0 + h_0^{ISS}\,\mathrm{D}_t^{ISS} + \sum_{k=1}^{12} h_k D_{k,t} + h_{CLS}\, D_{12,t}\, D_t^{ISS} + \varepsilon_{j,t}$.

where $|r_{j,t}|$ is the five-minute intraday absolute return for the underlying asset at interval j of day t,

D_t^{ISS} is a (0,1) dummy variable to control for the effects of the primary market process, hence, it is equal to 1 if day t is in the issuance period, otherwise 0; and $D_{k,t}$ for k = 1…12 are dummy variables controlling for intraday interval effects. If h_k for all k is equal to zero, this would indicate that the intraday volatility is all constant and no intraday seasonality in volatility exists. h_0^{ISS} measures the average intraday volatility effect, whereas h_{CLS} measures the possible day-end volatility effect.

2. The regression is run for each individual stock. The average t statistics are in the parentheses.
3. Numbers in brackets are those of coefficients that are significantly positive at 5% level.

In general, our results based on the standard CAR method and intraday models based on five-minute interval data do not support the primary market effect hypothesis. There is little evidence of the changes in the underlying asset risk and return during primary market process.

4.4. Tests of Issuers' Market Timing

From the point of view of the warrant issuers, the warrant writing profits will be enhanced if the warrants expire out of money. A good warrant writing strategy is to select the individual stock that has short run momentum but its price is overreacted when evaluated in a longer period. Short-run price momentum will help to success in the primary market process, while overreact in a longer period will increase the probability of warrants expiring out of money and enhance the profit of writing warrants. This implies that a post-issue underperformance by the underlying asset will be observed.

The potential overreaction in the underlying stocks is examined by employing a regression approach similar to Chopra et al. (1992). We use the average abnormal return of the thirty-day period (days -30 to -1) prior to announcement of warrant issuance as explanatory variables. The after-announcement periods include the next 90 trading days (days +1 to +90), the subsequent 120 trading days (days +1 to +120), and the subsequent 150 trading days (days +1 to +150). The basic egression model is

$$CAR_i(1,t) = \alpha + \gamma\ CAR_i(-30,-1) + \varepsilon_i\,, \tag{3}$$

where $CAR_i(\tau_1,\tau_2)$ is the CAR of firm *i* from day τ_1 to τ_2. Hence, $CAR_i(1,t)$ is the CAR during the subsequent t trading days following the announcement day for firm *i* and $CAR_i(-30,-1)$ is the 30-day abnormal return prior to announcement of warrant for firm *i*. Because of the error terms in equation (3) obviously will not be *iid*, a robust inference procedure is necessary to be applied for statistical inference of the above model. The above equation is estimated by GMM method and standard errors are adjusted for heteroskedasticity and autocorrelation by using the Newey and West (1987) type estimator for the variance-covariance estimator of $\hat{\alpha}$ and $\hat{\gamma}$. In general if γ in the above equation is negative, the overreaction hypothesis on the underlying asset price cannot be rejected.

Table 6

Regression results of the overreaction hypothesis

$CAR_i(1,t) = \alpha + \gamma\ CAR_i(-30,-1) + \varepsilon_i$			
	α	γ	R^2
CAR(1,90)	-9.566	-0.224	0.033
	(-3.702)	(-1.344)	
CAR(1,120)	-11.705	-0.364**	0.062
	(-4.058)	(-1.954)	
CAR(1,150)	-11.266	-0.503*	0.081
	(-3.167)	(-2.191)	

Notes:

$CAR_i(-30,-1)$ is the 30 day CAR prior to announcement of warrant for firm i.

'$CAR_i(1,90)$' refers to the 90-days CAR after announcement day.

'$CAR_i(1,120)$' refers to the CAR for the period from day 1 to day 120.

'$CAR_i(1,150)$' refers to the CAR for the period from day 1 to day 150.

The above equation is estimated by GMM method and standard errors are adjusted for heteroskedasticity and autocorrelation by using the Newey and West (1987) type estimator for the variance-covariance estimator of $\hat{\alpha}$ and $\hat{\gamma}$. * and ** denote significance at the 5% and 10% level, respectively.

Regression results in Table 6 in general support the overreaction hypothesis. The coefficient for the CAR of 120-day after announcement is -0.364, which is significant at 10% level, while that for the 150-day period is -0.503. In existing related empirical studies, the R^2 has been not high enough. For example, Liu and Ziebart (1999) report R^2 much lower than ours. The abnormal return after issuance is in general negatively related to the performance before issuance. In other words, the post-issuance underperformance is statistically significant. Our evidence is consistent with the fact that financial institutions take advantage of windows of opportunity by issuing warrants on overvalued equities. Our results contribute to the understanding of the major differences between the market impacts of warrant introduction and standard options introduction. As derivative warrants are initiated by profit-maximizing financial institutions, the empirical results based on the test of long run price behavior of the underlying assets seem to support the overreaction hypothesis.

4.5. Trading Volume and Liquidity

In order to investigate whether there are any significant differences evident between the market-adjusted trading values before and after the announcement day, we calculate the pre-announcement values (based on the 60-, 90- and 120-day periods prior to listing) and the post-announcement values (based on the 60-, 90- and 120-day periods after listing) around the announcement day. Market-adjusted trading value is the ratio of trading value of stock *i* to the trading value of the whole market.

As for liquidity test, since the TSEC adopts an order-driven system without designated market makers, the use of the daily bid-ask spread as a proxy for market liquidity would not be meaningful. Instead, following the methods of Amihud, Mendelson and Lauterbach (1997) and Elyasiani, Hauser and Lauterbach (2000), our liquidity measure is calculated as volume divided by absolute return, which provides an estimate of the volume levels associated with a percentage change in stock price. The problem with this ratio is that it does not differentiate between transient price movement, which is a sign of illiquidity, and efficient price movement, which results from information flow. Nevertheless, this measure does appear to embed a valuable signal and has been used successfully by Amihud, Mendelson and Lauterbach (1997) producing good results. We use the non-systematic variance of stock returns as an alternative measure of liquidity setting up the market model for periods both before and after announcement. We expect that all other factors being equal, an improvement in liquidity will enhance price accuracy and reduce the residual variance of the stock.

Table 7

Wilcoxon rank-sum tests for differences between changes in market-adjusted trading value, volume, liquidity and residual risk

	Trading days before and after issuance		
	60	90	120
Market-adjusted trading value	0.17 (0.86)	0.26 (0.78)	0.19 (0.84)
Market-adjusted trading volume	0.77 (0.43)	0.62 (0.53)	1.12 (0.25)
Liquidity (Volume/|return|)	-0.17 (0.86)	-0.21 (0.82)	0.32 (0.74)
Residual risk	-0.07 (0.94)	0.41 (0.68)	1.39 (0.16)

Notes:

1. Initial figures refer to Z-statistics (P-values are given in parentheses).

2. Market-adjusted trading value is the ratio of trading value of stock i to that of the whole market, while market-adjusted trading volume is the ratio of trading volume of stock i to that of the whole market.

3. Residual risk is the residual variance in the market model.

The results of the tests on the impacts on trading value and liquidity are presented in Table 7. The results of the reported Z-statistics and p-values for the Wilcoxon rank-sum tests generally demonstrate no evidence of any difference in the changes in market-adjusted trading value, trading volumes, and market liquidity. Previous studies documented that option listings may cause informed traders to migrate to the options market and the reduction in the proportion of informed traders in the underlying market, lowers the adverse selection costs of the market makers, thereby improving the liquidity. Kumar, Sarin and Shastri (1998) find evidence in support of the liquidity improvement effect. Our results based on the derivative warrant market do not seem to find supportive evidence of any improvement in liquidity. Although derivative warrants possess the superiority from their inherent leverage, short-sale of them is prohibited. This might limit the attractiveness of derivative warrants to informed traders and hence, the liquidity improvement is not significant.

In sum, the results suggest that warrant introductions have no real effects on the underlying stocks. This can be explained by warrants not expanding the opportunity set of investors as much as reported in previous studies of stock options, or that the more complex nature of warrants creates several different effects that sum to zero.

5. Concluding Remarks

This paper investigates the impact of Taiwan derivative warrant introductions on the returns, risks and trading activity of the underlying assets. We emphasize the important role of profit-maximizing investment banks in the market impacts of warrant introduction.

Since Taiwan derivative warrants market is a typical 'small versus large trader' market where individual investors buy warrants from financial institutions, and as in the case of IPOs or SEOs, there is a clustering of warrant issuance. There appears to be a high correlation between the number of call warrants issued and stock market performance. We find evidence to demonstrate that financial institutions tend to issue derivative warrants on stocks of high volatility.

The results indicate that in a few days prior to the issuance of a new derivative warrant, underlying stocks are subject to extra buying pressure. We find positive abnormal returns at the announcement day, but a decline in the returns after the announcement day. When there is observable consecutive issuance of a popular underlying asset, the hedging demand effects on the underlying asset prices are more significant. This result is somewhat inconsistent with Chan and Wei (2001) finding of the underlying stock prices only continue to increase up to the first day following the announcement of warrant issuance, and is strongly inconsistent with Aitken and Segara (2005) finding of significant negative abnormal returns on announcement date of derivative warrants. Our results also demonstrate that investment bankers display good market timing by selecting overvalued growth stocks as the underlying asset for derivative call warrants. Furthermore, our results show that there is no evidence of any difference in the changes in trading volumes and market liquidity. It is also inconsistent with Chan and Wei (2001). As leveraged derivative warrant becomes an important trading alternative to small and retail investors in emerging markets, the findings of this paper could help warrant investors to gain a better understanding of underlying stock prices and volume behavior surrounding the event dates related to the issuing of derivative warrants.

References

1. Aitken, M. and R. Segara (2005), 'Impact of Warrant Introductions on the Behaviour of Underlying Stocks: Australian Evidence, *Accounting and Finance*, **45:** 127-144.
2. Amihud, Y., H. Mendelson and B. Lauterbach (1997), 'Market Microstructure and Securities Values: Evidence from the Tel-Aviv Stock Exchange', *Journal of Financial Economics*, (September), **45:** 365-390.
3. Chan, Y. and K.C. Wei (2001), 'Price and Volume Effects Associated Derivative Warrant Issuance on the Stock Exchange of Hong Kong', *Journal of Banking and Finance*, **25:** 1401-26.

4. Chen, K.C. and L. Wu (2001), 'Introduction and Expiration Effects of Derivative Equity Earrants in Hong Kong', *International Review of Financial Analysis*, **10:** 37-52.
5. Chiang, R., C.-S. Lee and W.-L. Hsieh (2000), 'The Market, Regulations and Issuing Strategies of Covered Warrants in Taiwan', *Review of Pacific Basin Financial Markets and Policies*, **3:** 87-105.
6. Chung, H., C.-S. Lee and S. Wu (2002), 'The Effects of Model Errors and Market Imperfections on Financial Institutions Writing Derivative Warrants: Simulation Evidence from Taiwan', *Pacific-Basin Finance Journal*, **10:** 55-75.
7. Chung, H. and M.-M. Hseu (2005), 'Expiration Day Effects of Taiwan Index Futures: The Case of Singapore Exchange and Taiwan Futures Exchange', 18th Australasian Finance and Banking Conference.
8. Chopra, N., J. Lakonishok, and J. Ritter (1992), 'Measuring Abnormal Performance: Do Stock Overract?', *Journal of Financial Economics*, **31:** 235-268.
9. Conrad, J. (1989), 'The Price Effect of Options Introduction', *Journal of Finance*, **44:** 487-498.
10. Damodaran, A. and J. Lim (1991), 'The Effects of Option Listing on the Underlying Stock's Return Process', *Journal of Banking and Finance*, **15:** 647-664.
11. Detemple, J., and P. Jorion (1990), 'Option Introduction and Stock Returns', *Journal of Banking and Finance*, **14:** 781-801.
12. Elyasiani, E., S. Hauser and B. Lauterbach (2000), Market Response to Liquidity Improvements: Evidence from Exchange Listings, *The Financial Review*, **41:** 1-14.
13. Foster, F.D., and S. Viswanathan (1993), 'Variations in Trading Volume, Return Volatility and Trading Costs: Evidence on Recent Price Formation Models', *Journal of Finance*, **48:** 187-211.
14. Green, T.C. and S. Figlewski (1999), 'Market Risk and Model Risk for a Financial Institution Writing Options', *Journal of Finance*, **54:**1465-1499.
15. Hamill P.A., K.K. Opong and P. McGregor (2002) 'Equity Option Listing in the UK: a Comparison of Market-based Research Methodologies', *Journal of Empirical Finance*, **9:** 91-108.
16. Kumar R., A. Sarin and K. Shastri (1998), 'The Impact of Options Trading on the Market Quality of the Underlying Security: An Empirical Analysis', *Journal of Finance*, **53:** 717-732.
17. Liu, C.-S. and D.A. Ziebart (1999), 'Anomalous Security Price Behavior Following Management earnings Forecasts', *Journal of Empirical Finance*, **6:** 405-430.
18. Mayhew, S. (2000), 'The Impact of Derivative on Cash Markets: What Have We Learned?', Working paper, University of Georgia.
19. Mayhew, S. and V. Mihov (2005), 'Short Sale Constraints, Overvaluation, and the Introduction of Options', AFA 2005 Philadelphia Meetings.
20. Newey, W.K. and K.D. West (1987), 'A Simple, Positive Semi-definite, Heteroskedasticity and Autocoreelation Consistent Covariance Matrix', Econometrica, **55:** 703-708.
21. Ross, S.A. (1976), 'Options and Efficiency', *Quarterly Journal of Economics*, 90: 75-89.
22. Sorescu, S. (2000), 'The Effect of Options on Stock Prices: 1973-1995', *Journal of Finance*, **55:** 487-514.
23. Stucki, T. and W. Wasserfallen (1994), 'Stock and Option Markets: the Swiss Evidence', *Journal of Banking and Finance*, **18:** 881-893.
24. Watt, W.H., P. Yadav, and P. Draper (1992), 'The Impact of Option Listing on Underlying Stock Returns: The U. K. Evidence', *Journal of Business Finance and Accounting*, **19:** 485-503.