THE IMPACT OF WARRANT INTRODUCTIONS ON THE UNDERLYING STOCKS, WITH A COMPARISON TO STOCK OPTIONS

PER ALKEBÄCK
NICLAS HAGELIN

INTRODUCTION

Option pricing models, such as Black and Scholes (1973), treat options as redundant securities that can be duplicated by already existing assets. The Black and Scholes (1973) model implicitly assumes complete markets but if completeness is not the case, options would not be redundant. The fact that options, in different forms, do exist suggests that markets are not complete, at least not without them. The opportunity set expands as a result of option introductions and enables new possible payoff patterns. Equilibrium prices and allocations can be assumed to change when options are introduced. Ross (1976) states that "in an uncertain world options written on existing assets can improve efficiency by permitting an expansion of the contingencies that are covered by the market."

This paper investigates the impact of derivative introductions on the underlying stocks, investigating not only stock options but also warrants, and compares the introduction effects between the two to see if they differ in direction and magnitude.

The authors thank Mark J. Powers (the editor), two anonymous referees, and seminar participants at Stockholm University, the University of Lund, and the 1997 European Financial Management Association (EFMA) Conference in Istanbul. We also thank Raana Faroqi-Lind and Henrik Ferdfelt for helpful assistance.

■ *Per Alkebäck is a Ph.D. at Stockholm University presently working at Nordiska Fondkommission.*

■ *Niclas Hagelin is a Doctoral Candidate at Stockholm University.*

The Journal of Futures Markets, Vol. 18, No. 3, 307–328 (1998)

CCC 0270-7314/98/030307-22

Warrants are used, typically in conjunction with bonds and/or stocks, as a vehicle to finance the activity of a firm. The rationale for using warrants is based on the existence of market imperfections.[1] Since warrants are used as a financial vehicle, they are likely to change the capital structure, in contrast to stock options. Therefore, the introduction of warrants influences not only the underlying stocks by expanding the opportunity set of the investors, but also introduce potential changes in the capital structure of the firm. Moreover, investors in warrants are not necessarily driven by the same motives as investors in stock options. It is possible that warrants are used in different ways and by different types of investors than stock options. For instance, if warrants are used as substitutes for stocks, while stock options are used as complements, it is reasonable to expect them to have different impacts on the underlying stocks. Therefore, the results from previous studies of stock option introductions cannot be used as proxies for warrant introductions. However, if warrant introductions are found to have effects similar to stock option introductions, evidence from stock option introduction studies can be used potentially as proxies for effects surrounding warrant introductions. Therefore, a comparison between warrant and stock option introductions is included in this study.

There are at least two reasons why an investigation of warrant introductions is of interest to firms considering warrant issues. First, whether an issue is preferable or not depends, among other things, on how the trading volume and bid–ask spreads of the underlying stocks are influenced by the introduction of warrants. A firm would not issue warrants if the introduction itself causes decreases in trading volume and/or increases in bid–ask spreads.[2] This is especially important if the underlying stock already suffers from thin trading and large bid–ask spreads. Decreasing volume and increasing bid–ask spreads can occur if warrants are regarded as a substitute to stocks. On the other hand, if warrants are regarded as nonredundant complements, the opposite effect can occur.

Second, when a firm issues a warrant it has to establish an initial value for the warrant. The valuation of the warrant requires an estimate of the future volatility of the underlying stock. This estimate is often based on historical data. A volatility estimate based on price data prior to the introduction is not a fair estimate, if the introduction itself changes the volatility of the underlying stock. Therefore, knowledge about how an

[1]For a more detailed discussion on motives for using warrants, see Veld (1994).

[2]That some practitioners fear a diversion of trade from the stock market to the warrant market is suggested in a survey conducted by the authors.

introduction of a warrant influences the underlying stock's volatility is essential.[3]

Moreover, a study of potential effects of warrant introductions is more interesting for firms and the owners than a study of the potential stock option introduction effects, as warrants are issued by the firm in contrast to stock options; i.e., the impact of the introduction can be avoided by the firm in contrast to the impact of a stock option introduction.

Empirical studies investigating the effects of warrant introductions have not been conducted,[4] but several empirical studies on option introductions exist. These studies have focused on price, volatility, and trading volume changes of the underlying stocks. Price increases in the underlying stocks were found by Conrad (1989) and Detemple and Jorion (1990), implying a reduction in the risk level when options are introduced. Decreases in volatility were found by Gemmill (1989), Conrad (1989), Detemple and Jorion (1990), Damodaran and Lim (1991), and Skinner (1989). Trennepohl and Dukes (1979), Klemkosky and Maness (1980), Chamberlain, Cheung, and Kwan (1993), and Gjerde and Saettem (1995) were not, on the other hand, able to detect any significant effects from the option introductions on the volatility.

The impact of introductions on the trading volume of the underlying security was tested in studies by Hayes and Tennenbaum (1979), Gjerde and Saettem (1995), Skinner (1989), and Chamberlain et al. (1993). The first three of these studies found a significant influence, while Chamberlain et al. (1993) did not detect any influence. These results indicate that a decline in trading volume, because of a diversion of trading from stock markets to option markets, is not the case, as suggested by Skinner (1989).

[3]Warrants are more complicated to value than regular stock options because warrants cause dilution and normally are long lived (which makes changes in the return volatility and the risk-free interest rate more likely to occur). Galai and Schneller (1978) proposed a model for valuation of warrants that takes account of possible dilution. Their model estimates the value of a warrant to be a fraction of a similar stock option. Even though their model yields downward biased outcomes when the warrant is introduced to the market (see Galai, 1989; Crouhy and Galai, 1991) it is suitable for the initial valuation of warrants. Schulz and Trautmann (1989) and Lauterbach and Schultz (1990) proposed a model based on the equity volatility rather than stock volatility. That model assumes the firm's equity volatility to be constant, implying that the stock volatility changes over the life of the warrant. Nevertheless, an estimation of the future stock volatility is needed. Warrants as derivatives and financial vehicles have a rather complicated influence on the firm. Given the complexity, an empirical investigation of warrant introductions is even more motivated.

[4]Studies investigating stock price effects of security offering announcements (containing warrants) have been conducted by Long and Sefcik (1990) and De Roon and Veld (1995). However, these studies focus on the reactions to announcements of changes in capital structures rather than to trading effects of introduced warrants.

Finally, a significant decrease in bid–ask spreads due to the introduction of stock options was found by Damodaran and Lim (1991) and Gjerde and Saettem (1995), while Chamberlain et al. (1993) found a nonsignificant fall in bid–ask spreads.

Stock option introductions on the Swedish market have been investigated by Vinell and De Ridder (1990) and Bengtsson and Tikkanen (1994). Vinell and De Ridder (1990) found decreasing market adjusted volatility for 9 of 11 investigated stocks and decreasing betas for 10 of 11 investigated stocks. Bengtsson and Tikkanen (1994) examined 20 optioned stocks and found significantly decreasing betas while trading volume and volatility were unchanged. The differences in the conclusions of those two studies may be due to the fact that Vinell and De Ridder (1990) used market adjusted values. Overall, prior research shows that when significant effects are found, they are generally positive; i.e., stock prices increase, volatility decreases, trading volume increases, and bid–ask spreads decrease due to the introduction of stock options.

Warrants in Sweden have been issued and traded on the Stockholm Stock Exchange (StSE) since the end of 1981, with a "peak" in issuing during 1984. This "peak" can be explained by the favorable fiscal legislation at the time.

For tax purposes, the cost of a warrant-bond package has to be divided between the warrant and the bond. Before December 1983 no legislation was present describing how this should be done. In December 1983, legislation was passed calling for the whole cost to be attached to the bond and the warrant was valued at zero. The fact that the market value of the bond was below the estimated value made it possible to sell the bond and convert it into a deductible capital loss. This capital loss was 100% deductible if the bond was sold within two years. If the warrant turned out later on to be in the money, only a certain part of the realized capital gain was taxed, depending on how long the warrant had been possessed by the seller. This favorable tax legislation was changed on 7 December 1984, so that the value of the bond was set to the market value of a similar bond, with no warrants attached to it, and the warrant was valued at the difference between the market value of the bond and the cost of the issue.[5] Warrants were typically issued in conjunction with bonds, initially creating a higher debt-equity ratio.[6]

Standardized stock options (call options) were first introduced and traded at Optionsmäklarna (OM) in June 1985. Two years later, OM introduced put options on stocks. In 1985, a total of 128,249 stock option

[5]For more information about the fiscal legislation, see Herrlin (1984) and Kindlund (1985).
[6]For a more detailed description of the Swedish firms that issued warrants, see Hagelin (1995).

contracts were traded at OM, and for the following year a total of 2,057,435 contracts were traded. In 1993, the total annual trading volume for stock options surpassed four million contracts.

This study examines the effects on price, volatility, and liquidity (measured as trading volume, bid–ask spread, and number of actual trading days) of the underlying stocks at and around warrant introductions and also compares these effects with the effects of stock option introductions.

DATA

Information on firms issuing warrants is gathered from stock exchange guides,[7] prospectuses on issues from the firms, and annual reports. Similar information regarding introduction of stock options is obtained from OM. Data on bid–ask quotes and trading volume are collected from Dextel Findata. Bid–ask quotes instead of transaction prices are used due to infrequent (and thin) trading in many of the stocks (particularly for those issuing warrants). One way to circumvent the problem of infrequent trading is to use the average of the bid–ask quotes, since it is likely to incorporate new information faster, even if there is no trading. Information on the first trading day is collected from Dextel Findata and OM. Only the first introduction of warrants, for each stock, is included in this study and no warrants that are part of an Initial Public Offering (IPO) are included, because prior price information is nonexistent. All warrants used are listed on the StSE. After elimination, the final sample consists of 35 warrants and 32 stock option introductions.

METHODOLOGY AND HYPOTHESES

Direct Price Effects

To determine whether or not the introduction of a warrant (stock option) has an effect on the underlying stock price, the event study methodology is employed, using daily, discrete, dividend adjusted, average bid–ask returns. Under the null hypothesis, the average daily and cumulative returns should not be systematically positive or negative.

Since many of the stocks included in the sample are quite small and not heavily traded (this is particularly true for stocks underlying warrant introductions), the market adjusted returns methodology is employed (with a value weighted index, constructed on a bid quote basis, the Af-

[7]The guides used are published by Öhmans brokerage house.

färsvärldens General Index (AFGX)). The choice to use the market adjusted model instead of the market model is supported by Berglund, Liljeblom, and Löflund (1989). They tried to cope with the problem of misleading beta estimates due to problems produced by trading infrequency on the Helsinki Stock Exchange by using several methods to measure beta. Unfortunately, they were unable to solve the beta estimation problem. A mean adjusted model developed by Scholes and Williams (1977) has the advantage, in the presence of thin trading, of having an unbiased expectation in the situation where trades occur in consecutive periods. The authors of this study also used the mean adjusted model and the market model but there were no significant differences in the results.[8]

The market adjusted model defines abnormal return as

$$AR_{it} = R_{it} - R_{mt} \quad \text{for } -30 < t < 30 \tag{1}$$

where AR_{it} = abnormal return on security, i, over day, t; R_{it} = return on security, i, over day, t; and R_{mt} = return on the AFGX over day, t.

The average abnormal return (AAR_t) is calculated by taking the cross-sectional mean of the daily abnormal returns:

$$AAR_t = \frac{\sum_{i=1}^{N} AR_{i,t}}{N} \tag{2}$$

where N = number of observations.

Cumulative average abnormal returns ($CAAR_T$) are calculated by

$$CAAR_T = \sum_{t1}^{t2} AAR_t \tag{3}$$

where $T = t_2 - t_1 + 1$ (in days).

Since volatility is expected to change, as earlier studies on stock option introductions have shown, at the introduction date, the t-statistic based on the cross-sectional standard deviation is used instead of the t-

[8]It is evident that the betas are biased by thin and infrequent trading in the sample of warrant introductions. For instance, the average beta measured over the 90 days previous to the warrant introduction is estimated at 0.20, while the average beta for the stock option introduction sample is estimated at 1.11. This is also the reason why only changes in the total risk are reported (volatility) and not changes in systematic risk (beta), which would have been of interest given reliable estimates of the systematic risk. However, optioned stocks experience significantly lower betas, on average, for the two longest windows, after the introduction compared to before.

statistic based on the time-series standard deviation.[9] Since day 0 in this study is spread out over different years and different months during each respective year, perfect calendar-time clustering is nonexistent; and, because the independence assumption tends to increase efficiency, a *t*-statistic assuming cross-correlation independence is used. For cumulative average abnormal returns, the test statistic is calculated as the ratio of the cumulative average abnormal return to its standard deviation (assuming dependence across time and sample).

Volatility and Liquidity Effects

To test the null hypotheses that stock return volatility, bid–ask spreads, trading volume, and number of actual trading days are unaltered by warrant (stock option) introductions, after-period values (based on 90, 180, and 270 days after the listing) and before-period values (based on 90, 180, and 270 days before the listing) are calculated for each stock around the listing day.

Stock return volatility is defined in accordance with Chamberlain et al. (1993) by unadjusted volatility and adjusted volatility. The unadjusted volatility is estimated by the standard deviation of daily returns for each stock and period, and the adjusted volatility is estimated by the adjusted standard deviation for each stock and period. The adjusted standard deviation is calculated by dividing each stock's standard deviation by the contemporaneous standard deviation of the market. The adjusted volatility measure is used to take account of possible changes in the market volatility. Bid–ask spreads are defined as the ask quote divided by the bid quote, and trading volume is measured by summarizing the volume in Swedish Krona (SEK) for each stock and period, while the number of actual trading days is accounted for by calculating the number of days the stock trades in each period. Number of actual trading days is an interesting alternative to trading volume as a measure of liquidity, since the level of trading seems to be volatile.

Wilcoxon signed-rank tests are conducted to examine whether the unadjusted volatility, adjusted volatility, bid–ask spread, trading volume, and number of actual trading days after the listing differ significantly from

[9]Brown, Harlowm, and Tinic (1988, 1989) argue that an increase in variance accompanying an event is due to a temporary change in the firm's systematic risk. Thus, it is necessary to control for variance changes to obtain appropriate tests of the null hypothesis that the average abnormal return is zero. If the variance is underestimated, the test statistic leads to rejection of the null hypothesis more frequently than it should, even when the average abnormal performance is zero. One remedy is to ignore the estimation-period residual variance and use the cross-sectional variance in the event period itself to form the test statistic.

the period before the listing.[10] Under the null hypothesis, unadjusted volatility, adjusted volatility, bid–ask spreads, trading volumes, and number of actual trading days should not be systematically different before and after the introduction date.

The reason for using windows up to 270 days is that the introduction of derivatives, particularly on thinly traded stocks, might have a slow impact on volatility and liquidity. It is possible that trading in derivatives begins with relatively low trading volumes, and builds up over a number of months. Thus, the impact of derivative trading may be negligible in the early (low trading volume) period, but much greater in a later period.

The reason for not including windows longer than 270 days in this study is that many of the warrant issuing firms are newly introduced at the StSE. A longer window would significantly reduce the sample. In addition, a longer window could create measuring problems. The business risk and financial risk faced by firms may change during such a long period.

Wilcoxon rank-sum tests are used to test for possible differences in changes in unadjusted volatility, adjusted volatility, bid–ask spreads, trading volume, and number of actual trading days between warrant and stock option introductions.

RESULTS

Direct Price Effects

The results using the introduction day of the warrants (stock options) as the event date are presented in Table I. Column 2 in Table I presents the *AAR* for the 35 stocks, where day 0 is the actual warrant introduction date. All days around the introduction of warrants show insignificant *AARs*, with about as many positive as negative *ARs*. The *CAAR* is able to pick up a significant positive price effect the day after the introduction day and between days 3–6, but the effect seems not to be permanent since the values for day 7 and beyond are insignificant.

Table I also shows the *AAR* and *CAAR* for stock option introductions. Significant *AAR* values are reported for 3 of the 61 days (days -9, -4, and 3). The *CAAR* seems to imply a negative but insignificant price effect for stock option introductions. The fact that no consistent and permanent price effects are found shows that warrant introductions and stock option

[10]Nonparametric tests are used because of the non-normality of the data. However, *t*-tests are used also without any major differences in the results.

TABLE I

Average and Cumulative Average Abnormal Returns and Their Respective *t*-Statistics around Warrant and Stock Option Introductions

	Warrants ($N = 35$)					*Stock Options* ($N = 32$)				
Day	*AAR* (%)	*t-AAR*	*Positive* (%)	*CAAR* (%)	*t-CAAR*	*AAR* (%)	*t-AAR*	*Positive* (%)	*CAAR* (%)	*t-CAAR*
−30	−0.88	−2.808	29			0.12	0.408	53		
−25	−0.38	−0.847	51			0.35	1.067	6		
−20	−0.45	−1.022	40			0.26	0.904	5		
−15	−0.52	−1.972	37			0.30	1.051	56		
−10	0.58	1.418	57			0.18	0.915	53		
−9	0.30	0.702	51			−0.50	−2.546	38		
−8	−0.30	−0.878	40			0.70	1.181	53		
−7	−0.06	−0.165	49			−0.07	−0.206	41		
−6	0.51	1.625	51			0.22	0.626	47		
−5	0.69	1.088	54			0.08	0.355	47		
−4	0.17	0.432	51			0.96	2.246	59		
−3	0.00	−0.008	51			0.02	0.038	41		
−2	−0.80	−1.879	40			−0.31	−0.521	38		
−1	0.39	0.880	60			0.16	0.369	44		
0	0.71	1.191	51	0.71	0.007	−0.62	−1.768	38	−0.62	−0.006
1	0.66	0.919	57	1.37	37.565	−0.06	−0.168	50	−0.68	−1.696
2	−0.35	−0.572	49	1.01	1.686	0.04	0.118	50	−0.64	−1.781
3	0.29	0.587	54	1.30	2.657	0.64	2.154	59	0.00	−0.006
4	−0.10	−0.240	53	1.20	2.589	−0.33	−0.648	38	−0.34	−0.716
5	0.08	0.123	43	1.28	3.049	0.00	0.000	56	−0.34	−0.799
6	−0.18	−0.337	46	1.11	2.684	0.07	0.331	56	−0.26	−0.680
7	−0.34	−0.811	49	0.76	1.813	0.22	1.142	59	−0.05	−0.130
8	−0.84	−1.759	29	−0.08	−0.160	0.11	0.409	50	0.06	0.183
9	0.20	0.534	46	0.12	0.246	−0.27	−1.281	41	−0.20	−0.602
10	0.09	0.161	51	0.20	0.447	−0.30	−1.011	38	−0.50	−1.503
15	−0.57	−1.360	31	−0.49	−0.967	0.01	0.046	47	−0.51	−1.807
20	−0.06	−0.172	46	−0.21	−0.417	0.26	0.859	56	−0.66	−2.290
25	−0.35	−0.639	51	−1.35	−2.985	−0.15	−0.501	47	−0.08	−0.303
30	−0.22	−0.491	40	−1.01	−2.343	0.05	0.200	53	−0.09	−0.334

Notes: Positive refers to the percentage of firms with positive abnormal returns for a given day.

introductions are not to be associated with price increases/decreases in the underlying stocks, at least not for the 31 days at and after the events.

Further, to investigate if warrant introduction *CARs* (cumulative abnormal returns) differ from stock option *CARs*, a two-tailed Wilcoxon rank-sum test is performed for the difference between the two samples. No significant differences for any of the 31 days are found at and after the two introductions. Therefore, the null hypothesis that estimated *CARs* are the same cannot be rejected.

Volatility and Liquidity Effects

To illustrate changes in the volatility, Table II presents unadjusted volatility and adjusted volatility ratios for the stocks underlying the warrant introductions. The unadjusted volatility ratios are computed by dividing the standard deviation for stock, *i*, after the introduction by the standard deviation of stock, *i*, before the introduction. The adjusted volatility ratios are computed in the same way, but with an adjusted standard deviation. Thereafter, for each window, all ratios are added and then divided by the number of stocks. According to the null hypothesis of no changes in volatility, the mean ratio for all stocks should equal one. Table II shows that two of three unadjusted volatility windows have mean ratios lower than one. Further, the median ratio, in Table II, indicates that the unadjusted volatility is lower after the introduction of warrants than before, while the adjusted volatility increases for all windows after the introduction of warrants. However, no evidence of any significant changes, at a 5% level, is present according to the Wilcoxon signed-rank test. Therefore, the null hypothesis of no change in volatility surrounding warrant introductions cannot be rejected.

Table III presents a similar analysis for stocks underlying stock option introductions. The median ratios show that the unadjusted volatility and the adjusted volatility decrease after the introduction of stock options. In addition, the *p*-values on the last row show that the changes in unadjusted volatility and adjusted volatility are significant for three of six windows.

To examine possible changes in the bid–ask spread, Table IV presents bid–ask spread ratios. As mentioned earlier, the expectation of increasing bid–ask spreads as a result of warrant introductions is an important incentive not to issue warrants, especially if the underlying stock already suffers from large bid–ask spreads. The bid–ask spreads (the ask quote divided by the bid quote) are time-series averages of individual stocks. Under the null hypothesis, the ratio of these time-series should equal one.

The median ratios, in Table IV, indicate that the bid–ask spreads tend to be about the same before as after the introduction date, independent of window size. Since only 46–58% of the firms experience lower bid–ask spreads after the introduction of warrants, with insignificant Z-statistics for the three windows (270, 180, and 90 days), respectively, no evidence is found indicating that warrant introductions have any effect on the underlying stocks. Therefore, the null hypothesis that bid–ask spreads are the same before and after cannot be rejected.

TABLE II

Unadjusted Volatility Changes and Changes in Adjusted Volatility for 35 Stocks That Issued Warrants, Listed on the StSE

Firm	Listing Date	*Unadjusted Volatility Ratio*			*Adjusted Volatility Ratio*		
		270	*180*	*90*	*270*	*180*	*90*
ABV	12/5/84	0.87	0.75	0.66	0.85	0.93	0.84
Alfa-Laval	8/15/86	0.85	0.83	0.67	0.96	0.99	0.79
Anderssons	12/13/84	1.23	1.21	1.52	1.19	1.52	2.03
Aritmos	7/10/84	0.74	0.93	0.81	0.94	1.05	0.91
Asken	1/12/82	1.23	0.96	1.36	1.11	1.24	1.57
Atlas-Copco	9/27/84	0.91	0.97	1.09	1.17	1.08	1.10
B&B-Invest	1/18/82	1.65	0.99	0.79	1.50	1.29	0.90
Cabanco	12/12/84	—	—	1.94	—	—	2.54
Carnegie	5/15/86	1.06	0.94	0.80	1.22	1.12	1.32
Cardo	8/10/88	0.40	0.72	0.92	1.11	1.16	1.11
Componenta	11/24/88	0.95	1.10	0.63	0.48	1.23	0.51
Eken	7/3/84	0.67	0.95	0.74	0.88	1.10	0.92
Enator	10/29/84	0.76	0.95	0.54	0.86	1.01	0.47
Enstöm	1/2/85	0.61	0.45	0.51	0.57	0.56	0.62
Fabege	10/4/84	0.80	0.88	1.16	1.01	0.98	1.11
Finnveden	6/9/84	—	0.34	0.42	—	0.39	0.50
Grafoprint	9/1/83	1.07	1.01	1.66	1.53	1.30	1.76
Gunnebo	8/20/84	1.26	1.40	1.55	1.52	1.49	1.54
Hasselfors	8/16/84	0.94	1.04	1.22	1.13	1.13	1.20
Hevea	8/6/84	0.62	0.65	0.86	0.75	0.69	0.85
Hydro Carbon	1/2/91	1.09	1.03	1.07	1.24	1.21	1.45
Industrivärden	8/30/84	1.04	1.13	1.29	1.25	1.16	1.11
IRO	12/13/84	1.14	1.21	1.14	1.11	1.52	1.53
J&W	8/3/87	1.94	2.07	4.15	1.07	1.02	1.23
Lundberg	12/12/84	0.75	0.95	0.88	0.77	1.18	1.17
Munksjö	8/20/84	0.75	0.85	1.34	0.90	0.91	1.33
Nobel	4/23/85	1.86	1.11	2.47	1.33	0.92	2.38
N&T	12/22/88	0.92	0.77	0.79	0.28	0.77	0.61
Pronator	9/10/84	0.89	0.96	0.97	1.09	1.00	0.85
Proventus	6/4/84	0.75	0.88	0.74	1.03	1.08	0.90
SCA	11/11/83	0.98	1.03	0.98	1.57	1.52	1.29
SKF	5/15/90	1.44	1.34	1.08	3.03	3.05	0.82
Skåne-Gripen	12/17/84	0.75	0.70	0.69	0.75	0.87	0.94
Spendrup	7/3/84	0.82	0.96	1.18	1.06	1.10	1.46
Transatlantic	8/22/83	0.77	0.76	0.78	1.10	1.00	0.84
Mean ratio		0.985	0.966	1.125	1.101	1.134	1.157
Median ratio		0.908	0.955	0.966	1.088	1.091	1.107
SD		0.344	0.293	0.675	0.452	0.421	0.488
N		33	34	35	33	34	35
Number of ratios < 1		21	22	19	12	10	16
Z-statistic[a]		−1.331	−1.684	−0.524	−0.724	−1.804	−0.704
p-Value		0.183	0.092	0.600	0.469	0.072	0.481

Notes: The volatility ratio is defined as the volatility after the introduction of the warrant for stock, *i*, divided by the volatility for stock, *i*, before the introduction of the warrant. Adjusted volatility ratio is defined analogously. — = data are not available for the entire period.

[a]Refers to the Wilcoxon signed-rank test (two-tailed).

TABLE III

Unadjusted Volatility Changes and Changes in Adjusted Volatility for 32 Optioned Stocks, Listed on the StSE

Firm	Listing Date	*Unadjusted Volatility Ratio*			*Adjusted Volatility Ratio*		
		270	*180*	*90*	*270*	*180*	*90*
ASEA-a	4/11/88	0.62	0.55	0.47	1.59	1.75	0.84
Astra-a	6/12/85	0.69	0.72	0.79	0.50	0.51	0.83
Astra-b	7/23/90	0.87	1.04	1.34	0.54	0.53	0.42
Atlas Copco-a	6/12/85	1.12	1.06	0.88	0.81	0.76	0.92
Avesta	4/4/90	1.31	1.18	0.51	0.86	0.92	0.63
Boliden-a	6/12/85	1.84	0.91	0.84	1.33	0.65	0.87
Electrolux-b	2/10/86	0.93	0.90	0.90	0.73	0.81	0.83
Ericsson-b	2/10/86	0.79	0.76	0.79	0.62	0.68	0.72
Opharma-b	11/11/93	0.69	0.74	0.68	0.78	0.89	0.87
Investor-b	3/23/92	1.55	1.81	0.77	0.95	1.04	0.82
Kinnevik-b	10/11/93	0.67	0.75	0.94	0.95	0.64	0.75
MoDo-b	3/8/94	0.69	0.72	0.71	0.75	0.79	0.80
Munksjö-a	6/7/89	1.02	0.97	0.78	0.68	0.60	0.69
N&T	6/1/93	0.63	0.60	0.98	0.93	0.98	1.00
Nobel	3/16/92	0.77	0.72	0.42	0.48	0.41	0.44
Pharmacia-a	9/21/94	0.88	0.82	1.10	1.15	1.11	1.32
Pharmacia-b	7/21/86	0.90	0.95	1.59	1.05	0.78	1.34
Procordia-b	2/4/91	0.61	0.60	0.49	0.89	0.95	1.04
SAAB-a	3/23/89	1.37	1.50	1.15	1.10	1.15	2.19
Sandvik-b	5/28/93	1.06	0.85	0.86	1.57	1.39	0.86
SCA-b	6/12/85	1.11	1.17	0.96	0.80	0.84	1.00
S-E-B-a	6/1/87	1.04	1.18	0.70	0.61	0.61	1.09
SHB	3/23/89	1.36	1.34	1.40	1.10	1.03	2.66
Skandia	6/12/85	1.24	1.19	1.38	0.90	0.85	1.44
Skandia Int.	6/1/87	1.24	1.31	0.91	0.72	0.68	1.40
Skanska-b	2/6/89	1.16	1.16	1.26	0.99	0.95	1.99
SKF-b	7/21/86	0.80	0.70	0.84	0.91	0.84	1.08
SSAB-a	3/8/94	0.79	0.82	0.80	0.86	0.90	0.91
Stora-b	6/4/93	0.54	0.48	0.65	0.81	0.78	0.70
Trelleborg-b	9/12/88	0.41	0.76	1.19	1.15	1.06	0.92
Volvo-bb	6/12/85	1.09	1.10	1.00	0.79	0.78	1.04
Volvo-bf	3/16/87	1.28	1.57	0.82	0.82	0.81	1.26
Mean ratio		0.971	0.966	0.903	0.897	0.858	1.052
Median ratio		0.913	0.904	0.849	0.863	0.823	0.912
SD		0.323	0.314	0.283	0.265	0.262	0.477
N		32	32	32	32	32	32
Number of ratios < 1		17	19	24	24	25	19
Z-statistic[a]		−1.141	−1.234	−2.356	−2.749	−3.478	−1.028
p-Value		0.254	0.217	0.019	0.006	0.001	0.304

Notes: The volatility ratio is defined as the volatility after the introduction of the stock option for stock, *i*, divided by the volatility for stock, *i*, before the introduction of the stock option. Adjusted volatility ratio is defined analogously.
[a]Refers to the Wilcoxon signed-rank test (two-tailed)

TABLE IV

Bid–Ask Spread Changes, Trading Volume Changes, and Changes in Number of Actual Trading Days for 35 Stocks That Issued Warrants, Listed on the StSE

	Bid–Ask Spread Ratio			*Trading Volume Ratio*			*Number of Trading Days*[a]		
Firm	*270*	*180*	*90*	*270*	*180*	*90*	*270*	*180*	*90*
ABV	1.00	1.00	0.99	0.71	0.95	0.77	270/270	180/180	90/90
Alfa-Laval	1.00	1.00	1.00	0.90	1.12	1.12	270/270	180/180	90/90
Anderssons	1.01	1.01	1.02	0.45	0.27	0.33	152/176	87/98	47/39
Aritmos	0.99	1.00	0.96	0.86	1.68	4.58	200/76	116/57	31/21
Asken	1.03	1.01	1.01	0.46	0.50	0.49	251/201	163/126	81/60
Atlas-Copco	1.00	1.00	1.00	1.01	1.19	1.65	270/270	180/180	90/90
B&B-Invest	1.00	0.99	0.99	2.11	2.48	1.90	176/193	106/123	57/61
Cabanco	—	—	1.02	—	—	5.10	—	—	65/78
Carnegie	1.00	1.00	1.00	2.13	2.40	1.03	270/270	180/180	90/90
Cardo	0.99	0.99	0.99	1.06	1.52	1.29	258/257	174/175	87/89
Componenta	1.01	1.00	0.99	0.76	0.35	1.20	235/204	156/150	79/85
Eken	1.00	1.00	1.00	0.68	0.75	4.19	204/270	118/180	41/90
Enator	0.97	0.98	0.98	*	*	1.00	0/97	0/19	0/0
Enström	0.97	0.97	0.96	*	1.00	1.00	0/69	0/0	0/0
Fabege	1.00	1.00	1.00	0.76	1.28	1.36	211/213	121/123	43/44
Finnveden	—	0.97	0.99	—	1.00	1.00	—	11/0	0/0
Grafoprint	1.02	1.02	1.03	0.09	0.10	0.17	204/82	141/81	55/55
Gunnebo	0.99	1.00	1.00	0.81	1.52	2.23	174/270	142/180	90/90
Hasselfors	0.99	1.00	1.00	1.00	1.00	1.00	0/0	0/0	0/0
Hevea	0.99	0.99	0.99	1.54	0.36	0.33	187/270	159/180	90/90
Hydro Carbon	0.96	0.97	1.01	1.41	0.95	0.42	264/268	112/142	80/67
Industrivärden	1.00	1.00	1.00	0.70	0.70	1.51	261/270	174/179	84/89
IRO	1.06	1.00	1.00	1.19	4.12	1.46	127/212	80/180	90/90
J&W	1.00	1.00	1.01	0.20	0.24	0.15	270/270	180/180	90/90
Lundberg	1.00	1.00	1.00	1.89	1.13	0.60	215/268	180/178	90/88
Munksjö	1.01	1.00	0.99	0.09	0.22	0.86	194/270	150/180	90/90
Nobel	1.00	1.00	1.01	0.97	0.84	0.56	149/168	103/101	54/49
N&T	1.00	1.00	1.00	0.25	0.35	0.42	269/254	179/168	90/87
Pronator	1.01	1.00	1.00	0.14	0.37	0.56	256/257	167/169	86/88
Proventus	1.00	1.00	1.00	1.05	0.75	0.49	260/197	170/141	81/53
SCA	1.00	1.00	1.00	0.21	0.30	0.64	270/270	180/180	90/90
SKF	1.00	1.00	1.00	1.32	1.59	1.22	270/270	180/180	90/90
Skåne-Gripen	1.00	1.00	1.00	7.48	15.43	17.69	270/270	180/180	90/90
Spendrup	1.00	1.00	1.00	1.00	1.00	1.00	0/0	0/0	0/0
Transatlantic	0.95	0.95	0.96	1.07	1.01	0.94	119/268	93/178	50/88
Mean ratio	0.998	0.968	0.998	1.107	1.468	1.721	198/211	128/134	65/66
Median ratio	0.999	1.000	1.000	0.901	1.000	1.000	215/257	153/172	81/88
SD	0.018	0.013	0.014	1.301	2.631	3.010	87/83	61/64	32/33
N	33	34	35	31	33	35	33/33	34/34	35/35
Number of ratios < 1	19	19	16	17	16	15			
Z-statistic[b]	−0.974	−0.898	−0.377	−0.999	−0.319	−0.278	−1.627	−0.109	−0.071
p-value	0.330	0.369	0.706	0.318	0.750	0.781	0.104	0.273	0.943

Notes: The bid–ask spread ratio is defined as the bid–ask spread after the introduction of the warrant for stock, *i*, divided by the bid–ask spread for stock, *i*, before the introduction of the warrant. The trading volume ratio is defined analogously. * = the inability to measure the ratio, as the denominator is zero in the equation; — = data are not available for the entire period.

[a]Contrary to the ratios where the after-warrant listing period value is divided by the before-warrant listing period value, the number of trading days is shown before the warrant listing. For example, 152/176 indicates that the stock has been traded in 152 days before the warrant listing date and 176 days after the warrant listing date.

[b]Refers to the Wilcoxon signed-rank test (two-tailed)

TABLE V

Bid–Ask Spread Changes, Trading Volume Changes, and Changes in Number of Actual Trading Days for 32 Optioned Stocks Listed on the StSE

	Bid–Ask Spread Ratio			*Trading Volume Ratio*			*Number of Trading Days*[a]		
Firm	*270*	*180*	*90*	*270*	*180*	*90*	*270*	*180*	*90*
ASEA-a	0.99	0.99	0.98	0.79	0.77	1.72	174/170	126/112	61/57
Astra-a	0.99	0.99	0.99	1.82	1.90	1.43	254/259	168/172	85/83
Astra-b	1.00	1.00	1.00	2.20	1.63	1.43	264/270	176/180	89/90
Atlas Copco-a	1.00	1.00	1.00	1.31	0.94	0.29	270/270	180/180	90/90
Avesta	1.06	1.07	0.97	1.17	0.45	0.17	89/79	67/43	28/19
Boliden-a	0.99	1.00	1.01	4.29	1.35	0.30	269/270	179/180	89/90
Electrolux-b	1.00	1.00	1.00	0.68	0.84	1.12	270/270	180/180	90/90
Ericsson-b	1.00	1.00	1.00	1.38	1.29	0.78	270/270	180/180	90/90
Opharma-b	0.94	0.92	0.81	0.64	0.63	0.68	270/270	180/180	90/90
Investor-b	0.99	0.99	0.99	3.44	2.18	1.04	251/270	173/180	87/90
Kinnevik-b	0.99	1.00	1.00	1.60	0.92	0.74	227/270	180/180	90/90
MoDo-b	0.99	0.99	1.00	2.92	1.63	0.89	270/270	180/180	90/90
Munksjö-a	1.01	1.01	1.00	0.19	0.18	0.12	239/193	159.129	82/64
N&T	0.99	0.99	1.00	1.98	1.42	1.26	270/270	180/180	90/90
Nobel	0.99	0.98	0.96	1.97	0.02	0.05	268/60	180/41	90/31
Pharmacia-a	0.99	0.99	1.00	1.26	0.67	0.38	270/270	180/180	90/90
Pharmacia-b	1.00	1.00	1.00	1.22	1.29	1.49	270/270	180/180	90/90
Procordia-b	0.99	0.99	0.98	1.13	0.73	0.56	258/70	180/180	90/90
SAAB-a	1.01	1.00	1.00	0.63	0.66	0.34	250/220	165/155	88/74
Sandvik-b	1.00	1.00	1.00	1.26	1.00	0.76	270/270	180/180	90/90
SCA-b	0.99	1.00	1.01	1.34	1.07	0.84	270/270	180/180	90/90
S-E-B-a	1.00	1.00	1.00	0.61	0.64	0.77	270/270	180/180	90/90
SHB	1.00	1.00	1.00	0.91	0.82	0.66	270/259	180/179	90/90
Skandia	1.00	1.00	1.00	1.96	2.05	2.57	268/270	179/180	89/90
Skandia Int.	1.00	1.00	1.00	0.64	0.76	0.72	270/270	180/180	90/90
Skanska-b	1.01	1.01	1.01	0.91	0.76	0.42	259/258	179/178	90/88
SKF-b	1.00	1.00	1.00	0.76	0.60	0.65	270/270	180/180	90/90
SSAB-a	0.99	1.00	1.00	2.33	1.96	1.61	270/270	180/180	90/90
Stora-b	1.00	1.00	1.00	1.17	1.02	1.00	270/270	180/180	90/90
Trelleborg-b	0.99	1.00	1.00	1.59	1.57	1.98	254/268	179/179	90/90
Volvo-bb	1.00	1.00	1.00	1.09	0.51	0.28	270/270	180/180	90/90
Volvo-bf	1.00	1.00	1.00	0.63	1.10	0.95	270/270	180/180	90/90
Mean ratio	0.996	0.997	0.991	1.432	1.043	0.876	256/249	173/165	86/83
Median ratio	0.997	0.999	0.999	1.241	0.930	0.767	270/270	180/180	90/90
SD	0.017	0.020	0.034	0.880	0.536	0.580	36/53	22/36	12/18
N	32	32	32	32	32	32	32	32	32
Number of ratios > 1	23	20	21	11	18	21			
Z-statistic[b]	−2.543	−1.795	−1.665	−2.450	−0.094	−1.739	−0.092	−1.255	−1.867
p-Value	0.011	0.072	0.096	0.014	0.925	0.082	0.932	0.209	0.062

Notes: the bid–ask spread ratio is defined as the bid–ask spread after the introduction of the stock option for stock, *i*, divided by the bid–ask spread for stock, *i*, before the introduction of the stock option. The trading volume ratio is defined analogously.

[a]Contrary to the ratios where the after-stock option listing period value is divided by the before-stock option listing period value, the number of trading days is listed before the stock option listing. For example, 152/176 indicates that the stock has been traded in 152 days before the stock option listing date and 176 days after the stock option listing date.

[b]Refers to the Wilcoxon signed-rank test (two-tailed).

A similar analysis on changes in bid–ask spreads for stock option introductions is reported in Table V. Table V shows that the bid–ask spreads, independent of window size, decrease after the introductions, with a significant decrease for the longest window. The bid–ask spread decreases for 62–72% of the firms after the introduction. That the effect is significant for only the longest window can be explained by the fact that it takes time for the bid–ask spread to shift to a "new level." The fact that the bid–ask spread is significantly lower after than before, for all three windows, at a 10% level, but with only one window being significant at the traditional 5% level, makes conclusions regarding changes in bid–ask spreads precarious.

The results reported in Table IV for warrants, according to the mean ratios, suggest that the trading volume increases. On the other hand, the median ratio indicates lower trading volume after the introduction for the longest window and no changes for the other two windows. However, the null hypothesis that the after and before trading volumes are the same cannot be rejected.[11]

Table V describes trading volume ratios for stock option introductions. No significant effects are reported except for an increased trading volume for the longest window. That the effect seems to be more pronounced for the longest window can possibly be explained by the fact that trading in derivatives increases over time.

Since infrequent trading is present for several of the stocks with warrants, the last three columns in Table IV report how often (measured as number of actual trading days) the stocks are traded. On average, the stocks trade between 71.11% and 78.15% of the trading days depending on period (after or before) and window. The null hypothesis that the number of actual trading days is the same during the period after the warrant introduction as the period before the introduction cannot be rejected for any of the windows. The same conclusion is also valid for stock option introductions, presented in Table V, with an insignificantly lower number of actual trading days after than before, for all windows. Stocks underlying stock options are shown to be traded, on average, more than 90% of the days independent of period and window.

To investigate the reliability of the tests, each 270 day window is divided before and after the introduction into two windows, to compare

[11]The same analysis, as above, is performed also to see if the results in Tables II and IV are biased by extreme observations, by examining a sample containing only warrant introductions with stocks traded more than 0 days before and after each respective introduction. This results in a sample of 29 observations for the longer windows and 30 observations for the shortest window. No significant differences are detected in the results between the two samples, except for the adjusted volatility estimated over the 180 day window which becomes significant (p-value = 0.02) for the adjusted sample.

TABLE VI

Z-Statistics and p-Values for Wilcoxon Rank-Sum Tests on Differences between Changes in Unadjusted Volatility, Adjusted Volatility, Bid–Ask Spread, Trading Volume, and Number of Actual Trading Days for Stocks Underlying Warrant versus Stock Option Introductions

	270	*180*	*90*
Unadjusted volatility ratio	−0.026	−0.359	−1.155
	(0.979)	(0.719)	(0.248)
Adjusted volatility ratio	−2.559	−3.900	−1.306
	(0.011)	(0.000)	(0.192)
Bid–ask spread ratio	−1.365	−0.629	−0.665
	(0.172)	(0.530)	(0.506)
Trading volume ratio	−2.282	−0.328	−1.343
	(0.023)	(0.743)	(0.179)
Number of trading days	−1.129	−1.043	−0.476
	(0.259)	(0.297)	(0.338)

Notes: p-Values are given in parentheses.

whether the periods significantly differ from each other. If, e.g., the −270 to −136 day window differs significantly from the −135 to −1 day window, changes surrounding the introduction cannot necessarily be attributed to the introduction itself. The Wilcoxon signed-rank test is used to investigate unadjusted volatility, adjusted volatility, bid–ask spreads, trading volume, and number of actual trading days for warrant and stock option introductions. All windows are found to be stable except for the before trading volume window for stocks underlying stock option introductions, which contain a smaller trading volume for the first period compared to the later period. Therefore, conclusions regarding changes in trading volumes subsequent to the stock option introductions are precarious.

A two-tailed Wilcoxon rank-sum test is used to examine if changes in unadjusted volatility, adjusted volatility, bid–ask spreads, trading volume, and number of actual trading days differ significantly between warrant introductions and stock option introductions. The Z-statistics and p-values are reported in Table VI. Significant differences between the warrant introductions and the stock option introductions are present, for the adjusted volatility ratios measured over the 180 and 270 day windows and for the trading volume measured over 270 days.

Cross-Sectional Interrelation between Changes

Schwert (1989) reports that changes in trading volume are positively related to changes in stock return volatility. Any decrease in volatility fol-

lowing warrant (stock option) introductions should, therefore, be associated with a decrease in trading volume. On the other hand, it has often been argued that a decrease in volatility in the stock increases its trading volume and decreases its bid–ask spread. The rationale for this is that reduced volatility decreases the risk of the market maker for inventory. Hence, a lower risk premium will be needed. A lower risk premium, i.e., a lower price for trade, is assumed to increase the trading volume. In addition, larger trading volumes make market making cheaper (economies of scales) and can, therefore, be assumed to reduce bid–ask spreads further.

An alternative explanation for lower trading volume is that a diversion of trade from the stock market to the derivative market takes place because of competition between the instruments, independent of changes in return volatility. The fact that derivatives written on common stocks are similar to highly levered positions in the stock makes them a more attractive investment vehicle than the underlying stock for informed traders.[12] If informed traders move from the stock market to the derivative market, market makers are less likely to trade with traders who possess superior information and can, therefore, be assumed to reduce bid–ask spreads.

The following regression is performed to examine the cross-sectional effects:

$$\ln S_{ij} = \alpha + \beta_1 \ln V_{ij} + \beta_2 \ln T_{ij} + \beta_3 \ln D_{ij} + \varepsilon_{ij} \qquad (4)$$

where S_{ij} = the bid–ask spread ratio for stock, i, over window, j; V_{ij} = the unadjusted volatility ratio or the adjusted volatility ratio for stock, i, over window, j; T_{ij} = the trading volume ratio for stock, i, over window, j; and D_{ij} = the number of actual trading days ratio for stock, i, over window, j. The results of the regression are presented in Table VII. Changes in unadjusted volatility, for the stocks underlying warrant introductions, are shown to be positively related to changes in bid–ask spreads for all three windows and significant for two of three windows. Further, a positive significant relationship is evident between changes in adjusted volatility and bid–ask spreads for the 90 day window on a 5% level of significance.

The regression on stocks underlying stock option introductions also presents positive regression coefficients for changes in unadjusted volatility and adjusted volatility, but only one of the six coefficients is significant at a 5% level. Table VII also shows that no other investigated variable

[12]This argument is made, e.g., by Black (1975).

TABLE VII

Regression Results

	Unadjusted Volatility			*Adjusted Volatility*		
	270	*180*	*90*	*270*	*180*	*90*
			Warrants			
α	−0.0008	−0.0009	−0.0016	−0.0013	−0.0038	−0.0029
	(−0.231)	(−0.577)	(−0.892)	(−0.384)	(−1.727)	(−1.528)
	[0.819]	[0.569]	[0.379]	[0.704]	[0.095]	[0.137]
V_{ij}	0.0096	0.0207	0.0182	−0.0009	0.0141	0.0196
	(0.960)	(2.509)	(3.863)	(−0.108)	(1.809)	(4.245)
	[0.345]	[0.018]	[0.000]	[0.915]	[0.081]	[0.000]
T_{ij}	−0.0030	−0.0004	0.0007	−0.0034	−0.0018	−0.0015
	(−0.864)	(−0.196)	(0.306)	(−0.965)	(−0.887)	(−0.717)
	[0.395]	[0.846]	[0.762]	[0.343]	[0.383]	[0.479]
D_{ij}	−0.0090	−0.0227	−0.0150	−0.0089	−0.0214	−0.0114
	(−0.921)	(−1.707)	(−0.872)	(−0.887)	(−1.571)	(−1.208)
	[0.365]	[0.098]	[0.390]	[0.383]	[0.128]	[0.236]
N	31	33	35	31	33	35
			Stock Options			
α	−0.0014	−0.0018	−0.0048	−0.0022	−0.0027	−0.0087
	(−0.457)	(−0.475)	(−0.616)	(−0.603)	(−0.598)	(−1.121)
	[0.651]	[0.638]	[0.543]	[0.551]	[0.555]	[0.272]
V_{ij}	0.0189	0.0206	0.0400	0.0054	0.0038	0.0120
	(2.207)	(1.824)	(1.655)	(0.459)	(0.268)	(0.612)
	[0.036]	[0.079]	[0.109]	[0.649]	[0.790]	[0.545]
T_{ij}	−0.0037	0.0042	−0.0019	−0.0041	0.0040	0.0002
	(−0.790)	(0.514)	(−0.168)	(−0.818)	(0.462)	(0.014)
	[0.436]	[0.611]	[0.868]	[0.420]	[0.648]	[0.989]
D_{ij}	−0.0006	−0.0174	−0.0007	−0.0022	−0.0157	0.0149
	(−0.056)	(−0.696)	(−0.014)	(−0.176)	(−0.584)	(0.275)
	[0.955]	[0.492]	[0.989]	[0.861]	[0.564]	[0.785]
N	32	32	32	32	32	32

Notes: The table presents regression coefficients, *t*-statistics, and *p*-values for

$$\ln S_{ij} = \alpha + \beta_1 \ln V_{ij} + \beta_2 \ln T_{ij} + \beta_3 \ln D_{ij} + \varepsilon_{ij},$$

where S_{ij} is the bid–ask spread ratio for stock, *i*, over window, *j*; V_{ij} is the unadjusted volatility ratio or the adjusted volatility ratio for stock, *i*, over window, *j*; T_{ij} is the trading volume ratio for stock, *i*, over window, *j*; and D_{ij} is the number of days with trade ratio for stock, *i*, over window, *j*. *j* are estimated over 270, 180, and 90 day windows. *T*-statistics in parentheses and *p*-values in brackets are based on White (1980) standard errors, when heteroskedasticity is present at a 5% level of significance.

is able to explain changes in the bid–ask spread, at least not cross-sectional. This is not in line with the results of Chamberlain et al. (1993), who found that changes in bid–ask spreads are more successfully explained by changes in trading volume than by changes in volatility.

Alternative specifications are also used, with similar results which provide assurance that the changes in bid–ask spreads are better explained by changes in volatility than changes in the trading volume. More-

over, the regression conditional on before-trading volume is also performed, with similar results; i.e., the inclusion of trading volume does not improve the explanation of cross-sectional effects.

Infrequent Trading

Finally, to examine whether infrequent trading can explain the lack of significant changes, on average, at and around the introduction of warrants, stocks underlying warrant introductions are investigated to see if they react by different amounts, depending upon how frequently they are traded. All changes, in absolute terms, for each variable and window are ranked according to the before-trading volume (or before-number of actual trading days) and thereafter divided into one "high" trading volume group (or "many" actual trading days) and one "low" trading volume group (or "few" actual trading days). No significant differences are found, using the two-tailed Wilcoxon rank-sum test, in absolute changes between the two groups of stocks underlying the warrant introductions, except for bid–ask spreads measured over 270 days and 90 days (ranked with trading volume and number of actual trading days, respectively). The fact that no significant relationship between trading frequency and the magnitude of change for the investigated variables seems to exist indicates that the lack of observed effects is not a result of noise caused by infrequent trading.

However, the fact that the introduction of warrants does not result in any changes in the investigated variables for the underlying stocks can be a result of infrequent trading in the warrants themselves. If the introduced warrants typically have large bid–ask spreads and low trading volumes, it is reasonable to assume the impact of the introduction to be low. Unfortunately, an analysis of the relationship between changes in the investigated variables and the trading volume of the warrants is not possible because no data on the trading volume of the warrants are available prior to October 1988 at Dextel Findata or StSE. However, if the trading volume between stocks and warrants is correlated, which seems likely, an analysis between the trading volume of warrants and the magnitude of changes is likely to produce a similar outcome as the one presented for the stocks.[13] Nevertheless, introduction effects can exist for more liquid

[13]However, relating the absolute changes in the investigated variables to before-trading volumes or number of actual trading days can be a doubtful measure to investigate the potential impact from noise, since the impact from derivative introductions can influence low and high liquidity stocks differently, (e.g., see Watt, Yadav and Draper (1992)). This seems to be evident for the sample of stock option introductions, as the before-trading volume ranking is significantly related to the absolute changes for 6 of 12 variables investigated.

warrant markets and a study of such a market would, therefore, be of interest.

CONCLUSIONS

The results suggest that warrant introductions have no real effect on the underlying stock. The evidence indicates, on average, that no significant impact occurs on the price, bid–ask spread, volatility, trading volume, or number of actual trading days of the underlying stocks on the StSE in the year following the warrant introduction. This can be explained by warrants not expanding the opportunity set of the investors as much as reported in previous studies for stock options, or that the more complex nature of warrants creates several different effects that sum to zero. This indicates that (i) decreased liquidity caused by a diversion of trade from the stock to the warrant is nonexistent and (ii) volatility estimates for valuation purposes, before the actual introduction, can be approximated by historical estimates.

Further, the introduction of stock options, in contrast to warrants, is found to have a positive effect on the underlying stocks. Volatility and bid–ask spreads are found to decrease, while results regarding changes in trading volumes are more uncertain. The overall results are in line with those of Vinell and De Ridder (1990) and Bengtsson and Tikkanen (1994), except that the latter found no decrease in volatility. This can be explained by the fact that they used unadjusted estimates of volatility.

Finally, to examine whether infrequent trading can explain the lack of significant changes, on average, at and around the introduction of the warrants, stocks with more frequent trading are investigated to see if they react with greater magnitude than stocks with less frequent trading. No significant relationship between magnitudes in changes and trade is found. However, that the introduction of warrants does not result in any changes in the investigated variables for the underlying stocks can be a result of infrequent trading in the warrants themselves. Therefore, a similar study performed on a more liquid warrant market would be of interest.

BIBLIOGRAPHY

Bengtsson, K., and Tikkanen, K. (1994): "Introduktion av aktieoptioner och påverkan på handel i underliggande aktier." Seminarie Uppsats, Handelshögskolan i Stockholm.

Berglund, T., Liljeblom, E., and Löflund, A. (1989): "Estimating Betas on Daily Data for a Small Stock Market," *Journal of Banking and Finance,* 13:41–64.

Black, F. (1975): "Fact and Fantasy in the Use of Options," *Financial Analyst Journal,* 31:36–41, 61–72.

Black, F., and Scholes, M. (1973): "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy,* 81:637–659.

Brown, K., Harlowm, W. H., and Tinic, S. M. (1988): "Risk Aversion, Uncertain Information, and Market Efficiency," *Journal of Financial Economics,* 22:355–385.

Brown, K., Harlowm, W. H., and Tinic, S. M. (1989): "The Effect of Unanticipated Events on the Risk and Return of Common Stock." Working paper. Austin: University of Texas.

Chamberlain, T., Cheung, C., and Kwan, C. (1993): "Options Introduction, Market Liquidity and Stock Behavior: Some Canadian Evidence," *Journal of Business Finance and Accounting,* 20:687–698.

Conrad, J. (1989): "The Price Effect of Options Introduction," *Journal of Finance,* 44:487–498.

Crouhy, M., and Galai, D. (1991): "Common Errors on the Valuation of Warrants and Options on Firms with Warrants," *Financial Analyst Journal,* 47:89–90.

Damodaran, A., and Lim, L. (1991): "The Effects of Option Introduction on the Underlying Stocks Return Processes," *Journal of Banking and Finance,* 15:647–664.

De Roon, F., and Veld, C. (1995): "Announcement Effects of Convertible Bond Loans Versus Warrant-Bond Loans: An Empirical Analysis for the Dutch Market." Working paper. Tilburg: Tilburg University.

Detemple, J., and Jorion, P. (1990): "Option Introduction and Stock Returns," *Journal of Banking and Finance,* 14:781–801.

Galai, D. (1989): "A Note on Equilibrium Warrant Pricing Models and Accounting for Executive Stock Options," *Journal of Accounting Research,* 313–315.

Galai, D., and Schneller, M. (1978): "Pricing of Warrants and the Value of the Firm," *Journal of Finance,* 33:1333–1342.

Gemmill, G. (1989): "Stock Options and Volatility of the Underlying Shares," *Journal of International Security Markets,* 3:15–22.

Gjerde, Ö., and Saettem, F. (1995): "Option Initiation and Underlying Market Behavior: Evidence from Norway," *The Journal of Futures Markets,* 15:881–889.

Hagelin, N. (1995): "Why Warrants? An Empirical Study on the Swedish Market." Working paper. Stockholm: Stockholm University.

Hayes, S., and Tennenbaum, M. (1979): "The Impact of Listed Options on Underlying Shares," *Financial Management,* 8:72–76.

Herrlin, K. (1984): "Tre rättsfall om optionsrätter," *Skattenytt,* 75–85.

Kindlund, P. (1985): "Beskattning av konvertibla skuldebrev och optionslån," *Skattenytt,* 324–341.

Klemkosky, R., and Maness, T. S. (1980): "The Impact of Options on the Underlying Securities," *Journal of Portfolio Management,* 9:12–18.

Lauterbach, B., and Schultz, P. (1990): "Pricing Warrants: An Empirical Study of the Black-Scholes Model and Its Alternatives," *Journal of Finance,* 45:1181–1209.

Long, M. S., and Sefcik, S. F. (1990): "Participation Financing: A Comparison of the Characteristics of Convertible Debt and Straight Bonds Issued in Conjunction with Warrants," *Financial Management,* Autumn:23–24.

Ross, S. (1976): "Options and Efficiency," *Quarterly Journal of Economics,* 90:75–89.

Scholes, M., and Williams, J. (1977): "Estimating Betas from Non-Synchronous Data," *Journal of Financial Economics,* 5:309–327.

Schultz, G., and Trautmann, S. (1989): "Valuation of Warrants—Theory and Empirical Tests for Warrants Written on German Stocks." Discussion paper. Stuttgart: Universität Stuttgart.

Schwert, W. (1989): "Why Does Stock Market Volatility Change over Time?" *Journal of Finance,* 44:1115–1153.

Skinner, D. (1989): "Option Markets and Stock Return Volatility," *Journal of Financial Economics,* 23:61–78.

Trennepohl, G. L., and Dukes, W. (1979): "CBOE Options and Stock Volatility," *Review of Business and Economic Research,* 18:36–48.

Veld, C. (1994): "Motives for the Issuance of Warrant-Bond Loans by Dutch Companies," *Journal of Multinational Financial Management,* 4:1–24.

Vinell, L., and De Ridder, A. (1990): "Aktiers avkastning och risk—Teori och praktik," *Nordstedts,* (pp. 264–267).

Watt, W. H., Yadav, P. K., and Draper, P. (1992): "The Impact of Option Listing on the Underlying Stock Returns: The UK Evidence," *Journal of Business, Finance and Accounting,* 19:485–503.

White, H. (1980): "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica,* 48:817–838.