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**THE PRICE, LIQUIDITY AND VOLATILITY EFFECTS OF COVERED WAR-  
RANT INTRODUCTIONS: FINNISH EVIDENCE**

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Accounting and Finance  
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**THE UNIVERSITY OF VAASA**  
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**ABSTRACT**

Covered warrants have been traded in Finland since the 8<sup>th</sup> of December 2000. These instruments allow investors to gain leverage and also to speculate on the future value of an underlying asset with minimal capital. How does this affect the stocks underlying the covered warrants, if at all? What are the implications of the issuance of this kind of instruments to the overall market? The impacts of these instruments have been under debate in academic literature for over three decades.

This thesis adds to the already existing literature by studying the impact of first-time introductions of covered warrants on a sample of underlying stocks traded on NASDAQ OMX Helsinki. The examined time period is between the years 2000 and 2007. The dataset consists of all first-time issued covered warrants traded in the Finnish stock market during this period. 22 stocks with first-time issued covered warrants are found and after adjustments 14 stocks are selected to the sample. The price, liquidity and volatility impacts of the first time covered warrant introductions to the underlying stocks are studied. To test for these impacts a time interval of 90 days before and after the introduction and issuance dates of the covered warrants is examined, with both unadjusted and market-adjusted metrics. To control for the small sample size, effect size tests are utilized.

The results of the empirical tests are inconclusive. No impact on the prices of the underlying stocks is found. Liquidity metrics show some increase in bid-ask spreads, even though this increase is not completely attributable to the warrant issuance. Volume is found to increase. Volatility is found to be relatively stable surrounding the listing dates of the covered warrants, with some decline witnessed.

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**KEYWORDS:** Covered warrant introduction, derivatives, price impact, stock return volatility, bid-ask spread, NASDAQ OMX Helsinki



## 1. Introduction

Ever since options have been traded it has been argued what kind of impact, if any, these derivatives have on the underlying asset or the whole market. The basic theory of options assumes that the introduction of these derivatives should have no effect on the price of the underlying asset. Despite of this theoretical assumption Ross (1977) was one of the first theorists to suggest that options could actually give investors more choice in the market, which in turn would affect the price of the underlying asset. Eventually this suggestion gave rise to a number of studies concerning the impacts that derivatives could have on the underlying market. An era of study between 'real' and 'synthetic' securities is born. The issues that are most prevalent in these studies are three fold. First issue studied is whether the derivative markets make the securities markets more complete or not. The second issue is impact of the introduction of derivatives markets on the operational efficiency of the markets. The third issue is the effect that the derivative markets have on the informational efficiency of the underlying market. These studies have lead to an overall academic debate on whether the trading in derivative instruments is beneficial or disadvantageous to the underlying market. (Grossman 1988; Ross 1977; Sahlstöm 2001)

Among the arguments for the derivative markets are that the introduction of options should expand the opportunity set faced by the investor making the market more complete. This means that derivatives give investors a chance to take positions on the underlying which were not possible prior to the introduction of derivatives. Another argument supporting the introduction of options is that options should give the investors more freedom when reacting to new information by reducing friction, transaction costs and short-selling constraints. It is also argued that because the options markets allow for the profitable trading of private information the introduction of options gives more stimulus to the investors to collect and use this information. (Conrad 1989; Sahlström 2001)

Arguments against the derivative markets have also risen. One of these arguments is based on the speculative nature of derivatives, which in turn could increase the volatility of the underlying market. It is also argued that the introduction of op-



tions could decrease the liquidity of the underlying stocks as investors focus on the options instead of the underlying. Noise could also be increased after option introduction in the underlying market as option strategies involve a lot of long and short positions. There are also concerns that "... these instruments may be "driving down the value of stocks and other securities" ..." (Conrad 1989: 487). These and many more arguments for and against these derivative instrument exist still today and while new more complex instruments are developed continually there seems to be no end in sight for the on- going debate. (Aitken 2005; Conrad 1989; Sahlström 2001)

In general there are two broad categories of warrants: equity warrants and covered warrants. The listed company itself issues equity warrants. When equity warrants are exercised, new common shares will be released. This affects the value of an individual stock adversely as the number of shares increases, but the assets remain unchanged. A third party other than the issuer of the underlying securities or its subsidiaries issues covered warrants. Thus exercising covered warrants leaves the total number of outstanding stocks unaffected. (Yan 2000)

Throughout this thesis the warrants mentioned are all covered warrants. One of the main differences between an option and a covered warrant is that when the covered warrant is exercised, the ownership of the underlying is not affected. Instead exercising a covered warrant always results in a cash settlement. Hereafter when the term 'warrant' is used, it will be referring to covered warrants.

## 1.1. Motivation

The motivation behind this study is the ever-growing topical interest of market participants towards covered warrants, especially warrants in the Finnish stock market. While much of the existing work has focused on the impact of exchange-traded options, few studies have examined the impact of covered warrant introduction on the behavior of underlying stocks. Warrants also offer a relatively easy way to start investing or speculating on an underlying with minimal capital, making it more attractive to a bigger audience. The basic theory suggests that options

could raise underlying stock prices, lower them, or leave them unaffected. The underlying assumption is that common equilibrium effects are small enough to have no economic significance. This theoretical ambiguity alone justifies the need for extensive empirical research. It has also been hypothesized that the warrant issuers try to hedge their positions by buying or short selling the underlying stocks prior to the new warrant introduction. It may also be, that the warrant issuers want to benefit from the warrant issuance by introducing the new products to the market when the underlying asset is displaying certain characteristics to ensure high premiums. A part of the motivation is also the fact that the majority of the previous studies on exchange traded derivative introductions has been focused on the U.S. markets and mainly on exchange traded options.

Although there are some inconsistencies between the conclusions of the previous studies, on the whole one can note that option introductions have been associated with significant volatility decreases, price increases and liquidity increases in the underlying market. The key motivation in this study is to see whether or not the same conclusions apply to the small Finnish stock market with a similar kind of derivative (i.e. warrant). There have been no prior studies that the author is aware of concerning the impact of initial covered warrant introduction to the relatively small Finnish stock market, although equity warrants have been studied by Sahlström (2001) and Kaivolahti (2008). The results of this thesis can also help investors to gain a better understanding of the trading behavior in underlying stocks surrounding warrant issuances, enabling investors to make informed investment decisions.

## 1.2 Hypotheses

These hypotheses are derived from previous studies concerning the impact of initial covered warrant introductions on the underlying stock market. The first impact studied on this thesis is the price impact that the new covered warrant has on the underlying stock.

*Price impact*

The view that derivative introductions change the underlying prices on equilibrium and allocations to investors for the positive is supported by several empirical studies (Hakansson (1982), Green and Jarrow (1987), Hodges (1992)). According to these studies the investment opportunity set available for the investors is expanded by the introduction of derivatives. This expansion then makes the overall market more complete and enables investors to utilize more elaborate strategies to gain higher reimbursements. In accordance with this argument Ross (1976) argues that "... in an uncertain world derivatives written on existing assets can improve efficiency by permitting an expansion of the contingencies that are covered by the market." (Ross 1976: 75) All the aforementioned studies conclude that derivative introductions should improve the welfare of the trader and are associated with a positive price effect.

Also Conrad (1989) documents a permanent price increase following the option introduction, but in contrast she finds support for the view that derivative securities in general may be malign to investors. This argument states that trading in these instruments may be driving down the value of stocks and other securities and is supported by Miller (1977), Figlewski (1981) and Danielsen and Sorescu (2001).

A few large financial institutions dominate the issuance market in Finland with interests different to those of an option exchange. It can be hypothesized that when a warrant issuer perceives a mispricing opportunity it is more likely that it will issue a warrant. Because of the fact that warrant markets have thrived for several years now, it can also be assumed that warrant issuers are able to operate profitably. As the profits for the warrant issuers come from the warrant premiums, the issuances of call (put) warrants could give a pessimistic (optimistic) perception of the future movement of the underlying asset. This can produce abnormal price declines (increases) in the underlying asset resulting from the covered warrant issuance. This situation denotes straight wealth transfers to financial intermediaries in the form of warrant premiums paid by the investors. This view is supported by a study conducted by Aitken and Segara (2005).

As an theoretically conclusive argument is yet to be found, and the findings of Aitken et al. (2005) in mind, the following hypothesis is derived for the price impact:

*H1 : There should be a negative price impact on the underlying stocks following the introduction of the new covered call warrant.*

### *Liquidity impact*

The second impact that studied in this thesis is the impact that the introduction of the new covered warrant has on the underlying stocks liquidity. This impact has also been studied quite extensively, with most of the studies concluding that an increase in the trading volume of the underlying stock follows the derivative introduction.

Skinner (1989) studied the liquidity impact and suggested that the introduction of derivative instruments could divert attention towards the aforementioned from the underlying stock itself. This then, according to this hypothesis, results in a decrease of the stocks liquidity. While at first glance this analogy seems to be feasible, contradicting his own hypothesis Skinner (1989) found a significant increase in the raw trading volume of the underlying following the derivative introduction. These findings are supported by Ho and Liu (1997) who find that the mean daily percentage trading volume increases significantly after the option listing. These increases in underlying trading volume following first-time warrant introduction are linked by previous studies to the needs of the warrant issuer's hedging activity. This view is backed up by Aitken et al. (2005) study where they conclude that the aforementioned hedging activity is in part paid for by wealth transfers from investors to financial institutions issuing these derivatives. These views lead to the second hypothesis:

*H2 : Underlying stock liquidity should increase following warrant introduction.*

*Volatility impact*

The third impact studied is the impact the introduction of a covered warrant has on the underlying stock's volatility. The findings of the previous studies regarding the impact on the underlying stocks volatility are the most homogenous. Most of the previous studies conclude that the volatility should decrease after the derivative introduction. (Alkebäck & Hagelin 1998; Sahlström 2001)

According to Sahlström (2001), under the assumption that option markets improve the underlying markets' operational and informational efficiency, option introduction should lead to a more precise price adjustment process, decrease the noise effect and lower bid-ask spreads. It is also hypothesized that the introduction of options may attract new informed traders to trade. In fact the findings of Sahlström (2001) support the hypothesis that stock option market increases the efficiency of the underlying market. Especially the informational asymmetry shows signs of being lower following the option introduction. This would then indicate a stabilizing effect of the introductions. The overall consensus within the results of previous research conducted on the option introductions volatility impact seems to be quite clear-cut; with a few exceptions the majority of the previous research concludes that option introduction reduces the volatility of the underlying stock.

Nonetheless Bollen (1998) and Mayhew and Mihov (2004) conclude that in order for options exchanges to list an option the underlying stocks must meet certain criteria for options exchanges to list derivatives on them. Mayhew et al. (2004) also report that according to sources inside the option exchanges, unusually high or rising variance is one of the selection criteria. This makes the option introduction an endogenous event i.e. introducing options and warrants on large and highly volatile stocks is more attractive to the issuers. Aitken et al. (2005) note that the single characteristic that makes the covered warrant issuance diverge from the option issuance is the profit motives of the warrant issuers. These profit motives accompanied by the issuers capability to dictate when the warrant is issued indicates that the aforementioned are indeed able to generate significant gains from larger warrant premiums when the underlying is anticipated to be more volatile. Thus the hypothesis concerning the volatility impact of covered warrant introduction is as

follows:

*H3: Underlying stock return volatility increases following warrant introduction.*

### 1.3 Structure of the study

The structure of the thesis is as follows. Firstly the motivation of this thesis is addressed followed by the definition of the hypotheses. A review of the previous studies related to the topic is presented in section two. Section three presents the theoretical background of this thesis. In section four the dataset and methodology utilized are presented. Section five consists of the empirical results of this thesis. Section six concludes and addresses subjects for further studies.

## 2. Previous studies

In this part some of the previous studies concerning impacts of option and covered warrant introductions will be addressed. Although the impacts of the introductions of derivative instruments have been widely researched, the results seem to be surprisingly inconclusive. Moreover studies concerning the impacts of covered warrants are quite scarce. Nonetheless the one conclusion that most of the researchers of this topic seem to hold in common is the decrease in the volatility of the underlying stock after the option listing.

### 2.1 Price effect

Black and Scholes (1973) view options as redundant securities which means that they can be valued with a no-arbitrage relation and thus in their model, option introduction can have no price effect on the underlying security. Ross (1976) was the first theorist to suggest that option introduction would have an impact on the underlying stocks price. In his study Ross (1976) suggests that options may affect underlying stock prices by giving investors more choices and opportunities in the markets. Nonetheless Ross (1976) does not provide any further evidence regarding this price effect.

Miller (1977) argues that if short selling constraints are enforced, the absence of this possibility causes a synthetic disparity in the demand–supply relationship, which can result in higher equilibrium prices. Miller (1977) concludes that this disparity would cease to exist and the prices would subside to a new equilibrium following the introduction of option trading. Given that the sample in the study of Miller (1977) does not include the period when option listings resulted in positive price changes, extending these findings to a more general setting should not be feasible.

The value conservation capabilities of different market structures are studied by Hakansson (1982). Admitting that these comparisons are more demanding than expected, Hakansson (1982) finds that the opening of options markets, on equilibrium, are strongly beneficial for the consumers active in investing. Hakansson (1982) also adds, with the redistributive characteristics of options in mind, that the

introduction of option markets is probably the simplest and easiest way to achieve these aforementioned effects. As a side note, taking into account the current financial turmoil, partly stemming from certain types of derivatives and financial products, this statement could also awake some discussion among the consumers if presented today. Nonetheless the findings of Hakansson (1982) are based on equilibrium assumptions and can thus still be considered as valid.

Conrad (1989) examines the impact of option introductions on individual securities. In her study she concludes that the option introduction is followed by a permanent increase in the underlying assets price. Conrad (1989) finds that this price increase correlates positively to the opening day trading volume of the option. This effect is found to begin 3 days before the option introduction. These facts support the hypothesis that dealers or other traders are investing in the underlying for hedging purposes in anticipation of the trading volume in the option.

Early studies by of Branch and Finnerty (1981) and Detemple and Jorion (1990) document positive excess returns in narrow windows around call option introductions in accordance with Conrad (1989). Detemple et al. (1990) show that option introduction produces lower equilibrium prices. According to their studies it is also possible to procure higher stock prices with differing initial investments. In stark contrast to Conrad (1989) Ho et al. (1997) find a significant reversal in price behavior surrounding option introduction; a price increase starting approximately 100 days prior to option introduction is found followed by a price decrease after the introduction date.

The effect of option listings on the quality and quantity of information produced, and the speed with which stocks respond to new information are studied by Jennings and Starks (1986) and Damodaran and Lim (1991) respectively. The evidence from these aforementioned studies suggests that prices of optioned stocks adjust more quickly to new information than non-optioned stocks.

However, more recent work by Sorescu (2000) shows that the price effect of option introductions follows two divergent, distinct patterns, with an explicit breakpoint, taking place around July 1981. Prior to the aforementioned breakpoint the option



introductions were followed by a positive price impact while introductions after that date appeared to have a negative price impact. Although Sorescu (2000) provides no clear explanation for this 1981 pattern alteration, he notes that the pre-1981 positive price effects might be related to the market completion characteristics of options, a hypothesis first suggested by Detemple and Jorion (1990). According to this hypothesis, the “market completion” effect would have ceased in April 1982, when index options first began to trade. Another possible explanation for this anomaly could be that stock price reactions prior to 1981 might indicate an amalgamation of both the release of short sale constraints and some other unknown, exogenous factor that acts in the opposite direction. Danielsen and Sorescu (2001) analyze the link between diminishing short sale constraints and the price impact of post-1980 option introductions and report a significant relationship between these two factors, which could give some insight for understanding this anomaly although nothing conclusive can be derived from this.

Chan and Wei (2001) examine the price effects of underlying stock around the announcement date of covered warrants. They find a price decline 2–3 days after the warrant announcement. In addition, they find that underlying stocks have abnormal increases in price and volume during the last 5 minutes of trading on the warrant issuance day. According to Chan et al. (2001) this might be due to investors' speculation on the future value of the asset caused by information leakage about the successful warrant issuance and/or to the profit motives of the financial intermediaries trying to attain higher initial warrant premiums.

In more recent studies Aitken et al. (2005) find no price increase prior to the covered warrant issuance. On the warrant announcement date Aitken et al. (2005) find a statistically significant price decline in the underlying asset. The aforementioned is also witnessed on the first trading date to follow the announcement. This price decline is followed by slow price deterioration. As an explanation for this Aitken et al. (2005) suggest that warrant issuers continuously hedge their open positions by using equity options and/or underlying stock with different weights.

## 2.2 Liquidity impact

The impacts of derivative introductions on stocks liquidity metrics, both volume and bid-ask spread, is the least studied impact of the three impacts selected in this thesis. The results from these studies concerning the volume effects are the most conclusive of the aforementioned; a statistically significant increase in volume is found to follow the derivative introduction. The effects on the bid-ask spreads are more inconclusive.

In addition to price effects Branch et al. (1981) study the effects of option introduction on the underlying stocks volume. They conclude that initial call option introductions are followed by a statistically significant increase in the relative volume of the underlying. After the call option introduction the increase in volume is reported to continue for a few weeks. This view is supported by Bansal, Pruitt and Wei (1989) who study options listed on the CBOE between 1973 and 1986, and find an increase in total trading volume following the option listing.

A more extensive study is conducted by Long, Schinski & Officer (1994) who also study volume effects of initial option introductions. Their study consists of 111 OTC firms with options listed on the five option exchanges of Chicago (CBOE), New York (NYSE), American (AMEX), Philadelphia (PHLX), and Pacific (PSE) between June 1985 and June 1990. These firms are then studied over a period of 260 days before and after the initial option listing. An increase in the trading volume of the underlying OTC firms is reported. This increase is reported to being largest in the small- and medium-sized firms. Long et al. (1994) add that the increase is not evident only due to larger trade size, as the number of trades is also notably increased. These results are similar than those of Wei, Poon and Zeen (1997) who also notice an increase in volume, but receive mixed results regarding the behavior of bid-ask spreads. This study by Wei et al. (1997) is examined more extensively in the following chapter of this thesis discussing the volatility impacts.

Kumar, Sarin, and Shastri (1998) find similar results with a different approach. They use a broad range of microstructure characteristics in their analysis. Kumar et al. (1998) conclude that option introductions are followed by a decrease in bid-ask

spreads and an increase in volume.

Draper, Mak & Tang (2001) have also studied the effects of new derivative warrant issuance in Honk Kong. In their study Draper et al. (2001) find an increase in volume of trading as a result of the introduction. These findings are confirmed by Chan et al. (2001) who find a higher level of trading activity in the underlying stock for 5 days around the warrant announcement date.

A part of a study conducted by Sahlström (2001) is to analyze the impact of new option introductions on the bid-ask spreads of the underlying stock in the Finnish stock market. In this study a decrease in the bid-ask spreads is noticeable after the option introduction. This decrease is significant in all different time intervals studied. The explanation for this decrease is not that definite, since according to Sahlström (2001), a large part of the change in the spreads can be associated with changes in the spreads of the whole market. Sahlström (2001) also finds a notable difference between the short- and the long-period analysis. As an explanation for this Sahlström (2001) suggests that "... the spreads of the entire market are estimated using stocks with quite infrequent trading which is associated with large spreads. Changes in the trading volume of these stocks cause changes in the spread, which may significantly affect the market spread." (Sahlström 2001: 29)

In their study Aitken et al. (2005) study the liquidity impacts of introducing new covered warrants to the Australian stock market. These liquidity impacts are studied by two distinct metrics: relative volume and relative bid-ask spreads. Aitken et al. (2005) find both an increase of relative trading volume and an observable increase in bid-ask spreads. The results of the volume impact are statistically significant. The results from the effects these introductions have on the bid-ask spreads are more inconclusive; the observable increase in the bid-ask spreads does not give grounds to reject their null hypothesis that bid-ask spreads would differ significantly pre- and post-warrant listing in any of their estimation intervals. Nonetheless Aitken et al. (2005) note that the observed bid-ask spread increase is consistent with their findings regarding a decrease in the underlying price.

### 2.3 Volatility impact

The volatility impact of derivative introductions is widely debated among the academics. There are several studies that conclude that the derivative introduction has no significant effect on the underlying stocks volatility (Bollen 1998; Draper et al. 2001). Nevertheless the majority of studies concerning this topic conclude that the option or warrant introduction has a negative impact on the stocks volatility, even though there are some who find that the volatility actually increases following the aforementioned event.

The voice of the majority is represented by a study conducted by Conrad (1989). In her study she finds that the price effect is accompanied by a decline in volatility but the systematic risk appears to stay unaffected by the option introduction. In accordance with Conrad (1998), Gemmill (1989), Detemple and Jorion (1990), Damodaran and Lim (1991) and Sahlström (2001) also find a decrease in volatility of the underlying following a derivative introduction. Alkeback and Hagelin (1998) also find a decrease in volatility and bid-ask spreads in line with a previous study conducted by Vinell and De Ridder (1990). Kumar et al. (1998) also studied the impacts of option introduction on volatility, concluding that the underlying volatility is decreased after the introduction. Long et al. (1994) also studied the impact of an initial option listing on the price volatility of underlying OTC stocks. In their study Long et al. (1994) found no evidence of changes in price volatility following option listing.

Average stock return variances also change following initial options listings according to St. Pierre (1998) although Bollen (1998) contradicts this by concluding that option introductions do not significantly affect stock return variance because the differences between the control group and the optioned group used were statistically inseparable. The conclusions of Bollen (1998) receive support from several studies as Trennepohl and Dukes (1979), Klemkosky and Maness (1980), Chamberlain, Cheung and Kwan (1993), and Gjerde and Saetem (1995) find no significant impact on volatility. Similar results are also found by Bengtsson and Tikkanen (1994). The results of Bengtsson et al. (1994) can be biased as they use unadjusted estimates of volatility. Nonetheless, the findings of Bengtsson et al. (1994) are sup-

ported by Draper et al. (2001) who also find no significant impact on volatility after the warrant introduction.

Although in most of the research conducted on the volatility effect of option introduction the volatility or return variance seems to decline or remain unaffected, there are a few exceptions. Wei et al. (1997) examine the changes in spreads, price volatility, and trading activity surrounding option listings for a sample of 144 OTC stocks listed between 1985 and 1990. Controversially Wei et al. (1997) find an increase in the price volatility of the underlying stock. They attribute the increase in price volatility primarily to an increase in unsystematic risk. Wei et al. (1997) also test for changes in residual-return variances, market-adjusted return variances and raw return variances. A considerable increase that is statistically significant at the one per cent level is found. Furthermore, price volatility increased even after the authors control for volume, insider trading, and spreads. Even though the aforementioned does not fully explain the causes for the increase in price volatility, the results of the study suggest that the effect of insider trading on the price volatility is not as strong as the effect of liquidity trading or volume.

Heer, Trede and Wahrenburg (1997) study the effects of option trading at the DTB (Deutsche Terminbörse). They use a sample of 15 optioned stocks and compare this to a control sample comprised so that it has approximately the same size and industry structure as the basic DTB sample. Daily spot prices between 2 March 1987 and 31 August 1993 are used. Dividend payments and capital increases are taken into account by adjusting the prices. In contrast to most of the other research conducted, they also find similar behavior than Wei et al. (1997) from the DTB. The stocks in their sample become more volatile after option introductions. Heer et al. (1997) note that while the median variance of the control sample declines by 15% the median variance of option listed stocks rises by 34% over a 250-day interval. This makes the relative increase of return variance to reach up to almost 50%. One of the explanations for this increase in volatility according to Heer et al. (1997) seems to be the strong increase in trading volume on optioned stocks in the DTB. Nonetheless the authors themselves admit that their sample of only 15 stocks is quite small and furthermore 14 of them were optioned on the same day. Therefore the results of Heer et al. (1997) should be interpreted with discretion as the data

might be biased in some way.

In accordance with Heer et al. (1997) and Wei et al. (1997) the results of Aitken et al. (2005) indicate that the volatility of the underlying stocks is elevated for the post-warrant listing period. According to Aitken et al. (2005) these findings suggest that speculation in the underlying assets is stimulated by derivatives. The explanation for this perceived volatility increase offered by Aitken et al. (2005) is that warrant issuers are able to time the issuance of warrants and are motivated by profit to list warrants during a time of increased speculation or volatility in the underlying stock, which in turn secures higher premiums for the issuers. Aiten et al. (2005) also find that warrant holders are out of the money for the majority of trading days during the maturity of their warrants. These findings support the speculation that the direction of wealth transfers is from the consumer to the financial institutions.

The abundance of previous studies concerning this subject is staggering, as ever since options were first introduced to the market in 1973, the effects of these introductions have been discussed. Only the most relevant studies for this thesis were chosen, as this is merely a glimpse to the sea of studies concerning derivative introductions both on stocks and indices as underlying. In table 1 a summary of the findings of the previous studies is presented.

**Table 1.** Summary of the findings of the previous studies

Study	Market	Price	Liquidity	Volatility
Miller (1977)	USA	i		
Trennepohl & Dukes (1979)	USA			inconsistent
Klemkosky & Maness (1980)	USA			inconsistent
Branch & Finnerty (1981)	USA	i	i	d
Bansal, Pruitt & Wei (1989)	USA		i	d
Conrad (1989)	USA	i		d
Gemill (1989)	USA			d
Skinner (1989)	USA		i	d
Detemple & Jorion (1990)	USA	d	d	d
Vinell & De Ridder (1990)	Sweden		d	d
Damodaran & Lim (1991)	USA			d
Chamberlain, Cheung & Kwan (1993)	Canada			
Bengtsson & Tikkanen (1994)	Sweden			inconsistent
Long, Schinski & Officer (1994)	USA		i	inconsistent
Gjerde & Sættem (1995)	Norway		i	inconsistent
Heer, Trede & Wahrenburg (1997)	Germany		i	i
Ho & Liu (1997)	USA	d	i	inconsistent
Wei, Poon & Zee (1997)	USA	i	inconsistent	i
Alkebäck & Hagelin (1998)	Sweden		d	d
Kumar, Sarin & Shastri (1998)	USA		i	d
Sorescu (2000)	USA	inconsistent		
Chan & Wei (2001)	Hong Kong	d	i	
Danielsen & Sorescu (2001)	USA	d		
Draper, Mak & Tang (2001)	Hong Kong	d	i	inconsistent
Sahlström (2001)	Finland		d	d
Aitken & Segara (2005)	Australia	d	i	i
Kaivolahhti (2008)	Finland		i	inconsistent

Note: This table presents the summary of the results of previous studies. In this table “i” = increase, “d” = decrease and “inconsistent” implies that there was no significant change or the results were conflicting in some other way.

### 3.Theoretical background

In this part of the thesis the theoretical background is presented. Firstly the underpinnings of market efficiency are discussed followed by a closer look on how the theory of efficiency works in practice. Then stochastic processes and the key elements underpinning the most used pricing formulae in Finance i.e. the Black-Scholes-Merton differential equation are discussed. This is followed by a short look on the characteristics of covered warrants.

#### 3.1 Market efficiency

In the 1950s' one of the early applications of computers was to analyze economic time series. Business cycle theorists felt that a natural candidate to trace the evolution of several economic variables over time was the behavior of stock prices. A study by Maurice Kendall (1953) examines this behavior. Kendall (1953) is unable to identify any predictable patterns in stock prices. Kendall (1953) concludes that the data provides no way to predict price movements and the results appear to confirm the irrationality of the market. (Kendall 1953)

It soon became apparent that random price movements indicated a well-functioning or efficient market, instead of an irrational one. The efficient market hypothesis (EMH) became a topical part of economic theory on the strength of empirical tests in large part undertaken by finance theorist Eugene Fama in his 1970 study "efficient capital markets a review of theory and empirical work" published in the Journal of Finance. Fama (1970) concluded that the market seems to price securities as if there was a rational process behind this. In fact, the EMH can be seen as the inherent consequence of thinking about financial asset prices as equilibrium in a competitive market environment consisting of pragmatic market participants. The EMH states that competition between experienced investors empowers the stock market to consistently price stocks so that they are in line with the expectations of the long-term earnings of the underlying assets. (Bodie, Kane and Marcus 2008: 369-372; Haugen 1997: 642; Langevoort 1992)

For the markets to be considered as efficient, the prices in a given market must al-



ways fully reflect all available information. There are three basic categories of market efficiency under the EMH:

1. Under the *weak form of the efficient market hypothesis*, stock prices are assumed to reflect any information that may be contained in the past history of the stock price itself. Under the weak hypothesis all patterns derived from historical data of stock price movements will be priced away by intelligent or informed traders thus making it impossible to predict the future course of any series by analyzing its past behavior i.e. using technical analysis. Reaching this state, the weaker form of the efficient market hypothesis will be satisfied.

2. Under the *semistrong form of the efficient market hypothesis*, all publicly available information is assumed to be reflected in securities' prices. This includes information in the stock price series as well as information in the firm's accounting reports, the accounting reports of competing firms, announced information relating to the macro- and microeconomic outlooks, and any other publicly available information relevant to the valuation of the firm e.g. the quality of the management, patents held, accounting practices etc.

3. The *strong form of the efficient market hypothesis* is the most inflexible form of the hypothesis. Under the strong form all information is reflected in stock prices. This includes private, or inside information as well as that which is publicly available. This form of market efficiency is accepted as quite extreme and as the difference between private and inside information is often vague it is often accepted on a purely theoretical basis. (Haugen 1997: 643-644; Bodie et al. 2008: 373)

In an idealized world the efficiency of the market place would mean the following conditions to be met:

1. No transaction costs in trading securities.
2. All available information is available without cost to all market participants.
3. All agree on the implications of current information for the current price and

distributions of future prices of each security. (Fama 1970; Glen and Hornung 2005)

Efficiency in the realm of EMH can be further divided into two aspects: price efficiency and market efficiency. Price can be considered efficient in two ways; the current price of a security best predicts its future price and the prevailing price immediately absorbs new information provided to the market. To do this, the mechanism of price formation somehow captures information about and predicts the future payment of a security. In addition this aforementioned mechanism also absorbs the information from the investor who happens to know of this relevant information. Market efficiency is thus premised on the assumption that all relevant information will be available to the market and that the market rapidly, if not instantaneously, digests all information as it becomes available. (Gordon & Kornhauser 1985; Jeffrey et al. 1985; Glen et al. 2005)

Grossman and Stiglitz (1980) claim that the assumptions that all markets are always in equilibrium and always perfectly arbitrated are inconsistent when arbitrage is costly. The aforementioned inconsistency is explained by the fact that, if the equilibrium would be true, the informed would gain less than the uninformed because of the costs of collecting the information. Thus Grossman et al. (1980) claim that all the information is not included in the prices. (Grossman et al. 1980; Grossman 1988)

In his research for market efficiency Fama (1970) concludes that, with but a few exceptions, the efficient markets model stands up well and adds that “one would not expect such an extreme model to be an exact description of the world, and it is probably best viewed as a benchmark against which the importance of deviations from market efficiency can be judged.” (Fama 1970: 414)

The conclusions of Fama (1970) are very concise when breaking down the three hypotheses of market efficiency. Moving from the weak form of the hypothesis to the strong form, various types of investment analysis becomes ineffective in discriminating between profitable and unprofitable investments.

If the *weak form* is valid, technical analysis or charting becomes inefficient. If the weak form is in effect, there is no information in the past series that is useful in predicting the future. If the *semistrong* form of the efficient market hypothesis is in effect, no form of analysis will help an investor to gain superior returns as long as the analysis is based on publicly available information. In order to attain abnormal returns, investors must resort to attempts to uncover, or purchase, private information. When the *strong form* is in effect, there is no way to acquire superior returns; those who acquire inside information act on it and quickly force the price to reflect the information and all efforts to seek out insider information to beat the market are futile. (Haugen 1997: 645-646)

In order to find out whether the real market we are observing is efficient or not it should be noticed that an efficient market exhibits certain behavioral traits or characteristics. If the real market does not conform to these traits it can be concluded that the real market under observation is inefficient. If the market is efficient it should exhibit the following characteristics:

1. Security prices should respond quickly and accurately to new relevant information.
2. Changes in the risk premiums and the level of the risk-free rate associated with the security should be the only factors related to the changes in expected security returns from one period to the next. Returns related with other factors than the aforementioned, should be unpredictable.
3. Examining the attributes of current investments should not be of any assistance when choosing between profitable and unprofitable investments in the future.
4. There should be no statistically significant differences between the average investment performance of the informed and the uninformed investors. Differences found should be because of coincidence instead of systematic differences in the abilities of the investors to find information not already incorporated in stock prices. (Haugen 1997: 647)

In conclusion it can be stated that the market seems to be sufficiently efficient meaning that the information and / or insight that enables the investor to gain even marginal profits needs to be superior. This implies that with hard work, research, intelligence and a bit of luck it is possible for the professional investor to constantly “beat the market”. As Bodie et al. (2008) conclude, “... the easy pickings have been picked.” (Bodie 2008: 405)

### 3.2 Stochastic processes

If a certain variables’ value changes over time in an uncertain way it is said to follow a stochastic process. There are two types of stochastic process classifications; discrete time or continuous time. In a discrete-time stochastic process the value of the variable can change only at certain fixed points in time. In a continuous-time stochastic process the changes take place at any given time. Stochastic processes can also be divided into continuous variable or discrete variable stochastic processes. When a continuous-variable process is at hand the underlying variable can take any value within a determined range. In a discrete-variable process, only certain discrete values are possible. (Hull 2005: 263)

In practice stock prices are not observed following continuous-variable, continuous-time processes. Stock prices have individually separate and distinct values and changes in these prices can be distinguished only when the market place is open. Nonetheless the aforementioned processes have been proven to be a useful model for many purposes. Some of these purposes could include modeling stock prices or predicting certain instruments’ future movements in risk (i.e. volatility). The main reason for considering stochastic models is the fact that they lead to generalized results. These results are beneficial in empirical analysis and theoretically abundant. (Malliaris 1983)

#### *The Markov property*

A Markov process is a specific type of stochastic process where solely the present value of a variable is applicable for predicting the future. The previous values of

the variable and the way that the present has manifested from the past are not pertinent. As a rule Stock prices are presumed to follow a Markov process. As the Markov property is consistent with the weak form of market efficiency, it insinuates that the probability distribution of the price of the underlying is independent of the movements of the aforementioned in the past. If the weak form of market efficiency were not true, above-average returns would be possible to anyone by interpreting charts of the past history of stock prices. (Hull 2005: 264)

### *Wiener process*

Wiener process is a certain type of Markov stochastic process with a mean change of zero and a variance rate of 1.0 per year. It is also known as *Brownian motion*. If a certain variable  $z$  has the following two attributes it is said to follow a Wiener process:

**Property 1.** The change  $\delta z$  during a small period of time  $\delta t$  is

$$(1) \quad \delta z = \varepsilon \sqrt{\delta t}$$

where  $\varepsilon$  has a standardized normal distribution  $\phi(0,1)$ .

This insinuates that  $\delta z$  itself has a normal distribution with

$$\begin{aligned} \text{Mean of } \delta z &= 0 \\ \text{Standard deviation of } \delta z &= \sqrt{\delta t} \\ \text{Variance of } \delta z &= \delta t \end{aligned}$$

**Property 2.** The values of  $\delta z$  for any two differing diminutive intervals of time,  $\delta t$ , are discrete.

This property indicates that  $z$  follows a Markov process. These findings are next discussed in a more generalized setting. (Hull 2005: 265)

*Generalized Wiener process*

The elementary Wiener process,  $\delta t$ , has a drift rate of zero and a variance rate of 1.0. Zero drift-rate indicates that the expected value of  $z$  at any future time is the same as its current value and a variance rate of 1.0 implies that the variance of the change in  $z$  in a time span of length  $T$  equals  $T$ . In terms of  $\delta z$  a generalized Wiener process for variable  $x$  can be defined as

$$(2) \quad \delta x = a\delta t + b\delta z$$

where  $a$  and  $b$  are constants.

The  $a\delta t$  term indicates that  $x$  has an anticipated drift rate of  $a$  per unit of time. The  $b\delta z$  term can be regarded as adding volatility to the path followed by  $x$ . The amount of this volatility is  $b$  times a Wiener process. Thus  $b$  times a Wiener process has a standard deviation of  $b$ . In a minute time span  $\delta t$ , the change  $\delta x$  in the values of  $x$  is given by equations (1) and (2) as

$$(3) \quad \delta x = a\delta t + b\varepsilon\sqrt{\delta t}$$

where  $\varepsilon$  has a standard normal distribution. It follows that  $\delta x$  also has a normal distribution with

$$\begin{aligned} \text{Mean of } \delta x &= a\delta t \\ \text{Standard deviation of } \delta x &= b\sqrt{\delta t} \\ \text{Variance of } \delta x &= b^2\delta t \end{aligned}$$

Homogenous justifications to those given for a Wiener process show that alterations in the value of  $x$  in whichever time span  $T$  is normally distributed with

$$\begin{aligned} \text{Mean of } \delta x &= aT \\ \text{Standard deviation of } \delta x &= b\sqrt{T} \\ \text{Variance of } \delta x &= b^2T \end{aligned}$$

It follows that the generalized Wiener process (2) has an expected drift rate of  $a$  and a variance rate of  $b^2$ . (Hull 2005: 265-268)

*Geometric Brownian motion*

The stochastic process generally assumed for a stock price is geometric Brownian motion. In this process the enticing assumption that a stock price follows a generalized Wiener process, is replaced by a more appropriate assumption. This assumption states, that the stock's price does not affect the expected percentage return required. The constant drift rate assumption is thus replaced by the assumption that the expected return is constant. The geometric Brownian motion model in its essence designates the probability distribution of the possible future values of a security. (Chriss 1996: 97; Hull 2005: 270)

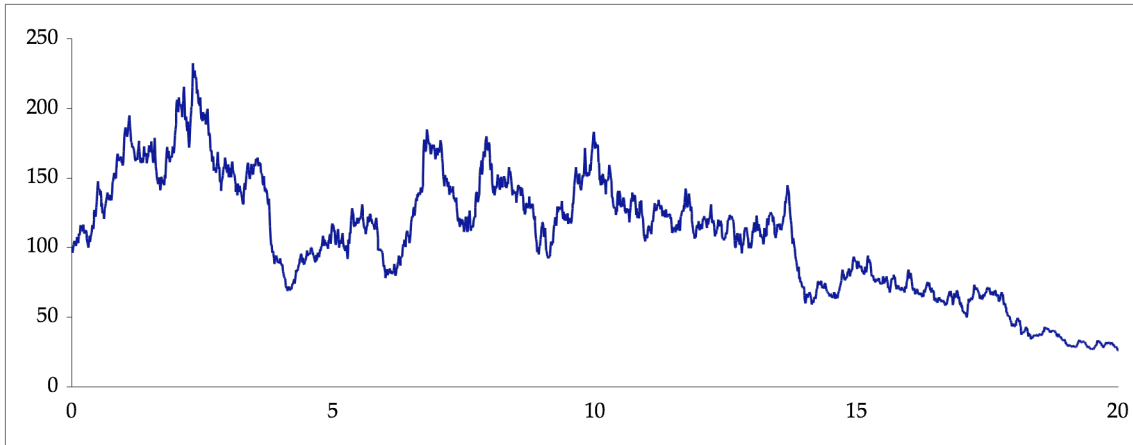
A sensible presumption is that the variability of the percentage return in a short period of time,  $\delta t$ , is the same in spite of the stock price; the same amount of uncertainty can be found in the expected returns whatever the value of the stock. From this can be concluded that the standard deviation of the change  $\delta t$  should correspond to the stock price. This leads to the model

$$(4) \quad dS = \mu S dt + \sigma S dz$$

or

$$(5) \quad \frac{dS}{S} = \mu dt + \sigma dz$$

This equation (4) is the most widely used model of stock price behavior, it is known as geometric Brownian motion. (Hull 2005: 270)



**Graph 1.** Geometric Brownian motion

### *Itô's lemma*

The price of any derivative is a function of the stochastic variables underlying the derivative and time. Based initially on solely mathematical questions, K. Itô discovered in 1951 an important result in this area; it is known as Itô's lemma. Even though Itô's theory was not enough by itself for the formulation and solution of the financial and economic models of today, it was still critical in laying the foundations for future breakthroughs in solving major economical problems. Thus the findings of K. Itô are still widely used in the financial markets of today as many theories, estimation methods and models are based on these. (Hull 2005: 273; Malliaris 1983)

Let us assume that  $x$  follows the Itô process

$$(6) \quad dx = a(x,t)dt + b(x,t)dz$$

Itô's lemma shows that a function  $G$  of  $x$  and  $t$  follows the process

$$(7) \quad dG = \left( \frac{\partial G}{\partial x} a + \frac{\partial G}{\partial t} + \frac{1}{2} \frac{\partial^2 G}{\partial x^2} b^2 \right) dt + \frac{\partial G}{\partial x} b dz$$



where  $dz$  is a Wiener process (6) and as a result  $G$  also follows an Itô process, with a drift rate (8) and variance rate (9) of

$$(8) \quad \frac{\partial G}{\partial x} a + \frac{\partial G}{\partial t} + \frac{1}{2} \frac{\partial^2 G}{\partial x^2} b^2$$

$$(9) \quad \left( \frac{\partial G}{\partial x} \right)^2 b^2$$

As argued earlier, equation (4) with  $\mu$  and  $\sigma$  constant, is an equitable model of stock price movements. When Itô's lemma is applied to the aforementioned the process followed by a function  $G$  of  $S$  and  $t$  is

$$(10) \quad dG = \left( \frac{\partial G}{\partial S} \mu S + \frac{\partial G}{\partial t} + \frac{1}{2} \frac{\partial^2 G}{\partial S^2} \sigma^2 S^2 \right) dt + \frac{\partial G}{\partial S} \sigma S dz.$$

Uncertainty, represented by  $dz$  affects both  $S$  and  $G$ . *Itô's lemma* is said to be in some respects "... as useful to stochastic calculus as the chain rule is for ordinary calculus." (Malliari 1983: 484) This is also one of the milestones in the derivation of the Black-Scholes results, which will be discussed next. (Hull 2005: 270; Malliari 1983)

### 3.3 The Black-Scholes-Merton differential equation

In 1973, Myron Scholes and Fischer Black published their pioneering paper on option pricing, Black and Scholes (1973). The Black-Scholes model revolutionized financial economics in several ways. First, it contributed to our understanding of a wide range of contracts with option-like features. Second, it allowed us to revise our understanding of traditional financial instruments. Third, these formulae have become probably the most used mathematical equations in the history of financial markets. Fourth, the formulae derived are also the basis for a huge number of studies regarding derivatives and other financial instruments. Fifth the Black-Scholes

model has proven itself as a very nimble model as it can also be utilized to value a diverse set of assets such as commodities, bonds or foreign currencies. The effect that these formulae alone have had on the financial world of today justifies the extensive presentation and derivation of these equations. (Brearley, Myers & Allen 2008: 600; Black & Scholes 1973; Hull 2005: 281)

### *Assumptions*

Underlying the Black-Scholes option-pricing model is the Black-Scholes-Merton differential equation. The assumptions used to derive the Black-Scholes model are as follows:

1. Short-term interest rates are known and uniform through time.
2. The stock price follows a random walk i.e. Geometric Brownian motion discussed in chapter 3.2. It follows that the distribution of conceivable stock prices at the end of any fixed interval is lognormal. The stocks' return variance is constant.
3. There are no dividends or other distributions during the life of the stock.
4. The option is of European style.
5. No transaction costs or taxes for the stock or the option.
6. Borrowing at the short-term interest rate is possible.
7. There are no short selling restrictions. (Black and Scholes 1973)

### *Derivation*

The derivation of the Black-Scholes-Merton differential equation is based on the assumption that the stock price follows the geometric Brownian (4) motion discussed earlier in chapter 3.2.

Assume that  $f$  is the price of a derivative dependent on  $S$ . The variable  $f$  must be some function of  $S$  and  $t$ . From Itô's lemma we get,

$$(10) \quad df = \left( \frac{\partial f}{\partial S} \mu S + \frac{\partial f}{\partial t} + \frac{1}{2} \frac{\partial^2 f}{\partial S^2} \sigma^2 S^2 \right) dt + \frac{\partial f}{\partial S} \sigma S dz.$$

The distinct versions of equations (4) and (10) are

$$(11) \quad \delta S = \mu S \delta t + \sigma S \delta z$$

and

$$(12) \quad \delta f = \left( \frac{\partial f}{\partial S} \mu S + \frac{\partial f}{\partial t} + \frac{1}{2} \frac{\partial^2 f}{\partial S^2} \sigma^2 S^2 \right) \delta t + \frac{\partial f}{\partial S} \sigma S \delta z$$

where  $\delta S$  and  $\delta f$  are changes in  $f$  and  $S$  in  $\delta t$ . As mentioned earlier in the discussion about Itô's lemma in section 3.2 the Wiener processes underlying  $f$  and  $S$  are the same. Choosing a distinct portfolio containing a certain amount of the stock and the derivative can then eliminate the Wiener process. The appropriate portfolio for the elimination of the Wiener process is a portfolio where the holder is short one derivative and long an amount  $\partial f / \partial S$  of shares.  $\Pi$  denotes the value of the portfolio. (Hull 2005: 291) By definition

$$(13) \quad \Pi = -f + \frac{\partial f}{\partial S} S.$$

The change  $\delta \Pi$  in the value of the portfolio in  $\delta t$  is given by

$$(14) \quad \delta \Pi = -\delta f + \frac{\partial f}{\partial S} \delta S.$$

When equations (11) and (12) are substituted into equation (14) the following result is arrived at

$$(15) \quad \delta\Pi = \left( -\frac{\partial f}{\partial t} - \frac{1}{2} \frac{\partial^2 f}{\partial S^2} \sigma^2 S^2 \right) \delta t.$$

The portfolios must thus be riskless during time  $\delta t$  as this equation does not involve  $\delta z$ . The assumptions underlying the Black-Scholes model indicate that the portfolio must immediately earn the same rate of return as other securities with similar traits. If these securities would earn more than this return, it would be possible to make riskless profit by borrowing money to buy the portfolio; if it earned less, risk-free profit would be possible by selling the portfolio short and buying risk-free securities. (Black et al. 1973; Hull 2005: 292) Thus

$$(16) \quad \delta\Pi = r\Pi\delta t$$

where  $r$  denotes the risk-free interest rate. When equations (14) and (15) are substituted into (16), the following is acquired

$$(17) \quad \left( \frac{\partial f}{\partial t} + \frac{1}{2} \frac{\partial^2 f}{\partial S^2} \sigma^2 S^2 \right) \delta t = r \left( f - \frac{\partial f}{\partial S} S \right) \delta t$$

so that

$$(18) \quad \frac{\partial f}{\partial t} + rS \frac{\partial f}{\partial S} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 f}{\partial S^2} = rf$$

This equation (18) is the groundbreaking Black-Scholes-Merton differential equation. It has as many solutions as there are different derivatives that can be defined with  $S$  as the underlying variable. The particular derivative that is derived when the equation is solved depends on the *boundary conditions* specified. These *boundary conditions* define the values of the derivative at the upward and downward thresholds of possible values of  $S$  and  $t$ . As in the case of a European call option, the key boundary condition is

$$(19) \quad f = \max(S - K, 0) \text{ when } t = T$$

In the case of a European put option, it is

$$(20) \quad f = \max(K - S, 0) \text{ when } t = T.$$

It should also be noticed that the portfolio used in the derivation of equation (18) is not constantly riskless. It is riskless only for an exceptionally short period of time. As  $S$  and  $t$  change,  $\partial f / \partial S$  also changes. To keep the portfolio riskless, it is therefore necessary to repeatedly change the relative weights applied to the derivative and the stock in the portfolio. (Hull 2005: 292)

### *Risk-neutral valuation*

Unquestionably the single most important tool for the analysis of derivatives is risk-neutral valuation. It stems from one key attribute of the Black-Scholes-Merton differential equation (18), which is that the equation does not contain any variables that can be affected by the risk preferences of investors. The variables included in the equation are the current stock price, time, stock price volatility, and the risk-free rate of interest. All of which are not dependant on risk preferences. Thus the risk preferences cannot affect its solution. It follows that any set of risk preferences can be used when evaluating  $f$ . From this stems a very simple assumption; all investors are risk neutral. This leads to a conclusion that the expected return on all investments is the risk-free interest rate. A risk neutral world is characterized as a place where the investors require no risk premium for their investments. In such an investment environment, the reason investors are neutral towards risk is because on an average there is no risk. (Chriss 1996: 190-191)

It is important to note that risk-neutral valuation is merely a synthetic way to acquire solutions to the Black-Scholes-Merton differential equation. From this it stems that even when investors are risk-averse, the solutions obtained are always viable. As long as our risk-averse reality fulfills the underlying assumptions of the Black-Scholes-Merton differential equation, the option prices derived from this model hold as well. This can be explained with an example: When moving from a risk-neutral world to a risk-averse world, two things happen; the expected growth rate in the stock price changes and the discount rate that must be used for any

payoffs from the derivative changes. These changes always cancel each other out precisely. (Chriss 1996: 191-192)

### *Black-Scholes pricing formulas*

The Black-Scholes formulas are presented next. These formulas are for the prices at time 0. The options are a European call option (21) and a European put option (22). The underlying is a non-dividend paying stock. The formulas are as follows

$$(21) \quad c = S_0 N(d_1) - Ke^{-rT} N(d_2)$$

and

$$(22) \quad p = Ke^{-rT} N(-d_2) - S_0 N(-d_1)$$

,where

$$(23) \quad d_1 = \frac{\ln(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$(24) \quad d_2 = \frac{\ln(S_0/K) + (r - \sigma^2/2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}.$$

The function  $N(x)$  represents the cumulative probability distribution function for a standardized normal distribution. (Chriss 1996: 180)

### 3.5 Covered warrants

In this section the covered warrants will be discussed in more detail. The key properties of the aforementioned and how they are different from exchange-traded options or equity warrants will be discussed.

The term warrant corresponds to a large number of differing derivatives. The terminology concerning warrants is quite heterogeneous. Term derivative warrant is used in Hong Kong only. It is called covered warrants in Britain, naked warrants in Germany, and structured warrants in Singapore. In Australia, no distinction in designation between warrants issued by underlying companies or a third party institution is made. There is, however, a distinction made between warrants with individual stock as underlying and warrants with stock indices as underlying, which are equity warrants and index warrants respectively. In mainland China, warrants issued by underlying companies and third party institutions are treated the same. The first covered warrants were issued already in the 1980's. Since then the expansion of the warrant market has been fierce. The biggest warrant markets are Hongkong, Germany, Switzerland, Italy and France. (Aitken 2005; Deutsche Bank 2009; LSE 2009; Nelskylä 2004: 15; SFC Hong Kong 2005; SGX 2009)

A covered warrant is a derivative similar to an option. While an option is a contract between two parties and traded on a securities exchange such as EUREX, a covered warrant is a securitized option that is traded on the stock exchange. When a covered warrant is bought the right to either buy or sell an underlying asset is actually purchased. This asset is usually a stock but can also be an index, a basket of stocks, a currency or a commodity. When a covered warrant is bought a future price as well as exercise price and expiration date is agreed upon. The party that sells the warrant is called an issuer. The issuer is a traditional bank or an investment bank operating on the stock exchange. At the expiration date the issuer of the warrant is obligated to buy or sell the underlying asset if the buyer wants to exercise the warrant. In practice though, the ownership of the underlying remains unchanged even if the warrant is exercised. Exercising a warrant always leads to a cash settlement. Because the buyer of a warrant has the right not to participate at the expiration date the investor has to pay compensation to the issuer. This compensation is simply the price of the warrant. (Nelskylä 2004: 15-20)

Covered warrants (and options) offer an investor or a trader a disparate opportunity set of risk/return payoffs that would be possible with the underlying security only. Warrants as well as options give the investor a leveraged position in the underlying security. The biggest difference between exchange traded options and

warrants is the counter-party risk included in the covered warrant. The options market eliminates the counter-party risk through margining and the clearinghouse, while warrants are issued by a bank or investment bank that guarantees payment. The purchaser of the warrant thus bears counterparty risk if the issuer of the warrant defaults. (Yan 2000; Nelskylä 2004: 20)

According to Aitken et al. (2005) even though warrants can be regarded as similar to options, it can be assumed that warrant introductions will have differing effects on the underlying assets as the issuing banks are active in the market and have significantly differing interests than those of an option exchange. The issuers use dynamic hedging strategies to manage the liabilities that stem from warrant introductions and the positions that follow. Investing in the underlying assets and / or the actual warrants themselves gives the issuers the ability to hedge their positions or even manage their profits. This strategy is dependant on conditions specific to certain markets and will differ among issuers. (Aitken et al. 2005)

#### *Benefits of covered warrants*

Covered warrants can be beneficial to the investor for a number of reasons. Firstly covered warrants offer significant leverage with minimal capital. This is because the percentage value of the warrant never changes less than the value of the underlying. Covered warrants also offer unlimited potential for profit with the losses limited to the total loss of capital invested. Thus an investor investing in warrants can never lose more than the capital invested. With covered warrants the investor knows the maximum loss in advance, which is not the case with short put options for example. The liquidity and the relatively low trading costs of the covered warrants can also be noted as a benefit as they are more liquid and cheaper to trade than options. In addition covered warrants offer the investor a chance to invest not only during bull-markets, but also in bearish market conditions. (Nelskylä 2004: 30-33)

Covered warrants also offer broader investment possibilities as the underlying assets can range from commodities to currencies. Investors can also add diversification to their portfolios on a country level with minimal capital and with more and



more exotic instruments very innovative payoff profiles are made possible. Additional benefits include the fact that covered warrants are exchange traded and thus must be approved not only by the exchange itself but also by the overseeing official of the market like SEC in the USA or FIN-FSA in Finland. The issuers of the covered warrants are not comparable to the bookies, as they must hedge their position to stay market neutral. From this follows that whenever an investor loses on a warrant, the issuer does not win. In fact the more the investor wins on a covered warrant the more likely it is that the investor will continue investing in warrants and thus benefiting the issuer of the covered warrant. As the issuers are market neutral, the more the individual investors know about these products and the more they gain on them is beneficial to the issuer. Covered warrants are also products aimed for the private investor; this again broadens the investors' opportunity set on the market as the issuers try to match the demand of the market by issuing new warrants with differing characteristics and underlying assets. (Nelskylä 2004: 33-36; SFC Hong Kong 2005)

#### *Drawbacks of covered warrants*

With many benefits of the covered warrants, there are also drawbacks. Some benefits mentioned in the previous section can also be considered as drawbacks, but that is a debatable issue not in the scope of this thesis.

The first and maybe foremost drawback of covered warrants is the complicated nature of these instruments. While covered warrants allow for great gains in the market, they are still derivative instruments with corresponding risks. One of the main contributors to this complexity is the relationship between the covered warrant and the volatility of the underlying asset. As volatility is a subjective estimate, it is possible for two distinct issuers to attribute a differing estimate of the volatility of the underlying to an otherwise identical covered warrant. This then will affect the price of the aforementioned instruments, making these in other respects identical products differ in price. This volatility estimate used by the issuers is not disclosed making these instruments even harder to understand for the everyday investor. The only way for an investor to deduce the volatility estimate used in the pricing of a certain covered warrant is to calculate the implied volatility of the in-

strument. This implied volatility is then, in some respects, also based on assumptions. Because of this inbuilt risk inherent from their complexity covered warrants are not suitable for everyone. (Fortune 1996; Nelskylä 2004: 36-37; SFC Hong Kong 2005)

The limited maturity and the accompanying leverage can also be seen as drawbacks, as covered warrants can expire worthless. With limited maturity comes also another disadvantage in comparison to stocks is the diminishing time-value of these instruments. Because of this diminishing time-value the investor must be careful when speculating with these instruments. The shorter the time to maturity, the lower the value of the warrant. The rough estimate of the diminishing time value with covered warrants is that on the first half of the maturity of the instrument one third of the time-value will have diminished. The rest of the time-value will then diminish on the second half of the maturity of the instrument with increasing speed. (Nelskylä 2004: 38; SFC Hong Kong 2005)

#### *Turbo warrants*

Turbo warrants are a form of covered warrants with distinct characteristics. As some of the warrants under scrutiny in this thesis are turbo warrants, a short glance in their characteristics is to follow. Turbo warrants are special types of barrier options in which the rebate is calculated as another exotic option. The name turbo warrant first emerged in Germany at the end of 2001. This name was given to a usual down and out - style barrier option, having its strike price as the barrier. Later the French bank Societe Generale issued a contract called a turbo warrant in early 2005. This instrument was defined as a down and out - style barrier option. The barrier was set to be in the money and the owner of the instrument was to receive a rebate if the barrier is hit. This rebate can be reconsidered as a new contract, which is essentially a call option on the effectuated lower limit. There are essentially two types of turbo warrants; Turbo warrant calls (turbo-calls) and Turbo warrant puts (Turbo-puts). (Eriksson 2006)

The payoff functions of turbo warrants differ from options and covered warrants in the following manner. If the price of the underlying asset is assumed to evolve according to

$$(25) \quad S(t) = S(0)e^{(r - \frac{1}{2}\sigma^2)t + \sigma W(t)}$$

, where  $W$  is some Brownian motion. Given a barrier  $b > 0$  and a strike price  $K < b$ , a turbo-call warrant pays

$$(19) \quad f = \max(S - K, 0), \text{ when, } t = T$$

at the maturity of the warrant if the predefined barrier has not been hit by the underlying stock at any time when the turbo call warrant is alive. If the barrier is hit at time  $t$  then a rebate

$$(27) \quad (\min_{0 \leq u \leq t} S(u) + \mu) - K$$

is paid at time  $t + \mu$ .

The pay-off of a turbo-put warrant is defined in a similar fashion. In the turbo-put case  $K > b$  and the pay-off at the maturity of the turbo-put is defined as

$$(28) \quad f = \max(K - S, 0) \text{ when } t = T$$

if the stock price stays below the predefined barrier until the maturity of the warrant. If again the barrier is hit at time  $t$  while the warrant is still alive a rebate defined by

$$(29) \quad (K - (\max_{0 \leq u \leq t} S(u) + \mu))$$

is paid at  $t + \mu$ . Here  $\min_{0 \leq u \leq t} S(u)$  and  $\max_{0 \leq u \leq t} S(u)$  denotes the running minimum and maximum respectively.

There is a common belief that turbo warrants are less sensitive to the change in volatility of the underlying asset than for example regular warrants. However, the characteristics and pricing of these instruments under stochastic volatility are still unknown. (Persson & Eriksson 2006; Eriksson 2006)

## 4.Data and Methodology

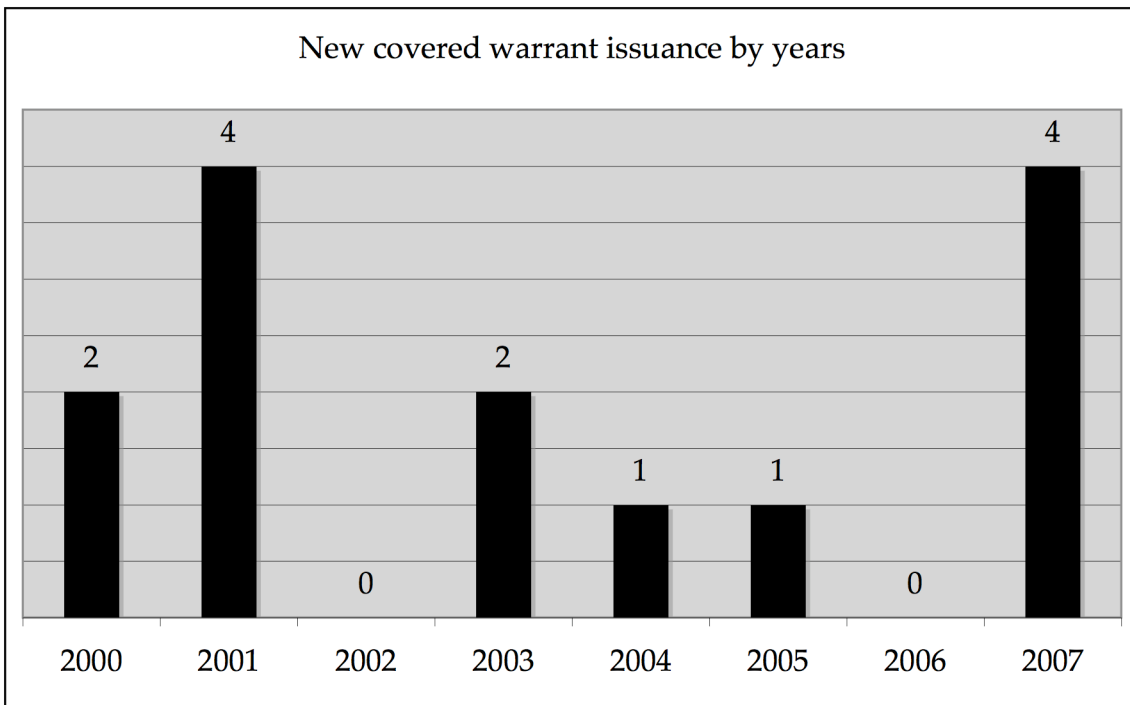
In this part the dataset used in this thesis will be described. The type of data, data extraction methods and data sources will also be tackled. Also the time period of this study will be addressed. Following this will be discussion about the methodology by which the data is interpreted.

### 4.1 Data

The data used in this study consists of daily closing quotes of all stocks traded in the OMX Helsinki from the last quarter of the year 2000 through 2007. The aforementioned time span is selected because the trading of covered warrants began in December of the year 2000. First time covered warrant announcement and issuance dates are derived from the OMX Helsinki disclosures. Issuer and underlying information are presented in table 3. Daily closing prices for covered warrants and the underlying stocks traded in the OMX Helsinki stock exchange are also gathered from the same time period. The announcement and listing dates were derived from the OMX Helsinki News database with the courtesy of University of Vaasa. First time covered warrant issuance and announcement dates are then matched with the aforementioned stocks. A total of 22 stocks with covered warrants issued for the first time are found. After controlling for the fact that this thesis concerns only covered call warrants, 17 stocks remain in the sample. For 3 of the aforementioned stocks insufficient data is found. The final sample is thus the stocks of 14 firms traded in the OMX Helsinki stock exchange. Table 2 presents the descriptive statistic for the dataset. The covered warrant issuance by years can be found in Graph 2. In table 3 the covered warrant issuer and underlying information are presented.

**Table 2.** Descriptive statistics for dataset

Estimation interval	+/-30		+/-60		+/-90	
Sample size (N)	420		840		1260	
Statistic	Pre	Post	Pre	Post	Pre	Post
Mean	0.0011	-0.0016	0.0006	-0.0015	0.0007	-0.0012
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum	0.1957	0.1304	0.1984	0.1304	0.1984	0.1309
Minimum	-0.1301	-0.1317	-0.1301	-0.1317	-0.2152	-0.1317
Standard deviation	0.0334	0.0297	0.0315	0.0304	0.0316	0.0307
Skewness	0.9550	-0.0757	0.8067	-0.1965	0.3650	0.0198
Kurtosis	5.8699	3.5992	6.3821	2.5841	7.2278	2.7830

**Graph 2.** New covered warrant issuance by years

**Table 3.** Covered warrant issuer and underlying information

<b>Issuer</b>	<b>Underlying</b>	<b>ISIN</b>	<b>Trading Code</b>
AlfredBerg	NOK1V	FI0009602767	1KNOKEW500
AlfredBerg	SRA1V	FI0009602809	1KSRAEW260
AlfredBerg	UPM1V	FI0009602940	2BUPMEW360
AlfredBerg	STERV	FI0009602957	2BSTE EW110
ArosMaizels	ELI1V	FI0009603054	2CELIEW240
Handelsbanken	TIE1V	FI0009605224	3ITIEEW400
Handelsbanken	ERIBR	FI0009609978	4EERIEW100
Handelsbanken	NDA1V	FI0009611198	4FNDAEW550
Handelsbanken	SAMAS	FI0009615322	5CSAMEW900
Handelsbanken	NES1V	FI0009622021	6FNESEW270
Nordea	OUT1V	FI0009638100	7ROUTEW240
Handelsbanken	MRLBV	FI0009640817	7LMRLEW40T
Handelsbanken	MEO1V	FI0009640833	7LMEOEW40T
Handelsbanken	KNEBV	FI0009640858	7LKNEEW40T

### *Market efficiency in the OMX Helsinki*

The Finnish stock market i.e. the OMX Helsinki has been a subject for a few studies concerning the efficiency of the marketplace. Berglund & Liljeblom (1988) study the thinly traded OMX Helsinki during 1977-1982 (formerly known as HeSE, Helsinki Stock Exchange) and find significant positive first-order serial autocorrelation. These results are confirmed by a study by Kallunki (1997) in which a longer time span from 1976 to 1990 is utilized. Further studies by Kallunki & Martikainen (1997) and Sahlström (2001) also confirm the existence of first-order serial autocorrelation in the Finnish stocks. According to these studies it seems that the first or-

der autocorrelation structure of the Finnish stocks has been relatively stable over time. These results also give rise to the question whether or not the Finnish stock market is weak form efficient. If so then abnormal returns would be possible by ways of technical analysis for example. Nevertheless according to Sahlström (2001) study the introduction of stock options reduces this autocorrelation and thus makes the overall market more efficient.

## 4.2 Methodology

Event study methodology is selected to determine whether the three hypotheses' presented earlier in chapter 1.2 can be accepted or not. The metrics utilized in the price impact analysis, liquidity impact analysis and volatility impact analysis are presented and defined next. As the sample size used in this thesis is relatively small, effect size metrics are also utilized in selected tests. These metrics will be discussed after the presentation of the impact analyses.

### *Price impact analysis*

An event study methodology is utilized to resolve whether the first-time introductions of warrants have an effect on the underlying stocks returns i.e. *H1*. Daily, discrete, dividend adjusted closing price returns are used. A similar event study methodology as used by Aitken et al. (2005) is utilized. The underlying stocks' return behavior is studied around both the announcement date and listing date of covered warrants. An event window of 31 days surrounding the warrant issuance date i.e. day-0, is selected. The selected event window thus spans from day -15 to day 15. The behavior of the stocks' returns on the selected interval are monitored with two distinct metrics; daily raw returns,  $RR_{it}$ , and daily market-adjusted abnormal returns  $AR_{it}$ . They are calculated using the following formulas:

$$(30) \quad RR_{it} = \ln P_{it} - \ln P_{it-1}$$

$$(31) \quad AR_{it} = RR_{it} - (\ln OMXH_t - \ln OMXH_{t-1})$$

where  $P_{it}$  is underlying stock  $i$ 's closing price on day  $t$  and  $OMXH_t$  is the closing



value of the OMX Helsinki Cap index on day  $t$ . The OMX Helsinki Cap index is selected because it controls for market capitalization by giving each stock a maximum weight of 10% in the portfolio. By selecting the Cap portfolio index the results will be unaffected by the stock price movements of the large companies traded in OMX Helsinki giving a more accurate result.

The main reasons for selecting the 31-day event window around day-0 are two fold. Firstly monitoring the underlying price return changes for 31 days allows for any price impacts that eventuate immediately before or after the warrant introduction to be distinguished. Secondly, the selected method will take into account the expectations built into the issuance as well as the possible real effects following the introductions. To obtain if the mean of raw returns and abnormal returns on a particular event day are significantly less than zero a standard one-tailed t-test is utilized.

The price changes of the introduced covered warrants will also be examined in six event windows. Prices 5, 10 and 15 days after the warrant listing date will be compared to the prices 15, 10 and 5 days before the warrant exit date. A Wilcoxon rank-sum test is utilized to test for statistically significant differences after the warrant listing and before the warrant maturity. The Wilcoxon rank-sum test is chosen because it avoids the assumptions of the standard t-test with minimal loss in efficiency.

The issued warrants will also be subject to moneyness analysis derived from Aitken et al (2005). Moneyness for covered call warrants is defined as:

$$(32) \quad MONEYNESS = \frac{S - (X + WP)}{(X + WP)} \times 100\%$$

,where  $S$  denotes the closing stock price of the underlying and  $X$  is the exercise price.  $WP$  is the warrant premium. This premium is adjusted by the number of warrants that must be exercised to obtain one unit of the underlying i.e. the conversion ratio. The conversion ratio influences the price of the warrant, but not the exercise price, because the trading prices are quoted on a per warrant basis but the

exercise price is quoted on a per asset basis. When  $MONEYNESS > 0$ , call warrants holders are in the money i.e. in a profit position. When  $MONEYNESS < 0$ , call warrants holders are out of the money i.e. in a loss position. The moneyness of the warrant holder is then studied for a 31-day event window, ranging from 15 days before and 15 after the introduction, for each underlying.

### *Liquidity impact analysis*

The second hypothesis H2 is tested by two distinct liquidity metrics: relative trading volume and relative bid-ask spreads.

The impacts of the warrant introductions on the underlying stocks volume is studied by a method derived from Aitken et al. (2005) study. In this method dividing the trading volume of each firm by the total number of securities outstanding for that trading day forms a ratio for each time period before and after the warrant introduction. The time periods chosen are 30, 60 and 90 days before and after the warrant listing. The statistical differences of these ratios will then be examined by utilizing a one-tailed Wilcoxon rank-sum test for each of the three time periods.

Relative bid-ask spreads will be studied by following the methodology utilized by Sahlström (2001). Bid-ask spreads are defined as the difference between the lowest ask and the highest bid during a trading day. Copeland and Galai (1983) note that as lower trading volume is usually a result of less recurrent trading, it is probable that the bid-ask spread is reversely related to measures of market activity. Bid-ask spreads are also prone to fluctuate with the price of a stock and are frequently exposed to capricious minimum tick size rules. Thus a relative bid-ask spread method, derived from Sahlström (2001) is used. In this method relative bid-ask spreads are calculated by dividing the dealers bid-ask spread by the average of the bid-price and the ask-price. It is defined with the following formula (Sahlström 2001: 26)

$$(33) \quad \text{relativespread} = \frac{\text{askquote} - \text{bidquote}}{(\text{askquote} + \text{bidquote})/2}$$

Relative bid-ask spreads are then calculated for each stock for three intervals of differing lengths; 30, 60 and 90 trading days before and after the warrant issuance. Daily average relative bid-ask spreads of the total market for the same time intervals were also calculated. From the relative bid-ask spread results those that implied that a bid- or ask-quote was not available, were excluded. In accordance with Sahlström (2001) to control for intertemporal shifts in the market, daily market-adjusted relative spreads are calculated. Daily market-adjusted relative spread is calculated by dividing the relative bid-ask spread of the stock with the matching daily average relative bid-ask spread of the total market. These bid-ask spread metrics are then studied with a Wilcoxon rank-sum test for statistical differences before and after the warrant issuance

#### *Volatility impact analysis*

A similar approach that is also used in the study conducted by Aitken et al. (2005) is used to test for the third hypothesis i.e. the impact of the new covered warrant issuance on the underlying stocks volatility. These volatility impacts are tested by forming variance ratios. These variance ratios are formed by dividing the estimated volatility of each stock after warrant introduction by their estimated volatility before. A ratio larger than one would indicate an increase in the measured volatility of the stocks returns while a ratio smaller than one indicates a decline in the aforementioned. To form these ratios the volatility of the stock returns is defined by unadjusted volatility and market-adjusted volatility.

The unadjusted volatility is calculated using Kunimotos (1992) estimator over a fixed interval surrounding the covered warrant listing date. The market-adjusted volatility is calculated by dividing each stock's unadjusted volatility estimate by the matching standard deviation of the market for the same fixed period. This method is applied because it adjusts for possible changes in the daily market volatility. These variance ratios are then calculated over three intervals; 30, 60, and 90 trading days before and after the listing of the warrant. Wilcoxon rank-sum tests are then conducted to examine whether the unadjusted and market-adjusted volatility measures after the warrant listing differ significantly from the period before the warrant listing.

*Kunimotos estimator*

In this thesis the volatility parameters of the underlying stock are examined. Thus the estimator derived by Kunimoto (1992) used in this thesis will be discussed next.

In his paper Kunimoto (1992) proposes a new method for estimating the volatility parameters of security prices, improving the estimation method for volatility by Parkinson (1980). Kunimoto (1992) assumes that the security prices follow the geometric Brownian motion (12), but in contradiction to a paper by Parkinson (1980) the geometric Brownian motion is allowed to have nonzero drift terms. The dependence of the Parkinson's (1980) estimator on zero-drift terms stems from the fact that Parkinson (1980) used a density function of the range for the Brownian motion originally derived by Feller (1951), in every time interval. This density function in turn does depend on the assumption of zero-drift terms.

The reason for choosing this method is that the variance of the unbiased estimator derived by Kunimoto (1992) is 10 times lower than the classical estimator (i.e. based on the standard deviation of daily closing stock price returns). (Kunimoto (1992; Parkinson 1980)

Kunimotos (1992) unbiased estimator for the variance parameter is given by (Kunimoto 1992: 299):

$$(34) \quad \hat{\sigma}(k) = \frac{1}{nT} \left( \frac{6}{\pi^2} \right) \sum_{i=1}^n R_i^2$$

,where  $n$  is the number of observations  $R_i$  ( $i=1, \dots, n$ ) in  $n$  intervals.

*Effect size*

Henson (2006) study states that even though statistical significance testing has been quite dominant in the resolution of the importance of the acquired results, the more contemporary views stress the significance of confidence intervals and effect

sizes. Henson (2006) also emphasizes the importance of effect sizes as they “... provide one avenue for evaluating practical significance.” (Henson 2006: 606) As the available sample size in this thesis is relatively small, an effect size measure is needed to accordingly interpret the results.

Wilcoxon rank-sum test is fairly similar to the standard t-test in regards to efficiency. It is also regarded as the non-parametric alternative to the t-test. The Wilcoxon rank-sum test also has specific characteristics, which make it more suitable to be utilized in this thesis than the standard t-test. This similarity in efficiency with the t-test also assisted in finding the appropriate effect size measure when controlling for the small sample size utilized in this thesis. In Henson (2006) study different effect size measures are paired with various analyses. The t-test is paired with Cohen’s  $d$  and Glass’s delta. According to Manolov & Solanas (2008) study the percentage of non-overlapping data metric is one of the better effect size measures when working with short data series. As Cohen’s  $d$  is regarded as a standardized mean difference effect and can also be interpreted as percentage of non-overlapping data, choosing Cohen’s  $d$  as the effect size metric in this thesis is well founded. In this thesis Cohen’s  $d$  is calculated as follows (Henson 2006: 609):

$$(35) \quad d = \frac{\bar{x}_{post} - \bar{x}_{pre}}{\sqrt{\frac{\sigma_{SDpost}^2 + \sigma_{SDpre}^2}{2}}}$$

where  $\bar{x}_{post}$  denotes the mean of the metric in question post warrant listing / announcement,  $\bar{x}_{pre}$  denotes the mean of the studied metric pre warrant listing / announcement,  $\sigma_{SDpost}$  is the standard deviation of the metric at hand post warrant listing / announcement and  $\sigma_{SDpre}$  is the standard deviation of the selected metric post warrant listing / announcement. (Cohen 1988)

## 5. Empirical Results

The empirical results are divided into three categories in accordance with the structure of the theoretical framework. The price impact to the underlying stocks of the first time announcement and issuance of covered warrants, along with an analysis of the price behavior of the covered warrants, will be discussed first. Second results to be analyzed will be the liquidity impact results, including bid-ask spread and volume impact analysis. The last results to be examined are the impacts that the new covered warrant issuances have on the underlying stocks' return volatility.

### *Price impact analysis*

The price impact results are shown in table 4 and table 5. The tables show the cross sectional-mean raw returns, abnormal returns and the associated p-values respectively around the announcement and listing date of the covered call warrants. This is followed by an analysis of the summary statistics on the price behavior of first-time issued covered warrants presented in table 6.

**Table 4.** Descriptive statistics for announcement price impact

(N) Day	Raw returns		Abnormal returns		
	14 Mean	14 p-value	14 Mean	14 p-value	14 Negative(%)
-15	0.0026	0.351	-0.003	0.690	53.3
-14	0.0038	0.366	0	0.499	53.3
-13	-0.0027	0.686	-0.0037	0.749	40
-12	-0.0148	0.969	-0.0106	0.945	60
-11	0.0015	0.408	-0.0035	0.774	53.3
-10	-0.0083	0.837	-0.0034	0.651	46.7
-9	-0.0026	0.591	-0.0075	0.773	60
-8	0.0128	0.097	0.0109	0.091	13.3
-7	0.0001	0.497	0.0018	0.363	40
-6	0.0103	0.020	0.0062	0.064	33.3
-5	-0.001	0.588	-0.0038	0.879	73.3
-4	0.0188	0.089	0.0198	0.040	26.7
-3	0.0023	0.390	0.0049	0.216	40
-2	0.0002	0.487	0.001	0.422	60
-1	0.0008	0.457	-0.0015	0.589	60
0	-0.0003	0.512	0.0058	0.242	33.3
1	0.0036	0.291	0.0017	0.383	53.3
2	-0.0038	0.706	-0.0086	0.934	73.3
3	-0.0029	0.620	-0.0024	0.637	46.7
4	-0.003	0.752	0.0059	0.118	40
5	-0.0077	0.869	-0.0022	0.619	46.7
6	-0.0001	0.504	0.0019	0.422	40
7	-0.0014	0.571	-0.0023	0.639	60
8	0.0027	0.318	0.0048	0.138	40
9	-0.0032	0.667	0.0056	0.212	46.7
10	-0.0077	0.794	-0.0068	0.802	46.7
11	0.0044	0.383	0.0109	0.216	40
12	0.0036	0.298	0.0069	0.129	46.7
13	0.0128	0.001	0.0079	0.020	33.3
14	0.0012	0.406	-0.0017	0.613	66.7
15	-0.0067	0.873	0.0022	0.368	40
Cohen's d	-0.217		0.167		

Note: This table contains the mean raw returns and mean abnormal returns, with their associated one-tailed  $p$ -values around the announcement date of warrant issuance. The sample used to examine the price behavior around warrant issuance consists of 14 stocks. Negative (%) refers to the percentage of firms in the sample with negative abnormal returns for a given day. Cohen's  $d$  is the effect size metric used in this thesis.

Table 3 presents the descriptive statistics for the announcement price impact analysis. As the null hypothesis of  $H1$  states, there should be a negative price impact following the covered warrant announcement. Covered warrant announcement seems to have little or no impact on the underlying stocks raw returns in stark contrast to previous studies. On the announcement date a price decline of 0.03 percent is found with a corresponding  $p$ -value of 0.511. This result is statistically insignificant. Prior to the announcement date the only statistically significant changes found in the raw returns are increases eight, six and four days before the covered warrant is announced. 13 days after the warrant announcement a statistically significant increase of 1.28% in the raw returns is found, with a corresponding  $p$ -value of 0.001. In addition to the statistical insignificance, the magnitude of the effect size (Cohen's  $d = -0.217$ ) is minimal.

The results from the analysis of abnormal returns yield similar returns than those of the raw return analysis. Eight, six and four days prior to the announcement statistically significant increases on the conventional levels of confidence in abnormal returns are found. On the announcement day no statistically significant changes are to be found on the abnormal returns. Interestingly the Negative (%) seems to increase sharply during two days after the announcement date from 33.3% to 53.5% on day one to 73.3% on day two. This would imply a decrease in the abnormal returns of the underlying, but as the statistical significance is not there and the effect size is minute but positive, no sound conclusions can be arrived at.



**Table 5.** Descriptive statistics for issuance price impact

(N) <u>Day</u>	<u>Raw returns</u>		<u>Abnormal returns</u>		
	14 <u>Mean</u>	14 <u>p-value</u>	14 <u>Mean</u>	14 <u>p-value</u>	14 <u>Negative(%)</u>
-15	-0.0027	0.686	-0.0022	0.658	46.7
-14	-0.0148	0.969	-0.0104	0.942	66.7
-13	0.0015	0.408	-0.0006	0.552	46.7
-12	-0.0083	0.837	-0.0097	0.894	66.7
-11	-0.0026	0.591	-0.0053	0.704	53.3
-10	0.0128	0.097	0.01	0.108	20
-9	0.0001	0.497	0.0007	0.446	46.7
-8	0.0103	0.020	0.0076	0.035	33.3
-7	-0.001	0.588	-0.0016	0.704	60
-6	0.0188	0.089	0.0169	0.065	33.3
-5	0.0023	0.390	0.0055	0.192	40
-4	0.0002	0.487	0.0035	0.248	53.3
-3	0.0008	0.457	-0.0031	0.675	60
-2	-0.0003	0.512	0.0043	0.302	33.3
-1	0.0036	0.291	0.0007	0.450	53.3
0	-0.0038	0.706	-0.0062	0.863	66.7
1	-0.0029	0.620	-0.0011	0.566	40
2	-0.003	0.752	0.0058	0.115	40
3	-0.0077	0.869	-0.0055	0.785	53.3
4	-0.0001	0.504	0.0036	0.352	33.3
5	-0.0014	0.571	-0.0024	0.643	60
6	0.0027	0.318	0.0079	0.021	26.7
7	-0.0032	0.667	0.0055	0.211	46.7
8	-0.0077	0.794	-0.0038	0.674	46.7
9	0.0044	0.383	0.0059	0.327	40
10	0.0036	0.298	0.0065	0.147	40
11	0.0128	0.001	0.0068	0.011	26.7
12	0.0012	0.406	0.0051	0.169	46.7
13	-0.0067	0.873	-0.0058	0.796	46.7
14	-0.0054	0.791	-0.0004	0.522	60
15	-0.0087	0.840	-0.0111	0.865	66.7
Cohen's d	-0.056		0.015		

Note: This table contains the mean raw returns and mean abnormal returns, with their corresponding one-tailed  $p$ -values around the listing dates of the covered warrants. The sample consists of 14 stocks. Negative (%) relates to the percentage of firms in the sample with negative abnormal returns for a given day. Cohen's  $d$  is the effect size metric used in this thesis.

Table 4 reports the results from the analysis of mean raw returns and mean abnormal returns of the underlying stocks on a 31-day event window surrounding

the covered warrant issuance. According to the null hypothesis of  $H1$  a negative impact on the raw and abnormal returns following the warrant introduction should be expected. Before the issuance date, a statistically significant increase in raw returns at the 0.1, 0.05 and 0.05 levels, ten, eight and six days before the issuance respectively is found. Thus even though under conventional levels of confidence statistically significant price increases are found in raw returns before warrant issuance, it seems that the derivative issuance has little or nothing to do with this increase. After the covered warrant issuance a statistically very significant increase of 1.28%, with a corresponding  $p$ -value of 0.001 is found in raw returns 11 days after the issuance date. Contradicting the null hypothesis, the only statistically significant change in the raw returns of the underlying is an increase instead of a decrease.

The results from the analysis of the abnormal returns are very similar to those found in the raw returns. A statistically significant increase in the abnormal returns of the underlying is found ten, eight and six days with corresponding  $p$ -values of 0.108, 0.035 and 0.065 prior to the covered warrant issuance. These aforementioned increases in the abnormal returns are confirmed by the Negative (%), with values of 20%, 33.3% and 33.3% respectively. Statistically significant increases in abnormal returns are found six and eleven days after the warrant issuance date with corresponding  $p$ -values of 0.021 and 0.011 respectively. On the warrant issuance date no significant change in the abnormal returns is to be found. As was the case with raw return results, the only changes in abnormal returns of the underlying that are statistically significant are increases. And as was the case with announcement, the effect sizes of the price impacts found around the warrant issuance are close to zero (Cohen's  $d$  values for raw and abnormal returns are -0.056 and 0.015 respectively). Thus the null hypothesis of  $H1$  must be rejected. These results are contradictory to the findings of Aitken et al. (2005) who find no significant increase in raw returns prior to the warrant issuance and a statistically significant increase on the issuance date.

**Table 6.** The price behavior of first-time issued warrants

Estimation interval (0,5)	(-5,0)	(0,10)	(-10,0)	(0,15)	(-15,0)	
Sample size (N)	66	121		176		
Statistic	Postlisting	Pre-exit	Postlisting	Pre-exit	Postlisting	Pre-exit
Mean	0.2420	0.0133	0.2209	0.0125	0.2218	0.0204
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Minimum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum	1.7000	0.4500	1.7000	0.4500	1.7000	0.4500
Standard deviation	0.4737	0.0565	0.4206	0.0472	0.3961	0.0584
Z-statistic	-1.029		-1.934		-1.881	
<i>p</i> -value	0.152		0.027		0.03	

Note: In this table the summary statistics on the price behavior of first-time issued covered warrants are presented. The table is divided into six event windows, three of which are Postlisting (i.e. after the listing of the warrant) and three are Pre-exit (i.e. before the end of maturity of the warrant). The analysis extends up to 15 trading days after listing (0,15) and before the end of maturity (-15,0) date of the warrant. To test for statistically significant differences in the Postlisting and Pre-exit event windows a Wilcoxon rank-sum test is utilized.

Following the price behavior analysis of the underlying stocks is the analysis of the price behavior of covered warrants in table 6. Using six event windows up to 15 trading days after the warrant listing and 15 days before the warrant exit date, warrant prices after the listing are compared to those before the exit date. A Wilcoxon rank-sum test is conducted to search for statistically significant differences in the aforementioned prices.

As table 6 reports, five days around the listing and end of maturity dates of the covered warrants no statistically significant differences in the means of the warrants prices can be found. It seems that in contrast with Aitken et al. (2005) the warrant prices 5 days after the listing date are not significantly higher than the prices 5 days before the end of maturity date. Nevertheless when extending the analysis to cover ten days Postlisting and Pre-exit a statistically significant difference is found with a *p*-value of 0.027 and a corresponding Z-statistic of -1.934. This result is statistically significant at the five percent confidence level. It seems that when the event window is expanded, the warrant prices after listing are significantly higher than Pre-exit prices. As the event window is further expanded to cover 15 days around the aforementioned dates the significance of the difference diminishes slightly with a *p*-value of 0.03. This change in significance is infinitesimally small confirming that the warrant prices are significantly higher after the warrant listing. These results confirm the diminishing time value of the covered

warrants. It also gives room to hypothesize that the warrant issuers could be able to gain profits by securing higher premiums a few days after the warrant listing with a possibility to buy them back before maturity at a lower cost.

The results derived from these statistical tests are inconclusive. Even though the data used consists of all the warrants issued from the whole period that warrants have been traded in the NASDAQ OMX Helsinki (formerly Helsinki Stock Exchange), there still are only 14 individual stocks found. Nonetheless, the results are quite different from previous studies; it seems that none of the characteristics of price impacts of covered warrants to the underlying stocks found in the previous studies are to be found in the Finnish stock market. The stock prices seem to be unaffected by the first time issuance of warrants.

When interpreting the results from the raw- and abnormal returns, the only conclusion that can be arrived at is that if the announcement of the covered warrants have an impact on the prices of the underlying, it is more likely to be an increase than a decrease. Further evidence for this notion is presented in the effect size metrics as effect sizes for both announcement and issuance abnormal returns are positive. The reason for these statistical inconsistencies might be that only a few large companies dominate the Finnish stock market making the sample statistically skewed and bias. The other explanation could be that as the stocks of the large companies are already highly traded and speculated on, the announcement of covered warrants on them is more likely to be expected by the markets. This explanation is dependent on the assumption that the Finnish stock market is informationally efficient. The changes in raw- and abnormal returns would then already be incorporated in the underlying before the announcement of the covered warrants by the expectations of the informed traders.

This gives also room for speculating on whether or not the covered warrants are the source of the change in the stocks behavior or are certain kinds of stock with certain anticipated characteristics selected to cater for the issuers needs. It also needs to be noted that the sample size available is relatively small. Still in accordance with theory and a the study conducted by Aitken et al. (2005) statistically significant differences are found in the prices of covered warrants after the listing

and before the exit date. The covered warrant prices are significantly higher right after the warrant listing than before the end of maturity.

### *Moneyness analysis*

Table 7 presents the results of the moneyness analysis. Results from the analysis are in line with the results from the study conducted by Aitken et al. (2005). As warrant holders are only 35.2% of the trading days in a profit position, warrants do not seem to be the best source of profits for private investors. Clearly the warrant issuers are able to trade warrants very profitably. As concluded in the price analysis of the covered warrants in table 6 it also seems that they are able to issue them so that initial premiums received are higher than those preceding the exit date of the warrant. This again gives room to hypothesize on which market dominates the other. These results seem to indicate that stocks are selected with certain attributes to cater for the needs of financial intermediaries dealing with warrants. This also raises questions on whether or not these warrants are issued because the issuers want to make the market place more complete and efficient, or is the motivation more profit oriented.

**Table 7.** First time issued covered warrants, moneyness analysis

Event window	Mean percentage of trading days of which the warrant holders are in the money or out of the money		(N)
	(+)	(-)	
<i>Post-listing</i>			
0,5	30.00	70.00	60
0,10	30.00	70.00	110
(0,15)	27.50	72.50	160
<i>Pre-exit</i>			
(-5,0)	40.00	60.00	60
(-10,0)	41.82	58.18	110
(-15,0)	42.50	57.50	160
<i>Whole sample mean</i>	35.20	64.80	

Note: This table presents the results of the moneyness analysis. The mean percentages of which the warrant holders are in a profit (in the money) or loss (out of the money) position in seven event windows are presented. The event windows include up to 15 days after the warrant is listed, up to 15 days before the warrant reaches maturity and the whole life of the warrants.

#### *Liquidity impact analysis*

The impact of new warrant introductions to the underlying stocks liquidity is studied by using two distinct metrics; relative bid-ask spreads and relative trading volume. The null hypothesis of  $H2$  is that the underlying stocks liquidity should increase following the covered warrant introduction.

**Table 8.** Relative and market-adjusted bid-ask spreads and relative trading volume around warrant listing

Estimation interval	+/-30		+/-60		+/-90	
Sample size (N)	14		14		14	
<b>Panel A: Relative bid-ask spread around warrant listing</b>						
Statistic	Pre	Post	Pre	Post	Pre	Post
Mean	0.0045	0.0076	0.0056	0.0076	0.0066	0.0074
Median	0.0020	0.0023	0.0020	0.0023	0.0021	0.0024
Z-statistic		-2.131		-1.771		-1.417
<i>p</i> -value		0.017		0.039		0.078
Cohen's d		0.179		0.115		0.041
Positive (%)		50.0%		42.9%		42.9%
<b>Panel B: Market-adjusted bid-ask spread around warrant listing</b>						
Statistic	Pre	Post	Pre	Post	Pre	Post
Mean	0.1362	0.2190	0.1544	0.2353	0.1741	0.2300
Median	0.0727	0.0862	0.0778	0.0848	0.0812	0.0862
Z-statistic		-1.008		-0.980		-1.319
<i>p</i> -value		0.157		0.164		0.094
Cohen's d		0.183		0.134		0.111
Positive (%)		57.1%		42.9%		50.0%
<b>Panel C: Relative trading volume around warrant listing</b>						
Statistic	Pre	Post	Pre	Post	Pre	Post
Mean	535.86	640.43	555.87	748.14	528.05	840.23
Median	261.61	274.26	246.50	269.13	238.45	263.59
Z-statistic		-0.236		-1.220		-2.526
<i>p</i> -value		0.638		0.111		0.006
Cohen's d		0.153		3.648		6.428
Positive (%)		0.0%		42.9%		42.9%

Note: The summary statistics of relative bid-ask spreads, market-adjusted bid-ask spreads and relative trading volume pre-warrant and post-warrant listings are reported in this table. To test for statistically significant differences between the chosen metrics during the three event intervals, a one tailed Wilcoxon rank-sum test is utilized. Cohen's d refers to the effect size estimator used. Positive (%) relates to the quantity of stocks for which relative spreads, market-adjusted spreads and relative trading volume are on average higher in the post warrant listing period.

In table 8 the results of the liquidity analysis are presented. A wilcoxon rank-sum test is used to identify statistically significant differences in the Pre- and Post-listing periods. The magnitude and direction of these differences is then found via comparing the means and the Positive percentage. In addition, owing to the fact that the sample sizes are relatively small, the effect sizes for the aforementioned tests are calculated. The effect size metric selected is Cohen's d. The tests are conducted in six event windows; 30, 60 and 90 days before and after the covered war-

warrant listings. The table itself is divided into three panels Panel A, Panel B and Panel C including results from relative bid-ask spread, market-adjusted bid-ask spread and relative trading volume impacts respectively

The relative bid-ask spread results are shown in Panel A of table 8. The results seem to indicate that the increase in relative bid-ask spreads found by Aitken et al. (2005) seems to be occurring also in the Finnish stock market. Nonetheless differing conclusions are arrived at. Depending on the time span, the statistical significance of the rise in the mean of the relative spreads seems to increase the shorter the selected interval is. In the 30-, 60- and 90-day intervals the means of the relative bid-ask spreads increase by 66.6%, 35.7% and 12.1%, with corresponding  $p$ -values of 0.017, 0.039 and 0.078 respectively. These  $p$ -values are statistically significant at the 0.1 level of confidence.

Similar behavior is found in the effect sizes; as the time span is increased the effect size decreases. In the shortest time interval an effect size of 0.179 is found, this relates to an approximate percent of non-overlap of 13%. As this is the highest effect size found in relative bid-ask spreads analysis and it is declining in nature as the time interval is increased, the effect size results give further evidence against increasing spreads.

The Positive percentage denotes the quantity of stocks with higher than average relative bid-ask spreads. These percentages show that even though there seems to be a statistically significant rise in the relative means, the rise in these means is concentrated on certain stocks and cannot be generalized as being the result of the warrant introductions. Also contradicting Aitken et al. (2005) results, the rise in the relative bid-ask spreads means seems to diminish the longer the time interval.

The results from the market-adjusted bid-ask spread analysis, shown in Panel B of table 8, confirms the results from Panel A, as similar rise in the means is found, now without the statistical significance for the 30- and 60-day intervals. A statistically significant rise in the mean with a  $p$ -value significant at the 1 percent confidence level is found at the 90-day interval. The greater  $p$ -values of the market-adjusted spreads also give further confirmation to the conclusion that no signifi-



cant difference is to be found between the pre- and post-warrant introduction time periods or that these differences are not stemming from the warrant introductions. When interpreting the Wilcoxon rank-sum test  $p$ -values from both the relative- and market-adjusted panels, it seems that the market fluctuations responsible for the results in panel A are corrected in the market-adjusted analysis and can thus be assumed to have originated from the overall movement of the market.

This assumption is reinforced by the effect size analysis results. Similar behavior to the effect sizes in the relative spread analysis is found in the market-adjusted spread analysis. In the market-adjusted spreads the magnitude by which the effect size decreases is much smaller than in the case of the relative spreads. This again implies that the statistically significant  $p$ -values witnessed in the relative spread analysis stem from some other factors than covered warrant introductions. In conclusion it seems that the covered warrant introduction has little or no effect to the bid-ask spreads of the underlying stocks. This result is in accordance with studies of Chamberlain et al. (1993) and Wei et al. (1997) who study the impacts of options in Canadian and the US markets respectively.

Panel C of table 8 reports the changes in the relative trading volume before and after the warrant listing. In the 30-day time window no significant increase in volume is found, it almost seems as if the volume of the underlying diminishes right after the covered warrant introduction as the Positive percentage, referring to the proportion of firms for which the relative trading volume is higher on average, is 0%. Nonetheless as the corresponding  $p$ -value is 0.638 no statistically significant difference can be found in the 30-day time interval. The significance of the difference in volume rises sharply when the analysis is expanded into 60-day window, as the Z-statistic is -1.220 with a corresponding  $p$ -value of 0.111, virtually statistically significant at the 0.1 level. The Positive (%) also rises from 0% to 42.9%, this being still below the 50% threshold; no statistically sound conclusions can be arrived at. When the time span is further expanded into 90-days before and after the warrant listing, a statistically significant difference is found at the highest level of confidence, with a corresponding  $p$ -value of 0.006 and a Z-statistic of -2.526. Even though the means are statistically highly different in the 90-day time period exam-

ined, the Positive (%) is still only 42.9%. This means that less than half of the examined stocks show higher volumes after the warrant introduction.

The effect size measures give more interesting results. In the first 30-day interval Cohen's  $d$  gives a value of 0.153, which is a minute effect size in any regards. When the interval is expanded to cover 60- and 90-days the effect sizes rise drastically to 3.648 and 6.428 respectively. This can be indicates that 60- and 90 days after the warrant introduction the underlying volumes are, on average, 3.648 and 6.428 standard deviations higher than before the warrant introduction. These effect size values are extremely high.

With the aforementioned finding in mind, it has to be taken into account that the time interval studied in this thesis was a period of almost constant growth of the overall market. Still as the rises in volumes are accompanied with statistically significant  $p$ -values and the effect size metric gives such extreme values it can be concluded that this witnessed rise in the underlying volume can be attributed to the issuance of covered warrants. This is in line with the majority of the previous studies (e.g. Draper et al. 2001, Aitken et al. 2005), which conclude that derivative introductions are followed by a rise in the underlying volume.

#### *Volatility impact analysis*

In this section the volatility impact of the new covered warrant listings on the underlying stocks is examined. The volatility impact is of great interest as the one of the key elements in defining the price and thus value of the warrant to the issuer through premiums, is the volatility of the underlying. Volatility is also one of the key measures of risk in the markets of today.

**Table 9.** Unadjusted and market-adjusted volatility ratios around warrant listing

Estimation interval	+/-30	+/-60	+/-90
Sample size (N)	14	14	14
<b>Panel A: Unadjusted volatility ratio</b>			
Mean	1.0218	0.9799	1.0096
Median	1.0131	0.9545	1.0570
Z-statistic	-0.138	-0.459	-0.138
<i>p</i> -value	0.445	0.323	0.445
Cohen's d	-0.009	-0.053	-0.006
Positive (%)	57.1%	42.9%	57.1%
<b>Panel B: Market-adjusted volatility ratio</b>			
Mean	0.8923	0.9381	0.9313
Median	0.8716	0.9533	0.9120
Z-statistic	-1.103	-0.414	-0.551
<i>p</i> -value	0.135	0.334	0.291
Cohen's d	-0.354	-0.168	-0.302
Positive (%)	21.4%	35.7%	28.6%

Note: This table reports the Unadjusted and market-adjusted volatility ratios for three distinct time intervals of 30, 60 and 90 days around warrant listings. The post-warrant listing volatility estimate of the underlying is divided by the estimated volatility before the listing. The volatility measure is calculated using Kunitomo's estimator. A one-tailed Wilcoxon rank-sum test is utilized to test for statistically significant differences in the mean volatility. Cohen's d refers to the effect size estimator used. Positive (%) denotes the quantity of stocks with higher than average volatility in the post warrant listing period.

The volatility impact results, measured by the unadjusted volatility, are presented in Panel A of table 9. In accordance with the null hypothesis of  $H3$ , there should be an increase in the underlying stocks volatility following the warrant listing. Nonetheless, in all of the time intervals studied, no statistically significant differences in the unadjusted volatilities of the underlying stocks can be found. Even though the Positive (%) in the 30-day estimation interval is 57.1%, implicating that more than 50 percent of the underlying in the sample showed elevated volatility following the listing of the warrant, the corresponding *p*-value is 0.445, insignificant in any of the conventional levels of confidence. Similarly insignificant *p*-values are arrived at when expanding the length of the estimation interval to 60- and 90-days around the listing dates. The effect size of the unadjusted volatility ratio is also minute with values close to zero. In addition the effect size values found are all negative, which contradicts the null hypothesis of  $H3$ . It seems that when measured with

volatility estimates unadjusted by the overall fluctuations of the market, the volatility of the underlying stays fairly stable around covered warrant listings.

Panel B of table 9 reports the market-adjusted volatility ratios of the underlying stocks surrounding the covered warrant listing dates. As with the unadjusted volatility ratios, no statistical significance is to be found in the results presented in Panel B. In the 30-day estimation interval around the warrant listing the Positive percentage is 21.4% with a corresponding  $p$ -value of 0.135 and a Z-statistic of -1.103. This result is the most statistically significant result arrived at in table 9. Here, after volatility ratios are subjected to the market adjustments, it seems that the overall volatility of the underlying is declining after the warrant introduction in the 30-day estimation interval.

This is also found in the effect sizes surrounding warrant introductions. With Cohen's  $d$  values of -0.354, -0.168 and -0.302 for the 30-, 60- and 90-day intervals respectively it seems that the adjusted volatility of the underlying is slightly lower after the warrant introduction. This then implies again that the underlying stocks volatility is, if not unaffected, certainly not elevated by the introduction of covered warrants. These findings contradict the findings of Bollen (1998) and Aitken et al. (2005) who find that volatility of the underlying is elevated following warrant introduction. Thus in accordance with Sahlström (2001) and the overall consensus of the previous studies, covered warrant introductions seem to have a more stabilizing than de-stabilizing effect on the underlying stocks volatility in the Finnish stock market.

## 6. Conclusions and further studies

The results of the price analysis are far from conclusive, and also contradictory to the results of Aitken et al. (2005). None of the characteristics of the price impacts found by Aitken et al. (2005) are present in the Finnish stock market. On the announcement and issuance date no statistically significant changes in either raw- or abnormal returns are found. As all of the statistically significant changes found are increases in the selected metrics and the effect sizes found are very small, the only possible change is an increase. Thus the null hypothesis of  $H1$  must be rejected. The results from the price behavior of the covered warrants are more conclusive. Statistically significant differences are found after the listing and before the exit date. The conclusion of the covered warrant price analysis is that the covered warrant prices are significantly higher right after the warrant listing than before the end of maturity.

The results from the moneyness analysis, combined with the results of the covered warrant price behavior analysis conducted also reminds about the nature of the issuers, and the motives behind these issuance decisions. The investors are in a profit position approximately only one thirds of the time that the warrants are alive. In addition, as the covered warrant prices are significantly higher right after the warrant listing than before maturity, the issuers are able to secure high premiums. When the covered warrant prices then decline, it is possible for the issuer to buy the warrants back with a reduced price. Thus the covered warrants seem to lead to significant wealth transfers from private investors to financial intermediaries.

The liquidity analysis also produced mixed results. The conclusion arrived at in the bid-ask spread analysis is similar to the price impact analysis conclusion; if covered warrant introductions have any impact on the bid-ask spreads, it is likely to be an increase. The volume of the underlying seems to experience a small rise after the warrant introduction. As this finding is backed up by the extremely large effect sizes found it is in line with the majority of the previous studies, even though the rise in volume found comes with a 30-day delay. Following these results, the null hypothesis of  $H2$  is accepted.

The impact that the covered warrant introductions have on the underlying stocks volatility is also somewhat inconclusive. As some decline is witnessed in the underlying volatility 30 days after the warrant introduction, the statistical significance of this decline diminishes rapidly when the analysis is extended into 60- or 90-days. This implies that the warrant introduction has a relatively small impact, which is declining in nature, on the volatility of the underlying. The effect size values confirm the declining nature of the volatilities for the adjusted metrics. The null hypothesis of  $H3$  is thus rejected. Thus the overall impact that the covered warrant issuance has on the market place seems to be more stabilizing than destabilizing.

The overall inconclusiveness of the results could stem from the fact that the Finnish market is very informationally efficient, and thus the real impacts are witnessed beyond the 181-day time interval chosen in this thesis. It could also be that the covered warrants are not the cause of these changes, but rather the effect. This would then lead to the conclusion that certain stocks which have shown recent improvements in market quality are selected to serve as the underlying asset for the warrant. Nonetheless the key attribute for such inconclusive results seems to be the small sample size used, despite the fact that all of the first time introduced covered warrants were included in the sample. (Danielsen, Van Ness and Warr 2007)

It also needs to be noted that on the question of making the markets more complete and efficient, options with identical or similar traits than warrants are available with similar prices. Admitting that options do not give similar room to speculation with higher transaction costs, in light of the findings of this thesis and the overall market situation, a fair question could be asked; is more speculation really necessary? (Bartram & Fehle 2007)

Topics for further studies are in abundance. Firstly the statistical correlations of the price, liquidity and volatility metrics in this thesis should be studied further. Cross-sectional OLS Regressions of the after-to-before and before-to-after metrics could also be implemented to further verify the results of this thesis. Also the question on whether or not the covered warrant issuance is an endogenous event or not

should be studied in the Finnish stock market. Secondly it would be interesting to investigate whether or not the Nordic warrant issuers use the implied volatility as a way to increase the premiums that they receive. In this hypothetical scenario the implied volatilities are purposely set as “too high” to artificially increase the warrants risk measure and the premiums received by the issuer. Thirdly the relationship of the options markets and the covered warrant market in Finland should be studied, as overlapping instruments with very differing prices are found in both. Fourth as some of the warrants in this study are so called turbo warrants, a topic to study further is the relationship of the covered call and put warrants to the turbo calls and puts. Do turbo warrants champion the new wave of market efficiency or are they only new means to speculate and transfer wealth?

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## APPENDICES

## APPENDIX 1: The efficiency of Kunimotos estimator

*The efficiency of Kunimotos (1998) estimator versus the classical estimator*

“Kunimotos (1998) unbiased estimator of  $\sigma^2$  is given by

$$(34) \quad \hat{\sigma}^2(k) = \frac{1}{nT} \left( \frac{6}{\pi^2} \right) \sum_{i=1}^n R_i^2$$

The classical estimator is based on a transformed Brownian motion (given in equation (12)) process. The transformed process  $X(t) = \ln(S(t))$  (security price  $S(t)$  at  $t$ ) follows the Brownian motion with the drift parameter  $\mu' = \mu - \sigma^2/2$  and the variance parameter  $\sigma^2$  by Itô's lemma. Allowing that the drift parameter  $\mu'$  of  $\{X(t)\}$  is not necessarily zero, dividing the interval  $[0, nT]$  into  $n$  intervals of  $[(i-1)T, iT]$  ( $i=1, \dots, n$ ) and defining the rate of return on  $\{S(t)\}$ , in the  $i$ th interval as  $d_i = \ln\{S(iT)\} - \ln\{S((i-1)T)\}$  where  $S((i-1)T)$  should be interpreted as both the closing price in the  $(i-1)$ th interval and the opening price in the  $i$ th interval. Having  $n$  observations on  $\{d_i\}$  in  $n$  intervals, the classical sample variance estimator ( $\hat{\sigma}^2(c)$ ) of the parameter  $\sigma^2$  is given by

$$(36) \quad \hat{\sigma}^2(c) = \frac{1}{T(n-1)} \sum_{i=1}^n (d_i - \bar{d})^2$$

,where  $\bar{d} = (1/n) \sum_{i=1}^n d_i$  and  $T$  is the length of each interval.

LEMMA. Suppose that a Brownian bridge process  $\{Y(t)\}$  in  $[0, T]$  is given by (12) and Kunimotos (1992) transformation  $Y(t) = X(t) - \frac{t}{T} X(T)$ . Defining the adjusted range  $R$  by  $R_i = \max_{t \in I_i} Y(t) - \min_{t \in I_i} Y(t)$ . Then for  $p \geq 2$ ,

$$(37) \quad E(R^p) = 2\sigma^p (p-1) \Gamma\left(\frac{p+2}{2}\right) \left(\frac{T}{2}\right)^{p/2} \zeta(p),$$

where  $\zeta(p)$  is Riemann's  $\zeta$  function, and for  $p = 1$ ,

$$(38) \quad E(R) = \sigma \sqrt{\frac{T\pi}{2}}$$

The efficiency of Kunimotos (1992) estimator against the classical estimator  $\hat{\sigma}^2(c)$  is then computed by using the lemma for  $p = 4$  and  $\zeta(4) = \pi^4/90$ . This gives

$$(39) \quad \begin{aligned} \zeta \text{var}(\hat{\sigma}^2(k)) &= \frac{\sigma^4}{nT^2} \left(\frac{6}{\pi^2}\right)^2 E\{R_i^4 - (E(R_i^2))^2\} \\ &= \frac{\sigma^4}{n} \left(\frac{6}{n^2}\right)^2 \left\{ \frac{\pi^4}{30} - \left(\frac{\pi^2}{6}\right)^2 \right\} = \frac{\sigma^4}{5n} \end{aligned}$$

Since it is known that  $\text{var}(\hat{\sigma}^2(c)) = 2\sigma^4/(n-1)$ , we have

$$(40) \quad \frac{\text{var}\{\hat{\sigma}^2(c)\}}{\text{var}\{\hat{\sigma}^2(k)\}} = 10 \frac{n}{n-1}$$

Thus Kunimotos (1992) estimator is 10 times more efficient in comparison to the classical estimator." (Kunimoto (1992: 2-5)



## APPENDIX 2: Announcement, introduction and maturity dates of the warrants

Announcement Date	Introduction Date	Issuer	Underlying	Last trading day	ISIN	Strike (€)	Trading Code
5.12.00	8.12.00	AlfredBerg	NOKIV	16.11.2001	FI0009602767	50	1KNOKEW500
15.12.00	19.12.00	AlfredBerg	SRAIV	16.11.2001	FI0009602809	26	1KSRAEW260
01.02.01	05.02.01	AlfredBerg	UPMIV	15.02.02	FI0009602940	36	2BUPMEW360
01.02.01	05.02.01	AlfredBerg	STERV	15.02.02	FI0009602957	11	2BSTEWEW110
07.02.01	09.02.01	ArosMaizels	ELIIV	01.03.02	FI0009603054	24	2CELIEW240
13.12.01	17.12.01	Handelsbanken	TIEIV	19.09.03	FI0009605224	40	3ITIEEW400
25.8.03	28.8.03	Handelsbanken	ERIBR	21.5.04	FI0009609978	10	4EERIEW100
9.12.03	11.12.03	Handelsbanken	NDAIV	19.11.04	FI0009611198	5.5	4FNDAEW550
19.10.04	21.10.04	Handelsbanken	SAMAS	18.3.2005	FI0009615322	9	5CSAMEW900
24.11.05	28.11.05	Handelsbanken	NESIV	16.6.06	FI0009622021	27	6FNESEW270
2.3.07	4.3.07	Nordea	OUTIV	15.6.2007	FI0009638100	24	7ROUTEW240
12.7.07	16.7.07	Handelsbanken	MRLBV	21.12.2007	FI0009640817	4	7LMRLEW40T
12.7.07	16.7.07	Handelsbanken	MEOIV	21.12.2007	FI0009640833	40	7LMEOEW40T
12.7.07	16.7.07	Handelsbanken	KNEBV	21.12.2007	FI0009640858	40	7LKNEEW40T