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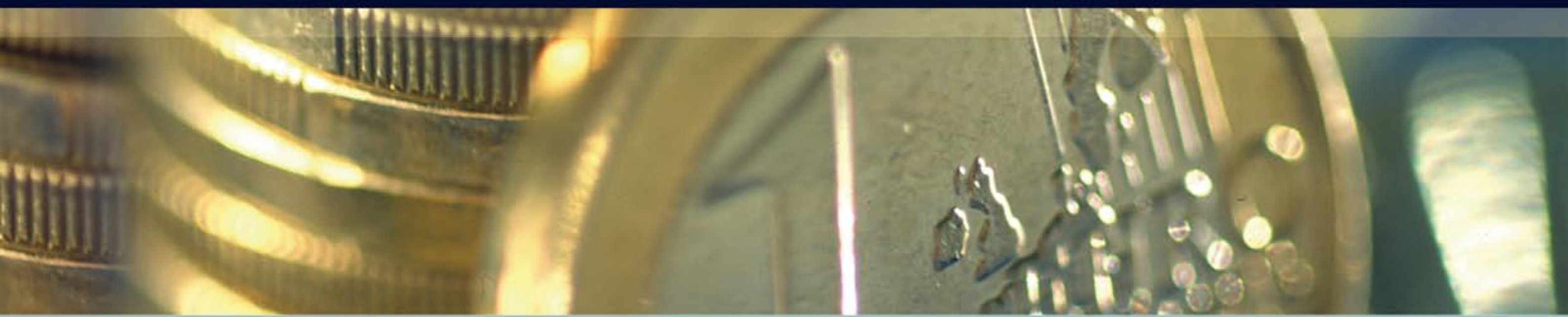

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The Price and Risk Effects of Option Introductions on the Nordic Markets

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Abstract

This paper examines the effects of option introductions on the price and risk of the underlying assets. The data, covering 58 introductions during the period 1985-1997, have been collected from the Nordic markets (Denmark, Finland, Norway, and Sweden). A persistent increase of stock returns is found right after the announcement date, rather than at the introduction date, as in US data. The volatility is found to decrease continuously over the ten-month period following the introduction of stock options.

1 Introduction

1.1 Background

With the opening of the Chicago Board Options Exchange (CBOE) in 1973 a new era of derivative trading started. CBOE revolutionized the option trading by

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creating standardized, listed stock options. In the same year Black and Scholes (1973) published their work on option pricing. They assumed that options are redundant assets and could thereby derive a pricing rule for derivative securities. This was done by applying a no-arbitrage argument and by constructing a dynamic hedge portfolio. Since then academics have questioned the assumption of redundancy. Researchers recognize that financial markets are not complete. Therefore, introducing derivative securities could increase the opportunity set of investors, which in turn could make markets more efficient, lead to welfare effects, and make the derivatives market interact with the underlying securities market (see e.g. Ross (1976), Hakansson (1982), and Detemple and Selden (1991)).

This study empirically investigates the effects of option introduction on the prices and risk of the underlying securities. The data used come from the stock markets in Denmark, Finland, Norway, and Sweden as well as from the option market in Sweden. The study is motivated fourfold:

(i). One reason is to check the results and implications of theories regarding option introduction presented in the academic literature.

(ii). So far most studies concerning the impact of option listing on the underlying stock has been based on data from the United States. To confirm the results from these studies evidence from other data sets are needed.

(iii). Recent studies based on US data have found time-varying price and risk effects. These, from most other findings divergent, results will be compared with those based on data from the Nordic markets.

(iv). Policy questions arise, because there is a fear that derivative trading adds to the instability of the underlying assets market. Not rarely such trading gets the blame for increased uncertainty. The proposed solutions to the presumed problem include introducing frictions into the market, such as turnover taxes on short-term positions, to reduce the speed of transactions. Although no explicit conclusions can be drawn, it is worthwhile checking if the allegation of adding instability has any empirical support.

There are several arguments suggesting that there exist effects on the underlying stock returns related to the listing of options. The structure, magnitude or even the directions of these effects are debatable, but they are potentially of great interest, not only to academics but also to practitioners and market regulators. However, a better understanding of the effects involved can only be determined empirically.

The disposition of this paper is as follows. The final part of the introduction provides some theoretical arguments leading to the hypothesis tested in the paper, and also gives a review of the empirical literature. Chapter two discusses the methodology. In the next chapter the data is described. In chapter four the results are presented, and in the final chapter the conclusions are summarized. Appendix A and B put forward derivations of parts of the methodology. In Appendix C all the shares of the companies used in this study are listed, together with their announcement and listing dates.

1.2 Theory and Tested Hypothesis

The aim of this study is to contribute to a better understanding of the effects of option introduction by examining evidence from the Nordic stock markets. There are several variables to be examined and there are several mechanisms by which the variables may be effected. More exhaustive reviews, both regarding the theoretical and empirical literature, can be found in the surveys of Damodaran and Subrahmanyam (1992) and Gjerde and Sættem (1994)[1].

1.2.1 Price Effects

Derivative securities are efficient and flexible instruments for controlling financial risks. These instruments enable different risk positions and opinions about risks to be expressed through trading, and thereby contribute to the reallocation of the risks among different market participants. Among other things, the access to a developed option market allows investors to unload their risks without having to change their positions in the underlying stock. This implies reduced transaction costs and makes it possible to manage better the investors' risk exposure in the underlying market, which should be beneficial both privately and to the society.

In a complete market all assets are perfect substitutes, and contingent cash flow claims can be duplicated by combining already existing assets (see Black and Scholes (1973)). In a complete market, options are therefore redundant assets. An important economic theorem states that a complete market is always pareto-efficient, while an incomplete market may be pareto-inefficient (see Cox and Rubinstein (1985, p 435). Practical circumstances prevent the construction of such a complete market. Among other things, simple contracts may be difficult to write and carry out, e.g. contracts on future labor income. Further, transaction costs and regulations could make it difficult to construct new derivative securities for all possible outcomes. Options could therefore in practice contribute to making the capital markets more complete. To the degree that investors are better off by their increased opportunity set when options are introduced, it can be claimed that the additional trading possibilities reduce the investors' cost of capital and increase the price of the underlying stock.

A negative external effect of trading options could be that this trading diverts capital from the equity market to the derivative market. This could lead to a higher liquidity premium, and therefore a higher required return and more

[1] The last survey of the two is written in Norwegian.

expensive equity. Cox and Rubinstein (1985) recognize a problem connected with this line of argument, which is in conflict with a fundamental economic principle. Call and put options are contracts between individuals or financial intermediaries, and are not issued by non-financial firms. At a national level, aggregated real asset value corresponds to the sum of aggregated equity, convertible instruments, and debt. Like any form of debt between individuals or financial intermediaries, options are not included in this balance. A holder of an option contract has claims corresponding to the other party's obligations. A buyer of a call option is a potential buyer of the stock, but has not yet bought it. Similarly, a seller of a call option is a potential seller of the underlying stock. Therefore it is not correct to say that buying an option represents a reduction in the total net demand of the stock. A more nuanced argument would be that the availability of an option market leads to a new equilibrium, whereby the total investment level could be either higher or lower.

Few papers have theoretically dealt with the implications from non-redundant option markets for the underlying price. Detemple and Selden (1987) provides one line of argument. They construct a general equilibrium model of an economy consisting of a risky asset and an option, where the asset market is assumed to be incomplete. The economy is populated by two types of investors, with homogenous utility functions, but with different beliefs about the risk connected with stock prices. They assume that there are two classes of investors who disagree on the probability of a fall of the stock price, i.e. there is a "high-risk" group and a "low-risk" group of investors. The option increases the number of attainable returns. In this incomplete market the derivative and the underlying assets will interact, i.e. their valuation becomes a simultaneous pricing problem.

Individuals with high-risk assessments have preferences for payoffs for high values of the stock, and therefore want to buy and hold call options to hedge the downside potential. For the high-risk investors the option serves as a substitute: they buy the call option while selling some of their shares in the endowed stock. The low-risk investors do the opposite; they demand the stock and supply the call option, and thus treat the derivative security as a complement to the stock. The net effect is that the demand for the stock increases. The stock is regarded to be more valuable when options are introduced, and the price increases. Further, the return volatility of the stock decreases.

The price effect occurs initially at the time of the introduction of the call contract, but could be anticipated. This could give rise to an arbitrage opportunity. By buying the stock before the actual introduction of the option one could secure an additional profit. Therefore, it is likely that a price effect should occur at the announcement date.

The model has nothing to say about any welfare effects that could arise when an option is introduced. But through an enhanced opportunity set, and given the investors' different risk assessments, consumption can be more easily smoothed, which should be beneficial to the economy as a whole. The positive price effect can be expected to be permanent, as the required yield on investments can be reduced.

Conrad (1989) suggests that another explanation for a price effect is the market makers' higher demand for stocks for hedging purposes when new stock options are introduced. In the case market makers anticipate writing calls, they might demand the underlying stock for inventory and hedging purposes. This should lead to a temporary price increase, likely to occur at the introduction day or a few days before the actual listing of new derivatives. Vice versa, if the market makers anticipate writing puts, they may short the stock for the same reasons. This should lead to a temporary price pressure in the stock at the introduction date, or a few days before. Other examples can also be constructed, giving rise to both price increases and price decreases.

In an efficient market, price changes can be expected to occur at the announcement date and not at the date of the option introduction. If regulatory or institutional constraints exist, it is possible to have a price effect on the introduction date. In Haddad and Voorheis (1991) it is argued that the most interesting time to analyze is the introduction date. Most option-traders want to issue covered options, but this strategy is not possible to implement before the options are actually traded.

1.2.2 Risk Effects

Concerning the risk effects of option introductions, Grossman (1988) states that trading in standardized derivative contracts reveals information about the demand for financial insurance to the counterpart, who supplies this insurance. He argues that the price variance in the underlying security will decline when trade in standardized contracts is introduced, as opposed to the case when this demand for financial insurance is generated through dynamic trading strategies, i.e. re-balancing the portfolio between risky assets and risk-free lending/borrowing.

A purpose of his study is to show how market frictions and incomplete information regarding the fraction of portfolio managers that implement a dynamic hedging strategy can leave liquidity providers unprepared to meet the increased supply induced by the portfolio hedgers. This causes the stock price to be more volatile than it would have been if put options had been traded.

It is crucial that liquidity providers know the fraction of portfolio managers who decide to use dynamic hedging strategies to be able to make a correct capital allocation decision. In the absence of perfect information about the fraction of portfolio insurers, the liquidity providers will choose to provide an amount of capital that is optimal for some average level of volatility. This leads to situations in which the allocated capital is less than demanded in times of high volatility, and is in excess in times of low volatility. Therefore, the stabilizing role of the liquidity providers will be undermined by imperfect information about the fraction of investors implementing dynamic hedging strategies.

In this situation a tradable put option may have an important role to fill. Suppose there exists a put option, and that the portfolio insurers implement their strategies via the derivative contract. The price of the put will then reveal the fraction of investors committed to dynamic hedging strategies. In the presence of real traded derivative contracts, the liquidity providers are informed about the fraction of portfolio insurers and thus can allocate their capital in an optimal and market-stabilizing way.

Therefore, it is rational to assume that the introduction of options is likely to reduce the total risk.

Focusing on two aspects of speculative behavior, risk-sharing and information transmission, Stein (1987) analyzes the risk effect connected with the introduction of derivatives. In his model the opening of a derivative market produces new investment choices, and enables more and new agents to participate in the economy, which improves the risk-sharing. The new agents are also differently informed, which can alter the informational content of prices. His model illustrates that the opening of a derivative market can be destabilizing.

Two mechanisms will determine the effects on price volatility and welfare. First, the opening of a derivative market will introduce more agents into the economy, and make it possible to transfer the risk of holding inventories to the new pool of investors. When inventories are more easily carried forward from one period to another, prices become more stable, which leads to a smoother allocation of consumption. It is assumed that consumers have concave utility functions. Thence it follows that consumption smoothing over time is welfare-improving.

The second mechanism affecting the prices has to do with the inference, which can be drawn from the observed asset price. If the derivative market is in place, and the new traders have imperfect information, their speculative trading can reduce the informational content of the asset's price. This muddling of the traders' information has two effects. It raises their conditional variance of the future price. Since traders are risk averse, they will be more reluctant to hold an inventory, which prevents consumption smoothing. This gives a destabilizing effect. Traders also make mistakes in their storage decisions, because they have to statistically predict the future price. Again, this is destabilizing. These two effects are of course reduced by the risk-sharing benefit provided by new traders. Still, the net effect may be destabilizing and welfare-reducing.

Thus the introduction of derivative instruments may also have a destabilizing effect on the underlying market, which tends to increase volatility and thereby the total risk.

Option trading could also open up opportunities for a manipulation of prices, and this could lead to destabilization. Examples of such a manipulation are strategies called “pooling” and “capping”. When implementing a “pooling” strategy, a holder of a call option uses the fact that options are highly leveraged instruments, i.e. the value of an option changes relatively more than that of the underlying stock. Thus, by trying to raise the stock price, it is possible to gain an additional return on a long position in a call option written on that particular stock. This strategy can be implemented at any time of an option’s life as soon as it is introduced.

“Capping” is a strategy where an issuer of a call option tries to push down the price of the underlying stock during the time of maturity. Selling off stocks at this particular period of time can lead to a lower price, which reduces the value of the options, and in the extreme case makes them worthless. The opposite tactics, called “pegging”, can be used to avoid such a reduction of the underlying stock price. Both "capping" and "pegging" can contribute to non-normal fluctuations in the stock price around the maturity of the option.

Another manipulation opportunity is connected with the front running of block holders, which involves taking advantage of information about a coming block trade by earning a profit through buying or selling options on the underlying stock. This type of action is closer to insider trading, and is easier to regulate and supervise than the type of manipulations mentioned above.

According to Damodaran and Subrahmanyam (1992), arguments about the destabilizing effect of option trading can be found in the popular press. In general, these arguments are not presented within the framework of a model, but are based on two factors, according to Damodaran and Subrahmanyam. First, in a market with frictions in the trading process, the actions of uninformed speculators can generate price bubbles, i.e. prices are determined by other factors than fundamental values. Second, actions like programmed trading by some market participants, such as index arbitrageurs and suppliers of portfolio insurance, tend to increase the speed of response to changes in market situations, which can accelerate market declines or increases, and thus add to volatility.

1.3 Review of Empirical Literature

The empirical findings concerning the effects of option introductions on the underlying stock prices can be divided into at least four areas, namely (i) the price level, (ii) the volatility, (iii) the information and price adjustment process, and (iv) the microstructure effects (i.e. spreads and volume). This study deals mainly with the first two issues. The following review of the empirical literature should by no means be seen as a complete review.[2] It is summarized in Table 1 below. Further, since this study does not deal with issues concerning variations

[2] There are some master theses from Stockholm Scool of Economics (using Swedish data) that are dealing with the issues discussed in this study. These papers will not be taken into consideration in the review that follows.

in the underlying stock around the time of maturity of the options, such literature will be omitted in this review.

1.3.1 Price Effects

Starting with the price effect, empirical findings employing data from US markets suggest that option introduction causes a permanent price increase in the underlying stock, beginning a few days before the introduction. Using a sample of 300 option introductions between 1973 and 1986, Detemple and Jorion (1990) report positive abnormal returns averaging 0.6% on the listing day, and 2.9% in the two weeks around the listing date. They also show that the effects are stronger in the earlier part of their sampling period than in the later years.

The price effect also seems to be more associated with the time of introduction, rather than the time of announcement. Conrad (1989) distinguishes between the announcement of a new listing and the actual listing. The sample used consists of 96 option introductions made between 1974 and 1980 at 30 different dates. She finds a positive abnormal return of 2.5% during the period from 3 days before to 1 day after the option listing. She could find no price effect around the announcement date.[3]

The absence of an announcement effect is somewhat puzzling since investors should progressively realize that the prices of newly optioned stocks usually increase. Hence, an announcement effect should appear.

In a more recent study the price effect is reconsidered. Sorescu (2000) shows that the effect of option introductions on the underlying stocks is best described by a two-regime switching means model. He finds a positive return effect of 2.37 percent over an 11-day window around the listing date of the options introduced from 1973 to 1980. In the period after 1980 he finds a negative effect of -1.52 percent. The sample consists of 1924 listings made on 877 separate dates.

An attempt was made to explain the causes of the switch in the price effect by observable characteristics of the optioned firms, instead of by the underlying economics of option introduction. Two such variables were age and size, which showed to be negatively related to the time of introduction. In the sample of the optioned stocks after 1980, the firms are relatively smaller and younger. For this group of stocks, the costs of establishing short positions may be high before the option listing, such that investors with negative information who do not own the stock are unable to borrow it. These short sale restrictions are effectively removed when options are listed. Thus, negative information can be incorporated in prices and lead to a negative price effect. Other characteristics, also used, were the type of contracts listed, and the trading place of the options and their underlying stock.

[3] Other students of the return effect of option introductions include Branch and Finnerty (1981), Rao and Ma (1987), and Haddad and Voorheis (1991).

The results show that the switch around 1980, from positive to negative abnormal returns, is not related to the type or trading place of the option contract, nor to the age, size or trading place of the underlying stock. The cross-sectional characteristics in the underlying firms merely serve as proxies for the regime switch.

Recognizing that option listing is an endogenous decision made by exchanges, Mayhew and Mihov (1999) investigate the factors affecting the exchanges' listing decisions. They find that firm size, volume, and volatility are positively related to the probability of listing. Using these results, they construct matched samples of stocks that were eligible, but not selected, for option listing, and re-examine some of the option listing effects using a control sample methodology, in order to correct for an eventual selection bias problem.

They use a sample consisting of 1953 stocks with options introduced between 1973 and 1996. The results show that there is a positive price effect prior to 1980 and a negative one after 1980. But in the years after 1980 the control samples also show negative excess returns. Thus, the negative return effect in the later period is less pronounced than that reported by Sorescu, and in some cases it even disappears.

So far, most studies concerning the impact of option listing on the underlying stock have been based on data from the United States. There is, however, some evidence regarding the effects of option introductions based on data sets outside the US.

Watt, Yadav, and Draper (1992) used 39 option listings (over 34 independent dates) made in the UK over the period 1978 to 1989, and report a temporary price increase of 1.3% immediately prior to the listing. Stucki and Wasserfallen (1994) investigate the effect on stocks traded in Switzerland. Their sample consists of 11 option introductions made at one single date in 1988. They find that the introduction of traded options leads to a permanent and significant increase in the prices of 2%. Gjerde and Sættem (1995) have a sample of 7 option introductions, listed at 4 individual dates in Norway. They report a temporary price increase, giving a positive excess return of 1% on the introduction day. Finally, findings from the Netherlands, as reported by Kabir (1998), indicate a decline in the stock prices. The magnitude of the decline was –2.3% over the 20 days before the listing and –0.46% on the day after the listing. The sample used consists of 53 option listings made at 27 individual dates during the period 1978 to 1993.

There is one study based on stocks traded in Sweden by Alkebäck and Hagelin (1998). Mainly they study the impact of warrant introduction on the underlying stocks, and for comparison they also study the effects of option introductions made in Sweden. Alkebäck and Hagelin report that the return is unchanged at the introduction of the options. The differences between this study and theirs are that in this study the sample of option introductions include all

Nordic markets, and that the question of an announcement effect is addressed. Further, the risk analysis is extended to include both the effects on the systematic risk and those on the unsystematic risk.

All the studies mentioned above, using data from European markets, have the weakness of not considering what happens at the announcement date. Another shortfall is that the studies using data from Norway and Switzerland contain very few independent observations.

1.3.2 Risk Effects

To date, most studies on the aspect of the impact of option markets are concerned with the effects on volatility. The consensus among studies using samples up to the mid-eighties is strong regarding the effects, and the findings show that volatility is reduced as a consequence of the introduction of options.

Applying variance measures of excess returns, Conrad (1989) finds that the average variance, measured over the 200 days preceding the option introduction compared to the value measured over the following 200 days, shows a decline from 2.29% to 1.79%. At the individual firm level, 86 of the 96 firms introduced during the period between 1974 and 1980 showed a reduction in variance. Skinner (1989) proves a decline in variance of 17%-25% after the listing of options depending on the time interval used. The sample consists of raw returns from 304 stocks with options introduced during the period 1973-1986. When the actual returns are adjusted day by day with due allowance for the overall market returns, the decline is in the order of 10%. In a sample consisting of 300 stocks with options introduced during the years between 1973 and 1986, DeTemple and Jorion (1990) find that the total risk declines on an average by 7%. Damodoran and Lim (1991) document a significant decline in the return variance of 21%. Their sample consists of 200 stocks with options introduced between 1973 and 1983. Nabar and Park (1994) develop a market model approach to investigate the effects of options on the underlying assets, as opposed to the earlier studies directed to tests of variance ratios. In a sample of 390 optioned stocks introduced at 153 different dates, they find that the variance corrected for market risk is reduced on the average by 4-8%.[4] Mayhew and Mihov (1999) find diverging results depending on the time period studied. Between 1973 and 1980 they find decreasing volatility compared to the control samples of stocks, but in the period following 1980 they find mixed results. They even report a significant increase in volatility during the period 1991 to 1996. They interpret this as if exchanges listed options in response to the stocks' permanent characteristics, but as these listing candidates became fewer over time, the exchanges gradually began listing the options in response to changes in market conditions. Thus, this reflects a

[4] Other scholars have come to the same conclusion regarding reduced risk. Among these are Ma and Rao (1988), and Bansal, Pruit, and Wei (1989).

change in the listing criteria, the exchanges become forward-looking, and list options in anticipation of high volatility.

Another risk examined is the non-diversifiable risk, measured by the beta of the underlying stock. An early study by Trennepohl and Dukes (1979) uses a sample of weekly returns from 32 optioned stocks, which were listed between 1970 and 1976. The average weekly-return beta in their sample declines from 1.22 before the listing to 0.87 after the listing. Klemkosky and Maness (1980) also come to a similar conclusion comparing monthly-return betas before and after the listing of options, but their results are statistically weaker. The sample consists of monthly returns on 39 optioned stocks during the period 1972-1978. More recent studies with an improved methodology and larger data sets have not been able to find any significant change in betas after the option listing. Examples of such studies are Whiteside, Dukes, and Dunne (1983), Skinner (1989), and Damodoran and Lim (1991).

The results reported by researchers using data sets from non-US markets are as follows. Regarding the total risk the results are mixed. Watt, Yadav, and Draper (1992) report that the total risk and the unsystematic risk decreased in the UK. Stucki and Wasserfallen (1994) investigate the effect on stocks traded in Switzerland. They find a reduction in the volatility of the stock returns of 31%. Sahlström (1998) using a sample of 13 option introductions made in Finland, finds that the total volatility is reduced by 31%. The study based on stocks traded in Sweden by Alkebäck and Hagelin (1998) report that the variance declines by 14%. With a sample of 37 option introductions made over the period 1979 to 1987 in Canada, Chamberlain, Cheung, and Kwan (1993) fail to find any significant effects on risk, volume, and bid-ask spreads. Gjerde and Sættem (1995) find no evidence of a change in the total risk of the stocks in Norway. Finally, findings from the Netherlands, as reported by Kabir (1998), indicate no significant change in volatility. The evidence on systematic risk measured by beta is more conclusive. No effect is found in the studies from Canada, Norway, the Netherlands, Switzerland, or the UK. The only exception is the study based on Swedish option introductions, which reports a decline in beta.

In summary, the empirical evidence on different risk measures indicates that stock return variance declines after option listing. This is true for both total risk and unsystematic risk. Only a weak or, more recently, no statistically significant change is found in the systematic risk measured by the beta of the underlying stock.

1.3.3 Information and Price Adjustment Process Effects

Several studies have documented the speed at which new information is incorporated in equity prices, both those with and those without options. At least three issues in this connection are examined in the academic literature. The first one is concerned with the effect option listing can have on the quantity and quality of the information produced. The second deals with the speed at which the prices of optioned stocks respond to new information relative to non-optioned stocks. A third issue is to what extent option prices lead or lag the prices of the underlying stocks.

Damodoran and Lim (1991) study the issue concerning the quantity and quality of the information produced. They look at the number of analysts following a stock and the frequency of Wall Street Journal articles about the company before and after the option listing. They conduct a test of whether the information structure is affected by option listing, and find a significant increase in the number of analysts concerned with stocks with options as well as a higher frequency of Wall Street Journal articles.

The speed of price adjustment to new information has been studied by Jennings and Stark (1986), among others. In a sample of 180 stocks having options introduced during 1981 and 1982, they find that the price of the optioned stocks adjust more quickly to earning reports than to the non-optioned stocks of a matched sample. Skinner (1990), also studying the effect of earnings announcements on optioned stocks relative to non-optioned stocks, reports smaller abnormal returns of unexpected news after the listing of options. Further, he concludes that the overall reaction to earnings reports is smaller after the listing of options. The sample in Skinner's study consists of 214 stocks having options introduced during the period 1973 to 1986, at 82 listing dates. Using the variance in different return intervals, Damodoran and Lim (1991) estimate price adjustment coefficients. Using a sample of 200 firms covering the period of 1973-1983 they find that prices adjust quicker to new information after the listing of options.

The last issue, dealing with which market responds to new information most quickly, the option market or the stock market, has been addressed by Manaster and Rendleman (1982), among others. They use a sample of 172 stocks with options listed between 1973 and 1976. They find that the option prices lead the stock prices by as much as 24 hours. In addition, they calculate the differences between implied and actual stock prices. On the basis of these differences they construct portfolios, which make excess returns. This result, however, has been challenged in other studies. For example, Stephan and Whaley (1990), using intraday price changes in 364 stocks with options traded during 1986, find that option prices lag stock prices by 15-20 minutes. They also document a modest feedback from the option markets.

In summary, there is evidence that option listings enhance the information set and increase the speed with which new information is incorporated in prices. However, the answer to the question whether it is the option market or the stock market that leads the information revelation remains open.

Table 1

Some Effects of Option Listing

Presented below is a summary of studies mentioned in the text above regarding the effects of option listing on returns, total risk, systematic risk, bid-ask spreads, and volume. In these studies excess returns are defined as the difference between the raw return and the market-adjusted return with market model parameters estimated from a prior time period. The total risk is usually measured by the return variance, sometimes adjusted to market variance. The systematic risk is measured by the beta of a stock. The bid-ask spreads are estimated using the Roll covariance method. The volume is measured by raw volume or market-adjusted volume. Weekly returns are used in earlier studies and daily in the later ones.

Study	Country	Sample Size	Sample Period	Excess return	Total Risk	Systematic Risk	Bid-Ask Spreads	Volume
Trennephol & Dukes (1979)	US	32	1970-76			Decline		
Klemkosky & Maness (1980)	US	39	1972-80			Decline		
Whiteside, Dukes, & Dunne (1983)	US	71	1973-81			None		
Conrad (1989)	US	96	1974-80	+2.5%	-22%	None		
Skinner (1989)	US	304	1973-86		-10%	None		Increase
DeTemple & Jorion (1990)	US	300	1973-86	+2.9%				
Damodoran & Lim (1991)	US	200	1973-86		-21%			No change
Watt, Yadav, & Draper (1992)	UK	39	1978-89	+1.3%	-12%	None		
Chamberlain, Cheung, & Kwan (1993)	CAN	37	1979-87		None	None	None	No change
Nabar & Park (1994)	US	390	1973-85		-4% to -8%			
Stucki & Wasserfallen (1994)	SCH	11	1988	+2.1%	-31%	None		
Gjerde & Sættem (1995)	N	7	1990-94	+1%	None	None	Decline	Increase
Alebäck & Hagelin (1998)	S	32	1985-94	None	-14%	Decline	Decline	Increase
Kabir (1998)	NL	53	1978-93	-2.3%	None	None		
Sahlstöm (1998)	FI	13	1992-95		-31%		Decline	
Mayhew & Mihov (1999)	US	1953	1973-96	< 0	Increase			Increase
Sorescu (2000)	US	1924	1973-95	-2.4				

1.3.4 Market Microstructure Effects

Theory suggests that options trading may have market microstructure effects. In the empirical literature it is hypothesized that bid-ask spreads and trading volume are affected. Damodoran and Lim (1991) estimate the serial correlation measure for the bid-ask spread proposed by Roll (1984), using a sample of 200 firms with options introduced during the period 1973-1986. They reached the conclusion that the bid-ask spreads declined after the listing of options. The decline is partially attributed to an increase in competition among market makers on the option market, and is partially due to an increased institutional trading activity in the stock.[5]

Studies dealing with the effects of option listing on trading volume have come to diverged conclusions. Skinner (1989) reports how the stock market trading volume changes around the listing time of options. The sample consists

[5] Others have also studied the effects on the bid-ask spread. Among them are Neal (1987) and Fedenia and Grammatikos (1992), and they draw similar conclusions as Damodoran and Lim (1991).

of 297 firms with options introduced between 1973 and 1986. The result indicates that the median trading volume in the stock increases after the listing by 17%.[6] Likewise, Damodoran and Lim (1991) report an increase in the raw trading volume of the same magnitude, but when controlling for general market changes the effect is insignificant.[7]
In summary, it seems like the bid-ask spread decreases after the listing of options, and there is no or little effect on the market-adjusted trading volume of the underlying stock.

1.4 Hypothesis

Based on the arguments above, four explicit hypotheses regarding a return effect are tested in this study. Since the return effect is a priori indeterminate, both regarding the time and the direction of a shift, the tests are designed to allow for either an increase or a decrease in the returns. Further, an effect is allowed to take place at both the announcement date and the introduction date. If a shift in the return-generating process is found, it is also tested if it is reversed at a later date following either the announcement or the introduction. The hypotheses are:

(i). Option introductions do not lead to a change in the price of the underlying assets at the announcement date.
(ii). In the case of a price effect at the announcement, the effect is not reversed.
(iii). Option introductions do not lead to a change in the price of the underlying asset at the introduction date.
(iv). In the case of a price effect at the introduction, the effect is not reversed.

As regards a risk effect, theory is not conclusive about in what direction the risk might shift. Thus, also in this case, the tests must allow for either an increase or a decrease in risk. Moreover, the theoretical analyses referred to above are not comprehensive enough to disentangle which risks are affected and how, i.e. the effect on the systematic and/or idiosyncratic risks. According to the theories it is clear that the total risk is affected, but it is hard to say what happens in a setting with more than one asset and how this affects the relation with other assets. This raises the questions of which risks are affected, and how. Three explicit hypotheses are tested in this study concerning a risk effect caused by the introduction of options:

[6] Jennings and Stark (1986) also find a positive volume effect of option introduction.
[7] Whiteside, Dukes, and Dunne (1983) and Bansal, Pruit, and Wei (1989) draw similar conclusions as Damodoran and Lim (1991), i.e. there is no change in volume when options are introduced.

(v). Option introductions do not change the total risk of the investments in the underlying assets, measured by the variance in returns.
(vi). Option introductions do not change the idiosyncratic risk.
(vii). Option introductions do not change the systematic risk, measured by beta.

2 Methodology

2.1 Return Effect

To investigate the price effect of an option introduction, an event study is undertaken based on introduction of options on the Nordic exchanges. The event is defined in two distinct ways. The first way is to use the announcement date of an option introduction as it appears in a newsletter from Options Mäklarna (OM) and Oslo Stock exchange (OSE), or in the newspaper Dagens Industri. The second way is to use the first day of trade of the standardized contract, as reported by the respective exchange. Throughout the study, continuously compounded returns are calculated in a standard fashion:

$$r_t = \ln(p_t + d_t) - \ln p_{t-1} \qquad (1)$$

In the equation above p_t denotes the price and d_t denotes the dividend at date t.

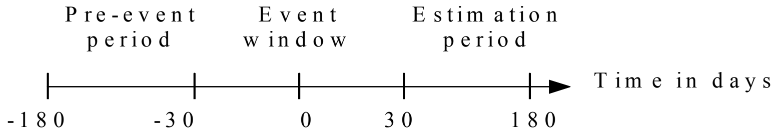
The securities on the Nordic exchanges are infrequently traded in comparison with stocks traded on the New York Stock Exchange (NYSE). Thus, there will be days with no closing prices and therefore missing values in the return series. In such cases, a return is calculated for the period of missing prices. For example if closing prices are missing for two days, a three-day return is calculated using the third day's price.

In sample one and two, the event window is defined to be 61 days, that is 30 days prior to the event day and 30 days after the event day. Calculating abnormal returns for a security, the normal return over the event window is subtracted from the actual ex-post return. A modified market model implementing Fowler and Rorke (1983) betas, which adjusts for non-synchronous trading, is used to model the normal returns. The parameters in the market model are estimated on data in a window of 150 days after the event window (see Figure 1). The pre-event period is used for alternative choices of estimation periods[8].

[8] Other specifications of the estimation period are also tried, e.g. 150 days before and 150 days after the event window, and just 150 days before the event window. The choice does not affect the results. But, as will be seen later, there is a risk of a selection bias in the data set, which could have an influence on the estimation of the parameters of the normal return models.

Figure 1

Time Line for the Event Study



When many options in the sample are introduced on the same calendar date, cross-sectional correlation in excess returns could give biased results. Therefore equally weighted portfolios are formed out of those stocks, which have identical option introductions and announcement dates. These portfolios are treated as individual securities. An inference is drawn by calculating z-scores from the standardized excess returns of the securities for each day in the event window. The methodology is more exhaustively presented in Appendix A.

2.2 Risk Effect

The second part of this analysis deals with the effect of an option introduction on the total risk, the idiosyncratic risk and the systematic risk of the underlying security. Using a similar event-study approach as in the analysis of the return effect, the total risk effect is first investigated.

2.2.1 Total Risk

Monthly variances are estimated from daily returns for 21 consecutive days. Since there are periods of days with no closing prices, there will be days without returns. Therefore some variances will be estimated by using fewer returns than 21. This infrequent trading of securities causes the returns to be autocorrelated, particular at a one day lag (see Scholes and Williams (1973)). Because of this autocorrelation, variances are estimated as

$$\sigma_{it}^2 = \frac{1}{N_{it}} \sum_{k=1}^{N_{it}} \left(r_{itk} - \bar{r}_{it}^{v} \right)^2 + \frac{1}{N_{it} - 1} \sum_{k=1}^{N_{it}-1} \left(r_{itk} - \bar{r}_{it}^{c} \right)\left(r_{it,k-1} - \bar{r}_{it}^{c} \right) \qquad (2)^{9}$$

[9] It should be noted that the covariance term in equation (2) does not enter by a factor two as it usually does. This is due to a Newey-West correction in order to make the variance-covariance matrix positive semidefinite in small samples (see Hamilton (1994, p 281)). If the covariance matrix is not positive semidefinite, it is not asserted that all variances are non-negative.

σ_{it}^2 Stock or market variance

N_{it} Number of trading days in a month

r_{itk} Daily return in day k within month t

$\bar{r}_{it}^{v}$ Mean return in month t excluding missing returns

$\bar{r}_{it}^{c}$ Mean return of the returns used when calculating the one-period lagged cross product[10]

A market model for monthly stock variance is used to describe the normal variance, i.e. the individual stock variance is expected to fluctuate around its mean and the variance is adjusted for shifts in the overall market variance. Three different market models for variances are considered:

$$
\begin{aligned}
\sigma_{it}^2 &= a_i + b_i \sigma_{mt}^2 + e_{it} \\
\sigma_{it} &= a_i + b_i \sigma_{mt} + e_{it} \qquad (3) \\
\ln \sigma_{it} &= a_i + b_i \ln \sigma_{mt} + e_{it}
\end{aligned}
$$

Nabar and Park (1994) specify these market models for volatility ad hoc. They use these models to answer similar questions as asked in this study, and they show that the methodology is statistically more powerful than comparing variance ratios adjusted for market volatility, as in Skinner (1989). The advantage of this specification of normal variances is that it adjusts to a potential market shift in volatility. It also makes it possible to follow the development of the excess volatility over time. Empirical results found by Schwert and Seguin (1990) support such a statistical model. The modeled normal variances are compared with realized monthly return variances, and the differences are considered to be the abnormal variances, as follows:

---

[10] The two mean returns $\bar{r}_{it}^{v}$ and $\bar{r}_{it}^{c}$ are essentially the same, but since cross products are calculated, resulting in more missing values, they could differ. The reason for $\bar{r}_{it}^{c}$ to differ from $\bar{r}_{it}^{v}$ could be that the time series of 21 consecutive days, used to estimate a monthly variance, include missing values. When the time series is lagged one day, and multiplied with the original (not lagged) time series to calculate cross products, the days following a missing value will become cross products of missing values. The number of cross products, therefore, become fewer than the number of days in the original time series. For example if there is one day missing out of the original 21 days, the resulting number of cross products is 18. One is lost due to the lagging of the series, and two more are lost due to the missing day. The mean return $\bar{r}_{it}^{c}$ is calculated by only using those returns which result in a cross product that does not result in additional missing values, i.e. in the example the 18 returns resulting in an existing cross product are used.

$$\hat{e}_i^* = \sigma_i^* - \hat{a}_i \iota - \hat{b}_i \sigma_m^* . \qquad (4)$$

In equation (4) the star superscript indicates that the vectors of standard deviations come from the event window, while $\hat{a}_i$ and $\hat{b}_i$ are estimated with data from the estimation period (see Figure 2). The abnormal variance can then be aggregated across stocks, and thereafter tested if it is significantly different from zero. Test statistics and hypotheses are developed in the same way as for the test concerning significant abnormal returns. As in the return study, a cross-sectional correlation in excess variances could bias the results. Therefore equally weighted portfolios are formed out of the stocks having identical option introduction dates. Portfolios are formed before variances are calculated, and they are treated as individual securities.

The timing of the events of the risk effect is presented in Figure 2. The first sub-period is the 44 months' estimation period, while the second period is the event window with 10 months prior to the listing and 10 months after the listing. The first day in month 1 is the listing day of any stock option. The pre-listing period in the event window is used to verify the predictability of the model. The post-listing period in the event window is used to test for excess volatility in returns.

Figure 2

Time Line for the Event Study

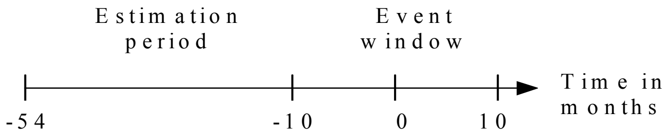


Table 2 shows summary statistics from the three specified volatility models in equation (3). It can be seen from the table that all estimated parameters are significant with one exception: the slope coefficient in the variance model. All models produce similar results. The ordinary least squares (OLS) estimation of the models in (3) shows that the residuals exhibit a significant serial correlation for many stocks. Therefore, the OLS estimates of the model coefficients will be biased. Instead, the methodology developed by Nabar and Park (1994) will be used, i.e. implementing generalized least squares (GLS) estimates of the parameters in the models, and adjusting for first order autocorrelation. The methodology is explicitly presented in Appendix B.

Table 2

Summary Statistics for Volatility Market Model Regressions

The table shows summary statistics from the regression models in equation (3). Separate regressions are conducted using variances from portfolio returns. Each portfolio consists of securities having the same introduction date. In each column the mean of each coefficient is displayed. Columns 2-5 show the parameter estimates with their respective standard deviations. A first order autocorrelation from OLS residuals is presented in column 6, the coefficient of determination in column 7, and in the last column the average skewness in the residuals.

Models	$\overline{\alpha}$	$\overline{\sigma}_a$	$\overline{b}$	$\overline{\sigma}_b$	$\overline{\rho}$	$\overline{R}^2$	Skewness
σ^2	0.079	0.030	1.60	0.854	0.202	0.20	2.10
σ	0.212	0.048	0.61	0.288	0.268	0.18	1.14
$\ln\sigma$	-0.799	0.271	0.26	0.132	0.288	0.14	0.04

To facilitate the interpretation, and due to a higher R^2, the model using market standard deviation as explanatory variable is chosen. The results are essentially the same regardless of the choice of model specification.[11]

2.2.2 Idiosyncratic Risk

Variance ratios are used in testing for a change in the idiosyncratic risk. The same methodology is also used for the test of changes in the total risk in such a way that a comparison can be made between the two risks.

When calculating the variance ratios for the idiosyncratic risk, the variances of residuals from a market model for each stock are computed for a ten-month period on either side of the option introduction date. To get the total risk effect, the variances of the stock returns are calculated. The variances of the corresponding market returns are also calculated on either side of the stock's listing date. This is done for each stock separately, using the same ten-month period. Dividing the post-listing period variance by the pre-listing period variance forms variance ratios (VR). Presented in equation (5) and (6) are the variance ratios for the idiosyncratic and total risks. The superscripts I and T indicate which risk is considered, the idiosyncratic or total risk.

$$VR_i^I = \frac{\sigma^2_{\varepsilon_i, post-listing}}{\sigma^2_{\varepsilon_i, pre-listing}} \tag{5}$$

[11] The parameters in Table 2 appear to differ considerably depending on the choice of model, and could potentially lead to a question of robustness in the results. This difference is due to the transformation of the monthly time series, and has no effect on the results whatsoever. All models were tested and the conclusions drawn are the same regardless of the model used.

$$VR_i^T = \frac{\sigma^2_{i,post-listing}}{\sigma^2_{i,pre-listing}} \quad (6)$$

To control for coexisting shifts in the market risk, the stock variances in each period is divided by the corresponding market variance. The quotient between the stock variances and the market variance is the market-adjusted or standardized variances. Dividing the standardized variances after the listing by the standardized variances before the listing forms the standardized variance ratio (SVR). Presented in equation (7) and (8) are the variance ratios of the idiosyncratic and total risks.

$$SVR_i^I = \frac{\sigma^2_{\varepsilon_i,post-listing} \Big/ \sigma^2_{M,post-listing}}{\sigma^2_{\varepsilon_i,pre-listing} \Big/ \sigma^2_{M,pre-listing}} \quad (7)$$

$$SVR_i^T = \frac{\sigma^2_{i_i,post-listing} \Big/ \sigma^2_{M,post-listing}}{\sigma^2_{i_i,pre-listing} \Big/ \sigma^2_{M,pre-listing}} \quad (8)$$

A VR or a SVR greater than one indicates an increase in the overall risk in each stock. A ratio less than one indicates a reduction in volatility. An F-test is performed on each security's variance ratio to test for significant deviations from one. The median variance ratio is also tested for a significant deviation from one by a Wilcoxson-signed rank test.

2.2.3 Systematic Risk

To test if option introduction has any impact on the systematic risk of the underlying securities, a market model regression is estimated over 360 days. Half of the data set occurs before the option listing, and the other half after the option listing. To adjust for the bias in the coefficient estimates arising from thinly traded securities, the approach of Fowler and Rorke (1983) is followed. A dummy variable is included in the model that takes the value one in the periods following the option listing and zero otherwise. More specifically, the following model is estimated:

$$\begin{aligned} R_i = \alpha_i + \beta_i^{--} R_m^{--} + \beta_i^{-} R_m^{-} + \beta_i^{0} R_m^{0} + \beta_i^{+} R_m^{+} + \beta_i^{++} R_m^{++} + \\ + \gamma_i D_i \left(\beta_i^{--} R_m^{--} + \beta_i^{-} R_m^{-} + \beta_i^{0} R_m^{0} + \beta_i^{+} R_m^{+} + \beta_i^{++} R_m^{++} \right) + \varepsilon_i \end{aligned} \quad (9)$$

In the regression model R_i and R_m represent vectors of stock returns and market returns, respectively. The superscripts ++, +, 0, -, and -- indicate that each time series is shifted to lead or lag two days, one day, or no day. A γ_i-coefficient significantly different from zero indicates that the option listing may have affected the beta values. The null hypothesis tested is $\sum_i \gamma_i = 0$. D_i represents the dummy vector.

3 Data

This study is based on all stocks on which options were listed in the four Nordic countries Denmark, Finland, Norway, and Sweden between the years 1985 and 1998. During this period there were a total of 90 listings at 62 individual dates. The option introduction dates are the dates reported by the respective exchange in each country. The announcement dates were collected from newsletters from Options Mäklarna (OM) and Oslo Stock Exchange (OSE). For the first two years the sample announcement dates were gathered from Dagens Industri, a major Swedish business newspaper.

Three samples are collected and used in this study. Sample one and two consist of daily stock return data aligned at the announcement date and at the introduction date respectively. Sample three consists of 64 months of daily stock returns aligned at the introduction date. It is used to calculate 64 monthly variances. Sample one is used to test hypothesis (i) and (ii). Sample two is used to test hypothesis (iii), (iv), (vi), and (vii). Sample three is used to test hypothesis (v).

All observations in all three samples included in the study must meet the following criteria. When options are introduced on several types of stocks of a company, only the first introduction is considered. This means that if the options on Volvo B-shares were introduced before those on Volvo A-shares, only the Volvo B option introduction date will be considered in the study.[12] After this has been taken into account, 85 stocks remain. In sample one and two, the individual shares must have been publicly traded 180 days prior to and 180 days after the considered date. The 361-day interval is chosen to match the estimation period. This reason for the rejection of data excludes 27 stocks. The selection criterion results in a remaining sample of 58 stock option introductions, and the number of different introduction dates is 37. Announcement dates could only be received on introductions made in

[12] The sample includes companies, which have as many as four types of stocks. Two of these, A-shares and B-shares, refer to voting rights. Both types can also be classified as restricted or unrestricted, referring to whether domestic or foreign ownership is allowed. This last classification does no longer exist.

Table 3

Number of Listings and Announcements, and Sample Falloff

The first four rows show the number of option introductions in each of the Nordic countries between 1985 and 1998. Row five and six are the sum of all introductions on all exchanges, and the total number of dates at which these introductions occurred. The following rows, seven through nine, give the number of introductions that had to be excluded from the study. The three reasons for excluding the events are "Already existing", "Lack of data", and "No announcement". The first one is concerned with companies that already have options introduced on other types of shares. The second takes into account that the price series in the underlying stocks are too short. The third tells the number of introductions where no announcement date could be attained. The rows ten through thirteen show the final number of listing dates and announcement dates that are included in the study. The last four rows show the final number of listing dates and announcement dates distributed over the four Nordic countries.

	Year	85	86	87	88	89	90	91	92	93	94	95	96	97	98	Σ
Country	Denmark						4			2	1					7
	Finland									7	6					13
	Norway						5	1		1	1		1	6	4	19
	Sweden	6	4	3	2	5	2	1	2	6	3	5	9	3		51
	Total listings	6	4	3	2	5	11	2	2	16	11	5	10	9	4	90
	Total dates	1	2	2	2	4	4	2	2	9	10	5	10	6	3	62
	Already existing			1			1				1		1	1		5
	Lack of data			1		1	1	1		5	5	2	7	2	2	27
	No announcements						9	1		10	8		1	2		31
Sample	Listings	6	4	1	2	4	9	1	2	11	5	3	2	6	2	58
	Listing dates	1	2	1	2	3	3	1	2	8	4	3	2	4	1	37
	Announcements	6	4	1	2	4	1	0	2	5	2	3	2	5	2	39
	Announcem. dates	2	2	1	2	3	1	0	1	5	1	3	2	3	3	27
			Denmark				Finland			Norway			Sweden			
	Listings		6				5			14			33			58
	Listing dates		2				3			8			25			37
	Announcements		0				0			6			33			39
	Announcem. dates		0				0			3			24			27

Sweden and partly in Norway. This shortfall reduces the number of announcements to 39, at 27 individual dates. [13]

Table 3 shows the number of option introductions that have occurred in the Nordic countries, and the number of stocks that had to be excluded because of the selection criteria. Out of the 58 listings in the final sample the majority are Swedish. In sample three, which is used in the study of the risk effect, the individual shares must have been publicly traded 54 months prior to and 10

[13] For comparison, Conrad (1989), the most widely cited paper in the area, used 96 stock options in her study. After the forming of portfolios there were 30 portfolios at the introduction date and 15 at the announcement date.

Table 4

Descriptive Statistics of Return Series for the Total Sample Period, and Before and After Option Introduction

The sample of 361 trading days is divided into three time periods, signed Total, Before, and After, The last two consist of the first and last 150 trading days, excluding the middle 61 trading days. Separate regressions of the type $R_{it} = \alpha_{it} + \beta_{it} Rm_{it} + \varepsilon_{it}$ are run for each stock and period individually. The values presented in the table are the averages of the estimated parameters and standard deviations. Columns 2 to 5 contain the sample average of the parameter values from the regressions with the corresponding average standard deviation. Columns 6 and 7 contain the standard deviation for the return series. The last column contains market-adjusted standard deviations.

Period	$\overline{\alpha}$	$\overline{\sigma}_{\alpha}$	$\overline{\beta}$ [a]	$\overline{\sigma}_{\beta}$	$\overline{\sigma}_{i}$	$\overline{\sigma}_{m}$	$\overline{\sigma}_{i} / \overline{\sigma}_{m}$
Total	0.0006	0.0010	0.4927	0.1105	0.3392	0.1560	2.12
Before	0.0010	0.0017	0.3786	0.1829	0.3571	0.1527	2.23
After	0.0002	0.0016	0.4472	0.1632	0.3346	0.1647	1.99
$\sigma_{AL} / \sigma_{BL}$ [b]					0.94	1.08	

a) In the Total period 49 out of the 58 estimated betas are significantly different from zero at a five percent significance level. In the Before period 33 betas are significant, and in the After period 37 betas are significant.
b) Quotient between the standard deviation after listing and the standard deviation before listing.

months after the introduction date.[14] Due to the longer return horizon required when calculating variances, fewer stock option introductions can be considered. The selection criterion results in 48 stock option introductions at 31 individual dates. Only introduction dates are considered when the risk effect is studied. Since monthly variances are used, and introduction dates and announcement dates are close together in time, the results are not affected.

The price and dividend data are drawn from SIX Trust[15] and Datastream. The market index is Datastream's Scandinavia-DS Market index[16] (SDSM), which is a value-weighted total return index.

Table 4 shows descriptive statistics of the return series concerning the sample of stocks. Each stock in the sample is studied during a total interval of 361 consecutive trading days around the listing, 150 days “Before”, 61 days around

[14] Outside of this time interval too many shares would have to be excluded. Some options have been introduced recently, which means that not enough time has elapsed between the introduction and today’s date, to generate relevant return data. Also, some stocks were not publicly traded prior to the considered introduction and announcement dates. The introduction of the stock and the option occurred close together in time, which prohibits a satisfactory estimation of model parameters.

[15] Trust is a financial database, which is administered by Scandinavian Information Exchange (SIX).

[16] Included in the index are 220 stocks, out of which the Danish, Finnish, and Norwegian markets contribute with 50 stocks each, and the Swedish with the residual 70.

and 150 “After” the listing. Two observations can be made from Table 4. The average beta increases after the option introduction, and rises from 0.3786 to 0.4472. This shift in beta is not significant at any conventional significance level. After the option introduction the standard deviation is reduced on average by 6% in the underlying stocks, while the total market volatility increases by 8% on an average over the corresponding period. This means that the optioned stocks show a decreasing volatility during a period whereas the rest of the market shows an increase in volatility. This could potentially be an indication of a selection bias in the sample. It is possible that the options are introduced in the beginning of a period of rising volatility. The exchanges have a selection procedure to be able to see which securities have the necessary prerequisites for listing, where market conditions and circumstances in general are taken into account. Variables affecting the decision are likely to be, among others, volume, size, and liquidity. A consequence could be to that the sample of optioned stocks differs from that of non-optioned stocks.

4 Results

4.1 Return Effect

The main results of the study are presented in Table 5 and Table 6. Note that in Table 5 the announcement day data are used, which only include stock returns from Norway and Sweden. In Table 6 returns from all Nordic markets are included.

4.1.1 Announcement Effect

As a point of departure, abnormal returns around the announcement date are examined. It can be seen from column three in Table 5[17], showing the t-statistic for the excess return at each day, that there is essentially no evidence of excess returns on the announcement day. There is a small increase on day 0 of 0.15 percent, with a t-statistic of 0.37. However, on the day after the announcement there is a substantial excess return of one percent, strongly significant with a t-statistic of 2.67. Since the market participants in some cases do not have the possibility to immediately absorb and analyze the information on option introductions, or if the announcements reach them late in the afternoon, they may react either on day 0 or day 1. To check if traders do respond to the information

[17] In Table 5 results from 21 days in the event window are presented. During the excluded 40 days there are 5 days showing significant excess returns, out of which four occur in the pre-listing period.

Table 5

Average and Cumulative Return Residuals, and Test Statistics, Around Option Introduction Announcement

The table shows 21 out of 61 daily excess returns and cumulative excess returns in the event window, defined to be 30 days before and after the announcement day of an option introduction. To calculate excess returns, a one-factor market model is used to describe normal returns, which are then subtracted from realized returns. The estimated parameters in the market model are adjusted for asynchronous trading using the Fowler-Rorke [1983] methodology to calculate betas. Thirty-nine stocks from Norway and Sweden are used and are grouped into 27 separate portfolios, one for each event date. In the first column the days are numbered according to the event time where day zero is the day of announcement. Columns two and three show the average excess return of the portfolios day by day with their respective t-statistic. Columns four and five show the cumulative average excess return, starting cumulating at date 0, with respective t-statistic. Returns are expressed in percentage terms. All t-statistics are asymptotically normally distributed with mean zero and standard deviation one.

Day	Average Excess Return	t-Statistic	Cumulative Excess Return	t-Statistic
-10	0.4098	1.0585	-	-
-9	0.4725	1.1979	-	-
-8	0.3339	0.8562	-	-
-7	0.1899	0.4385	-	-
-6	0.5019	1.2881	-	-
-5	0.3915	0.9981	-	-
-4	0.1861	0.4496	-	-
-3	-0.1924	-0.6729	-	-
-2	0.3460	0.8646	-	-
-1	0.0843	0.1791	-	-
0	0.1532	0.3665	0.1532	0.3665
1	1.0203	2.6689	1.1734	2.1393
2	-0.0835	-0.2916	1.0899	1.5730
3	-0.3323	-0.9450	0.7576	0.8896
4	0.1236	0.2631	0.8813	0.9095
5	0.2398	0.5815	1.1211	1.0624
6	0.0568	0.0745	1.1779	1.0086
7	-0.5156	-1.4202	0.6622	0.4524
8	0.0108	-0.0075	0.6730	0.4229
9	0.2355	0.5959	0.9085	0.5826
10	-0.6070	-1.6738	0.3015	0.0666

on either the day of the announcement or the day after that, the cumulative effect over day 0 and 1 is tested. Over the two days the return effect is positive and amounts to 1.17 percent, which is significant with a t-statistic of 2.14. It is also worth noting that 67 percent of the securities on day 1 show positive excess returns. Thus, hypothesis (i) is rejected, as the outcome shows that there is a positive price effect of an option introduction in connection with the announcement.

Table 5, column four, presents cumulative excess returns from day 0 and onwards. Corresponding t-statistics are presented in column five. There is no evidence of a price reversal during the eleven-day period included in the table. This is also true for the rest of the event period following the announcement date, even though this is not shown in the table. Therefore, hypothesis (ii), stating that there is no reversed price effect, cannot be rejected at a conventional significance level.

4.1.2 Introduction Effect

The study of the introduction effect is based on data from all Nordic markets. The results from the analysis of the return effect around the introduction date are presented in Table 6.[18] No immediate effect on the stock returns at the introduction date is found: the excess return cannot be distinguished from zero. This is true even if the returns from day 0 and +1 are cumulated and jointly tested. Therefore, hypothesis (iii) cannot be rejected. As a consequence hypothesis (iv) is not of current interest.

A reason for an effect around the introduction day could be the inventory build up by market makers for hedging purposes. More detailed information about the introduction date is provided in Table 7. This is done in order to see if the market participants are building inventories up to one week before the introduction. It is tested whether the cumulated excess returns over the trading days 0 to 1, -1 to 1, -2 to 1, and so on up to -5 to 1, differ significantly from zero.[19] At no interval can any effect be found.

In spite of the statement above, there is a significant price effect at date -4 amounting to 0.9 percent. This could indicate the existence of a positive price effect caused by market makers building inventories of the share to hedge their future option positions. In that case the price effect should be temporary. But the effect is permanent; there are no price reversals, as can be seen from column five in Table 6. This statement holds for the whole 30-day period following the introduction. Considering that about 50 percent of the announcements occur seven to four days before the introduction date, it is possible that the announcement effect shows up as a positive excess return over the days -7 to -4. This argument is in line with the finding that there is no price reversal after the introduction date, and the significant cumulative effect during the days -7 to -4, found in column 6 and 7.

Additional tests are made to disclose any possible patterns in the excess returns. Cumulative abnormal returns over days -10 to +2 are plotted against the calendar time, to see if there exists a learning process among the market

[18] In Table 6 the results from 21 days in the event window are presented. During the 40 days not displayed in the table, there is only one significant excess return.

[19] Other intervals were also tested, with no interesting results.

Table 6

Average and Cumulative Return Residuals, and Test Statistics, Around Option Introduction

The table shows 21 out of 61 daily excess returns and cumulative excess returns in the event window, defined to be 30 days before and after the listing day of an option. To calculate excess returns, a one-factor market model is used to describe normal returns, which are then subtracted from realized the returns. The estimated parameters in the market model are adjusted for asynchronous trading using the Fowler-Rorke [1983] methodology to calculate betas. Fifty-eight stocks from all Nordic markets (Denmark, Finland, Norway, and Sweden) are used and are grouped into 37 separate portfolios, one for each event date. In the first column the days are numbered according to the event time where day zero is the day of announcement. Columns two and three show the average excess returns of the portfolios day by day with their respective t-statistic. Columns four and five show the cumulative average excess returns, starting cumulating at date –4, with their respective t-statistic. Columns six and seven show the cumulative average excess returns, starting cumulating at date –7, with their respective t-statistic. The returns are expressed in percentage terms. All t-statistics are asymptotically normally distributed with mean zero and standard deviation one.

Day	Average Excess Return	t-Statistic	Cumulative Excess Return	t-Statistic	Cumulative Excess Return	t-Statistic
-10	0.5123	1.5148	-	-	-	-
-9	0.0863	0.2181	-	-	-	-
-8	-0.2727	-1.0146	-	-	-	-
-7	0.5315	1.4455	-	-	0.5315	1.4455
-6	0.6547	1.9284	-	-	1.1862	2.3775
-5	0.3553	1.0210	-	-	1.5415	2.5198
-4	0.8909	2.6051	0.8909	2.6051	2.4324	3.4644
-3	-0.2850	-0.9998	0.6059	1.1311	2.1474	2.6483
-2	0.2950	0.8078	0.9009	1.3841	2.4424	2.7338
-1	0.2637	0.7238	1.1646	1.5526	2.7061	2.7893
0	-0.2750	-0.8722	0.8896	0.9991	2.4311	2.2986
1	-0.1236	-0.4013	0.7660	0.7411	2.3075	2.0212
2	0.1802	0.4731	0.9462	0.8595	2.4877	2.0579
3	0.4809	1.4102	1.4270	1.2877	2.9686	2.3669
4	-0.2738	-0.8850	1.1533	0.9236	2.6948	2.0134
5	-0.0681	-0.2308	1.0852	0.8028	2.6267	1.8670
6	0.1862	0.5244	1.2714	0.9158	2.8129	1.9278
7	-0.2517	-0.8059	1.0196	0.6503	2.5612	1.6585
8	0.3243	0.9369	1.3440	0.8723	2.8855	1.8239
9	-0.3090	-0.9613	1.0350	0.5919	2.5765	1.5428
10	-0.0712	-0.2475	0.9638	0.5089	2.5053	1.4392

participants. The hypothesis is that CARs could decrease over time as traders learn about the positive return effect. However, no results are found to support this idea. Further, both the total risk and the systematic risk prior to the introduction are plotted against, and regressed on the excess returns. This is done in order to test if there is a difference in the abnormal returns depending on whether the stocks are of a high-risk or low-risk type prior to the introduction. Again no statistically significant results were obtained.

Table 7

Tests of Cumulative Excess Returns Five Days Before Option Listing to One Day After Option Listing

Cumulating Days	Cumulative Excess Return	t-statistic
-5 – +1	1.1214	1.0611
-4 – +1	0.7660	0.7411
-3 – +1	-0.1248	-0.3301
-2 – +1	0.1601	0.1224
-1 – +1	-0.1349	-0.3179
0 – +1	-0.3986	-0.8931

Even though this study spans over a fairly long period of time, and the sample contains firms of variable size and age, the results cannot verify those of Sorescu (2000) and Mayhew and Mihov (1999). The reason could be that there is no time effect in the Nordic data, or that the short selling restrictions are not as severe in the Nordic markets.

In summary, the combined results from Table 5 and Table 6 indicate that there is a positive price effect on the underlying securities of the option introduction associated with the announcement date, but not with the introduction date. The cumulative excess return over the announcement day and the day after that is significantly positive, amounting to about one percent. The figures in column five, table 5, also show that the price effect is permanent. The Nordic stock markets, therefore, behave fairly efficiently, without anomalies or delayed effects.

4.1.3 Selection Bias or Large Firm Effect

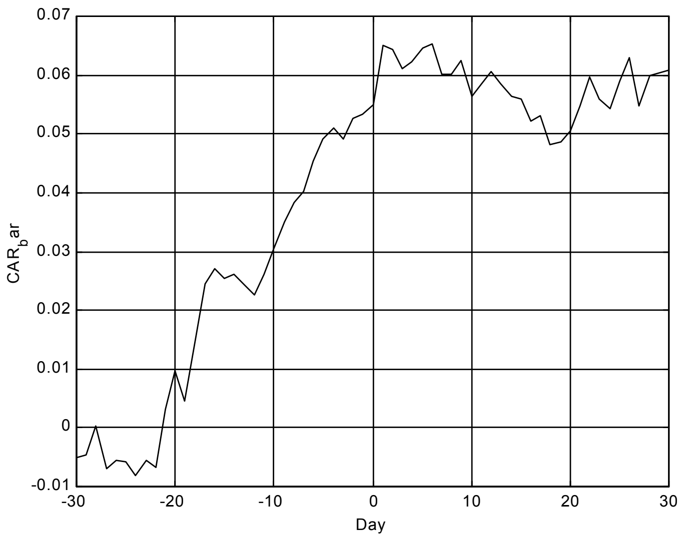
Figure 3 shows a distressing effect. There is a persistent price increase continuing during the entire first half of the event window. This finding can have three explanations.

Information could leak to the market participants prior to the actual announcement made by the respective stock exchange. This would lead to increasing prices if the information is considered as good news, and the information would be incorporated in the prices prior to the announcement day.

Furthermore, the significant price increase prior to the event date could be a result of the fact that mainly large enterprises are selected for option trading. These large firms have for a long time done relatively well compared to the rest of the stock market. In an attempt to control for such a large firm effect, a large firm return-index was used instead of the market index. This did not alter any of

Figure 3

Cumulative Return Residuals Around Option Introduction Announcement



the results presented above. If anything, the results were confirmed on a higher level of significance.

The early price increase could also be due to the special selection criteria used by the exchange when deciding which stocks to base new option listings on. (See also the discussion after Table 4.) To be able to set prices on derivative products, the underlying securities must be fairly liquid. This means that large, profitable growth firms, which are heavily traded, will be of greatest interest to use as an underlying security. New listings will therefore follow only if the stock has reached a certain level of volume, size, and liquidity.[20] Before a security reaches this threshold for being listed, it is probable that the stock is a "winner" in relation to the rest of the market. Just subtracting each stock return series by the market return for a few years prior to the listing shows that in general the stocks in the sample outperform the market. This speaks in favor of a strong increase in the cumulative excess returns that can be seen prior to the event dates. Therefore, the outcome could be explained as a selection bias phenomenon.

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[20] Mayhew and Mihov (1999) show that a firm's size, volume, and volatility are positively related to the probability of having options on its stock listed. Thereby a potential selection bias is introduced. Forming control samples of stocks that were eligible, but not selected for an option introduction, they re-examine some of the option listing effects in the literature. The effects still persist after this selection bias has been taken into consideration.

4.2 Risk Effect

4.2.1 Total Risk

The results presented in this section originate from the examination of volatility in the underlying stocks at the introduction date only. The returns used to estimate portfolio variances are largely the same as for volatility measures around the announcement date and the introduction date. Twenty-one consecutive trading days are used in measuring volatility, and the median number of the trading days between announcement and introduction is five. Therefore the results are virtually the same, independently of which of the two possible event dates are used. Even though the previous section indicates that the return effect is more associated with the announcement day, the listing day has been used as the defined event. It enables the use of option introductions from all Nordic markets, i.e. to enlarge the sample from 22 to 31 portfolios.

In Table 8, column two, twenty months of average excess standard deviations are presented. Excess standard deviations are expressed on a yearly basis. Cumulative excess standard deviations are calculated by adding the monthly deviations over time, and these values are used in the tests displayed in column five and seven. However, the cumulative excess standard deviations have no economical interpretation, but give some guidance to where the results are heading. The event occurs the first day in month one. The outcome of the ten months prior to the event month indicates how well the model works. As long as the model has some predictive power, there should be no significant excess standard deviation during the ten months prior to the introduction. As seen in Table 8, column three, none of the first ten months exhibit any significant excess volatility at a five-percent significance level. Neither shows the cumulated excess standard deviation over the ten-month period prior to the announcement any significant abnormal volatility. The t-statistics are presented in column five. During the following ten-month period after the introduction, six months (month 1 through 5, and 10) exhibit significant abnormal volatility. However, during the months with a significant decrease in standard deviation, the reduction in standard deviation lies between six and seven percent in the respective months. The figures from the whole period of ten consecutive months show a reduction in volatility. This makes it interesting to test whether the cumulative effect is significant. In column six and seven, the cumulative excess standard deviations and their respective t-statistics for the ten months after the introduction date are presented. The cumulative effect shows a significant reduction in volatility after the introduction.

It is hard to give the numbers in column four and six a sound economic interpretation, since the standard deviations do not sum up to a meaningful

Table 8

Average and Cumulative Volatility Residuals, and Test Statistics, Around Option Listing

The table shows excess standard deviations and cumulative excess standard deviations in the event window, defined to be ten months before and ten after the announcement day of an option introduction. The day of listing is included as the first day in the first month in event time following the introduction. To calculate excess volatility, a one-factor market model is used to describe normal volatility, which is then subtracted from the realized volatility. Monthly standard deviations, estimated over 21 consecutive trading days, are used as a volatility measure. Forty-eight stocks from all Nordic markets are used and are grouped into 31 separate portfolios, one for each event date. In the first column the months are numbered in event time where month one is the month including the listing day. Columns two and three show the average excess standard deviations of the portfolios month by month with their respective t-statistic. The standard deviations are expressed on a yearly basis. Columns four and five show the cumulative average excess standard deviations starting cumulating at month –9, with their respective t-statistic. Columns six and seven show the cumulative average excess standard deviations starting cumulating at month 1, with their respective t-statistic. All t-statistics are asymptotically normally distributed with mean zero and standard deviation one.

Month	Average Excess Std	t-Statistic	Cumulative Excess Std	t-Statistic from month –9 to 10	Cumulative Excess Std	t-Statistic from month 1 to 10
-9	-0.0049	-0.2122	-0.0049	-0.2122	-	-
-8	0.0240	0.9778	0.0191	0.5094	-	-
-7	0.0269	1.0608	0.0460	0.9250	-	-
-6	0.0350	1.4116	0.0809	1.3460	-	-
-5	-0.0017	-0.0666	0.0793	1.1331	-	-
-4	-0.0263	-1.0613	0.0529	0.6706	-	-
-3	-0.0455	-1.8358	0.0075	0.0856	-	-
-2	-0.0417	-1.6833	-0.0342	-0.3593	-	-
-1	-0.0220	-0.8839	-0.0562	-0.5459	-	-
0	-0.0193	-0.7780	-0.0755	-0.6850	-	-
1	-0.0587	-2.3684	-0.1342	-1.1430	-0.0587	-2.3684
2	-0.0655	-2.6321	-0.1997	-1.6075	-0.1242	-3.1387
3	-0.0589	-2.3738	-0.2586	-1.9737	-0.1830	-3.5423
4	-0.0664	-2.6738	-0.3249	-2.3567	-0.2494	-3.9999
5	-0.0663	-2.6370	-0.3913	-2.7079	-0.3157	-4.3874
6	-0.0406	-1.6052	-0.4318	-2.8575	-0.3563	-4.3893
7	-0.0349	-1.3886	-0.4668	-2.9603	-0.3912	-4.3612
8	-0.0476	-1.9227	-0.5144	-3.1364	-0.4389	-4.4947
9	-0.0309	-1.2409	-0.5453	-3.2063	-0.4698	-4.4663
10	-0.0663	-2.6473	-0.6116	-3.4831	-0.5361	-4.7790

number. In spite of the problems with interpreting the numbers, the tests are still valid since the residuals are normally distributed by assumption. The results attained when implementing the model that utilizes the variances instead of the standard deviation in equation (3), it is possible to get an idea of what an interpretable number could be for the reduction in standard deviation over the ten-month period after the introduction. By assumption there are no autocorrelations in the residual variances. Therefore it is possible to cumulate the monthly residual variances over the period. Cumulating and taking the square root of the excess variance over the total ten-month period results in a number that can be interpreted as the cumulative reduction in standard deviation over the ten-month period. The result is a reduction of the standard deviation by 21.9 percent on a yearly basis, i.e. if the standard deviation were 40 percent before the announcement, it would be 31 percent one year later.

Thus, as total risk has changed, hypothesis (v) is rejected.

To see if the volatility effect has changed over time, the time of introduction is regressed upon the cumulative excess volatility for each stock. No significant time pattern is found, so the results of Mayhew and Mihov (1999) cannot be verified. An explanation might be that the Nordic exchanges have not yet exhausted the obvious candidates for listing, and are therefore still listing options in response to the permanent characteristics of the stocks, rather than to changes in market conditions, such as anticipated high volatility.

4.2.2 Idiosyncratic Risk

Variance ratios are used to test for a change in the idiosyncratic risk in connection with an option introduction. The total risk is also studied at the same time, using the same methodology, enabling a comparison between the different types of risks. The results are therefore presented together in this section.

As can be seen from Table 9, the two average SVRs are less than one (0.983 and 0.976), indicating that both the measured residual risk and the return volatility decline after the options have been introduced. Because the expectation of a ratio in general is greater than the ratio of expectations due to Jensen's inequality, it is likely that the median ratio is more informative. For the ten-month period considered, the median ratio is 0.909 and 0.843 respectively, indicating that the total volatility is reduced by almost 16%, while the firm specific volatility is reduced by 9 %. Testing the median to be different from one results in p-values in the order of 11%.

Due to the high p-value, the hypothesis (vi) cannot be rejected using variance ratios as measurement. The lack of significance when using variance ratios could, however, be explained by the low-powered test methodology. Support for this statement can be found when comparing the results from the previous section studying the effect on the total risk. As is shown there, the effect is strongly significant, but when using variance ratios the total risk effect is insignificant. Nabar and Park (1994) also point out the lack of power when using variance ratios. Even though the results are not statistically significant at conventional significance levels, it seems that more than half of the reduction of the total risk can be explained by a decline in the firm specific risk.

Table 9

Variance Ratios and Standardized Variance Ratios For Idiosyncratic and Total Risk Around Option Introduction

The table shows variance ratios (VR) and standardized variance ratios (SVR) for 58 firms with optioned stocks. Market model residuals estimated with ten months of daily returns before and after the listing date are used to estimate the idiosyncratic risk. The residuals are used to calculate variances before and after the listing. Ten months of daily returns are used to estimate the stock return variance before and after the listing date. Standardized variance ratios are calculated by dividing each period's variance by its corresponding market variance. The standardization adjusts for contemporaneous shifts in market volatility.

	Idiosyncratic Risk		Total Risk	
	VR	SVR	VR	SVR
Mean	1.188	0.9835	1.193	0.976
Median	1.008	0.909	1.007	0.843
Proportion of firms with declining volatility	0.50	0.55	0.50	0.57
No. of VR significantly greater than one	20	12	20	12
No. of VR significantly less than one	17	26	17	26
Wilcoxon Test p-value for H0: Median = 1	0.423	0.113	0.394	0.112

4.2.3 Systematic Risk

In the light of the significant decrease in the total risk, and considering that only half of it is explained by a reduction in the idiosyncratic risk, it could be expected that also the systematic risk would be influenced by the introduction of options. The analysis of the data has not supported this expectation. Estimating equation (9), 30 stocks out of 58 showed a reduction in beta. Six of these stocks showed significant shifts. Twenty-eight stocks showed an increase in beta after the option listing. Four of these were significant shifts. The shift coefficients were also plotted against calendar time. The coefficients were evenly distributed around zero with no time trend to be detected. Thus, the hypothesis (vii), presuming no change in the systematic risk, cannot be rejected.

This result differs from that of Alkebäck and Hagelin (1998), who find a significant decline in beta in their sample of Swedish optioned stocks. This difference may be explained by a difference in the methodology used, and by the fact that they use average bid-ask spreads instead of transaction prices.

To conclude from the results in this section, the total risk in the underlying stocks are reduced on an average by 21.9 percent during the ten-month period after the introduction of options. Six out of ten individual months show a significant reduction in volatility, and the downward trend over the whole ten-month period is clear and significant. Although not significant, part of the

Table 10

Stability of Beta Around Option Introduction

The table shows the results from running 58 separate regressions for each firm of optioned stocks. The regression model used is the one described in equation (11). 361 days of returns are used in the estimation. The dummy variable in the model takes the value one in the periods following the option listing and zero otherwise. The table shows the shift coefficient γ_i and the number of shifts in beta, with their respective shift direction.

Average γ_i -value	0.0175	t-Statistic	0.22
No. of negative shifts	30	No. of sign. Neg. shifts	6
No. of positive shifts	28	No. of sign. Pos. shifts	4

reduction of the total risk can be attributed to the reduction in the idiosyncratic risk. No evidence could be found in support of the possibility that option listing effects the systematic risk of the underlying stocks. These findings are in accordance with findings in other studies. The results support the idea that introducing options enhance people's investment opportunities in a risk-reducing and market-stabilizing way.

5 Conclusions

In the Nordic countries, the introduction of standardized options with stocks as underlying securities has reached a volume, and has covered a time span long enough to generate data for a statistical analysis of the effects of option trading.

The results of this investigation are mostly in accordance with the outcome of studies based on data from other countries, mainly the USA.

The introduction of options has proved to render the underlying stocks a significant price increase, and a persistent excess return compared to an index indicating normal return. The positive effect is strong and similar in magnitude to those in studies based on data from other countries. Contrary to the experiences from other studies, however, the observed increase in return seems to be associated with the date of announcement of the option program, rather than the date of introduction. Further, there is no evidence of a trend in the size of the price effect, as found in recent work based on option introductions made in the US. The findings in this study are therefore in harmony with the market efficiency hypothesis and the expectations that prices should be promptly adjusted when additional information reaches the market participants.

The positive price effect could be explained by a change in the risk of the underlying stock. An increased systematic risk or an increased idiosyncratic risk can lead to a price increase, assuming that the Capital Asset Pricing Model

(CAPM) holds. As the results show, no statistically significant support can be found for this argument. It can also be argued that options expand the opportunity set of investors and promote risk reallocation, which can be beneficial to market participants. To the degree that the investors experience a better control of the financial risk when options are introduced, the required yield can be reduced.

The impact on the total risk is also favorable, and in line with findings in other studies. No influence on the systematic risk could be verified. The volatility in the underlying stocks is found to decrease continuously for ten months after the introduction of the option program. Further, there is no evidence of a trend in the size of the volatility effect, as found in recent US studies. These results support the notions that derivatives widen the investment choices of the market participants, decrease risks, and provide improved hedging opportunities.

The reduced total risk could be explained by a reduction in the systematic and/or idiosyncratic risk. However, the last mentioned two types of risks have not significantly changed. One reason may be the power of the methodology used, and given the amount of data. It is also possible that the total risk will shift without a change in the systematic risk, since an introduction of options should not affect the balance sheet of a company. In this case the different risk levels can be attributed to a change in the idiosyncratic risk, although this has not been possible to verify at conventional significance levels.

In all, this study supports the idea that option introductions make markets more efficient. Nothing in the analysis gives any indication that derivative trading should contribute to financial unrest. On the contrary, option programs seems to add increased stability to the market.

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Appendix A

To investigate the price effect of an option introduction, an event study is undertaken. When calculating the abnormal returns of a security, the normal return over the event window is subtracted from the actual ex-post return. A modified market model implementing Fowler-Rorke [1983] betas[21], which adjusts for non-synchronous trading, is used to model the normal returns. It is assumed that the error term in the market model is normally distributed.

$$\hat{\varepsilon}_i^* = R_i^* - \hat{\alpha}_i \iota - \hat{\beta}_i R_m^* \qquad \text{(B1)}$$

$\hat{\varepsilon}_i^*$	Abnormal return
R_i^*	Vector of daily stock returns in the event window
R_m^*	Vector of daily market returns in the event window
ι	Vector of ones
$\hat{\alpha}_i$	Intercept coefficient estimated in the estimation window
$\hat{\beta}_i$	Regression coefficient estimated in the estimation window

The parameters in the market model are estimated on data in a period of 150 days after the event window (see Figure 1). To test for significant abnormal returns on individual stocks when options are introduced, the abnormal returns are averaged across stocks:

[21] Fowler-Rorke betas are calculated by running the regression below:

$$R_t = \alpha + \beta^{--} Rm_{t-2} + \beta^{-} Rm_{t-1} + \beta^{0} Rm_t + \beta^{+} Rm_{t+1} + \beta^{++} Rm_{t+2}$$

The stock's beta is then a weighted sum of the estimated regression parameters, as follows:

$$\text{plim}\hat{\beta} = \frac{1+\rho_1+\rho_2}{1+2\rho_1+2\rho_2}\beta^{--} + \frac{1+2\rho_1+\rho_2}{1+2\rho_1+2\rho_2}\beta^{-} + \beta^{0} + \frac{1+2\rho_1+\rho_2}{1+2\rho_1+2\rho_2}\beta^{+} + \frac{1+\rho_1+\rho_2}{1+2\rho_1+2\rho_2}\beta^{++}$$

The superscripts ++, +, 0, -, and -- indicate that each time series is shifted two days' lead, one day's lead, no lag, one day's lag, and two days' lag. ρ_1 and ρ_2 are the first and second order autocorrelation coefficients. This way of estimating beta is consistent with the methodology proposed by Scholes-Williams [1977].

$$\bar{\varepsilon}^* = \frac{1}{N}\sum_{i=1}^{N}\hat{\varepsilon}_i^* . \tag{B2}$$

Because of the uncertainty about the event date, it is sometimes interesting to test the abnormal return earned over a period of time. For this exercise the abnormal return is added over the considered time period. Define $\overline{CAR}(\tau_1, \tau_2)$ to denote the cumulative average abnormal return from τ_1 to τ_2, where τ_1 and τ_2 are two dates within the event window. For the cumulative average abnormal return we have:

$$\overline{CAR}(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2}\bar{\varepsilon}_t^* . \tag{B3}$$

The average cumulative abnormal returns are normally distributed with an expected abnormal return of zero. This can be used to draw an inference about the abnormal returns. To derive a test statistic that can be used to test for the significance of the average cumulative abnormal return, the variance of the average cumulative abnormal return in equation (B3) is needed. Denote the covariance matrix of the estimated abnormal return by $V_i = E\left[\hat{\varepsilon}_i^* \hat{\varepsilon}_i^{*'} \middle| X_i^*\right]$. Let γ be a (61 x 1) vector with ones in the position of the days corresponding to the interval τ_1 to τ_2 and zeros elsewhere. Aggregating the covariance matrices V_i across stocks results in a covariance matrix for the average abnormal return vector $\bar{\varepsilon}^*$, i.e.

$$Var(\bar{\varepsilon}^*) = V = \frac{1}{N^2}\sum_{i=1}^{N} V_i . \tag{B4}$$

By using the gamma vector to aggregate over time the variance of the average cumulative abnormal return can be calculated as

$$Var\left[\overline{CAR}(\tau_1, \tau_2)\right] = \bar{\sigma}^2(\tau_1, \tau_2) = \gamma' V \gamma . \tag{B5}$$

The hypothesis that the abnormal return is equal to zero can be tested by using the test statistic

$$J = \frac{\overline{CAR}(\tau_1, \tau_2)}{\sqrt{\hat{\bar{\sigma}}^2(\tau_1, \tau_2)}} \overset{a}{\sim} N(0,1) \tag{B6}$$

where a sample estimate of $\bar{\sigma}^2(\tau_1, \tau_2)$ is used.

Appendix B

The following is the derivation of the estimation procedure for the different volatility models proposed in section two, equation (3). The standard deviation σ will be used throughout the derivation, but the derivation is the same independently of the volatility measure. Just change σ to any of the other two measures. The notation used in the derivation follows Nabar and Park [1994], and Judge et al. [1980]. The derivation is carried out for one single security.
Let

$$Y = \begin{bmatrix} \sigma_{i,1} \\ \vdots \\ \sigma_{i,T} \end{bmatrix}$$

be the vector of independent values during the estimation period, and

$$X = \begin{bmatrix} 1 & \sigma_{m,1} \\ \vdots & \vdots \\ 1 & \sigma_{m,T} \end{bmatrix}$$

be the matrix of dependent variables in the estimation window. σ_{it} is the standard deviation of stock i in month t and σ_{mt} is the standard deviation of the market index in month t. Also, let

$$\varepsilon = \begin{bmatrix} \varepsilon_1 \\ \vdots \\ \varepsilon_T \end{bmatrix} \tag{C1}$$

be the disturbance vector, which is assumed to be normally distributed. Recall that the market model for standard deviations is

$$\sigma_{it} = a_i + b_i \sigma_{mt} + e_{it}. \tag{C2}$$

This can be expressed as a regression system on the form

$$Y = X\beta + \varepsilon, \tag{C3}$$

where $\beta = [a \quad b]'$ is the vector of parameters. In this case assume that the residuals follow an AR(1) process, i.e.

$$\varepsilon_\tau = \rho\varepsilon_{\tau-1} + v_\tau \Rightarrow \sigma_\varepsilon^2 = \frac{\sigma_v^2}{1-\rho^2}. \tag{C4}$$

Let $\hat{\varepsilon}$ be the OLS residual and estimate $\rho = corr(\hat{\varepsilon}_t, \hat{\varepsilon}_{t-1})$ by

$$\hat{\rho} = \frac{\sum_{t=2}^{T} \hat{\varepsilon}_t \hat{\varepsilon}_{t-1}}{\sum_{t=1}^{T} \hat{\varepsilon}_t^2}. \tag{C5}$$

Estimate the variance of the residual in the AR(1) process by

$$\hat{\sigma}_v^2 = \frac{(Y - X\beta)' \hat{P}' \hat{P} (Y - X\beta)}{T - K}, \tag{C6}$$

where $\hat{P}$ is the estimated transformation matrix. The estimation is done by using $\hat{\rho}$. The transformation matrix is described next. If

$$E(\varepsilon\varepsilon') = \sigma_\varepsilon^2 \Omega = \frac{\sigma_v^2}{1-\rho^2} \Omega = \sigma_v^2 \Psi \tag{C7}$$

let

$$P'P = \Psi^{-1} \tag{C8}$$

where P is a transformation matrix. Using ρ it looks like

$$P = \begin{bmatrix} \sqrt{1-\rho} & 0 & 0 & \cdots & 0 & 0 \\ -\rho & 1 & 0 & \cdots & 0 & 0 \\ 0 & -\rho & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & 1 & 0 \\ 0 & 0 & 0 & \cdots & -\rho & 1 \end{bmatrix}. \tag{C9}$$

From the definition of P it follows that

$$\Psi = \frac{1}{1-\rho^2} \begin{bmatrix} 1 & \rho & \cdots & \rho^{T-2} & \rho^{T-1} \\ \rho & 1 & \cdots & \rho^{T-3} & \rho^{T-2} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \rho^{T-2} & \rho^{T-3} & \cdots & 1 & \rho \\ \rho^{T-1} & \rho^{T-3} & \cdots & \rho & 1 \end{bmatrix} \tag{C10}$$

and

$$\Psi^{-1} = \begin{bmatrix} 1 & -\rho & 0 & \cdots & 0 \\ -\rho & 1+\rho^2 & \ddots & \ddots & \vdots \\ 0 & \ddots & \ddots & \ddots & 0 \\ \vdots & \ddots & \ddots & 1+\rho^2 & -\rho \\ 0 & \cdots & 0 & -\rho & 1 \end{bmatrix}. \tag{C11}$$

Transform the data

$$\begin{aligned} & PY = PX\beta + P\varepsilon \\ & \quad \Rightarrow Y_* = X_*\beta + \varepsilon_* \\ & \quad \Rightarrow \hat{\beta} = \left(X'\Omega^{-1}X\right)^{-1}\left(X'\Omega^{-1}Y\right) \\ & \quad \Rightarrow \hat{\varepsilon} = Y - X\hat{\beta} \end{aligned} \tag{C12}$$

Post estimation period residuals become

$$\begin{aligned} \hat{\varepsilon}^*_{T+1} &= y^*_{T+1} - \hat{\beta}' x^*_{T+1} - \rho\hat{\varepsilon}_T \\ \hat{\varepsilon}^*_{T+n} &= y^*_{T+n} - \hat{\beta}' x^*_{T+n} - \rho^n\hat{\varepsilon}_T \end{aligned} \tag{C13}$$

and result in a 1 by n vector

$$\begin{aligned}\varepsilon^* &= Y^* - X^*\hat{\beta} - V'\Psi^{-1}\left(Y - X\hat{\beta}\right) \\ &= Y^* - X^*\hat{\beta}V'\Psi^{-1}\hat{\varepsilon}\end{aligned}, \tag{C14}$$

where n is the number of months in the event window. Y^* and X^* are the dependent and independent variables in the event window, see Figure 2. The matrix V is described in what follows. To be able to draw an inference about the abnormal variances ε^*, the covariance matrix has to be derived. Let

$$E\left[\begin{pmatrix}\varepsilon \\ \varepsilon^*\end{pmatrix}\begin{pmatrix}\varepsilon' & \varepsilon^{*'}\end{pmatrix}\right] = \sigma_v^2\begin{bmatrix}\Psi & V \\ V & \Psi^*\end{bmatrix} = E\begin{bmatrix}\varepsilon\varepsilon' & \varepsilon\varepsilon^{*'} \\ \varepsilon^*\varepsilon' & \varepsilon^*\varepsilon^{*'}\end{bmatrix} \tag{C15}$$

then

$$V = \frac{1}{1-\rho^2}\begin{bmatrix}\rho^T & \rho^{T+1} & \cdots & \rho^{T+n-2} & \rho^{T+n-1} \\ \rho^{T-1} & \rho^T & \cdots & \rho^{T+n-3} & \rho^{T+n-2} \\ \vdots & \vdots & \cdots & \vdots & \vdots \\ \rho^2 & \rho^3 & \cdots & \rho^n & \rho^{n+1} \\ \rho & \rho^2 & \cdots & \rho^{n-1} & \rho^n\end{bmatrix} \tag{C16}$$

and

$$\Psi^* = \frac{1}{1-\rho^2}\begin{bmatrix}1 & \rho & \cdots & \rho^{n-2} & \rho^{n-1} \\ \rho & \ddots & & & \rho^{n-2} \\ \vdots & & \ddots & & \\ \rho^{n-2} & & & \ddots & \rho \\ \rho^{n-1} & \rho^{n-2} & \cdots & \rho & 1\end{bmatrix}. \tag{C17}$$

The variance covariance matrix becomes (C18)

$$\begin{aligned}&\Sigma = E\left[\hat{\varepsilon}^*\hat{\varepsilon}^{*'}\middle|\mathbf{X}^*, \Psi^{-1}, \mathbf{V}\right] = \\ &= \sigma_v^2\left[\mathbf{X}^*\mathbf{C}\mathbf{X}^{*'} + \Psi^* - \mathbf{V}'\left(\Psi^{-1} - \Psi^{-1}\mathbf{X}\mathbf{C}\mathbf{X}'\Psi^{-1}\right)\mathbf{V} - \mathbf{X}^*\mathbf{C}\mathbf{X}'\Psi^{-1}\mathbf{V} - \mathbf{V}'\Psi^{-1}\mathbf{X}\mathbf{C}\mathbf{X}^{*'}\right]'\end{aligned}$$

where

$$C = \left[X^{'} \mathbf{\Psi}^{-1} X \right]^{-1} . \tag{C19}$$

Appendix C

Listed in the table below are all the shares of companies, announcement dates and listing dates used in the study.

Company Name	Symbol	Exchange[a]	Database[b]	Listed	Delisted	Announced
ASTRA A BU	ASTR-AB.SE	OM	SIX	850612		850506
ATLAS COPCO A	ATCO-A.SE	OM	SIX	850612		850506
BOLIDEN A	BOLI-AB.SE	OM	SIX	850612	871216	850429
SCA B BU	SCA-BB.SE	OM	SIX	850612		850429
SKANDIA FR	SDIA.SE	OM	SIX	850612		850429
VOLVO B BU	VOLV-BB.SE	OM	SIX	850612		850429
ELECTROLUX B FR	ELUX-B.SE	OM	SIX	860210		860131
ERICSSON B FR	LME-B.SE	OM	SIX	860210		860131
PHARMACIA B	GPHA-BB.SE	OM	SIX	860721	900709	860717
SKF B FR	SKF-B.SE	OM	SIX	860721		860717
S-E-BANKEN A	SEB-A.SE	OM	SIX	870601		870521
ASEA A BU	ABB-AB.SE	OM	SIX	880411		880405
TRELLEBORG B BU	TREL-BB.SE	OM	SIX	880912		880908
SKANSKA B BU	SKA-BB.SE	OM	SIX	890206		890202
SAAB A	GSAA-AB.SE	OM	SIX	890323	910308	890321
SVENSKA HANDELSBANKEN	SHB-A.SE	OM	SIX	890323		890321
MUNKSJÖ A BU	GMUN-AB.SE	OM	SIX	890607	910122	890602
AVESTA BU	AVES-BU.SE	OM	SIX	900404		900328
BERGESEN	N:BEB(RI)	OSE	DS	900522		
HAFSLUND NYCOMED B	N:HNB(RI)	OSE	DS	900522	Dec-90	
NORSK HYDRO	N:NHY(RI)	OSE	DS	900522		
SAGA PETROLEUM A	N:SAG(RI)	OSE	DS	900522		
DANISCO	N:DAOG(RI)	CSE	DS	901207		
DEN DANSKE BANK	N:CL@G(RI)	CSE	DS	901207		
NOVO NORDISK B	N:NI@G(RI)	CSE	DS	901207		
UNIDANMARK A	N:UNNDK(RI)	CSE	DS	901207		
HAFLUND NYCOMED A	N:HNA(RI)	OSE	DS	911220	May-96	
INVESTOR B FR	INVE-B.SE	OM	SIX	920323		920312
CARLSBERG B	N:CQBG(RI)	CSE	DS	930107		
ISS B	N:IS@G(RI)	CSE	DS	930107		
KVAERNER A	N:KVI(RI)	OSE	DS	930429		
SANDVIK B FR	SAND-B.SE	OM	SIX	930528		930519
NORDSTRÖM & THULIN	N&T-B.SE	OM	SIX	930601		930525
STORA B FR	STOR-B.SE	OM	SIX	930604		930528
HUHTAMÄKI I	M:HUIF(RI)	HSE	DS	931001		
NOKIA A	M:NOKP(RI)	HSE	DS	931001		
POHJOLA B	M:POBR(RI)	HSE	DS	931001		
KINNEVIK B FR	KINV-B.SE	OM	SIX	931011		931007
ENSO R	M:EGR(RI)	HSE	DS	940117		
AKER A	N:AKE(RI)	OSE	DS	940131	Feb-99	
MODO B	MODO-B.SE	OM	SIX	940308		940304
SSAB A	SSAB-A.SE	OM	SIX	940308		940304
OUTOKUMPU	M:OUTO(RI)	HSE	DS	940802		
HENNES & MAURITZ B	H&M-B.SE	OM	SIX	950517		950510

Company Name	Symbol	Exchange[a]	Database[b]	Listed	Delisted	Announced
STADSHYPOTEK	SHYP-A.SE	OM	SIX	950616	970516	950609
AUTOLIV AB	ALAB.SE	OM	SIX	950919	970509	950914
OY NOKIA AB	NOKI-SDB.SE	OM	SIX	960627		960619
NORDBANKEN AB	NORB.SE	OM	SIX	961014		961007
ALLGON B	ALLG-B.SE	OM	SIX	970128		970120
ELKEM	N:ELK(RI)	OSE	DS	970214		970204
NORSKE SKOGINDUSTRIER	N:NSG(RI)	OSE	DS	970214		970204
DEN NORSKE BANK	N:DNB(RI)	OSE	DS	970410		970407
PGS	N:PGS(RI)	OSE	DS	970410		970407
NYCOMED A	N:NYC(RI)	OSE	DS	970515		
ORKLA A	N:ORK(RI)	OSE	DS	980420		980402
STOREBRAND	N:STB(RI)	OSE	DS	980420		980402
NCL HOLDING	N:NCL(RI)	OSE	DS	980828		980821
MERKANTILDATA	N:MED(RI)	OSE	DS	981120		981104

a) The abbreviations stand for Options Mäklarna (OM), Oslo Stock Exchange (OSE), Copenhagen Stock Exchange (CSE), and Helsinki Stock Exchange (HSE).

b) The price series were taken from either Scandinavian Information Exchange (SIX) or Datastream (DS).