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An Event-Study

The impact of new information on
the return in shares
and
the implicit volatility in call options.

Master Thesis in Financial Economics

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Abstract: This essay explains the relation between the return on a company's stock and the implicit volatility in its call option on one hand and the impact new information has on these on the other hand. The purpose with this essay is to explain how the Swedish Share Market and Option Market react on new information in content of quarterly reports and investigate if the is any abnormal return on the selected shares during this period. The study will also observe if it exist any abnormality in the implicit volatility in the company's call option. To investigate this properly; an Event Study will be performed and a significance test and a cross sectional analysis will be used. The conclusion of the study shows, in line with previous studies conducted by Pramborg&Hagelin, that there is a divergence the time around the report date. As shown in the figures above and in the significance test, there is an abnormal return in shares the period around a report date. This however is an one-time adjustment to the new information being released on the market. The same pattern can be seen in the implicit volatility in the respective share's call option.

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1 Prologue

Commerce with derivatives is not a recent invention, rather it has been here for quite some time now. But it is only in the last couple of decades that the commerce with derivatives has been a key instrument in the world of finance. What exactly is a derivative and what can it be used for? One kind of derivative is options, which is the content of this paper. An option is a contract between a buyer and a seller, where the buyer has a right to and the seller is obliged to carry out a deal of a underlying commodity, such as a share, on a certain time in the future, to a certain price.[1] Options are like any other commodity and its price is decided on the basis of supply and demand, but what is the "right" price and how can options properly be analysed?

There has been a tremendous amount of research in the field of derivatives and among the first to derive a pricing formula for options were three very distinct gentlemen, namely Fischer Black, Myron Scholes and Robert Merton. Their research in the 70's resulted in the famous Black&Scholes formula. To explain the formula in short, there is only one variable that has to be appreciated and that is the implicit volatility, all the other variables are known. The implicit volatility is the future movement in return of the underlying share. How could the implicit volatility be appraised and is it constant over time? One way of making such estimation is by analysing past behaviour. But this method has some disadvantages.

"Trying to predict the future by analysing in the past, is like driving a car only looking in the rear view mirror" Professor Bill Worner

This paper will investigate if there is a case of abnormal return of 12 selected companies on the SAX during the event of a quarterly report and at the same time investigate if the implicit volatility behaves in a similar pattern.

[1] Hull, 2003, ch 1

1.1 Background

Risk is a concept that has a very broad definition, but what exactly is the definition? One definition is; “The possibility of suffering hurt or loss, or a particular course of events that contents danger or uncertainty”.[2] Within the field of finance is the definition slightly modified, “A situation, where more than one outcome can occur and the probability for every outcome can be estimated".[3] Or, "to what extent the spread of a variable has around its mean"[4]

The problem concerning risk and the wish of redistribute risk between buyer and seller was the very driving force behind the invention of derivatives. To minimize the risk of loss in the future, a person can in a contract today decide the price of a share and he doesn’t have to guess what the price will be in the future. This service is not for free, the buyer of the commodity has to pay a certain amount for this contract to the seller. The beautiful part with options is that the buyer doesn’t have to carry out the deal if he wishes not to, whereas the seller of the contract always is obliged to participate. But a serious option trader doesn’t only look at the price of the option and the share. A serious trader analyses other factors as well, i.e. time horizon of the option and perhaps the most important one, the volatility in return of the underlying share, because this determines for the most part the implicit volatility of the option. The higher the implicit volatility is the riskier option.

Why is interesting at all, if the implicit volatility does change during the time around a quarterly report? It is interesting to see how the market reacts to the fact that new information is going to be released and what the consequences are. The most likely scenario is that the market will do a one-time adjustment of the share prices and this will for the most cases not affect the general risk profile of the company, but of course there are exceptions. This is under the assumption that the market is more or less efficient and it has a free flow of information. If there is abnormal return in the underlying share, then that increase in variance may “follow” to the option of the share. Is that really the case in reality?

1.2 Formulation of the problem

In this paper I want to analyze how the market reacts on new information. The problems I will investigate are; Is the return on certain shares is normal or abnormal the time around a

[2] Eiteman, Stonehill & Moffet, 2001, sid.470
[3] Parkin, Powell & Mathews, s. 402
[4] Moosa, 2001, s. 416

quarterly report? Has the call option of the same company's implicit volatility the same movement?

1.3 Purpose

The purpose of this paper is to explain how the Swedish Share Market and Option Market react on new information in context of quarterly reports and investigate if there is any abnormal return on the selected shares during this period. The study will also observe if it exist any abnormality in the implicit volatility in the company's call option. To investigate this properly; an Event Study will be performed and a significance test and a cross sectional analysis will be used.

1.4 Delimitation

From the companies that are listed on the SAX, there are 35-40 that also have options listed. I have chosen 12 companies for this paper. The reason is that the volumes of traded options differ quite substantially. I chose the companies where the trading volume is the largest, which almost always are the largest companies on the SAX. I have also chosen three different options for every quarterly report. That means 12 companies on 4 dates and 3 different option each date. In total 144 observations. The objective with the sample is to get a broad variety of industries, to prevent any industry specific phenomenon. The companies that I have chosen are; ABB, Ericsson, Nokia, Handelsbanken, AstraZeneca, Investor, Pharmacia, SKF, Electrolux, Stora Enso, Telia och Volvo. The time period of my selection is the year 2002 and it should be noted that the SAX fell heavily during this period and it would be interesting to do a similar investigation when the SAX rises. This paper will only consider call options.

2 Theory of Options

The first section of this chapter explains what an option is and what determines its value. Latter parts will present the most famous of pricing formulas concerning options, namely Black&Scholes. In the end of the chapter the problems with calculating the volatility for the option will be discussed.

2.1 Option

2.1.1 What is an option?

There are two different kinds of options, call and put. A call option gives the buyer the right to buy the underlying share at a specific price, at a specific date in the future. A put option is the other way around; the owner has the right to sell the underlying share at a specific price, at a specific date in the future. It has to be stressed that the owner of an option has the right to make a deal, not obliged to, like the seller. That is the major difference between options and futures/ forwards.[5] Because the seller is the risk taker in this deal, he naturally wants to be compensated and that is called the premium of the option. In the case with futures or forwards both parties are risk takers and therefore no premium is necessary. Options can be divided into two broad groups, namely American and European. The difference between the two is fairly simple; the first can be used, or cashed in, at any time from day one until maturity, while the latter can only be used at maturity date. This advantage for American options is not for free and an American option generally goes for a higher price than a European option.[6] The share option listed at OM is the American type, while the index options are European.[7]

2.1.2 What determines the value of an option?

The premium or the price of an option is determined by a number of factors, but most important is the marketplace. It is supply and demand that practically speaking decides the premium.

[5] Hull, 2003, p. 6
[6] Elton & Gruber, 1995, p. 577
[7] Karlsson, 1995 p. 102c

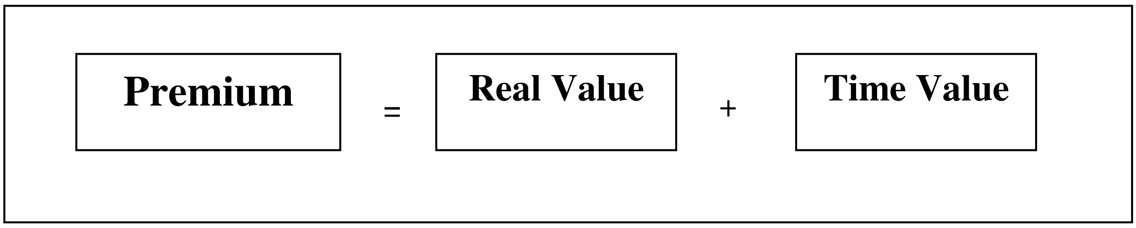


Figure 1: Premium of an option

It is also possible to calculate the theoretical value of an option. The theoretical price is a benchmark for the actual price. One easy way of calculate the value of an option is to add the *real* value of an option with its *time* value[8], which is illustrated above.

The real value of a…

…call option is equal the spot price of the share less the exercise price, if the spot price is higher than the exercise price.

…put option is equal the exercise price of an option less the spot price, if the spot price is lower than the exercise price.

The time value of an option is made up of several different factors such as interest rate, volatility of the underlying share, time to maturity etc. The size of the interest rate is of a smaller significance for the price of the option. So if the price of the share is constant, the value of the option will fall a little day by day, theoretically speaking. Time is then working against the owner of the option. The time value falls especially fast the last month, as seen in the diagram on the next page.

[8] OM, educational material, www.stockholmborsens.se 2005-03-20

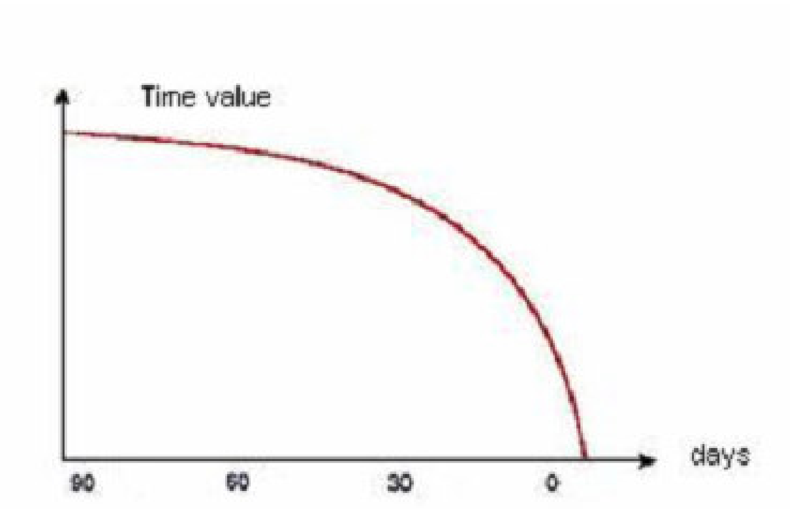


Figure 2: Time Value of an option

With the remaining the days to maturity decreasing, the chance of higher share price decreases and so does the value of the option.[9]

The implicit volatility is defined as; the markets expectations of a share's future movements in price. A rule of thumb is, the higher the implicit volatility, the greater is the risk of bigger movements in share price. With a higher risk comes higher premium, because the share price can be really high or low at maturity date.

To summarize this section,

Real Value	**Time Value**
Spot Price – Exercise Price	Interest Implicit Volatility Time remaining

Figure 3: Value of an option in detail

2.1.3 Black&Scholes

While it is the Black&Scholes formula that is foundation of my paper, it is also proper to explain the formula and also give the assumptions and the limitations of it. Thereby I am also pointing out some of the limitations of my study.

[9] OM, educational material, www.stockholmborsens.se 2005-03-20

The Black&Scholes formula for call options;

$$C = SN(d_1) - Ke^{(rT)}N(d_2)) \tag{2.1}$$

$$d_1 = \frac{\ln(S / K) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}} \tag{2.2}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{2.3}$$

Where;

C = Call options theoretical value

S = Spot price of the share

N(d) = cumulative normal distribution

K = Exercise price of the option

e = 2,7183

r = risk free interest rate

T = time to maturity

ln = the natural logarithm

σ = the volatility of the share

For the variables d_1 and d_2, I have written the mathematical proof in the appendix.

2.1.4 Assumptions for Black&Scholes[10]

No dividend during the time period of the option

This may seem to be an extreme assumption, because many companies do give out dividend at some point during the year. The higher the dividend is, the lower the price of the option. A

[10]http://www.nek.lu.se/option/BlackScholesDiff.pdf 2005-07-10

common way of compensate for the dividend is to subtract the discounted future dividend from the share price.

European options

European options can only be cashed in at maturity date, while American options have no such restriction. Due to greater flexibility, American options are usually a little more expensive. This is not a very big problem, because the holders of American options usually cash in just days before maturity date, which means that they lose a small portion of the time value.

Effective markets

This assumption says that no one can make consequent predictions of what directions the market or certain shares will take in the future.

No transaction costs

In general, investors pay a fee when making a transaction. Individual investors pay a higher fee than institutional investors, which can result in a minor error in calculating the price of the option.

The risk free rate of return is constant and known

In reality, there is no such thing as a risk free rate of return, but a 90 days government bond is the somewhat the closest to it.

The return on shares are log normally distributed

This assumption states that the return of underlying share is log normally distributed. It is not necessarily so, but is it a reasonable approximation.

2.1.5 Difficulty with the volatility

The most difficult part in calculating the price of an option is to estimate the volatility in return of the underlying share. It is impossible to know the movements of the volatility in the future, but it has to be estimated. One way of estimating the future volatility is to calculate the historical volatility. There are number of ways to do this and one of them is to calculate the change in return from day to day, or week to week, and use that data to calculate the variance.

Previous studies show that shares have a volatility in return of approximately 20-50%.[11] To choose exact number of days or weeks for the calculations of the variance is not an easy task to do. In general, the more observations the better, but there is a problem with this methodology; the variance of a share is not constant over time, so if the observations are too old, they may not be so relevant for predicting the future. A rule of thumb is to use equal amount of historical time periods as the time periods one wish to estimate. For an example, if you want to estimate the variance of daily return on share in the next 100 days, it is reasonable to use the previous 100 trading days. A mapping of the implicit volatility of share options, when it is a function of its exercise price, is called *volatility smile* or *volatility skew*. The volatility smile has a general appearance, which is illustrated in figure 4. For an example, say that the share price is 50 SEK. An option with 50 SEK as an exercise price is called at-the-money. If the share price is 40 or 60 SEK, they are called out-the-money and in-the-money respectively.

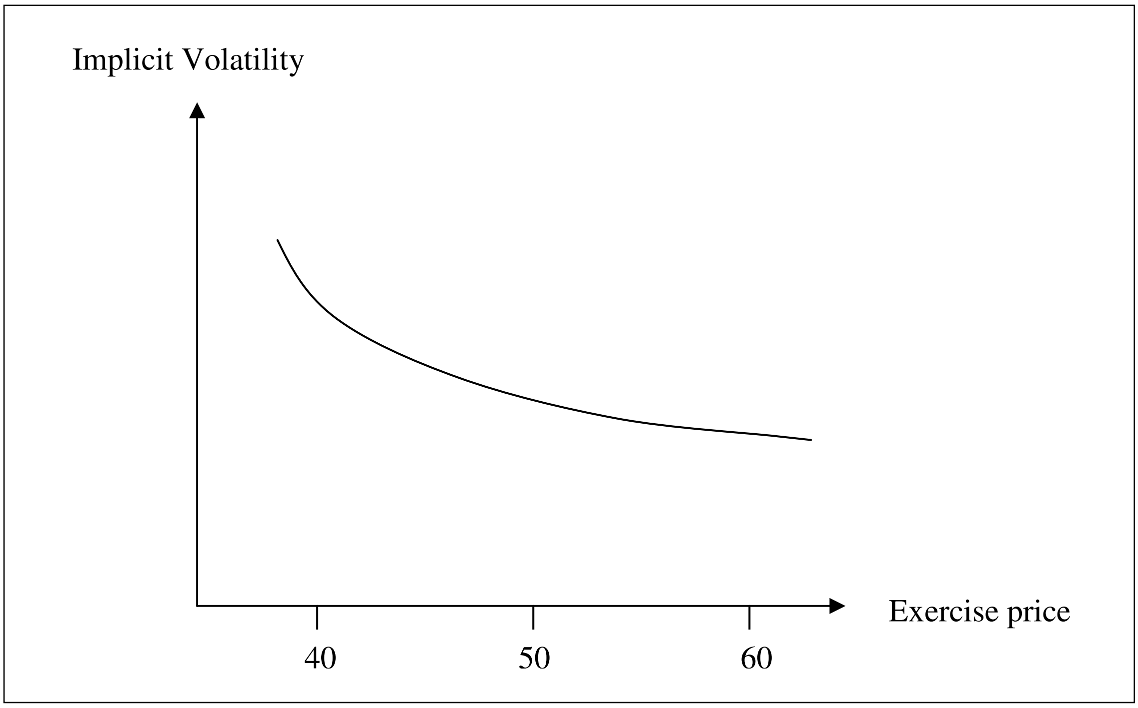


Figure 4: Volatility skew

The volatility decreases as the exercise price gets larger. One possible explanation to the volatility smile could be the leverage of a share option. Leverage is the relation between

[11] Hull, 2003, s. 238

liabilities and equity plus liabilities. When the share price decreases, the leverage ratio is increasing. The reason for this is that the proportion of equity is smaller.

$$Leverage = \frac{Debt}{Debt + Equity}$$

The result is a higher volatility for the particular share, which makes even lower share prices more likely. If the share price is increasing, the leverage ratio is decreasing due to a higher proportion of equity. This leads to a lower volatility, which makes higher share prices less likely. An interesting observation is that this pattern has only existed after the crash in October 1987. Before the crash, the implicit volatility was less dependent on the share price. The pattern in figur is called *crashophobia*[12] In short it means that investors are intimidated by the risk of another crash, similar to the one in October 1987 and the share options are valued in a similar fashion. There is some empirical evidence that supports crashophobia. When there is a significant bear market, there are some tendencies that the volatility skew is getting steeper. The negative correlation between share prices and volatility decreases and vice versa.

[12] Rubinstein M. Journal of Finance, 1994, s. 771-818.

3 Event study

The governing idea through this paper is to analyse how the implicit volatility change the days before and after a quarterly report. The twelve above mentioned companies constitute the material for this paper, beginning with 2001's accounts. In a similar fashion, the change in return on respective share will be calculated. The purpose is to test and analyse if there is a connection between the change in return and implicit volatility of the share option. The time horizon for this investigation is ten days before and after the report.

3.1 Previous studies

There is a number of studies performed using Event study as a methodical concept, but I'm just looking into one particular, name the paper written by Pramborg&Hagelin.[13] This paper investigated different companies' exposure to the exchange rate of foreign currency. In a highly internationalized and competitive economy, many companies can expect to be more affected to exchange rate exposure than others. Modern capital market theory states that the valuation of a company is directly affect by unexpected movements in the exchange rate. But the empirical research shows that it exists a time-delay between changes in the exchange rate and the valuation of a company. The main contribution of Pramborg&Hagelin's paper to previous research is that it investigates the role quarterly reports play, when it comes to informing investors about the effects of hedging. Hedging is basically a way to protect your investment by invest your capital in many different commodities. A successful hedging results in a decrease in exchange rate exposure and therefore decreases the effects of a sudden change in the exchange rate. Pramborg&Hagelin have examined if the volatility of a share has a connection with the company's exposure to changes in the exchange rate. The result showed that it exists an abnormally large volatility in return for the company's shares at the day of the report, which means that the quarterly reports contain new information, which is crucial for investors and the increase in volatility is positively correlated to the company's exposure to changes in the exchange rate.

Some event-studies concerning the implicit volatility has been conducted, but they have analysed how volatility smile is reacting to new information, that is how the implicit volatility as a function of the exercise price looks like when new information is released. The result

[13] Pramborg, 2002, ch. 4.

from these studies shows that the options with the highest implicit volatility are those which are at-the-money. Both out-of-the-money and in-the-money have a lower implicit volatility.[14]

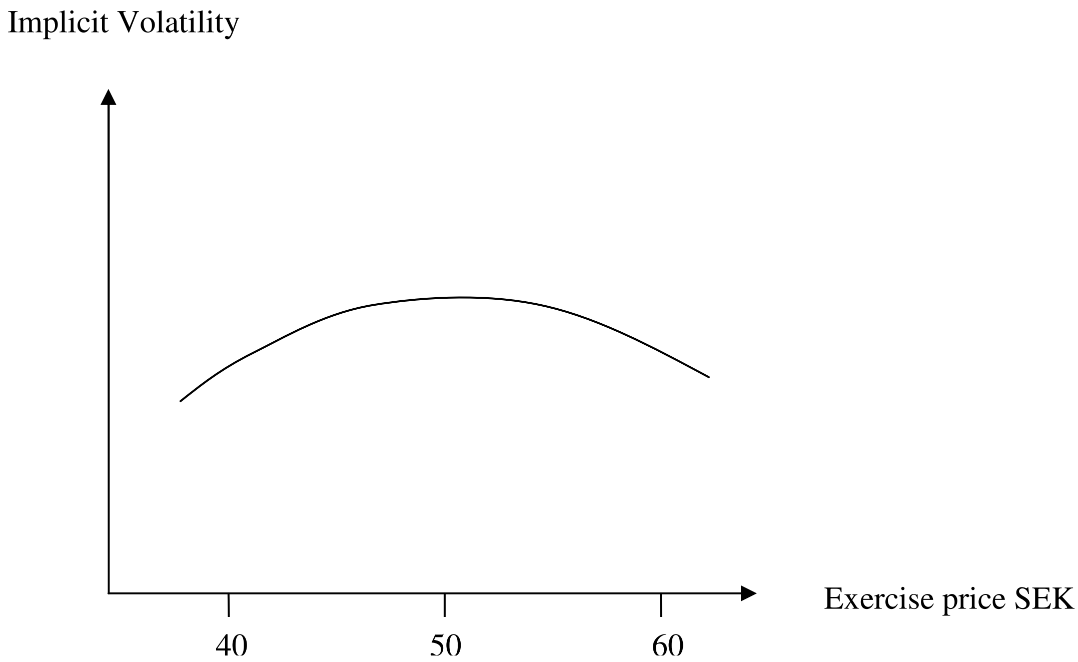


Figure 5: Volatility skew days before a report.

The key difference between my paper and previous studies is the fact that my paper investigates the implicit volatility regardless of the exercise price. To do this I have taken one of each out-of, at- and in-the-money options at a particular date of report.

3.2 Assumptions for the calculations of Implicit Volatility

While the Black&Scholes formula has been the foundation of my calculations of the implicit volatility, I feel it is only natural that I explain the other variables in the formula and how they have been handled.

Daily value of share

The daily price of the shares in question has been taken from Affärsdatas database and it is the closing value that will be used. There are some problems associated with using closing value and those will be addressed later on.

Exercise price

[14] Hull, 2003, s.339.

For every report date, I have chosen three options with different exercise price. The reason for this is to eliminate volatility skew or volatility smile. Since options have different volatility at different exercise prices, it may occur some errors using only one option. This error can be avoided if three options are used, one of each in-, at and out-of-the-money options and an average of the three are calculated. When I take the fact that different exercise prices have different implicit volatilities into consideration, the result of the movement pattern will be more just. The sample criterions for selecting the options have been;

- As I mentioned above, the selection has been three options for every report, one in-the-money, one at-the-money and one out-of-the-money.
- Another important criterion has been the trading volume of the option. It is a very important aspect, particularly when it comes to find the "correct" price of the option.

Risk free interest rate

For the risk free interest rate I have used the 90 days government bonds, since that is the practically the closest to a risk free financial commodity one can get.

Time to maturity

There are two ways of calculating time to maturity[15]

$$T = \frac{Number\ of\ days\ until\ maturity}{Number\ of\ businessdays\ per\ annum}$$

The standard number of trading days in one year is 252.

$$T = \frac{Number\ of\ calendardays\ until\ maturity}{Number\ of\ days\ per\ annum}$$

When calculating implicit volatility, the former formula should be used. The main reason is that it is trading itself that causes volatility and since trading only occurs on business days it is only natural to use trading days. In this paper the latter formula is used, because it is easier and a time saver. It should be noted that this does not affect the result of this paper, since all observations are treated the same way. The exercise date is the third Friday every month.

[15] French, K. R., 1980, p. 55-69

The price of the call option

Commerce with options on the Share Exchange works exactly the same as for shares. There are two prices noted, bid and ask. The difference between the two is called the *spread*. So there are two prices noted, but only one can be used in Black&Scholes formula, what price should be used? Well, I decided that the average price between bid and ask if quite fair. Earlier I mentioned that the trading volume of the option was an important criterion in selecting the right option. The reason for this is, with a high trading volume comes a smaller spread, which makes the average price calculated more precise. And vice versa, if the trading volume is small, the spread is bigger and the calculated average may not be so precise. It should be noted that an exact estimation of the price can never be found.

3.3 Problem with preparation of the data material

Problems concerning the data always occur when using Black&Scholes pricing formula. First, which is true for all pricing formulas concerning option pricing, the market has to be efficient and the model must be correct. If one of these criterions or both are not met, the formula falls. The second problem is, future share prices are not an observable variable, so it is impossible to calculated volatility on, but it has to be estimated. There are alternatives, like historical or implicit share prices, but they will never be 100% accurate. Third problem is a synchronisation problem between share price and option price. If an option has a small trading volume, it is very hard to find the "right" share price. For an example, say that the options were sold at 13,00 PM and the closing share price is used, it can result in errors. A lot of things can happen on an afternoon.[16] The last problem is the dividend of the share. It makes a lot of sense to include the dividend in the calculations, but it has complications. If dividends are included, tax considerations must be too.[17] This makes Black&Scholes formula very difficult, so I have not included dividends that may occur in my calculations.

3.4 Calculation Implicit Volatility

As I mentioned earlier there is only one variable that has to be estimated, namely Implicit Volatility. The others; Historical option prices, Share prices, Exercise prices, Risk free rate of return and Time to maturity are all known. Simply by using Solver in Excel, it is easy to derive the Implicit Volatility with all these variables known.

[16] Hull, 2003, s.340
[17] Hull, 2003, s.241

The result of this calculation will be how the implicit volatility moves the time around a company report. The compilation will be; Every company has 3 different call option at 4 different occasions, in sum 12 and an average will be calculated for day -10 for all 12 occasions. The same procedure will be used for day -9 and so on. Relating back to previous discussions about volatility skew and different exercise prices to every report, the volatility skew can be eliminated from the investigation, because every option has the same weight in calculating the average.

3.5 Calculation Abnormal Return

For this calculation I have chosen the Constant-mean-return model, because it gives a fair value of the abnormal return. There are other slightly more advanced methods one can choose for this calculation, that gives a higher R^2 factor such as the Market-model[18], which reduces the variance of the abnormal return. The Multi-Factor model is an even more advanced formula that takes other variables than the market variance into account and the result is a higher R^2 factor. The reason I chose the Constant-mean-return model is, it gives me a good enough value for my comparison with the implicit volatility and since I have such large number of quarterly reports it would not give the research a "better" value using the other methods.

The Constant-mean-return model;

$$R_{it} = \mu_i + \xi_{it}$$

$$\xi_{it} = R_{it} - \mu_i$$

$$E[\xi_{it}] = 0$$

$$Var[\xi_{it}] = \sigma^2_{\xi i}$$

Where;

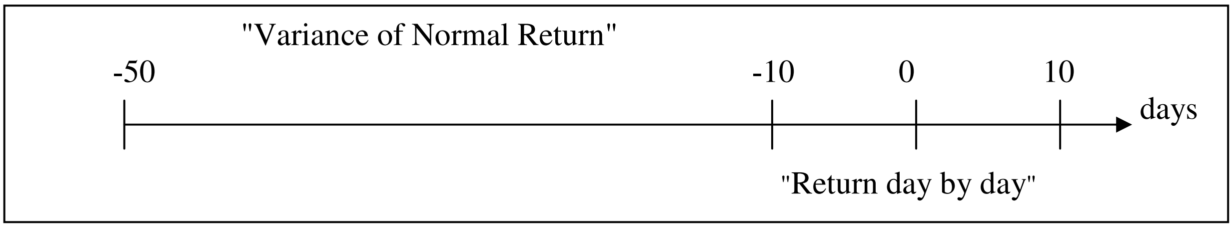
R_{it} = Return of the stock

μ_i = Average return of the stock

ξ_{it} = residual

[18] Appendix

In order to calculate any abnormal return, one must start calculating normal return. Just like the calculations for implicit volatility, the time horizon is ten days before and ten days after the report. First, one must take the logarithms of the share price in order to calculate the relative return from day to day.[19] Then I calculated the average of the change in return on the 40 days before the first day of the event study, -10. Then the 40-day average is compared to each of the 21 days in the time horizon window, -10 to 10. For an example, $R_{-10} - \mu_{40}$ and so on.



When this procedure is done for all the companies' four reports, then the average for all reports is calculated. Here I have to mention that the variance for the 40 days actually can be translated to the same unit as the implicit volatility[20], but this is such a complicated procedure that it does not fit in this paper. The purpose of this paper is to do a significance test and a cross sectional analysis of the material received from the Event study, regarding change in return and implicit volatility.

3.6 Significance test[21]

In order to investigate if the data has a significant divergence from its mean, this test will be performed for both stock return and implicit volatility.

$$C\hat{A}R_i(\tau_{-i},\tau_i) \qquad (3.1)$$

$$Var\left[C\hat{A}R_i(\tau_{-i},\tau_i)\right] = \sigma^2(\tau_{-i},\tau_i) \qquad (3.2)$$

The standard deviation is the square root of equation 4.2.

$$s(\tau_{-i},\tau_i) = \sqrt{\sigma^2(\tau_{-i},\tau_i)} \qquad (3.3)$$

[19] Campbell, Lo & McKinaly, 1997, s.105
[20] McMillan, 1993, kap 38
[21] http://www.nek.lu.se/NEKHAS/Documents/notesv05.pdf, p. 51

In order to standardize the test the standard deviation equation in 4.3 has to be divided by the square root of the number of observations, namely 48. So

$$\hat{s}(\tau_{-i}, \tau_i) = \frac{s(\tau_{-i}, \tau_i)}{\sqrt{d}}$$

To receive a t-value following calculation must be done,

$$t = \frac{C\hat{A}R_i(\tau_{-i}, \tau_i)}{\hat{s}(\tau_{-i}, \tau_i)} \tag{3.4}$$

The hypothesis for abnormal return in shares can be written as follows;

H_0: the return is normal

H_1: the return is abnormal

with a significance level of 95%, the t-value must be over 1,96 for the H_0 hypothesis to be rejected.

4 Empirical Results and Analysis

In this chapter of the paper the material and results will be presented and analysed. The fact the I want to highlight for the reader is that the results shows a clear deviation the time around the report date for most of the companies with respect to return on stock and this deviation "follows" down to its respective option as an increase in implicit volatility. The chapter is divided into following sections, first the result of the abnormal return, second the result of the implicit volatility and finally I will statistically prove that there is a deviation the time around the report date.

4.1 Abnormal Return in Shares

4.1.1 All companies

A company report shows how good or bad the company has performed during the last three months or previous year, but most important is it gives a fair picture of how the company is expected to perform in the near future. Like previous studies performed by Hagelin&Pramborg, this paper shows that there is a divergence the same day the report is released. This will also be proved statistically in a later section. The conclusion is that company reports do contain new information that is vital for investors. This is not a very surprising result. A possible explanation to this phenomenon can be that the market makes a one-time adjustment to the share prices, but it does not affect the overall picture of the company when it comes to risk. When analyzing all companies it is totally clear that there is a vast deviation in return at the report date, as shown in figure 6.

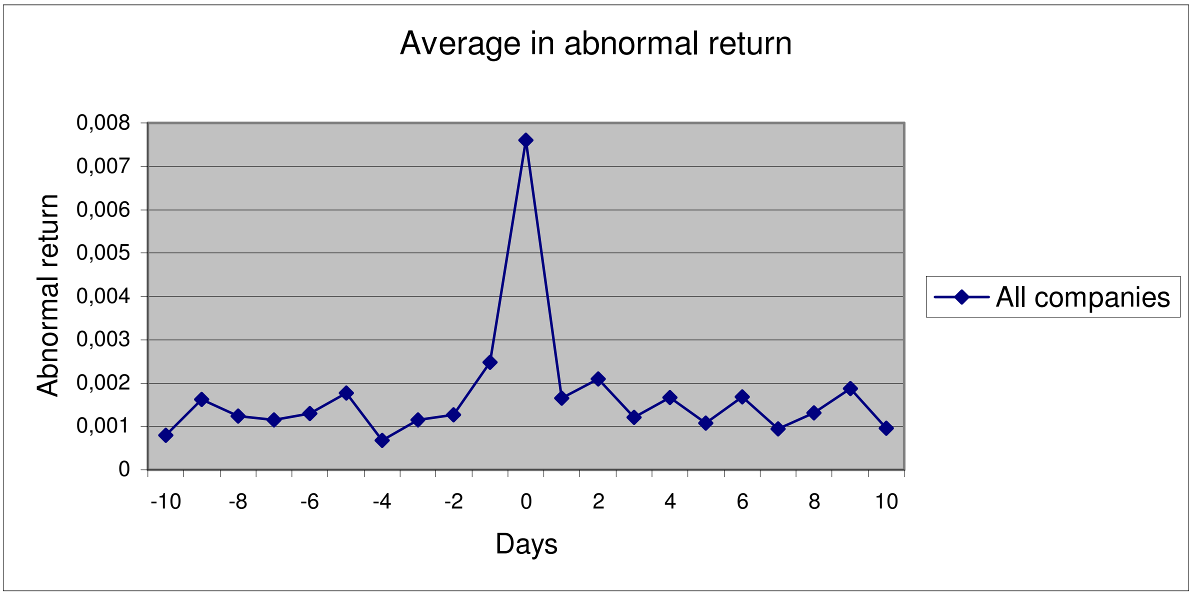


Figure 6: Abnormal Return, Average for all companies

4.1.2 Industries

If the companies are divided into industry, the following diagram shows the difference in variance for the respective industries. The classification is;

Finance: Investor and Handelsbanken

Manufacturing: SKF, Stora Enso, ABB, Electrolux and Volvo

Telecom: Nokia, Ericsson and Teliasonera.

Pharmaceutical: Astrazeneca and Pharmacia.

It clearly shows that the industry with the highest variance is the Telecom, followed by Manufacturing. In both Finance and Pharmaceutical industries an abnormal change in return cannot be detected. To see the individual company, look in the appendix 6.

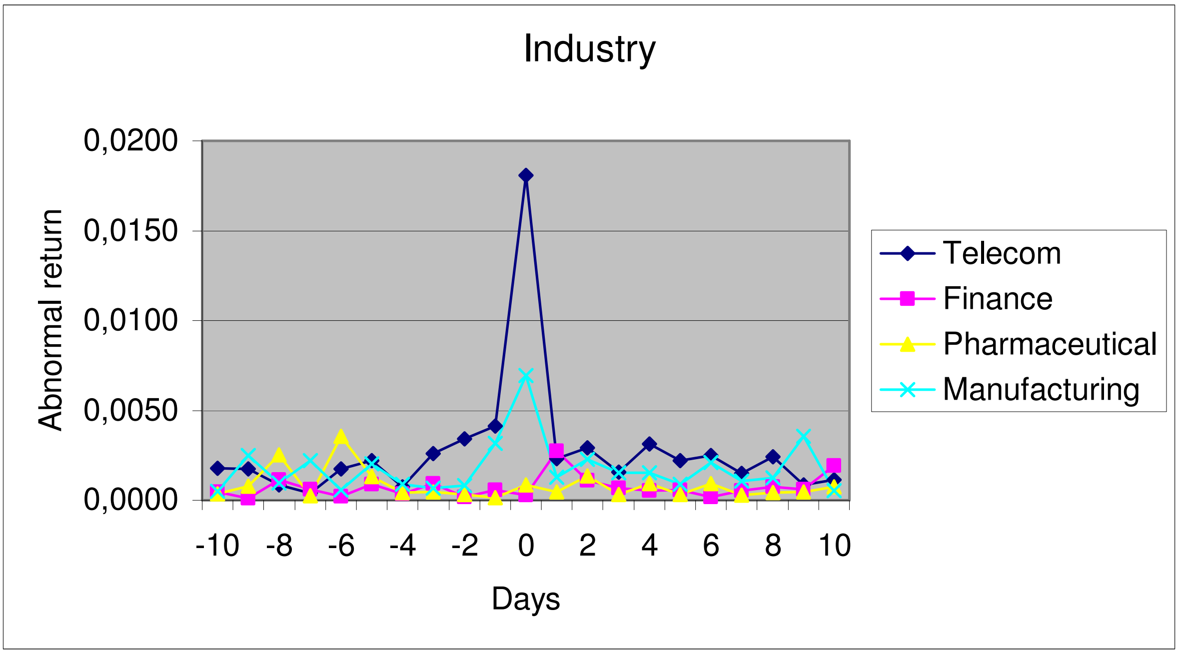


Figure 7: Abnormal return, Industry

4.1.3 Turnovers

To see if the size of the company has any impact on the change in return, I have divided my material into three groups regarding their turnovers. The unit is in Millions of SEK and the groups are divided as follows;

Group 1	Less than 50
Group 2	50-100
Group 3	More than 100

The table below represents the turnover for respective company in 2002.

Company	Turnover 2002 in Million SEK
ABB Ltd	56 370
AstraZeneca	138 502
Electrolux B	81 823
Ericsson B	594 288
Investor B	37 245
Nokia SDB	262 356
Pharmacia	45 458
SKF B	47 184
Stora Enso R	42 039
Sv. Handelsbanken A	82 653
TeliaSonera	60 325
Volvo B	58 542

This leads to following groups,

Group 1; Investor, Pharmacia, SKF and Stora Enso.

Group 2; ABB, Electrolux, Handelsbanken, Volvo and Teliasonera.

Group 3; Astrazeneca, Ericsson and Nokia.

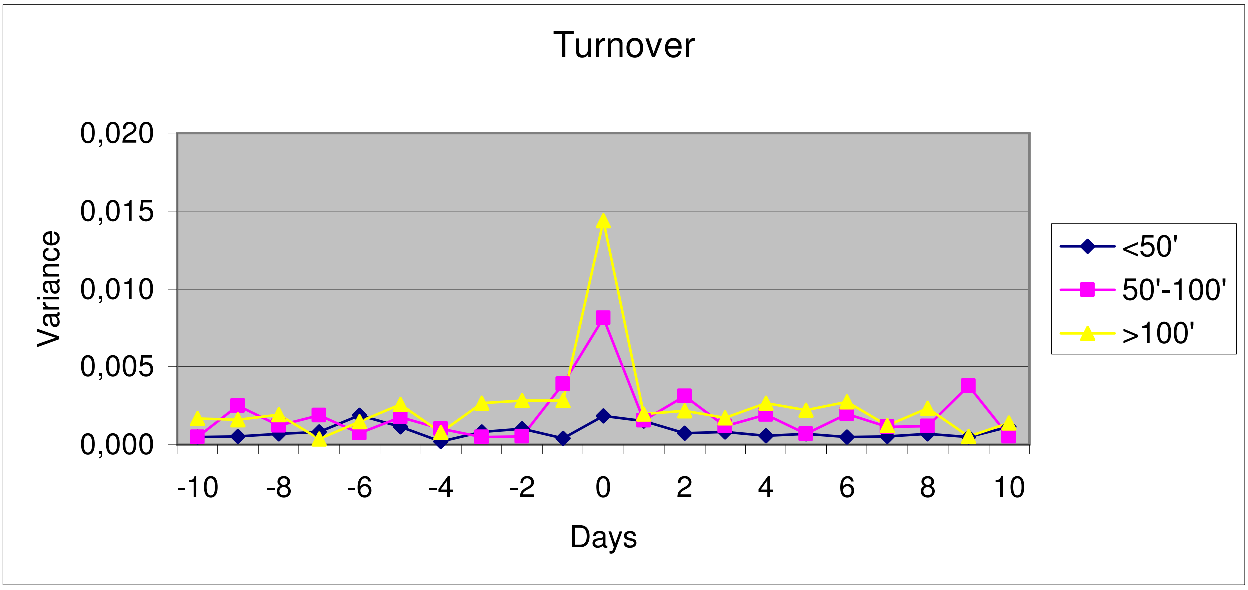


Figure 8: Abnormal return, Turnover

It is difficult to make any conclusive facts from this material, but it appears that the companies with the biggest turnover also have the most significant abnormal return when new information is released into the market. Companies that have less than 50' Millions in turnover show no divergence in return at the report date.

4.1.4 Company specific factors

The year of 2002 was a very turbulent year for a lot of companies and for the entire stock market. For instance, ABB and Ericsson are two of the largest companies in Sweden that had a particularly tough period during this year. So is the rather large abnormality in return for those industries, manufacturing and telecom respectively, due to company specific factors within these two companies? Well in the diagram below it shows that the variance has decreased substantially for these two industries when deducting ABB and Ericsson. From a variance of 0,0181 at day 0 for the telecom industry to a level of 0,0102 without Ericsson and the manufacturing industry changes from 0,0069 to 0,0036 without ABB. Both these industries cut its variance by almost half when these companies are excluded.

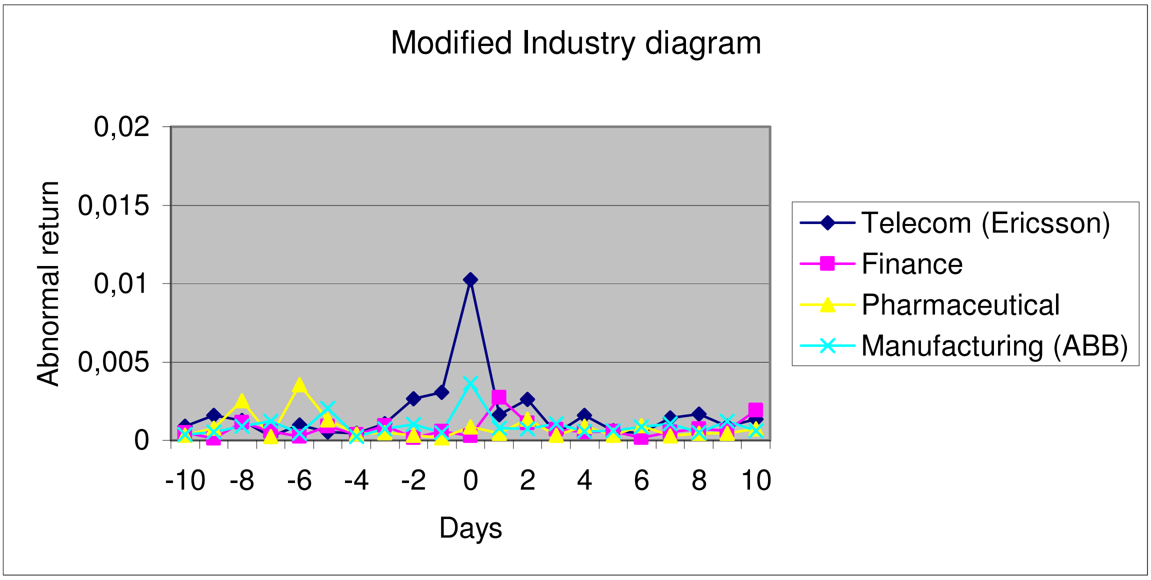


Figure 9: Abnormal return, Modified industry

The conclusion of all this is that there seems to be a clear divergence in the return when the whole market is considered. But when looking deeper into the material it shows that there are two industries in particular that contribute to this divergence, namely Telecom and Manufacturing. It also shows that, the bigger the turnover is for a company the larger is the divergence in the return at the report date. To be consequent, is it Ericsson and ABB that causes the higher variance for Group 3 and Group 2 respectively? In the diagram below it shows a dramatic cut in variance for Group 3, but the decrease in variance for Group 2 is not that big.

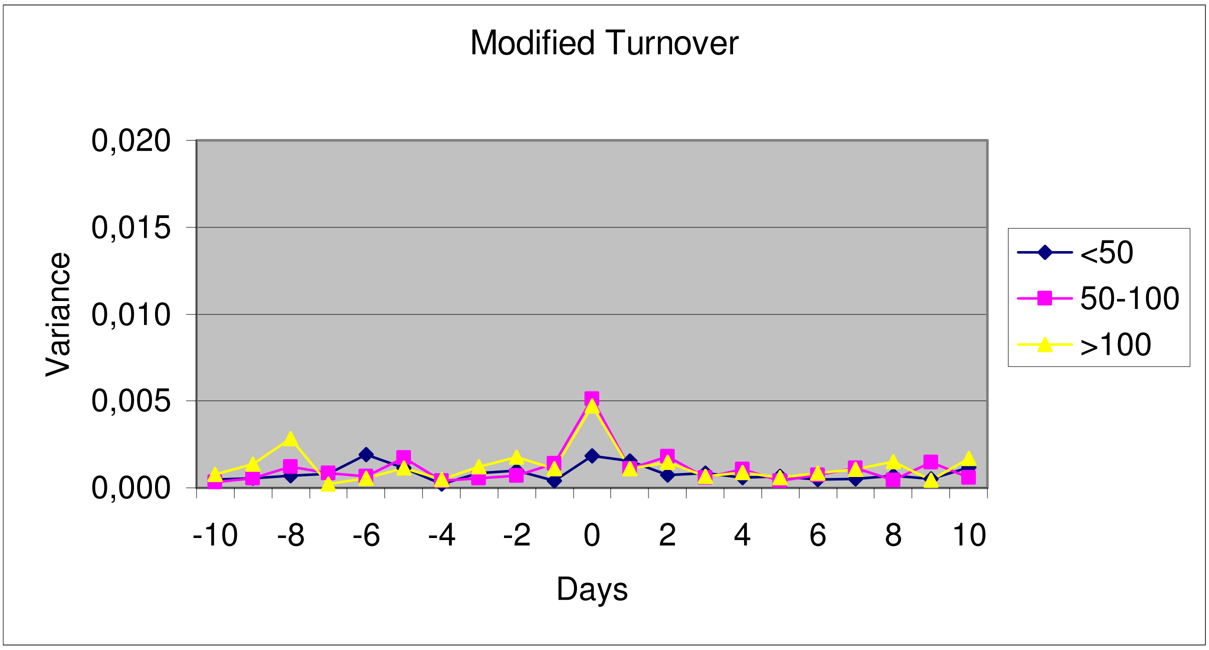


Figure 10: Abnormal return, Modified turnover

And it still evident that medium and large size companies have greater variance in return at the report date than smaller companies.

When analysing the Finance and Pharmaceutical sectors, as I stated earlier, there is no clear divergence in the return at the report date. What can the reasons be for this? Well, it might be that investors are more interested in other kinds of information concerning these companies, such as patent rights for new drugs invented by the pharmaceutical companies or interest rate changes by the Riksbank for the Finance sector. Naturally the quarterly reports are not useless or unnecessary, but other information such as this could be equally important.

4.2 Implicit Volatility

4.2.1 All companies

In order to make this comparison, the implicit volatility will be investigated in the exact same fashion. After calculating the options in ways described above, I have now compiled the result. In figure 11 it is a clear rise in volatility from day -10 to -1, about 8%. Then from day 0, the report day, it stabilises and has no particular movement after the report.

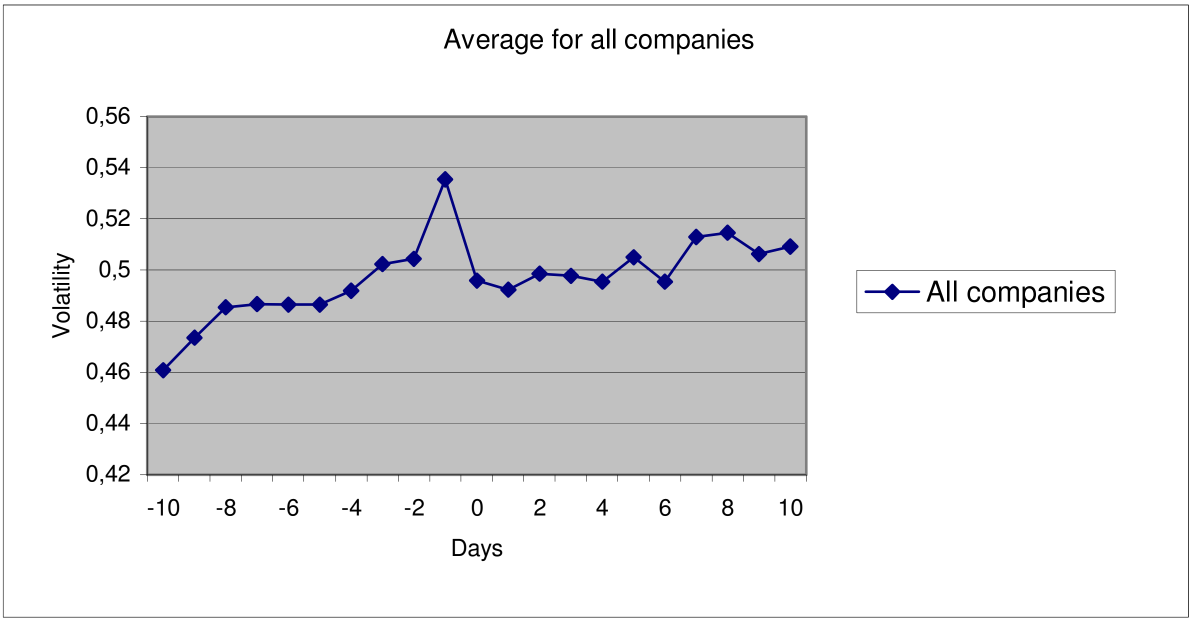


Figure 11: Implicit Volatility, Average for all companies

When making a comparison with figure 6 and page 18, not in values but rather in movements, the results are quite similar. First a rise before the report date and then a stabilisation phase.

4.2.2 Industry

To see if there is a particular industry or company that is contributing to this pattern or if it is the same for all companies, once again the different industries are compared to each other. In figure 12 there is only one industry that stands out from the other, namely Telecom. It has a sharp rise in volatility up to the report date, around 15% and then a stabilisation phase. The other three industries, Manufacturing, Pharmaceutical and Finance, have no clear deviation around the report date. In comparison with the change in return, in figure 7 on page 19, it is expected that the Finance and Pharmaceutical sector do not have a change in the implicit volatility, since those sectors do not show any abnormal return at the report date.

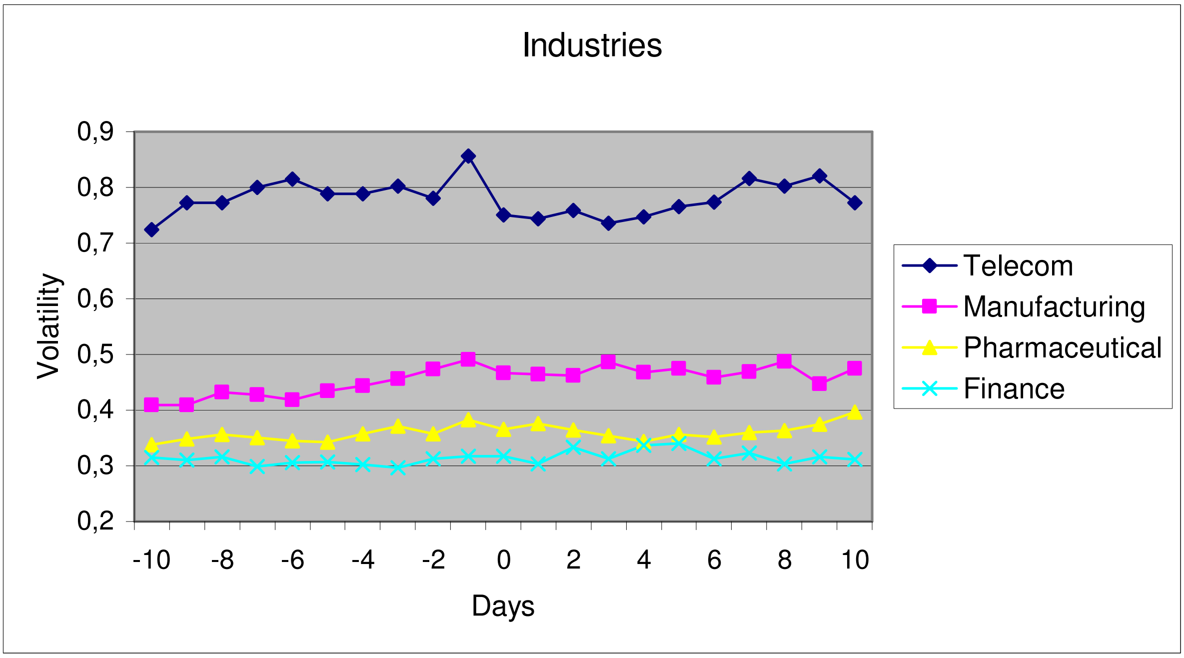


Figure 12: Implicit Volatility, Industries

In analysing the Manufacturing sector it is a little bit more complex. In the return figure 7 on page 19 it clearly shows an abnormal return at the report date, but in the volatility diagram a modest rise can be seen but not the expected stabilisation phase. As stated earlier, previous studies shows that the volatility in the return is approximately 20-50% and although implicit volatility and volatility in return are not in the same unit, it can be served as a benchmark. It is only one industry that is clearly above, namely Telecom.

4.2.3 Turnover

To draw any parallels with the figure 8 and the figure 13 is quite complicated. In figure 13 it is clearly the case that the bigger the company is, the larger the implicit volatility is over the whole period, which is very odd. It seems to be no reaction to the implicit volatility regarding the companies' size, when a report is being released except for maybe the large companies. When looking in the figure 8 on page 20 it clearly shows a divergence at the report date and that is quite different regarding the size of the company. So, what is the reason behind this? Well, it might be the fact that the category, over 100, is containing both Nokia and Ericsson which both are in the telecom industry and have a high implicit volatility, also shown in figure 12. The explanation for the mid-size companies being above the small-size is most likely due to ABB, who had a very turbulent year.[22]

[22] Appendix 6

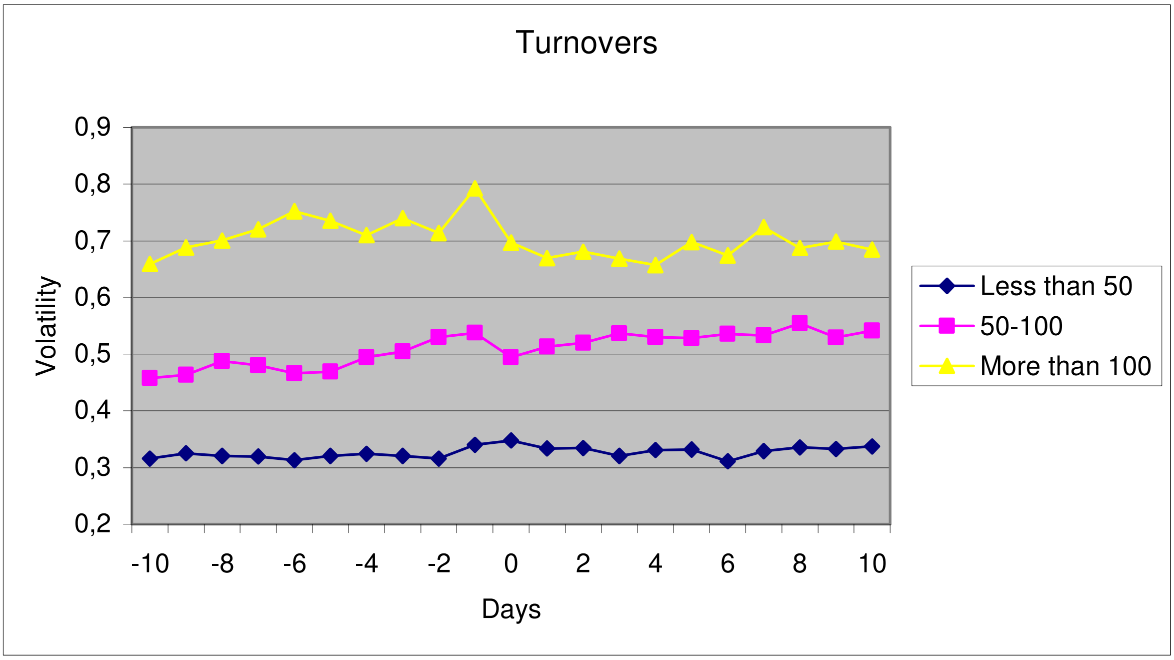


Figure 13: Implicit Volatility, Turnover

4.3 Significance Test

To round off this chapter, I will now perform a significance test to statically see if there is any abnormality in the return of the stocks and in implicit volatility. The procedure I have used here is as follows; first the observation window has been decreased to -3 to 3 days before and after the report date, since that is the most crucial period. Since I have 12 companies and 4 reports from each company, the total number of observations is 48 for each day. To see if one day has an abnormal return for all companies, an average on the cumulative abnormal return and its variance is calculated,

$$C\hat{A}R_i(\tau_{-3},\tau_3) \qquad (4.1)$$

$$Var\left[C\hat{A}R_i(\tau_{-3},\tau_3)\right] = \sigma^2(\tau_{-3},\tau_3) \qquad (4.2)$$

The standard deviation is the square root of equation 4.2.

$$s(\tau_{-3},\tau_3) = \sqrt{\sigma^2(\tau_{-3},\tau_3)} \qquad (4.3)$$

In order to standardize the test the standard deviation equation in 4.3 has to be divided by the square root of the number of observations, namely 48. So

$$\hat{s}(\tau_{-3},\tau_3) = \frac{s(\tau_{-3},\tau_3)}{\sqrt{48}}$$

To receive a t-value following calculation must be done,

$$t = \frac{C\hat{A}R_i(\tau_{-3}, \tau_3)}{\hat{s}(\tau_{-3}, \tau_3)} \qquad (4.4)$$

The hypothesis for abnormal return in shares can be written as follows;

H_0: the return is normal

H_1: the return is abnormal

with a significance level of 95%, the t-value must be over 1,96 for the H_0 hypothesis to be rejected.

Abnormal Return

Dagar	-3	-2	-1	0	1	2	3
t-value	2,551943	1,081463	2,221528	3,379285	4,225999	3,474276	4,27973

As we can see the result is that almost all days are over 1,96, which means that we can reject H_0 and conclude that we do have an abnormal return for these 12 companies in aggregate. The result also indicate at the report date and after the abnormal return seem to a bit higher, just as we have seen in the diagrams above.

The test for any abnormality regarding implicit volatility is calculated in the same fashion as for abnormal return in shares.

The hypothesis for abnormality in implicit volatility can be written as follows;

H_0: the return is normal

H_1: the return is abnormal

Days	-3	-2	-1	0	1	2	3
t-value	4,262337	4,058028	4,18336	4,12749	4,543086	4,520028	4,071807

Here it is really obvious that we need to reject the H_0 hypothesis and conclude that there is an abnormal movement in the implicit volatility the days before, during and after the report.

So, the final remark to this research is that it clearly shows an abnormal return in the shares in aggregate and this abnormality also shows in the implicit volatility in the same companies call options, irrespectively of exercise price. This answers the purpose of this paper, which was to see if there is any abnormal return on the selected shares the period over a company report and see if it is a similar phenomenon can be detected in the call options for the same companies.

Summary

In this chapter I will do a review the purpose of the study, plus I will summarize the choices I have made and the problems that I have encountered and how these will affect my study.

Summary

The purpose of this study is to describe, from a selection of options, how the Swedish market of stockoptions reacts to new information being released in the market, namely company reports. The variables that I intend to compared is the historic return in shares around a particular report date and the implicit volatility for the call option at that same date to see if the if it shows a pattern and if that pattern also shows for the implicit volatility. To do this I have decided to do a so called Event study, where the two variables are investigated 10 days before and 10 days after the report date.

The selection is 12 companies, which are listed in SAX so called A-list. The target of companies has been to choose a broad range of companies to include as many different industries as possible.

During my research I have encountered many obstacles along the way when processing the data material that will influence the result of the study. This relates to the selection of companies and it is the volume of traded options. Some of the companies has a rather low volume traded from time to time, which results in a large spread (the difference between buy and sell price) and this results in a dilemma to decide *one* price for that day. That is a price between buy and sell or the average price. The bigger the spread is the bigger the problem is. So the selection of companies must consider this fact. The second problem is a synchronization problem between the price of the stock and the price of the option. Third problem being if there has been any dividend during the period of research it should be considered, but this is not something I have chosen not to consider since it will complicate the calculations quite substantially.

The conclusion of the study shows, in line with previous studies conducted by Pramborg&Hagelin, that there is a divergence the time around the report date. As shown in the figures above and in the significance test, there is an abnormal return in shares the period around a report date. This however is an one-time adjustment to the new information being released on the market. The same pattern can be seen in the implicit volatility in the respective share’s call option.

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www.volvo.se	2002-11-23

Appendix 1

Here is the mathematical derivation of d_1 and d_2 in the Black&Scholes formula.

E is equivalent to expected value.

Define g(V) as the probabilitydensity of the function V. It follows;

$$E[\max(V-K),0]=\int_K^\infty (V-K)g(V)dV \tag{1}$$

The variable V is lognormally distributed with standard error *s*. The distinguishing feature from the lognormally distribution, ln V, is that the average is *m*, where

$$m=\ln[E(V)]-s^2/2 \tag{2}$$

Define a new variable,

$$Q=\frac{\ln V-m}{s} \tag{3}$$

This variable is normally distributed with an average equal to 0 and a standard error of 1,0. Denote the densityfunction of Q with h(Q), so

$$h(Q)=\frac{1}{\sqrt{2\pi}}e^{-Q^2/2} \tag{4}$$

Use the equation 3 to convert the expression at the right hand side in equation 1, from an integral over V to an integral over Q,

$$E[\max(V-K,0]=\int_{(\ln K-m)/s}^\infty (e^{Qs+m}-K)h(Q)dQ \tag{5}$$

Or

$$E[\max(V-K,0]=\int_{(\ln K-m)/s}^\infty (e^{Qs+m}h(Q)dQ-K\int_{(\ln K-m)/s}^\infty h(Q)dQ$$

It now follows,

$$\begin{aligned}
e^{Qs+m}h(Q)&=\frac{1}{\sqrt{2\pi}}e^{(-Q^2+2Qs+2m)/2}\\
&=\frac{1}{\sqrt{2\pi}}e^{(-(Q-s)^2+2m+s^2)/2}\\
&=\frac{e^{m+s^2/2}}{\sqrt{2\pi}}e^{(-(Q-s)^2)/2}\\
&=e^{m+s^2/2}h(Q-s)
\end{aligned}$$

Which means that the equation 5 will be,

$$E = \left[\max(V - K,0\right] = e^{m+s^2} \int_{(\ln K - m)/s}^{\infty} h(Q - s)dQ - K\int_{(\ln K - m)/s}^{\infty} h(Q)dQ \tag{6}$$

If now N(x) is defined as the probability that a variable with an average equal to 0 and a standard error equal to 1,0 is less than x, the first integral in 6 will be,

$1 - N\left[(\ln K - m)/s - s\right]$

Or

$1 - N\left[(\ln K - m)/s + s\right]$

A substitution of *m* from the equation 2 results in,

$$N\left(\frac{\ln\left[E(V)/K\right] + s^2/2}{s}\right) = N(d_1)$$

Similar is for the second integral in equation 6 is it for $N(d_2)$. Equation 6 now looks like,

$$E\left[\max(V - K,0)\right] = e^{m+s^2/2} N(d_1) - KN(d_2)$$

By substituting *m* from equation 2 it follows,

$$E\left[\max(V - K,0)\right] = E(V)N(d_1) - KN(d_2) \tag{7}$$

Where,

$$d_1 = \frac{\ln\left[E(V)/K\right] + s^2/2}{s}$$

$$d_2 = \frac{\ln\left[E(V)/K\right] - s^2/2}{s}$$

Where E is equivalent to expected value.

Appendix 2

Market model

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

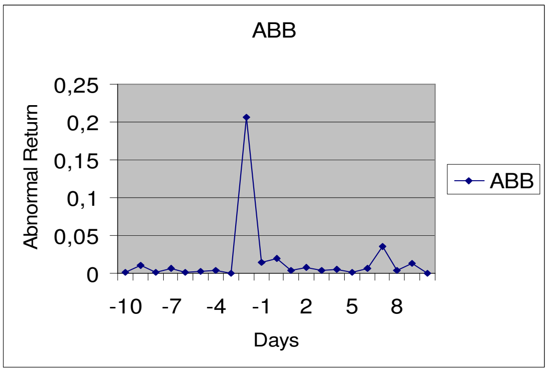
$$E[\varepsilon_{it}] = 0$$

$$Var[\varepsilon_{it}] = \sigma^2_{\varepsilon i}$$

Appendix 4

Company		Date	Company		Date
Telia		Report dates	Volvo		Report dates
Full year report		20020208	Full year report		20020208
Part year report	jan-mar	20020506	Part year report	jan-mar	20020422
Part year report	jan-jun	20020725	Part year report	jan-jun	20020723
Part year report	jan-sep	20021025	Part year report	jan-sep	20021024
Stora Enso			SKF		
Full year report		20020130	Full year report		20020129
Part year report	jan-mar	20020423	Part year report	jan-mar	20020418
Part year report	jan-jun	20020724	Part year report	jan-jun	20020715
Part year report	jan-sep	20021022	Part year report	jan-sep	20021015
Handelsbanken			Pharmacia		
Full year report		20020212	Full year report		20020205
Part year report	jan-mar	20020422	Part year report	jan-mar	20020423
Part year report	jan-jun	20020820	Part year report	jan-jun	20020723
Part year report	jan-sep	20021022	Part year report	jan-sep	20021022
Nokia			Investor		
Full year report		20020124	Full year report		20020124
Part year report	jan-mar	20020418	Part year report	jan-mar	20020416
Part year report	jan-jun	20020718	Part year report	jan-jun	20020410
Part year report	jan-sep	20021017	Part year report	jan-sep	20021010
Ericsson			Electrolux		
Full year report		20020125	Full year report		20020208
Part year report	jan-mar	20020422	Part year report	jan-mar	20020418
Part year report	jan-jun	20020719	Part year report	jan-jun	20020718
Part year report	jan-sep	20021018	Part year report	jan-sep	20021022
Astrazeneca			ABB		
Full year report		20020131	Full year report		20020213
Part year report	jan-mar	20020425	Part year report	jan-mar	20020424
Part year report	jan-jun	20020725	Part year report	jan-jun	20020724
Part year report	jan-sep	20021024	Part year report	jan-sep	20021024

Appendix 5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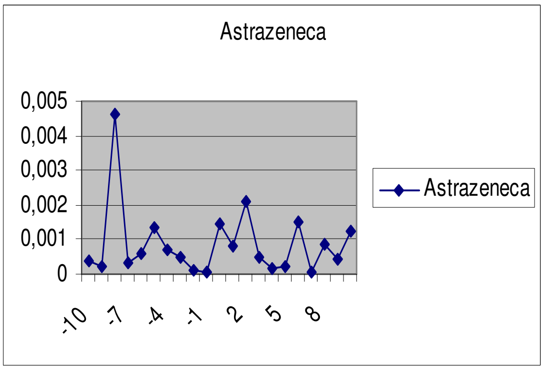
Days
ABB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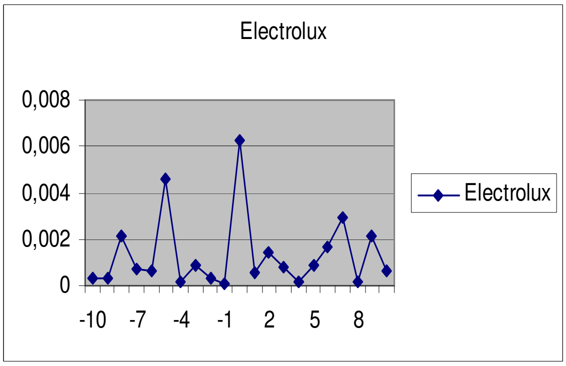
Astrazeneca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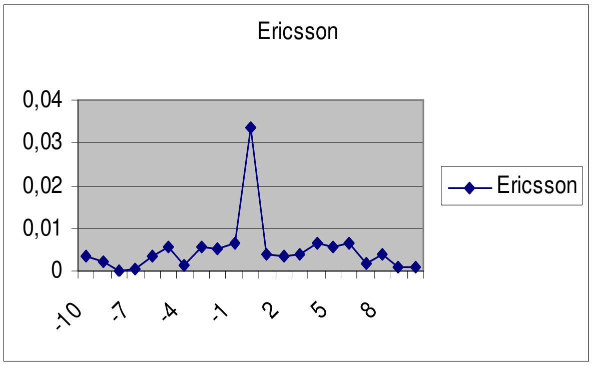
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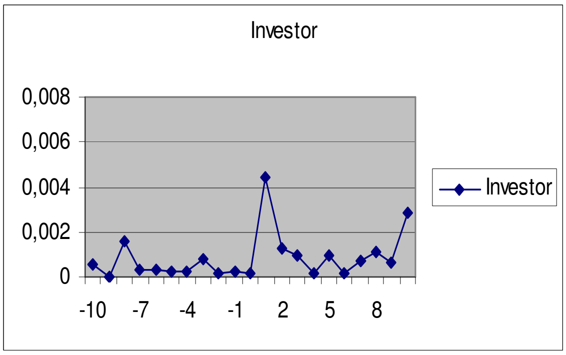
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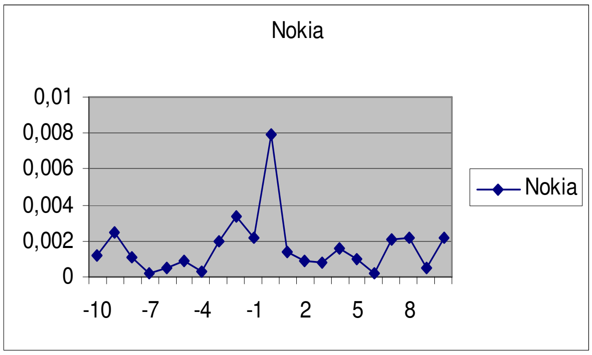
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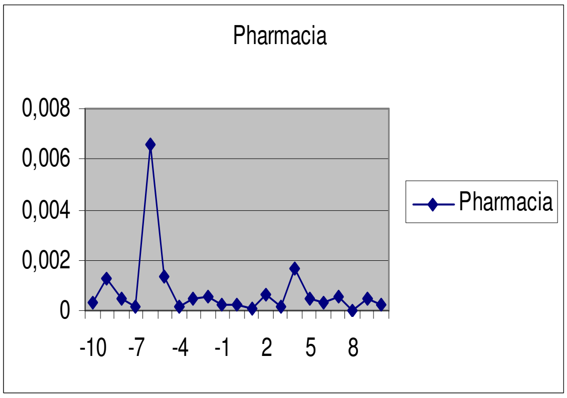
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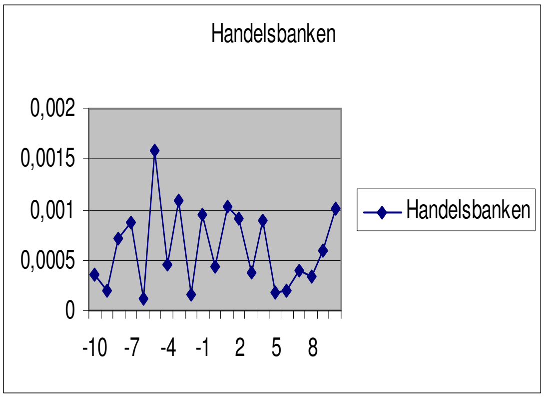
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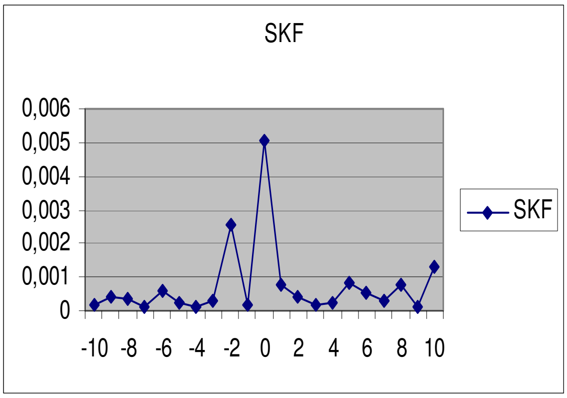
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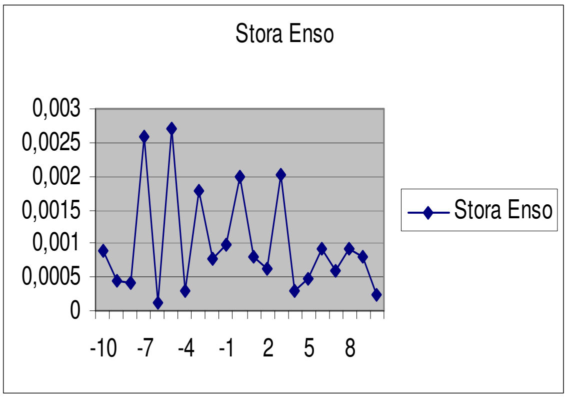
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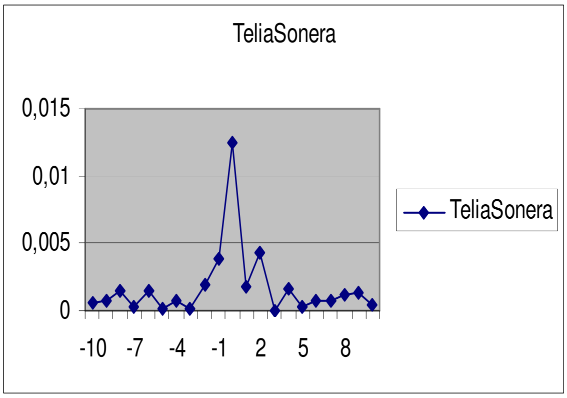
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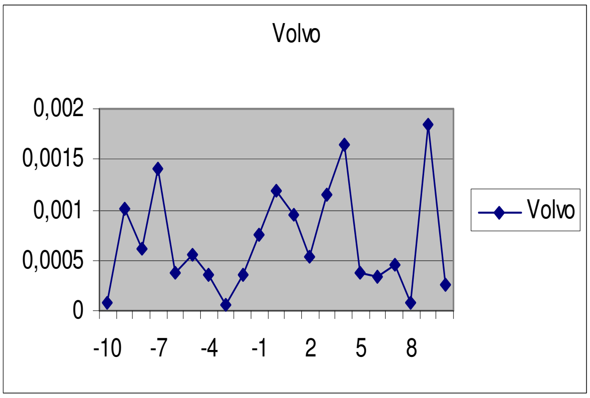
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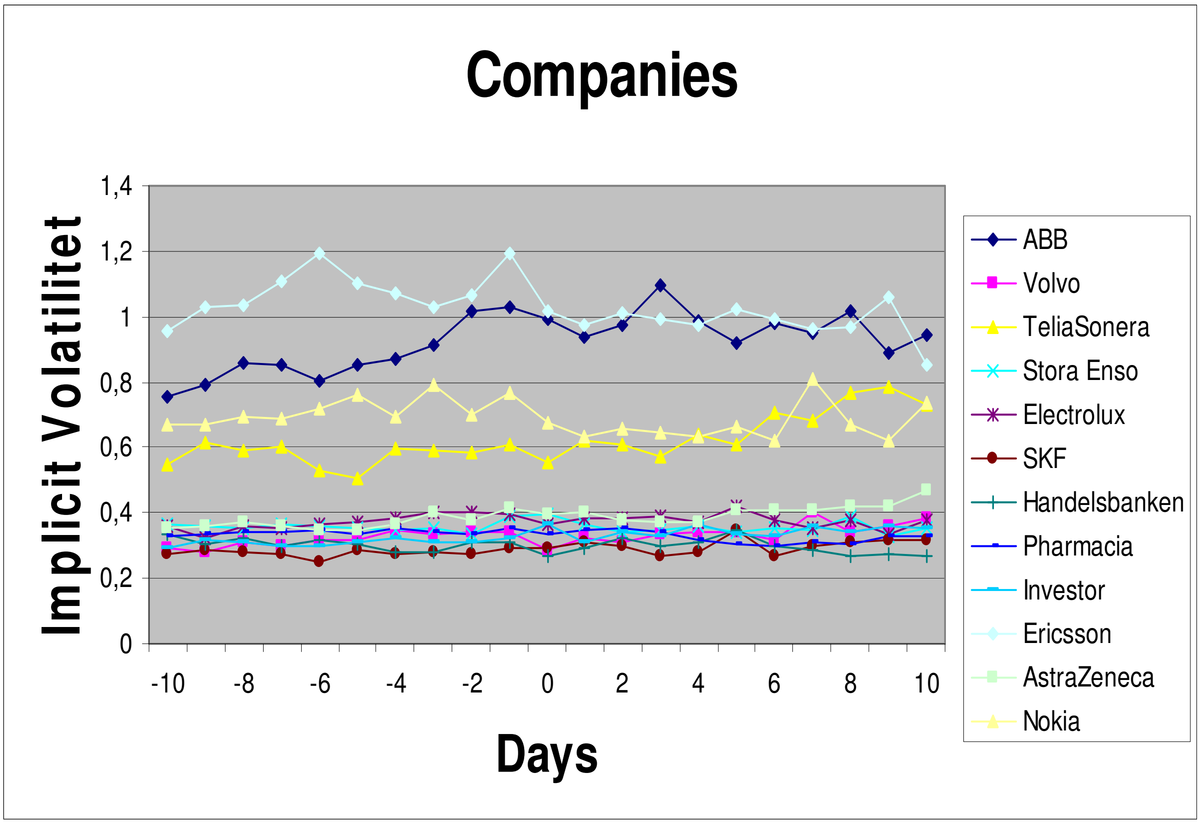
Volvo

Appendix 6


Companies
Implicit Volatilitet
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0,4
0,2
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-10
-8
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-4
-2
0
2
4
6
8
10
Days
ABB
Volvo
TeliaSonera
Stora Enso
Electrolux
SKF
Handelsbanken
Pharmacia
Investor
Ericsson
AstraZeneca
Nokia