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How does the Norwegian stock market react to IT investment announcements?

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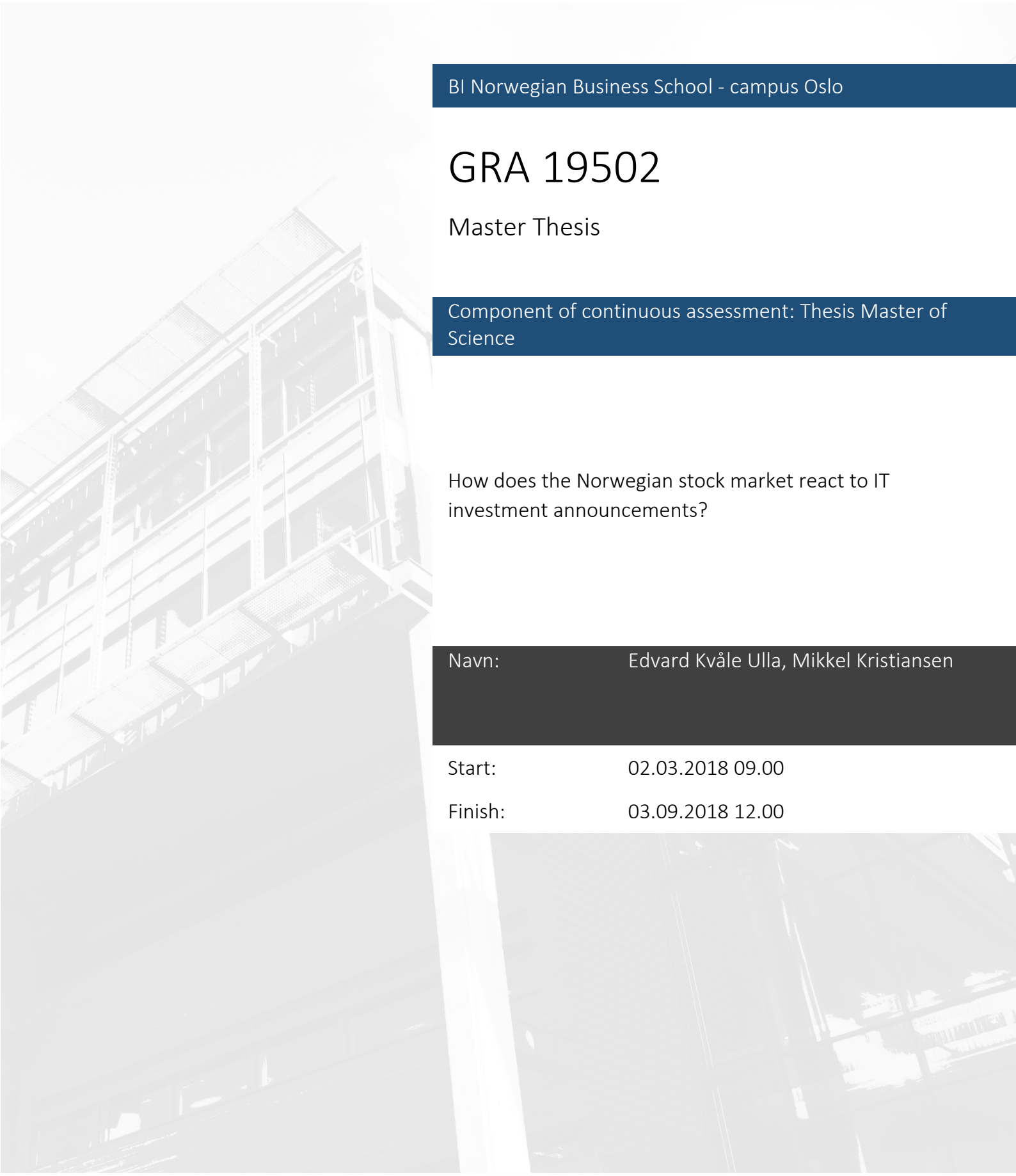

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Abstract

This thesis examines how IT investment announcements affect the stock returns of firms listed at the Oslo Stock Exchange. An event study approach, using the Market model, Fama French Three Factor- and Carhart Four Factor-model to estimate normal returns, is applied. Estimated normal returns are compared to the actual historical returns in the market. Previous studies[1] suggest that one should expect positive abnormal returns following announcements of IT investments. This study was not able to find any clear evidence supporting the idea that IT investment announcements create abnormal returns significantly different from zero. We did, however, find signs suggesting that small firms do experience some significant positive market reaction following their announcements.

[1] Ajit et al., 2014; Chatterjee et al., 2002; Hayes et al., 2001; Ranganathan & Brown, 2006; Shea et al., 2017

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We would like to take the opportunity to thank our thesis supervisor, Associate Professor Salvatore Miglietta, of the Department of Finance at the Norwegian Business School in Oslo. He helped us overcome several hurdles and provided valuable guidance throughout our research. We would also like to express our gratitude to our families and friends for their support and motivating words during our entire studies. Without them, this would not have been possible.

1. Introduction and motivation

Today's society has grown accustomed to a rapidly changing technological environment. No matter the industry, companies have been expected to keep track of, and adapt to, the technological developments (Carr, 2003; Shea, Vincent J., Dow, Kevin E., Chong, Alain Yee-Loong & Ngai, Eric, W. T., 2017).

The purpose of this thesis is to examine whether IT investment announcements, by firms listed on the Oslo Stock Exchange (OSE), can be linked to abnormal stock returns. An increase in the stock price after the announcement of the IT investment would indicate that investors expect a positive net cash flow following the implementation, if the cost of capital stays constant (Hayes, D. C., Hunton, J. E. & Reck, J. L., 2001). This mechanism has never been studied in Norway, as far as we know. Hence, we find it interesting to study whether this phenomenon can be found in the Norwegian stock market, as it has in the US market.

Our main research question is the following:
"How does the Norwegian stock market react to IT investment announcements?"

With this study, we aim to contribute to existing literature by conducting a similar experiment to previous work, but in a new environment. We want to evaluate the Norwegian economy, using Norwegian firms listed at the Oslo Stock Exchange. The study is based on an event study methodology. Using the Market-, Fama French- and Carhart-models, we'll estimate and evaluate abnormal returns surrounding the announcements.

Assuming the semi-strong Efficient market hypothesis hold, stock prices should reflect all available information in the market. An announcement of an IT investment represents new information to the market that should be reflected in the stock price. For that reason, we expect a quick correction to the firms' stock prices. However, there should not be a prolonged trend according to the Efficient market hypothesis (Bodie, Z., Kane, A. & Marcus, A. J., 2014).

We suspected it might be difficult to find a statistically significant connection between the announcements and the stock returns in the Norwegian stock market. Compared to the US market, the OSE is much smaller, leaving us with a smaller sample size. A study by the Norwegian company Kreasoft suggest that small and medium sized Norwegian companies do not get the same benefit from investing in Customer Relationship Management (CRM) systems as American ones. They found that 29% of Norwegian firms investing in CRM failed to realise any return on their investment, compared to only 5% of American firms (Bjerke, 2004).

As we suspected, we struggled to find a significant relationship between IT investment announcements and cumulative aggregate abnormal stock returns, in general. We did however, find some statistically significant aggregate abnormal returns on a few specific days prior and after the announcements. The significant days prior to the announcement may indicate a potential leakage issue, where the correction in stock price occur before the announcement date, because the information of the investment has been leaked to the market prior to the announcement. After the event date, we observe that the aggregate abnormal returns stabilize, which can be a result of a more comprehensive understanding of the companies, in the market.

By analysing the difference in firm size, we also obtained results indicating that small firms see greater positive reactions to their announcements compared to larger firms.

This report contains six main sections. Section 2 provides a review of the existing literature, including a discussion of some developments in the research on the topic. Section 3 outlines the methodology. Section 4 presents the data used to conduct the study. Section 5 shows the empirical results and a discussion of the impact of these findings. Finally, conclusions, implications and ideas for further research are presented in section 6.

2. Literature review

Studies evaluating the business value of information technology have yielded mixed results over the years. Some researchers have claimed to have found evidence of IT as an important contributor to increased productivity. However, investments in IT systems have not always proven to be successful, as one may experience a certain "time lag" between implementation and the positive result (measured in productivity growth)[2], often referred as the "productivity paradox" (Brynjolfsson & Hitt, 1996). This idea stems from research conducted in the 1980's, which did not indicate significant improvements in productivity at the time, but rather showed that productivity wasn't affected until years after the investment was made. This finding was supported by the substantial increase in firm value for many after 1991, for firms who made significant IT investments in the 80's (Brynjolfsson & Hitt, 1996).

More recent literature measures the effects of IT investment announcements with movements in stock prices. This way, one can investigate whether IT investment announcements have created abnormal stock returns and disregard the potential issues in relation to productivity growth. These studies have shown that firms announcing IT investments will, in general, experience increased stock returns (Shea et al., 2017). They focus more on firm and technology specific characteristics to determine the effect of the investment announcement on firm value. The majority of these studies have used an event study methodology that allows the researcher to focus more on the firm value through stock prices, rather than accounting performance measures. As the research has turned towards the event study methodology over the years, it can be difficult to compare the two approaches. The research may have come to the same conclusions if the event study approach was applied earlier. However, the productivity approach is more exposed to measurement errors compared to the event study, which is one of the main reasons why it is common today.

[2] The researchers (Brynjolfsson & Hitt, 1996) created a measure for the amount of capital invested in IT, called computer capital, in order to analyse the gross returns on their investments

Several studies have applied a conventional event study methodology, looking to find significant cumulative abnormal returns, through parametric testing of the market model (Brown, S. J. & Warner, J. B. 1985; Dos Santos, B. L., Peffers, K. & Mauer, D. C., 1993; Hayes et al., 2001; Im, K., Dow, K., & Grover, V., 2001; Chatterjee, D., Pacini, C. & Sambamurthy, V., 2002; Ranganathan, C. & Brown, C. V., 2006; Benco, D. C. & Prather, L., 2008).

Some studies have also conducted non-parametric tests, arguing that there are several violations of the assumptions relating to parametric tests, rendering them non-reliable (Hayes et al., 2001; Chatterjee et al., 2002; Ranganathan & Brown, 2006). Several studies have expanded the market model, using Fama French Three Factor- and Carhart Four Factor-models, arguing that the sample size is too small for the market model to capture all relevant variations in the normal returns (Fama, E. & French, K., 1993; Carhart, M. M., 1997; Ranganathan & Brown, 2006; Ajit, D., Donker, H., & Patnaik, S., 2014; Shea et al., 2017).

Hayes et al. (2001) studied how the market reacted to announcements of ERP implementations, using an event study approach with abnormal market returns. They found an overall positive reaction to ERP announcements, especially among small healthy firms. They also found that announcements of implementation by well renowned suppliers like SAP or PeopleSoft, yielded a significantly more positive response than those with smaller, less recognised, vendors. Other studies support Hayes et al.'s (2001) findings, emphasizing this positive relationship between announcement and abnormal returns (Ajit et al., 2014; Ranganathan & Brown, 2006; Chatterjee et al., 2002). Chatterjee et al. (2002) did, however, find more positive abnormal returns for IT infrastructure investments, than for IT application investments.

Some studies have taken a deeper look at certain variables they believed to be influential in the outcome of abnormal returns after IT investment announcements. The most common ones being firm size, industry and time lag effects.

Dos Santos et al. (1993) looked at the effect of the announcement on stock returns across firms in different industries, as well as whether investments were innovative or not. They analysed industry because they believed that the

information intensive financial industry was more likely to gain from investments in IT, compared to the manufacturing industry. The innovation variable was meant to capture firms introducing new technology, giving them a chance to increase profitability, by gaining a competitive advantage. They used a sample of 97 firms, between 1981 and 1988. Their study failed to find any significant evidence to support their theory of abnormal returns for firms with IT investment announcements. They did however, find that the market reacts positively to innovative investments, compared to follow up or non-innovative investments. The result indicates that investors view innovative investments as valuable, while follow-up on non-innovative investments are zero net present value investments - at best.

Im et al. (2001) examined the stock price reactions to IT investment announcements based on three different variables, industry, size and time period, where industry had the same argumentation as for Dos Santos et al. (1993). Size and time period was introduced because they believed that smaller firms have a higher potential to gain a competitive advantage, as they are not subject to as much scrutiny as larger firms. They suggest that firm size can be a proxy for the information available to investors about the firm. The larger firms are often extensively featured in the media and may have several significant projects going at the same time. This would make the formal announcement of an IT investment a smaller portion of information about the firm, and hence likely to cause a smaller reaction compared to smaller firms. Additionally, the stock price of smaller firms is often more volatile than the bigger ones. For that reason, the announcements from larger firms are expected to have a marginally smaller effect than of those of smaller firms. They also argue that the investment might need additional investments in intangible assets, such as the education of employees or structural changes within the organisation. They included a time period variable to account for this lagged effect of the investment.

The latest study we found on the topic, was conducted by Shea et al. (2017). They used Regression Discontinuity Design to analyse the effect of IT investment announcements on stock returns. They found that press releases could positively affect the value of a firm, by providing investors with information about the current and future operations and strategy of the company. They also suggest that

the press releases attract investors who believe the investment is a good indication of belief in growth and expansion potential of the firm.

The general findings suggest that announcements of investments in IT results in positive abnormal stock returns (Shea et al., 2017; Ajit et al., 2014; Hayes et al., 2001; Chatterjee et al., 2002; Ranganathan & Brown, 2006).
These studies are however, limited to the United States and focused on large public companies listed at the largest stock exchanges. We have not found any similar studies of firms listed on the Oslo Stock Exchange. We therefore want to extend the existing literature to include a study on the Norwegian market.

3. Methodology

Our methodology mainly relies on the methodology outlined by Brown & Warner (1985), MacKinlay (1997) and Schimmer, M., Levchenko, A., & Müller, S. (2015), as a basis for our empirical study. In this section we'll go more deeply into how our model is built, based on the event study methodology.

3.1 Event study

The event study refers to a specific empirical technique, widely used in financial research, where the aim is to assess the impact of a particular event on firm's stock prices (Bodie et al., 2014). The event in this case, refers to the particular announcements and the aim is to quantify the relationship between the events (announcements) and stock returns. The methodology aims to specify company-specific events rather than market specific events, and the goal is to compute the cumulative abnormal returns potentially created by the event (Bodie et al., 2014).

The methodology assumes that the information provided by the announcement is not expected by the public. For that reason, the methodology provides unbiased estimates of the market reaction to the event. However, if the announcements were to a certain degree expected, the estimates of abnormal returns are likely to be on the lower bound (Dos Santos et al., 1993). The aim of the event study methodology is to estimate stock returns as if the event did not occur, then evaluate the difference between that estimate and the actual outcome when the event occurred. Subsequently, try to determine if there is a significant connection between the abnormal return and the event (MacKinlay, 1997).

The Efficient market hypothesis is a key underlying assumption of the event study methodology, as the method rely on how the stock prices are influenced by new information in the form of IT investment announcements (MacKinlay, 1997).

3.2 Beta testing

Our analysis is based on investments that may cause significant changes to the firms, which might alter the market risk it reflects. The problem that can occur is that our estimates of normal returns are wrong, as they would be based on the wrong beta[3]. This issue was addressed as a robustness test, prior to the main event study, as any significant difference would require some adjustments in the methodology. We did this using a two-sample, t-test for difference in means. Conducting this test required more data prior to and past the event window, forcing us to omit a few observations, leaving us with 47 events across 28 firms for this test.

$$t_{\beta} = \frac{\overline{\beta_{pre}} - \overline{\beta_{post}}}{\sqrt{\frac{s^2_{pre}}{n_{pre}} + \frac{s^2_{post}}{n_{post}}}} \qquad \textit{(Equation 1)}$$

Using the market model, we estimated the average beta across the firms, 6 months before and 6 months after the events. Subsequently we calculated the standard errors and conducted a t-test to evaluate the difference between the periods.

3.3 Estimation- and event-window

The event window is the period over which the impact of the announcement on the stock price is measured. A shorter event window is advised to reduce the noise in the data (Ranganathan & Brown, 2006). It is, however, normal to include at least the announcement day and one day after the event. This to allow the model to capture the reactions of any announcements that occur after the closing time of the stock exchange (MacKinlay, 1997). Many also include days prior to the event in order to capture the effect of any potential leakage of the announcement, prior to the formal announcement date (Chatterjee et al., 2002).

The event date is denoted as $\tau = 0$. The event window is noted as $\tau = T_1$+ 10 to $\tau = T_2$(MacKinlay, 1997). The event window we initially decided to analyse was [-2, 2]. However, in order to make our analysis more robust, we ran our analysis with a few different windows in addition to the original 5-days window; [-1,1],

[3] A stock's beta refers to the systematic risk compared with the market (Bodie et al., 2014)

[-3,1], [-5, 0] and [-9, 9]. Announcements during OSE's opening hours are captured at the announcement day, $\tau = 0$. However, if an announcement is published after the end of the trading day, the effect should be observed in the stock price on the following day, $\tau = 1$.

It is common to use 250 trading days prior to the event window as the estimation window, as it is considered to be the length of a financial year. The estimation window is noted as $\tau = T_0 + 1 \; to \; \tau = T_1$ (MacKinlay, 1997). It is important that the estimation window does not overlap into the event window, as this would lead us to include the effect of the event on the estimation of the stock price without the event (MacKinlay, 1997). Therefore, we used the following estimation window to eliminate these issues, [-260, -10].

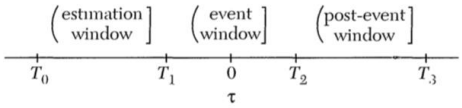

Figure 1. Time line for an event study.

(MacKinlay, 1997:20)

3.4 Estimation of normal returns

Brown & Warner (1985) claimed that the most important factors affecting company returns, do in fact behave like a market factor. This implies that including more factors has limited effect when it comes to adding explanatory power. Moreover, it seems like the market model is valid in more cases than other models, considering estimation of normal returns for larger samples. However, Brown & Warner (1985) specifies that while the simple market model yields good estimations for normal returns in large samples, it may be necessary to extend the model when dealing with smaller samples.

For robustness purposes, we decided to include both the market model, the Fama French Three Factor- and the Carhart Four Factor-model, to estimate expected normal returns. All these models are widely used in previous research within economics and finance in general, and theory suggest that the multifactor models may generate more precise estimates of expected returns than the market model

(MacKinlay, 1997). For that reason, we find it useful to implement all three models.

In order to calculate returns, we've decided to rely on a daily growth approach. This is a common practice within similar studies.

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \qquad \textit{(Equation 2)}$$

3.4.1 Market model

The market model suggest that the expected return can be affected by both a market factor and a firm-specific factor (MacKinlay, 1997).

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad \textit{(Equation 3)}$$
$$E(\varepsilon_{it}) = 0 \qquad Var(\varepsilon_{it}) = \sigma_\varepsilon^2$$

Where:
R_{it} = Return of stock i at time t
R_{mt} = Market portfolios return at time t
ε_{it} = The part of a security's non-systematic components of return
β_i = Slope (the parameter that captures the sensitivity to the market return, based on stock i's systematic risk)
α_i = Intercept (the average return of stock i if the market return is equal to zero)

We estimated the coefficients using an OLS-regression, to get estimates of the expected return. Under the classical linear regression assumptions, we have that the OLS estimates are BLUE. This means that they are the Best Linear Unbiased Estimator of the coefficients, or the linear unbiased estimator with the smallest variance (Wooldridge, 2009).

3.4.2 Fama French Three Factor model

This model was developed by Fama & French (1993), as an extension to the market model. Fama & French (1993) believed that risk premiums could be explained by market to book ratio and size, not as single explanatory risk factors, but serving as fundamental variables explaining investors compensation demand.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \varepsilon_{it}$$

(Equation 4)

3.4.3 Carhart Four Factor model

Carhart (1997) added one additional factor, compared with Fama French' model. Carhart claimed that stocks trending upwards tend to keep rising, and vice versa, which is known as the momentum effect.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \beta_{i,SMB} SMB_t + \beta_{i,HML} HML_t + \beta_{i,UMD} UMD_t + \varepsilon_{it}$$

(Equation 5)

Where:

SMB_t = Size factor premium (return of a portfolio containing small firms minus return of a portfolio containing big firms)

HML_t = Value factor premium (book to market - high minus low)

UMD_t = Momentum factor premium (winners minus losers)

$\beta_{i,X}$ = Risk factor exposure

Beyond this, the statistical properties of these models are identical to the market model (MacKinlay, 1997).

3.5 Abnormal Returns

We now have 3 models, all able to show how much the returns are affected by the market factor. Additionally, the Fama French- and the Carhart-model shows how some defined other factors (SME, HML and UMD) affect returns.

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt}$$

(Equation 6)

$$AR_{it} = R_{it} - (\hat{\alpha}_i + \widehat{\beta}_i R_{mt} + \widehat{\beta_{i,SMB}} SMB_t + \widehat{\beta_{i,HML}} HML_t + \varepsilon_{it})$$

(*Equation 7*)

$$AR_{it} = R_{it} - (\hat{\alpha}_i + \widehat{\beta}_i R_{mt} + \widehat{\beta_{i,SMB}} SMB_t + \widehat{\beta_{i,HML}} HML_t + \widehat{\beta_{i,UMD}} UMD_t + \varepsilon_{it})$$

(*Equation 8*)

We used these models to estimate the expected return conditional on factor realization. A more extensive explanation of the normal distribution of abnormal returns can be found in MacKinlay (1997).

3.6 Aggregate/cumulative abnormal returns

A typical problem related to announcements is leakages. This refers to leaking information spread some time in advance of the announcement. This might cause a change in the stock price before the actual event date (Bodie et al., 2014). In order to take the total impact of the information release into consideration, we accumulated abnormal returns and called it Cumulative Abnormal Returns (CAR). This step also contributed to draw inferences for the events.

$$CAR_i(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} (AR_{it}) \qquad \textit{(Equation 9)}$$

In order to evaluate each day in the event windows separately, we aggregated the abnormal returns for each given day in the event window, across all events in the sample.

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_t \qquad \textit{(Equation 10)}$$

$$\sigma^2(AAR_t) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_{\varepsilon i}^2 \qquad \textit{(Equation 11)}$$

We cumulate and aggregate the abnormal returns in order to capture all the effects of the new information.

$$CAAR(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AAR_t \qquad \textit{(Equation 12)}$$

$$Var(CAAR(\tau_1, \tau_2) = \frac{1}{N}\sum_{i=1}^{N} \sigma_i^2(\tau_1, \tau_2) \qquad \textit{(Equation 13)}$$

The assumption that the event windows are not overlapping is used to set the covariance term to zero, giving us a normal distribution of aggregated cumulative abnormal returns.

$$CAAR(\tau_1, \tau_2) \sim N[0, Var(CAAR(\tau_1, \tau_2))] \qquad \textit{(Equation 14)}$$

3.7 Statistical testing

Based on our research question and the theory presented regarding the anticipated market reactions to new information, our hypothesis becomes the following:

"Given the new information provided by an IT investment announcement, we expect to see a correction in the stock prices, in terms of abnormal returns"

To test for abnormal returns on each day within the event window surrounding the event date, we evaluated the Aggregate Abnormal Returns for each day. This gives us the following hypothesis test.

$$H_0: AAR_t = 0 \qquad H_A: AAR_t \neq 0$$

$$t_{AAR_t} = \sqrt{N}\,\frac{AAR_t}{\sigma(AAR_t)} \qquad \textit{(Equation 15)}$$

Bartholdy et al. (2007) indicates the possible issue if the returns data is not normally distributed. If they are, the above parametric test is good. However, if they are not, a non-parametric test is said to be better. As we rely on a parametric t-test in this study, it's important that the AR does not violate the normality assumption. Earlier studies, however, suggests that this assumption is in fact quite often violated. Although we sometimes see quite significant deviations, MacKinlay (1997) states that the Central Limit Theorem claims a normally distributed aggregate abnormal return, if we have I.I.D. (independent and identically distributed) variables. We have no reason to believe that we violate the I.I.D assumption, hence we assume that our abnormal returns are normally distributed. This is also supported by the figures of the distribution of abnormal returns in the appendix. The assumed normal distribution of the aggregated cumulative abnormal returns allows us to conduct a standard parametric t-test to analyse the abnormal returns for the entire event window. Under the null hypothesis, the cumulative aggregate abnormal return is equal to zero.

$$H_0: \text{CAAR} = 0 \qquad \text{H}_\text{A}: \text{CAAR} \neq 0$$

$$t_{CAAR(\tau_1,\tau_2)} = \sqrt{N}\,\frac{CAAR(\tau_1,\tau_2)}{\sigma(CAAR(\tau_1,\tau_2)} \qquad (\textit{Equation 16})$$

With this cross-sectional test, Brown & Warner (1985) claims that the potential non-normality in daily stock returns is no longer an issue, as the sample mean abnormal return will converge towards a normal distribution. In addition, the test also yields some information regarding the Efficient market hypothesis, as a drifting, non-zero, CAAR could imply violations to the Efficient market hypothesis (Bodie et al., 2014).

Based on the ideas presented by Dos Santos et al. (1993), Hayes et al. (2001), Im et al. (2001) and Chatterjee et al. (2002), we decided to search for evidence of differences in market reactions for firms of different sizes, and whether they are in the financial industry or not. This leaved us with two hypotheses;

The cumulative aggregate abnormal returns are greater for smaller firms than large ones, and for firms in the financial sector compared to those that are not.

$$H_0: CAAR_{Small} \leq CAAR_{Big} \quad H_A: CAAR_{Small} > CAAR_{Big}$$

$$H_0: CAAR_{Fin} \leq CAAR_{Non-Fin} \qquad H_A: CAAR_{Fin} > CAAR_{Non-Fin}$$

By generating grouping variables, we were able to test these hypotheses. The firms were organized by size and divided into three groups (small, medium and large), based on the firms' market capitalization at the time of the announcement. We ran a one-sided, two sample, difference in means-test to search for significant differences between the groups.

$$t_{Size} = \frac{CAAR_{Small} - CAAR_{Big}}{\sqrt{\frac{s^2_{Small}}{n_{Small}} + \frac{s^2_{Big}}{n_{Big}}}} \qquad \textit{(Equation 17)}$$

$$t_{Industry} = \frac{CAAR_{Fin} - CAAR_{Non-Fin}}{\sqrt{\frac{s^2_{Fin}}{n_{Fin}} + \frac{s^2_{Non-Fin}}{n_{Non-Fin}}}} \qquad \textit{(Equation 18)}$$

4. Data

4.1 Data description

Using databases containing news articles and press releases, we determined the date of the firms' IT investment announcements (see Table 1x in the Appendix). We subsequently obtained historical stock price data for the relevant companies for the entire sample period, in order to estimate stock returns if the announcements did not occur. We also used these data in order to calculate potential abnormal returns, comparing estimated stock prices with real stock prices.

IT investments may vary a lot, both in size and character. In order to specify the type of IT investments we are focusing on, we set some constraints. We are generally excluding mergers and acquisitions, new plants bought etc. and are focusing more on information systems, software-solutions and IT infrastructure in general. The market for information systems is a growing one, and it seems interesting to analyse whether investors see these investments as valuable. We imagine that investors may find it more challenging to evaluate investments in information systems, as it is a little more abstract in comparison to an acquisition or a new plant.

Similar studies in the US have generally had samples of around 90 to 110 observations of IT investment announcements over a period of less than 10 years. Considering the relative size of the US economy and their stock exchanges to the Norwegian counterpart, we believe it is unreasonable to expect a similar number in our sample. Bartholdy et al. (2007) analysed whether it was possible to conduct event studies on small stock exchanges with thinly traded stocks. One of their conclusions were that they needed a minimum number of 25 observations to get any reliable results. We therefore decided to expand our time horizon a little and ended up with a sample period from 01.01.2002, to 31.12.2017.

We have not only included firms that are currently listed on the OSE, but also firms that used to be listed but have been taken off the market. By not doing so, our sample might have been subject to survivorship bias, as we would have

excluded all the firms that did not "survive" on the stock exchange (Bodie et al., 2014). In addition, we require no missing return data material for the last 20 days (Brown & Warner, 1985).

4.2 Data gathering

To acquire announcements of IT investments, we have used the ATEKST (Retriever, 2018) database. We also conducted a search within Dagens Næringsliv (2018) as we see it as a natural location for relevant articles, and it was excluded from the Atekst database at the time the data was collected. Additionally, we used OSE's own news channel, NewsWeb. Our main search words include "ERP", "CRM", "avtale", "kontrakt", "IT", and "implement*", among others. We also looked for well renowned vendors, and all the firms listed on the OSE during our sample period, in combination with the mentioned keywords. This yielded a total of 104 IT investment announcements within our time period.

After the investment announcements were obtained, we gathered stock prices for each of the firms for the entire sample period. We made sure we had data for at least 260 days prior to the events, as required by our chosen estimation window. Our main source for financial data is the Bloomberg (2018) terminal. For the estimations we use closing prices, adjusted for Spin-offs, Stock splits/consolidations, Stock dividend/bonus, rights offerings/entitlement and ordinary- and extra-ordinary dividends.

For the Fama French factors, we used the data published by Bernt Arne Ødegaard (2018).

4.3 Data cleaning and description

The initial dataset included several observations we had to exclude, in order to conduct inference. The following exclusions took place; 20 of the observations were from non-listed companies, 3 announcements disclosed acquisitions, 4 announcements were duplicates. The announcements can come from the same firm, provided they are at least 1 year apart. This is to avoid mixing effects, where

we might be unable to determine which of the announcements that are creating the potential abnormal returns. Following this criterion, we excluded 15 additional announcements.

One of our main concerns with this study is the possibility of selection bias. There is a possibility that the largest firms on the OSE receive more media attention, and for that reason announce more actions such as IT investments. By limiting the maximum number of events on a single firm to 4, we have tried to eliminate this potential bias. Due to this criterion we removed another 5 observations.

Finally, we had to exclude another 7 stocks as they were not listed at the time of the announcement, or within a year prior to the announcement, which would inhibit our ability to estimate normal returns as planned. We also made sure that the firms in the sample were older than 5 years such that we did not include start-ups that might have a very steep growth, or struggle to survive.

By this point, we had a total of 50 announcements.

A possible issue is that some of the announcements in the sample have been previously announced outside of our sample period, which would distort our expected change in stock prices for that announcement. For that reason, we checked for earlier announcements of the earliest observations we had, to obtain the exact date of the announcements. This led to no further exclusions, only some adjustments of the announcements date. According to theory this part is crucial and may be even more important than the methodology framework itself (Bodie et al., 2014). Hence, we emphasized this part significantly, using a lot of time to cross-check the dates.

After gathering, cleaning and filtering, we ended up with 50 announcements spread across 31 firms within several different industries. All the firms are quite well established, all a part of the OSEBX index. The data sample, including number of announcements distributed on each firm, is visualized graphically in Figure 1x in the appendix. This distribution gives a mean of 1.613 announcements per company.

5. Empirical results and analysis

Through estimation of normal returns across the three models we have found the explanatory variables to be statistically significant for the majority of the events and models. This means that they have statistically significant explanatory power on the returns that we estimate. A potential concern was the low R^2 that we got in some of our regressions. This is however, a characteristic of many event studies within accounting and finance. According to Chatterjee et al. (2002), the majority of regressions of cumulative abnormal returns on unexpected earnings through cross sectional models, show R^2 less than 0.05. Another concern was the possibility that systematic market risk would change from before to after the announcements. We conducted a difference in means test of the betas (explained in section 3), which did not indicate any significant change in the firm's market risk exposure. Therefore, we proceeded with our study as planned.

5.1 Aggregate Abnormal Return – AAR

As we wanted to make overall inferences for the actual event, we had to aggregate the abnormal returns (MacKinlay, 1997). From section 3, our hypothesis was that an announcement could lead to abnormal returns, mainly on the event date. However, the results of our AAR analysis indicate that the day of the event has very small abnormal returns on average, and therefore not significantly different from zero. Even though we are not surprised by the lack of significant results, we do find it puzzling that the event day is on the lower end of days with regard to abnormal returns. This because we know there has been introduced new information that should be reflected in the price. Perhaps the announcements don't come as unexpected as to cause a change of opinion about the stocks in general. Perhaps there are groups of companies or types of investments that may yield different results, disguised in our full sample. This is further discussed in section 5.3.

	Market model		Fama French		Carhart	
Day	AAR	t-stat	AAR	t-stat	AAR	t-stat
-10	-0.337 %	1.036	-0.283 %	-0.919	-0.304 %	-1.003
-9	0.480 %	0.986	0.526 %	1.086	0.554 %	1.118
-8	0.192 %	0.413	0.297 %	0.669	0.275 %	0.607
-7	0.355 %	1.381	0.316 %	1.370	0.310 %	1.329
-6	0.277 %	0.516	0.336 %	0.616	0.339 %	0.627
-5	-0.503 %	-1.812*	-0.572 %	-2.123**	-0.521 %	-1.952*
-4	-0.300 %	-1.398	-0.281 %	-1.349	-0.273 %	-1.292
-3	0.452 %	0.833	0.511 %	0.960	0.486 %	0.910
-2	0.729 %	1.609	0.750 %	1.700*	0.712 %	1.614
-1	-0.083 %	-0.285	-0.051 %	-0.181	-0.065 %	-0.224
0	-0.218 %	-0.608	-0.340 %	-0.971	-0.357 %	-1.012
1	0.120 %	0.322	0.070 %	0.185	0.130 %	0.342
2	0.265 %	0.433	0.231 %	0.376	0.185 %	0.301
3	-0.023 %	-0.078	-0.083 %	-0.299	-0.090 %	-0.322
4	0.410 %	1.372	0.512 %	1.963**	0.576 %	2.219**
5	-0.394 %	-1.529	-0.376 %	-1.438	-0.396 %	-1.548
6	-0.302 %	-1.153	-0.513 %	-2.153**	-0.531 %	-2.195**
7	0.240 %	0.606	0.283 %	0.701	0.289 %	0.716
8	-0.158 %	-0.444	-0.059 %	-0.171	-0.078 %	-0.221
9	-0.074 %	-0.275	0.001 %	0.004	-0.055 %	-0.208
10	0.118 %	0.501	0.130 %	0.557	0.162 %	0.687

Table 2: Aggregate Abnormal Returns

Note: *90%, **95%, ***99% significance level

If we look at the rest of the event window, we find mixed results. Some days indicate positive and some negative abnormal returns. Only a few days gave significant results, -5, -2, 4 and 6. The negative abnormal returns five days prior to the events suggest that the normal returns estimated by our models are greater than the actual return that day on average. There is a possibility that there is a leakage issue, meaning that the information, and therefore the market correction,

reach the market before the actual announcement is even made. If this is the case, the abnormal returns on the announcement day would be a poor indicator of how the market reacts to the information, as part of the market reaction would have occurred on the day the information was leaked.

Alternatively, we may have misjudged the announcement dates, causing the effect of the announcement to occur before our selected event date. In the case that we missed by 5 days on average, these announcements cause investors to devalue firms, and vice versa if we missed by 2. We do however, find this unlikely as we have double checked the dates thoroughly, and we find it odd that a leakage issue should be so widespread across all events.

Furthermore, we see significant positive aggregate abnormal returns on the fourth day after the event, and significant negative aggregate abnormal returns on the sixth day after the event, for the Fama French- and the Carhart model. These results are also similar for the market model, even though they are not significant. We will return to the intuition behind these results under the test of the cumulative aggregate abnormal return.

If we compare the three models we see that the results are similar, both in sign and in size, for the majority of the event window. This suggest that the choice of model is not drastically significant for the results of our study, hence suggesting that the market model is fairly good estimator of normal returns, even for this relatively small sample size.

5.2 Cumulative Aggregate Abnormal Return – CAAR

	Market model		Fama French		Carhart	
Event window	CAAR(t1,t2)	t-stat	CAAR(t1,t2)	t-stat	CAAR(t1,t2)	t-stat
(-1,1)	-0.180 %	-0.305	-0.321 %	-0.546	-0.292 %	-0.492
(-2,2)	0.813 %	0.843	0.660 %	0.689	0.606 %	0.629
(-3, 1)	1.000 %	1.084	0.906 %	0.994	0.940 %	1.035
(-5, 0)	0.078 %	0.085	-0.018 %	-0.019	0.017 %	0.019
(-9,9)	1.466 %	0.873	1.558 %	0.943	1.489 %	0.898

Table 3: Cumulative aggregate abnormal returns for the days surrounding the announcement

Note: *90%, **95%, ***99% significance level

As previously mentioned, we had to look at the cumulative abnormal returns to analyse the total impact of the new information provided by the announcement. Table 3 displays the results for the different event windows across the three models, and as we can see, none of the tests yielded significant cumulative aggregate abnormal returns. Our main event window (-2, 2) yielded the following results.

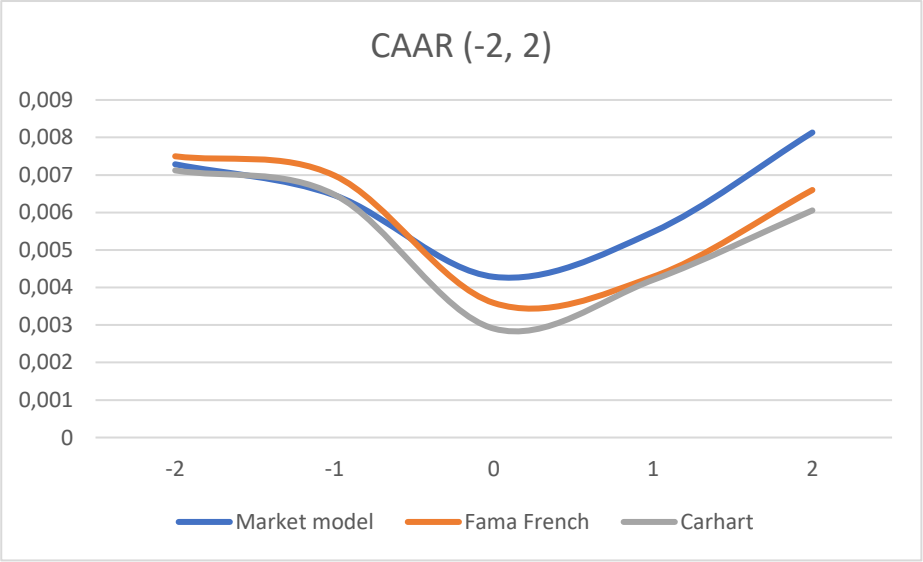

Figure 1: Cumulative Aggregate Abnormal Returns for event window (-2,2)

Figure 1 shows a dip in the cumulative aggregate abnormal returns at the event date. This is in line with the aggregate abnormal returns found on the event day and the days prior. These result however, are not statistically significant at the 90% level, hence we cannot reject the null hypothesis of zero cumulative aggregate abnormal returns in the event window.

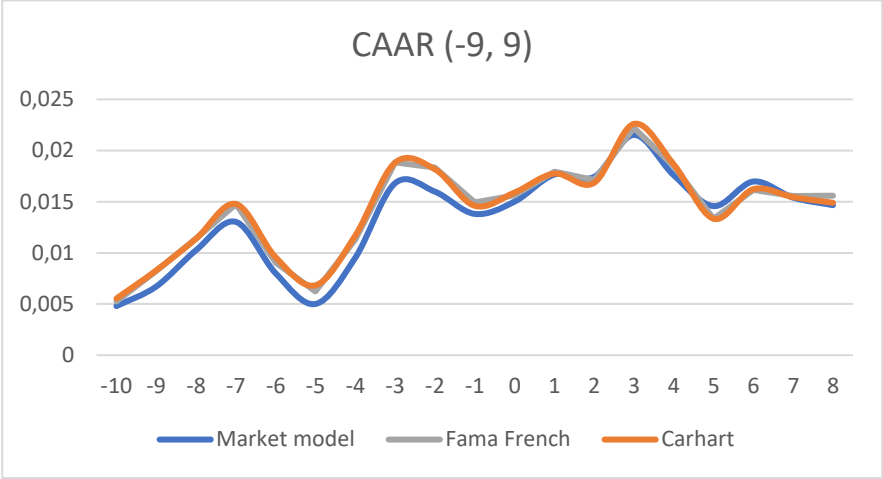

Figure 2: Cumulative Aggregate Abnormal Returns for event window (-9,9)

Figure 2 give some insight to the significant aggregate abnormal returns on the days after the event window. We see that there is a positive spike, supporting the positive abnormal returns on day 4. This is followed by a flattening out in the cumulative aggregate abnormal returns, supporting the negative aggregate abnormal returns found on day 6. In this event window we also fail to find abnormal returns statistically significantly different from zero. This is however not surprising as it includes a lot of days outside of the event where the expectation for cumulative abnormal returns is zero.

From Figure 2, the cumulative aggregate abnormal returns seem to trend upwards in the days before the event. The trend displays continuous higher returns of the firm in real time, compared to the estimated normal returns based on the past financial year. Moreover, we see the flattening of the graph after the event as a sign of close to full information in the market, which reduce the gap in the real vs estimated value close to zero.

5.3 Firm size & Industry

As stated in section 2, it might be reasonable to think that smaller firms can expect slightly greater market reactions compared to large firms, due to the weight of new information provided by the announcement. Firms in the financial sectors are also assumed to see greater value of investments in information systems due to their information intensive nature (Chatterjee et al., 2002; Dos Santos et al., 1993; Im et al., 2001).

We were not able to find any evidence supporting the difference between firms in the financial sector against others. We did however find a statistically significant evidence to support the idea that smaller firms see greater cumulative aggregate abnormal returns, following an IT investment announcement. Hence that investors seem to value IT investment announcement greater for small firms than big.

	Size		**Industry**	
	Diff	P-value	Diff	P-value
CAAR (-2,2)	0,0773	0,041**	-0,0382	0,545

Table 4: Difference in CAAR based on firm characteristics
Note: *90%, **95%, ***99% significance level

The question then becomes whether the group of small firms (not taking the big firms into consideration) see cumulative abnormal returns significantly greater than zero, following their announcements. By analysing the 5-day event window, we found that cumulative abnormal returns were significantly greater than zero at the 90% significance level. By using this grouping, we are however left with a quite small sample of only 9 announcements, which makes the validity of this test a little questionable, but the difference is still interesting.

	Small firms	
	CAAR (-2,2)	P-value
Market Model	0,073	0,067*
Fama French	0,069	0,084*
Carhart	0,068	0,087*

Table 5: CAAR for small firms
Note: *90%, **95%, ***99% significance level

5.4 Discussion

As claimed in section 1, we suspected that it might be difficult to find a significant connection between IT investment announcements and abnormal stock returns. Our findings support this view as we struggled to find evidence for statistically significant abnormal returns, created by IT investment announcements. This is contrary to what's been found in recent studies, claiming that press releases regarding IT investments could yield positive abnormal stock returns (Hayes et al., 2001; Chatterjee et al., 2002, Ranganathan & Brown, 2006; Ajit et al., 2014; Shea et al., 2017).

Our study is based on the Norwegian stock market, while earlier research has mostly used other financial markets, most frequently the US stock market. This may explain different findings, as the OSE is relatively small compared with the US stock market, such that our sample is more exposed to extreme outliers. What we did, was to limit the number of announcements per firm, in order to reduce the impact of each single firm.

Most of the data presented in earlier studies is from the 90's, while our data is more recent. As mentioned in section 2, many IT investments undertaken in the 80's didn't see the benefit until the 90's. For that reason, there is the possibility that these studies are affected by this lagged effect of earlier investments. Another potential reason for why our study differ from earlier findings might be that IT investment announcements reflected more value to the shareholders in the 90's, as the willingness to invest in IT was increasing at that time. Compared with the 2000's, it might be reasonable to think that this "hype" was decreasing, as the shareholders have become more or less expecting such investments. Hence, if the investors view IT investments as non-value-adding (spending money without getting any direct benefit with respect to net cash flow), such announcements may have a neutral or negative affect to the stock prices - at least in a short-term view. With that in mind, the differences between our findings and that of earlier studies, might be explained by changes over time.

There is also a possibility that the dotcom bubble of 2002 and the financial crisis of 2008 could have affected stock returns. Even though we learned that the amount of IT investments declined significantly after the dotcom bubble, we have no reason to believe it should have affected the valuation of the investments that did occur during this period. However, since only 4 out of 50 announcements was done within this period, we did not believe that this event actually affects our results, although we cannot completely neglect the opportunity. By inspecting the abnormal returns surrounding the 4 announcements from 2008 to the end of 2009, we found that if anything, these announcements pull towards a significant result. Even though the effect of the announcements doesn't seem to pull our study towards insignificant results during the crisis it is hardly conclusive evidence, and we cannot say whether it had an impact on the time after the crisis. This might therefore be an interesting area of further research.

We have not accounted for whether the firms were announcing an innovative investment or not, which may be of importance (Dos Santos et al., 1993). Another variable we did not assess was the size of the vendors for the investments. As Hayes et al. (2001) found, larger vendors tend to cause greater abnormal returns. Perhaps firms on the OSE tend to use smaller vendors, or maybe the knowledge of IT providers across investors is limited, making it hard to value the investment.

IT investments often take some time to be implemented. This can result in a delayed return that increase over time. This is consistent with the idea of optimal investment in the presence of learning by doing. The learning curve would lead to an initially low valuation of the investment, which will increase over time. For this reason, we can expect a time lag effect on the market value of the firms (Im et al., 2001). This may explain why investors can be somewhat reluctant to invest before they're able to experience some positive effects from the announced investment.

Another possible issue is the absence of causality. In order to claim causality, we must be able to hold everything else constant. This is difficult when we are looking at economic events where we are only able to run an "experiment" once and are not able to control the surroundings. There can be company specific, industry or economy wide events, around the same time of the announcement that

can distort the value of the stocks drastically (Wooldridge, 2009). For that reason, we cannot claim that the announcement is the sole reason for the effect on the stock price, even though we have no reason to believe otherwise. We do, however, think that reverse causality seems unlikely. This is the idea that the investment announcement is caused by the abnormal returns. In this case we require significant abnormal returns, prior to the announcement. Even though we did find this on certain days, the magnitude of abnormal returns seems too small to cause a firm to make investment decisions on that basis.

6. Conclusion

6.1 Summary

The question we set out to answer was how the Norwegian stock market react when a firm's IT investment plans are published in the media.

We did not find any statistically significant results for the cumulative aggregate abnormal returns across any of the event windows, or any of the aggregate abnormal returns close to or on the announcement day, for the full sample. As we're assuming semi-strong market efficiency, we should see that the stock prices quickly reflect new public information. The potential abnormal returns created should converge back to zero after some time. In the case where investors expected the announcement before it arrived, we cannot say much about the market reaction, as the correction for this information should already have been implemented in the share prices. This might be a contributing factor to the low abnormal returns and thus the lack of significant results in our study. Another reason might be that the insecurity in the market during our sample period had a greater impact than we initially thought.

The lack of significant results and a clear trend in the direction of abnormal returns makes it difficult to suggest a single effect following IT investment announcements with the greatest impact. With this result, it makes sense that not all IT investments are announced in the media.
We did however, see that smaller firms had significantly greater abnormal returns on average, compared to larger firms. We also found indications that small firms obtain positive abnormal returns following IT investment announcements. This idea demands more extensive study when more data is obtainable, but if it holds, it looks like a good idea for small firms to announce their IT investment plans in the future.

A significant positive result could have been used as incentive to announce such investments in the future, and a negative result as the opposite. This finding, however, suggest that the total group of investors do not interpret announcements of this type as a cause of significant change to the value of the firms.

6.2 Strengths and limitations of the study

This study is, as far as we know, the first on the topic limited to the Norwegian stock market. Hence, our study may add value to previous literature, by exploring a different market. It is also one of few to assess the possible change in systematic market risk before and after the announcement.

We have 50 announcements spread across 31 firms, which is a decent amount, taking the size of the Norwegian stock market into consideration. This suggests that we have a fairly even distribution of events across firms, hence our results should not be too heavily weighted by the effects on a single firm. Several models and event windows have been used to ensure robust results, as well as a quite large estimation window. The limited data has, however, put some restraints on our study. A larger data sample would most likely enhance our ability to analyse different characteristics, such as firm size and industry, more in detail. For that reason, it would be interesting to see similar studies as this in the future, based on a more comprehensive dataset.

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8. Appendix

Firm	*Size*	*Announcement date*
Aker	Big	03.07.2006
BW Offshore	Medium	02.09.2014
DNB	Big	22.03.2004 | 19.12.2013
EVRY	Medium	02.06.2008 | 23.10.2012 | 01.10.2015
Ekornes	Medium	11.03.2013
Europris	Small	03.07.2017
Gaming Innovation Group	Small	24.04.2015
Gjensidige Forsikring	Big	14.12.2012
Grieg Seafood	Medium	30.05.2014 | 07.12.2016
Hafslund	Medium	24.02.2015
IDEX	Small	21.04.2017
Kitron	Small	10.11.2010
Kongsberg Gruppen	Medium	15.08.2011 | 20.06.2014
Marine Harvest	Big	20.06.2005 | 27.08.2015
NEXT Biometrics Group	Small	27.10.2017
Norsk Hydro	Big	09.07.2007 | 19.11.2012 | 21.02.2014
Orkla	Big	10.09.2008 | 13.06.2013
Q-Free	Small	27.09.2017
Rieber & Søn (Orkla Foods)	Small	20.08.2004
SAS	Big	30.04.2007 | 05.02.2013
Sbanken (Skandiabanken)	Medium	07.12.2017
Seadrill	Big	17.09.2012
Selvaag Bolig	Medium	15.08.2016
Solstad Farstad	Small	08.01.2014
Sparebanken Vest	Medium	24.06.2003 | 01.07.2014
Equinor	Big	13.11.2006 | 01.07.2009 | 30.08.2011 | 03.02.2014
Storebrand	Big	14.04.2009 | 28.03.2011 | 15.02.2013 | 14.06.2016
Telenor	Big	03.11.2003 | 06.12.2013
Veidekke	Medium	31.08.2010 | 18.05.2017
Weifa	Small	03.12.2013
Yara International	Big	24.01.2007

Table 1x: Table of announcements

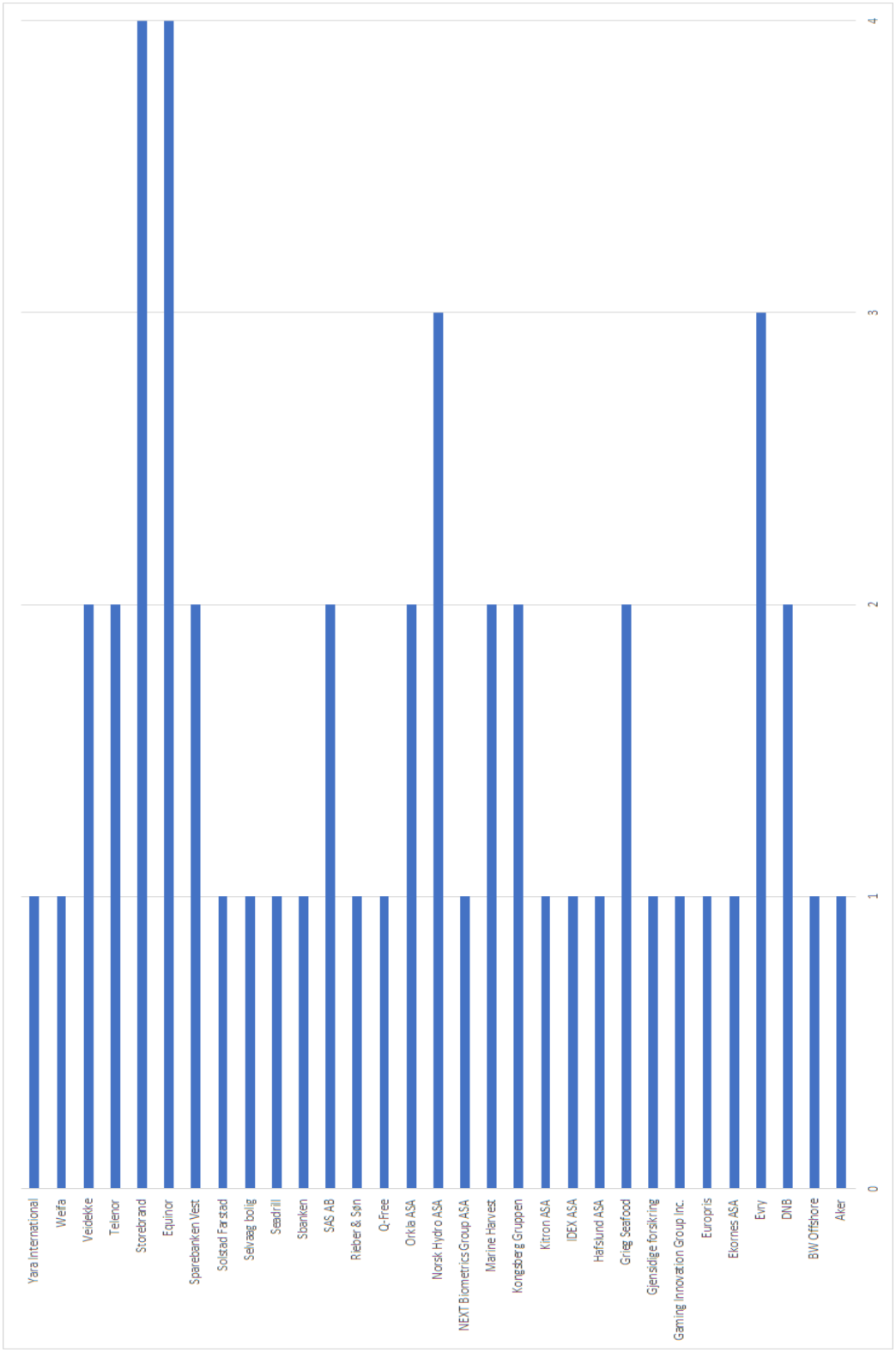

Figure 1x: Distribution of announcements across firms.

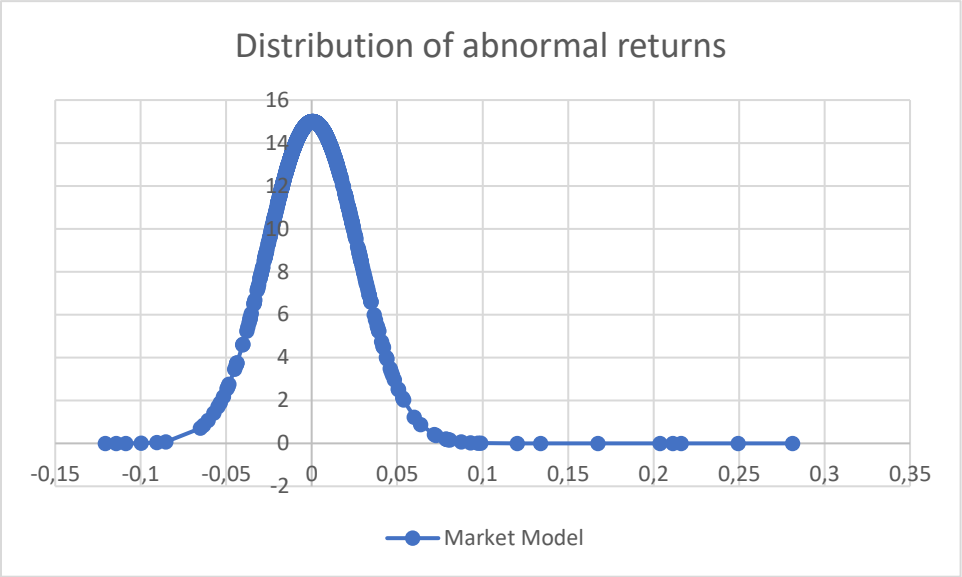

Figure 2x: Abnormal returns from the Market model

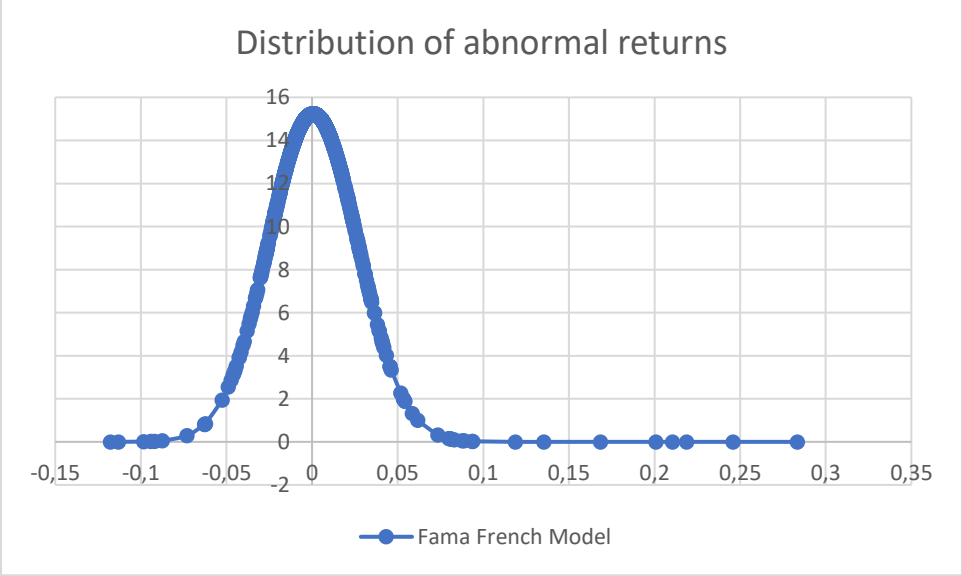

Figure 3x: Abnormal Returns from the Fama French model

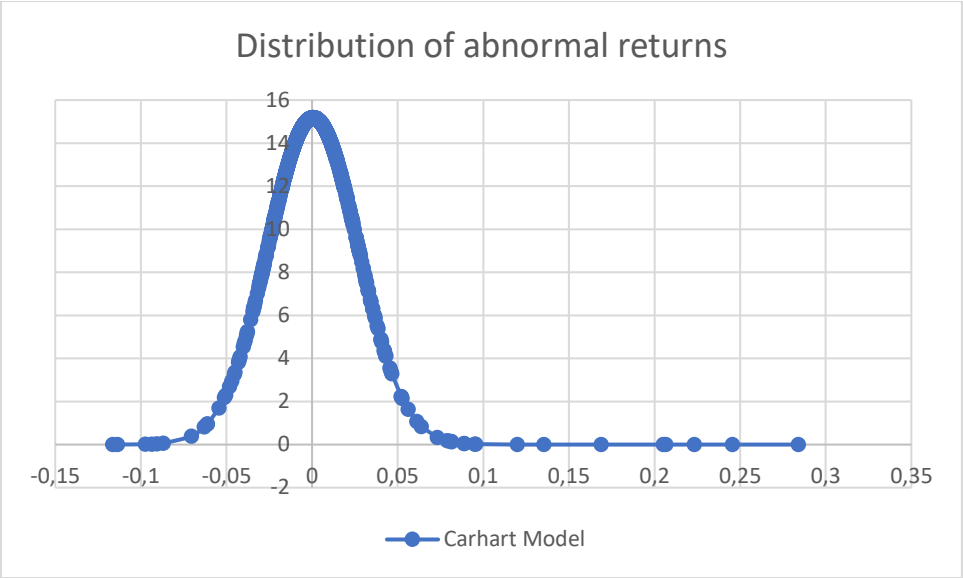

Figure 4x: Abnormal Returns from the Carhart model

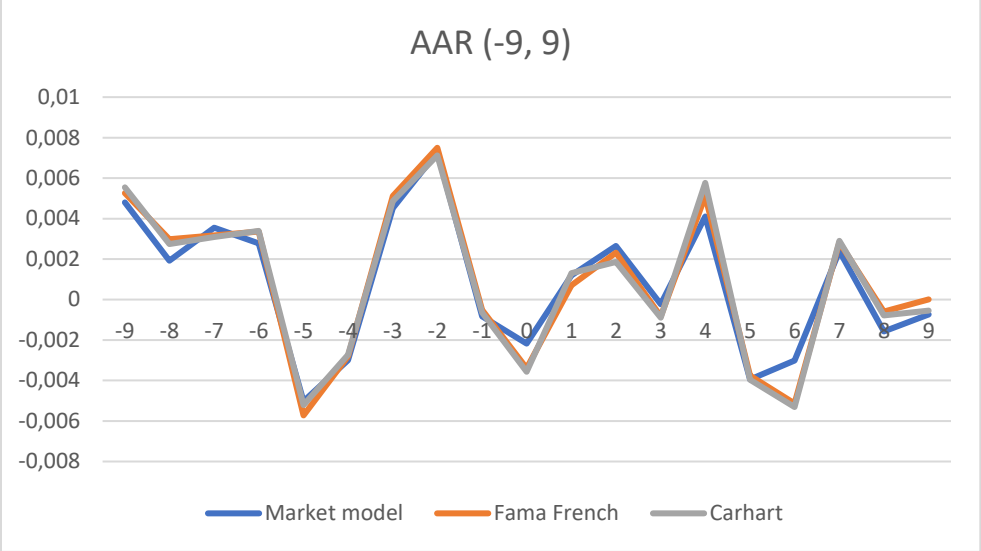

Figure 5x: Aggregate Abnormal Returns for event window (-9,9)