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INTRADAY STOCK PRICE VARIABILITY AROUND QUARTERLY EARNINGS ANNOUNCEMENTS

ARE MARKETS EFFICIENT AT INTERPRETING QUARTERLY EARNINGS ANNOUNCEMENTS?

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Abstract: This study examines the market reactions to earnings announcements and investigates the relationship between market cap segment and stock price variability around quarterly earnings announcements, on the Nasdaq OMX Stockholm main market during the year of 2021. Consistent with theoretical hypothesis, the empirical analysis shows that in the days surrounding an announcement of earnings, the abnormal intraday price ranges are elevated, and the elevated ranges are sustained for up to eight days following an announcement. In the days from ten to two days leading up to an announcement, negative abnormal price ranges were observed, meaning the daily price range was lower compared to the mean non-announcement period price range. Additionally, firms listed as mid cap exhibit a larger abnormal price range during the announcement period compared to both small cap and large cap stocks at a significance level of 0.01. These results suggest that information distribution is scarcer in the days nearing an earnings announcement, and that investors value information conveyed in the earnings announcement differently, implicating a possibility for arbitrage opportunities.

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1. Introduction

1.1. Background

Girolamo Cardano (1564) wrote in his book *Liber de Ludo Aleae ('The Book of Games of Chance')*:

"The most fundamental principle of all in gambling is simply equal conditions, e.g., of opponents, of bystanders, of money, of situation, of the dice box, and of the dice itself. To the extent to which you depart from that equality, if it is in your opponent's favor, you are a fool, and if in your own, you are unjust."

So, when all the cards are dealt faceup on the table then all the players will know how to place their bets since they all can see where the winning hand is at, right? Studies of efficient market hypothesis and stock price variability around earnings announcements, depict a contrasting reality of capital markets.

In an efficient market it is reasonable to assume there is some uncertainty about quarterly earnings in the days leading up to an earnings announcement, which will lead to an increased intraday stock price variability compared to days further away from or after earnings announcements. However, as presented by Lobo and Tung (2000), research concerning stock price and trading volume reactions to earnings announcements suggests that there are significant increases in daily price ranges from eight days prior to the announcement, and up to five days after the announcement, contradictive to the theory that market prices reflect all available information.

The pertinence of a firm's earnings and the market value of that firm is one of the most well established in the field of company valuation models and research. Arguably one of the most influential papers to ever be published in the history of corporate finance and financial valuation research, Modigliani and Miller's 1958 paper presented the theory that the market value of a firm is determined by the present value of future earnings. Consequently, it is intuitively sound to assume that uncertainty regarding earnings announcements will lead to an increase in the stock price variability for a firm in the days leading up to an earnings announcement.

Published ten years after Modigliani and Miller's 1958 paper, Beaver (1968) presented his findings from studying the information content of annual earnings announcements. Under the assumption that the efficient market hypothesis holds true for stock markets, a firm releasing information in the quarterly or annual earnings announcement report would be key triggers for the firm's stock price.

If market prices are often irrational and market returns are predictable, then professionally managed investments funds should be able to outperform passive index funds quite easily according to Malkiel (2005). However, Malkiel found that professional investment managers in the US and abroad do not outperform their respective index benchmarks, and he argues that this means that market prices do seem to reflect all available information.

1.2. Purpose of the study and contribution

This study investigates the intraday stock price variability around quarterly earnings announcements and intends to evaluate the correlation between daily price range and the number of days prior to and following the announcement date.

A question of interest is to evaluate if there are cross-sectional differences in the market reactions to earnings announcements. This is valuable because it would provide a tool for estimating the impact of accounting information on investor's decisions. This study contributes to answering the question of which cross-sectional differences can help explain price variability around earnings announcements, through testing the relation between market cap segment and abnormalities in the daily price range for stocks around earnings announcements, in a regression model.

While the effects that earnings have on stock price is a very well-studied subject, the published literature on the phenomena of prolonged periods of significantly increased intraday stock price ranges before and after earnings announcements is scarcer. Much of the published literature is based on data from before the 21st century, and to the best of my knowledge there have been no studies on the subject, published on data from 2021 of Swedish companies. Consequently, this study contributes to existing literature by providing an analysis of firms listed on the Swedish capital market, Nasdaq OMX Stockholm, with earnings announcements made in the year of 2021.

With the study, I aim to answer the following research question:

> *Are markets efficient when it comes to interpreting accounting information from earnings announcements?*

1.3. Research boundaries

The regression model is based on a dataset from firms listed on the Nasdaq OMX Stockholm main market in year 2021.

Prior research on post earnings announcement drift and price variability around earnings announcements include a regression test of several different dependent variables. This study examines how market cap segment (small, mid, or large cap) is related to stock price variability around earnings announcements.

1.4. Disposition

This study is split into six chapters. In chapter 2 an overview of current literature regarding relevant subject areas to stock price variability around earnings announcements is presented. Chapter 3 consists of a description of the data and methodology used for the study, as well as relevant variable definitions. In chapter 4 the data set and the regression test results are presented. These results are further analyzed and discussed in chapter 5. In the 6^{th} and final chapter, my conclusions and suggested further research topics are presented.

2. Theoretical framework

The following chapter is intended to provide an overview of the current literature that is relevant for this study, starting with a brief timeline of the history of the efficient market hypothesis and different views on whether the hypothesis holds true for real world financial markets. Thereafter an introduction to the theoretical framework regarding market reactions to earnings announcements will be presented, followed by an overview of current literature regarding post-earnings-announcement drift. Lastly, this chapter will present the study’s hypotheses, together with the background and justification for these.

2.1. Efficient market hypothesis

Fama (1970) stated that an efficient market is to be defined as: “A market in which prices always ‘fully reflect’ available information is called ‘efficient’.” A common perception regarding financial markets is that they are becoming more efficient over time, as information spreads quicker with technological advancements etcetera. I will therefore present a timeline of key published studies of the efficient market hypothesis.

In 1972, Scholes published his study on price effects of secondary offerings. Secondary offerings refer to when a company that has already made its initial public offering (IPO), issues new stock for sale to the public. He found that the market is efficient, apart from some indications of post-earnings-announcement price drift.

Five years later, Osborne (1977) published *The Stock Market and Finance From a Physicist’s Viewpoint*, which is a collection of lecture notes where he discusses concepts of market-making, statistical analysis methods, random walks, and sequential analysis on stock markets. In the same year, Beja (1977) presented evidence for the argument that efficient markets in the real world are impossible.

Pareto efficiency is the optimized situation when an economy uses its resources to the maximum level of efficiency, where no change can be made without the cost of making someone worse off. Stiglitz (1981) showed that even markets that are said to be competitive and 'efficient', the allocation of resources may not be Pareto efficient. LeRoy and Porter (1981) examined stock markets and discovered that they exhibit 'excess volatility' and argued that this would reject the efficient market hypothesis. Furthermore, Shiller (1981) also showed that stock markets exhibit excess volatility, since stock prices overreact and "move too much" for subsequent changes in dividends to justify it. Their findings generate an interest for my intended study of examining the stock price variability and market reactions to earnings announcements, because abnormally high price ranges around the earnings announcement would implicate excess volatility, and thereby the efficient market hypothesis should be rejected.

In 1985, De Bondt and Thaler published the study that has since been marked as the start of behavioral finance (Sewell, 2011), in which they showed that stock prices tend to overreact, which demonstrates considerable weak form market inefficiencies (De Bondt and Thaler, 1985). With this study I aim to contribute to answering the question of if capital markets are efficient, through investigating the daily price range around quarterly reports releases, where abnormal ranges would imply that stock prices do in fact over- or under-react to earnings announcement.

Metcalf and Malkiel (1994) investigated if stocks picked out by experts can consistently outperform the market and found that this was not the case. They argued that their findings indicate that market prices do not reflect all available information. Lakonishok et al. (1994) showed that value strategies will generate higher yields on the account of being exploitive of the suboptimal behavior of the average investor, and not due to the strategies being fundamentally riskier. If the daily price range around earnings announcements appear abnormal compared to the price range during the non-announcement period, this could indicate that different investors value information revealed in earnings announcements differently. This would imply a possibility for arbitrage opportunities.

Schleifer (2000) published a study on behavioral finance which questions the assumptions of investor rationality and arbitrage. Schiller (2000) showed that historically, stock prices cannot be explained by the movement of company earnings or dividends, which challenges the efficient market hypothesis. Malkiel (2005) again showed that professional fund and investment managers cannot outperform their respective index benchmarks, and present evidence market prices in fact do not appear to reflect all available information.

Tóth and Kertész (2006) examined the temporal changes in the cross correlations of returns on the New York Stock Exchange. They found that lead-lag relationships between daily stock returns vanished in less than 20 years. They argue that their findings are indicative of increasing efficiency in the stock market. If stock markets are in fact exhibiting increasing efficiency, studies on the market reactions to earnings announcements would provide valuable insights through using more recent data compared to previous studies.

The timeline of the history of the efficient market hypothesis and researchers' views on it is important for understanding how my results may differ from earlier studies on the market reactions to earnings announcements, as a common conception of financial markets is that they are becoming more efficient over time as technology improves and information distribution becomes closer and closer to instantaneousness.

2.2. Market reactions to earnings announcements

In one of the earlier published articles on the investor reactions on earnings announcements, Beaver (1968) investigates the extent to which common stock investors perceive earnings as important information content for firm value. A body of literature has since been published on the subject.

Atiase (1985) studied the stock price behavior of stocks around earnings announcements, and if there were significant systematic cross-sectional differences in the price behavior around earnings announcements associated with firm size (capitalization), as a specific firm characterization. He argues that the production and distribution of private pre-disclosure information is an increasing function to market capitalization, or firm size.

Lobo and Tung (2000) examined the relation of the behavior of the daily price range around quarterly earnings announcements and the level of dispersion in analyst's estimates. They found that for firms where the analyst's earnings forecasts are highly dispersed, the increases in price variability are significantly higher for periods both prior and post earnings announcements, compared to firms where earnings forecasts are low. Lobo and Tung argue that their results indicate that there is information concerning the earnings announcement that become available to a small subset of investors before the announcement, and that market participants take varying amounts of time to process the information revealed by the earnings announcement.

Syed and Bajwa (2018) studied the market reactions to earnings announcement from an efficient market hypothesis perspective on the Saudi Arabian stock market. They found that the Saudi stock market does not bear semi-strong form of the efficient market hypothesis and presented evidence for significant abnormal returns around earnings announcement dates and post-earnings-announcement drift. As their study was limited to the Saudi stock market, my study could further contribute to the existing literature through selecting data on a different capital market which would be valuable for further research on cross-sectional similarities between different capital markets.

2.3. Post-earnings-announcement drift

Post-earnings-announcement drift refers to a stock's tendency to yield returns in the direction of an earnings surprise for several weeks and even months, after the announcement of earnings. This tendency for a stock's price to drift is also referred to as the "Standardized Unexpected Earnings (SUE)".

Earliest evidence presented in a published paper showing the post-earnings-announcement drift is Ball and Brown (1968). They showed that even after firms had made their announcement of earnings, estimated cumulative abnormal returns will be prevalent and drift up for firms presenting positive news and drift down for firms presenting negative news.

Foster, Olsen and Shevlin (1984) examined proposed explanations for post-earnings announcement drifts. They found that firm size independently explains 61 percent of the variation in post-announcement drifts, where the magnitude of the drift is inversely related to firm size.

Bhushan (1994) examined the relation of drift with share price and trading volume. In his study, he also tested the relation of drift to firm size and analyst following. He found an inverse relation between firm size and drift, implying that smaller firms will demonstrate a larger drift compared to larger firms.

There are three general explanations presented by researchers of the post earnings announcement drift (Mendenhall 2004):

1) The result of methodological shortcomings in the studies that have documented the effect.

2) A systematic misestimation of expected returns following surprises in earnings announcements.

3) Investors underreact to value-relevant information regarding a firm’s earnings.

In his study, Mendenhall examines the possibility of a relation between arbitrage risk and post-earnings-announcement drift, as a response to the question of why market efficiency is not enforced through arbitrageurs, or unbiased investors as he describes them. He argues that the third explanation for post-earnings-announcement drift as described above, raises the question why these arbitrageurs cannot, or do not, eliminate the underreaction. He finds a strong relation between the magnitude of the drift and the risk faced by arbitrageurs and argues that his findings support the explanation of post-earnings-announcement drift because of investors underreacting to value-relevant earnings information.

Post-earnings-announcement drift is mainly referred to as a more long-term effect of the market reactions to an earnings announcement, compared to the intraday price variability. However, the explanation for the drift, particularly when viewed as a result of investors underreacting to the information in earnings announcements as described by Mendenhall (2004), makes current literature on post-earnings-announcement drift highly relevant for my study on the short-term effects measured through intraday price variability. If the long-term drift is in fact an underreaction-effect, then the reaction captured in the days surrounding an earnings announcement could be an important indicator for predicting the long-term effects.

2.4. Hypotheses development

Based on prior research, two main themes form the foundation for the hypotheses, which are further elaborated below:

- If the Nasdaq OMX Stockholm main market is efficient, the intraday stock price variability should not exhibit abnormally high or low ranges in the days before or after the day of an announcement of earnings. When an earnings announcement is made then all investors should have the same information available, and as such there should be no difference in the high and low stock price because this would imply that prices do not reflect all available information, or that there are arbitrage opportunities as a result of investors valuing the same information differently. Based on prior research, I expect the daily price ranges to exhibit abnormally high prices around earnings announcements, consequently, the first hypothesis is:
    - H1: The Abnormal daily Price Ranges (APR) will be higher during the announcement period, where elevated ranges will be apparent even days following an announcement.
- Prior research suggests an inverse relation of abnormal intraday price range and the size of the firm reporting. A possible explanation for this is that there is more uncertainty regarding smaller firms, and therefore less violent volatility when information is released for large cap firms compared to small or mid cap firms. There should therefore be an inverse relation between market cap segment and abnormal price range during the announcement period, defined as the 21-day-period centered on the day of an announcement (day 0). The mean Abnormal daily Price Range (APR) during the announcement period should therefore be the biggest for small cap

stocks, and smallest for large cap stocks. Consequently, the second hypothesis will be:

- H2: There is an inverse relation between market cap segment (firm size) and Abnormal daily Price Range (APR).

3. Variable definitions and sample selection

3.1. Variable definitions

When measuring the price variability around earnings announcements, a common approach is to use the daily return variance as an estimator. However, as pointed out by Lobo and Tung (2000) this measure comes with a drawback of being unlikely to reflect intraday price variation, because daily returns are computed using closing prices for the day. The coarseness of daily data, obscures intraday price changes that may occur as different groups of investors respond to the earnings information. I have therefore used the same "Daily Price Range (DPR)" metric for measuring price variability as they have suggested:

$$DPR_{it} = \frac{H_{it} - L_{it}}{(H_{it} + L_{it)}/2} * 100$$

where H_{it} = the high price of firm *i*'s shares on day *t*, and L_{it} = the low price of firm *i*'s shares on day *t*.

As pointed out by Lobo and Tung (2000) a weakness associated with using only DPR_{it} is that it does not take the level of average price range across firms into consideration. To adjust for cross-sectional differences in the level of the price range, I have also applied a second metric to estimate abnormal price ranges, which is measured by the difference between the daily price range and the mean price range for that firm during the non-announcement period. The announcement period is defined as the 21-trading-day[1] period centered on the earnings announcement date, day 0 Days "-10" through "-1" are the ten days preceding the day of the earnings announcement and days "+1" through

[1] Trading days exclude weekends and holidays or other days when the Nasdaq OMX Stockholm is closed.

"+10" are the ten days following the announcement day. This metric represents the "Abnormal daily Price Range (APR)" and is defined as follows:

$$APR_{it} = DPR_{it} - \overline{DPR_i}$$

where DPR_{it} = daily price range for firm *i* on day *t*, and $\overline{DPR_i}$ = mean daily price range for firm *i* during the non-announcement period (remaining trading days when excluding the 21-day announcement period around each earnings announcement).

The empirical analysis examines the DPR_{it} and APR_{it} over a 21-day period, centered on the quarterly announcement of earnings day, where day 0 = announcement date. This will limit the probability of a skewed data due to earnings announcement released during days when the stock market is closed, or announcements released outside of the market's trading hours.

3.2. Sample selection

The data is retrieved in three steps. The first step is daily stock prices for all listed firms on the Nasdaq Stockholm main market during the calendar year 2021. Data for ten calendar years beginning with year 2012 and ending with year 2021 was collected, but since data on earnings announcement dates were scarcer for earlier years, only 2021 has been used for the analysis and regression tests.

3.2.1. Stock prices

Daily high and low stock prices were collected directly from Nasdaq. The file consists of the following parameters:

- DATE (yyyy-mm-dd)
- CODE_CUR (stock ticker)
- HIGH_PAID_ORIG (highest daily transaction price paid)
- LOW_PAID_ORIG (lowest daily transaction price paid)

The data was separated based on calendar year, starting with the first trading day of 2021, and ending with the final trading day of 2021. Since stocks get their market cap segment classifications on an annual term each new calendar year, this filter help avoiding stocks having shifting market cap segment when comparing the regression tests across market cap segments.

3.2.2. Market cap segment and primary industry

Data on the market cap segment (i.e., small/mid/large cap) as well as the primary industry for each firm was collected through Nasdaq's "Monthly Report – Equity Trading by Company and Instrument" for December 2021.

The segment Large Cap includes companies whose shares have a market value of 1 billion euro or more. In the segment Mid Cap companies whose shares have a market value between 150 million euro and 1 billion euro, and the segment Small Cap includes companies whose shares have a market value of less than 150 million euro.[2]

The number of firms in each respective market cap segment and primary industry included in the analysis is exhibited in table 1.

Table 1. Distribution of firms in each respective market cap segment and primary industry.

Market cap segment	Number of Firms
Small cap	60
Mid cap	100
Large cap	62
Total	222

[2] As defined by Nasdaq in their December 2020 press release, "Changes to the Nasdaq Nordic market cap segments": https://www.nasdaq.com/press-release/changes-to-the-market-cap-segments-2021-12-20

Industry	Number of Firms
Basic Minerals	8
Consumer Discretionary	33
Consumer Staples	7
Energy	2
Financials	15
Health Care	43
Industrials	58
Real Estate	22
Technology	25
Telecommunications	8
Utilities	1
Total	222

3.2.3. Earnings announcement dates

Dates for announcement of earnings was collected from S&P's CapitalIQ database. The following criteria were used in the screening:

4) Exchanges (Primary listing): (OM) OMX Nordic Exchange Stockholm

5) Key Developments by Type: Announcement of Earnings [1/1/2021 – 12/31/2021]

Firms with less than four announcements of earnings were filtered out. This may lead to a survivor's bias in the data and should be considered when reviewing the results.

Each line of data with daily stock prices for each firm is then matched with the relevant earnings announcement dates for that firm, and the closest announcement is calculated so that day "-x" represent "x" days prior to an announcement date, and "+y" represent "y" days after an announcement date. There is only one day value for each data row, and it displays the smallest absolute value of "x" and "y". When calculating days to- and from days of earnings announcements, only trading days have been used. To avoid issues with firms releasing earnings announcements in late 2020 and early 2022, data rows containing the ten smallest (-x) and ten largest (+y) number of days have been removed.

4. Empirics and analysis

4.1. Full sample price range behavior

Table 2 presents descriptive statistics for the full sample of 52,004 trading days for all firms in the sample.

Table 2. Descriptive statistics of price range for the full sample, during both non-announcement period and around quarterly earnings announcements.

	N	Minimum	Maximum	Mean	Std. Deviation
DPR[3]	52004	.000	127.935	3.522	2.592
APR[4]	52004	-8.409	118.015	.109	2.310
Valid	52004				

Table 3 provides an overview of mean Daily Price Range (DPR) and mean Abnormal daily Price Range (APR) for the full sample around 833 quarterly earnings announcements. The Abnormal Price Range is calculated as the difference between the Daily Price Range and the mean Daily Price Range for that firm during the non-announcement period (i.e., excluding the 21 trading days, -10 prior through +10 following, the day of the announcement, day 0). The table presents mean DPR and mean APR for all firms in the sample for each of the 21 trading days centered on the announcement of earnings day (day 0). A negative value in the Day column represents

[3] $DPR_{it} = \frac{H_{it}-L_{it}}{(H_{it}+L_{it})/2} * 100$

[4] $APR_{it} = DPR_{it} - \overline{DPR_i}$

where DPR_{it} = daily price range for firm *i* on day *t*, and $\overline{DPR_i}$ = mean daily price range for firm *i* during the non-announcement period. The announcement period is the 21-day period centered on the day of the earnings announcement (day 0), with -10 days prior to, and +10 days following the day of the announcement.

days prior an announcement, and a positive value represents days following an announcement. Day 0 represents the calendar day of the announcement, regardless of if the announcement was made outside or within open trading hours of the stock exchange.

Table 3. Mean daily price range surrounding quarterly earnings announcements (*n* = 833)

Day	Daily Price Range (DPR) Mean	Abnormal Price Range (APR) Mean
-10	3.307	-0.109
-9	3.228	-0.189
-8	3.288	-0.100
-7	3.270	-0.127
-6	3.191	-0.235
-5	3.236	-0.169
-4	3.343	-0.079
-3	3.417	0.017
-2	3.422	0.013
-1	3.700	0.276
0	7.703	4.288
1	5.010	1.603
2	4.161	0.741
3	3.801	0.401
4	3.602	0.197
5	3.514	0.109
6	3.437	0.055
7	3.481	0.067
8	3.439	0.036
9	3.386	-0.029
1	3.411	-0.002

4.2. Differences in market cap segment and price range

4.2.1. Descriptive statistics and announcement period price range behavior

Table 4 provides descriptive statistics for the full sample of 52,004 trading days for all firms in the sample, grouped by market cap segment. An observation in the data represents Daily Price Range (DPR)[5] or Abnormal daily Price Range (APR)[6] for one trading day and for one stock.

Table 4. Descriptive statistics of price range for the full sample, grouped by small, mid, and large cap stocks, during both non-announcement period and around quarterly earnings announcements.

Panel A: Small cap stocks

	N	Minimum	Maximum	Mean	Std. Deviation
DPR	14227	.000	127.935	4.417	3.400
APR	14227	-8.409	118.015	0.096	3.170

Panel B: Mid cap stocks

	N	Minimum	Maximum	Mean	Std. Deviation
DPR	24018	.000	64.109	3.592	2.347
APR	24018	-4.706	57.986	0.128	2.174

Panel C: Large cap stocks

	N	Minimum	Maximum	Mean	Std. Deviation
DPR	13759	.213	25.059	2.473	1.374
APR	13759	-3.000	21.636	0.090	1.232

[5] $DPR_{it} = \frac{H_{it}-L_{it}}{(H_{it}+L_{it})/2} * 100$

[6] $APR_{it} = DPR_{it} - \overline{DPR_{\iota}}$

where DPR_{it} = daily price range for firm *i* on day *t*, and $\overline{DPR_{\iota}}$ = mean daily price range for firm *i* during the non-announcement period. The announcement period is the 21-day period centered on the day of the earnings announcement (day 0), with -10 days prior to, and +10 days following the day of the announcement.

Table 5 provides an overview of mean Daily Price Range (DPR) and mean Abnormal daily Price Range (APR), for each respective market cap segment around the quarterly earnings announcements. The table presents mean DPR and mean APR for all firms in the sample for each of the 21 trading days centered on the announcement of earnings day (day 0). A negative value in the Day column represents days prior an announcement, and a positive value represents days following an announcement. Day 0 represents the calendar day of the announcement, regardless of if the announcement was made outside or within open trading hours of the stock exchange.

Table 5. Mean daily price range surrounding quarterly earnings announcements conditional on market cap segment classification.

	Small Cap		Mid Cap		Large Cap	
Day	Mean DPR	Mean APR	Mean DPR	Mean APR	Mean DPR	Mean APR
-10	4.028	-0.310	3.408	-0.052	2.382	0.001
-9	3.799	-0.541	3.415	-0.048	2.314	-0.067
-8	4.111	-0.179	3.388	-0.076	2.313	-0.065
-7	3.927	-0.363	3.419	-0.051	2.362	-0.021
-6	3.889	-0.457	3.293	-0.188	2.299	-0.089
-5	3.795	-0.507	3.379	-0.091	2.428	0.035
-4	3.985	-0.366	3.564	0.097	2.301	-0.087
-3	4.453	0.148	3.489	0.018	2.234	-0.120
-2	4.510	0.174	3.390	-0.067	2.365	-0.014
-1	4.876	0.555	3.662	0.191	2.546	0.137
0	9.268	4.939	7.698	4.230	6.105	3.718
1	5.747	1.416	5.221	1.761	3.916	1.526
2	4.930	0.580	4.425	0.965	2.909	0.515
3	4.547	0.225	4.035	0.580	2.635	0.274
4	4.779	0.430	3.629	0.187	2.353	-0.024
5	4.313	0.003	3.700	0.235	2.370	0.000
6	4.271	0.018	3.629	0.163	2.270	-0.098
7	4.432	0.101	3.580	0.118	2.325	-0.056
8	4.373	0.086	3.585	0.108	2.237	-0.140
9	4.075	-0.279	3.509	0.052	2.466	0.085
10	4.564	0.219	3.309	-0.134	2.380	-0.006

4.2.2. Results from regression analysis tests

In table 6, results from the regression model testing are presented. In panel A the dependent variable is the Daily Price Range[7], where I have estimated the following model:

$$DPR_{it} = \alpha_0 + \alpha_1 LargeCap_{it} + \alpha_2 MidCap_{it} + \varepsilon_{it}$$

Where $LargeCap_{it}$ is a dummy variable that is given value 1 if the firm is listed as a large cap stock and given value 0 if is not. The same methodology is used for the variable $MidCap_{it}$. There is no dummy variable for small cap firms, as this would lead to issues with multicollinearity between variables. Consequently, the intercept at α_0 represents small cap firms where $LargeCap_{it}$ and $MidCap_{it}$ are both given values 0. The coefficients for large cap and mid cap will represent the differences between the mean for small cap stocks and the respective comparison groups, mid cap, and large cap stocks.

In Panel B the same model has been applied to the dependent variable Abnormal Price Range[8], and the model I have estimated is as follows:

$$APR_{it} = \alpha_0 + \alpha_1 LargeCap_{it} + \alpha_2 MidCap_{it} + \varepsilon_{it}$$

[7] $DPR_{it} = \frac{H_{it}-L_{it}}{(H_{it}+L_{it})/2} * 100$

[8] $APR_{it} = DPR_{it} - \overline{DPR_i}$

where DPR_{it} = daily price range for firm *i* on day *t*, and $\overline{DPR_i}$ = mean daily price range for firm *i* during the non-announcement period. The announcement period is the 21-day period centered on the day of the earnings announcement (day 0), with -10 days prior to, and +10 days following the day of the announcement.

Table 6. Regressions of price range around earnings announcements on market cap segment classification.

Panel A: *Model:* $DPR_{it} = \alpha_0 + \alpha_1 LargeCap_{it} + \alpha_2 MidCap_{it} + \varepsilon_{it}$

Residuals:	Min	1Q	Median	3Q	Max
	-4.605	-1.467	-0.573	0.745	123.330

Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	4.60517	0.04068	113.20	<2e-16 ***
LargeCap	-1.96089	0.05783	-33.91	<2e-16 ***
MidCap	-0.76257	0.05135	-14.85	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.811 on 17502 degrees of freedom
Multiple R-squared: 0.06283, Adjusted R-squared: 0.06272
F-statistic: 586.7 on 2 and 17502 DF, p-value: < 2.2e-16

Panel B: *Model*: $APR_{it} = \alpha_0 + \alpha_1 LargeCap_{it} + \alpha_2 MidCap_{it} + \varepsilon_{it}$

Residuals:	Min	1Q	Median	3Q	Max
	-8.028	-1.276	-0.460	0.686	117.733

Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.28198	0.03841	7.341	2.21e-13 ***
LargeCap	-0.01897	0.05461	-0.347	0.7284
MidCap	0.09735	0.04849	2.008	0.0447 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.655 on 17502 degrees of freedom
Multiple R-squared: 0.0004083, Adjusted R-squared: 0.0002941
F-statistic: 3.575 on 2 and 17502 DF, p-value: 0.02804

4.3. Robustness testing

In the data used for the regression tests, no outliers have been excluded. As the number of observations are relatively high (n=14,227, 24,018 and 13,759 for small, mid, and large cap stocks, respectively), outliers will have a smaller impact compared to a data set with fewer observations. Further, I find it relevant to include outliers in the data due to the nature of the study, as the topic of my study is to examine abnormalities in the stock price variability and therefore outliers are of special interest to investigate. However, it is still important to note that including outliers leads to risks of distortion of the data as firm specific events may occur that lead to excessive variance of high and low intraday stock prices, that is not connected to the proximity of an earnings announcement.

Because the *MidCap* variable exhibited a significant difference compared to the reference group (*SmallCap*) and *LargeCap* did not, I also tried using the mid cap stocks as the reference group, to evaluate if the difference between small cap and large cap compared to mid cap are significant. The results are displayed in Table 7.

Table 7. Regressions of abnormal price range around earnings announcements on market cap segment classification, using the *MidCap* variable as reference group (intercept).

Model: $APR_{it} = \alpha_0 + \alpha_1 LargeCap_{it} + \alpha_2 SmallCap_{it} + \varepsilon_{it}$

Residuals:	Min	1Q	Median	3Q	Max
	-8.028	-1.276	-0.460	0.686	117.733

Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.37933	0.02959	12.821	<2e-16 ***
LargeCap	-0.11631	0.04880	-2.383	0.0172 *
SmallCap	-0.09735	0.04849	-2.008	0.0447 *

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.655 on 17502 degrees of freedom
Multiple R-squared: 0.0004083, Adjusted R-squared: 0.0002941
F-statistic: 3.575 on 2 and 17502 DF, p-value: 0.02804

The potential for human error should also be considered as the data has been processed and filtered manually, and a survivor’s bias may be apparent due to filtering out firms with less than four quarterly reports published during the year 2021.

5. Discussion of results

5.1. Price range behavior around earnings announcements

Consistent with my hypothesis, the Daily Price Range (DPR) and Abnormal daily Price Range (APR) increase around earnings announcements. However, compared to previous studies (Lobo and Tung 2000; Syed and Bajwa 2018), the period of abnormally large price ranges seems to be shorter, and in the days leading up to an earnings announcement, the abnormal price ranges exhibit negative values, implying that the daily price range is smaller than usual. For small cap stocks, negative APRs were noted from 10 to 4 days prior to the announcement, for mid cap stocks they were noted from 10 to 5 days, and again on 2 days prior to an announcement, and for large cap stocks negative APRs were noted from 9 days to 6 days, and again from 4 days to 2 days prior to an announcement of earnings.

5.2. Market cap segment

The regression test for daily price range exhibits extremely high significance levels indicating a very strong relation between the size of the daily price range and the market cap segment, however this is expected as the DPR measure is not a relative measure, meaning if the average stock prices are generally significantly different across market cap segments, this will cause the regression variables to appear significant as well. What is more interesting to look at is the results from the abnormal price range. The model uses two dummy coded variables for MidCap and LargeCap stocks, assuming values 1 for the matching market cap segment, and for small cap stocks both the MidCap and LargeCap variables will be zero, meaning the intercept will represent the mean for small cap stocks. The model exhibits a statistically significant MidCap variable at a significance level of 0.01 but does not evidence a significant difference to large cap stocks, compared to the reference group (small cap stocks).

When using the MidCap variable as the reference group, the regression test shows significant differences to both small cap and large cap stocks. The coefficients for both LargeCap and SmallCap are negative, implying that the mean abnormal price range during the announcement period is higher for mid cap stocks compared to both small- and large cap stocks.

I also tested the relation between abnormal price range around earnings announcements and the primary industry, as a different possible cross-sectional difference, but found no distinct relationship.[9]

[9] See appendix table A3 for results of the regression test.

6. Conclusions and further research

6.1. Conclusions

The purpose of my study was to evaluate if markets appear to be efficient at interpreting value-relevant information in quarterly earnings announcements, through examining the daily price range behavior around earnings announcements. This study presents empirical evidence for an increased intraday stock price variability during the days surrounding an earnings announcement. The results exhibit smaller (negative) abnormal price ranges in the days leading up to an earnings announcement (10 to 2 days prior) and higher prices in the day before, and up to ten days following an announcement. In the three-day period centered on the day of the earnings announcement, positive abnormal price ranges can be found for all market cap segments. This implies that market participants value information revealed in the earnings announcement differently. Consequently, I argue that my findings are indicative of a weak efficiency according to the efficient market hypothesis since abnormal large daily price ranges infer that the market exhibits excess volatility. Consistent with my hypothesis, abnormal price ranges will be higher on the day of the announcement and the effects seem to be sustained for multiple days following an announcement.

Abnormally small (negative) price ranges in the days leading up to an earnings announcement, may be indicative of that information of the company is more scarce than usual, under the assumption that prices reflect all available information, and price changes at large occur due to new information becoming available to investors. One could argue that this implies an efficiency of financial markets, as there seems to be a positive relation between information and price variability. Atiase (1985) argues that the production and distribution of private pre-disclosure information is an increasing function to market capitalization (firm size). My findings indicate that there is a relation between negative abnormal price ranges leading up to an earnings announcement and market capitalization segment (firm size). I thereby argue that my results provide evidence for the theory presented by Atiase (1985), as consistency of negative abnormal price ranges for stocks with smaller market capitalization segment evidence a lack of private pre-disclosure information distribution in the days prior to an earnings announcement.

This study also indicates a relation between market cap segment (i.e., size of the firm) and the magnitude of the abnormal price range, around earnings announcements. The regression model uses daily price range for small cap stocks as the reference group and finds that the difference between the mean for small cap stocks and mid cap stocks is significant at a significance level of 0.01, but no significant difference can be found for large cap stocks. Using a sample of quarterly earnings and daily stock prices for 222 firms listed on the Nasdaq Stockholm Main Market, in the year 2021, I find a significant inverse relationship between market cap segment and the magnitude of the Abnormal daily Price Range[10]. My hypothesis that there is an inverse relation between market cap segment and the magnitude of the abnormal price range does thereby not seem to hold true. While it is true that my empirical results depict a statistically significant difference that can be explained my market cap segment, it is not an inverse relation, but rather mid cap stocks seem to have higher abnormal price ranges compared to both small cap and large cap stocks.

6.2. Further research

My suggestion for further research would primarily be to examine the price variability and market reactions to earnings announcements over longer periods of time, to investigate how the effects changes over time. Additionally, by increasing the number

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[10] $APR_{it} = DPR_{it} - \overline{DPR_i}$

where DPR_{it} = daily price range for firm *i* on day *t*, and $\overline{DPR_i}$ = mean daily price range for firm *i* during the non-announcement period. The announcement period is the 21-day period centered on the day of the earnings announcement (day 0), with -10 days prior to, and +10 days following the day of the announcement.

of observations through larger datasets on additional exchanges, such as non-main markets withing Sweden and exchanges in other countries, the regression tests could be further strengthened and provide further insights not recorded in my study.

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8. Appendix

Table A1. Descriptive statistics of price range around quarterly earnings announcements by market cap segment. DPR2 and APR2 respectively, represent the grouped price range and abnormal price range, over the day before and the day of an announcement.

Panel A: Firms listed as small cap

Variable[11]	N	Minimum	Maximum	Mean	Std. Deviation
DPR2	229	1.851	66.441	11.784	7.419
APR2	229	-3.847	61.066	7.456	7.306
Valid	229				

Panel B: Firms listed as mid cap

	N	Minimum	Maximum	Mean	Std. Deviation
DPR2	381	.803	26.835	9.849	4.966
APR2	381	-2.450	22.079	6.381	4.832
Valid	381				

Panel C: Firms listed as large cap

	N	Minimum	Maximum	Mean	Std. Deviation
DPR2	223	.941	23.941	7.494	3.814
APR2	223	-1.437	19.854	5.107	3.574
Valid	223				

[11] DPR2 represent cumulative daily price range over (periods (-1, 0), APR2 represents corresponding cumulative abnormal price range over periods (-1, 0).

Table A2. Regressions of price range on market cap segment classification

Panel A: *Model:* $DPR_{it} = \alpha_0 + \alpha_1 LargeCap_{it} + \alpha_2 MidCap_{it} + \varepsilon_{it}$

Residuals:	Min	1Q	Median	3Q	Max
	-4.417	-1.330	-0.482	0.708	123.518

Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	4.41696	0.02089	211.49	<2e-16 ***
LargeCap	-1.94428	0.02979	-65.28	<2e-16 ***
MidCap	-0.82503	0.02635	-31.30	<2e-16 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.491 on 52001 degrees of freedom
Multiple R-squared: 0.07632, Adjusted R-squared: 0.07628
F-statistic: 2148 on 2 and 52001 DF, p-value: < 2.2e-16

Panel B: *Model:* $APR_{it} = \alpha_0 + \alpha_1 LargeCap_{it} + \alpha_2 MidCap_{it} + \varepsilon_{it}$

Residuals:	Min	1Q	Median	3Q	Max
	-8.505	-1.125	-0.353	0.648	117.919

Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.096157	0.019364	4.966	6.86e-07 ***
LargeCap	-0.006435	0.027616	-0.233	0.816
MidCap	0.031372	0.024435	1.284	0.199

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.31 on 52001 degrees of freedom
Multiple R-squared: 5.662e-05, Adjusted R-squared: 1.816e-05
F-statistic: 1.472 on 2 and 52001 DF, p-value: 0.2294

Table A3. Regression test of abnormal price range during announcement period with dummy coded variables to measure differences based on primary industry. The reference group in the test is basic minerals.

$$\textit{Model: } APR_{it} = \alpha_0 + \alpha_1 LargeCap_{it} + \alpha_2 MidCap_{it} + \varepsilon_{it}$$

Residuals:	Min	1Q	Median	3Q	Max
	-8.280	-1.289	-0.456	0.686	117.481

Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.272729	0.109	2.512	0.0120 *
ConsumerDiscretionary	0.261281	0.121	2.167	0.0303 *
ConsumerStaples	0.072479	0.159	0.456	0.6481
Energy	-0.111	0.243	-0.458	0.6467
Financials	0.002	0.134	0.018	0.9859
HealthCare	0.083	0.118	0.705	0.4805
Industrials	0.068	0.115	0.588	0.5562
RealEstate	-0.407	0.126	-3.240	0.0012 **
Technology	0.123	0.124	0.993	0.3209
Telecommunications	0.114	0.155	0.735	0.4624
Utilities	-0.386	0.312	-1.236	0.2164

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.65 on 17494 degrees of freedom
Multiple R-squared: 0.004233, Adjusted R-squared: 0.003663
F-statistic: 7.436 on 10 and 17494 DF, p-value: 6.749e-12