Exploiting the Post Earnings Announcement Drift Using a Long Short Trading Strategy

Bachelor Thesis

Banking & Finance

Author

Bouddat Aladin

Student ID: 17-932-831

Prof. Dr. Felix Kübler

Professor of Financial Economics

Supervisor: Igli Bajo

Department of Banking and Finance

University of Zurich

Abstract

This bachelor thesis investigates the post-earnings announcement drift (PEAD) and its exploitation using a long-short trading strategy. Based on the data from 1994 to 2023, this study examines the potential for achieving excess returns in S&P 500 equities as well as within the technology sector as a subset. The backtest confirms that this long-short PEAD strategy generates 2.74% annualized excess returns in comparison to a buy-and-hold benchmark when applied to our test data from 2009-2023. Furthermore, this study reveals that focusing on technology equities enhances these returns to 8.93%, providing empirical evidence for the technology sector-specific strategy. Potential limitations of this strategy are explored and improvements are proposed.

Thesis Assignment

Exploiting the Post-Earnings Announcement Drift using a Long-Short Strategy

Objectives:

- Motivate why it is interesting to backtest a Long-Short Strategy exploiting the post-earnings announcement drift.
- Discuss the work that has been done in the literature on this topic, and how it is different from your paper. State your contributions.
- Give a definitive answer to your two hypotheses via the results of your analysis. In particular, show via your analysis whether the two hypotheses that you have tested hold true or not.
- Interpret your results. Try to explain the reasons why the hypotheses hold true or not, and when possible, provide supporting evidence for your explanations. [In your case, this point is particularly relevant for Hypothesis 2. For Hypothesis 1, this point becomes relevant in case you cannot find superior returns.]
- Discuss potential problems, if any, associated with your methodology, your sample, and the potential external validity of your results. Show me that you are also aware of the limitations of your study. Just to give you some ideas: a) do you think the strategy's scope is slightly more limited in reality considering the time gaps in the earnings reports of different companies?; b) do you think that the results that you are finding can be extrapolated to other stock exchanges?
- Draw a conclusion that adequately summarizes your results, your contribution, and provides some implications of your analysis.

Process:

- You will be given the opportunity to discuss your disposition with your supervisor. If this is required, feel free to contact us to make an appointment.

Please note the following formal criteria:

- Write the thesis in English.
- Focus on quality rather than quantity. Use a compact writing style; Dispense long

and unnecessary statements and get quickly to the point. Your paper (excl. directory and appendix) should not exceed 40 pages.

- Please make sure to use an error-free language as well as a scientific, compact, and fluent writing style. Pay also great attention to a correct citation format.
- Use sufficiently described and labeled graphs. Tables and graphs should be selfexplaining and thereby understandable even when being read independently from the thesis.
- Set up your thesis as follows:
    - Title page
    - Abstract based on the model of scientific papers (max. 100 words)
    - This assignment task
    - Table of contents
    - Main body
- Hand in your thesis electronically via OLAT. Please make sure that you submit the following documents (zip-file):
    - Title page of the thesis (PDF document)
    - Executive Summary (PDF document): Summary of maximum 3 pages
    - Whole thesis (LaTex- or Word-file as well as PDF-document)
    - Full data material which has been used for the paper, Computer-codes for a replication of your results
    - Electronically saved references (papers in PDF format).

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1. Introduction

Earnings announcements reflect a company’s financial health. The reported earnings serve as an indicator of the company’s current and future performance. When earnings are being announced there is new publicly available information which influences stock prices as well as investors decisions. Because a company’s valuation is directly influenced by the earnings, the announcements are watched closely by investors and analysts. Regular earnings reports are important for transparency in financial markets. That is why these documents are regulated to protect investors and keep market integrity. This makes them a reliable source of information.

Leading up to an announcement numerous analysts forecast the earnings. When the actual earnings numbers are being released, they could exceed or fall short of expectations resulting in a surprise. If the earnings do not align with the analysts’ consensus it can tilt the market sentiment towards a company which can lead to bullish or bearish tendencies.

2. Literature Review

Ball & Brown (1968) were pioneers in documenting the market's reactions to earnings announcements. They have laid the foundation for PEAD research. Their study revealed that stock prices responded significantly to unexpected earnings. Interestingly they found that the market anticipates some of the information before the actual announcement. The adjustment of the prices was found to be not only on the announcement day itself. Ball & Brown observed that prices continue to drift in the direction of the earnings surprise beyond the immediate announcement period - a phenomenon now known as the Post-Earnings Announcement Drift (PEAD).

This behavior conflicts with the semi-strong form of the efficiency market hypothesis (EHM) which states that all publicly available information is reflected in the price of a security (Fama, 1970). PEAD exemplifies a scenario where public information is not fully absorbed by the market immediately after publication.

Subsequent studies have further investigated the anomaly. Foster, Olsen & Shevlin (1984) illustrated the cumulative abnormal return (CAR) as a function of days prior and after the earnings announcements for decile portfolios, that were sorted by the amount of surprise (Figure 1). Greater surprises showed a significant positive CAR than those with smaller surprises.

The drift was demonstrated to continue at least 60 days after the release of the earnings announcements. Two reasons for the existence of the drift were presented by Bernard & Thomas in 1989 as they conducted a pivotal investigation into PEAD, analyzing the dynamics of stock prices after earnings reports. One class of explanations suggests the delayed price response due to missing information as the explanation for the drift, the other suggests that risk modeling was misestimated and a fair compensation for the high risk taken (risk premium).

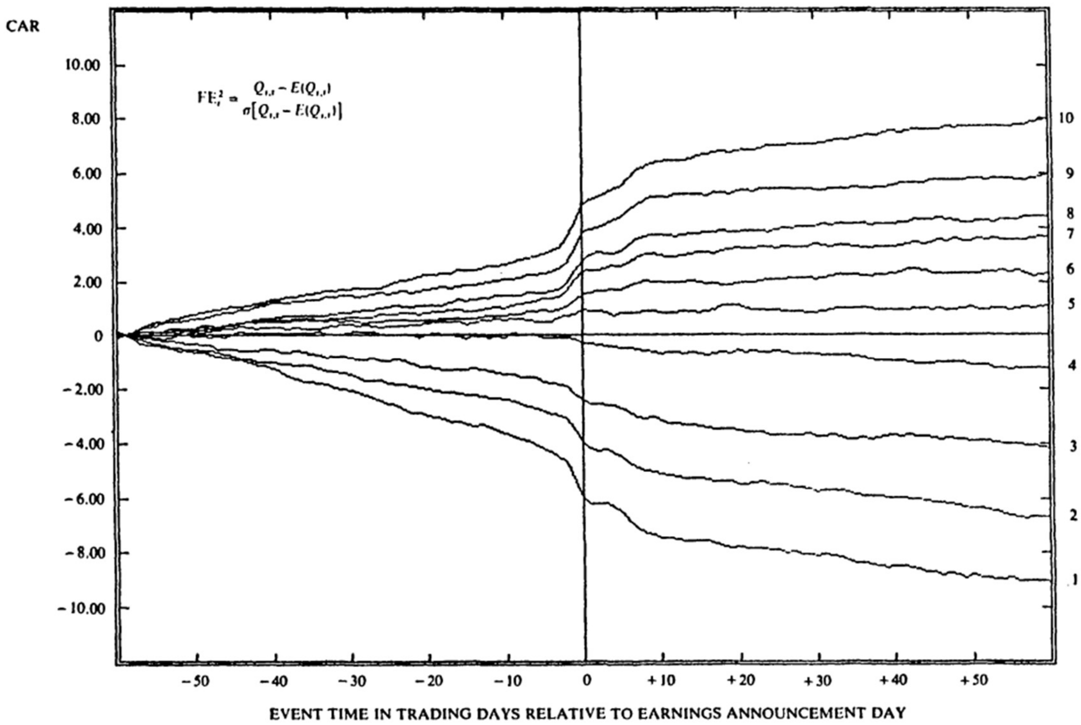

Figure 1: Cumulative abnormal returns for decile portfolios assigned by the standing of standardized unexpected earnings (SUE) relative to the SUE of the prior-quarter. Portfolio 10 includes firms with the largest surprise (highest SUE ranking). Data is based on 1974-1981. Reprinted of G. Foster, C. Olsen, and T. Shevlin, "Earnings Releases, Anomalies, and the Behavior of Security Returns," The Accounting Review [October 1984].

Bernhard & Thomas (1989) empirically demonstrated that stock prices continue to drift well beyond the announcement date. This supports the delayed price response priorly discovered by Ball & Brown (1968). Bernard & Thomas (1989) provided evidence that the market systematically underreacts to new earnings information. Their analysis suggests that the initial adjustment is often incomplete and that the market cannot fully digest the implications immediately. Instead, a gradual adjustment of stock prices was observed.

Taking up on their earlier study, Bernard & Thomas (1990) explored the reasons for PEAD. They wanted to find out whether the drift could be attributed to a risk premium demanded by investors holding riskier stocks or if it was purely due to delayed information processing. Their results showed no significant correlation between PEAD and the risk level of the security. Instead, Bernard & Thomas demonstrated that the drift was primarily due to the market's slow absorption of the new earnings information. Their study concluded that investors often fail to fully consider the implications of current earnings for future earnings of a stock. These insights do not only highlight a consistent anomaly in how stock prices react to earnings announcements but also suggest opportunities to generate abnormal returns. By understanding and anticipating this distinctive underreaction, sophisticated investors could exploit this market inefficiency to achieve excess returns.

As research in this area progressed, the focus on how markets process information became more precise. Key studies, such as the one conducted by Foster et al. (1984), further investigated market anomalies specifically linked to earnings announcements. Their study discovered that the timing of earnings releases plays a crucial role in how prices adjust. Earlier or unexpected announcements have a disproportionate impact on investors' reactions. Furthermore, they demonstrated that the quality of the earnings significantly affects investors' perceptions. For example, it depends on whether the earnings figures are driven by one-off events or by recurring operational activities. These insights have significantly contributed to an enhanced understanding of the intricacies of market inefficiencies, showing how nuances in earnings information can result in diverse price development.

Recent studies on the PEAD have found mixed results regarding its persistence and magnitude of impact. Chordia et al. (2014) discovered a notable decline in the magnitude of returns resulting from PEAD exploitation. Their results suggest that the abnormal returns have reduced to near insignificance in some markets. The reason for this development has been attributed to factors which have enhanced the market's efficiency in processing the information from earnings announcements. According to Chordia et al. (2014) these factors include increased arbitrage activity of sophisticated investors as well as an improved information environment.

Meanwhile other studies continue to measure abnormal returns attributed to PEAD across different firm sizes. For example, Ali et al. (2020) provide evidence that the drift remains significant, especially in some sectors. Their research suggests that more liquid markets experience less pronounced PEAD due to quicker information assimilation than smaller firms that still exhibit noticeable PEAD.

However, not much is documented on this anomaly for specific industry sectors. This study aims to investigate if the long-short PEAD strategy makes profitable returns adjusted for risk in the S&P 500 and compares this with the U.S. technology sector, as technology gained significant public interest in the past years.
Here, I present the two hypotheses of this study:

Hypothesis 1:
The post-earnings announcement drift (PEAD) can be exploited using a long-short strategy with a large portfolio of S&P 500 equities to create excess returns compared to a buy and hold benchmark.

Hypothesis 2:
The excess returns described in hypothesis 1 will be even greater using exclusively technology equities within the S&P 500 as a subset of the original portfolio described in hypothesis 1.

With this study, I expect to show that the earnings announcement anomaly serves as a basis for a successful long-short strategy exploiting excess returns compared to buy and hold strategy (benchmark). Additionally, since transaction costs will be considered in the calculation, I aim to assess if the strategy would be profitable under real market circumstances. Furthermore, I investigate how the strategy performs in the U.S technology sector. Overall, this thesis will contribute to more insight into inefficiencies in the market and how they can be harnessed.

3. Methods

3.1 Data

The data is obtained from four different databases. The analyst estimates are from the Institutional Brokers' Estimate System (IBES) database. The daily prices of the stocks are from the Center for Research in Security Prices (CRSP) and Compustat. For the benchmark, daily prices of the SPDR S&P 500 ETF Trust (SPY) were downloaded from Yahoo Finance. All the data, except the SPY, has been accessed through the Wharton Research Data Services (WRDS) platform. The data was downloaded as csv files and read into the implementation for processing in python.

The earnings data from IBES includes the reported quarterly EPS and the mean of the analysts EPS estimates. Additionally, the standard deviation of the estimates is provided along with the stock ticker and the announcement date. All tickers were chosen to be the ones that have been in the S&P 500 within the 30 years from 1994 to 2023. The list of these tickers comes from the CRSP dataset which is called msp500list. It contains all constituents of the S&P 500 index for given dates. This served to get the complete list of 1337 individual stocks. The total number of earnings announcements for these tickers is 95,748. There are on average 71 announcements per ticker. Given the quarterly announcement frequency, this translates to 17 years of announcement history per company. That represents the maximum amount of trading opportunities for the earnings announcement long-short strategy.

This strategy requires daily adjusted prices of the stocks that have been in the S&P 500 within the timeframe. The dataset from CRSP contains the daily prices and adjustment factors for all the stocks. There are also bid and ask prices which were used to calculate the median bid ask spread of the equities. Since there were some missing prices within the daily prices dataset from CRSP, all prices from the Compustat database were added that complemented the data from CRSP. This increased the number of daily prices from 5,668,063 to 6,184,738. This provides an average of an additional 1.5 years of daily prices per equity. The database also includes the SIC (Standard Industrial Classification) codes. This is used to select the stocks from specific sectors which will be used to evaluate the second hypothesis about using exclusively stocks from the technology sector. To prevent jumps in the stock prices, all prices were adjusted for stock splits and mergers as well as dividends using the provided adjustment factor.

The benchmark for this strategy needs to be tradable and active within the whole period of the backtest. The oldest exchange traded fund (ETF) for the S&P 500 Index Exchange Traded Fund is the SPDR S&P 500 ETF Trust (SPY). It is also the most liquid S&P 500 ETF. Therefore, the index SPY was chosen as the benchmark for this strategy. The data from Yahoo finance includes the adjusted daily close prices.

3.2 Strategy

This section delves into the specifics of this long-short PEAD trading strategy, detailing the approach taken.

3.2.1 Holding period

For every quartal, the mean of analysts' estimates for the earnings per share (EPS) measure and the actual EPS the company reported in their quarterly earnings announcement are explored. To factor in the degree of uncertainty, the difference of the estimate and the actual EPS by the standard deviation of all the estimates are divided. This yields the Standard Uncertainty Estimate (SUE). Small standard deviations indicate that the uncertainty amongst analysts is low, resulting in a higher SUE. When there is more uncertainty, the standard deviation of the estimates is higher, yielding a smaller SUE. The trading signal used in this paper is directly derived from the SUE. The SUE measure is a pertinent measure for the trading strategy since it highlights the magnitude of the surprise while considering the uncertainty amongst the analysts' estimates. It is calculated using the following formula:

$$SUE = \frac{Mean\ Earnings\ Surprise}{\sigma_{Earnings\ Surprise}}$$

The mean earnings surprise is the average of all differences between reported earnings and the expected earnings that were estimated by the experts. The index i stands for the different estimates and N is the total number of estimates.

$$Mean\ Earnings\ Surprise = \frac{1}{N}\sum_{i=1}^{N}\left(Earnings_{reported_i} - Earnings_{expected_i}\right)$$

The standard deviation is calculated using the following formula:

$$\sigma_{Earnings\ Surprise} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(Earnings\ Surprise_i - Mean\ Earnings\ Surprise)^2}$$

SUE scores above a certain threshold result in opening a long position while negative scores below another specified threshold are a signal to open a short position. As soon as the earnings announcement is public and the SUE is of a high enough magnitude we open the position. The holding period for long positions and short positions are variable but all long positions have the same holding period, and all short positions have the same holding period. They can be set between 1 day and 90 days leading to the position being closed before the next quarterly announcement.

3.2.2 Bayesian Optimization

The strategy requires a set of 5 tuning parameters consisting of the order size, the SUE thresholds for the long and short positions, as well as the holding times for the long and short positions. To find the optimal parameter set to maximize returns, Bayesian optimization was used. In this method, a number of samples of parameter sets is initially drawn. For each parameter set, the objective function is calculated. Here, this corresponds to the returns. From the initial samples, a model is fitted which is then used to iteratively optimize the parameters. The process was implemented in Python using the BayesianOptimization module.

3.3 Backtesting

3.3.1 Implementation

Once the strategy has been set, meaning that a parameter set has been found, the strategy is evaluated through the backtesting algorithm which has been implemented in Python. The algorithm reads in all the data from different sources as described in the section above (section 3.1) and combines them into a format such that the prices for all individual stock, the benchmark, the risk-free rate, as well as the earnings announcements can easily be accessed. The algorithm is then simulated from the beginning to the end of the testing period and trades are made according to the strategy, always keeping track of the available cash as well as the individual options which were bought, from which the daily returns can be calculated.

3.3.2 Transaction Costs

In back testing transaction costs are crucial to consider. They can really make or break a strategy. In general, the transaction costs consist of the bid-ask spread and various fees. Transaction fees have been modeled using the Interactive Brokers fee structure (in appendix). There is a commission as well as regulatory fees, exchange fees, clearing fees and pass-through fees. All of these have been implemented and calculated for each transaction during the backtest. While the fees are important to consider, the bid-ask spread is the main constituent of the total transaction cost. Here, the spread is estimated using a CRSP dataset with all the available bid and ask close prices of the companies used in the backtest. The spread was calculated and the median spread in percent was derived. The median spread is used for all transactions in the backtest. While this is an approximation, it has been the best solution considering the incompleteness of the historical CRSP data.

3.3.3 Performance Evaluation

The performance and risk of the strategy have been evaluated and compared to the benchmark, the S&P 500 index SPY. On completion of the backtest, there is the daily total portfolio value as well as the daily benchmark value. Daily log returns are calculated as follows, where the subscript t indicates the day:

$$Daily\ Log\ Return_t = ln\left(\frac{Total\ Value_t}{Total\ Value_{t-1}}\right)$$

The total log return is calculated as the sum of all logarithmic returns over the trading period T.

$$Total\ Log\ Return = \sum_{t=0}^{T} Daily\ Log\ Return_t$$

To get the annualized logarithmic return, the total logarithmic return is divided by the number of years. The number of years is calculated by dividing the number of days in the period by 252 trading days.

$$Annualized\ Log\ Return = \frac{Total\ Log\ Return}{\frac{Days}{252}}$$

The annualized logarithmic return can be converted to a simple annualized return.

$$Annualized\ Return = \ e^{Annualized\ Log\ Return} - 1$$

The volatility is calculated using the standard deviation of the daily logarithmic returns whereas μ is the mean of the daily logarithmic returns.

$$Volatility = \sqrt{\frac{1}{T}\sum_{t=0}^{T}(Daily\ Log\ Return - \mu)^2}$$

The annualized volatility is calculated using the 252 trading days in the US.

$$Annualized\ Volatility = Volatility \cdot \sqrt{252}$$

3.3.4 Risk Management

To evaluate systematic risk, the portfolio's beta has been calculated according to the Capital Asset Pricing Model (CAPM) . The SPY index serves as the benchmark. The covariance and variance are calculated from the daily returns r.

$$\beta = \frac{Cov(r_{Portfolio}, r_{Benchmark})}{Var(r_{Benchmark})}$$

To estimate an appropriate risk-free rate (r_f), the three-month US treasury bonds were chosen, since three months is close to the holding period of the positions in this strategy. Here, the risk-free rate averages to 2.38%. To adjust for the idiosyncratic risk, the Jensen's Alpha has been calculated. The Jensen's Alpha is calculated according to the CAPM and represents the abnormal return over the expected return.

$$\alpha = r_{Portfolio} - \left[r_f + \beta \cdot \left(r_{Market} - r_f\right)\right]$$

To compare the performance of the PEAD strategy to the benchmark including the return and risk, the Sharpe ratio is an excellent measure. It characterizes how well the return of a portfolio compensates the investor for the risk taken. The Sharpe ratios were calculated using the following formula:

$$Sharpe\ Ratio = \frac{Mean\ Excess\ Return}{\sigma_{Excess\ Returns}}$$

The mean excess return for the portfolio is calculated by averaging the difference of all daily returns and the daily risk free rate over the trading period. Daily US treasury yield curve rates were converted to daily risk free rates, since the rates are given on a yearly payout.

$$Mean\ Excess\ Return = \frac{1}{T}\sum_{t=1}^{T}\left(r_{Portfolio_t} - r_{f_t}\right)$$

Similarly, when calculating the Sharpe ratio of the benchmark (SPY index), the mean excess return of the benchmark is derived from this equation:

$$Mean\ Excess\ Return = \frac{1}{T}\sum_{t=1}^{T}\left(r_{Benchmark_t} - r_{f_t}\right)$$

Further, the standard deviation of excess returns is calculated using the following formula:

$$\sigma_{Excess\ Returns} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Excess\ Return_t - Mean\ Excess\ Return)^2}$$

4. Results and Discussion

In this section, the results of this long-short PEAD trading strategy are presented and compared to literature. Further, the results are critically analyzed and discussed.

4.1 Performance and risk of this strategy compared to the benchmark

To avoid the common problem of overfitting in backtesting, the data from 1994-2023 was split in a train set (1994-2008) and a test set (2009-2023). The optimized parameters from the train set were used to verify if abnormal returns can be generated with an acceptable risk.

4.1.1 Performance and risk of the PEAD strategy: 2009-2023

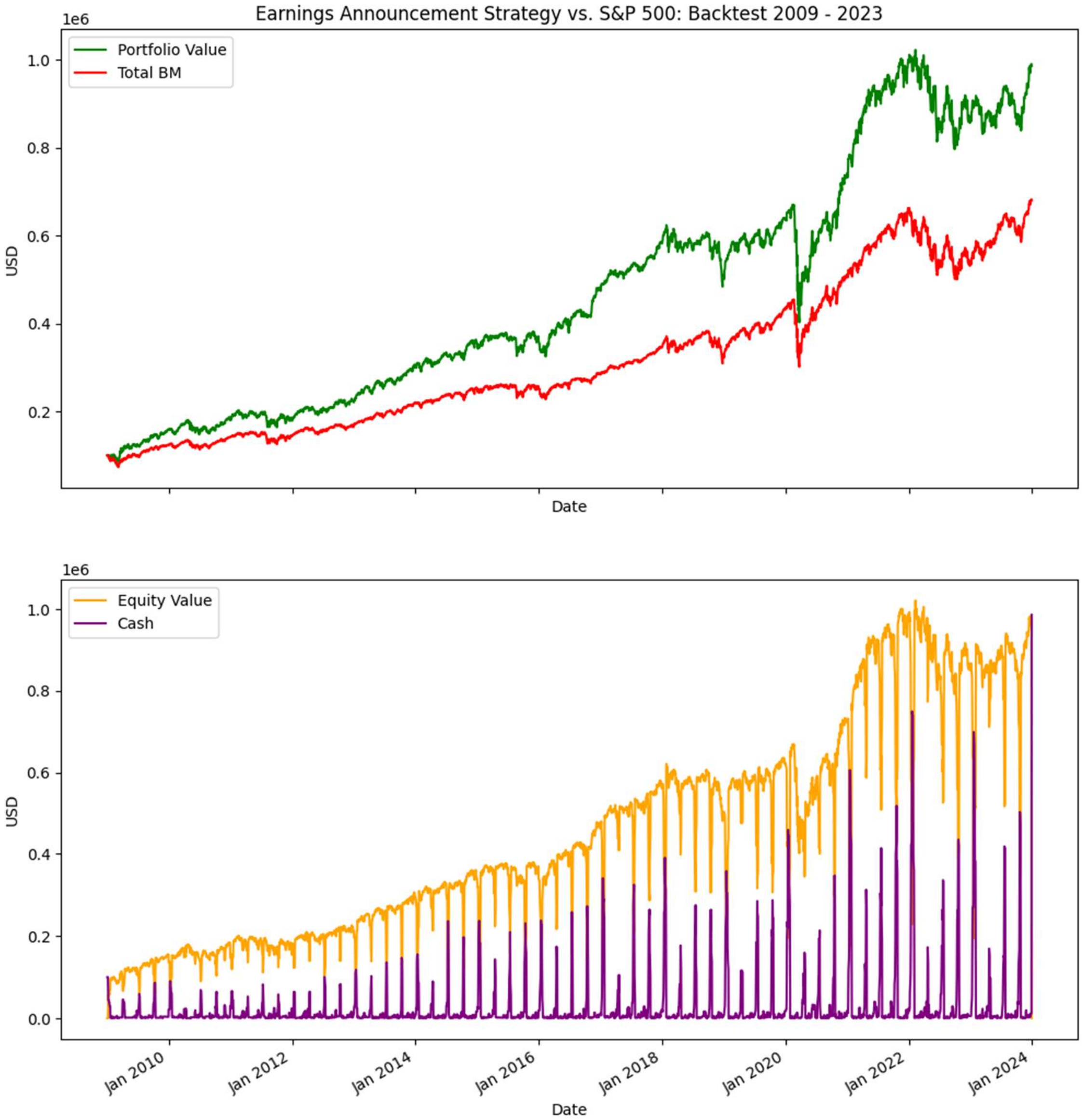

Figure 2: Performance Comparison and Equity-Cash Distribution of the here presented long-short PEAD strategy vs. S&P 500 SPY as benchmark in 2009-2023.
a) Performance of this long-short PEAD trading strategy (red) compared to the S&P 500 index SPY (green) from 2009 to 2023. The PEAD strategy achieved 886% total return, outperforming the 580% total return of the benchmark. Total excess return is 306% and an annualized excess return is 2.74%.
b) Equity value of the portfolio (orange) and the level of cash (purple) change over the depicted period. Spikes indicate the selling of equity prior to a new earnings announcement.

Figure 2a illustrates the portfolio value of this long-short PEAD trading strategy in comparison to the benchmark S&P 500 index SPY in the years 2009 until 2023. The strategy, depicted in red, and the benchmark (BM) in green, both start with an initial value of $100,000. Over the observed period, the benchmark increased its value by 580%, whereas this long-short PEAD strategy achieved a total growth of 886%. Annualized return for the benchmark is 13.15%, while the strategy came to 15.89%. This results in a total excess return of 306% and an annualized excess return of 2.74%. These results underscore the potential profitability of trading based on earnings announcements using a long-short strategy and align with the studies that detected the anomaly of PEAD (Ball & Brown, 1968).

Figure 2b shows how the equity value of the portfolio (orange) and the level of cash (purple) change over the depicted period. This strategy aims to ensure sufficient cash availability before the announcement of new earnings. Therefore, selling the stocks from the previous quarter results in the depicted dips in equity and the mirrored cash spikes. The holding period of stocks can nicely be seen from the period between cash spikes. The spike width indicates that not all earnings are released on the same day.

To account for the risk, the beta, Jensen's alpha as well as the Sharpe ratio were calculated. The beta coefficient for this strategy is 0.9994, which indicates that the level of systematic risk is comparable with the benchmark. Further, with a Jensen's alpha of 2.74%, the strategy delivers an abnormal return higher than the expected market return, adjusted for idiosyncratic risk. The annualized volatility of this strategy came to 19.64%, which is slightly higher than the benchmark's volatility of 17.8%. The higher volatility suggests a higher level of risk, which is indeed an outcome in a more active trading strategy. The Sharpe ratio, which is used as a measure of abnormal return in relation to the taken risk, was found to be 0.0518 for this strategy and 0.0474 for the benchmark. The slightly higher Sharpe ratio potentially highlights a better risk-adjusted return for my PEAD strategy.

Moreover, Figure 2 also shows the large market dip in the COVID-19 pandemic for the strategy as well as the benchmark. This indicates the market-wide impact of the crisis. Encouragingly, my long-short PEAD strategy seems to recover nicely, proving its resilience and ability to gain returns once the crisis is overcome.

4.1.2. Confrontation with the hypothesis

The first hypothesis, stating that *"the post-earnings announcement drift (PEAD) can be exploited using a long-short strategy with a large portfolio of S&P 500 equities to create excess returns compared to a buy and hold benchmark"*, was confirmed in the calculations shown above.
As the PEAD strategy is implemented with the large portfolio of S&P 500 equities, it is a logical extension that the strategy pays off, given the size, coverage and liquidity of these stocks.

The PEAD exploit with a long-short strategy has been explored multiple times after the first influential papers by Bernard & Thomas (1989;1990). More recently, Ke & Ramalingegowda (2005) have shown how sophisticated investors, such as institutional traders, are indeed still exploiting this drift to achieve excess returns, which aligns with the findings of the analyses of this paper.

4.2 Performance and risk in the technology sector

In this sector, the performance of the long-short PEAD in the technology sector is assessed. For this, the stocks which were available to trade were limited to a subset of the original data using the SIC codes. The following two SIC codes were used to select stocks: 737 (Computer Programming, Data Processing, and other Computer Related Services) and 35 (Industrial and Commercial Machinery and Computer Equipment).

4.2.1 Performance and risk of the PEAD strategy in the technology sector: 2009-2023

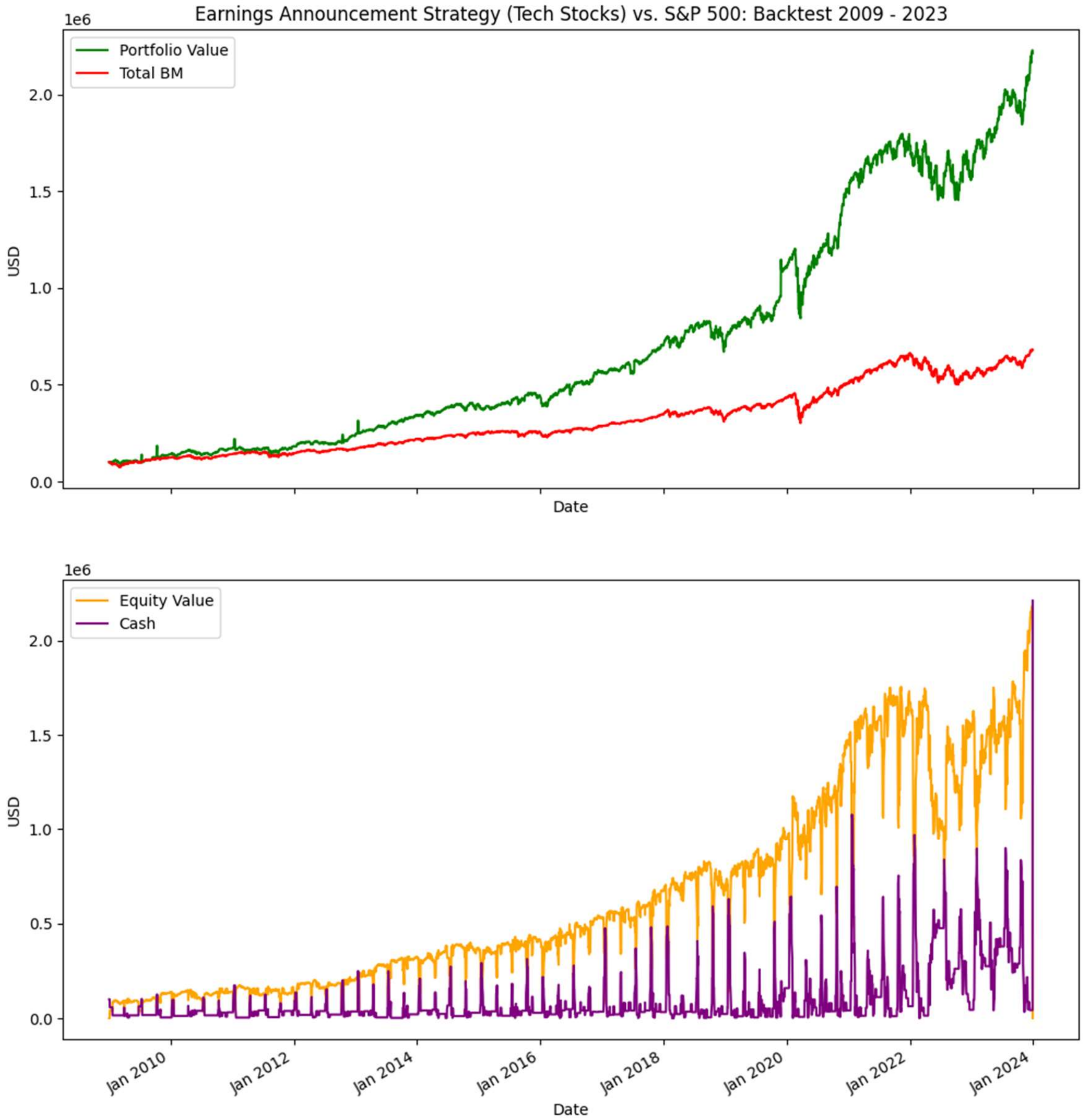

Figure 3: Performance Comparison and Equity-Cash Distribution of the long-short PEAD strategy in the technology sector vs. S&P 500 index SPY as the benchmark from 2009 to 2023.
a) Performance of this long-short PEAD trading strategy in the technology sector (red) compared to the S&P 500 index SPY (green) from 2009 to 2023. The PEAD strategy achieved 2112% total return, outperforming the 580% total return of the benchmark. Total excess return is 1532% and an annualized excess return is 8.93%.
b) Equity value of the portfolio (orange) and the level of cash (purple) change over the depicted period. Spikes indicate the selling of equity prior to a new earnings announcement.

Figure 3a shows the performance of this strategy in the technology sector (red) in comparison to the S&P 500 index SPY benchmark (green) from 2009 to 2023. The portfolio value reached a total return of 2112% (580% for the benchmark), which results in the total excess return of 1532%. Annualized return for the strategy is 22.08% (13.15% for the benchmark), resulting in an annualized excess return of 8.93%. However, the portfolio's annualized volatility is 30.22%, which is significantly higher than the benchmark (17.81%), and also higher than the PEAD strategy not focusing on the technology sector solely (19.64%). The higher volatility resulted from trading with fewer companies (only 153 out of 1337 stocks). This is also reflected in the lower beta value 0.931, as a smaller number of companies are less correlated with the broader market. When looking at the Jensen's alpha for the strategy in the technology sector of 9.68%, the strategy seems to deliver substantial abnormal returns adjusted for idiosyncratic risk. However, the Sharpe ratio is 0.0443 which is lower than 0.0474, the one for the benchmark. This indicates the strategy's abnormal returns are relative to the amount of risk taken, which is in agreement with higher volatility observed.

Generally, for calculations of risk-adjusted performance, the Sharpe ratio is more critical, as it displays if the strategy compensates investors well for their risks taken. A high Jensen's alpha indicates that the strategy is successfully capturing abnormal returns due to its specific strategy, such as exploiting the post-earnings announcement drift in the technology sector. In the particular case of the subset of the technology sector, Jensen's Alpha seems particularly important as it shows the ability of the PEAD strategy to yield substantial excess returns, higher than what is explained by market movements. This highlights the effectiveness of the strategy in exploiting specific market inefficiencies such as the post-earnings announcement drift. However, the Sharpe ratio frames these returns in terms of risk taken. The lower Sharpe ratio compared to the benchmark indicates that these abnormal returns come with a larger risk-level. Whether the risk is taken in order to gain the shown return is a decision each investor should carefully take.

4.2.2. Confrontation with the hypothesis:

The second hypothesis, stating that *"the excess returns described in hypothesis 1 will be even greater using exclusively technology equities within the S&P 500 as a subset of the original portfolio described in hypothesis 1."*, can be answered affirmatively. It was assessed by the calculations above, for the subset of defined stocks belonging to the technology sector. With an annualized excess return of 8.93%, the technology sector dramatically outperforms in the calculations. This highlights the potential for sector-specific strategies. The technology sector might exhibit stronger or more predictable post-earnings announcement drifts compared to the broader market.

There are several specific characteristics to the technology sector that serve as possible explanations for the high result. Characterized by rapid innovation and high growth rates, the technology sector often yields significant earnings surprises and keeps the market very dynamic, both positive and negative, which the long-short PEAD strategy is created to exploit. Furthermore, the complexity of the many business models of technology companies increases information asymmetry that are affecting post-earnings announcement drifts. Lastly, company merging and acquisitions are often associated with technological innovation, which makes the earnings estimate for analysts harder.

4.3 Parameter Optimization: 1994-2008

Figure 4a shows the performance of the long-short PEAD trading strategy with optimized parameters in red, compared to the benchmark (BM) in green. A total return of 839% (152% for benchmark) and 687% total excess return are realized with the portfolio. Further, annualized return of the portfolio is 15.51% (6.12% for benchmark). With this, an annualized excess return of 9.39% was achieved. The annualized volatility is similar in both cases (19.04% for portfolio, 19.49% for benchmark). This proves that the Bayesian optimization was effective in exploiting post-earnings announcement drifts during the period. The optimization also worked similarly in the technology sector (data not shown here).

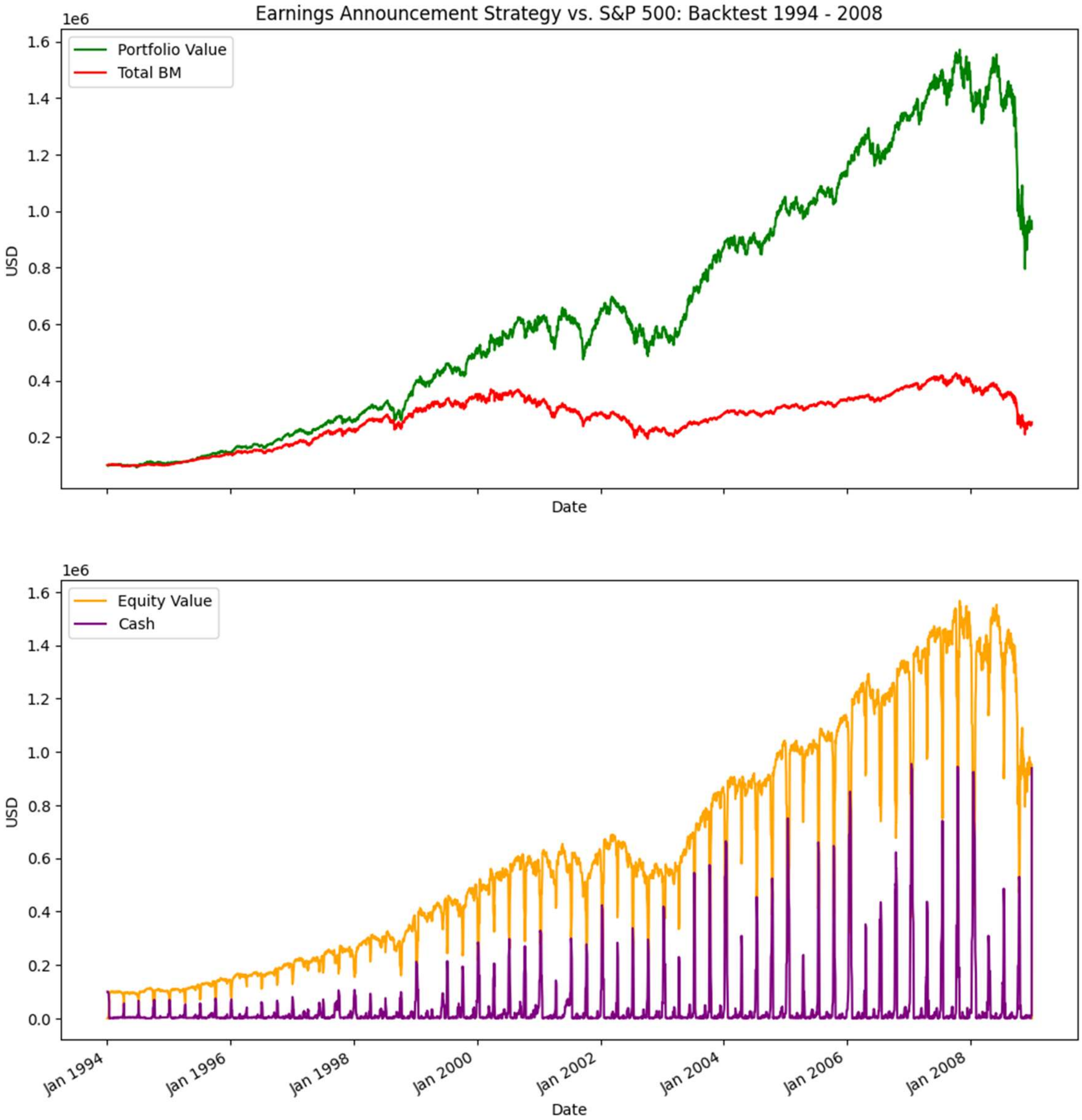

Figure 4: Performance Comparison and Equity-Cash Distribution of the long-short PEAD strategy vs. S&P 500 SPY as benchmark in the train set from 1994 until 2008.
a) Performance of this long-short PEAD trading strategy (red) compared to the S&P 500 index SPY (green) from 1994 to 2009. With optimized parameters, the PEAD strategy achieved 839% total return, outperforming the 152% total return of the benchmark. Total excess return is 687% and an annualized excess return is 9.39%.
b) Equity value of the portfolio (orange) and the level of cash (purple) change over the depicted period. Spikes indicate the selling of equity prior to a new earnings announcement.

Figure 4b shows the equity value of the portfolio (orange) and the cash level (purple) change over the depicted period. The purple spikes again show the selling of equities before new earnings announcements. The overall upward trend in the equity value aligns with the strong performance observed in Figure 4a.

In the train set here, the portfolio beta is 0.8503 and Jensen's alpha 9.95%. Since this data was used to find optimal parameters, the beta and Jensen's alpha do not account for real risk.

In Table 1, the optimal parameters found by Bayesian optimization are listed for the long-short PEAD strategy for the whole portfolio and the technology sector:

Table 1: Optimal parameters for the long-short PEAD strategy in the train sets: 1994-2008

	Order size [Dollars]	SUE long	SUE short	Holding period short[days]	Holding period long[days]
Portfolio	5649	0.635	-3.78	9	85
Tech sector	42315	0.15	-0.65	10	85

SUE long / SUE short indicates the minimum level of positive / negative earnings surprise required to initiate a long / short position. Further, for simplicity, a constant order size was chosen. As shown in Table 1, the order size in the technology sector is higher than in the overall portfolio. This is due to the smaller number of stocks available for trading in the technology sector. A larger order size is necessary to ensure full investment of the capital. However, this also leads to higher volatility in the technology sector and generally bears more risk.

Furthermore, for both portfolios, the SUE short threshold is higher (farther away from 0) than the SUE long threshold. This indicates that the strategy takes short positions only when there is a substantial negative earnings surprise. This suggests that opening long positions seem to be more profitable, which can be explained by the overall upward trend of the market. This is inline with the study from Hsu (2001), where higher negative SUE thresholds for their short positions were also used, but in the Asia/Pacific equity market. In the UK market, it was further shown that positive and negative earnings surprises have

an asymmetrical effect (Levis & Liodakis, 2001). In other words, positive earnings surprises have a disproportionately larger positive impact and negative surprises have a relatively mild effect.
This asymmetry is also reflected in the significant shorter holding period for short positions. A brief holding duration is chosen to minimize the risk of a price rebound avoiding the potential for recovery if the market will stabilize again.

Overall, the presented optimized parameters for the long-short PEAD strategy are designed to balance risk and return effectively. Here it was shown that the Bayesian optimization worked well in the train set and the parameters could effectively be used to gain abnormal returns in the test period (Section 4.1.1 and 4.2.1).

4.4 Limitations and Improvements

In this section, potential limitations regarding this long-short PEAD strategy that may affect the applicability of my results are discussed.

4.4.1 Potential Bias in Company Selection

For the analysis of this strategy, all companies that were part of the S&P 500 at any time from 1994 to 2023 were included. This means that during a given trading period, companies that were not yet in the S&P 500 (but appeared in it later) were still considered for potential earnings surprises and could be traded. This introduces a bias, since it anticipates the incorporation of future well-performing companies. This knowledge is not available in real-time trading and a limitation of this backtest. Therefore, this leads to an overestimation of the performance due to this inclusion of companies that were not actually part of the index at the given time. To mitigate this shown bias, the strategy should restrict the pool of companies to only those that are part of the S&P 500 at the specific trading times.

4.4.2 Benchmark for Technology Sector

For the exploration of the second hypothesis, where the technology sector is compared to the benchmark, the same benchmark as for hypothesis 1 was used, leading to an annualized excess outperformance of almost 9%. However, given that this benchmark is the S&P 500 index SPY that includes a broad range of sectors, it is not the appropriate comparison for a technology-focused strategy. I suggest adjusting the benchmark to a technology sector index like the NASDAQ-100 (Nasdaq, n.d.), as this would yield a more accurate comparison of performance of the PEAD strategy in the technology sector.

4.4.3 Generalizability to other Stock Exchanges

The study here only focuses on US companies in the S&P 500. As mentioned above, the results could be comparable with studies that used the London Stock Exchange (Levis & Liodakis, 2001) and international stocks from Asia/Pacific and Europe (Hsu, 2001). Further, Dische & Zimmermann (1999) reported that excess return can be achieved using a PEAD strategy using Swiss stocks. This provides strong evidence that PEAD can be exploited in different markets. To estimate whether the results found here could really be generalized to other stock exchanges, a comparison of the market dynamics is important. I suggest testing the strategy in different international markets to validate its applicability to other stocks.

4.4.4 Market Delay

One potential explanation for the post-earnings announcement drift was the slow market adjustability. The test period for this analysis was 2009 to 2023, a time where automated trading strategies were slowly emerging. To predict if automated trading, machine learning algorithms and artificial intelligence will influence future anomaly trading is extremely hard. Nonetheless, it has been demonstrated that a slow market cannot be the sole explanation for the anomaly, suggesting that the strategy can still be utilized in the future. However, it is possible that the excess returns may fall shorter.

4.5 Further Improvement of this Strategy

Here, I aim to show potential methods to further improve this strategy that have become evident in discussing its limits.

4.5.1 Linear Order Size with SUE

Instead of selecting a constant order size and SUE thresholds, the position size could linearly adjust to the SUE as follows:

$$Order\ Size\ = C_1 \cdot SUE\ + C_2$$

With this approach, more funds would go into larger, more agreed on surprises according to the SUE score. This allows the investment of more capital in a substantial unexpected earnings surprise.

4.5.2 Order size as a fraction of total portfolio value

A further improvement of the strategy would be to allow the order size to adjust in proportion to the total portfolio value. As the portfolio value increases over time, maintaining a fixed order size may result in underutilization of available capital. This decreases the efficiency and potential returns. Therefore, I suggest having an order size that is dynamically adjusted with the portfolio's growth. By scaling the order size in relation to the portfolio's value, the strategy could maintain optimal investment levels at all times.

4.5.3. Sampling time frame

The period from 2009 to 2023 might have been exceptionally strong for the technology sector, characterized by rapid growth and significant advancements. The model's performance could be enhanced by the favorable conditions during this time, which may not be as pronounced in other periods or sectors. Including a more broad timeframe for the analysis is necessary to corroborate the findings.

4.5.4 Predicting SUE

The earnings announcement not only drives the market post its announcement, but already shifts the stock values before the actual announcement release (Figure 1). Studies also confirmed that arbitrage returns could be achieved by trading portfolios on the basis of past earnings surprises (Bernhard & Thomas, 1990; Hsu, 2002). Hsu (2002) demonstrated a quarterly mean return of 9.3% could be achieved by creating portfolios on previous SUE scores larger than five (2002). Taking advantage of this pre-announced momentum can significantly enhance the portfolio's returns. However, this constitutes a slightly different strategy.

5. Conclusion

This bachelor thesis aimed to explore the potential of exploiting the post-earnings announcement drift (PEAD) through a long-short trading strategy. This strategy is of interest because it combines the investigation of a well-known market anomaly with a practical trading strategy that balances the risk taken and aims for abnormal returns. This study covered the period from 1994 to 2023 and utilized the S&P 500 equities. In the primary hypothesis, I aimed to determine whether this long-short PEAD trading strategy could generate abnormal returns when compared to a conventional buy-and-hold approach. Secondly, the goal was to assess the strategy's efficacy within the technology sector.

The results from section 4.1 confirmed the first hypothesis of creating an annualized excess return of 2.74% when exploiting the PEAD using the long-short strategy. Further, it could be shown that by taking long positions in stocks with positive earnings surprises and short positions in those with negative surprises, the strategy performed effectively. This result is consistent with the existing literature, affirming the persistence of PEAD as a market anomaly.

The second hypothesis was also confirmed in section 4.2, which states that excess returns would be even greater when using exclusively technology equities within the S&P 500 as a subset. I could reach an annualized excess return of 8.93% compared to the same benchmark used in hypothesis 1.

Despite the promising results, it is important to be aware of the limitations of this backtest. A potential bias in company selection needs to be kept in mind, as well as possible changes in the results if one uses a technology specific benchmark for the comparison. Expanding the analysis to future research, I suggest improving the strategy by using a linear order size with the SUE score and adjusting it to the overall portfolio value. Further, I would also look at other sectors than the technology sector, and widen it to international markets.

In summary, my findings contribute to the academic research in this field and provide valuable guidance for investors seeking to optimize their portfolios based on earnings announcements.

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7. Appendix

7.1 Transaction Costs

The tiered fee structure by Interactive Brokers was used to model the transaction costs. An overview of the applied fees can be seen in the table below.

Exchange commision	0.0035 USD/share
Minimum exchange commission	0.35 USD/order
Clearing fee	0.0002 USD/share
NYSE pass through fee	0.000175 * (exchange commission)
FINRA pass through fee	0.00056 * (exchange commission)
SEC transaction fee	0.000008 * (order value)
FINRA trading activity fee	0.000166 * (order value)
Stock borrowing fee	0.0025 * (order value)