
Technische Universität Wien

Department of Business Informatics


Interdisciplinary Project

# Short term performance of female vs. male directors‘ dealings in shares of Nasdaq Composite Index companies in the period 2004 - 2023


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**Abstract**

This project examines the difference in share price development following director dealings based on the director's gender and corporate position. The study focuses on companies listed in the NASDAQ Composite Index from 2000 to 2023.

After gathering relevant data from various sources, extensive preprocessing was conducted, including the classification of directors' gender and a comprehensive exploratory data analysis. Key metrics were then calculated following the event study methodology. Finally, statistical tests were performed to verify the significance of the results.

The event study revealed that while directors' dealings generate significant abnormal returns compared to the market index, the differences between male and female directors' dealings are insignificant. Furthermore, the corporate position of the person conducting the transaction does not significantly impact short-term performance. Transactions conducted by individuals holding the same corporate position do not yield significantly different abnormal returns based solely on their gender.

# Contents

# 1 Motivation, Problem Statement, Hypotheses

All executive board members and non-executive directors are regarded as company insiders. They must report their trades to prevent gaining an unfair advantage, which might be then classified as legal insider trading.[4]
Those legal insider transactions, whether they are a purchase or sale of own company securities, might imply important information on the development of a company's performance and therefore other shareholders might react as they seem fit by also selling their securities or purchasing even more. Consequently, the company's share price is likely to be impacted by the insider trading. [5]
This project analyses the short term impact of directors' dealings (DD) on the share price development with respect to the director's gender.
Companies in scope are all those listed in the Nasdaq Composite index from 2004-2023, which adds up to 7670 companies in total. The following hypotheses will be examined to determine if there is a significant difference in market response to insider trading based on the director's gender:

**1. Hypothesis:** The trade announcement of Directors' dealings result in a greater magnitude of abnormal short term returns if the director's gender is male, compared to those involving female directors.

**2. Hypothesis:** The abnormal return following a director's trade is greater (whether positive or negative) over a longer time period after the trade announcement if the director is male, compared to trades involving female directors.

**3. Hypothesis:** The magnitude of the announcement effect is higher for male than for female traders in the same corporate position.

The DDs are split into the following groups based on the three different trade types for further cross sectional analysis and the final hypothesis testing:
(a) All purchases of female directors
(b) All purchases of male directors
(c) All sales of female directors
(d) All sales of male directors
(e) All sales + OE* of female directors
(f) All sales + OE* of male directors

Description of trade types:

- S - Sale: Sale of securities on an exchange or to another person.
- S - Sale+OE: Sale of securities on an exchange or to another person (after option exercise).
- P - Purchase: Purchase of securities on an exchange or from another person.

# 2 Previous Research

Previous research mainly focused on differences in the share performance after directors' dealings based on geological factors, the industry sector or company size. [3] [6]
A study of abnormal returns from insider trading for the Swedish OMXS30 securities found that male insiders have a significant positive cumulative abnormal return (CAR) in short-term purchase transactions, whereas the results for female insiders are not conclusive. Moreover, they discovered significant negative CAR after any transaction done by a company's CEO, whether it was a purchase or sale, irrespective of the CEO's gender. Board members experience significant positive CAR after

purchase transactions and negative CAR for sales.[7]
Another study analysed if investors rewarded gender diversity, by comparing transactions of companies listed in the MSCI World Women's Leadership Index to those not listed. They found significant differences in how regions react and no general pattern. In Europe, investors seem to punish firms with insufficient gender equality measurements, indicated by significant negative abnormal return after deletion from the index. [14]
Other event studies in the U.S. have shown that boardroom diversity has a positive effect and that investors respond positively to the appointment of women into powerful positions. [2] [13]

# 3 Dataset

The event study is based on multiple datasets:

1. Companies in scope: All companies in the Nasdaq Composite from 2004-2023. The Nasdaq Composite is a stock market index that contains mostly companies from the information technology sector. (Source: LSGE Datastream[1])

2. Transaction data: All insider tradings of Nasdaq companies in scope, as explained in 1. The screenshot in Figure 1 below demonstrates the filter settings that were applied to each company. All stocks listed on the Nasdaq have a unique four-digit ticker. The transactions were downloaded on November 29, 2023.

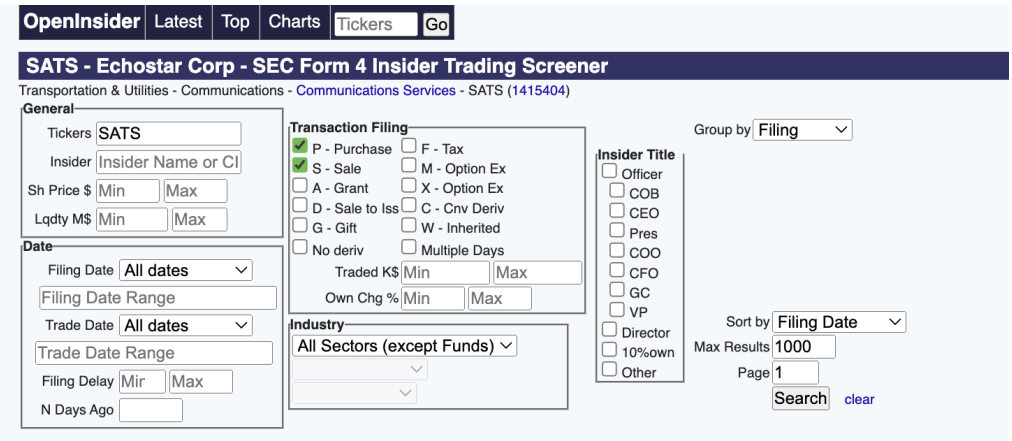



Figure 1: Screenshot of openinsider.com website.

3. Company and market total return indices: Total return indices of individual companies, as well as the Nasdaq Composite Index for the relevant years. They are necessary to calculate daily returns. (Source: LSGE Datastream[1])

[1] https://www.lseg.com/en/data-analytics/products/datastream-macroeconomic-analysis

# 4 Methodology

This interdisciplinary project requires the execution of every step within the Data Science process. All steps are conducted in Python.

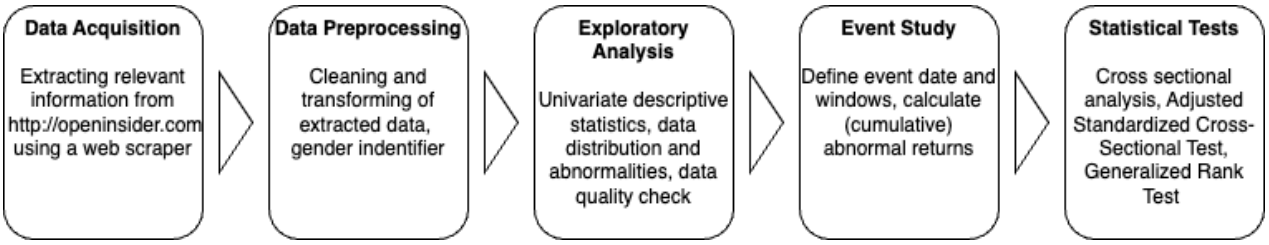



Figure 2: Project methodology

## 4.1 Data Acquisition

The first step of this project is to download all DDs of companies that were previously or are still listed in the Nasdaq Composite Index between 2000-2023. We use the HTTP client library "Requests"[2] to query and download the OpenInsider tables and afterwards an HTML parser provided by the Python library "Beautiful Soup"[3] to store the information in Python data frames. The resulting dataset contains the following columns:

| Column Name | Description |
|---|---|
| Filing Date | Date of submission of Form 4 as required by the United States Securities and Exchange Commission (SEC) to ensure transparency and avoid information asymmetry regarding the DD. |
| Trade Date | Date of security trade. |
| Ticker | Unique company abbreviation used at stock market. |
| Insider Name | Full name of insider. |
| Title | Title of insider, explaining their corporate position. |
| Trade Type | Trade type as described in section 1. |
| Price | Trade price of one security in USD. |
| Qty | Amount of securities traded. |
| Owned | Amount of securities owned before trade. |
| $\Delta Own$ | Percentage difference in owned securities due to trade. |
| Value | Value of owned securities after trade in USD. |

Table 1: Column Names and Descriptions from OpenInsider Data Download

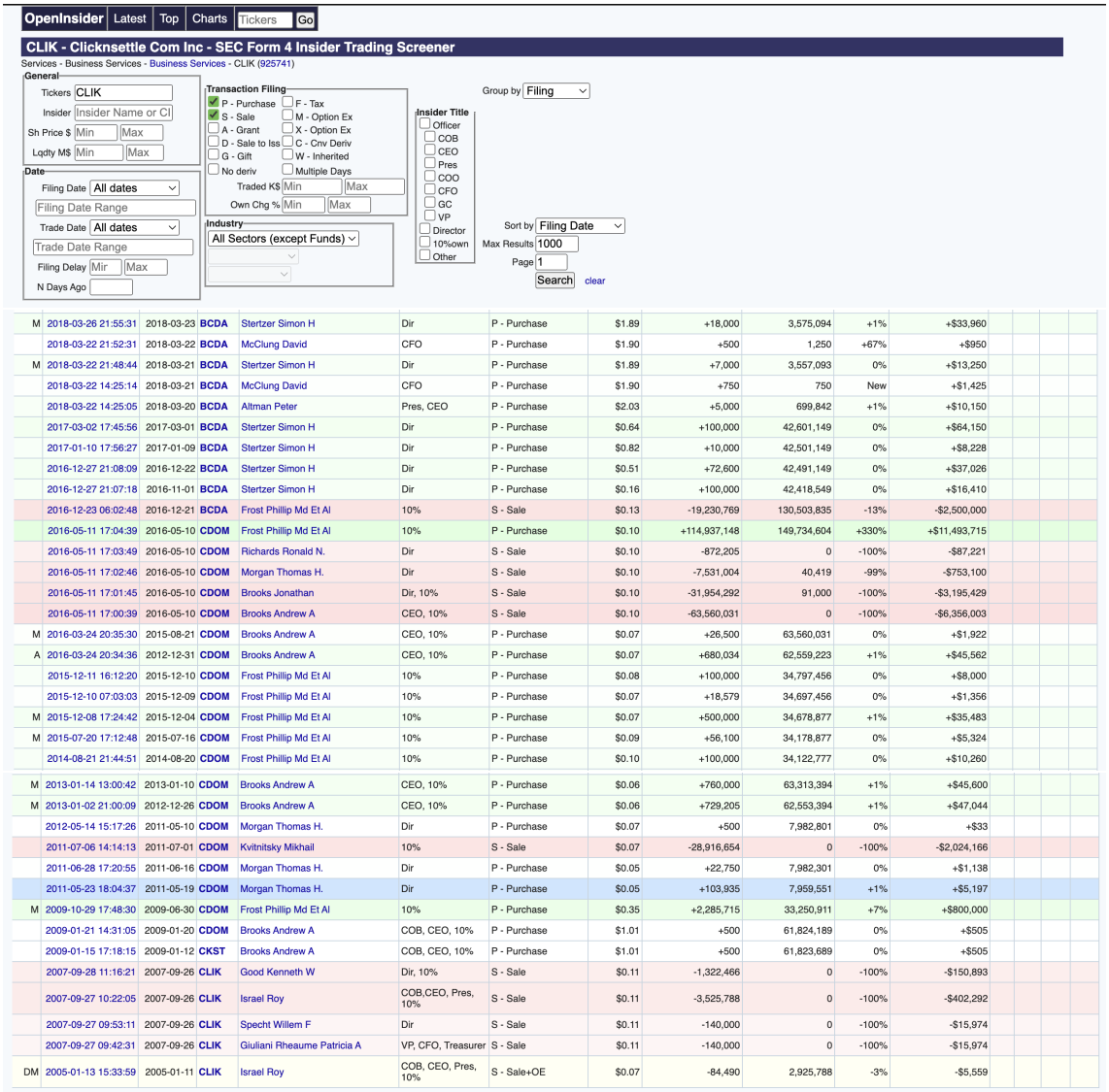
## 4.2 Data pre-processing

Due to different data sources and a lot of requirements for further analyzing of the data, this project required extensive data pre-processing:

1. Drop companies, which have a different Ticker than in the original list. This happens, because Tickers are newly assigned after a company hasn't been in the Nasdaq Company Index for a while. Figure 3 shows an example, where one ticker 'CLIK' results in the download of 4 different tickers. It won't be possible to match them to the correct company afterwards and

[2] `https://requests.readthedocs.io/en/latest/`
[3] `https://beautiful-soup-4.readthedocs.io/en/latest/`

therefore, as aligned with Prof. Aussenegg, those transactions that have a mismatch in input and output ticker are excluded from the analysis.




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M | 2018-03-26 21:55:31 | 2018-03-23 | BCDA | Stertzer Simon H | Dir | P - Purchase | $1.89 | +18,000 | 3,575,094 | +1% | +$33,960 |
| | 2018-03-22 21:52:31 | 2018-03-22 | BCDA | McClung David | CFO | P - Purchase | $1.90 | +500 | 1,250 | +67% | +$950 |
| M | 2018-03-22 21:48:44 | 2018-03-21 | BCDA | Stertzer Simon H | Dir | P - Purchase | $1.89 | +7,000 | 3,557,093 | 0% | +$13,250 |
| | 2018-03-22 14:25:14 | 2018-03-21 | BCDA | McClung David | CFO | P - Purchase | $1.90 | +750 | 750 | New | +$1,425 |
| | 2018-03-22 14:25:05 | 2018-03-20 | BCDA | Altman Peter | Pres, CEO | P - Purchase | $2.03 | +5,000 | 699,842 | +1% | +$10,150 |
| | 2017-03-02 17:45:56 | 2017-03-01 | BCDA | Stertzer Simon H | Dir | P - Purchase | $0.64 | +100,000 | 42,601,149 | 0% | +$64,150 |
| | 2017-01-10 17:56:27 | 2017-01-09 | BCDA | Stertzer Simon H | Dir | P - Purchase | $0.82 | +10,000 | 42,501,149 | 0% | +$8,228 |
| | 2016-12-27 21:08:09 | 2016-12-22 | BCDA | Stertzer Simon H | Dir | P - Purchase | $0.51 | +72,600 | 42,491,149 | 0% | +$37,026 |
| | 2016-12-27 21:07:18 | 2016-11-01 | BCDA | Stertzer Simon H | Dir | P - Purchase | $0.16 | +100,000 | 42,418,549 | 0% | +$16,410 |
| | 2016-12-23 06:02:48 | 2016-12-21 | BCDA | Frost Phillip Md Et Al | 10% | S - Sale | $0.13 | -19,230,769 | 130,503,835 | -13% | -$2,500,000 |
| | 2016-05-11 17:04:39 | 2016-05-10 | CDOM | Frost Phillip Md Et Al | 10% | P - Purchase | $0.10 | +114,937,148 | 149,734,604 | +330% | +$11,493,715 |
| | 2016-05-11 17:03:49 | 2016-05-10 | CDOM | Richards Ronald N. | Dir | S - Sale | $0.10 | -872,205 | 0 | -100% | -$87,221 |
| | 2016-05-11 17:02:46 | 2016-05-10 | CDOM | Morgan Thomas H. | Dir | S - Sale | $0.10 | -7,531,004 | 40,419 | -99% | -$753,100 |
| | 2016-05-11 17:01:45 | 2016-05-10 | CDOM | Brooks Jonathan | Dir, 10% | S - Sale | $0.10 | -31,954,292 | 91,000 | -100% | -$3,195,429 |
| | 2016-05-11 17:00:39 | 2016-05-10 | CDOM | Brooks Andrew A | CEO, 10% | S - Sale | $0.10 | -63,560,031 | 0 | -100% | -$6,356,003 |
| M | 2016-03-24 20:35:30 | 2015-08-21 | CDOM | Brooks Andrew A | CEO, 10% | P - Purchase | $0.07 | +26,500 | 63,560,031 | 0% | +$1,922 |
| A | 2016-03-24 20:34:36 | 2012-12-31 | CDOM | Brooks Andrew A | CEO, 10% | P - Purchase | $0.07 | +680,034 | 62,559,223 | +1% | +$45,562 |
| | 2015-12-11 16:12:20 | 2015-12-10 | CDOM | Frost Phillip Md Et Al | 10% | P - Purchase | $0.08 | +100,000 | 34,797,456 | 0% | +$8,000 |
| | 2015-12-10 07:03:03 | 2015-12-09 | CDOM | Frost Phillip Md Et Al | 10% | P - Purchase | $0.07 | +18,579 | 34,697,456 | 0% | +$1,356 |
| M | 2015-12-08 17:24:42 | 2015-12-04 | CDOM | Frost Phillip Md Et Al | 10% | P - Purchase | $0.07 | +500,000 | 34,678,877 | +1% | +$35,483 |
| M | 2015-07-20 17:12:48 | 2015-07-16 | CDOM | Frost Phillip Md Et Al | 10% | P - Purchase | $0.09 | +56,100 | 34,178,877 | 0% | +$5,324 |
| | 2014-08-21 21:44:51 | 2014-08-20 | CDOM | Frost Phillip Md Et Al | 10% | P - Purchase | $0.10 | +100,000 | 34,122,777 | 0% | +$10,260 |
| M | 2013-01-14 13:00:42 | 2013-01-10 | CDOM | Brooks Andrew A | CEO, 10% | P - Purchase | $0.06 | +760,000 | 63,313,394 | +1% | +$45,600 |
| M | 2013-01-02 21:00:09 | 2012-12-26 | CDOM | Brooks Andrew A | CEO, 10% | P - Purchase | $0.06 | +729,205 | 62,553,394 | +1% | +$47,044 |
| | 2012-05-14 15:17:26 | 2011-05-10 | CDOM | Morgan Thomas H. | Dir | P - Purchase | $0.07 | +500 | 7,982,801 | 0% | +$33 |
| | 2011-07-06 14:14:13 | 2011-07-01 | CDOM | Kvitnitsky Mikhail | 10% | S - Sale | $0.07 | -28,916,654 | 0 | -100% | -$2,024,166 |
| | 2011-06-28 17:20:55 | 2011-06-16 | CDOM | Morgan Thomas H. | Dir | P - Purchase | $0.05 | +22,750 | 7,982,301 | 0% | +$1,138 |
| | 2011-05-23 18:04:37 | 2011-05-19 | CDOM | Morgan Thomas H. | Dir | P - Purchase | $0.05 | +103,935 | 7,959,551 | +1% | +$5,197 |
| M | 2009-10-29 17:48:30 | 2009-06-30 | CDOM | Frost Phillip Md Et Al | 10% | P - Purchase | $0.35 | +2,285,715 | 33,250,911 | +7% | +$800,000 |
| | 2009-01-21 14:31:05 | 2009-01-20 | CDOM | Brooks Andrew A | COB, CEO, 10% | P - Purchase | $1.01 | +500 | 61,824,189 | 0% | +$505 |
| | 2009-01-15 17:18:15 | 2009-01-12 | CKST | Brooks Andrew A | COB, CEO, 10% | P - Purchase | $1.01 | +500 | 61,823,689 | 0% | +$505 |
| | 2007-09-28 11:16:21 | 2007-09-26 | CLIK | Good Kenneth W | Dir, 10% | S - Sale | $0.11 | -1,322,466 | 0 | -100% | -$150,893 |
| | 2007-09-27 10:22:05 | 2007-09-26 | CLIK | Israel Roy | COB,CEO, Pres, 10% | S - Sale | $0.11 | -3,525,788 | 0 | -100% | -$402,292 |
| | 2007-09-27 09:53:11 | 2007-09-26 | CLIK | Specht Willem F | Dir | S - Sale | $0.11 | -140,000 | 0 | -100% | -$15,974 |
| | 2007-09-27 09:42:31 | 2007-09-26 | CLIK | Giuliani Rheaume Patricia A | VP, CFO, Treasurer | S - Sale | $0.11 | -140,000 | 0 | -100% | -$15,974 |
| DM | 2005-01-13 15:33:59 | 2005-01-11 | CLIK | Israel Roy | COB, CEO, Pres, 10% | S - Sale+OE | $0.07 | -84,490 | 2,925,788 | -3% | -$5,559 |

Figure 3: Screenshot of company with different tickers over the years

2. Drop transactions, where ticker has no ISIN Code in the dataset obtained from LSGE Datastream.

3. Directors' dealings that were made by the same person on the same day and same transaction type, are merged to one (all but first transaction are dropped).

4. Classification of director into either male or female for every transaction. With the help of the Python Names Dataset library[4], the probability of each first name to belong to either a male or female person is determined and afterwards assigned to the group with the highest probability. If the classification based on the first name is ambiguous, the second name is used instead. The last name is never considered relevant for the classification.

5. Drop companies, if no daily returns are available in the dataset obtained from LSGE Datastream.

[4] `https://pypi.org/project/names-dataset/`

6. Drop transactions if filing date is after 01.01.2023, because not enough daily return information is available for event window calculation.

7. Drop transactions if filing date is before 01.08.2004, because not enough market return information is available for estimation window calculation.

8. Drop transactions if not enough past daily company returns are available. As further explained in section 4.4, we need to estimate the normal company returns as if the event didn't happen in order to calculate the abnormal returns. To predict the normal company returns appropriately, we learn from past data (estimation window). However, if we have less than half of the company reutrn indices available in the LSGE Datastream dataset (less than 100 days within the 200 days estimation window), we delete the transaction.

### 4.3 Exploratory Data Analysis

An extensive Exploratory Data Analysis (EDA) is the cornerstone for identifying hidden outliers, visualize distribution patterns or learn from descriptive statistics. We will put a special focus on the gender distribution.

### 4.4 Event Study

In order to understand the data, the event study calculations and final hypothesis testing, some definitions of subject-specific terms and calculations are necessary.

- **Event:** In scope of this project, we define an event as the DD disclosure indicated by a filing i. Thus, the event date $t_i = 0$ is represented by the filing date in the dataset.

  Figure 4 shows the event date $t_i = 0$ as well as the key elements necessary for conducting an event study.

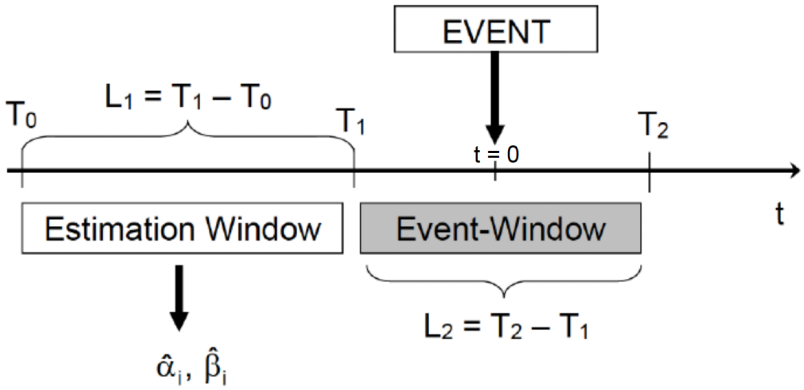



Figure 4: Event and Estimation window definition[1][10]

- **Event window:** We apply an event window ranging from 20 days before to 20 days after the DD transaction (20,20). This 41-days window has the advantage to include any reaction to potential information leakage or insider trading before the official announcement. Moreover, the short- and long-term trade announcement magnitude can be analysed comparatively. More precisely, we define 4 time frames to investigate: -20 to -1 trading days, 0 to 5 trading days, 0 bis 10 trading days, and 0 to 20 trading days. Figure 4 illustrates the event window $L_2$ from $T_1$ to $T_2$.

- **Estimation window:** The estimation window is used to calculate the predicted company return and includes 200 trading days, ending 20 days before the event date. Figure 4 shows

the estimation window $L_1$ from $T_0$ to $T_1$, which is used to retrieve the estimation parameters using the Ordinary Least Squares (OLS) method:
$\hat{\alpha}_i$ = Intercept term, representing the average stock return that is not explained by market movements,
$\hat{\beta}_i$ = Slope term (beta coefficient), representing the sensitivity of the stock return to the market return.

- **Abnormal Return:** Abnormal returns are the difference in estimated normal company returns (without event) and actual realized returns for the event window. We use the Market Model-Adjusted Return method to calculate the abnormal returns using the Nasdaq Composite Index as market index.[1] The corresponding equation for a trade filing $i$ at day $t$ and market index $m$ is:

$$AR_{i,t} = R_{i,t} - \widehat{\alpha_i} - \widehat{\beta_i} * R_{m,t} \tag{1}$$

Where:
$R_{i,t}$ = Realized return on security i for period t,
$\hat{\alpha}_i$ = Intercept term, representing the average stock return that is not explained by market movements,
$\hat{\beta}_i$ = Slope term (beta coefficient), representing the sensitivity of the stock return to the market return,
$R_{m,t}$ = Return on the market portfolio for period t.

As mentioned before, we use the estimation window to retrieve the estimation parameters using the Ordinary Least Squares (OLS) method.

Positive abnormal return indicates higher returns than expected, whereas negative abnormal return indicates lower returns than expected, based on the Nasdaq Composite market index and the expected normal return.

In order to carry out cross-sectional analyses, we need to calculate the **average (mean) abnormal returns** of $N$ filings for day $t$:

$$AAR_t = \frac{1}{N} \sum_{i=1}^{N} AR_{i,t} \tag{2}$$

- **Cumulative Abnormal Return:** The cumulative abnormal return (CAR) for filing $i$ is calculated for the event window $(\tau_1, \tau_2)$, surrounding the announcement day (day 0), as shown in equation 3[11]:

$$CAR_i(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{i,t} \tag{3}$$

Again, we aggregate the CARs for N filings over the time period $(\tau_1, \tau_2)$ as **cumulative average abnormal return**[11]:

$$CAAR(\tau_1, \tau_2) = \frac{1}{N} \sum_{i=1}^{N} CAR_i(\tau_1, \tau_2) \tag{4}$$

### 4.5 Statistical Tests

To test the magnitute of DDs on abnormal return, the following significance tests are used for statistical testing:

1. Adjusted Standardized Cross-Sectional Test (adjusted BMP test) based on Kolari and Pynnönen (2010). [8]

2. Generalized Rank Test based on Kolari and Pynnönen (2011). [9]

Both tests take into consideration that many filings have overlapping event windows (event-date clustering), which could result in correlated abnormal returns and over-rejecting the null hypothesis of zero average abnormal returns when it is true. [8]

The parametric adjusted BMP test addresses this problem by utilizing scaled (or standardized) abnormal returns and proposing a new t-test statistic that takes into account both cross-correlation and inflation of event-date variance for the null hypothesis $E(AAR_{t_0}) = 0$ for day $t_0$ in the event window.[8]
The nonparametric Generalized Rank Test is applied for the null hypothesis $E(CAAR(t_0, t_1)) = 0$.[9]
For this project, we applied the Python EventStudyStatistics library[5] to conduct all the statistical tests. The library facilitates the calculation of the standardized cross-sectional test (with either null hypothesis: $E(CAAR) = 0$ or $E(AAR) = 0$) and the generalized rank t test. All tests require the same input parameters:

- Abnormal Returns as n x L2 matrix.
- Residuals from the market model, as n x L1 matrix.
- Returns of the market in the estimation window for each event, as n x L1 matrix.
- Returns of the market in the event window for each even, as n x L2 matrix.
- Period of the event window we are observing ([-20,-1],[0,20],[0,5],[0,1]).

With n = number of events, L1 days in the estimation window, L2 days in the event window.

The function returns the test statistic t and the p-value per test. The CAAR value is calculated manually for the corresponding time frames as described in the section before. Tables 6-8 show the output obtained from the EventStudyStatistics function.

However, these tests only reveal potential significant abnormal returns per subgroup. As we want to compare male and female groups, we need another test that measures the significance of different CAAR values *between* groups. Therefore, we use a method suggested by Prof. Aussenegg and verified by previous event studies, which simulates CAAR mean differences.[12] For this test, we create 10,000 bootstrap sub-samples of size 1,500, both for male and female transactions respectively. Afterwards, we calculate the mean CAAR $\Delta(CAAR)$ difference and use a non-parametric significance test. Hence, if $\Delta(CAAR)$ is positive for the entire sample, we use the null hypothesis $E(\Delta(CAAR)) < 0$ and otherwise $E(\Delta(CAAR)) < 0$.

[5] `https://event-study-statistics.readthedocs.io/en/latest/autoapi/latest/eventstudystatistics`

### 4.6 Reproducibility

Reproducibility is guaranteed by online availability of the insider trading data. The used dataset can be provided upon request. Moreover, the public project repository contains detailed code documentation[6].

[6] `https://github.com/AnnabelRe/Interd_Project`

# 5 Results

## 5.1 Data Acquisition

The initial download of DDs from OpenInsider yields in 718.960 unique trades from 7.937 unique company Tickers.

## 5.2 Data pre-processing

The individual steps are explained in detail in section 4.2, step 2.

| Preprocessing Step | Number of excluded transactions | Remaining number of transactions |
|---|---|---|
| Initial Transaction Download | | 718.960 |
| Original ticker != download ticker | 97.738 | 621.222 |
| Ticker cannot be matched to ISIN Code | 6 | 621.216 |
| Same person, same day, same trade type | 19.681 | 601.535 |
| No gender classification | 25.458 | 576.077 |
| No daily returns available | 4.431 | 571.646 |
| Transactions after 1.1.2023 | 21.084 | 550.562 |
| Transactions before 1.8.2004 | 31.821 | 518.741 |
| Too many missing daily returns in AR calculation | 36.555 | 482.286 |

Table 2: Preprocessing steps that reduced the number of transactions

In conclusion, after running all pre-processing steps, we use 482.214 transactions for the hypothesis testing. Those transactions are allocated to 4.841 company Tickers.

## 5.3 Exploratory Data Analysis

First of all, we will explore the distribution of transactions:
**Mean number of trades per company:** 103.30.
**Median number of trades per company:** 48.0.

Top 5 companies with most transactions:

| Ticker | Company Name | Number of Trades |
|---|---|---|
| ISCA | International Speedway Corp. | 8.978 |
| MORN | Morningstar, Inc. | 2.158 |
| SYBT | Stock Yards Bancorp, Inc. | 1.949 |
| QCOM | Qualcomm Inc. | 1.945 |
| UTHR | United Therapeutics Corp. | 1.822 |

Table 3: Top 5 Nasdaq Composite companies with most trades

**Gender distribution**:
Out of 601.535 total transactions that we are analysing at this step, 85.22% are made by male directors, 10.55% are made by female directors and 4.22% are not identifiable, as displayed in

Figure 5. The reason for missing classification could be very rare names, that cannot clearly be classified or company names in the insider name column, which also cannot be classified to a gender. It is a highly imbalanced dataset, as it was to be expected due to the great gender gap in director positions.

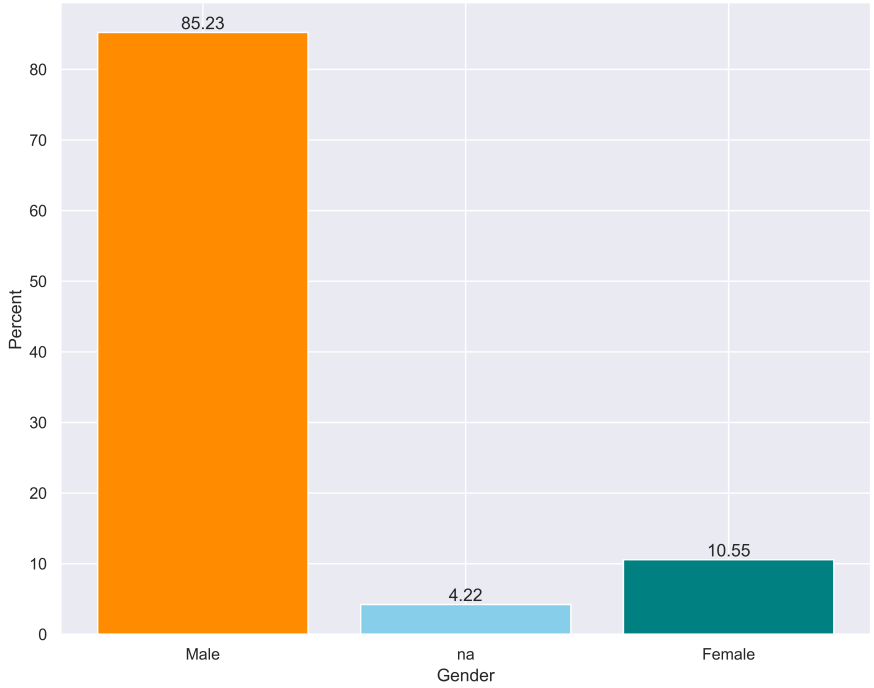



Figure 5: Trades per Gender

After dropping all trades, that couldn't be classified, we can further split the groups according to their trade type. Table 4 specifies the distribution of transactions among trade types and gender once more. The sale of company securities is much more common than purchases, whereas the trade types are roughly similar distributed for male and female directors' dealings.

| Trade Type | Female | #Transactions | Male | #Transaction |
|---|---|---|---|---|
| P - Purchase | 25.43% | 13379 | 27.51% | 118179 |
| S - Sale | 37.01% | 19468 | 39.55% | 169920 |
| S - Sale+OE | 37.56% | 19758 | 32.94% | 141510 |

Table 4: Transaction Distribution per Gender and Trade Type

In conclusion, purchases are the least frequent trade type with 25% for females and 27% of all male trades, as shown in table 4. Sales are much more common, accounting for 37% of female trades and 39% of male trades. Sales + OE (option execution and sale of underlying security) even accounts for 38% of insider dealings conducted by female directors, and 33% for male directors' dealings.

### 5.4 Event Study

As described in Section 4.4, the calculation of abnormal returns (AR) and cumulative abnormal returns (CAR) is necessary for the final significance tests.

Figures 6 and 7 illustrate the average abnormal return, using the median and mean respectively. Both figures show the same pattern: In the 20 days before the event date (vertical red line) of a purchase of shares from a director, the company return is lower than expected based on market total return index. 3 days before the event, we observe a drop, which recovers within a day and turns into a strong rise of the company return, that peaks 2 days after the event date. From there, the company return normalizes above 0.0, higher than before the director dealing. The median peak is significantly lower than the mean peak, which means that the dataset contains some transactions, that spike the company return significantly high and therefore shift the group mean. Same goes for the mean minimum before the event day, which is significantly lower than the median low, indicating that some companies with very strong drop shift the group average negatively.
Sales and Sales+OE depict the opposite development. Before the trade announcement, the average company return hovers around the market total return index with a peak above 0.0 1-2 days before the event day and declining afterwards, reaching the lowest point 2 days after the event day and then recovering still below 0.0. Again, the mean high and low lash out more than the median extreme points. Interestingly, we can observe that the mean AR in the timeframe before the event day is above market total return index, but the median AR isn't.

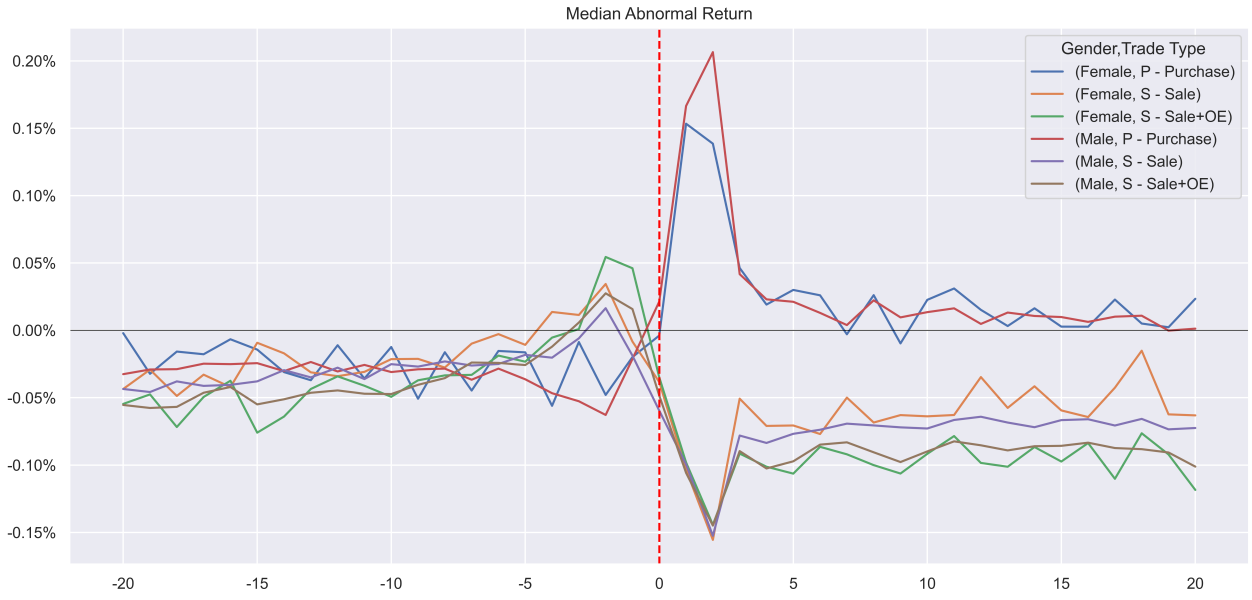



Figure 6: Median abnormal return


Figure 7: Mean abnormal return

According to figures 8 and 9, it seems that some outliers with very low AR shift mean CAR after a share purchase of a male (red line) negatively, resulting in a lower recovery after the transaction for CAAR compared to MCAR. Sales + OE transactions conducted by female directors reach the highest peak compared to total market return index, but female sales stagnate on a higher AR over time.

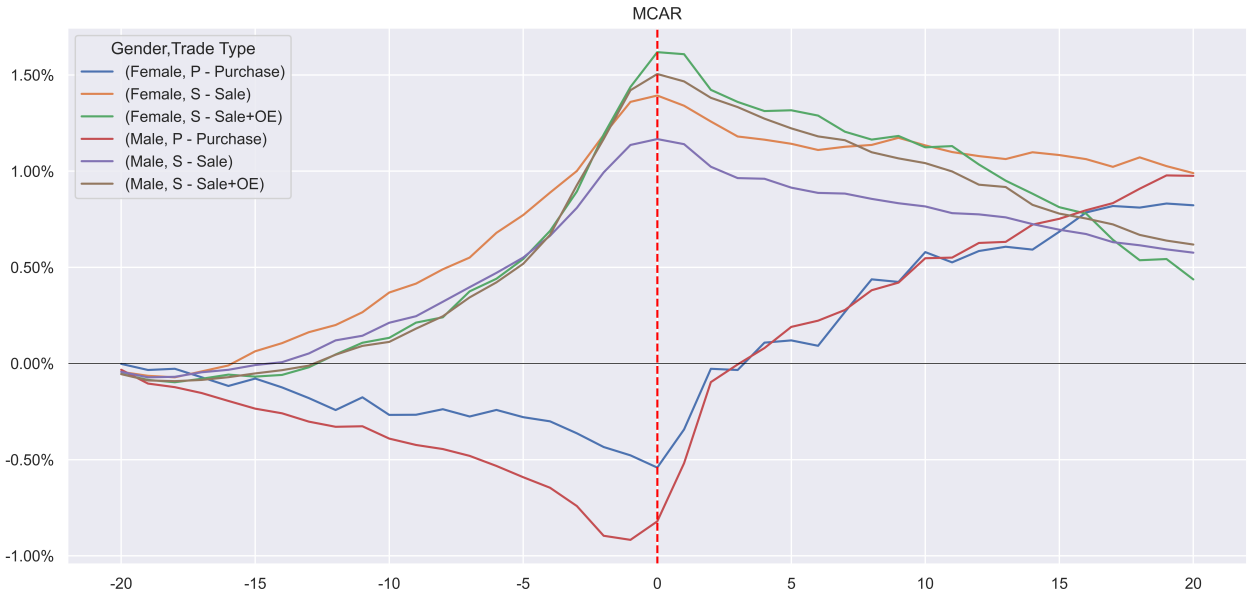



Figure 8: Median cumulative abnormal return

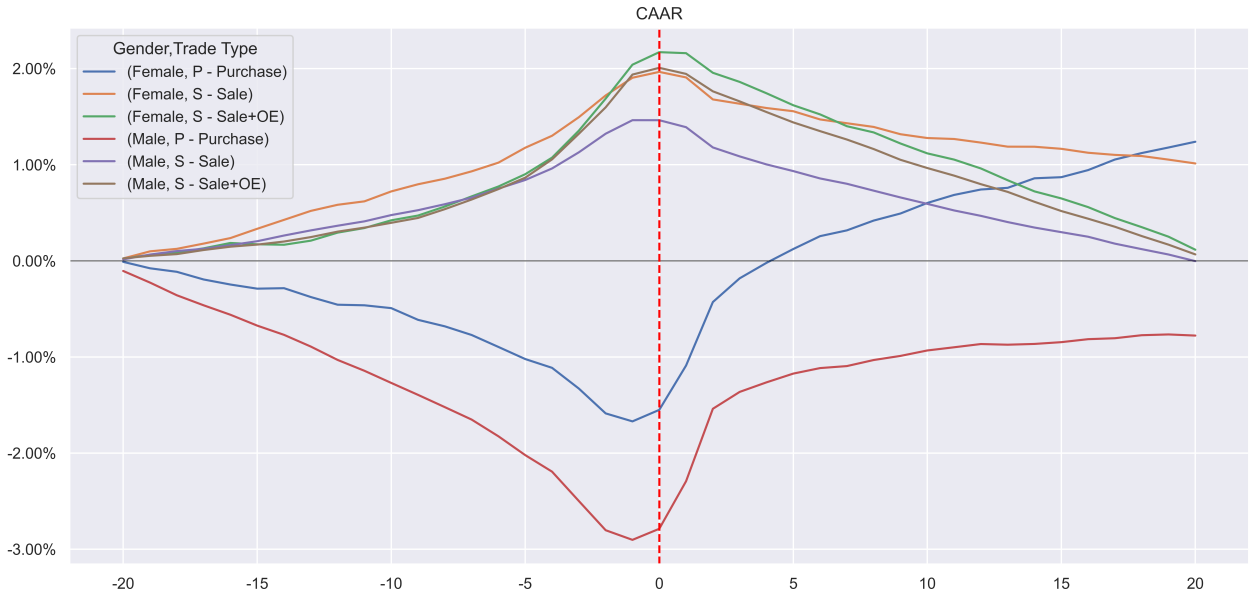



Figure 9: Mean cumulative abnormal return

## 5.5 Statistical Tests

After analyzing the abnormal returns per group, we conduct statistical tests as explained in section 4.5 in order to confidently decide whether or not to reject the hypotheses.

**1. Hypothesis:** Directors' dealings result in a bigger magnitude of the trade announcement, if the director's gender is male, compared to female directors' dealings.
That would imply, that the CAARs of companies, that experienced an insider trading by a male director deviates more from 0.0 (market average) than the CAARs of companies with female director dealing. To test this hypothesis, we've calculated the CAARs per gender for every trade type and time frame. Tables 6, 7 and 8 contain detailed information about the individual CAAR values per group. Afterwards, we use a non-parametric test to analyse how much the CAARs differ for both groups in each time frame.[12] Even though both parametric and non-parametric statistical tests in tables 6, 7 and 8 show significant differences in CAAR values from the market average, there is no significant difference in magnitude between male and female dirctor dealings. Table 5 shows that with 5% significance level as threshold, there's not one significant difference in any timeframe. Generally, most $\Delta$CAAR values are negative, which implies that for those groups either male DDs have a larger negative magnitude than the female DDs or a smaller positive CAAR value.

| Trade Type | CAR Period | Δ CAAR | p-value |
|---|---|---|---|
| P - Purchase | [-20,-1] | -0.0174 | 0.6080 |
| | [0,20] | -0.0137 | 1.1154 |
| | [0,5] | -0.0024 | 1.2838 |
| | [0,1] | -0.0005 | 1.1962 |
| S - Sale | [-20,-1] | 0.0017 | 0.7782 |
| | [0,20] | -0.0027 | 0.6214 |
| | [0,5] | -0.0009 | 0.7304 |
| | [0,1] | -0.0002 | 0.8896 |
| S - Sale+OE | [-20,-1] | 0.0011 | 0.8544 |
| | [0,20] | -0.0001 | 0.9836 |
| | [0,5] | -0.0005 | 0.8304 |
| | [0,1] | -0.0009 | 0.5388 |

Table 5: P-values for CAAR differences between male and female directors' dealings

Table 4 lists the absolute and relative number of transactions per subgroup and section 4.5 explains the bootstrap sampling applied for this statistic test.
Figure 11 serves as visual example for the difference in mean CAAR values for Sales+OE transactions for each time frame. The histograms are mostly overlapping, which agrees with the conclusion that the difference is insignificant and the hypothesis is rejected.

**2. Hypothesis:** The abnormal return after a director dealing is greater (positive or negative) over a longer period of time after the trade announcement, if the director's gender is male, compared to female directors' dealings.

To validate this hypothesis, we focus on the longest time frame after the trade day [0,20]. Figure 8 and 9 reveal that male abnormal returns are more effected by outliers, which actually make female transactions result in longer, greater abnormal returns, but when looking at the MCAR graph, the differences are diminishing.

Purchase:

| Gender | CAR Period | CAAR | GRANK p-value | GRANK t-statistic | adjBMP p-value | adjBMP t-statistic |
|---|---|---|---|---|---|---|
| Male | [-20,-1] | -0.0290 | 0.0000 | -7.8689 | 0.0000 | -18.5290 |
| | [0,20] | 0.0212 | 0.0000 | 23.7332 | 0.0000 | 71.8555 |
| | [0,5] | 0.0173 | 0.0000 | 22.6347 | 0.0000 | 44.4483 |
| | [0,1] | 0.0061 | 0.0000 | 12.7118 | 0.0000 | 19.4556 |
| Female | [-20,-1] | -0.0167 | 0.0001 | -3.9222 | 0.0000 | -13.1806 |
| | [0,20] | 0.0291 | 0.0000 | 13.7785 | 0.0000 | 18.9293 |
| | [0,5] | 0.0179 | 0.0000 | 12.4261 | 0.0000 | 16.6501 |
| | [0,1] | 0.0058 | 0.0000 | 6.9521 | 0.0000 | 8.2332 |

Table 6: Significance test result for Purchases

Sales:

| Gender | CAR Period | CAAR | GRANK p-value | GRANK t-statistic | adjBMP p-value | adjBMP t-statistic |
|---|---|---|---|---|---|---|
| Male | [-20,-1] | 0.0146 | 0.0000 | 23.3225 | 0.0000 | 16.8390 |
| | [0,20] | -0.0147 | 0.0000 | -18.1142 | 0.0000 | -8.5819 |
| | [0,5] | -0.0053 | 0.0000 | -16.0037 | 0.0000 | -5.9632 |
| | [0,1] | -0.0007 | 0.0000 | -6.2957 | 0.8493 | -0.1900 |
| Female | [-20,-1] | 0.0190 | 0.0000 | 16.2735 | 0.0000 | 14.5640 |
| | [0,20] | -0.0089 | 0.0000 | -7.7511 | 0.0000 | -5.1354 |
| | [0,5] | -0.0035 | 0.0000 | -7.3249 | 0.0001 | -3.8235 |
| | [0,1] | 0.0000 | 0.0761 | -1.7831 | 0.2254 | 1.2122 |

Table 7: Significance test result for Sales

Sales + OE:

| Gender | CAR Period | CAAR | GRANK p-value | GRANK t-statistic | adjBMP p-value | adjBMP t-statistic |
|---|---|---|---|---|---|---|
| Male | [-20,-1] | 0.0194 | 0.0000 | 24.8772 | 0.0000 | 15.5753 |
| | [0,20] | -0.0187 | 0.0000 | -25.0746 | 0.0000 | -10.4463 |
| | [0,5] | -0.0050 | 0.0000 | -16.7298 | 0.0000 | -4.9233 |
| | [0,1] | 0.0001 | 0.0000 | -5.4915 | 0.2803 | 1.0797 |
| Female | [-20,-1] | 0.0204 | 0.0000 | 19.5413 | 0.0000 | 13.3167 |
| | [0,20] | -0.0192 | 0.0000 | -20.2369 | 0.0000 | -8.4656 |
| | [0,5] | -0.0042 | 0.0000 | -11.2682 | 0.0018 | -3.1140 |
| | [0,1] | 0.0012 | 0.0777 | -1.7731 | 0.0254 | 2.2356 |

Table 8: Significance test result for Sales+OE

Tables 5-8 confirm the assumption that the announce magnitude is insignificantly diverging for the long term period after the trade announcement. Thus, the second hypothesis is rejected, too.

**3. Hypothesis:** The magnitude of the announcement effect is higher for male than for female traders in the same corporate position.
This hypothesis deals with the importance of corporate positions in the context of directors' dealings. Because titles are spelled in various different ways and often unique to the company, there are a total of 16,333 different titles in the data set. We only consider titles that correspond to at least 1000 transactions in order to be able to draw statistically significant conclusions. Table 9 lists the most common titles and their frequency split to the trade types.

| Title | Trade Type | Female (%) | Male (%) |
|---|---|---|---|
| 10% | P - Purchase | 3.48 | 4.85 |
| | S - Sale | 6.13 | 5.17 |
| | S - Sale+OE | 1.08 | 0.36 |
| CEO | P - Purchase | 0.66 | 1.64 |
| | S - Sale | 1.55 | 2.65 |
| | S - Sale+OE | 2.28 | 2.82 |
| CFO | P - Purchase | 1.63 | 1.38 |
| | S - Sale | 3.19 | 2.55 |
| | S - Sale+OE | 3.34 | 2.62 |
| Dir | P - Purchase | 26.84 | 25.12 |
| | S - Sale | 20.56 | 20.80 |
| | S - Sale+OE | 14.67 | 12.92 |
| EVP | P - Purchase | 0.76 | 0.89 |
| | S - Sale | 1.76 | 1.43 |
| | S - Sale+OE | 2.10 | 1.72 |
| Pres, CEO | P - Purchase | 1.05 | 2.94 |
| | S - Sale | 1.76 | 3.56 |
| | S - Sale+OE | 2.34 | 3.59 |
| SVP | P - Purchase | 1.64 | 0.40 |
| | S - Sale | 1.24 | 1.11 |
| | S - Sale+OE | 1.93 | 1.47 |

Table 9: Most common Titles of legal insider traders

The initial analysis of all 7 titles from the table above for the 3 trade types and 4 time frames, respectively for both genders, resulted in 168 CAAR values to be again compared against each other. To draw conclusive results, only the subgroups with the greatest (positive or negative) CAARs were further analysed for the time frame of [0,1] and [0,20] days after the trade day. However, for male and female transactions different titles resulted in greatest CAAR values per time frame. Only for purchases, both male and female for both time frames matched with the same title, which was 'CEO'. Table 10 shows the results of the statistical analysis of the CAAR values, which revealed no significant differences over all time frames with a significance level of 1%. However, with a 5% significance level as threshold, $\Delta(CAAR)$ is significant for the [0,5] time frame. Additionally, figure 14 visually highlights the (more or less strong) overlap.
There are 3422 purchases of male CEOs and 148 purchases of female CEOs. For the significance test, we created various sub-samples with bootstrap samling, as explained in section 4.5.

| Trade Type | CAR Period | $\Delta$ CAAR | p-value |
|---|---|---|---|
| P - Purchase | [-20,-1] | -0.0032 | 0.7214 |
| | [0,20] | -0.0000 | 0.9812 |
| | [0,5] | -0.0114 | 0.0116 |
| | [0,1] | -0.0040 | 0.1500 |

Table 10: P-values for CAAR differences between male and female CEO purchases

Because we have a lot less female transactions than male transactions, the statistics might suffer from representation bias even if the relative distribution in table 9 seem balanced. Thus, we will focus further analysis on all trades conducted by Directors ('Dir').

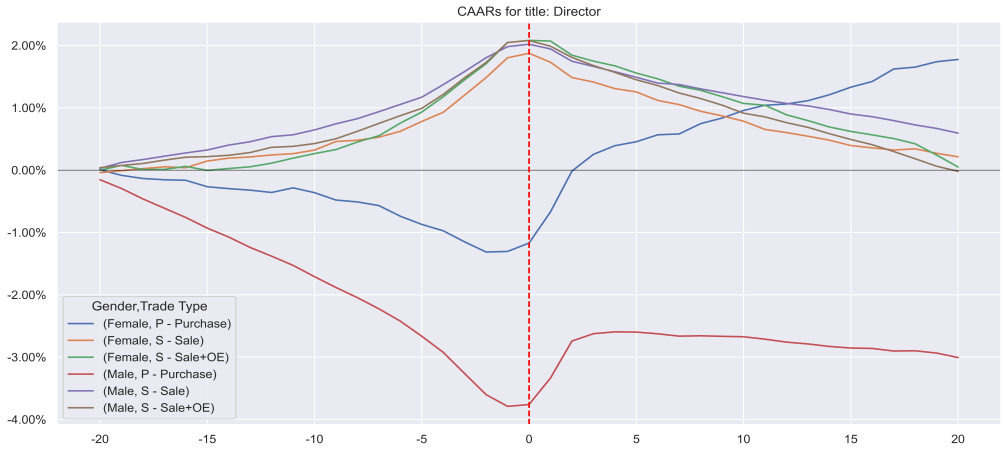



Figure 10: CAARs for all Director ('Dir') dealings per group

Figure 10 shows the same trend as the overall CAARs in figure 9. Interestingly, the red curve (purchases for the male subgroup) shows almost no increase in abnormal return after the security purchase filing date, different from the overall CAAR (figure 9) or MCAR (figure 8) graph. This is an indicator that an outlier with great negative abnormal returns after the director dealing exists, which manipulates the group mean negatively.
Table 11 confirms that the ΔCAAR values are not significant for any of the subgroups.

| Trade Type | CAR Period | Δ CAAR | p-value |
|---|---|---|---|
| P - Purchase | [-20,-1] | -0.0123 | 0.8788 |
| | [0,20] | -0.0078 | 1.4448 |
| | [0,5] | -0.0006 | 1.4478 |
| | [0,1] | 0.0003 | 0.6212 |
| S - Sale | [-20,-1] | -0.0044 | 0.6598 |
| | [0,20] | -0.0057 | 0.4640 |
| | [0,5] | -0.0018 | 0.6142 |
| | [0,1] | -0.0008 | 0.6972 |
| S - Sale+OE | [-20,-1] | -0.0010 | 0.8560 |
| | [0,20] | 0.0005 | 0.9214 |
| | [0,5] | -0.0008 | 0.7770 |
| | [0,1] | -0.0011 | 0.5712 |

Table 11: P-values for CAAR differences between male and female 'Director' (Dir) dealings

The table below shows the number of trades per subgroup.

| Gender | Trade Type | #Transactions |
|---|---|---|
| Female | P - Purchase | 6046 |
| | S - Sale | 4632 |
| | S - Sale+OE | 3305 |
| Male | P - Purchase | 52265 |
| | S - Sale | 43269 |
| | S - Sale+OE | 26891 |

Table 12: Number of transactions per subgroup with title 'Director' ('Dir')

In conclusion, there is no evidence for any correlation between the corporate position of the person carrying out the transaction and the magnitude of the announcement effect. Furthermore, there is no significant difference in abnormal returns for transactions made by male and female with the same corporate title. Consequently, the magnitude of the announcement effect is not higher for male than for female traders in the same corporate position and the hypothesis is rejected.

# 6 Discussion and Conclusion

This event study has revealed that directors' dealings result in significant CAARs and therefore have a meaningful impact on the company's stock price development, which could be (legally and illegally) taken advantage of. However, the study has also shown that the CAAR differences between male and female directors' dealings is insignificant. Moreover, the corporate position of the director doesn't impact the short term performance either. Directors in the same position don't yield significant different abnormal returns only based on their gender. Further analysis could be done on the importance of the trade volume or on the seniority of the directors.

It should be noted, that the gender of the person conducting a trade is solely derived from the person's first and second name and therefore might result in a wrong classification for gender-neutral names. Furthermore, we only consider two genders (male and female) in this project without having any information on what the individuals actually identify as.

Last but not least, I want to remark the extensive effort and countless hours this project required. Researching the topic, gathering the data, pre-processing, EDA, event study calculations and finally the statistical tests added up to way more hours than officially required by the project guidelines. I'd highly recommend anyone with the same research field to reach out and to exchange previous work and project repositories on this topic to save at least a little time on research.

# 7 Annex

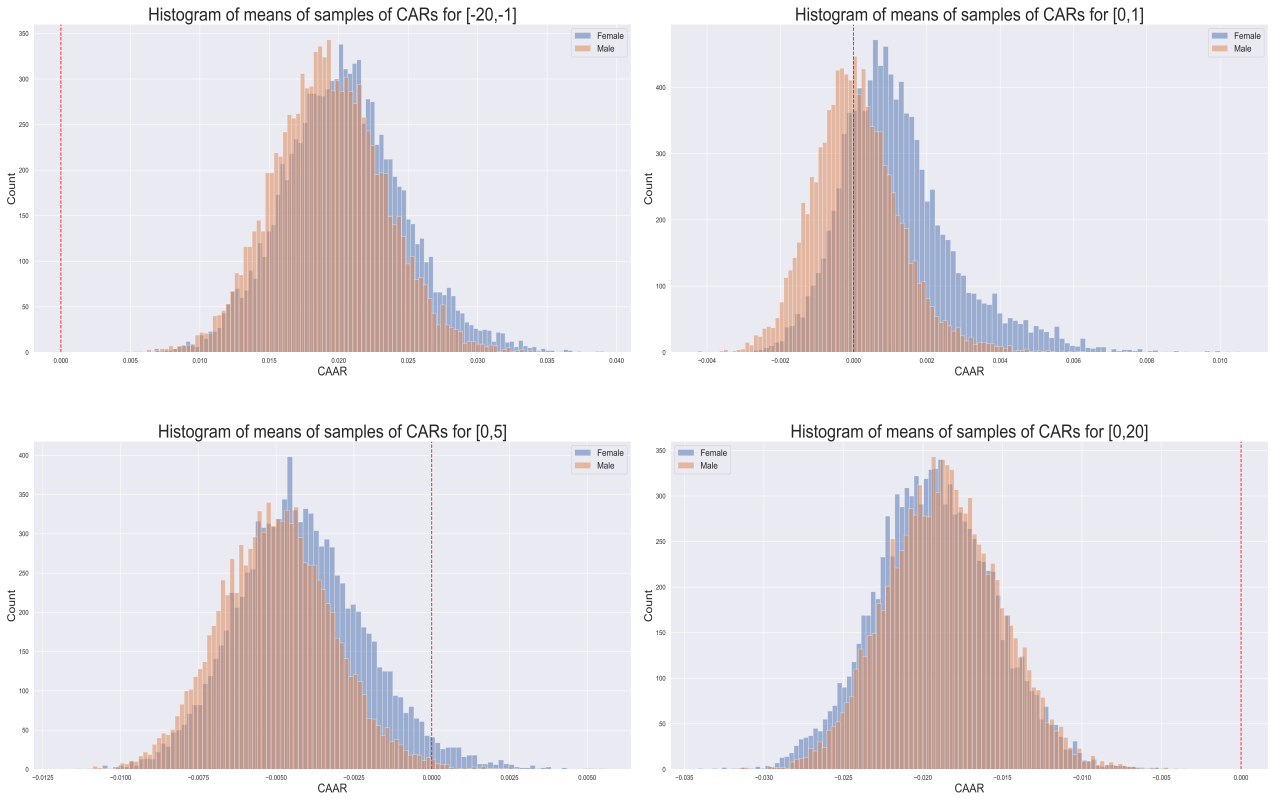



Figure 11: Mean CAR differences between male and female Sale+OE dealings

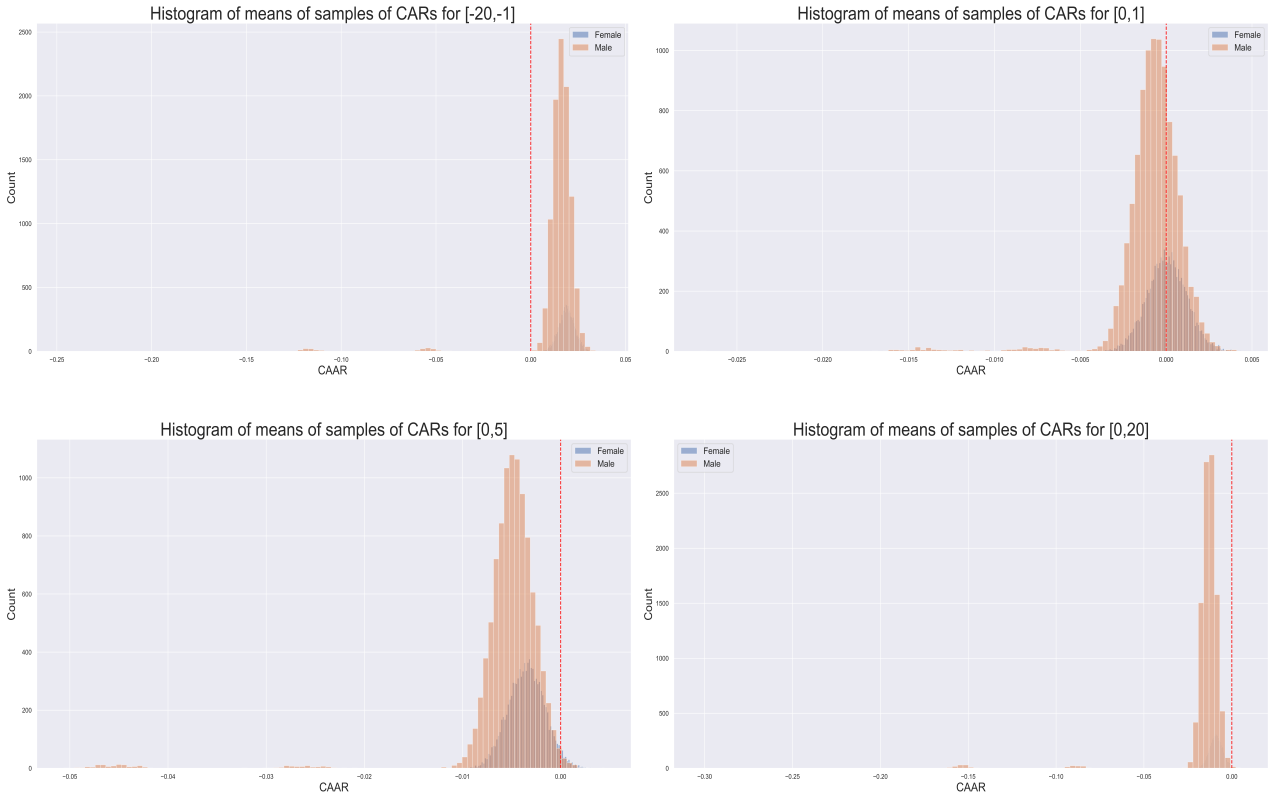



Figure 12: Mean CAR differences between male and female Sale dealings

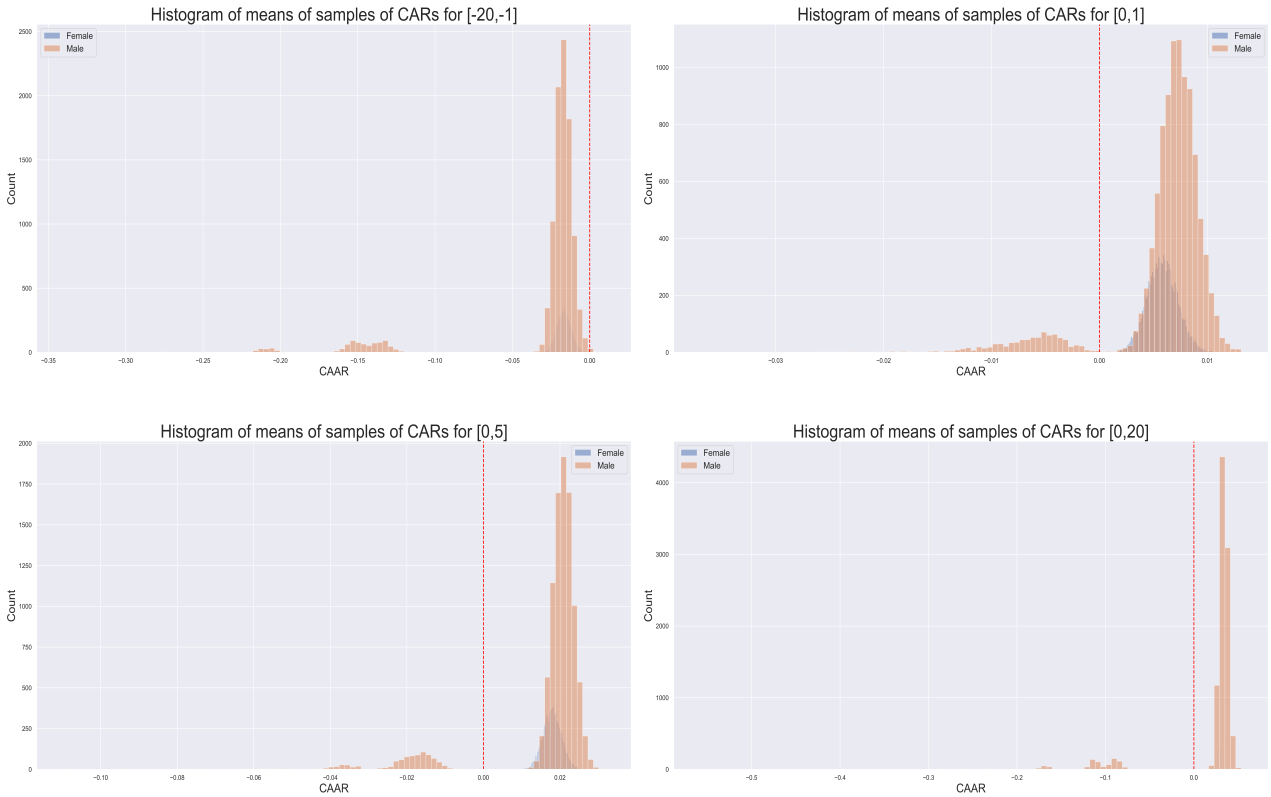



Figure 13: Mean CAR differences between male and female Purchase dealings

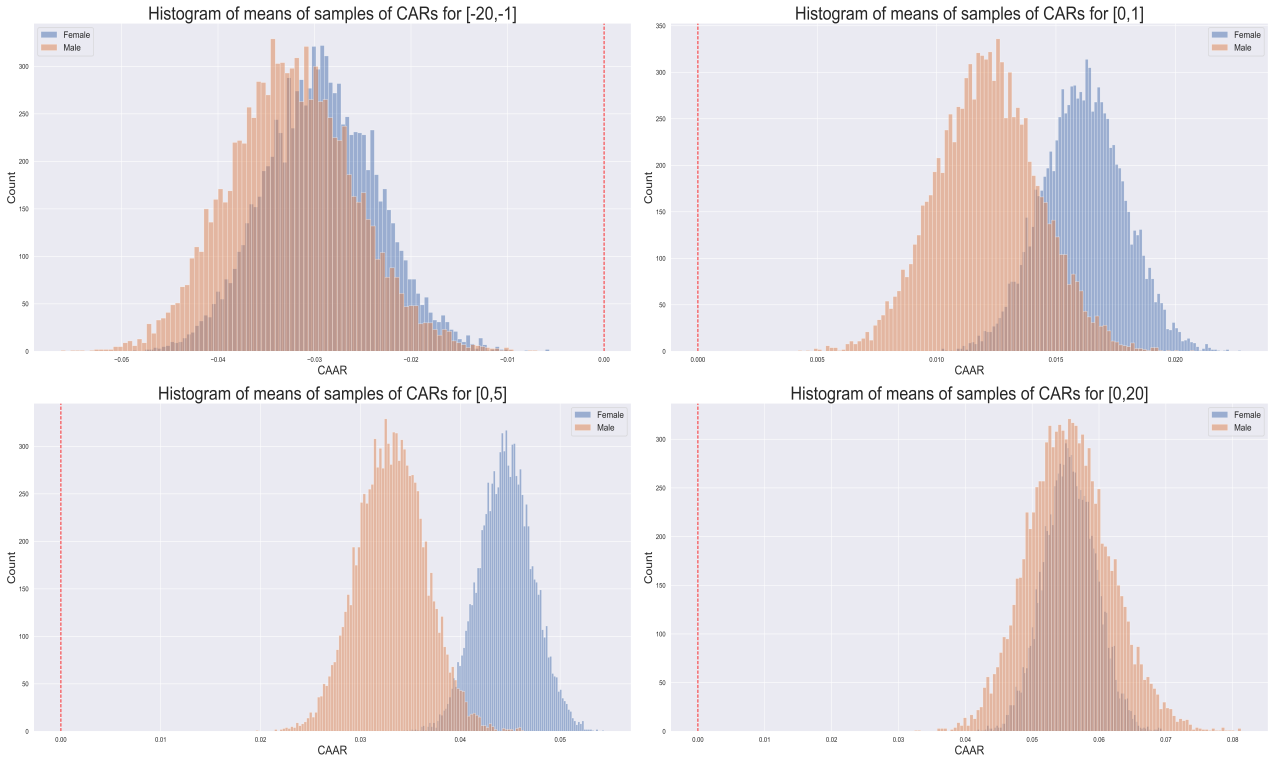



Figure 14: Mean CAR differences between male and female CEO purchases

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