Analysis of the Impact of Gender of the CEO on Stock Prices

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Declaration

I, the undersigned, declare that this work has not previously been submitted as an exercise for a degree at this, or any other University, and that unless otherwise stated, is my own work.

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There are various aspects of investor sentiments that affect stock price movements. This research tries to identify whether the investor sentiment is different based on the gender of the CEO. This research work is an attempt to statistically show whether the gender of the CEO of an organisation has a significant impact on the organisation's stock price movements. The case study selected for this research included companies from the S&P 500 list of organisations. S&P 500 is a market index in the New York Stock Exchange that provides an overall measure for the movement of 500 top firms in the US, selected periodically. Statistical methods employed in this research are summary statistics using stylised facts, Chi-square tests, vector autoregression and panel analysis. Visual analysis was also performed on the data using Tableau. GRETL, an econometric tool, was used for implementing vector autoregression. The research was performed at an aggregate level as well as at an individual company level. From this research performed using these methods, it was found that the gender of the CEO has a statistically significant impact on the stock price movements.

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Chapter 1

Introduction

Gender diversity, in recent times, has become a much researched and advertised aspect for most large organisations across the world. Creating a workplace with equal opportunities for all has become a basic requirement for all organisations across the globe. Furthermore, environmental, social and governance (ESG) related commitments of organisations have gained popularity among investors. Due to this added focus on ESG aspects of a company, organisations are working on increasing gender diversity across the boards in order to attract more investors. In order to improve gender diversity in workplaces, there have been focused efforts by governments and other non-profit organisations to gather and analyse the current statistics.

Despite this, the status quo in terms of men and women in upper management positions is far from ideal. This disparity in status quo has also motivated various researchers to look at the impact of having a gender-diverse board in relation to the performance of the firm in terms of company risk, return on investment, innovation etc., while comparing it against a board having all men. One of the researchers (Martínez and Rambaud (2019)) has noted that the presence of females on the board can have a positive influence on the firm's overall management and financial standing. On the other hand, another research (Rose (2007)) concerning the Danish market shows that the role of gender diversity in the board has no effect on the performance of the organisation.

Further, the number of women leading organisations are substantially lower than men. There have been numerous research attempts regarding the impact of appointing a female lead (Jadiyappa et al. (2019), Peni (2014) etc.) but the conclusions are varied and not comprehensive. Hence, there is a need to analyse it in order to find any statistically significant findings, specifically in terms of the firm performance post the appointment of a females in lead positions such as Chief Operating Officer (CEO).

1.1 Background - Stock Market and Analysis

The stock market is a regulated and monitored environment where investors can go to buy or sell stocks of an organisation. A stock, also called a share, is an entity that represents a percentage of ownership of a corporation or company. In current times, the stock market is a complex system that is influenced by various macroeconomic and microeconomic factors. A simplistic explanation of the fluctuations of the stock market can be attributed to a supply-demand scenario where the price of each share at any point in time is decided based on this relationship between supply and demand. If the buyers were to bid a higher price, then the sellers would quote a higher price as well, and the price of the share would increase and vice-versa if the bid is decreased. This fluctuation in the stock market can also be viewed in terms that the general sentiment of the investors plays a major role in the movements in the stock market and share prices.

1.1.1 S&P 500

Market indices are hypothetical portfolios that represent a certain selection of financial organisations. A stock market index measures the performance of a set of organisations together within one market space. Investors can look at these indexes to perceive the overall direction and performance of the market. (Young (2022))
The Standard and Poor's 500 or S&P 500 is a stock market index in the New York Stock Exchange (NYSE) which tracks the performance of the top 500 publicly listed companies in the United States. The list of these 500 companies is selected based primarily on their market capitalisation. This list of 500 companies is selected by a committee and is regularly updated based on the firm's performance, usually quarterly, but can also be within the quarter. It is maintained by S&P Dow Jones Indices, a joint venture that S&P Global majorly owns. (Wikipedia (2022))

1.1.2 Organisational Analysis Methods

There are two methods of analysing the movement of shares - fundamental analysis and technical analysis.
The fundamental analysis approach takes an overall view of the organisation without diving into the day-to-day stock prices. Fundamental analysis is performed by analysing the organisation as well as its industry using information such as financial statements, industry, management strategies etc. It aims to evaluate the intrinsic value of the organisation from a long-term point of view.

On the other hand, technical analysis is performed for the short-term analysis of an organisation. It considers the stock price movement, volume of stocks traded etc.

1.2 Research Objectives

The intent of the research is to analyse and find statistically significant results to note whether the appointment of a female CEO has an impact on the stock prices.

Hypothesis

The null hypothesis, denoted by H_0, set for this research is stated as follows.
H_0 : The appointment of a woman as CEO has no impact on the movement of stock prices

1.3 Layout of Thesis

Chapter 2 describes various previous researches performed pertaining to gender diversity in boardrooms and CEO positions and their findings. Chapter 3 explains the statistical methods employed for this research, the technologies utilised to implement the methods as well as the process of gathering the data for this research. Chapter 4 provides an overview of the methods employed specifically for the case study in this research, as well as the results obtained. Chapter 5, the final chapter, presents the conclusion for the results obtained in the previous chapter as well as notes down the challenges and the areas of future work for this research.

Chapter 2

Motivation and Literature Review

2.1 Motivation

Volatility and share price movements in the stock market are common, and many aspects contribute to these movements. Market forces alone cannot account for the movement of open stocks. It has been argued that human behaviour, sometimes rational and other times contrarian, can make a contribution to the price of stocks. This subject is also called behavioural finance.

"Behavioral finance attempts to explain and increase understanding of the reasoning patterns of investors, including the emotional processes involved and the degree to which they influence the decision-making process" (Ricciardi and Simon (2000))

In the case of this research, the focus is on the perception related to gender diversity in high-level appointments, such as the CEO of an S&P 500 organisation. A previous study looking at female CEO appointments from the years 1990-2000 notes that investor sentiment related to female CEOs is significantly more negative than for their male counterparts. (Lee and James (2007)). However, there have been various efforts put in by governments and other organisations to improve the social status of women since the 2000s. This research looks to analyse whether there has been a change in fashions in terms of the investors' perception of women CEOs. The aim of the research is to examine it by looking at the change in the price of stocks before and after a woman CEO is appointed. If no significant change is noted, then the performance of women CEOs is at least at par with their male counterparts.

In addition, most previous researchers have chosen to employ fundamental analysis methods, which take into consideration the overall business factors along with the economic conditions. In this research, the technical analysis method, which looks at factors such as historical performance, market returns etc., has been employed.

2.2 Literature Review

2.2.1 Female Board members/CEO Statistics

There have been various studies that show that despite the growing interest in gender diversity, there is a large gap between the number of females in managerial positions compared to men.

(Catalyst (2022)), a global non-profit organisation that aims to promote the progress of women in workplaces, reports the number of females in senior management roles globally at 31% as of 2021. It is also reported that, as of 2021, almost 90% of companies worldwide have at least one female member in a senior management role. Additionally, as per the report, in the United States, the working population comprises 47% females while only 40.9% of managerial positions are held by females. Considering the S&P 500 list of companies as of January 2022, only 32 women hold CEO positions which amount to a mere 6.4

Although the number has grown from about 5% as of the end of 2019, it is moving at a very slow pace. The growth can be attributed to the fact that the investors are generally concerned about gender diversity metrics.

Similarly, in Europe, according to the European Institute for Gender Equality (2022), only 8.3% of CEO positions are held by females in all 27 countries within the European Union.

As per Workplace Gender Equality Agency (WGEA (2022)) by the Australian Government, 41% of all managers are females, yet when considering women in CEO positions, only 19.4% of all CEOs are women.

2.2.2 Women in Boardrooms

Gender equality is a concept of widespread concern and importance. The statistics show us that there is still a need for further steps to achieve it, especially in terms of management positions. While gender equality is essential, there have been various works that show us how gender diversity affects the overall functioning of an organisation.

One of the elementary and intuitive reasons for including more female members into the boardroom is that females represent a large portion of the human capital available to organisations. Boards can enhance their effectiveness by thus broadening their spectrum of talent pool.

Another argument is that women, by virtue of their gender, are in the minority and hence, can be closely associated with an independent director, as described in governance theory. This also has the effect that the presence of female board directors can improve the overall

efficacy of the boardroom. (Adams and Ferreira (2009))

Singh et al. (2008), in their research, investigated the reason for the disparity in the gender ratio in boardrooms and their validity in terms of females not having the same skill set or experience as their male counterparts. They observed that female directors had more varied experience in previous boardrooms as compared to their male peers. It was also noted that female board members were more likely to have both financial as well as community expertise as compared to males.

Additionally, females tend to have a more developed ethical sense, due to which they are more likely to be invested in ESG commitments such as pollution and climate change (Quintana-García et al. (2022)). Another research also shows the validity of the previous statement but also states that female members of the board might not be as concerned with the impact of the CSR results on the overall finances compared to their male counterparts. (Bristy et al. (2020))

Another research observed that organisations that have female CEOs have a lesser likelihood of discrimination lawsuits and can further help reduce it in cases where the firm has had previous misconduct lawsuits. (Dadanlar and Abebe (2020)) These firms, headed by female CEOs, are known to have favourable diversity rankings as they are able to provide a favourable diverse environment and hence, lower the probability of diversity misconduct lawsuits.

In terms of innovation, gender diversity in managerial positions has been discovered to have a positive influence on overall innovations, although the same research found that having a female CEO has not shown to have any significant relationship with innovation. (Martin et al. (2009))

Powell and Ansic (1997), in their work, stated that females tend to prefer significantly lower risk than men while also stating that financial decision-making shows no difference in terms of gender. Skała and Weill (2018), in their more recent study related to Polish banks, confirm that women are more risk averse than men. They found that banks headed by females report higher capital adequacy and equity to asset ratios. Shakil (2021) also found that better gender diversity in the board has been seen to have a negative impact on the firm's total and systematic risk in oil and gas companies.

With regard to firm performance, Adams and Ferreira (2009) presented that while women do increase the monitoring aspect of the board, on average, diversity in the board has a negative impact on the firm performance. They found that diversity in the boardroom can create a positive effect only in cases where additional monitoring was required for the firm. They provided a possible explanation for this is that greater diversity could be causing over-monitoring. Rose (2007) noted that, in the Danish market, gender diversity did not seem to affect the firm performance with a possible explanation that this could be

due to the fact that since women are in the minority, they tend to adopt the way of the conventional majority members. Conversely, related to the Spanish market, Martínez and Rambaud (2019) discovered a positive correlation between gender diversity in the board and the firm's valuation.

2.2.3 Female CEO and Firm Performance

There has been a gradual increase in the number of female CEOs globally since the early 2000s. According to the data released by the organisation Catalyst, as of 2022, there are 32 female CEOs in the S&P 500 companies, which amounts to 6.4%. This is an increase, albeit slight, from the 5.2% CEO positions held by females observed in 2015. Figure 2.1 shows the historical trend of percentage positions of female CEOs of S&P 500 for the years 2000 through 2022.

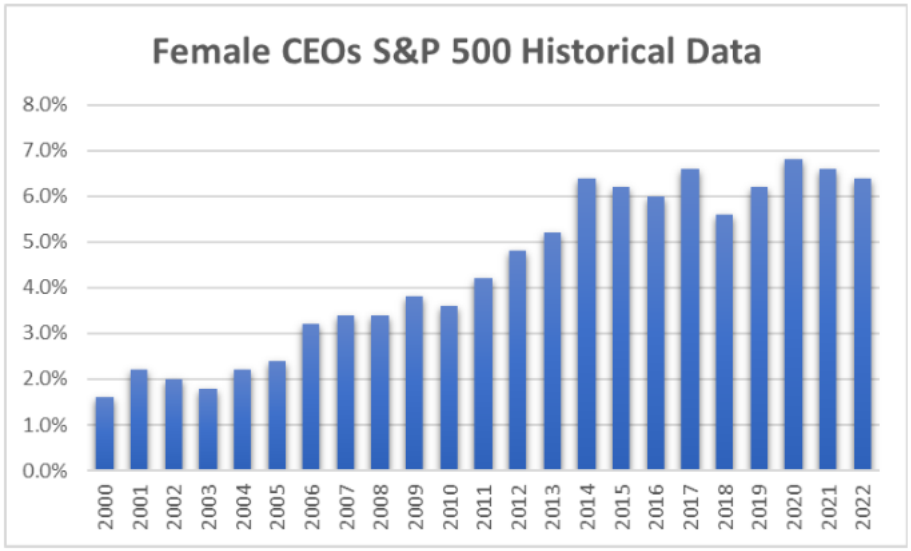

Figure 2.1: Graph showing historical percentage data of female CEOs through 2000-2022

From a social point of view, it is known that females have to face more challenges as compared to men to reach the position of functioning CEO. A notable theory is that of Kanter (2008), the theory of tokenism, which states that minority group members or women, in this case, are appointed to top positions merely as a token meant by the company to display that they are not biased against women. Since these women are appointed as mere tokens, they do not hold authority over their role and, in certain cases, are less qualified. These factors can portray an image of females performing worse than males at such top positions.
Additionally, as seen by Hurley and Choudhary (2016), for women to be chosen for CEO

positions competing against men, having children is known to have a detrimental effect while being more educationally qualified does not have a significant effect on their selection.

Jadiyappa et al. (2019), in their study related to female CEOs in the Indian market, also present the view that female CEOs have a negative effect on firm performance, which may be due to the low social status of women in the Indian society. They also lay out their observation that female CEOs are associated with higher total agency costs, which could be attributed to lower financial and investment decision-making abilities together with the difficulties faced by them due to operating in a patriarchal society.

Peni (2014) observed CEO characteristics and firm performance by taking S&P 500 companies and found that firms with female CEOs tend to outperform those led by males. They also noted that since most businesses are male-dominated, females tend to exhibit special talent so as to be nominated as CEOs and are hence, more talented and dedicated as compared to males and this could be understood as a factor for the better firm performance seen. It was also noted that executives with more experience tend to be better than those with lower experience as more experienced members would have larger and more widely spread connections that could help them make better financial and investment decisions.

Elsaid et al. (2014) observed the effect of change of the CEO on the firm performance, specifically from female CEO to male CEO, and noted that there seemed to be an increase in the firm performance and a decrease in the probability of bankruptcy for the firm post succession of the new CEO as compared against pre-succession. It was also discovered that the firm performance is negatively affected by a change in the background, functional or educational, of the newly appointed CEO as compared with the previous CEO.

Hurt et al. (2020), in their recent study, also analysed the performance of S&P 500 firms with female CEOs, comparing them against male CEOs and found that the firms clustered together, relaying the conclusion that firms led by female and male CEOs tend to perform similarly.

Table 2.1 presents an overview of the method, data and results of previous research performed with respect to the performance of a firm and its CEO characteristics, specifically gender.

Table 2.1: Overview of previous work related to firm performance and gender of CEO/owner

Author	Sample Data	Methods and Criteria Used	Results
Hurt et al. (2020)	S&P 500 (historic and current) Companies	Time series analysis of share price, k-means clustering on share price and volatility to analyse performance difference	No significance seen between performance of male vs female CEOs
Jadiyappa et al. (2019)	100 Indian firms with female CEO preceded by male CEO from Prowess database	Regression analysis on ROA and ROE, in time and space dimensions, used to assess performance	Female CEO appointment has negative effect on ROA and ROE
Peni (2014)	305 firms and 1,525 firm-year observations	Cross sectional panel regression of CEO characteristics and firm performance measured using Tobin's Q and ROA	Firms with female CEOs tend to outperform those with male CEOs
Elsaid et al. (2014)	46 CEO successions where the outgoing CEO is female and the incoming CEO is male from S&P Educomp Database	Paired sample t-tests performed on CEO characteristics and firm performance measured using Tobin's Q	Firm performance increases post-succession as compared against pre-succession

Continuation of Table 2.1			
Author	Sample Data	Methods and Criteria Used	Results
Khan and Vieito (2013)	11315 observations of executive compensation from S&P database	Two stage least square method and OLS Regression on ROA adjusted calculated using ROA subtracted by average industry ROA	Female CEOs have a positive effect on ROA and hence firm performance
Watson and Robinson (2003)	2367 Australian SMEs (2236 male-controlled SMEs and 131 female-controlled) collected through questionnaires	Performance measured using annual profits and reward-to-variability ratio (Sharpe, 1975) analysed against gender using Mann-Whitney U test, t-test and ANOVA tests	No significant difference seen between performance of male vs female CEOs
Watson and Robinson (2003)	U.S. sample of 3976 (2174 female) and 905 (451 female) retail and service SMEs from the census data for 1982 and 1987, respectively.	Regression analysis on gender and business performance assessed on the basis of firm survival rate	Mean survival rates of male-owned businesses were 4–6% higher than those of businesses owned by women after controlling for industry and firm age.

From the above-mentioned studies, we see that there are differences in the results owing to differences in the region or domain of study. Hence, there is scope for further analysis of the role of gender of CEO on the firm performance, specifically considering the stock price movements.

Chapter 3

Research Methods

The intent of this research is to analyse the effect of appointing a female CEO on stock prices. For analysing this effect and gathering inferences, statistical methods need to be employed. These methods have been explained in the following sections of this chapter. Additionally, the key variables considered, as well as the data preparation steps, are also described in this chapter. Any statistically significant findings in relation to the data selected and the specific case study analysed will lead to further understanding of the topic.

3.1 Key Variables

In this case study, returns and summary statistics on returns have been used for further analysis.

3.1.1 Returns

The more accepted definition of returns is that it is the difference in the logarithm of stock prices between two consecutive days taken at a specific time each day, and the prices are adjusted for any dividends distributed.
The equation for calculating returns is given in equation 3.1.

$$r_t \;=\; log(p_t \;/\; p_{t-1}) \;=\; log(p_t) \;- log(p_{t-1}) \tag{3.1}$$

In the equation, r_t refers to the return at a time t which equals the difference of log stock price at a time t is p_t and the log of the stock price at a previous time shown as p_{t-1}. Also, it is suggested that for the accurate calculation of a series of returns, the time period for the price selected should remain constant.

Table 3.1: Return and price interpretation

Return		Price	Interpretation
Positive	$r_t > 0$	$p_t > p_{t-1}$	Price increase, Profit
Negative	$r_t < 0$	$p_t < p_{t-1}$	Price decrease, Loss
Zero	$r_t = 0$	$p_t = p_{t-1}$	Price constant

Most research related to stock prices is performed using returns. Looking at a single value of return, we can gauge when the price has increased, decreased or remained constant based on whether it is positive, negative, or 0, respectively. Table 3.1 summarises this information about returns.

There are various reasons that most analysts prefer to use returns instead of analysing stock prices. One of the main reasons is that multiple-day returns are very weakly correlated, while stock prices between consecutive days are highly correlated and can be up to 99% correlated. Additionally, in order to analyse prices, there is a requirement to adjust these prices based on inflation, currency changes etc. Further, noise, which refers to uncertainty in the market, can cause inaccuracies in the stock price analysis. This noise is also reflected in the returns and can be analysed through it.

3.1.2 Stylised Facts

Stylised facts are some general properties that are present in any set of returns. There are three important properties of this variable: "[..] first is that the distribution of returns is not normal. Second[..], there is almost no correlation between returns for different days. Third, the correlations between the magnitudes of returns on nearby days are positive and statistically significant." (see for details: Taylor (2011))
Stylised facts are used to analyse time series data sets. These are also known to be pervasive through time and in different markets. This makes it ideal for comparison between different organisations. Stylised facts provide a statistical summary of the characteristics of a set of returns and the shape and tendencies of their distribution. An explanation of the key summary statistics of stylised facts is shown as follows.

Mean

A mean of a group of data provides a summary of the values in terms of overall value, as per magnitude and sign of the value. It provides information regarding the central tendency of a set of values.
Considering our case study, for a range of n returns, starting from 1 to n, where each value

of r is represented as r_1, r_2, r_3 going up till r_n. The mean of this range is represented by $\overline{r}$. Equation 3.2 shows the calculation for the mean return.

$$\overline{r} = \frac{1}{n}\sum_{t=1}^{n} r_t \tag{3.2}$$

One of the key aspects to note regarding the mean of returns is that mean of returns between a period can be calculated by taking the difference of the log of returns of the last and first days and dividing it by n. It is shown in mathematical form in equation 3.3 by replacing the value of return at time t r_t with the formula from equation 3.1.

$$\begin{aligned}
\overline{r} &= \frac{1}{n}\sum_{t=1}^{n} log(r_t/r_{t-1}) \\
&= \frac{1}{n}(\frac{log(r_t)}{log(r_{t-1})} + \frac{log(r_n}{log(r_{n-1})} + \frac{log(r_{n-1})}{log(r_{n-2})} + ... + \frac{log(r_2)}{log(r_1)}) \\
&= \frac{1}{n}(log(\frac{r_n}{r_{n-1}}\frac{r_{n-1}}{r_{n-2}}..\frac{r_2}{r_1})) \\
&= \frac{1}{n}log(\frac{r_n}{r_1})
\end{aligned} \tag{3.3}$$

Standard Deviation

The standard deviation of a set of data points provides the summary statistic for the differences of each observation in the group from the mean of the data set. It represents the spread of the data or the average value of variability in the data set.
Taking a range of n values, where each value of r is represented as r_1, r_2, r_3 going up till r_n and the mean of this range is represented by $\overline{r}$, the equation of standard deviation, represented by s, is shown in Equation 3.4.

$$s^2 = \frac{1}{n-1}\sum_{t=1}^{n}(r_t - \overline{r})^2 \tag{3.4}$$

Skewness

The skewness of a set of data points provides a summary statistic for the measure of asymmetricity in the probability distribution of the data set, considering that the data point is a random variable. Skewness provides a measure of how much the probability distribution of that random variable deviates from a normal distribution. A dataset can be right or left skewed based on this value of skewness which indicates that the variable's distribution contains more values on the right or left side of the peak of the distribution,

respectively. Zero skewness would indicate that the spread is the same as a normal distribution.
Taking a range of n values, where each value of r is represented as r_1, r_2, r_3 going up till r_n, and the mean of this range is represented by $\overline{r}$ and the standard deviation of the data set is defined as s, the equation of skewness, represented by b, is shown in Equation 3.5.

$$b = \frac{1}{n-1} \sum_{t=1}^{n} \frac{(r_t - \overline{r})^3}{s^3} \tag{3.5}$$

Kurtosis

Kurtosis is a statistical measure that also helps describe the shape of the distribution of a random variable, similar to skewness. The difference between the two lies in the fact that while skewness measures the deviation of the distribution from the normal distribution in terms of the peak and its symmetricity, kurtosis measures whether the tail of the distribution is heavier or lighter compared to a normal distribution. Heavy-tailed or higher kurtosis is interpreted as having a higher frequency of outliers being present in the dataset, while light-tailed or a lower value of kurtosis tends to mean a lower number of outliers. For a normal distribution, the kurtosis is 3.
Taking a range of n values, where each value of r is represented as r_1, r_2, r_3 going up till r_n and the mean of this range is represented by $\overline{r}$, and the standard deviation of the data set is defined as s, the equation of kurtosis, represented by k, is shown in Equation 3.6.

$$k = \frac{1}{n-1} \sum_{t=1}^{n} \frac{(r_t - \overline{r})^4}{s^4} \tag{3.6}$$

3.2 Pearson's Chi Square Test

The chi-square test is a statistical hypothesis test that is used to determine the difference between the frequencies of a variable based on certain categories that are usually mutually exclusive and their expected frequencies. (Glen (2022)) Pearson's chi-square test is a variant of this test, and it was introduced by Pearson around 1900. If the distribution of the variable follows the chi-square (χ^2) distribution, the null hypothesis, which states that there is no difference in the distribution based on the categories, is accepted as true. There are two types of chi-square tests - the chi-square goodness of fit test and the chi-square test of independence. The chi-square goodness of fit test is used when a sample distribution is tested against a population to see if the distributions match. The chi-square test of independence is applied when the test aims to determine whether the distributions of multiple categorical variables are different from each other. A contingency matrix is

built for these categorical variables on their frequencies are used to test whether they are related.

For a range of n observations, represented as O_1,O_2 until O_n, and the expectation for each observation is represented as E with respective subscripts. The degrees of freedom, which is the number of variables that can be varied freely in the dataset or, in most cases, the number of values in the categorical variable minus 1, is represented by c. Chi-square statistic is calculated using the formula shown in equation 3.7.

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i} \tag{3.7}$$

A low value of Chi-square indicates that there is a high correlation in the data. For more understanding of the data, the p-value is also calculated from the chi-square distribution. P-value, in graphical terms, is the area under the tail of the calculated distribution. P-value is useful for accepting or rejecting the null hypothesis. P-value can be seen in terms that the p-value is the probability of obtaining the results by chance. Hence, a very low p-value indicates that the null hypothesis should be rejected. For analysing the p-value to determine whether to accept or reject the null hypothesis, an alpha value, also called the significance level or level of confidence set by the researcher, is employed. If the p-value falls under the alpha value, the null hypothesis is rejected. Generally, the alpha value is set to 0.05 (or 5%) but can also be set to 0.01 (1%) or 0.1 (10%) in some cases, based on the researcher's judgement.

3.3 Vector Autoregression

Time series data can be classified into two segments based on the datasets - univariate or multivariate time series. The statistical analysis of these time series is called univariate analysis and multivariate analysis, respectively. A univariate time series is a time series that contains observations for only one variable over a time period. As the name suggests, multivariate time series contains observations for multiple variables across a time period. Since the dataset for this case study contains multiple variables (returns, absolute returns, volume difference etc.), multivariate analysis needs to be performed.

One of the most common methods of multivariate analysis is vector autoregression (VAR), introduced by Sims (1980). Vector autoregression is an easy and flexible method for analysis which makes it one of the most successful methods for multivariate analysis. While vector autoregression models are generally used for forecasting in macro-econometric studies, they can also be used for structural inference. VAR model functions on the theory that the value of a variable is dependent on the previous values of the variable in a time

series. The calculation for VAR over a univariate time series is shown in equation 3.8.

$$r_t = f(r_{t-1}, r_{t-2}, r_{t-3}, \dots) \tag{3.8}$$

Taking the current case study as an example, consider returns denoted by r and return at time t denoted by rt and the lagged values of return, denoted as r_{t-1} (1 day before t), r_{t-2} (2 days before t) and so on. Lags refer to the number of previous data points considered for the model. The calculation for return at time t is shown in Equation 3.9.

$$r_t = C + \alpha_1 r_{t-1} + \alpha_2 r_{t-2} + \alpha_3 r_{t-3} + \alpha_4 r_{t-4} + \alpha_5 r_{t-5} + \epsilon_t \tag{3.9}$$

where C is the constant, α_1, α_2, α_3, α_4, α_5 are the coefficients, and ϵ_t is the residual term.

A more general method of depicting the VAR model equation with one variable where the lag is 5 is shown in Equation 3.10.

$$r_t = C + \alpha_t r_t L_{\tau=5} + \epsilon_t \tag{3.10}$$

where α_1 is the coefficient, r_t is the return value at time t, and ϵ_t is the error term at time t for 5 lag values ($L_{\tau=5}$).

Var(5) represents a model where the lag is 5

This can be further extended to include other variables in the model for multivariate analysis. Equation 3.11 shows a matrix form of the model equation for two variables y1 and y2 taking 1 lag.

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} a_{1,1} & a_{1,2} \\ a_{2,1} & a_{2,2} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \end{bmatrix} \tag{3.11}$$

Similarly, an equation for n variables can be defined in the model having m lag values where each variable can be explained as a linear function of its own lag values with the addition of the past values of other variables.

Additionally, the VAR model uses endogenous and exogenous variables. Endogenous variables refer to those variables in a system that are affected by other variables in that system, while those that are independent and not affected by other variables in the system are endogenous variables.

Considering the case study in this research, if a VAR model is performed to note the relationship between returns and gender, the endogenous variable will be returns and the exogenous variable will be gender. Equation 3.12 shows the equation for calculation of returns at time t denoted as r_t with previous returns denoted as r_{t-1}, r_{t-2} and so on and

gender denoted as g(t), taking a lag period of 3.

$$r_t = C + \alpha_1 r_{t-1} + \alpha_2 r_{t-2} + \alpha_3 r_{t-3} + \beta g(t) + \epsilon_t \tag{3.12}$$

where C is the constant, α_1, α_2 and α_3 are the coefficients of returns at times t-1, t-2 and t-3, β is the coefficient of gender at time t, and ϵ_t is the residual term.

The residual term or the error term ϵ_t selected for the case study is the Heteroskedasticity-robust standard error, variant HC1. Heteroskedastic error is generally applied in time series datasets since the variance is not the same for each observation. Hence, it is selected for this case study as the data contains time series data.

Through this, the VAR model also takes into consideration the effect of other variables, which makes it better than the autoregression model since it fails to take other variables into consideration. Thus, using the VAR model, the dependencies and relationships between different variables can be examined and analysed.

Adjusted R-Squared

In a VAR model, the coefficients of the independent variables provide information related to the extent of the impact of each variable on the target or dependent variable. There is also a requirement for a measure to evaluate the VAR model itself. The measure selected for this is adjusted R-squared.

R-squared is a measure of the extent to which the variance of the target variable is explained by the independent variables. Adjusted R-squared is an updated value of R-squared that increases the precision of R-squared by taking into account the number of independent variables used in the model and only those that affect the target variable instead of taking all, which is the case for R-squared.

Hence, an adjusted R-squared is considered to measure how well the model fits the observations and the extent of variance of the dependent variable explained by the model.

3.4 Panel Analysis

Panel data or longitudinal data refers to data that contains time series data for multiple attributes. The analysis of panel data is called panel analysis. Panel analysis is popularly used applied in econometric data analysis.

For economic research, panel data is advantageous compared to time series data as it provides more accuracy in inferences drawn from results of different models, aids more realistic behavioural hypotheses as well as simplifies computational and statistical inferences. (Hsiao (2022))

One of the reasons for using panel data is to introduce dummy variables in the time series data, which have constant values for different categories and vary across time but are an important factor for determining the effect of a characteristic on the time series data. This is an important aspect considering this research as it aims to look at the effect of gender on the time series data of daily stock prices for each company.

3.5 Tools Used

3.5.1 Python

Python is a programming language that uses various built-in libraries and packages. It is very useful for data cleaning, transformation, manipulation, summarising and visualisation. For the purpose of this research, it has been used for data extraction for each company using the Yahoo finance library. Additionally, it has also been used for calculations of stylised facts for analysing the time series data using the stats library present in it. This information is collated and extracted into a CSV file using Python for further statistical analysis and visualisation.
There are various interfaces used for running Python. The Google Colaboratory ("Colab") has been used for this research, which provides a notebook format for running Python codes through a browser, utilising Google's cloud servers. It also provides a platform where libraries are either pre-installed or can be installed with ease. The platform also provides a server GPU which accelerates data processing.

3.5.2 R

R is a programming language that is used for statistical computing and graphics. It is often used for analysing and visualising data. In this research, the R programming language was used to run the Chi-square tests on the data extracted from Python. With the help of the R code, contingency matrices were built on the classifications performed based on values of the calculated stylised facts. These contingency matrices were passed in the chi-square test function in order to calculate the p-values required to find statistically significant results.

3.5.3 Tableau

Tableau is an interactive data visualisation software that is primarily used for data analysis and visualisation. It is one of the leading business intelligence tools present in today's market. Tableau provides a simple user interface and easy drag-and-drop tools that are

very useful in creating visualisations for the analysis of a dataset. It also features data loading through multiple platforms. Since the data for this research is stored in a CSV, this CSV is loaded into Tableau, and various graphical views are created using different metrics and dimensions in order to study the data and find better insights. Tableau has a sophisticated system with multiple functionalities specifically developed for visual analysis, which makes it better than traditional systems such as Microsoft Excel. Using Tableau, one can create and analyse multiple views or charts together while having the ability to drill down using filters. Figure 3.1 shows a snapshot of a dashboard on Tableau.

Figure 3.1: Snapshot of Tableau Dashboard

3.5.4 GRETL

GRETL, which stands for GNU Regression, Econometrics and Time-Series library, is an open-source software for statistical analysis and econometrics. It has multiple features that can be used for the analysis of a dataset. Any dataset loaded into GRETL can be classified into three structures - cross-sectional, time-series and panel dataset. Based on this, further analysis can be performed. GRETL can also be used for plotting the dataset as scatter plots, box plots or time-series plots for analysis. One of the key features provided by GRETL is that it can create various kinds of models over the dataset loaded and provide results based on user selections. For time-series analysis, one can use GRETL to fit a vector autoregression over the dataset and obtain results to analyse for statistical

significance. It uses both exogenous and endogenous variables to create a regression model based on a time series data comprising several variables. Gretl also enables you to select the variables to include in the model, the order in which the VAR (number of lags) should be considered, and if the model should include constant, trend, or seasonal dummies. Figures 3.2 and 3.3 provide snapshots of GRETL and the options provided by it.

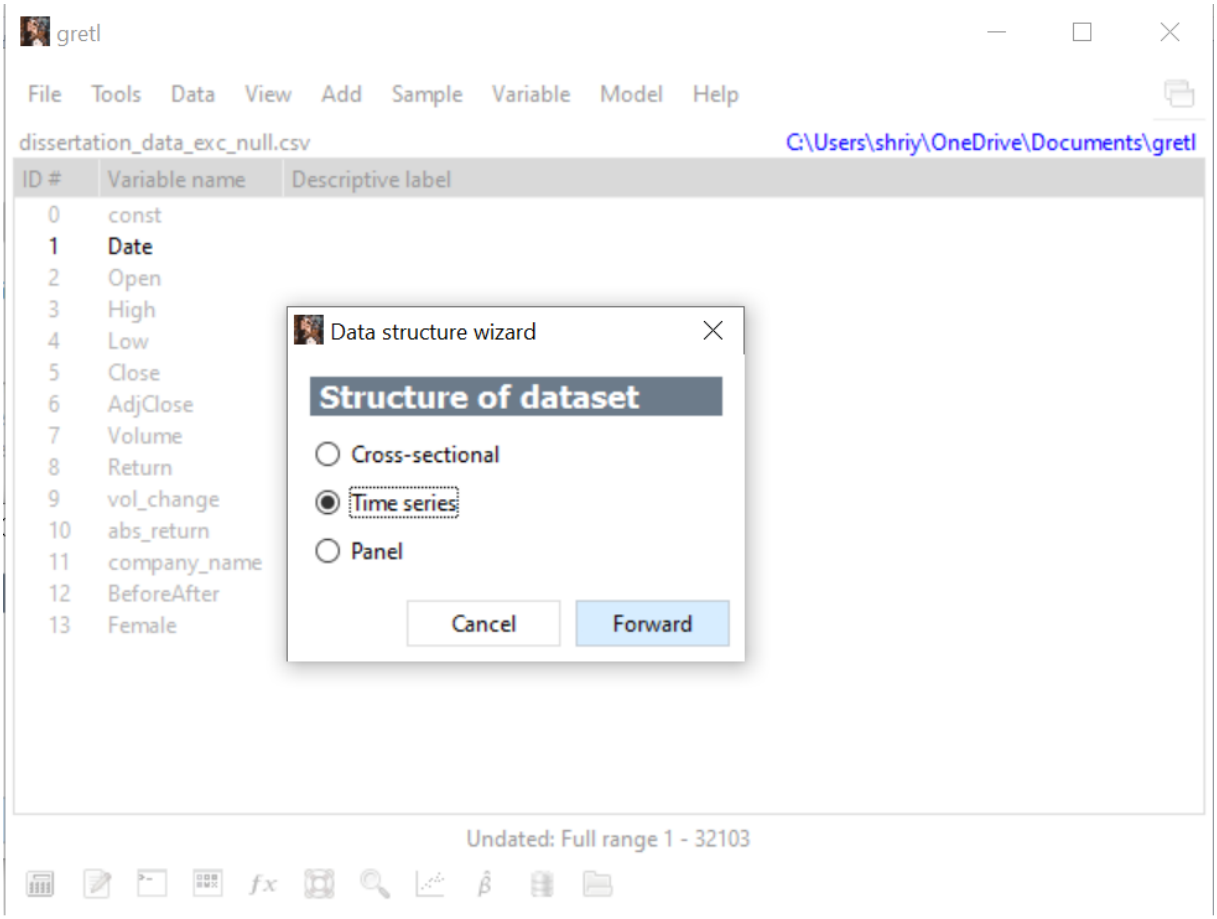

Figure 3.2: Snapshot of GRETL Dataset Structure Options

3.6 Data Selection

Data collection is the first step of the process of analysis. There are multiple factors that need to be considered while selecting appropriate data for the analysis of stock price movements in relation to a female CEO.

Firstly, the choice was made to select large organisations. This can be explained by the observation that stock price movements of small and medium enterprises as compared to large enterprises show more movement due to major events. Larger enterprises can balance this movement in prices as they have additional company resources and assets to fall

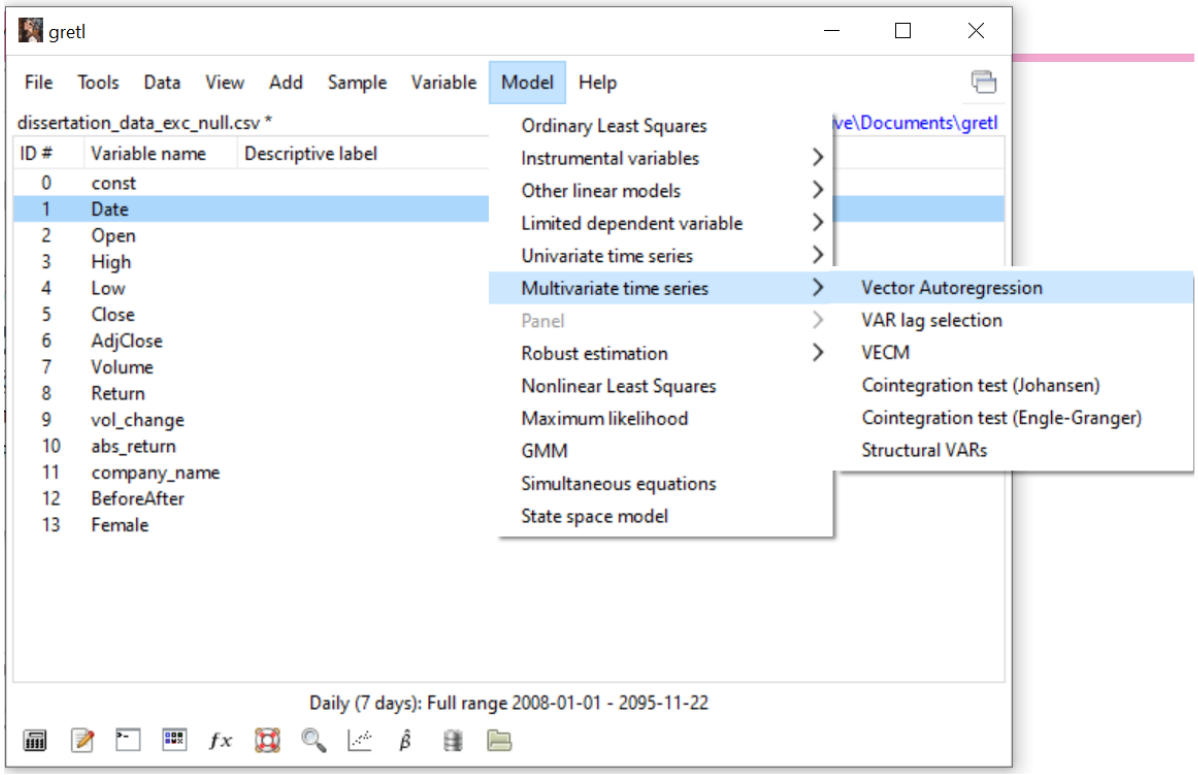

Figure 3.3: Snapshot of GRETL Vector Autoregression

back on. This can be observed by looking at the COVID-19 effect on small organisations and their observed financial fragility (Bartik et al. (2020)).

Secondly, since we needed accurate data with ease of access, publicly listed companies were selected as their data is easily accessible to everyone. Additionally, CEO appointments are also publicly announced for these companies, and their details are publicly available.

Thirdly, as noted in the previous chapter, it is seen that societal norms and the status of women in general, as well as governmental reforms, play a role in the selection of a female CEO. This could raise the issue that if the female CEO being analysed is appointed as a result of some government-imposed mandates or company mandates, it could lead to negative results as the person selected might not be the ideal candidate for the position. Due to these, S&P 500 companies were selected. In the US, only California and Washington States have mandated a minimum percentage of females on board. Despite that, there are no mandates, voluntary or otherwise, for selecting a female CEO in the United States. Additionally, as mentioned in the previous chapter, S&P 500 selects 500 of some of the largest organisations that are publicly traded in the United States.

From the companies listed under S&P 500, we selected those that have appointed female CEOs. Those cases where the CEO was appointed after mid-2021 were rejected as the

analysis is based on 1 year's data before and after the appointment of the CEO. Additionally, cases where the CEO was appointed before the company launched its IPO were removed as the selection criteria for this research had been set for publicly listed companies and stock price data would not be available before the IPO.
Based on this, a list of female CEOs, the company they were appointed to and their date of appointment was obtained. In order to compare these CEOs against male CEOs, we needed male CEOs of the S&P 500 companies. As we know that the market has fluctuations due to various events, and the market keeps changing from time to time, it was required that the male CEO was appointed around the same time period as the female CEO to minimise the effects of daily changes in the market. It was also required that the male CEO be the CEO of an organisation that functions in the same domain as the female CEO so that the comparison between the two is similar and other factors influencing the market that could create differences are kept to a minimum. This process required analysing each CEO of the S&P 500 list and selecting those whose appointment dates and whose company's domain fell in the same area as our selected female CEO list. Figure 3.4 shows a flow chart of the data selection process.

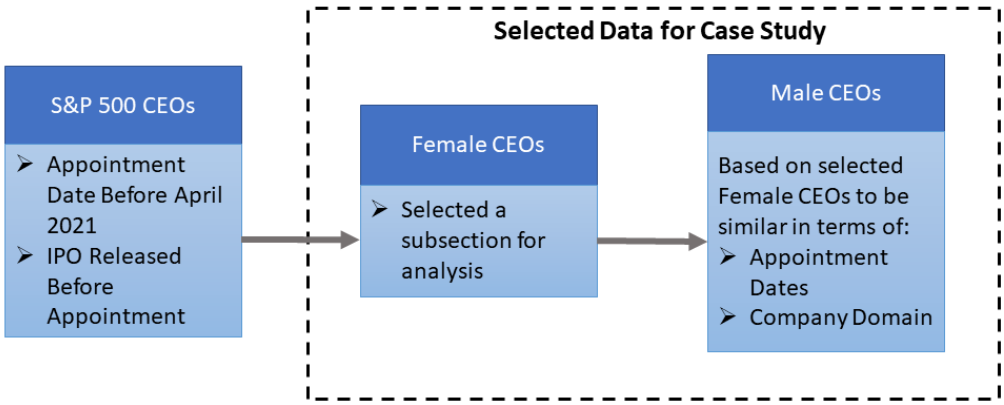

Figure 3.4: Data Selection Process

3.7 Data Acquisition

The first step to acquiring data was to obtain a list of female CEOs of the S&P 500 list of companies. BoardEX (2021) has published a public dashboard with a list of all female CEOs and their appointment dates of the S&P 500 companies appointed until 1st March 2021. Catalyst (2022), a global NGO, has provided a list of current female CEOs in the

S&P 500 companies and their appointment dates. These CEOs were then filtered based on the availability of 1 year stock price data in terms of whether the company IPO was launched before their appointment, the company being on the S&P 500 list as of January 2022 as well as the appointment date being prior to April 2021, as mentioned in the previous section.
The next step of data acquisition was obtaining a list of S&P 500 companies and their domain of functioning. This information is hosted by Datahub under licence by Open Data Commons Public Domain Dedication and License. This list also contains the Global Industry Standard Classification or GICS sector, which is required to identify the domain for each company. Using this information, male CEOs and their appointment dates were identified for S&P 500 companies. Comparing the list of female CEOs selected, relevant male CEOs were discovered and selected.
After this, a list was created consisting of the CEO name, company name, company symbol, GICS sector and appointment date.
The following step after creating the list was to procure stock price data for 1 year before and after the appointment date for each CEO. Historical stock price data, including day-wise opening and closing stock price data, the stock volume traded and adjusted closing stock price data, can be procured from Yahoo Finance. Since there were multiple data points to extract for each CEO from a list of multiple CEOs and also there was a requirement for manipulation of that data, an automated approach was opted for so as to minimise any errors that might arise due to manual processes. Python coding language was selected for this approach. One of the reasons for choosing Python is that there is a Python library for Yahoo finance using which daily stock prices can be extracted. This library, while not affiliated with Yahoo, sources its data using Yahoo's publicly available APIs (Aroussi (2022)). Additionally, data manipulations and transformations while maintaining accuracy are relatively easy to perform using Python. These manipulations and calculations will be explained further in the next section.

3.8 Data Transformation and Calculations

The data extracted from Yahoo Finance contains adjusted starting stock price, closing stock price, adjusted closing price for each day and volume of stocks traded for that day. For maintaining accuracy, stock prices need to be analysed based on a single time of the day for each day. For this purpose, the adjusted closing stock price for the day is selected for analysis.
In order to analyse the stock price values, as mentioned in section 3.1.1, returns need to be calculated. For calculating returns, Python code was used, taking the difference in

the log of the price of each day and its previous day. Hence, we got the resultant returns for each day. Taking this return, the absolute return value for each day was calculated. Absolute return is the value of return without considering its sign, that is, looking at the magnitude of the value while discarding its direction. Additionally, the difference in volume traded for each day compared to the previous day was calculated.

Taking these returns, the average or mean return for each company's dataset for before and after the CEO appointment was calculated. Further, the mean of the absolute returns and difference in volume traded was calculated. The next step was to calculate stylised facts on the returns. Standard deviation, skewness and kurtosis were calculated using Python. Based on the stylised facts, some classification groups were created for further analysis.

Finally, the complete dataset was extracted into a CSV. Since the stock price data is only available for business days, the time series contains non-holiday dates. This CSV was further cleaned, and dummy variables were added for vector autoregression analysis as well as visual analysis. Vector autoregression was performed using GRETL, and visual analysis was accomplished using Tableau. For panel analysis and other data manipulations, MS Excel was used.

Chapter 4

Case Study - Implementation

4.1 Dataset

As shown in the Data Selection section, S&P 500 companies were selected. S&P 500 is an index in the New York Stock Exchange that represents a portfolio of 500 leading organisations in the United States that are publicly traded, based primarily on their market capitalisation value.
As the selection criteria mentioned, data pertaining to all female CEOs appointed in the S&P 500 list of companies was obtained.
From this dataset, a selection criterion specific to the case study to choose more recent CEOs, that is, those that were appointed since 2006, was applied for a further selection of CEOs to analyse for firm performance. This case was applied as there has been a shift in the ideologies and societal norms, and taking those cases where the person was appointed prior to this could have other factors affecting the firm's performance. The GICS sector for the firm where the female CEO was appointed was also extracted.
The next step in the data collection process was to identify male CEOs who were appointed around the same time period as the female CEO so as to minimise any factors that affected the business due to major events causing changes in the market. For this purpose, the CEO for each of the S&P 500 companies was identified and their appointment dates extracted using sources such as company newsletters, news articles, biographies of CEOs and similar reports found on the internet.
Table 4.1 shows the final list of CEOs (42 Male and Female CEOs each) selected and their appointment dates, and their firm and GICS sector, shown according to their symbols as traded in the New York Stock Exchange.

Table 4.1: Table showing dataset of Female CEOs and related information

GICS Sector	**NYSE Symbol (F)**	**Female CEO Name**	**Female CEO Start Date**	**NYSE Symbol (M)**	**Male CEO Name**	**Male CEO Start Date**
Communication Services	MTCH	Shar Dubey	Mar-20	T	John T. Stankey	Jul-20
Consumer Discretionary	TJX	Carol M Meyrowitz	Jan-07	HD	Frank Blake	Jan-07
Consumer Discretionary	ULTA	Mary N Dillon	Jul-13	GRMN	Clifton A. Pemble	Jan-13
Consumer Discretionary	GM	Mary Teresa Barra	Jan-14	CCL	Arnold W. Donald	Jul-13
Consumer Discretionary	ROST	Barbara Rentler	Jun-14	TGT	Brian Cornell	Aug-14
Consumer Discretionary	BBY	Corie Sue Barry	Jun-19	NWL	Ravi Saligram	Oct-19
Consumer Discretionary	GPS	Sonia Syngal	Mar-20	BBWI	Andrew Meslow	Feb-20
Consumer Discretionary	TPR	Joanne C Crevoiserat	Jul-20	F	Jim Farley	Oct-20
Consumer Staples	ADM	Patricia Ann Woertz	May-06	HRL	Jeff Ettinger	Jan-06
Consumer Staples	MDLZ	Irene Blecker Rosenfeld	Jun-06	MKC	Lawrence E. Kurzius	Feb-06
Consumer Staples	PEP	Indra Krishnamurthy Nooyi	Oct-06	TSN	Richard L. Bond	May-06
Consumer Staples	CPB	Denise M Morrison	Aug-11	COST	W. Craig Jelinek	Jan-12

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Continuation of Table 4.1						
GICS Sector	**NYSE Symbol (F)**	**Female CEO Name**	**Female CEO Start Date**	**NYSE Symbol (M)**	**Male CEO Name**	**Male CEO Start Date**
Consumer Staples	HSY	Michele G Buck	Mar-17	KO	James Quincey	May-17
Consumer Staples	CLX	Linda Rendle	Sep-20	MO	Billy Gifford	Apr-20
Consumer Staples	WBA	Rosalind Brewer	Mar-21	PG	Jacek Olczak	May-21
Energy	OXY	Vicki Ann Hollub	Apr-16	DVN	Dave Hager	Jul-15
Financials	KEY	Beth E Mooney	May-11	CINF	Steven J. Johnston	May-11
Financials	PGR	Susan Patricia Griffith	Jul-16	CME	Terrence A. Duffy	Nov-16
Financials	NDAQ	Adena T Friedman	Jan-17	USB	Andrew Cecere	Apr-17
Financials	BEN	Jennifer M Johnson	Feb-20	WFC	Charles W. Scharf	Oct-19
Financials	C	Jane Nind Fraser	Mar-21	AIG	Peter Zaffino	Mar-21
Health Care	ANTM	Gail Koziara Boudreaux	Nov-17	CAH	Mike Kaufmann	Jan-18
Health Care	ZTS	Kristin C Peck	Jan-20	ABT	Robert Ford	Mar-20
Health Care	VRTX	Reshma Kewalramani	Apr-20	DHR	Rainer M. Blair	Sep-20
Health Care	CVS	Karen S Lynch	Feb-21	VTRS	Michael Goettler	Nov-20

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Continuation of Table 4.1

GICS Sector	NYSE Symbol (F)	Female CEO Name	Female CEO Start Date	NYSE Symbol (M)	Male CEO Name	Male CEO Start Date
Industrials	XYL	Gretchen W McClain	Oct-11	CMI	Tom Linebarger	Jan-12
Industrials	GD	Phebe N Novakovic	Jan-13	ITW	Ernest Scott Santi	Nov-12
Industrials	LMT	Marillyn A Hewson	Jan-13	VRSK	Scott G. Stephenson	Apr-13
Industrials	NOC	Kathy J Warden	Jan-19	MMM	Michael F. Roman	Jul-18
Industrials	UPS	Carol B Tomé	Jun-20	IEX	Eric D. Ashleman	Dec-20
Information Technology	HPQ	Meg Cushing Whitman	Sep-11	AAPL	Tim Cook	Aug-11
Information Technology	ORCL	Safra Ada Catz	Sep-14	TER	Mark E Jagiela	Jan-14
Information Technology	AMD	Lisa T Su	Oct-14	CSCO	Chuck Robbins	Jul-15
Information Technology	CDW	Christine A Leahy	Jan-19	BR	Tim Gokey	Jan-19
Information Technology	ACN	Julie Spellman Sweet	Sep-19	CTSH	Brian Humphries	Apr-19
Materials	CE	Lori Jo Ryerkerk	May-19	NEM	Tom Palmer	Oct-19
Real Estate	REG	Lisa Palmer	Jan-20	AMT	Tom Bartlett	Mar-20
Utilities	SRE	Debra L Reed-Klages	Jun-11	AES	Andres Gluski	Sep-11

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Continuation of Table 4.1						
GICS Sector	**NYSE Symbol (F)**	**Female CEO Name**	**Female CEO Start Date**	**NYSE Symbol (M)**	**Male CEO Name**	**Male CEO Start Date**
Utilities	LNT	Patricia Leonard Kampling	Apr-12	EXC	Christopher M. Crane	Mar-12
Utilities	DUK	Lynn J Good	Jul-13	WEC	Allen L. Leverett	Aug-13
Utilities	AWK	Susan N Story	May-14	AEE	Warner L Baxter	Apr-14
Utilities	CMS	Patricia Kessler Poppe	Jul-16	EIX	Pedro J. Pizarro	Sep-16

Using the company symbol and appointment dates from Table 4.1, 1 year data for each company before and after the appointment of the CEO was extracted using the yfinance library, which extracts data sourced by Yahoo finance, in Python. A small code snippet on the syntax for downloading data using yfinance library is shown below (4.1).

```
import yfinance as yf
data = yf.download("MTCH", start="2020-03-01", end="2021-03-01")
```

Listing 4.1: Python code snippet for downloading company stock price data using yfinance library

The data extracted contains stock price information comprising date, the stock price at the opening of the market on the day, the stock price at the closing of the market on that day, the closing price adjusted for dividends and the volume of stocks traded during that day. A short summary of the dataset is presented in table 4.2.

Using this dataset, further transformations and calculations will be performed in order to test the hypothesis H_0.

4.2 Data Calculations and Transformations

The dataset retrieved from the previous section needs to be utilised for further calculations and transformations for analysis. Figure 4.1 shows a flow diagram depicting the steps

Table 4.2: Summary of Stock Price Dataset Extracted

Collected Data Features	
No. of Female CEOs	42
No. of Male CEOs	42
Time Period of CEO appointment	2006-2021
Daily Stock Price Data Extracted	1 year
Total Data Points	42047
Average Data Points Per Company	500

taken after obtaining the dataset in order to reach our results.

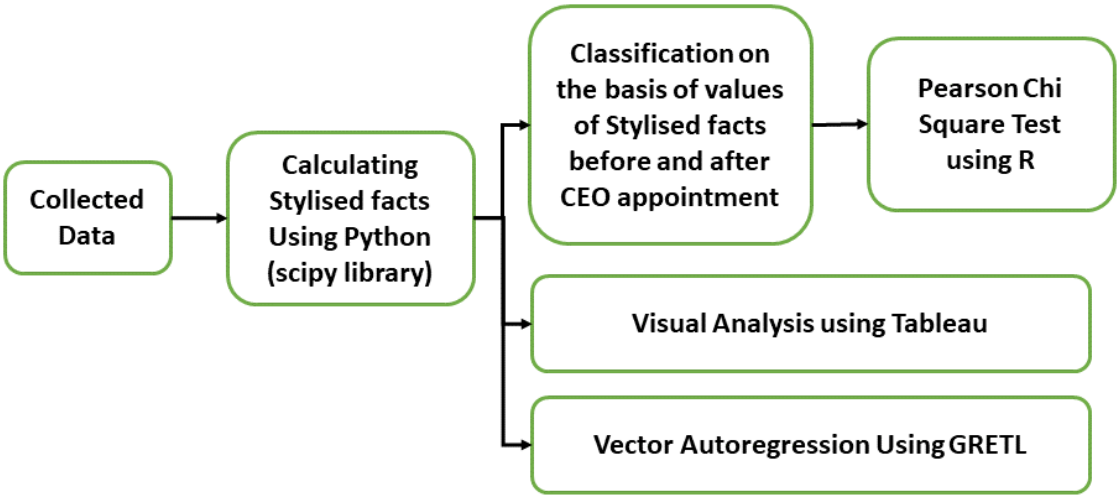

Figure 4.1: Flow Diagram showing Methodology for Selected Dataset

The following sections explain the different steps of the methodology used for the statistical and visual analysis of this case study.

4.2.1 Data Calculations

For the purpose of this case study, the adjusted closing stock price for each day is selected for analysis. Using the adjusted closing stock price, the returns for each day are calculated by taking that day's closing stock price and the previous day's closing stock price, also using Python.

Taking this list of returns for each day as our basis, stylised facts including the mean return, absolute mean return, standard deviation, skewness and kurtosis of these returns for each company, before and after the appointment of the CEO is calculated using stats library in Python.

4.2.2 Data Transformations

Further, once these returns are calculated, some classifications of the results gathered from the previous calculations are performed. There are five categories created using classifications taking the stylised facts of returns.

State of Mean Returns

The first classification is performed on the mean return by looking at the sign of the mean returns before and after the appointment. The state of the return is classified as 'P' for positive and 'N' for negative. The resultant classification for each company can be 'PP', 'PN', 'NP' or 'NN', representing that the mean returns for the company were positive before and after the CEO appointment, went from positive to negative after the appointment, went from negative to positive or were negative before and after the CEO's appointment respectively.

Change in State of Mean Returns

The second classification was also performed on the sign of the mean returns before and after the appointment of the CEO based on whether the state or the sign of the returns were consistent or if there was a change in it. It was represented using 'Y' or 'N'. If the factor was 'Y', it refers to the situation where there was a change in the state of the returns, which would take those cases where the mean return for the company went from positive to negative or negative to positive before and after the CEO appointment. If the factor is 'N', it would imply that the company's mean return did not change its sign or stayed the same in terms of positive or negative before and after the CEO appointment.

Change in Value of Mean Returns

The third classification was implemented based on the value of the mean returns. It is set to 'I' or 'D' based on whether the mean returns increased or decreased after the CEO was appointed from the value before.

Change in Value of Skewness

Similar to the previous classification, this classification was performed on the value of skewness, setting it to 'I' or 'D' based on whether the skewness value increased or decreased after the CEO was appointed as compared to the value derived from before the appointment.

Change in value of Kurtosis

This classification was performed based on the value of kurtosis, similar to the previous classification. It is set to 'I' or 'D' based on whether the value of kurtosis increased or decreased by comparing the value of kurtosis after the CEO was appointed against the value of kurtosis before the CEO was appointed.

The purpose of this exercise of classification is to run Chi-square tests on these classifications to gather evidence regarding whether there is a statistically significant relationship between these classifications and the gender of the CEO.

4.3 Data Visualisation and Analysis

In order to analyse the data populated using the above-mentioned steps, some visual analytical methods were attempted to enhance the understanding of the data. This was performed using Tableau, an interactive visualisation tool which is built to help users visualise and comprehend their data.

Returns of Company Before vs After

Figures 4.2, 4.3, 4.4 and 4.5 show a comparative visualisation plot of the mean returns for 1 year before the CEO was appointed, shown in blue, against the return 1 year after the CEO was appointed, shown in orange. Figures 4.2 and 4.3 show plots for female CEOs and 4.4 and, 4.5 show for male CEOs. Each figure shows 28 companies each, divided for clarity.

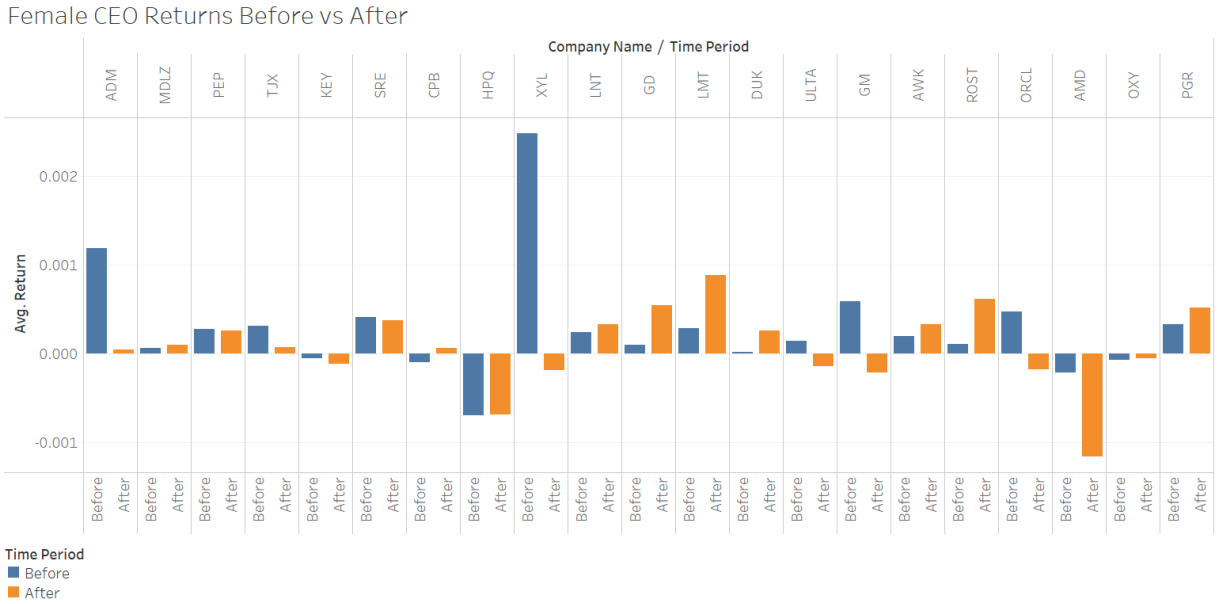

Figure 4.2: Company Return Before vs After Appointment of Female CEO (Part 1)

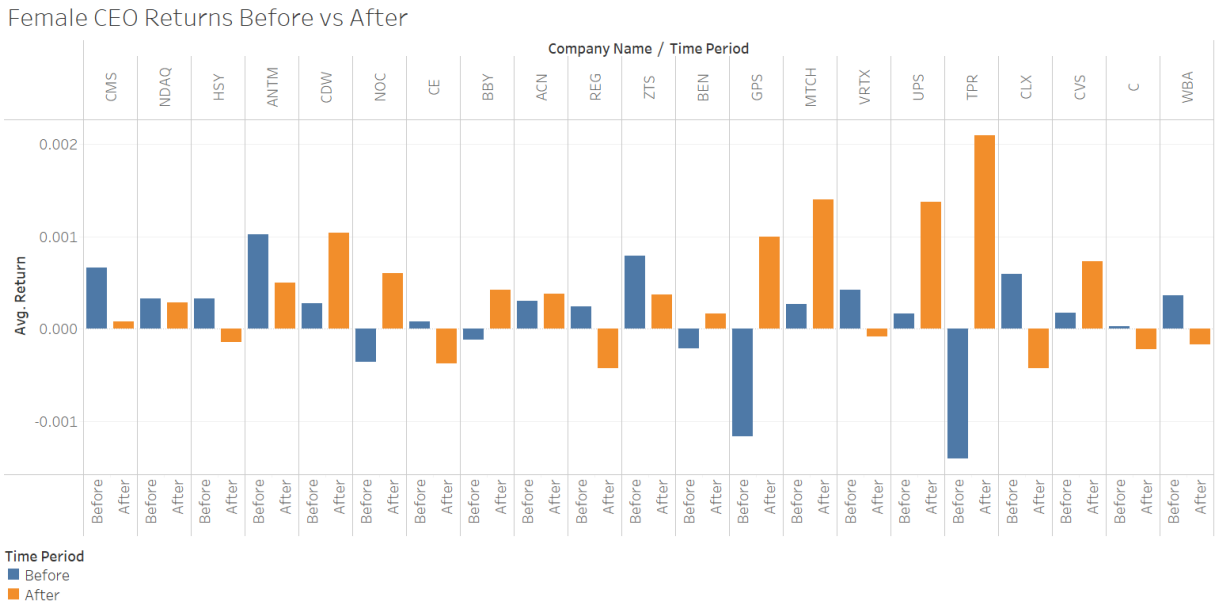

Figure 4.3: Company Return Before vs After Appointment of Female CEO (Part 2)

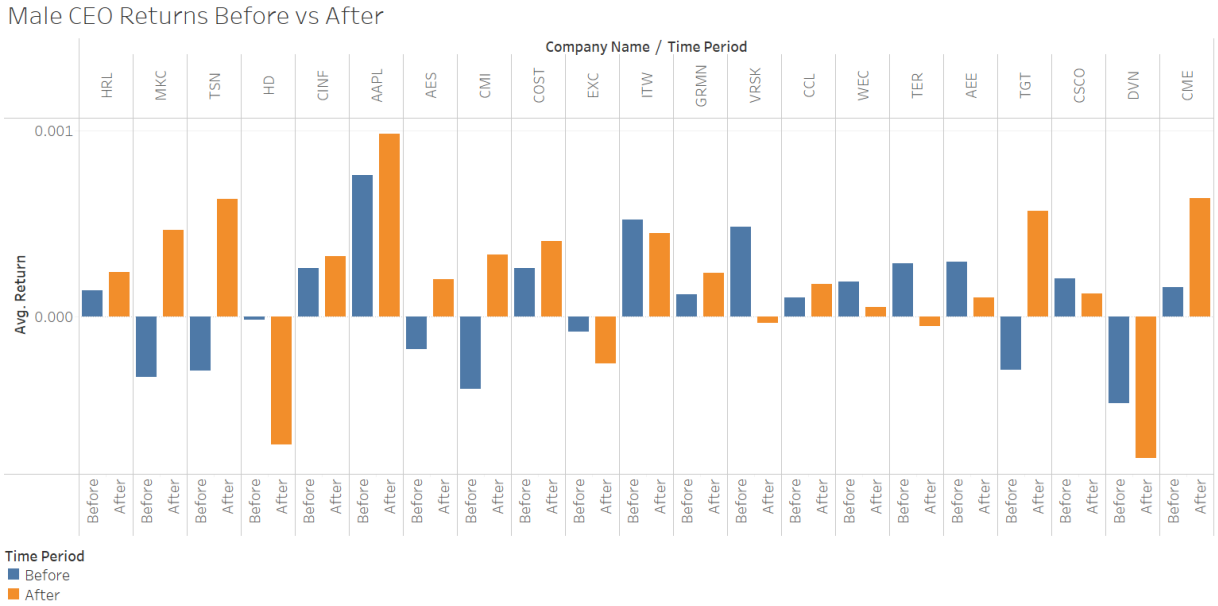

Figure 4.4: Company Returns Before vs After Appointment of Male CEO (Part 1)

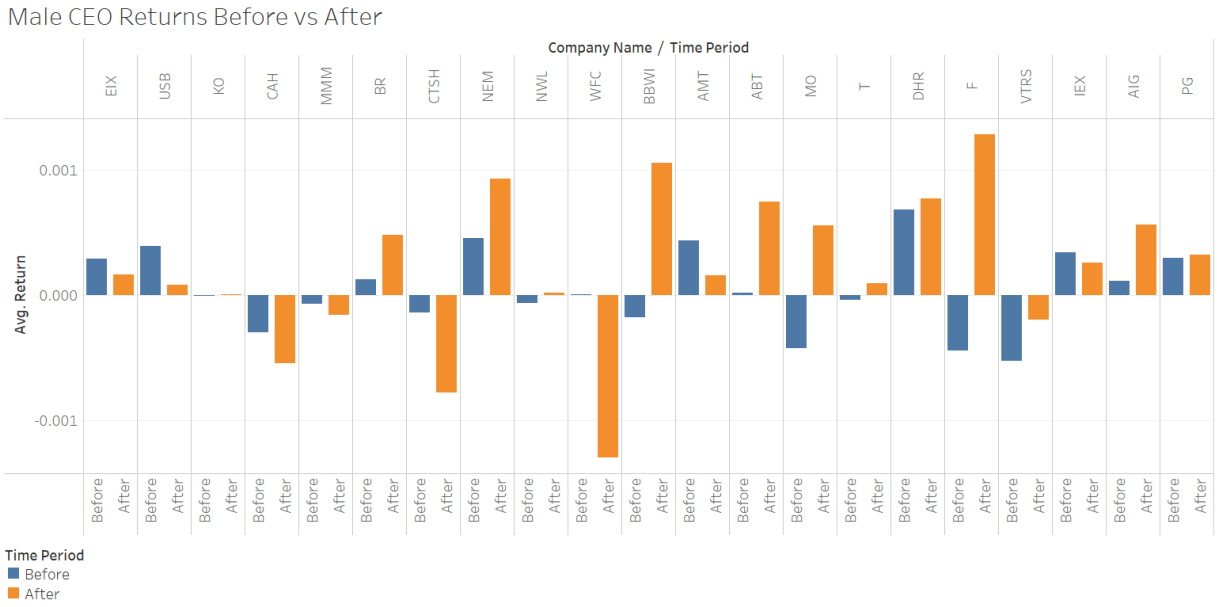

Figure 4.5: Company Returns Before vs After Appointment of Male CEO (Part 2)

While trying to observe any trends in the data that can be seen looking at the two graphs, it can be noted that the number of companies that had a negative mean return 1 year before the appointment of a new CEO is higher in cases of males as compared against females. To evaluate this understanding further, it is seen that from the list of 42 companies for Female and Male CEOs each, only 10 companies (24%) had a negative

mean return before the appointment of a Female CEO, while there were 16 companies (38%) in case of Male CEOs. This presents the suggestion, contrary to the glass ceiling concept for female CEOs, that females are less likely to be appointed as CEO when the company is undergoing losses as compared to men. This has also been previously researched and is supported by Adams et al. (2009).
Conversely, another possible reason for explaining this phenomenon could be that the random sample of male CEOs of the S&P 500 companies selected had more negative mean return values, and this has no implication on the trend of hiring a Female CEO.

Spread of Returns After Appointment

Another aspect of the data analysed through visualisation methods was the spread of daily returns for companies after the CEO was appointed in order to view whether there is a visible pattern that distinguishes based on the gender of the CEO. Figures 4.6, 4.7 and 4.8 show box plot diagrams, split into three graphs with 28 companies each for more clarity in showing the complete list of companies. These box plot diagrams show the spread of daily returns for each company, comparing the female CEO against the selected male CEO having a similar time period of appointment.

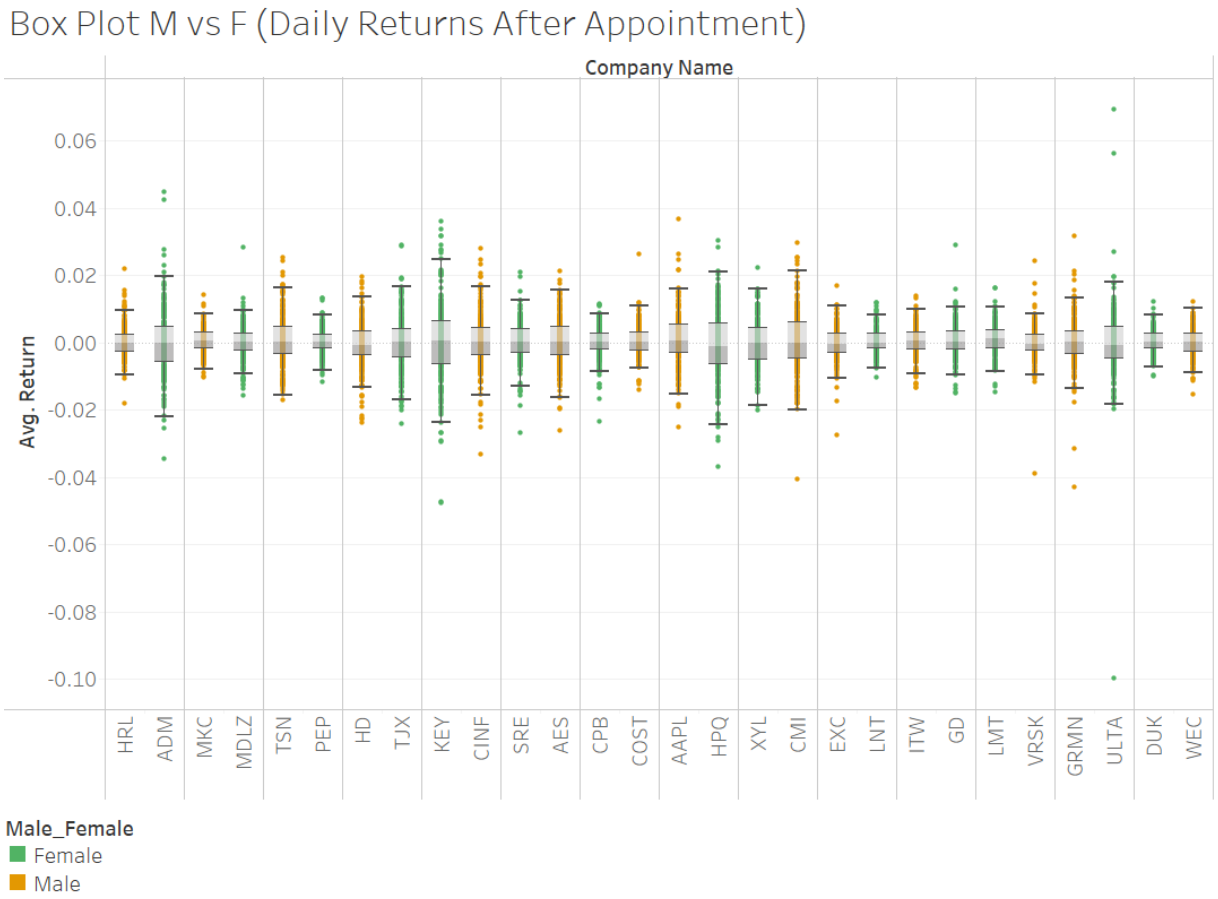

Figure 4.6: Box plot showing Company Daily Returns Spread After Appointment of new CEO (Part 1)

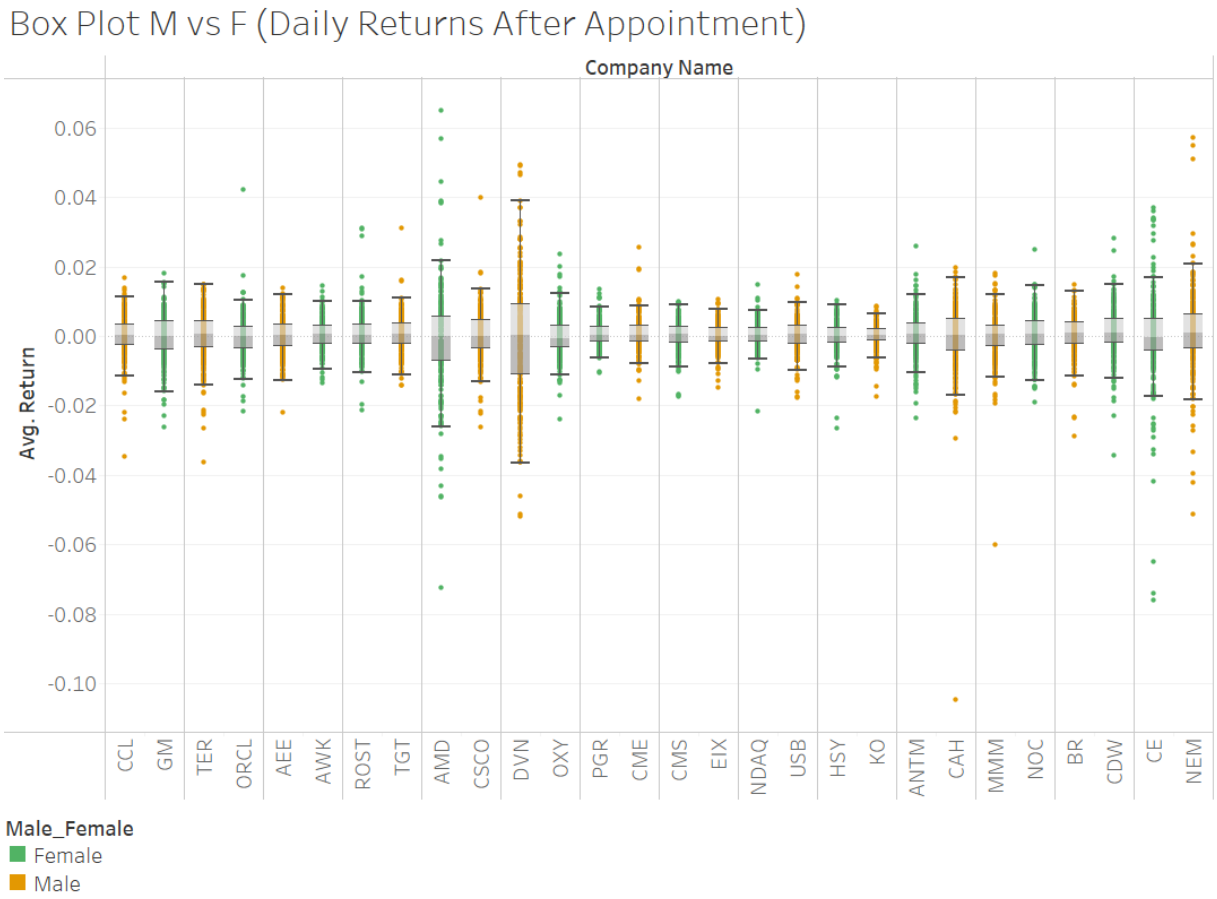

Figure 4.7: Box plot showing Company Daily Returns Spread After Appointment of new CEO (Part 2)

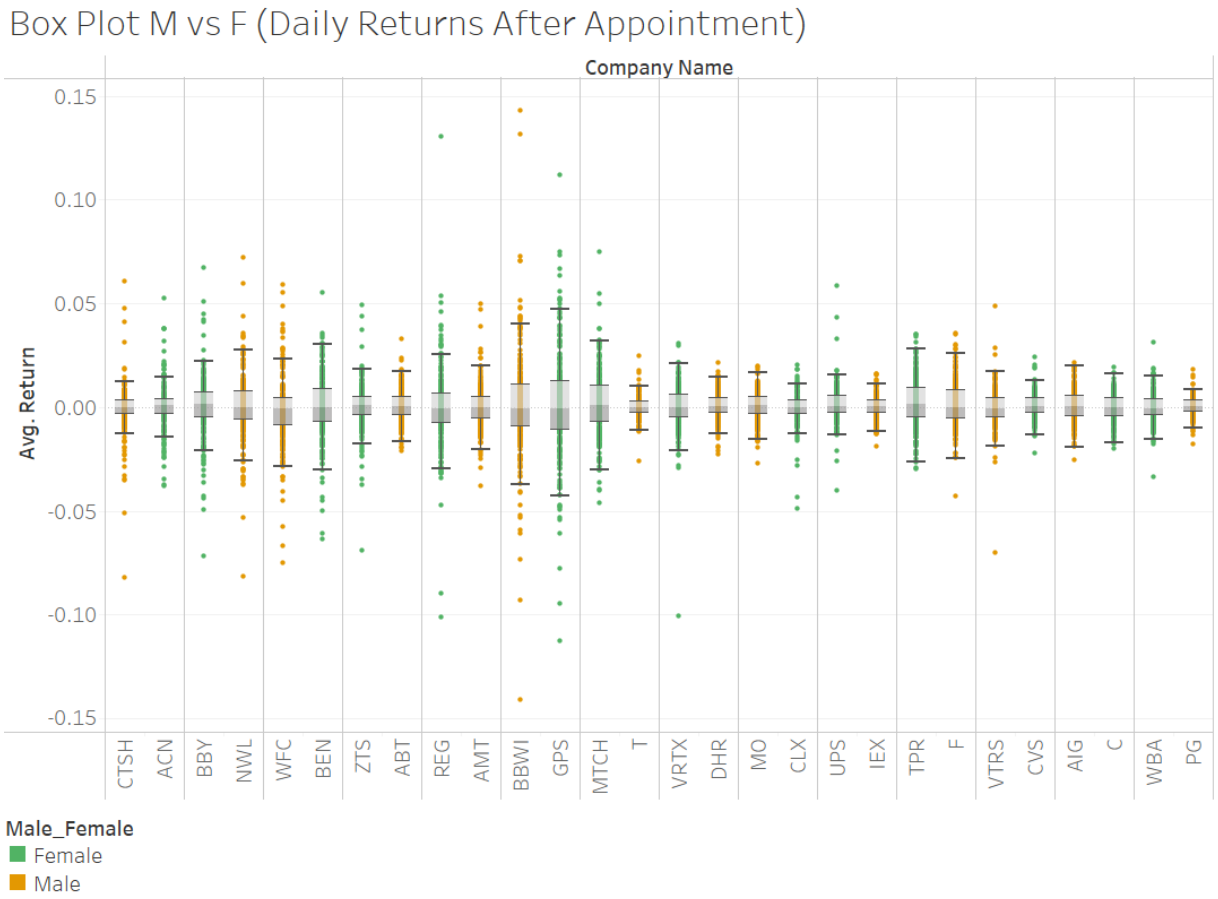

Figure 4.8: Box plot showing Company Daily Returns Spread After Appointment of new CEO (Part 3)

Looking at these three plots, we can see that, in most cases, there is no visible overall difference in the spread of returns between the companies led by females as compared to those led by males.

Another point to note is that we see that the median of returns for all companies lies around 0, which shows us that the market always strives to reach an equilibrium state despite the upwards and downwards movements in the stock prices. This phenomenon is called the mean reversal, where a quantity shows upward and downward movement but reverses itself towards the mean.

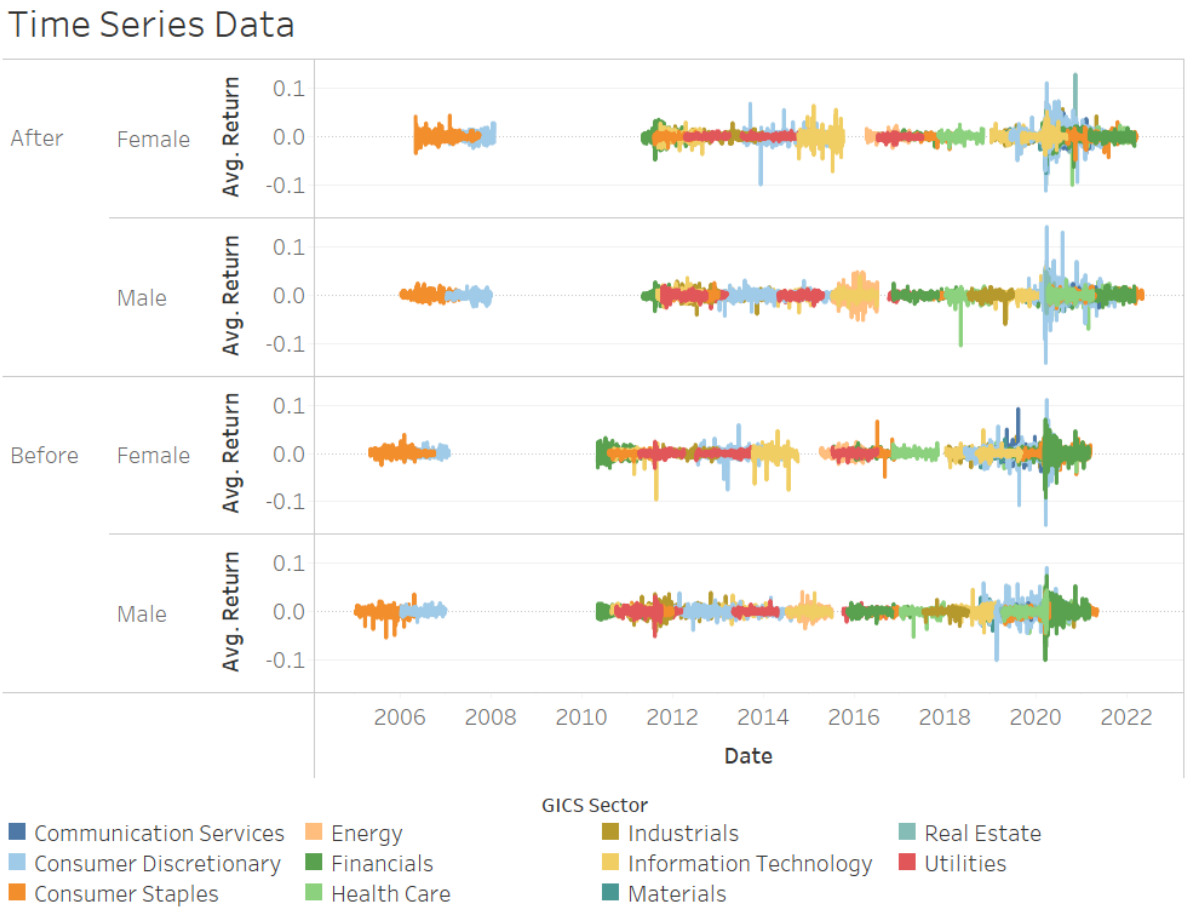

Figure 4.9: Time series showing GICS sector wise daily returns

Additionally, we see high values of outliers, signifying noise in the market, for returns during 2020 due to COVID, which is matched in both, companies led by males and females. This was a turbulent period for the market, which is expected for major events, and it is visible through the spread of returns for that period. This can be viewed more clearly looking at figure 4.9, which shows the time series spread of daily returns divided into two segments, showing daily returns before a new CEO was appointed and after their appointment. These two sections are further divided into Male or Female based on which section of the analysis the companies lie in, considering the CEO and their corresponding company being analysed, denoted by Male or Female, and coloured based on the sector of the company.

4.4 Statistical Analysis

While visual analysis provides an overall understanding, it is difficult to gather the extent of the results. For this reason, statistical tests are performed on the data to understand underlying relationships and correlations within the data.
In this case study analysis, two types of statistical analysis methods are implemented, Chi-square test of independence and vector autoregression.
Using these methods, hypothesis H_0, which states that the gender of a new CEO has no significant impact on the movement of stock prices of the company, is tested.

4.4.1 Chi Square Test

One of the methods used in this case study is the Chi-Square test of independence. This test is used to determine whether the frequency distribution of various categorical variables in a data set has a significant difference or not, as explained in 3.2. Different categorical variables are created and are used to run Chi-square tests in order to find statistically significant results.
As per the categories created, taking the mean returns, skewness and kurtosis from before and after the appointment of a CEO, as explained in section 4.2.2, the Chi-square test was performed to determine the p-value taking into consideration each of these categories along with the gender of the CEO.

State of Mean Returns

The state of mean returns was calculated based on the mean return, specifically looking at the sign of the mean returns before and after the appointment of a new CEO.
The categories created are 'PP', 'NP', 'PN' or 'NN', where 'P' signifies positive (including 0) and 'N' signifies negative, and the first character represents the state of mean returns 1 year before the CEO was appointed and the second character represents that of 1 year after appointment.
Table 4.3 shows the contingency matrix for the observed, expected and standardised residuals frequency distribution of the resultant classification against each gender. Standardised residuals are calculated by taking the difference between the observed values and expected values and then dividing it by the square root of the expected values.

Table 4.3: Contingency matrix of frequency distribution for Chi Square test taking state of returns

Frequency Distribution	Gender	State of Mean Returns			
		NN	NP	PN	PP
Observed	F	4.0	6.0	11.0	21.0
	M	7.0	10.0	3.0	22.0
Expected	F	5.5	8.0	7.0	21.5
	M	5.5	8.0	7.0	21.5
Std. Residuals	F	-0.6	-0.7	1.5	-0.1
	M	0.6	0.7	-1.5	0.1

Change in State of Mean Returns

This category looks at whether the state of mean returns has changed after the CEO was appointed as compared to the state before the appointment, taking 1 year of data, or if it has maintained the status quo.
The categories created contain 'Y' and 'N' values signifying a change in the state of returns and status quo maintained, respectively.
Table 4.4 shows the contingency matrix for the observed, expected and standardised residuals frequency distribution of the classification for each gender.

Table 4.4: Contingency matrix of frequency distribution for Chi Square test taking change in state of returns

Frequency Distribution	Gender	Change in State of Mean Returns	
		N	Y
Observed	F	25.0	17.0
	M	29.0	13.0
Expected	F	27.0	15.0
	M	27.0	15.0
Std. Residuals	F	-0.4	0.5
	M	0.4	-0.5

Change in Value of Mean Returns

This category looks at whether the mean returns from before the CEO was appointed have increased or decreased after the CEO was appointed, taking into consideration 1 year daily returns.

The categorical variable takes the values 'I' to signify increase and 'D' to signify decrease. Table 4.5 shows the contingency matrix for the observed, expected and standardised residuals frequency distribution of the categorical variable for each gender.

Table 4.5: Contingency matrix of frequency distribution for Chi Square test taking change in value of returns

Frequency Distribution	Gender	Change in Value of Mean Returns	
		D	I
Observed	F	21.0	21.0
	M	17.0	25.0
Expected	F	19.0	23.0
	M	19.0	23.0
Std. Residuals	F	0.5	-0.4
	M	-0.5	0.4

Change in Value of Skewness

This category, similar to the last category, looks at whether the skewness, calculated from 1-year daily returns, from before the CEO was appointed has increased or decreased after the CEO was appointed.
This categorical variable also takes the values 'I' to signify increase and 'D' to signify decrease.
Table 4.6 shows the contingency matrix for the observed, expected and standardised residuals frequency distribution for skewness for each gender.

Table 4.6: Contingency matrix of frequency distribution for Chi Square test taking change in value of skewness

Frequency Distribution	Gender	Change in Value of Skewness	
		D	I
Observed	F	19.0	23.0
	M	19.0	23.0
Expected	F	19.0	23.0
	M	19.0	23.0
Std. Residuals	F	0.0	0.0
	M	0.0	0.0

Change in Value of Kurtosis

This category, similar to the last two categories, looks at whether the kurtosis, calculated from 1-year daily returns from before the CEO was appointed has increased or decreased after the CEO was appointed.
This categorical variable also takes the values 'I' to signify increase and 'D' to signify decrease.
Table 4.7 shows the contingency matrix for the observed, expected and standardised residuals frequency distribution for kurtosis for each gender.

Table 4.7: Contingency matrix of frequency distribution for Chi Square test taking change in value of kurtosis

Frequency Distribution	Gender	Change in Value of Kurtosis	
		D	I
Observed	F	15.0	27.0
	M	24.0	18.0
Expected	F	19.5	22.5
	M	19.5	22.5
Std. Residuals	F	-1.0	0.9
	M	1.0	-0.9

Pearson Chi-Square Test Results

The Chi-Square test provides a chi-square value and a p-value which helps to identify if there is a statistically significant relationship between any set of variables based on their frequency distributions. For this case study, the significance levels or the alpha values considered are 0.1, 0.05 and 0.01, for a more comprehensive analysis. The degrees of freedom (denoted as df) are calculated based on each of the categories.
Table 4.8 shows a summary of results generated from running chi-square tests on the previously mentioned calculated categories and gender.

Table 4.8: Pearson Chi Square Test Results for Each Category

Pearson Chi Square Test (1 Year Data)				
Categories (Gender vs)	**Chi Squared**	**p-value**	**df**	**Significance**
Transition State (PP/NN/PN/NP)	6.4129	0.09316	3	*
Change in State (Same/[NP or PN])	0.46667	0.4945	1	
Increase/Decrease in Returns	0.43249	0.5108	1	
Increase/Decrease in Skewness	0	1	1	
Increase/Decrease in Kurtosis	3.0632	0.08008	1	*

In table 4.8, the significance of the p-value results is denoted as * for a statistically significant result to reject the null hypothesis taking the significance level or $\alpha = 0.1$. Similarly, it is denoted as ** considering $\alpha = 0.05$ and *** for $\alpha = 0.01$. The significance level is the probability of rejecting a null hypothesis for an alternate hypothesis falsely. Hence, a p-value below the significance level denotes a low probability of erroneously rejecting the null hypothesis.
Looking at the Chi-square results table, it is visible that the p-values for change in transition states and change in the value of kurtosis are 0.09 and 0.08, respectively, which also show significance denoted by *. As stated previously, * shows true statistical significance considering $\alpha = 0.1$. Hence, the statistical significance of gender with respect to the different movements of returns is tested and displayed. Based on the results, the null hypothesis can be rejected, and the alternate hypothesis that the gender of the CEO has some impact on the movement on returns will be accepted.

It can also be noted that the Chi-square test for change in skewness resulted in a p-value equal to 1. This result indicates that the skewness quotient for men and women is the same, and any differences that might be seen can be considered a consequence of pure chance.

4.4.2 Vector Autoregression

As explained in section 3.3, vector autoregression model can be used to determine the relationship between two variables in a system using exogenous and endogenous variables. Endogenous variables are those that are affected by other variables, while those variables that are independent in the system are exogenous variables.
For analysing the relationship between gender and the movement of returns, the endogenous variable is set to daily returns and the exogenous variable is set to gender. The gender attribute in this dataset is populated as 1 when the CEO was female and 0 for

male. Essentially, since the companies being considered are those where female CEOs were appointed, the time period before their appointment is taken as 0, and after their appointment is set to 1. The total dataset contains 2 years of data, 1 year before the appointment and 1 year after the appointment of the female CEO, with approximately 500 data points for each company. The lag for this system is set to 5.
Equation 3.12 shows the equation for calculation of returns at time t denoted as r_t with previous returns denoted as r_{t-1}, r_{t-2}, r_{t-3}, r_{t-4} and r_{t-4} and gender denoted as g(t).

$$r_t = C + \alpha_1 r_{t-1} + \alpha_2 r_{t-2} + \alpha_3 r_{t-3} + \alpha_4 r_{t-4} + \alpha_4 r_{t-5} + \beta g(t) + \epsilon_t \tag{4.1}$$

where C is the constant, α_1, α_2, α_3 are the coefficients of returns, β is the coefficient of gender at time t and ϵ_t is the residual term.

Vector autoregression with lag 5 for each company headed by a female CEO is run to check whether the p-value generated for gender is statistically significant or not.
Table 4.9 shows the results of the VAR(5) model for each company. The coefficient analysed here is β for the gender variable and its generated p-value. For this case, three values of significance levels are considered, 0.1, 0.05 and 0.001, each showing statistical significance of the gender on the dependent variable r_t in increasing order of impact. In the table, significance is denoted by *, ** and *** to show true statistical significance for 0.1, 0.05 and 0.001 significance levels, respectively.

Table 4.9: Vector autoregression results for exogenous variable gender

Company Symbol	**Dates**	**Coefficient**	**P-value**	**Significance**
ACN	Sep-19	0.0001	0.8944	
ADM	May-06	-0.0014	0.0747	*
AMD	Oct-14	-0.0011	0.3767	
ANTM	Nov-17	-0.0004	0.3625	
AWK	May-14	0.0002	0.6816	
BBY	Jun-19	0.0007	0.5485	
BEN	Feb-20	0.0005	0.6209	
C	Mar-21	-0.0008	0.5307	
CDW	Jan-19	0.0010	0.1153	
CE	May-19	-0.0004	0.6572	
CLX	Sep-20	-0.0015	0.0391	**
CMS	Jul-16	-0.0006	0.1866	
Continued on next page				

Continuation of Table 4.1				
Company Symbol	**Dates**	**Coefficient**	**P-value**	**Significance**
CPB	Aug-11	0.0002	0.6210	
CVS	Feb-21	0.0008	0.3054	
DUK	Jul-13	0.0001	0.6399	
GD	Jan-13	0.0005	0.2267	
GM	Jan-14	-0.0009	0.1526	
GPS	Mar-20	0.0021	0.2639	
HPQ	Sep-11	0.0000	0.9668	
HSY	Mar-17	-0.0005	0.3362	
KEY	May-11	-0.0002	0.8179	
LMT	Jan-13	0.0006	0.1259	
LNT	Apr-12	0.0001	0.7767	
MDLZ	Jun-06	-0.0000	0.9638	
MTCH	Mar-20	0.0012	0.3480	
NDAQ	Jan-17	-0.0000	0.9411	
NOC	Jan-19	0.0011	0.0550	
ORCL	Sep-14	-0.0007	0.1783	
OXY	Apr-16	0.0001	0.8641	
PEP	Oct-06	-0.0000	0.9706	
PGR	Jul-16	0.0002	0.6031	
REG	Jan-20	-0.0007	0.5650	
ROST	Jun-14	0.0005	0.2586	
SRE	Jun-11	0.0000	0.9739	
TJX	Jan-07	-0.0003	0.6280	
TPR	Jul-20	0.0034	0.0233	**
ULTA	Jul-13	-0.0003	0.7831	
UPS	Jun-20	0.0015	0.0641	*
VRTX	Apr-20	-0.0006	0.5430	
WBA	Mar-21	-0.0006	0.4726	

It is observed that out of the 42 companies, 4 companies show statistically significant results. 2 companies out of these 4, Tapestry Inc (TPR) and Clorox Companies (CLX), show higher statistically significant results considering the significance level, α=0.05. The other two, Archer-Daniels-Midland Company (ADM) and United Parcel Service (UPS),

show significance considering significance level, α=0.1.
Looking at the above result, it can be noted that approximately 10% (4/42) of the dataset shows a statistically significant impact of gender on the returns of the company. Since these are large organisations, it can be expected that the stock price movement of these organisations has more complex factors affecting them, but it is important to note that the gender of the CEO is seen to be significant in 10% of the dataset considered in this case study. The results for these companies will be further analysed using panel analysis.

4.4.3 Panel Analysis

The four companies showing significance with respect to gender have been further compared and analysed. For analysis of the four companies (Company symbols: TPR, CLX, UPS and ADM), vector autoregression was rerun, once with gender as a variable and once without gender, to note the effect on the model.
Table 4.10 shows a summary of the data analysed.

Table 4.10: Summary for Panel Analysis

TPR						
	Without Gender			With Gender		
	Coeff	P-value	Signif	Coeff	P-value	Signif
const	0.0004	0.6557		-0.0013	0.3296	
Return_1	-0.0297	0.7009		-0.0390	0.6167	
Return_2	0.1105	0.1832		0.1010	0.2201	
Return_3	-0.0595	0.4399		-0.0676	0.3732	
Return_4	-0.0900	0.1469		-0.0993	0.1028	
Return_5	0.1238	0.1323		0.1145	0.1639	
Gender				0.0034	0.0233	**
Adjusted R-squared	0.0274			0.0337		
CLX						
	Without Gender			With Gender		
	Coeff	P-value	Signif	Coeff	P-value	Signif
const	0.0001	0.6937		0.0009	0.0758	*
Return_1	-0.0799	0.2597		-0.0885	0.2132	
Return_2	0.0344	0.6064		0.0259	0.6957	
Return_3	-0.1534	0.0520	*	-0.1600	0.0436	**

Continued on next page

Continuation of Table 4.10						
UPS						
	Without Gender			With Gender		
	Coeff	P-value	Signif	Coeff	P-value	Signif
Return_4	-0.1227	0.0296	**	-0.1308	0.0217	**
Return_5	-0.0380	0.5318		-0.0469	0.4424	
Gender				-0.0015	0.0391	**
Adjusted R-squared	0.0341			0.0413		
UPS						
	Without Gender			With Gender		
	Coeff	P-value	Signif	Coeff	P-value	Signif
const	0.0008	0.0616	*	0.0001	0.9149	
Return_1	-0.1232	0.0664	*	-0.1297	0.0511	*
Return_2	0.0987	0.1029		0.0920	0.1340	
Return_3	-0.0032	0.9549		-0.0096	0.8628	
Return_4	-0.0996	0.0910	*	-0.1067	0.0667	*
Return_5	0.0199	0.6878		0.0133	0.7908	
Gender				0.0015	0.0641	*
Adjusted R-squared	0.0274			0.0319		
ADM						
	Without Gender			With Gender		
	Coeff	P-value	Signif	Coeff	P-value	Signif
const	0.0007	0.0757	*	0.0015	0.0049	***
Return_1	-0.0348	0.5009		-0.0409	0.4356	
Return_2	-0.1470	0.0086	***	-0.1538	0.0056	***
Return_3	0.0166	0.7364		0.0090	0.8544	
Return_4	-0.0068	0.8919		-0.0139	0.7835	
Return_5	-0.0357	0.4446		-0.0426	0.3703	
Gender				-0.0014	0.0747	*
Adjusted R-squared	0.0148			0.0190		

Discussion

Looking at the results seen in table 4.10, comparing the model with and without gender, it can observed that the adjusted R-squared value for all four organisations increases when

the gender variable is added to the vector autoregression model. Hence, it can be noted that gender has a role of influence in the case of these companies and the model is more aligned to the actual observations when considering the gender of the CEO.

One of the statistically notable cases is that of the company Tapestry Inc (TPR). It can be observed from the summary results that the only factor having a statistically significant effect on the model is gender. Since the previous day returns are not significant, correlation is not present in inter-day returns. For this organisation, it can be stated that the gender of the CEO has a significant effect on the stock price movement of this organisation.

Another aspect observed from the results is that the coefficient is positive for two companies (TPR and UPS) while it is negative for the other two (CLX and UPS). A positive coefficient indicates that the impact of gender on the return is positive and vice versa for negative.
Since the other coefficients are not significant in the case of TPR, this indicates that gender has a positive effect on the returns. The value of the coefficient for gender for TPR is 0.0034, which is equal to 3.4 basis points. A basis point is a standard measure used in finance, and one basis equals 1/100 of a percentage or value. So, the female CEO, in the case of TPR, shows an increase in the returns by 3.4 basis points.
For the other 3 companies, as there is a significant impact of the previous day returns as well as of gender on the calculation of returns, the overall impact can not be stated conclusively.

4.5 Security and Privacy Concerns

All data for this research, concerning the CEO as well as the organisation, is collected from public domains, so there are no concerns related to the privacy of individuals. Additionally, the research does not comment on any individual CEO's abilities but looks objectively at the stock prices to find any relationship with the gender of the CEO. Further, the research methods applied have very low scope for security implications as it is not hosted over the internet or stored publicly.
Hence, there are no serious security, privacy or ethical concerns for this research.

Chapter 5

Conclusions & Future Work

5.1 Summary

Gender equality is gaining traction but it is still a long way to go. In this research, an attempt was made to analyse whether the gender of the CEO of a large organisation has any impact on its stock prices, specifically considering the S&P 500 list of organisations. Various previous researches pertaining to the role of gender in top management positions were carefully surveyed for deeper understanding. Case study dataset was created by gathering information from multiple sources of publicly available data, in order to analyse it.

The statistical methods employed in this research include the use of summary statistics of stylised facts, Chi-square tests, vector autoregression and panel analysis. These methods were implemented to analyse the performance of the organisations in the dataset. In terms of technologies used, Python and R programming languages, as well as MS Excel, were utilised for data collection, data transformation and manipulation, calculation, and some statistical testing. Visual analysis was implemented using Tableau due to its interactive interface. Finally, for the implementation of vector autoregression, the tool GRETL was used.

The statistical methods were employed to analyse the movement of stock prices, using returns, at an aggregated level taking companies together as well as at individual organisation levels to reach the results. Analysis of the results from both these levels suggests that there are instances of statistical significance of the gender of the CEO of an organisation on the movements of its stock price returns.

5.2 Challenges and Limitations

One of the major challenges encountered while implementing this research was the collection of data. Since there was no publicly available dataset to collect information related to each CEO of the S&P 500 companies, it resulted in a tedious task of individually identifying the CEO of each organisation of the S&P 500 companies as well as their appointment dates. Furthermore, since the study required stock price data 1 year before and after the appointment of the CEO, it was also important to gather information related to when the company released its initial public offering (IPO), which refers to the process of offering company stocks to the public by a private company for the first time.

One of the limitations of this research is that there are very few female CEOs in the S&P 500 companies. Due to this, random sampling was not possible in the case of organisations with female CEOs. Due to the data selection process, the resultant dataset was not too large to effectively investigate the problem statement.

Another limitation of this research is that it is performed using technical analysis and not combining it with fundamental analysis of the organisation. Due to this, the current results obtained could be ignoring certain organisational aspects, which could also be affecting its performance. For example, if a company faces a lawsuit for some previous misdoings due to which its performance is affected, it would be reflected in the current CEO's performance.

Further, in terms of limitations, it is important to note that there are various other behavioural aspects apart from the gender of the CEO that defines the public sentiments towards a company which are not considered in this research. While the differences in the organisations were tried to minimise by selecting the top firms, there could still be other aspects that play a role in influencing the stock price movements.

Additionally, this research considers the appointment date of the CEO as the initial point of their impact on the firm's performance. This is not necessarily applicable for all cases as companies tend to release news related to CEO changes before the appointment, and hence, the public sentiment related to the gender of the CEO can be seen since the news release instead of the appointment dates.

Finally, since the companies considered in this research are those within the S&P 500 list, the results can not be generalised to the overall impact of gender on stock price movements in other areas.

5.3 Future Work

This research presents a set of research methods applied to one case study. Due to the time and resource limitations in this research, it was not possible to extend this research further. However, there is larger scope for the research. There are various other areas where it can be applied, and some of these are proposed below.

The gender of the CEO is one of the aspects tested in this research to analyse its impact on the organisation's performance. This can be further extended to analyse other characteristics of the CEO such as age, ethnicity, educational background, amount of experience etc. As mentioned in section 2.2.3, another trait to inspect could be the number of children of the CEOs and test their impact on the firm performance to add to the literature by Hurley and Choudhary (2016). These would provide more insight into the current workings of the market.

While the current model is demonstrated with a single variable of gender, it is possible to include multiple such attributes, denoting different characteristics, to examine their overall effect on the stock price movements.

The dataset could also be changed to consider small and medium organisations. Since different regions have different cultural and societal aspects, there is scope for more analysis in terms of regional behavioural tendencies and features of the managerial lead considered. It would be interesting to discover aspects where the results are contradictory for the two regions due to cultural differences.

This research can also be extended to include fundamental analysis in addition to the technical analysis being performed in order to eliminate other aspects of the firm or industry affecting the stock price movements.

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