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PERFORMANCE OF NORDIC TECHNOLOGY COMPANIES DURING COVID-19

Bachelor's thesis

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I hereby declare that I have compiled the thesis independently
and all works, important standpoints and data by other authors
have been properly referenced and the same paper
has not been previously presented for grading.

The document length is 9679 words from the introduction to the end of the conclusion.

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ABSTRACT

The aim of this thesis is to analyze the stock performance of Nordic technology companies during Covid-19 and its relationship with the size of the company and performance among Nordic technology companies during Covid-19. The sample consists of 300 Nordic technology companies and they were divided into 3 separate portfolios based on the size of their revenue. For analyzing portfolio performance, this paper uses regression analysis and financial performance indicators. Regression analysis is modeled by Capital Asset Pricing Model and performance indicators are the Treynor ratio, Sharpe ratio and Jensen's alpha. After running regression analysis and calculating values by using the selected performance indicators, the results show that portfolios medium and small-size portfolios performed relatively better compared to the largest portfolio during Covid-19. In fact, while medium and small-sized portfolios performed better during Covid-19 than before it, the largest portfolio actually performed worse during Covid-19 than before it. To summarize, smaller companies performed relatively better than larger companies during Covid-19, therefore at least to some extent, there is a relationship between size and performance.

Keywords: Capital Asset Pricing Model, Covid-19, portfolio performance, regression analysis

INTRODUCTION

In today's world, societies and well-being are closely tied to the health of the economy. If the economy is thriving, most often so are the people. In a way, we can measure and predict our well-being and future by interpreting the financial market. In other words, the economy is a complex system on which our well-being is dependent and generally speaking continues to go forward. However, a crisis can stop this continuation. There have been other crises in the past, this time it was Covid-19. A virus that forced this system to a standstill. After the first wave of the pandemic, many companies declared bankruptcy, people lost their jobs, and the financial markets crashed. The economy found itself in chaos. However, during the peak of Covid-19, technology companies around the world started to perform better which was also reflected in the stock market. This was due to the sudden rise in demand for technology because taming the virus required social distancing and almost all contact between people switched to online communication. After the virus had been tamed, some companies became even larger than before Covid-19 in a situation where most industries were in a crisis. Throughout history, technology has carried humankind forward, in today's world especially. It seems that even in a crisis, modern technology companies have figured out a way to adapt to the situation and carry the economy forward. For these reasons, technology companies are the focus of this thesis.

The aim of this thesis is to analyze the stock performance of Nordic technology companies during Covid-19 and its relationship with the size of the company.

Currently, there are a large number of articles and data on the technology sector's response to the Covid-19 pandemic but the correlation between positive returns and the size of the companies is unspecified. This thesis will focus therefore also on analyzing how the stock returns of Nordic technology companies have changed during Covid-19 compared to their historical data before the pandemic.

The thesis seeks to answer to following research questions:

1. How have Nordic technology stock returns changed during Covid-19 compared to the time before the pandemic?

2. What is the relationship between the size of Nordic technology companies and their performance during the Covid-19 pandemic?

The sample for this study consists of 300 Nordic technology companies. Data of these companies is weekly stock price data gathered from Eikon. Among the 300 companies, 181 are from Sweden, 34 are from Finland, 40 are from Denmark, 40 are from Norway and 5 are from Iceland. Companies are divided into 3 separate portfolios based on their average revenue during the years 2016-2022.

Portfolios are compiled by size and defined as “large-sized portfolio”, “medium-sized portfolio” and “small-sized portfolio”. Portfolios will then be analyzed by financial models and ratios which are Capital Asset Pricing Model, Sharpe ratio, Treynor ratio and Jensen’s alpha. Portfolio returns during Covid-19, from December 2019 to December 2022 are being compared to companies own respective historical stock return data previous to Covid-19, from December 2016 to December 2019.

This thesis has 3 main sections. The first part is the literature review which covers the previous literature on the topic. This includes studies about the topic which seem the most relevant. To be more precise, theoretical and empirical studies. In addition to studies, this section will go through the models on which the portfolio analysis will be based. These models include Capital Asset Pricing Model, Traynor ratio, Sharpe ratio and Beta. The second section will cover data and methodology. This section will cover the models being used and discuss their functionality. The final section is the findings and conclusion. In other words, this section will present the findings of the portfolio analysis and discuss them.

1. PORTFOLIO PERFORMANCE MEASURES

This chapter will go through the literature and studies relevant to the topic of this paper. These are theoretical and empirical studies regarding the subject. This chapter will also cover the models that are being used in portfolio analysis and break down how they are being utilized. The chapter is divided in sub-chapters which will cover the topic in order of Capital Asset Pricing Model, Treynor ratio, Sharpe ratio, Efficient market hypothesis and empirical studies.

1.1. Capital Asset Pricing Model

Capital Asset Pricing Model or as it is abbreviated, CAPM, is a financial model used for calculating the expected rate of return for an investment. It was first developed by Jack Treynor (1961) William Sharpe (1964) and by John Lintner (1965) and it is based on the earlier work of diversification and modern portfolio theory by Harry Markowitz in 1959 (Elbannan, 2015). Risk-averse is a psychological and financial term that means that the investor or person prefers a less risky investment or choice over the riskier one. Markowitz’s theory, Modern Portfolio Theory, assumes that investors are rational and risk-averse and therefore choosing the portfolio will be based on the investor's risk-return utility function on a one-period investment return (Elbannan, 2015). Markowitz’s theory is often also referred to as the “mean-variance model”. The nomination comes from the fact that based on the theory, investors choose portfolios that minimize the variance of the portfolio and maximize expected return (Fama & French, 2004).

As stated, Capital Asset Pricing Model is a continuation of Markowitz’s theory. Sharpe and Lintner developed the model from the “mean-variance model” by adding two key assumptions to the theory. The first assumption is “homogenous expectations”, meaning all the investors have access to the same information and therefore are all capable of analyzing it in a rational manner. In other words, all investors share the same expectations of expected returns and risk, hence the name, “homogenous expectations”. The second assumption focuses on borrowing and lending. According to the assumption, all investors can borrow and lend unlimited amounts of money at a risk-free rate. By this assumption, all investors can also invest in risk-free assets. (Elbannan, 2015)

However, these assumptions are based on theory and most probably won’t be realistic in practice. In reality, investors have different needs and skill levels. This means that all investors are actually not rational, at least not in the way that the assumptions assume them to be. Also, investors do not usually share the same expectations nor have the access to the same information or at least interpret them differently. Secondly, all investors can't always borrow and lend money at a risk-free rate, they might have liquidity problems or problems with getting credit for example. (Ross, 1978)

Capital Asset Pricing Model is a widely used model for analyzing portfolio and stock returns. The model is a great tool for gathering key indicators of companies financial well-being. The capital asset pricing model is also multi-functional. Some functions of the model include valuation of the firm's stock, capital budgeting, merger and acquisition analysis and valuation of warrants and convertible securities. It can also be used in finding the cost of equity which is quite common use for it. In addition to the Capital Asset Pricing Model being a financial tool for investors in decision-making, the model can also be used as a planning tool for corporations and firms in their financial side of the business. (Naylor & Tapon, 1982)

Capital Asset Pricing Model is used for finding the relationship between the required rate of return and risk. By finding this relationship, it is possible to make conclusions about whether the price of a stock is at the right level when being compared to its expected return (Perold, 2004). Capital Asset Pricing Model finds out this information by the use of its formula which gives out a value for the expected return of an asset. The expected return has to take into consideration the risks so the formula consists of multiple parts, risk-free rate, the beta of the investment and market risk premium (Blume & Friend, 1973). Risk-free rate means interest rate which is risk-free, for example, yield on government bonds. The beta of the formula tells us the systematic risk or volatility of an asset or portfolio (Ansari, 2000). Beta is always given in relation to the whole market. Beta which gives a value larger than 1 is considered to be more volatile, or risky, than the market. Vice versa, beta which has a value below 1 is considered less risky than the market. The third variable of the formula is the market risk premium. The market risk premium is calculated by subtracting the risk-free rate from the expected market return (Elbannan, 2015).

Even though, Capital Asset Pricing Model is one of the most appreciated financial pricing models in use, it has faced criticism. Most of the criticism is about beta and its accuracy. In the 1970s, studies found deviances in Capital Asset Pricing Model. These deviances indicated that other factors than beta would explain more about cross-sectional change in returns than they should according to Capital Asset Pricing Model (Ansari, 2000). Other factors here are the company's individual characteristics. This contradicted the model since the differences in beta could not explain the differences in the expected returns like the Capital Asset Pricing model indicates. (Ansari, 2000)

These deviations forced a debate about the Capital Asset Pricing Model and especially about the use of beta. Even though deviations were found, most professionals and academics still use Capital Asset Pricing Model and consider it to be a key indicator in modeling portfolio performance and risk relation to expected returns. What is more, the debate only brought out the stiffness of the model which is valuable information for its appliers. (Ansari, 2000)

1.1.2 Treynor ratio

The Treynor ratio is a financial performance metric named after its creator, American economist Jack Treynor. The ratio was considered to be an enormously helpful tool since it was the first performance metric to measure the performance of a portfolio while deducing the market component (Steinki & Mohammad, 2015). The Treynor ratio is used as a performance metric that provides a reward- to- risk ratio (Verma & Hirpara, 2016). The reward-to-risk ratio in this regard means that the ratio computes the risk premium per unit of systematic risk. In the Treynor ratio as well as in the Sharpe ratio, the risk premium is defined as the portfolio's beta, however, the Treynor ratio uses the systematic risk, also known as beta, as the risk parameter therefore it cannot be removed through diversification (Samarakoon & Hasan, 2005).

The Treynor ratio is considered useful in portfolio analysis mainly because it helps investors to assess whether the investment's returns are appropriate considering the amount of risk taken. When it comes to the actual formula, it is easily applicable and interpreted. The formula is calculated by subtracting the risk-free rate from the portfolio return and then dividing the result by the beta of the portfolio as the Treynor ratio measures risk with beta (Scholz & Wilkens, 2005). In the Treynor ratio formula, the larger the calculated number is, the better the investment is for investors. In other words, higher values of the Treynor ratio equal better risk-adjusted returns because the investment or portfolio is creating more returns per unit of systematic risk taken. (Steinki & Mohammad, 2015)

1.1.1 Sharpe ratio

The Sharpe ratio was invented in 1965 by William Sharpe. As mentioned before in this thesis William Sharpe was also developing Capital Asset Pricing Model. Sharpe won the Nobel prize later in 1990 for his achievements in developing models that help in investment decision-making. Sharpe himself initially named the ratio as “Reward- to-variability ratio” but the ratio is more commonly known as the “Sharpe ratio” among academics and financial professionals. (Steinki & Mohammad, 2015)

The Sharpe ratio is quite similar to the Treynor ratio and the basic point of view is the same in both of these ratios, they investigate portfolio’s or assets' expected returns in regard with the risk being taken. However, the main difference lies in their way to examine the risk at hand. While the Treynor ratio takes into consideration only the systematic risk, the Sharpe ratio measures the variance as the total risk of the portfolio. This difference can be detected straight from comparing the formulas of the ratios, Treynor ratio uses the Beta of systematic risk as the nominator while the Sharpe ratio uses the total risk as the nominator. Total risk in Sharpe’s ratio is the standard deviation of returns of the portfolio. In other words, the Treynor ratio is more useful for analyzing portfolio performance with similar systematic risk to the market while the Sharpe ratio is more directed in evaluating the risk-adjusted performance of a diversified portfolio. (Ferson, 2010)

While the Sharpe ratio is a useful tool for evaluating and analyzing portfolio performance, it has also faced criticism. Sharpe ratio, like many other financial models are often created for a certain purpose and ignore the other factors in the larger picture. Sharpe ratio has been mostly criticized for its inability to take the shape distribution of returns into consideration. Sharpe ratio assumes that the returns are normally distributed when in reality they often are not which then makes the results of calculation with the Sharpe ratio less accurate (Farinelli *et al.*, 2008). Other criticisms the model faces are more associated with time in performance evaluation. Sharpe ratio is calculated by using historical data and therefore it may not be a reliable indicator of future performance. Another problem is that the Sharpe ratio assumes that the risk taken stays the same over time when in reality it may change in whichever direction (Farinelli *et al.*, 2008). However, as mentioned before, the Sharpe ratio is only a tool for financial analysis and the users of this model are most often aware of its flaws.

1.1.2 Jensen's alpha

Jensen's alpha, also known as the Jensen index, is a risk-adjusted measure of a portfolio's performance. Jensen's alpha gets its name from its creator, Michael Jensen. The model is based on Capital Asset Pricing Model (CAPM). Like other models evaluating portfolio performance such as the Treynor ratio or Sharpe ratio, Jensen's alpha does share similarities with them. The core idea behind Jensen's alpha is similar to other models, investigating the relationship between the returns of an investment and the level of risk. However, when comparing Jensen's alpha with other models, the main difference lies in how the Jensen model measures risk. Like mentioned in the previous chapter, Sharpe ratio uses the total risk of the portfolio while Jensen's alpha uses systematic risk as beta, similar to Treynor ratio (Moy, 2002).

Jensen's alpha essentially measures portfolios' performance against a benchmark. The benchmark is measured as the expected return calculated from Capital Asset Pricing Model or the market (Samarakoon & Hasan, 2005). Like mentioned in the chapter about Capital Asset Pricing Model, Capital Asset Pricing Model tells us the expected return by its formula which includes a risk-free rate, systematic risk and the market risk premium. In the formula of Jensen's alpha, the alpha is calculated by subtracting the expected return given by the Capital Asset Pricing Model-formula from the return of the given portfolio (Samarakoon & Hasan, 2005). From this formula the alpha can have a value of above zero, below zero or equal to zero. A positive alpha, a value of alpha that is above zero, means that the portfolio or investment at hand has earned a better return than the given benchmark (Perez Liston & Soydemir, 2010). In other words, Jensen's alpha is a simple tool for evaluating whether the portfolio is doing better or worse compared to the market.

Because of its easy usability, Jensen's alpha is a well-known and used method in financial work environments. For example, many fund managers and investment analysts can utilize this particular performance metric in order to find out whether investments or assets have good profitability. Jensen's alpha does not only provide information about owned investments for fund managers but it is also used as an investment strategy. Investors seek out securities or portfolios with a positive alpha in order to beat the overall market and to gain profit (Phuoc, 2018).

1.1.3 Efficient Market Hypothesis

Efficient Market Hypothesis, also known as efficient market theory, is a financial theory that claims that stock prices already mirror all possible information available and known and therefore beating the market is actually not possible in the longer run. Efficient Market Hypothesis is considered as one of the most important financial theories in modern times. (Titan, 2015)

Theory has 3 forms, weak form, semi-strong form and strong form (Malkiel, 1989). Weak form of Efficient Market Theory dictates that stock prices reflect all historical and past prices which makes it impossible to beat the market and gain profit. Semi-strong form means that all stock prices reflect all the public information available in addition to historical data. Therefore it is impossible to beat the market because now historical data and public information are not usable in order to beat the market (Titan, 2015). Strong form of Efficient Market Hypothesis claims that the current stock prices reflect and represent all historical information, all public information and all private information. According to strong form of this theory, it is not possible to beat the market even if one would have insider information (Titan, 2015).

1.2 Previous empirical studies

This chapter consists of empirical studies which have used the models mentioned in this paper in analyzing portfolio performance. To iterate, the models include Capital Asset Pricing Model, Treynor ratio, Sharpe ratio and Jensen's alpha. These studies provide insight on how the previously mentioned models can be applied in financial studies and more accurately, in analyzing portfolio performance.

As mentioned in previous chapters, Capital Asset Pricing Model is a very often used model linked to evaluating portfolio performance. Trifan (2009) conducted an empirical test of the Capital Asset Pricing Model for the Romanian capital market for both individual assets and portfolios. Sample data in the study consisted of daily data of 24 companies that were listed on the Bucharest Stock Exchange from January of 2003 until July of 2009 (Trifan, 2009). The aim of the testing was the find whether there the relationship between expected return and risk was linear, if the beta is a enough accurate measure of risk and whether higher or lower risk correlates with higher or lower expected returns (Trifan, 2009). In other words, the aim of the study was to find out whether Capital Asset Pricing Model's assumptions hold by applying the daily data of the 24 companies in the Bucharest Stock Exchange to the model.

The results of the study show that tests do not provide evidence against Capital Asset Pricing Model. Results of analyzing the data provide information that the intercept is statistically insignificant, meaning it is close enough to zero, which supports the assumption of the Capital Asset Pricing Model (Trifan, 2009). This was true for both individual assets and the portfolios. Results of the study also provide evidence that beta is a complete enough measure of risk and beta behavior in the study is in line with the assumptions in Capital Asset Pricing Model (Trifan, 2009).

Win (2023) conducted a case study about Zebra Technologies stock performance in relevance with the market index and Capital Asset Pricing Model. Stock market and market index data of Zerba Technologies was gathered from 2018-2022, a total of five years. The aim of this study was to analyze the performance of Zebra Technologies stock performance compared to market index benchmark performance from the same time period and to make a suggestion on whether Zebra Technologies' stock should be invested in based on its own historical data of these 5 years. (Win, 2023). The estimated expected return was calculated from the stock returns and compared with market index returns. In order to achieve this comparison, the author computed the beta value for the stock for the 5 year period used in the study.

The findings of the study show that Zebra Technologies' stock performance shares a strong correlation with market index stock performance. According to Win (2023), this could indicate that Zerba Technologies' business strategies could be aligned with the economic trend of the current market. Findings also presented that the stock returns exceeded the estimated expected returns calculated by Capital Asset Pricing Model and they also shared a strong positive correlation indicating that estimated expected returns were able to reflect the actual stock returns (Win, 2023). With these results, the author concluded that Zebra Technologies stock is able to provide investors additional value and therefore is a good investment (Win, 2023).

Since Covid-19 is a very recent event in human history, there is quite a limited number of literature available on portfolio analysis before and during Covid-19. However, there still are studies related to this topic. May & Yeing (2022) conducted a study of portfolio analysis of stocks in the Malaysia stock market before and after the Covid-19 pandemic. In the study, the Sharpe ratio and Sortino ratio were used the evaluate the performance. In identifying the optimal portfolio, the study applied the Treynor ratio, Sharpe ratio and Jensen's alpha (May & Yeing, 2022). A total of 13 industry sectors were selected for the study where their individual performance before and after Covid-19 was evaluated, one of them being the technology sector. It is also announced in the study that comparing the performance of the technology sector before and after Covid-19 is one on the main objectives of the study. Daily stock data was selected and the time period defined before Covid-19 was from March 2019 to February 2020. The time period during Covid-19 was defined from March 2020 to December 2021 (May & Yeing, 2022).

Results based on the performance measures used indicate that there are 4 sectors among the 13 sectors that have a performance that is not affected during Covid-19. These sectors were technology, industrial, property and consumer products and services (May & Yeing, 2022). This means they have been able to perform similarly to the time period before Covid-19 or better. In the study results, it is mentioned that the technology sector was able to perform better during Covid-19 than before Covid-19 (May & Yeing, 2022). In other words, the technology sector actually had a positive impact of Covid-19. The author of the study reasons that this is due to the high demand for software and hardware as well as heavy internet usage caused by the transition from working in the office to working at home. The author concludes that the optimal portfolio formed from Malaysian stocks is found in the four sectors that were not affected by Covid-19 in their performance (May & Yeing, 2022).

2 DATA AND METHODOLOGY

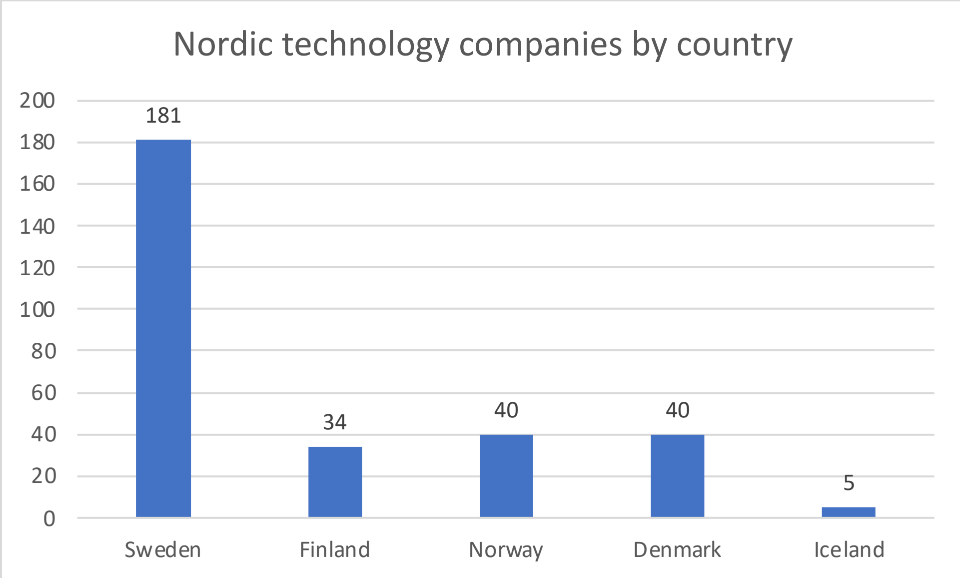
In this chapter, the paper will present and explain the data used in the study. Moreover, the chapter goes through the origin of the data and the justification of choosing the particular data for the study. After the section of the origin and justification of data, the chapter will go through the tests and models used to analyze the data. These models include Capital Asset Pricing Model, Sharpe ratio, Treynor ratio and Jensen's alpha. This will be discussed in the methodology of the study.

2.1 Data

This paper focuses on the performance of Nordic technology companies before and during Covid-19. Therefore, the data used in the study consists of total returns of 300 Nordic technology companies from a time period of six years, three years before the start of Covid-19 and three years during Covid-19. To be precise, from December 2016 to December 2022. Data used in the study is weekly closing prices, market index returns and risk-free rates of these companies selected for the study.

All of the data is gathered from a financial online database, Eikon. As the study focuses on Nordic technology companies, weekly closing prices gathered are from the technology companies listed publicly on stock exchanges in Finland, Sweden, Norway, Denmark and Iceland. Actual companies which were selected were filtered using the Eikon database's own filters. Filters selected were publicly listed, headquarters in any of the Nordic countries, Finland, Sweden, Norway, Denmark or Iceland and classified as technology companies. Classification of technology companies is Eikon's own criteria which categorizes companies to certain industries. In Eikon, there are 581 companies publicly listed as Nordic technology companies. However, after adding filters for weekly closing prices for the six years, from December 2016 to December 2022, the total number of Nordic technology companies which from the data possible to gather, drops to a little bit over 300 companies but for clarity and for even distribution of portfolio diversification the author has chosen 300 companies which will be the sample of this study.

Figure 1. Nordic technology companies by country



Source: Authors' own calculations

Amongst the Nordic technology companies where both monthly total return and monthly closing price data could be gathered, over half were Swedish technology companies. As we can examine from Figure 1, from the total 300 Nordic technology companies which met the criteria, 181 are Swedish, 34 are Finnish, 40 are Norwegian, 5 are Icelandic and 40 are Danish. Percentages for these number amount to the following, 60% are Swedish, 11% are Finnish, 13% are Norwegian, 2% are Icelandic and 13% are Danish. When interpreting the numbers, it is very clear that Sweden is the leader in the technology industry amongst Nordic countries by a landslide.

2.2 Methodology

As mentioned in the introduction section is this chapter, financial models applied in analyzing the data are Capital Asset Pricing Model, Sharpe ratio, Treynor Ratio, and Jensen's alpha. By utilizing these financial performance indicators, we are able to make assumptions and conclusions about whether Covid-19 had significantly changed the total returns among Nordic technology companies and whether size has a relationship with stock performance during Covid-19.

Before models can be applied properly, the data had be categorized into portfolios the represent companies of different sizes. For this study, 300 companies in the study were divided into three portfolios based on their size measured in average revenue calculated from years 2016-2022. The large-sized portfolio being the portfolio with 100 companies with the largest average revenues, the medium-sized portfolio with 100 largest average revenues after the large-sized portfolio and the small-sized portfolio with the 100 last companies which had the lowest average revenues. In the large-sized portfolio, the largest average revenue was 22,9 billion and the lowest was 44,8 million. For medium-sized portfolio, the largest average revenue was 41,5 million and the lowest was 4,4 million. For the small-sized portfolio, the largest average revenue was 4,3 million and the lowest was 190 thousand. Of the 300 companies selected for the study, around 60 companies were missing weekly closing prices from the years 2016-2018. However, after constructing the portfolios based on their average revenue for the years 2016-2022, the missing data was fortunately quite evenly distributed to all portfolios, thus rebalancing the available data for each portfolio. By the even distribution of missing data in the portfolios, the study was able to make more precise and informative calculations and evade unbalances in results.

The main model to analyze portfolio performance is Capital Asset Pricing Model. Capital Asset Pricing Model determines the estimated expected return.

$$Rit - Rft = \alpha + \beta(Rmt - Rft) \tag{1}$$

where:
Rit=return of the asset at a time t
Rft=risk-free rate at a time t
Rmt=return on market at a time t
β=beta
α=alpha

Above is the formula for Capital Asset Pricing Model. As we can see Capital Asset Pricing Model equals to the expected return on investment. In order to calculate the expected return of an investment, Capital Asset Pricing Model takes into consideration the risk-free rate which is the level that an investor would expect to earn from an investment that has zero risk, hence the name risk-free rate (Mukherji, 2011). Typically risk-free rates are based on the yield of government bonds, in this case, the author has chosen the yield of Euribor as the risk-free rate. Risk-free rates used in the study are weekly Euribor rates and they are gathered from the database of the Bank of Finland.

Other components that are that the Capital Asset Pricing Model takes into consideration are the beta of the investment and market risk premium. The beta of an investment is the indicator of the investment's volatility or systematic risk compared to the market. This study gathers Beta values from running a regression analysis for Capital Asset Pricing Model using regression analysis software called Gretl. This way Beta values are more accurate than ones gathered from the Eikon database.

The final variable in Capital Asset Pricing Model is the market risk premium. The market risk premium is the extra return an investor is looking to receive from investing in a risky asset rather than a risk-free asset (Mayfield, 2004). As we can see from the Capital Asset Pricing Model formula, the market risk premium is calculated by subtracting the risk-free rate from the expected market return. As mentioned previously, this paper uses Euribor yield as the risk-free rate and for the expected market return the author has chosen the yield of OMX Nordic 40-index. OMX Nordic 40- index is a stock market index that is made of 40 of the most traded stocks in the Nordic countries and its focus is on technology stocks. OMX Nordic 40-index weekly closing prices are gathered from Eikon database which weekly returns are calculated from.

In this paper, Capital Asset Pricing Model will be modeled by doing a regression analysis. The analysis will be conducted using a regression analysis software Gretl. Modeling the Capital Asset Pricing Model with regression analysis will result in alpha what is also known in this paper as Jensen’s alpha. The results of alpha will indicate whether an asset, in this case each of the portfolios, has underperformed or outperformed the market.

In order to get a more detailed and informative performance analysis, this paper will also utilize the Sharpe ratio and Treynor ratio in measuring portfolio performance. Formulas for both ratios are presented below.

Sharpe ratio formula:

$$= \frac{Rp - Rf}{\sigma p} \tag{2}$$

where:

Rp=return of portfolio

Rf=risk-free rate

σp=standard deviation of the portfolio's excess return

Treynor ratio formula:

$$= \frac{Rp - Rf}{\beta p} \tag{3}$$

where:

Rp=Portfolio return

Rf=Risk-free rate

βp=Beta of the portfolio

Sharpe ratio and Treynor ratio share a lot of similarities as it can be seen in their formulas as well. In fact, only the denominator is different in their formulas. Sharpe ratio uses standard deviation as the denominator while the Treynor ratio uses the beta of the portfolio as the demoninator. In other words, Sharpe ratio measures investments return in regards to it's risk while Treynor ratio calculates the extra return per unit of risk taken in a portfolio. In this paper, the author uses weekly data in order to calculate both Sharpe ratio and Treynor ratio. In other words, average return is calculated from the weekly data for each of the portfolios. Same process will be done for weekly risk-free rates as well. After the calculations that can be applied for both of the ratios, the author will calculate standard deviation from the excess returns and finally use to built-in fucntions of Excel to calculate the value of Sharpe ratio for each portfolio. For Treynor ratio, the average Beta of each portfolio is gathered from regression analysis on Capital Asset Pricing Model where one of the outcomes of running the analysis is Beta coeffient. Once each of the variables needed are known, the author will use Excel in order to calculate the results for Treynor ratio for each of the portfolios.

2.3 Descriptive statistics

In this chapter of the thesis, the author presents descriptive statistics of the data in a form of a correlation matrix between weekly returns from each portfolio, market and risk-free rate. After the correlation matrix weekly averages for market returns, market excess returns and risk-free rate for each of the time periods of the study will be presented, followed by average weekly portfolio returns, excess returns and standard deviation for each portfolio for each time period. All visualization of the data is presented in the form of tables.

Table 1. Correlation matrix between weekly portfolio returns, market returns and risk-free rates, December 2016 to December 2022

	Large-sized portfolio	*Medium-sized portfolio*	*Small-sized portfolio*	*Market return*	*Risk-free rate*
Large-sized portfolio	1				
Medium-sized portfolio	0,719	1			
Small-sized portfolio	0,664	0,840	1		
Market return	-0,017	0,078	0,072	1	
Risk-free rate	-0,053	-0,043	-0,088	0,046	1

Source: Authors own calculations

As we can see from Table 1, weekly returns among the portfolios have a quite high correlation. The highest correlation of the weekly returns of portfolios can be found between small-sized portfolio and medium-sized portfolio as its get a correlation value of 0,84, meaning the correlation is strong between the variables. In other words, weekly returns of small-sized portfolio and medium-sized portfolio tend to move similarly when there are changes in the market. Weekly returns of the large-sized portfolio has a correlation of 0,719 with medium-sized portfolio and correlation of 0,664 with the small-sized portfolio. Large and medium sized weekly portfolio returns have a quite strong correlation and they tend to move in similar directions whereas weekly returns of large and small-sized portfolios have a moderate correlation, meaning they also tend to move quite similarly in the market, however the inconsistencies. As we can see from Table 1, the correlation between weekly market returns and weekly returns of all sized portfolios is almost nonexistent with all correlation values close to zero meaning there is no relationship between the weekly market returns and weekly returns of all sized portfolios. When we examine Table 1, we can also see the similar results between the weekly risk-free rate and all other weekly returns of the rest of the variables. Risk-free rates are known to be very stable so changes in weekly risk-free rates are very minimal therefore the negligible correlation between it and the variables that are sensitive to market movements is logical.

From the weekly data gathered from databases of Eikon and Bank of Finland, the author was able to calculate the averages for portfolio returns, market index returns, risk-free rates, portfolio excess returns, standard deviations and market index excess returns for each of the required periods. These values are needed for regression analysis calculations as well as for performance measure formulas. Calculated values are presented below.

Table 2. Weekly averages for market returns, market excess returns and risk-free rate for each period of study

	Market index returns	**Market excess returns**	**Risk-free rate**
Averages before covid	0,13 %	0,14 %	-0,0075 %
Averages During Covid	0,24 %	0,25 %	-0,0079 %
Averages whole period (2016-2022)	0,18 %	0,19 %	-0,0077 %

Source: Authors' own calculations

In Table 2 is presented the weekly averages for market index returns, market index excess returns and risk-free rates for each time period in the study. Before Covid-19, average market index return was 0,13%, average market index excess return was 0,14% and average risk-free rate was -0,0075%. During Covid-19, average market index return was 0,24%, average market index excess return was 0,25% and average risk-free rate was -0,0079%. For the whole time period, average market index return was 0,18%, average market index excess return was 0,19% and average risk-free rate was -0,0077%. Due to the strange economic movements of the 2010s, risk-free rate was actually negative for each time period.

Table 3. Large-sized portfolio weekly averages for portfolio returns, portfolio excess returns and standard deviation.

	Large-sized portfolio average returns	**Large-sized portfolio average excess returns**	**Standard deviation from excess returns**
Before Covid-19 (2016-2019)	0,21 %	0,22 %	2,15 %
During Covid-19 (2019-2022)	0,06 %	0,07 %	3,61 %
Whole period (2016-2022)	0,14 %	0,14 %	2,97 %

Source: Authors own calculations

Notes: Portfolio weekly average excess returns calculated by substracting weekly risk-free rates from portfolio returns

Table 3 presents the values calculated from weekly stock data of companies belonging to the large-sized portfolio. As mentioned previously, portfolios are created according to average revenue of the company. The large-sized portfolio holds 100 companies that had the largest average revenue out of 300 companies selected for the study. As we can see from Table 3, large-sized portfolio average returns before Covid-19 were 0,21%, during Covid-19 they were 0,06% and for the whole time period it was 0,14%. Large-sized portfolio average excess returns are calculated by subtracting the average risk-free rate from average portfolio returns. Large-sized average excess returns before Covid-19 were 0,22%, during Covid-19 they were 0,07% and for the whole time period they were 0,14%. Standard deviations are calculated from portfolio average excess returns. Before Covid-19 standard deviation was 2,15%, during Covid-19 it was 3,61% and for the whole time period it was 2,97%. As we can see from Table 3, large-sized portfolio has been able to generate positive returns in every time period. However, before Covid-19 it has been performing better when we only examine the raw returns. Table 3 also shows us that excess returns are just slightly larger than regular returns for large-sized portfolio. This is explained by the risk-free rate being negative so when values are put into the formula, the numbers actually create a sum instead of subtraction.

Table 4. Medium-sized portfolio weekly averages for portfolio returns, portfolio excess returns and standard deviation.

	Medium-sized portfolio average returns	**Medium-sized portfolio average excess returns**	**Standard deviation from excess returns**
Before Covid-19 (2016-2019)	0,07 %	0,08 %	1,18 %
During Covid-19 (2019-2022)	0,19 %	0,20 %	3,21%
Whole period (2016-2022)	0,13 %	0,14 %	2,41 %

Source: Authors own calculations

Notes: Portfolio weekly average excess returns calculated by substracting weekly risk-free rates from portfolio returns

In Table 4, we can see the average returns, excess returns and standard deviation for medium-sized portfolio for each time period. Average return for medium-sized portfolio before Covid-19 was 0,07%, during Covid-19 it was 0,19% and for the whole time period it was 0,13%. Average excess return for medium-sized portfolio before Covid-19 was 0,08%, during Covid-19 it was 0,20% and for the whole time period it was 0,14%. Standard deviation before Covid-19 was 1,18%, during Covid-19 it was 3,21% and for the whole time period it was 2,41%. Analysing the values in Table 4, we can see that medium-sized portfolio has performed better during Covid-19 than it has before Covid-19. This is opposite of large-sized portfolio performance when evaluating just the returns.

Table 5. Small-sized portfolio weekly averages for portfolio returns, portfolio excess returns and standard deviation.

	Small-sized portfolio average returns	**Small-sized portfolio average excess returns**	**Standard deviation from excess returns**
Before Covid-19 (2016-2019)	-0,06 %	-0,05 %	1,44 %
During Covid-19 (2019-2022)	0,02 %	0,03 %	3,26%
Whole period (2016-2022)	-0,02%	-0,01 %	2,52 %

Source: Authors own calculations

Notes: Portfolio weekly average excess returns calculated by substracting weekly risk-free rates from portfolio returns

In Table 5, we can see the average returns, excess returns and standard deviation for small-sized portfolio for each time period. Average return for small-sized portfolio before Covid-19 was -0,06%, during Covid-19 it was 0,02% and for the whole time period it was -0,02%. Average excess return for small-sized portfolio before Covid-19 was -0,05%, during Covid-19 it was 0,03% and for the whole time period it was -0,01%. Standard deviation before Covid-19 was 1,44%, during Covid-19 it was 3,26% and for the whole time period it was 2,52%. Values in Table 5 show us that small-sized portfolio has not had very ideal returns during the whole period. small-sized portfolio barely recorded positive returns for time period during Covid-19 but they had negative returns for time period before Covid-19 and the whole time period.

3 RESULTS AND DISCUSSION

This chapter will present the results of the study and discusses them. Author presents results from regression analysis conducted on each portfolio in the correct time periods. After presenting the regression analysis results, the author moves on to show the results of financial models and measures which have been calculated based on the regression analysis results and data.

Like mentioned in previous chapter, the regression analysis was conducted by software called Gretl. In Gretl, the author ran a OSL regression analysis for modeling Capital Asset Pricing Model. However, regression ran for Capital Asset Pricing Model is not the standard model but a bit more accurate model which takes in to account excess returns of both portfolio and market returns. Running a regression analysis for Capital Asset Pricing Model excess values gives out the important outcomes amongst other values. These outcomes are Jensen's alpha and Beta. In total, 9 regression models were ran for Capital Asset Pricing Model values. First 3 were for large, medium and small-sized portfolios for the time period before Covid-19, December 2016 to November 2019. Next 3 regression models were also for large, medium and small-sized portfolios but this time for the time period during Covid-19, December 2019 to December 2022. After finding values for periods being compared, 3 more regression analysis's were run for large, medium and small-sized portfolios but for these values, the time period consisted of the whole time period of examination. In other words, for these models the time period for the whole six years, from December 2016 to December 2022. Regression analysis provides a multitude of values but author will present only the ones that are crucial for the study.

Table 6 below presents the values for large, medium and small-sized portfolios retrieved by running a regression analysis for the time periods before Covid-19 and during Covid-19. Time period before Covid-19 is from December 2016 to December 2019 and time period during Covid-19 is from December 2019 to December 2022. Values are gathered from weekly portfolio excess returns and market excess returns. Both time time periods consist of 157 weeks each. In Table 7 are the values for large, medium and small-sized portfolios retrieved by running the same regression but for the whole time period which is from December 2016 to December 2022. Values are received from weekly portfolio excess returns and market excess returns and the whole time period consist of 314 weeks.

Table 6. OSL regression results for portfolios sized large, medium and small for time periods before Covid-19 and during Covid-19.

Regression analysis results

Before COVID-19						
	Large-sized portfolio		Medium-sized portfolio		Small-sized portfolio	
	Coefficients	P-value	Coefficients	P-value	Coefficients	P-value
Alpha coefficient	0,24 %	0,154	0,08 %	0,381	-0,04 %	0,727
Beta coefficient	-0,198	0,039	-0,044	0,413	-0,065	0,314

During COVID-19						
	Large-sized portfolio		Medium-sized portfolio		Small-sized portfolio	
	Coefficients	P-value	Coefficients	P-value	Coefficients	P-value
Alpha coefficient	0,06 %	0,841	0,17 %	0,514	-0,001 %	0,996
Beta coefficient	0,046	0,64	0,122	0,165	0,126	0,157

Table 6 presents the regression results for alpha and beta coefficients and their p-values for each sized portfolio for time periods before Covid-19, December 2016 to December 2019 and during during Covid-19, December 2019 to December 2022. As we can see from Table 6, before Covid-19 large-sized portfolio had an alpha of 0,24% and beta of -0,198. However, the p-value for alpha is more than 5% so it is considered insignificant and analysis can't confirm that large-sized portfolio actually overperformed the market. However, the beta coefficient is signifficant meaning large-sized portfolio is less volatile than the market, at least on a theoretical level. Before Covid-19 medium-sized portfolio recorded an alpha of 0,08% and a beta of -0,044. However, when we look at the p-value we can see that these values are not significant and we cant conclude that medium-sized portfolio has overperformed the market. As for the beta, medium-sized portfolio does not follow the market index significantly. Similar to medium-sized portfolio, the small-sized portfolio also had larger p-values than 5% therefore the coefficients are not signifficant. No conclusion can be made about whether small-sized portfolio has underperformed the market and we can only say that the small-sized portfolio does not follow the market significantly.

During Covid-19 large, medium and small-sized portfolios all had positive alpha scores. Large-sized portfolio recorded an alpha of 0,06% per week, medium-sized portfolio recorded an alpha of

0,17% per week and small-sized portfolio recorded and alpha of -0,001% per week. However, once again the alpha coefficient results are not significant because the p-value for each of the coefficients is more than 5%. Therefore we cannot make any conclusion whether portfolios have over- or underperformed the market. Beta values were small for every portfolio. Large-sized portfolio had a beta value of 0,046, medium-sized portfolio had beta value of 0,122 and small-sized portfolio had beta value of 0,126. However, these coefficients are not signifficant and we cant make conlusions about the portfolios volatility. We can only say that the portfolios do not follow the market index significantly.

Table 7. OSL regression results for portfolios sized large, medium and small for the whole time period, December 2016 to December 2022

Regression analysis results

Whole period (2016-2022)						
	Large-sized portfolio		Medium-sized portfolio		Small-sized portfolio	
	Coefficients	P-value	Coefficients	P-value	Coefficients	P-value
Alpha coefficient	0,15 %	0,382	0,12 %	0,369	-0,02 %	0,867
Beta coefficient	-0,021	0,766	0,077	0,168	0,075	0,204

Table 7 represents the regression results for the whole time period in the study which is from December 2016 to December 2022. Results show the alpha and beta coefficients as well as their p-values. For the whole time period, large-sized portfolio recorded an alpha of 0,15% per week and beta value of -0,021. Alpha is positive but since the p-value is too large, the alpa coefficient is not signifficant and we cannot make conclude if large-sized portfolio has overperformed the market. P-value for beta is also too large so making conclusions about the volatility of the portfolio for the whole time period is not possible. In other words, portfolio did not follow the market index significantly. Medium-sized portfolio recorded an alpha coefficient of 0,12% per week and beta value of 0,077. However, since the p-value is again too large, the coefficients are not significant. Therefore we can't make any conclusions about the porfolios performance against the market or its volatility relative to market. Small-sized portfolio had and -0,02% alpha per week and beta value of 0,075. Similar to other coeffient values for the whole time period, we are unable to make any conclusions whether small-sized portfolio has underperformed to market index. As for volatility, small-sized portfolio does not follow the market index significantly.

Since almost every coefficient result from regression analysis is not significant, we cant make conclusions whether the portfolios have over- or underperformed the market. However, when comparing just the raw alpha scores each portfolio from time period before Covid-19 to time period during Covid-19 we can see at least some pattern of which time period they have performed better. As we can see from Table 6, the large-sized portfolio had worse alpha scores during Covid-19 than before Covid-19 whereas medium-sized portfolio and small-sized portfolio had better alpha scores during Covid-19 than before Covid-19. However because alpha scores are not significant these conclusions are not valid and therefore only speculation.

3.1 Performance indicators

Table 8. Jensen's alpha, Treynor ratio and Sharpe ratio for each sized portfolio before Covid-19.

Before COVID-19

	Large-sized portfolio	Medium-sized portfolio	Small-sized portfolio
Jensen's alpha	0,24 %	0,08 %	-0,04 %
Treynor ratio	-0,011	-0,012	0,008
Sharpe ratio	0,101	0,065	-0,034

Source: Authors own calculations

Table 8 represent's the results of performance measures Jensen's alpha, Treynor ratio and Sharpe ratio. Before Covid-19 large-sized portfolio recorded the highest alpha of 0,24%, with medium sized company following with 0,08% and small sized company which recorded a negative alpha of -0,04%. However, as mentioned in the previous chapter about regressions results, all alpha values had too large p-values meaning they are not significant. Therefore the evidence is too weak for confirming that large-sized portfolio actually performed the best against the market index. For this time period the Treynor ratio for large-sized portfolio was -0,011. As we can see from Table 8, medium-sized portfolio has similar negative value of -0,012 in Treynor ratio. Out of the 3 portfolios, small-sized portfolio is the only one that has a positive Treynor ratio with a value of 0,008. However, these values are calculated with a negative beta therefore they do not mean anything and no conclusion what so ever can be made of them. Sharpe ratio before Covid-19 was

0,101 for large-sized portfolio. Medium-sized portfolio has also a positive Sharpe ratio with 0,065 but small sized company has negative Sharpe ratio with value of -0,034. This is due to the fact that small-sized portfolio returns for this time period are less than the risk-free rate.

These results indicate that before Covid-19 large and medium-sized portfolios have been able to generate excess returns relative to their total risk while the small-sized portfolio could not. In Table 8 we can see that large-sized portfolio has the highest Sharpe ratio performance measure. To summarize, before the start of the virus, large-sized portfolio performed the best, followed by medium-sized portfolio and the worst performed the small-sized portfolio.

Table 9. Jensen's alpha, Treynor ratio and Sharpe ratio for each sized portfolio during Covid-19.

	During COVID-19		
	Large-sized portfolio	Medium-sized portfolio	Small-sized portfolio
Jensen's alpha	0,06 %	0,17 %	-0,001 %
Treynor ratio	0,015	0,016	0,002
Sharpe ratio	0,019	0,062	0,009

Source: Authors own calculations

In Table 9 is presented the performance measures of Jensen's alpha, Treynor ratio and Sharpe ratio for each sized portfolio during Covid-19. During Covid-19 large-sized portfolio recorded an alpha of 0,06%, medium-sized portfolio recorded an alpha of 0,17% and small-sized portfolio had an alpha of -0,001%. However, the p-values for all alpha values are too large, therefore the alpha scores are not significant and provide too weak evidence to confirm if portfolios have over- or underperformed compared to the market. During Covid-19 each sized portfolios had positive Treynor ratios. Large-sized portfolio had a Treynor ratio of 0,015, medium-sized portfolio had a Treynor ratio of 0,016 and small-sized portfolio had a Treynor ratio of 0,002. This values indicate that all portfolios have been able to generate excess returns relative to their systematic risk. Sharpe ratios for this period are also all positive and each portfolio has generated excess returns relative to their total risk. Sharpe ratio for large-sized portfolio was 0,019, for medium-sized portfolio it was 0,062 and for small-sized portfolio it was 0,009.

When comparing these numbers we can see that during Covid-19, medium-sized portfolio had the highest values in each category and small-sized has the worst. Compared to time period before Covid-19, it seems that medium-sized portfolio has overtaken the large-sized portfolio as the best performing portfolio. For medium-sized portfolio, Treynor ratio is largest and now significant because beta is positive and Sharpe ratio remained about the same as before Covid-19. Sharpe ratio score is lower during Covid-19 than before Covid-19 for large-sized portfolio. For small-sized portfolio, Treynor ratio is worst among all portfolios but now significant and Sharpe ratio is better than before Covid-19. It is also notable that beta values used for calculating Treynor ratios are not significant.

Results and comparisons indicate that medium sized companies have adapted the best to Covid-19. Allthough it has to be noted that alpha scores are not significant and conclusions of performance against the market cant be made but if we compare other measures and just portfolio returns, medium-sized portfolio has gained the most during the pandemic. It is possible that medium sized Nordic technology companies have been able to adapt better to the rise in demand for technology during the pandemic than large or small sized companies. Large sized companies may have still been able to answer the need of rising demand of technology during the virus but it is possible they have lost some of their regular supply which is linked to everyday life where social distancing is not present. Smaller companies have had quite similar performance indicators as before the pandemic which could mean that they have been able to answer the demand but have been unable to gain significant difference in performance due to the fact that they most likely have less money to invest in adapting to the situation.

Table 10. Jensen's alpha, Treynor ratio and Sharpe ratio for each sized portfolio for the whole time period (2016-2022).

Whole period (2016-2022)

	Large-sized portfolio	Medium-sized portfolio	Small-sized portfolio
Alpha	0,15 %	0,12 %	-0,02 %
Treynor ratio	-0,070	0,018	-0,001
Sharpe ratio	0,048	0,057	-0,004

Source: Authors own calculations

Table 10 represents the performance measure results from Jensen's alpha, Treynor ratio and Sharpe ratio. During the whole time period from December 2016 to December 2022, large-sized portfolio recorded an alpha score of 0,15%, medium sized recored alpha score of 0,12% and small-sized portfolio recorded an alpha score of -0,02%. Treynor ratio for large-sized portfolio was -0,070 but the beta was negative so the result of Treynor ratio does not mean anything and conclusions cannot be made. For medium-sized portfolio Treynor ratio was 0,018 and small-sized portfolio it was -0,001. Sharpe ratio for large-sized portfolio was 0,048, for medium-sized portfolio it was 0,057 and for small-sized portfolio Sharpe ratio was -0,004.

Since the p-values for alpha scores are too large, we cannot confirm that large-sized portfolio performed the best against the market. As for Treynor and Sharpe ratios, medium-sized portfolio performed the best during the whole time period and the small-sized portfolio the worst. Medium sized companies were able to make the most of adapsation to Covid-19 which is also reflected in the results for the whole time period.

CONCLUSION

This thesis set its aim to analyse how the performance of Nordic tehcnology companies had changed during the time period of December 2016 to December 2022 and whether companies' size played a role in the performance. In other words, how performance of Nordic technology companies changed when comparing a time period before Covid-19 pandemic to a time period during Covid-19 pandemic.

For this paper, 300 companies which met the criteria for being a Nordic technology companies were selected and weekly stock data of these companies was retrieved from Eikon financial database. In order to take size into consideration in the study, these 300 companies were divided into 3 portfolios based on the size of their average revenue during the years 2016-2022. After portfolios were set, the author calculated the average returns for each portfolio for each time period examined. From these values it was possible to run a regression analysis for Capital Asset Pricing Model and gain values for beta and alpha. After these steps, the author was able to start inserting the values in performance measure models. For measuring performance, the author chose multiple financial performance models and measures to examine the performance of Nordic technology stocks. These models were Jensen's alpha, Treynor ratio and Sharpe ratio. OMX Nordic 40-index was selected as the market index for the study and weekly Euribor was selected as risk-free rate.

Study also faced some limitations. Out of the 300 companies, some companies were missing weekly data from years 2016-2018. Approximately 60 companies did not have data from this period. However, when companies were put in order of their average revenues and portfolios were being formed, companies with limited data from years 2016-2018 were fortunately quite evenly balanced for each portfolio and therefore this limitation was not able to create unbalances in portfolio data or results.

Two crucial variables were the market index returns and risk-free rate. Average market index returns remained positive through out all of the examination periods but due to to the strange economic climate of the 2010's, the avegare risk-free rate in this study remained negative for each time period. Negative risk-free rates are quite a rare sight and they played a large role in the results.

Results of on solely portfolio returns would indicate that larger companies in the Nordic technology sector were actually generating less returns during Covid-19 than before Covid-19 whereas medium sized and smaller sized companies had the opposite result. In other words, two portfolios with medium and small sized companies recorded better returns during Covid-19 than before Covid-19. Even though these changes were percentually quite small, these results would indicate that there is at least some relationship between portfolio size and return.

Regression analysis was results provided Jensen’s alpha values and beta values. Results of Jensen’s alpha show the same situation with larger companies as with portfolio returns, alpha was larger before Covid-19 than it was during Covid-19. However, the changes are small and the large p-values make the results not significant. For medium-sized portfolio, alpha was larger in time period during Covid-19 than time period before Covid-19 and for the smallest portfolio, alpha stayed almost exactly the same. However we cannot make any conclusion on these results neither because values are not significant. Beta values for time period before Covid-19 were all negative and almost everyone of them were not significant. Meaning portfolio returns did not follow the market index significantly. During Covid-19 however, they became all positive but were still not significant.

Performance measure result of Sharpe ratio showed that large-sized portfolio did worse during the pandemic than before it when considering generating excess returns relative to total risk. For medium-sized portfolio Sharpe ratio remained the same. The small-sized portfolio was able to have a better Sharpe ratio than before the pandemic.

To summarize, when comparing the performance of Nordic technology companies before and during Covid-19, the time period during Covid-19 was more lucrative for medium sized companies than for large sized companies in almost every indicator. Small companies' performance remained quite similar in both periods. Even though the changes are not percentually quite large, the pattern is still there and at least some conclusions can be made that for medium and small companies in the Nordic technology sector, Covid-19 has been more profitable than the time period before Covid-19. In other words, especially medium sized companies could answer the high demand better during the pandemic. As for the relationship between size and performance, there is also a relationship at least to some degree. During Covid-19, medium and small-sized portfolios tended to perform relatively better than the largest portfolio when compared to time period before Covid-19. For portfolio returns, portfolio with largest companies was the only one to perform worse during Covid-19 than before it. As a result, conclusions can be made that size did have some effect in the performance of Nordic technology companies during Covid-19.

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APPENDICES

Appendix 1. Regression model outputs

Table 6. OSL regression results for portfolios sized large, medium and small for time periods before Covid-19 and during Covid-19.

Large-sized portfolio before Covid-19.

```
Model 1: OLS, using observations 2016-12-01:2019-11-28 (T = 157)
Dependent variable: Portfolio1weeklyexcessretur

                      coefficient   std. error   t-ratio   p-value
  ----------------------------------------------------------------
  const                0.00243979   0.00170417    1.432    0.1543
  Marketindexexces~   −0.198029     0.0952723    −2.079    0.0393   **

Mean dependent var   0.002170   S.D. dependent var   0.021517
Sum squared resid    0.070265   S.E. of regression   0.021291
R-squared            0.027118   Adjusted R-squared   0.020841
F(1, 155)            4.320407   P-value(F)           0.039306
Log-likelihood       382.5971   Akaike criterion    −761.1941
Schwarz criterion   −755.0816   Hannan-Quinn        −758.7116
rho                 −0.149155   Durbin-Watson        2.260324
```

Medium-sized portfolio before Covid-19.

```
Model 1: OLS, using observations 2016-12-01:2019-11-28 (T = 157)
Dependent variable: Portfolio2weeklyexcessretur

                      coefficient    std. error    t-ratio   p-value
  ------------------------------------------------------------------
  const               0.000834176   0.000949454    0.8786   0.3810
  Marketindexexces~  −0.0435578     0.0530795     −0.8206   0.4131

Mean dependent var   0.000775   S.D. dependent var   0.011850
Sum squared resid    0.021810   S.E. of regression   0.011862
R-squared            0.004326   Adjusted R-squared  −0.002098
F(1, 155)            0.673409   P-value(F)           0.413126
Log-likelihood       474.4340   Akaike criterion    −944.8680
Schwarz criterion   −938.7556   Hannan-Quinn        −942.3855
rho                  0.003737   Durbin-Watson        1.990064
```

Small-sized portfolio before Covid-19.

```
Model 1: OLS, using observations 2016-12-01:2019-11-28 (T = 157)
Dependent variable: Portfolio3weeklyexcessretur

                      coefficient    std. error   t-ratio   p-value
  -----------------------------------------------------------------
  const               -0.000403850   0.00115647   -0.3492   0.7274
  Marketexcessretu~   -0.0653398     0.0646528    -1.011    0.3138

Mean dependent var  -0.000493   S.D. dependent var   0.014450
Sum squared resid    0.032358   S.E. of regression   0.014449
R-squared            0.006546   Adjusted R-squared   0.000137
F(1, 155)            1.021365   P-value(F)           0.313770
Log-likelihood       443.4671   Akaike criterion    -882.9341
Schwarz criterion   -876.8217   Hannan-Quinn        -880.4516
rho                  0.102286   Durbin-Watson        1.791181
```

Large-sized portfolio during Covid-19.

```
Model 1: OLS, using observations 2019-12-05:2022-12-01 (T = 157)
Dependent variable: Portfolio1weeklyexcessretur

                      coefficient   std. error   t-ratio   p-value
  ----------------------------------------------------------------
  const               0.000582093   0.00289849   0.2008    0.8411
  Marketindexexces~   0.0462376     0.0986616    0.4686    0.6400

Mean dependent var   0.000696   S.D. dependent var   0.036099
Sum squared resid    0.203002   S.E. of regression   0.036190
R-squared            0.001415   Adjusted R-squared  -0.005028
F(1, 155)            0.219631   P-value(F)           0.639980
Log-likelihood       299.3134   Akaike criterion    -594.6269
Schwarz criterion   -588.5144   Hannan-Quinn        -592.1444
rho                  0.061165   Durbin-Watson        1.861536
```

Medium-sized portfolio during Covid-19.

```
Model 1: OLS, using observations 2019-12-05:2022-12-01 (T = 157)
Dependent variable: Portfolio2weeklyexcessretur

                      coefficient   std. error   t-ratio   p-value
  ----------------------------------------------------------------
  const               0.00167450    0.00256028   0.6540    0.5141
  Marketindexexces~   0.121698      0.0871493    1.396     0.1646

Mean dependent var   0.001975   S.D. dependent var   0.032064
Sum squared resid    0.158391   S.E. of regression   0.031967
R-squared            0.012424   Adjusted R-squared   0.006053
F(1, 155)            1.950022   P-value(F)           0.164581
Log-likelihood       318.7929   Akaike criterion    -633.5858
Schwarz criterion   -627.4733   Hannan-Quinn        -631.1033
rho                  0.187310   Durbin-Watson        1.623595
```

Small-sized portfolio during Covid-19.

```
Model 1: OLS, using observations 2019-12-05:2022-12-01 (T = 157)
Dependent variable: Portfolio3weeklyexcessretur

                      coefficient   std. error   t-ratio   p-value
  ----------------------------------------------------------------
  const              -1.11063e-05  0.00260257  -0.004267  0.9966
  Marketindexexces~   0.125952     0.0885889    1.422     0.1571

Mean dependent var   0.000300   S.D. dependent var   0.032601
Sum squared resid    0.163667   S.E. of regression   0.032495
R-squared            0.012873   Adjusted R-squared   0.006505
F(1, 155)            2.021401   P-value(F)           0.157105
Log-likelihood       316.2207   Akaike criterion    -628.4414
Schwarz criterion   -622.3289   Hannan-Quinn        -625.9589
rho                  0.279636   Durbin-Watson        1.435949
```

Table 7. OSL regression results for portfolios sized large, medium and small for the whole time period, December 2016 to December 2022.

Large-sized portfolio for the whole time period.

```
Model 1: OLS, using observations 2016-12-01:2022-12-01 (T = 314)
Dependent variable: Portfolio1weeklyexcessretur

                       coefficient   std. error   t-ratio   p-value
  -----------------------------------------------------------------
  const                 0.00147268   0.00168248    0.8753   0.3821
  Marketindexexces~    -0.0205719    0.0691780    -0.2974   0.7664

Mean dependent var   0.001433   S.D. dependent var   0.029678
Sum squared resid    0.275605   S.E. of regression   0.029721
R-squared            0.000283   Adjusted R-squared  -0.002921
F(1, 312)            0.088433   P-value(F)           0.766377
Log-likelihood       659.4472   Akaike criterion    -1314.894
Schwarz criterion   -1307.396   Hannan-Quinn        -1311.898
rho                 -0.017224   Durbin-Watson        2.011915
```

Medium-sized portfolio for the whole time period.

```
Model 1: OLS, using observations 2016-12-01:2022-12-01 (T = 314)
Dependent variable: Portfolio2weeklyexcessretur

                       coefficient   std. error   t-ratio   p-value
  -----------------------------------------------------------------
  const                0.00122656    0.00136458   0.8989    0.3694
  Marketindexexces~    0.0774868     0.0561067    1.381     0.1682

Mean dependent var   0.001375   S.D. dependent var   0.024140
Sum squared resid    0.181294   S.E. of regression   0.024105
R-squared            0.006076   Adjusted R-squared   0.002890
F(1, 312)            1.907327   P-value(F)           0.168249
Log-likelihood       725.2071   Akaike criterion    -1446.414
Schwarz criterion   -1438.915   Hannan-Quinn        -1443.418
rho                  0.153637   Durbin-Watson        1.691696
```

Small-sized portfolio for the whole time period.

```
Model 1: OLS, using observations 2016-12-01:2022-12-01 (T = 314)
Dependent variable: Portfolio3weeklyexcessretur

                      coefficient   std. error  t-ratio  p-value
  --------------------------------------------------------------
  const               -0.000239106  0.00142390  -0.1679  0.8668
  Marketindexexces~    0.0745021    0.0585457    1.273   0.2041

Mean dependent var  -0.000096   S.D. dependent var   0.025178
Sum squared resid    0.197398   S.E. of regression   0.025153
R-squared            0.005164   Adjusted R-squared   0.001975
F(1, 312)            1.619375   P-value(F)           0.204126
Log-likelihood       711.8460   Akaike criterion    -1419.692
Schwarz criterion   -1412.193   Hannan-Quinn        -1416.696
rho                  0.241159   Durbin-Watson        1.512802
```

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