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Is There a Low-Beta Anomaly in the Nordic Stock Market? An Empirical Analysis of Risk and Return from 2000-2023

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ABSTRACT

In this master thesis we analyse the relationship between risk and return in the Nordic stock market. Established financial theory states that there is a linear relationship between risk and return and that investors will be compensated for taking on additional risk. However, research such as Black, Jensen and Scholes (1972) found that the relation between expected return and beta is weaker than anticipated. Positive abnormal returns have been found for portfolios consisting of low-beta stocks, this is known as the beta anomaly. We investigate if the low-beta anomaly was present from 2000 through 2023, in the Nordic stock market. We construct two long portfolios, one high-beta and one low-beta portfolio for each country. The anomaly was most present in Norway and found in 14 out of 19 years. The cumulative return for the low-beta portfolio outperformed the high-beta portfolio in Norway, Sweden, and Denmark over the long run from 2005-2023. For Finland, the cumulative return for the high-beta portfolio outperformed the low-beta portfolio. The results suggest that the low-beta anomaly was present in Norway, Sweden, Denmark, and Finland.

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1. INTRODUCTION

This thesis discusses whether the so-called “low-beta anomaly” existed in the Nordic stock markets from 2000-2023. The anomaly implies that low-beta stocks yield higher returns than high-beta stocks. In other words, the opposite of what established financial theory states. The CAPM states that differences in expected return are explained by beta and beta only, and that there is a linear relationship between expected return and beta. The anomaly implies that the standard assumptions of a positive linear relationship between beta and return does not exist. Rather, low-beta stocks have higher risk-adjusted returns compared to high-risk stocks. However, a number of studies have concluded that this is not always the case, finding evidence that the relation between beta and average return is weaker than predicted by the version of the CAPM presented by Sharpe, Mossin and Lintner (Black, Jensen and Scholes, 1972; Fama and French, 2004; Frazzini and Pedersen, 2014).

The “low-beta anomaly” is a well-known anomaly, and the topic has been investigated in many articles (Black, Jensen and Scholes (1972); Blume and Friend (1973); Fama and MacBeth (1973); Fama and French (1992)). Earlier studies date back to the 1970s when researchers started looking into other variables that might play a part in explaining expected return; like size, P/E and momentum. The topic is still relevant today. Investors and researchers are puzzled by the anomaly and looking for good explanations. Economist Bergh have engaged in the low-beta anomaly and kept track of the stock returns in Norway in relation to the market risk. He found clear signs of the anomaly in Norway (Bergh, 2023). Carnegie recently published an empirical study (March 2024) where they, as others before them, found that stocks with low-risk yield higher returns (Carnegie, 2024). Their study analyzed companies included in the S&P 500 over the 20 years from 2003 to 2023. It seems that low-risk stocks are often undervalued and traded at a lower price, whereas high-beta stocks are more expensive, and that in the long run the low-beta stocks yield higher returns (Frazzini & Pedersen, 2014). Knowledge of the existence of the anomaly is beneficial when it comes to stock picking and portfolio management.

Our research will focus on the Nordic countries, analyzing the market from 2000 through 2023. Specifically, we will test whether low-risk companies in Norway, Sweden, Denmark and

Finland outperformed high risk companies from 2005 through 2023, as suggested by the low-beta anomaly. We will analyze whether investors are compensated for taking on high systematic risk as the CAPM states, or if low-risk yields higher return for portfolios composed annually.

The paper is structured as follows. Section 2 outlines the basics of the CAPM and presents relevant research literature on the low-beta anomaly. Section 3 presents the method applied in our study, and section 4 explains the data sample used in the paper. The main results and findings are presented in section 5. Finally, we summarize and conclude in section 6.

2. LITERATURE REVIEW

2.1 Risk and return in capital markets and the CAPM

In an efficient capital market, asset prices fully reflect all available information (Fama and MacBeth, 1973; Fama, 1970). Return is expected to rise with an increase in the systematic non-diversifiable risk. The Capital Asset Pricing Model (CAPM), introduced by Traynor (1961), Sharpe (1964), Litner (1965) and Mossin (1966), is a fundamental model in finance that is used to calculate the appropriate return requirements for investments. The CAPM outlines the relationship between the systematic risk and the expected return for an asset. The model is based on the earlier work of Harry Markowitz (1999). The central idea of the model is that investors demand a higher return to compensate for a higher risk.

The CAPM is defined as:

$E(R_i) = R_f + \beta_i(E(R_m) - R_f),$

where $E(R_i)$ is the expected return of investment, R_f is the risk-free rate, β_i is the beta of the investment, and $(E(R_m) - R_f)$ is the market risk premium.

Beta is a measure of systematic risk of a security, or a portfolio compared to the market. The market beta is 1, and a portfolio with a higher beta implies higher risk, as it is more volatile than the market. Beta describes the relationship between systematic risk and expected return in the capital asset pricing model.

Beta is defined as:

$$\beta = Correl(r^x, r^{market}) * \frac{std(r^x)}{std(r^{market})}$$

The CAPM implies that there is a linear relationship between expected return and beta. Secondly, the expected return on the market portfolio is larger than the return on assets that are uncorrelated with the market return. Assets are expected to have returns equal to the risk-free rate if they are uncorrelated with the market, and the beta premium is the expected market return minus the risk-free rate (Fama & French, 2004). The model does not take taxes, inflation, and transaction costs into account. However, studies have found that the relation between beta and average return is flatter than predicted by the CAPM (Black, Jensen and Scholes, 1972; Fama and French, 2004; Frazzini and Pedersen, 2014). According to Fama and French, these empirical issues may be a result of theoretical failings and the use of simplifying assumptions. Research often limits the market portfolio to common stocks, whereas the CAPM states that risk should be measured relative to a comprehensive market portfolio. This portfolio could also include consumer durables, real estate, and human capital in addition to traded financial assets. The use of the CAPM is often invalid, regardless of what causes the CAPM to fail, whether it is weakness in theory or the implementation (Fama and French, 2004).

The CAPM assumes that investors are risk averse.This follow a "mean-variance model" where they choose portfolios that minimize the variance of portfolio return for a given expected return, and maximize expected return for a given variance (Fama & French, 2004). Sharpe (1964) and Lintner (1965) added two other assumptions; complete agreement, and borrowing and lending at a risk-free rate. Complete agreement means there is agreement among investors about distributions of asset returns. Investors all lend at a risk-free rate regardless of the amount borrowed or lent. However, this is an unrealistic assumption. Black (1972) therefore developed a version without the assumption of risk-free borrowing and lending. With this, he showed that the mean-variance-efficient portfolio can be obtained by allowing unrestricted short sales of risky assets.

Complete agreement, unrestricted risk-free borrowing and lending, and unrestricted short selling are all unrealistic assumptions (Fama & French, 2004). Both the Sharpe-Lintner and Black version of The CAPM share the assumption that *no other variables* than the differences in market beta explain the differences in expected return. Simplifications and unrealistic assumptions may however impact the credibility and accuracy of models. The CAPM has therefore been tested by many (i.e. Jensen 1968; Blume 1970; Black, Jensen & Scholes 1972; Basu 1977; Banz 1981; Statman 1980 and Rosenberg, Reid & Lanstein 1985).

Figure 1a displays the Capital Market Line with expected risk on the x-axis and expected return on the y-axis. The security market line (SML) is displayed in figure 1b, which is derived from the capital asset pricing model. The capital market line applies to efficient portfolios. This states that the total risk (standard deviation) of the efficient portfolio determines the expected return (Bøhren et al., 2018). The Security Market Line is a representation of the relationship between the expected return and the systematic risk, beta. The figure shows that, starting with the risk-free rate, when the systematic risk (beta) increases, the expected return also increases.

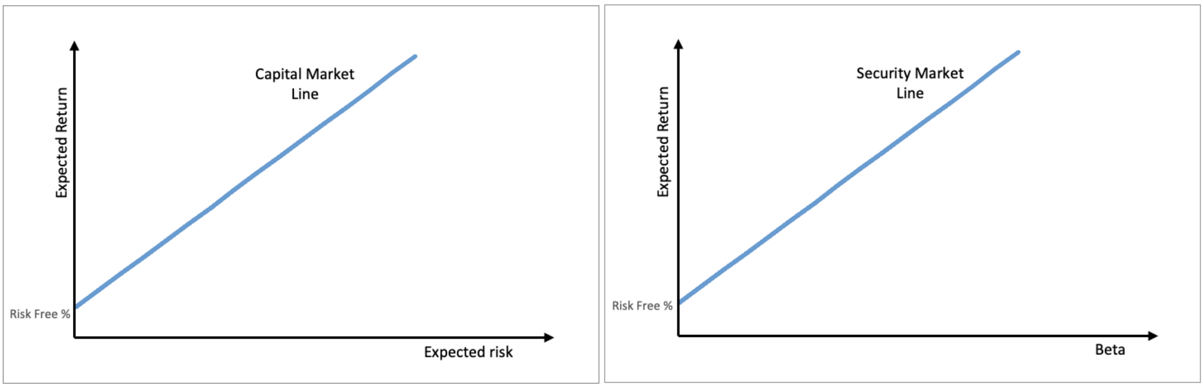

Figure 1: a) The Capital Market Line (CAPM), where the y-axis represents the expected return, while the x-axis represents the expected risk. b) The Security Market Line (SML) is a representation of the capital asset pricing model. The y-axis represents the expected return, while the x-axis shows the systematic risk, beta.

2.2 Empirical tests of the CAPM

Many empirical tests of the Sharpe-Lintner CAPM found that the relation between beta and average return is too flat compared to what is predicted by the CAPM (Fama and French 2004). The Sharpe-Lintner model states that the intercept is the risk-free rate, and the beta coefficient is the expected market return minus the risk-free rate. Black, Jensen and Scholes (1972), Blume and Friend (1973), Fama and MacBeth (1973) and Fama and French (1992) found that the intercept is greater than the risk-free rate and that the beta coefficient is less than the average excess market return.

Basu (1977) found that future returns on high P/E stocks are higher than predicted by CAPM when common stocks were sorted on earnings-price ratios. Banz (1981) found that when sorting stocks based on market capitalization the average returns on small stocks was higher than what the CAPM predicts. Bhandari (1988) looked at the debt-equity ratio and found that the return of companies with high debt-equity ratio were too high relative to their market betas. Rosenberg, Reid and Lanstein (1985) found that the betas did not explain the returns of stocks with high book-to-market ratios and found evidence of market inefficiency. Fama and French (2004) pointed out that market betas excluded information from ratios involving stock prices that could bring information about expected return. This was also confirmed by Fama and

French (1992) who found that size, earrings-price, debt-equity and book-to-market ratios could add valuable information about expected returns.

The conditional CAPM is an extension of the traditional CAPM, which says that the expected return is a proportion to the conditional beta. The conditional CAPM allows for variation in the betas and the expected return (Jagannathan & Wang, 1996). Jagannathan and Wang (1996) studied the conditional CAPM and the cross-section of expected return and suggested that the conditional CAPM holds. They found that the size effect and the statistical rejection of the model specifications became much weaker when the beta and the expected return was allowed to vary over time. This by assuming that CAPM holds period by period. Jagannathan and Wang (1996) suggested that the firm size does not contribute any additional explanatory capability. Including human capital when measuring wealth, they found that the unconditional model (i.e. where β_i is constant) implied by the conditional CAPM was able to explain 50% of the cross-sectional variation in the average returns in the period, and their data did not reject the model. They used the value-weighted index from Center for Research in Security Prices (CRSP) as the market portfolio, and monthly stock returns of nonfinancial listed firms on New York Stock Exchange (NYSE) and American Stock Exchange (AMEX), from 1962 – 1990. Furthermore, they followed Fama and French (1992) and created 100 portfolios of stocks from NYSE and AMEX.

Asset pricing tests often assume that beta is constant over time, and according to Lewellen and Nagel (2006), empirical tests often assume that beta is stable for five years or more. They argued that ignoring all the variation in beta had small impact on the asset pricing tests. Their simulations, where the risk and expected returns change daily or weekly, showed that their short-window regression captured nearly all impacts from the time-varying betas. Lewellen and Nagel (2006) suggested that the beta variation over time was not enough to explain the large unconditional pricing errors.

Lewellen and Nagel (2006) analyzed whether the conditional CAPM could explain asset pricing anomalies. This was done with focus on size, book-to-market ratio and momentum portfolios 1964-2001. The portfolios were value-weighted and contained all common stocks from NYSE and AMEX. The momentum portfolios were constructed separately and used all stocks on CRSP. Lewellen and Nagel (2006) tested both daily, weekly, and monthly returns.

They suggested that the conditional CAPM performed nearly as badly as the unconditional CAPM. Furthermore, they found that the conditional CAPM did not explain the asset pricing anomalies, such as the book-to-market ratio or momentum.

2.3 The low-beta anomaly

The low-beta anomaly states that low-beta stocks outperform high-beta stocks and provide higher returns than predicted by the Capital Asset Pricing Model. Findings by Black, Jensen and Scholes (1972), Fama and MacBeth (1973) and Haugen and Heins (1975) showed that the CAPM is violated as portfolios with high-beta stocks generate lower return than CAPM implies and have negative alphas. Positive alphas were found for portfolios of low-beta stocks.

In an influential paper Fama and French (1992) found that the expected return of a stock is not determined by its beta. The simple relation between the beta and the average return on NYSE, AMEX, and NASDAQ stocks disappeared in the period between 1963-1990. The period 1941-1990 also showed a weak relationship between beta and the average return. Their results did not support the central prediction of the Sharpe-Lintner-Black (SLB) model - the average stock returns were not positively related to the market beta. Even when beta was the only explanatory variable, they found that when the tests allowed for variation in beta the relation between the market beta and average return was weak. They found a strong relation between average return and size, but not for the average return and beta. Their study led to further research on the low-beta anomaly in the U.S. stock market, which found evidence of the low-beta anomaly in the U.S. stock market as well as in other equity markets.

Blitz and Vliet (2007) suggested that stocks with low volatility earn high risk-adjusted returns over the sample period 1986 to 2006. They observed this in US, European and Japanese markets in isolation - the volatility effects were persistent over the three regions as well as on a global basis. Blitz and van Vliet (2007) also made robustness tests for the volatility anomaly and showed its resilience across regions and under adjustments for size, value and momentum effects. Their results suggested that investors overpay for risky stocks, and that this can be explained by leverage restrictions and behavioral biases of the investors.

Baker et al. (2011) studied the U.S holdings from 1968-2008 and found that high-beta stocks earned a higher total return than low-beta stocks in up markets, while the high-beta stocks earned a lower total return than the low-beta stocks in down markets. However, they found that the low-beta anomaly was present in both environments on a capital asset pricing model market-adjusted basis. Baker et al. (2011) suggested that the beta drives the anomaly in large stocks, while both risk measures, beta and volatility, play a role in the small stocks – which is aligned with the tendency of benchmarked managers to mostly focus on large stocks. Small stocks are expensive to trade, especially when shorting. Baker et al. (2011) suggested that this was why investors do exploit the knowledge about the anomaly. They proposed that the anomaly may be somewhat explained by investors aim to outperform the benchmark and that this discourages arbitrage activity in high- and low-beta stocks. Their results suggested that the CAPM works to some extent across asset classes, differing from its long-term performance within the stock market.

The article "Betting Against Beta" by Frazzini and Pedersen (2014) has gained a lot of attention. Frazzini and Pedersen (2014) concluded that high-beta stocks seem to underperform, providing evidence that the beta anomaly is driven by funding liquidity. They used a BAB (betting against beta) factor, a portfolio that holds low-beta assets, leveraged to a beta of one, and shorts high-beta assets, de-leveraged to a beta of one. They found evidence that the betting against beta (BAB) factor produced significant positive risk adjusted returns and that when funding constraints tighten, the return of the BAB factor was low. They studied 20 international equity markets[1] using data from 1926-2012 for the US, and data 1989-2012 for the other 19 countries. Betas were computed with respect to corresponding MSCI local market index and all returns are in US dollars. When estimating betas they used daily data, when possible, to improve accuracy of covariance estimation. They required 36 observations for correlation when using five-year windows and monthly data. They found statistically significant returns for their BAB portfolio in six countries[2] when looking at stocks for each of the 19 countries. They found positive excess returns for the Nordic countries. They did not find statistically

[1] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Italy, Japan, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, United Kingdom, and United States.
[2] The alphas were statistically significant for Belgium, Canada, Switzerland, Hong Kong, Netherlands, and Singapore.

significant alphas for the Nordic countries, from 1984-2012. However, a small number of stocks in many of the countries made it difficult to reject the null hypothesis of zero return.

Cederburg and O'Doherty (2016) found that the beta anomaly is resolved by the conditional CAPM when modeling the conditional market risk for beta-sorted portfolios. They constructed long-short decile portfolios. They found that the conditional beta for the high-minus-low-beta portfolio had a negative covariation with the equity premium and positively covariates with market volatility. They used six variables[3] to identify the economic drivers for the changes in CAPM betas. They used data from NYSE, AMEX, and NASDAQ from 1926-2012, sorting firms into 10 groups based on beta. The first portfolio formation date was in 1930 due to lagged estimates of conditional betas. Their portfolios were held for 12 months before rebalancing. Portfolio returns were converted to excess returns by subtracting the corresponding risk-free rate. Missing returns due to delisting during a given month were replaced with delisting returns provided by CRSP (Center for Research in Security Prices). Their analysis suggested viewing the findings of success for betting against beta with caution. They argue that the findings in prior studies is a result of biases in unconditional performance measures.

Bali et al. (2017) suggested that an important driver of the beta anomaly is investors' demand for lottery-like stocks. They looked at the U.S. market from 1963-2012 and found that the beta anomaly was no longer found if they controlled portfolios for lottery demand. Lottery investors look for stocks that have a high probability of generating high returns in the short-term. Large short-term up moves are partially affected by a stock's sensitivity to the market (market beta). High demand for lottery-like stocks drives the prices of these stocks up and future returns decrease. An intercept greater than the risk-free rate and a slope less than the market risk premium (for the line that describes the relation between beta and expected stock return) is generated because of the price pressure. This results in positive alpha for portfolios with long low-beta stocks and short high-beta stocks. When calculating beta, they required a minimum of 200 valid daily returns to be used in the regression. They sorted stocks into 10 portfolios in ascending order based on beta. The stock's lottery demand was measured by a max (the average

[3] The fitted market risk premium, number of IPOs in the prior five years divided by the number of sample firms, the cross-sectional standard deviation of firm-level log book-to-market ratios, the cross-sectional standard deviation of firm-level book leverage, the cross-sectional average of firm-level idiosyncratic volatility computed from daily returns over the prior 12 months, and the standard deviation of the daily TED (Treasury Eurodollar) spread of innovations over the prior three months

of the five highest daily returns of the stock during the given month). Furthermore, they controlled for the variables: firm characteristics (including market capitalization, book-to-maket ratio, momentum, stock illiquidity, and idiosyncratic volatility), measures of risk, and measures of stock sensitivity to aggregate funding liquidity factors.

Barroso et al. (2020) found that large and significant CAPM alphas are produced by betting-against-risk (BAR) portfolios when analysing U.S stocks, from 1967-2018. They studied six BAR portfolios, where four of the portfolios were betting-against-beta portfolios, one formed on total volatility and one on idiosyncratic volatility. They build more conventional betting-against-beta portfolios as the strategy by Frazzini and Pedersen (2014) was found by Novy-Marx and Velikov (2018) to not be profitable if the stocks are value weighted as opposed to rank-weighted like the paper proposed. Barosso et al. (2020) tested risk adjusted-returns using the Fama and French (2018) 6-factor model. Five out of six BAR portfolios had insignificant alphas and only the BAB portfolio, as in Frazzini and Pedersen (2014), had a significant positive alpha driven by micro-caps that are overrepresented in the portfolio. This was the only long-short portfolio that was not value-weighted. The abnormal returns of risk-managed versions of the portfolios could not be explained by the Fama and French (2018) 6-factor model[4].

Hwang et al. (2020) studied beta herding through overconfidence. Betas are compressed towards the market beta as a result of investors' biased perceptions, this is known as beta herding. They constructed high-minus-low beta portfolios over 12 months. Their results implied the presence of a low-beta anomaly in the standardized-beta sorted portfolios in the US stock market. They looked at common stocks on the NYSE, AMEX, and NASDAQ whose market capitalizations are larger than the bottom 20% of the NYSE stocks from 1967-2016. This was determined through the construction of value-weighted decile portfolios created on standardized betas of non-microcap stocks. Subsequently, post-formation risk-adjusted returns were calculated for each portfolio over the following 12 months using the market model. They estimated betas every month by using rolling windows of the prior 12 months of daily returns. For robustness, they also estimated betas using 60-months rolling windows (minimum 24 months).

[4] Market (RMRF), size (SMB), value (HML), profitability (RMW), investment (CMA), and momentum (MOM.)

Hwang et al. (2020) suggest that the low-beta anomaly following adverse beta herding could not be explained by the substantial difference in post-formation betas in the sample period. They found that the low-beta anomaly occurred solely after adverse beta herding. Hwang et al. (2020) suggested that low-beta anomaly disappeared when the lagged beta heard measure was introduced as an explanatory variable. They suggested that following high sentiment, when the investors are optimistic or bullish, the return of the high-minus-low standardized beta portfolios decreased. Hwang et al. (2020) added explanatory variables to capture time variation in betas. Their results supported Cederburg and O'Doherty (2016) allegation that the low-beta anomaly disappeared when using the six lagged instrumental variables[5] to model time-varying betas. They suggested that the relationship between beta herding and market (the market timing) did not explain the low-beta anomaly. Their findings further suggested that the low-beta anomaly only occurred when the market volatility was high and adverse beta herding occurred – the market return in along with volatility timing was responsible for the low-beta anomaly (Hwang et al., 2020). The relationship between the beta herd measure and the market volatility generated the low-beta anomaly only when the market return was positive.

Novy-Marx and Velikov (2022) argued, in the article "Betting against betting against beta", that Frazzini and Pedersen (2014) used unconventional procedures (i.e. rank-weighted portfolio construction, hedging by leveraging and novel beta estimation technique) to construct their BAB factor and that this affected the paper's results. They found that rank-weighted portfolio construction, which assigns each stock to a "high" or "low" portfolio with a weight proportional to the cross-sectional deviation of the stock's beta rank from the median rank, drives the BAB's performance. Furthermore, hedging by leveraging, using the same portfolios to hedge the strategy, also affected the papers results as this puts more weight on the smallest and most illiquid stocks. Novy-Marx and Velikov (2022) argued that this makes for an impressive "paper" performance but would not be possible for an investor to actually achieve in practice. They also commented on the novel beta estimation of Frazzini and Pedersen (2014), that used five years of overlapping three-day returns for market correlation combined with one-year daily

[5] The six instrumental variables include the fitted market risk premium, number of IPOs in the prior five years divided by the number of sample firms, the cross-sectional standard deviation of firm-level log book-to-market ratios, the cross-sectional standard deviation of firm-level book leverage, the cross-sectional average of firm-level idiosyncratic volatility computed from daily returns over the prior 12 months, and the standard deviation of the daily TED (Treasury Eurodollar) spread of innovations over the prior three months.

data for volatilities, instead of estimating the betas as slope coefficients from CAPM regressions. Novy-Marx and Velikov (2022) argued that "for each dollar invested in BAB, the strategy commits on average $1.05 to stocks in the bottom 1% of total market capitalization".

Bradriana et al. (2023) studied the beta anomaly and the quality effect in international stock markers and used daily and monthly data for 22 developed markets[6], spanning from 1990-2021. They created beta sorted quantile portfolios for each aggregated portfolio, the European, Pacific, and Global (excluding the US). They made a low-high-beta portfolio by taking a long position in the lowest beta quantile as well as a short position in the highest beta quantile. The portfolios were equally weighted and rebalanced every month (from January 1993), and the betas were estimated based on the three last years. The performance of the low-high-beta portfolios from 1993- 2021 showed that the low-beta stocks yielded higher returns than the high-beta stocks, on average. They argued that the beta anomaly was found when including junk stocks (low-quality stocks) and did not apply in high-quality stocks. Their findings suggested that the beta anomaly was economically and statistically significant in aggregate stock portfolios in the sample period. They also explored the beta anomaly at each country level, where the portfolios were constructed in the same way but for 22 countries. They found that all alphas relative to CAPM and the Fama-French 3-factor model[7] were positive for all 22 countries. They suggested that the anomaly was present in Europe, Pacific and Global, and in 14 out of 22 countries. The alphas were positive for all the Nordic countries. Their results suggested that the strength in the beta anomaly was stronger when controlling for size and value factors, which is in line with the findings from Fama and French (1992). The results were also consistent with the findings for the aggregated portfolios – the beta anomaly also existed at a country level (Bradriana et al., 2023).

[6] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Singapore, Spain, Sweden, Switzerland, and the United Kingdom.

[7] size risk, value risk, market risk

3. METHODS

In order to test whether the low-beta anomaly is present in the Nordic market we estimated betas and constructed two portfolios for each country that was rebalanced annually from 2005-2023. The high-beta portfolios were constructed of the stocks with the 20% highest betas, while the low-beta portfolios were constructed with the stocks with the 20% lowest betas, each holding long positions. The portfolios were reconstructed annually, including the stocks with the 20% highest/lowest beta values. By assessing the returns from the high- and low-beta portfolios we investigated the premises of the capital asset pricing model (CAPM) when it comes to risk and expected return. Section 3.1 and 3.2 explains the estimation of betas and portfolio construction in detail. Section 3.3 explains the estimation of the variables that are used to evaluate the portfolios, such as Sharpe ratio, portfolio betas, total risk, and proportion of systematic and unsystematic risk for the high- and low-beta portfolio for each country.

3.1 Beta Estimation

Betas was estimated using monthly stock returns and prices from the previous five years for each portfolio. According to Novy-Marx and Velikov (2022), betas estimated by using daily data tend to be downward biased due to nonsynchronous trading issues. Nonsynchronous trading is a phenomenon that occurs when the prices are assumed to be recorded at fixed intervals but are actually recorded at intervals of varying lengths - which may cause inaccuracies in the data analysis (Lo & MacKinlay, 2002). We used monthly data to mitigate these issues. We required 60 coherent observations for the beta calculations. The calculation of the ex-post betas involves computing logarithmic returns, as it enhances comparability when analyzing historical return indices and price indices. The beta values were calculated using moving regression of log returns with a 60 month moving period that was moved 12 months forward every year. The betas were computed with respect to the benchmark in each country. Alternatively, one could be less strict and only require 36 observations as in Frazzini and Pedersen (2014). We used Oslo Exchange All Share, OMX Stockholm, OMX Copenhagen, and OMX Helsinki as benchmarks for Norway, Sweden, Denmark, and Finland when calculating the betas. Stocks with negative beta values and beta values higher than 2, in the 60 months moving period, were removed from the given period.

High-beta is defined as stocks with beta above 1. However, some years it was not possible to construct a decent sized high-beta portfolio where all stocks had betas above 1, as some companies have a large market share. This led to some of the 20% stocks with the highest betas in the high-beta portfolio for Denmark and Finland having betas below 1.

3.2 Portfolio construction

Two equally weighted long portfolios were constructed each year from 2000 to 2023, with a one-year holding period. These was constructed based on the stocks with the 20% highest and the 20% lowest monthly beta values from the last 5 years. The portfolios were constructed with stocks listed on Oslo Exchange All Share (OSEAX), OMX Stockholm (OMXS), OMX Copenhagen (OMXC), and OMX Helsinki (OMXH) today, from Refinitiv Datastream. The portfolios were reconstructed each year from 2005 to 2023. This resulted in 19 portfolios for both the high- and low-beta stocks. The first portfolio formation date was January 2005, and the last portfolio formation date was January 2023. The sample for Sweden was more than twice as large as Norway's sample, which made Sweden's portfolios more diversified. Furthermore, Norway, Sweden, Denmark, and Finland consisted of 8 to 60 stocks in each portfolio when including the stocks with the 20% highest/lowest betas.

We constructed a long high-beta stock portfolio and a long low-beta stock portfolio. The first long high- and low-beta portfolio was constructed in 2005 and were reconstructed every year for each country. Each stock in the portfolio was equally weighted. Alternatively, the portfolios could be rank-weighted, as in Frazzini and Pedersen (2014), or value-weighted – but we have not controlled for size and value factors in this paper. The strength in the beta anomaly was found to be stronger when controlling for size and value factors according to Bradriana (2023) and Fama and French (1992). The decision to avoid using rank-weighted portfolios is influenced by the critiques presented by Novy-Marx and Velikov (2021) regarding Frazzini and Pedersen (2014) use of rank-weighted portfolios. Novy-Marx and Velikov (2021) found that the rank-weighted portfolios used by Frazzini and Pedersen (2014) affected BAB's performance and that the portfolios would not be profitable if the stocks were value-weighted.

When we constructed portfolios based on the 20% highest and lowest betas, we did not consider other variables that would be considered when constructing a well-diversified portfolio, such as market capitalization, momentum, leverage, book-to-market ratio, P/E, market risk premium, and liquidity. Many companies from the same sectors may also be included in the same portfolios when choosing the companies with the 20% highest/lowest betas. Ideally, an investor should hold a well-diversified portfolio as the CAPM assumes that investors are risk averse and choose portfolios that minimize the variance of portfolio return.

We calculated the annual simple returns for the portfolios each year, investing in January and selling in December. This means that big changes in the last portfolio months will affect the portfolio returns at a higher scale compared to using the average return for the 12 months. With local currencies, 100 NOK/SEK/DKK/EUR were invested in each portfolio the first year in 2005. The cumulative returns were reinvested in the reconstructed portfolio the following years to 2023. The performance of the two portfolios was compared to each other as well as to the country's benchmark.

3.3 Portfolio Evaluation

In addition to evaluating the cumulative return when investing the 100 NOK/SEK/DKK/EUR in each portfolio for each country, and analyzing the portfolio returns, we calculated the annual risk adjusted return, the Sharpe ratio, for the high-low portfolio for each country. When calculating the Sharpe ratio, we annualized the monthly portfolio returns, and the monthly standard deviation of the portfolio returns. We subtracted the risk-free rate in the given country from the portfolio return and divided this by the standard deviation. We used the risk-free Norwegian 10-year government bond; risk-free Sweden 3-month government bond; risk-free Denmark 3-month government bond; and risk-free Finland 10-year government bond, respectively.

We also analyzed the 19 years the portfolio was held, as a whole. We used regressions for all the monthly portfolio returns against the benchmarks for the high- and low-beta portfolio, from 2005 through 2023. The regression output gave us the portfolio betas, and the proportion of systematic risk (R^2). We also estimated the proportion of unsystematic risk (1-R^2) based on the regression output. The annualized total returns, calculated by standard deviation, was estimated by the average portfolio returns. The risk adjusted returns for each country, Sharpe ratio, was calculated using the annualized monthly returns minus the corresponding risk-free rate, divided by the annualized monthly standard deviation.

4. DATA

The data was downloaded from Refinitv Datastream. We used monthly total return indices for Norway, but monthly price indices for Sweden, Denmark and Finland from January 2000 through December 2023. The companies are listed on OSEAX, OMXS, OMXC and OMXH. We use local currencies in each of the four countries[8]. Prior to filtering, Norway had 189 stocks throughout the entire sample period, while Sweden had 394 stocks. Denmark and Finland had 128 and 139 stocks pre-filtering.

It is important to note that the composition of the indices have varied over time due to factors such as delisting's, bankruptcies, mergers, and acquisitions. The selection and number of stocks in the indices have been different each year throughout the sample period. Stocks with less than 72 coherent monthly observations have been filtered out in our data. This means that stocks that were delisted during the 72 months were not included in the portfolios. This can lead to some bias in the results. Alternatively, one could remove the stocks at the point they were delisted and reinvest the invested amount in new stocks. B-class shares have been removed when the company has both A- and B-class shares in the portfolio.

In order to obtain relevant benchmarks back to 2000, we chose to use return indices for Norway and price indices for Sweden, Denmark and Finland. The price index only considers the price movements, while the total return index includes dividends. This could lead to some bias if comparing the results between the countries. The countries, however, were analyzed individually. The monthly total returns indices and price indices are from the 1st every month. The sample period was set to 23 years, which includes several dramatic periods such as the

[8] On January 1, 2002, Finland replaced the Finnish markka with the euro, becoming its official currency. The data were converted through a fixed conversion rate, where €1 = 5.94573 FIM.

Dot-com bubble from 1995-2001, the financial crisis in 2008, the Covid19 Pandemic in 2020, and the invasion of Ukraine in 2022.

We used OSEAX, OMXS, OMXC and OMXH as benchmarks for Norway, Sweden, Denmark, and Finland. Figure 2 illustrates the monthly total return indices and monthly price indices from January 2000 through December 2023 for all the benchmarks, starting at 100 NOK/SEK/DKK/EUR in local currency. The four indices followed some of the same patterns in most of the same periods. The graphs all reached a peak in 2007 before dropping in 2008 due to the financial crisis. The economy developed similarly in the Nordic countries during the corona pandemic despite the different ways the pandemic was handled. Norway earned records on oil and gas after the war in Ukraine started in 2022. Some of the biggest sectors in Norway are energy, finance, and shipping[9]. In Sweden producer manufacturing, finance and health technology are large sectors[10], while the biggest sectors in Denmark are health technology, finance, and transportation[11]. In Finland finance, producer manufacturing and process industries are key sectors[12]. Based on total market capitalization the two largest sectors in the Nordics are the industrial and financial sector[13].

9 https://www.tradingview.com/markets/stocks-norway/sectorandindustry-sector/
10 https://www.tradingview.com/markets/stocks-sweden/sectorandindustry-sector/
11 https://www.tradingview.com/markets/stocks-denmark/sectorandindustry-sector/
12 https://www.tradingview.com/markets/stocks-finland/sectorandindustry-sector/
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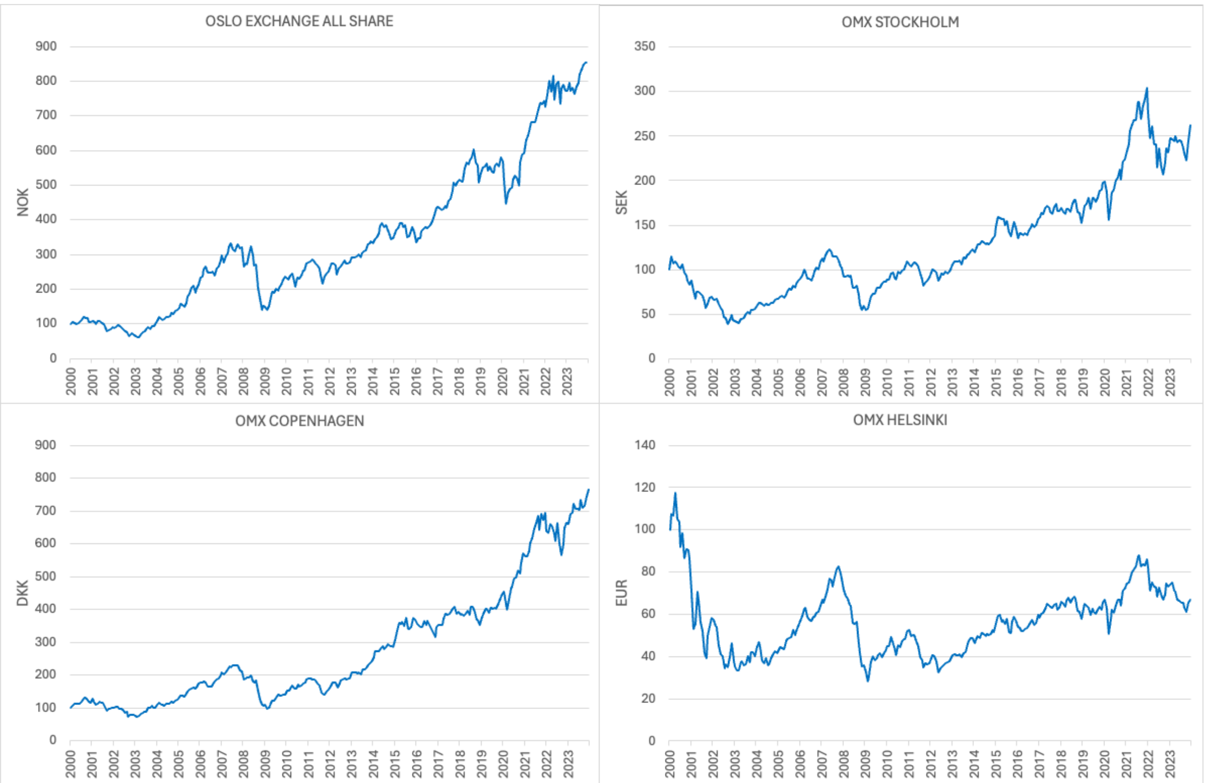

Figure 2: Stock indices for a) Oslo Exchange All Share Return Index, b) OMX Stockholm Price Index, c) OMX Copenhagen Price Index, and d) OMX Helsinki Price Index from 2000-2023. All starting at 100 NOK/SEK/DKK/EUR.

4.1 Descriptive Analysis of The Benchmark

Oslo Exchange All Share is used as the benchmark for Norway. It contains a broad range of stocks from the Norwegian stock market in the sample period. While the Oslo Exchange Benchmark contains 68 stocks, Oslo Exchange All Share contains 189 stocks. However, one could alternatively use the Oslo Exchange Benchmark as the index. In this context, we have compared the two indices and their performances by examining the correlation between Oslo Exchange All Share and Oslo Exchange Benchmark. The correlation between the monthly total return indices was 0.9986. The linear relationship between the two indices was strong – they are positively correlated in the sample period.

Figure 3 illustrates the annual 36 months rolling standard deviation for Oslo Exchange All Share (OSEAX), OMX Stockholm (OMXS), OMX Copenhagen (OMXC) and OMX Helsinki (OMXH) in the sample period. The OSEAX, OMXS, OMXC, and OMXH experienced some fluctuation in the annual returns in the sample period and followed around the same patterns. The rolling 36 months standard deviation in for Oslo Exchange All Share varied from its highest at 0.34 from December 2007 to November 2010, to its lowest at 0.10 from July 2012 to June 2015. OMX Stockholm were at its highest at 0.29 from December 2000 to November 2003, and its lowest at 0.10 from July 2012 to June 2015. The OMX Copenhagen varied from its highest at 0.25 from November 2007 to October 2010, and its lowest at 0.10 from January 2017 to December 2019. The OMX Helsinki was at its highest from February 2003 to January 2003 at 0.44, and its lowest from November 2015 to October 2018 at 0.10.

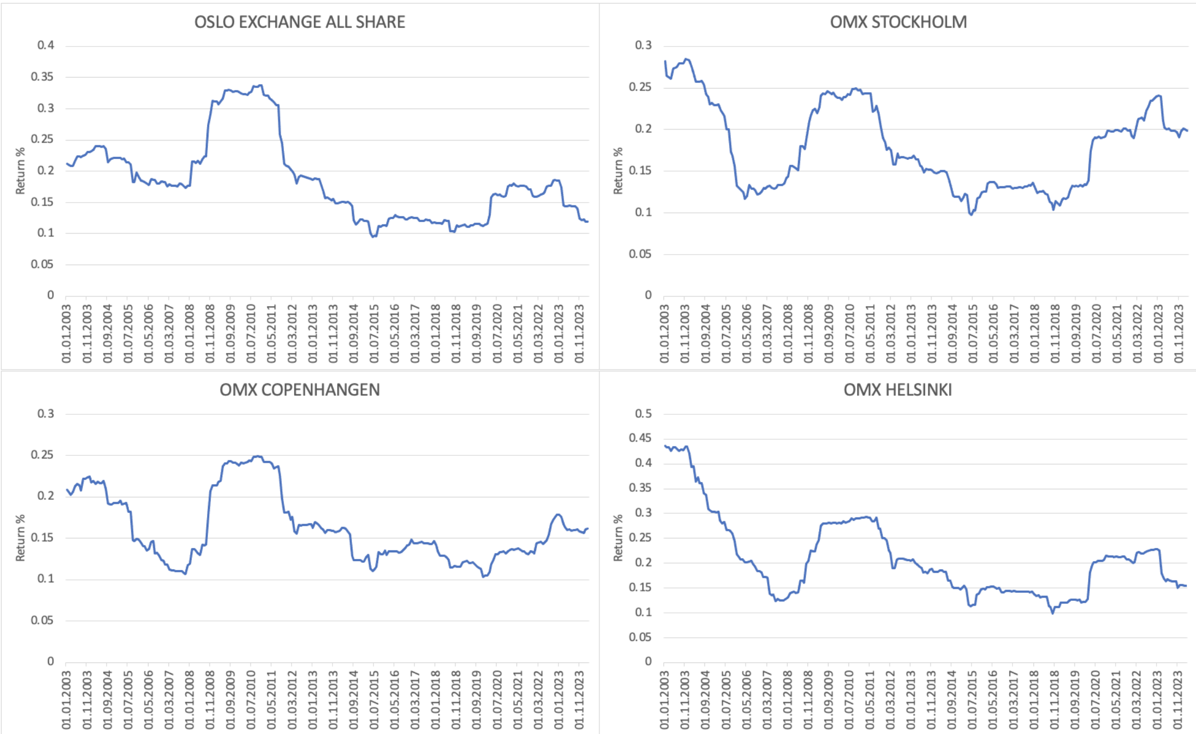

Figure 3: The figure illustrates the annualized 36 month rolling standard deviation for a) Oslo Exchange All share (OSEAX), b) OMX Stockholm (OMXS), c) OMX Copenhagen (OMXC) and d) OMX Helsinki (OMXH), from 2000 through 2023.

5. RESULTS

In this section we present the findings of the low-beta anomaly in the Nordic market from 2005 to 2023. In section 5.1, 5.2, 5.3, and 5.4, we present our findings for Norway, Sweden, Denmark, and Finland. First, we present the long high- and low-beta portfolio that were constructed based on the 20% highest and lowest beta values. The long high- and low-beta portfolios were equally weighted. In section 5.6, we present summery result for the high- and low-beta portfolio for each country.

We looked at the development in the 100 NOK/SEK/DKK/EUR that was invested in each portfolio and reinvested the following years, as well as the annual portfolio returns. Furthermore, we compared the portfolio performances against the benchmark for each country. We also looked at the changes in the 60 months moving betas. Comparing the betas calculated from the 60 months prior to the holding period to the betas calculated based on the 60 months including the holding period. This to see if the betas change substantially from the period the portfolio formation is based on to the period when the portfolio is held. Lastly, we looked at the risk adjusted returns by calculating the Sharpe Ratio.

5.1 Norway

Figure 4 illustrates the performance of the long high- and low-beta portfolio and the benchmark, when investing the 100 NOK in each portfolio. The high- and low-beta portfolio for Norway consists of 8-21 stocks each. The low-beta portfolio outperformed the high-beta portfolio over the long run in Norway from 2005-2023. The 100 NOK invested ended up at 287 NOK for the high-beta portfolio and at 2832 NOK for the low-beta portfolio. As illustrated in figure 4, the low-beta portfolio had an extreme performance compared with the high-beta portfolio in the long run. The cumulative return for the high-beta portfolio was at its lowest in 2008 at 72 NOK, while the low-beta portfolio was at its lowest in 2005 at 190 NOK.

We can compare the high- and low-beta portfolio performances upon the performance of the benchmark, Oslo Exchange All Share (Figure 4). The results show that the low-beta portfolio outperform the benchmark in the long run and did yield a higher return in all the 19 years, from 2005 to 2023. In contrast to the low-beta portfolio, the benchmark outperformed the high-beta portfolio from 2005 to 2023. While the high- and low-beta portfolios ended up at 287 NOK and 2832 NOK, the benchmark ended up at 608 NOK.

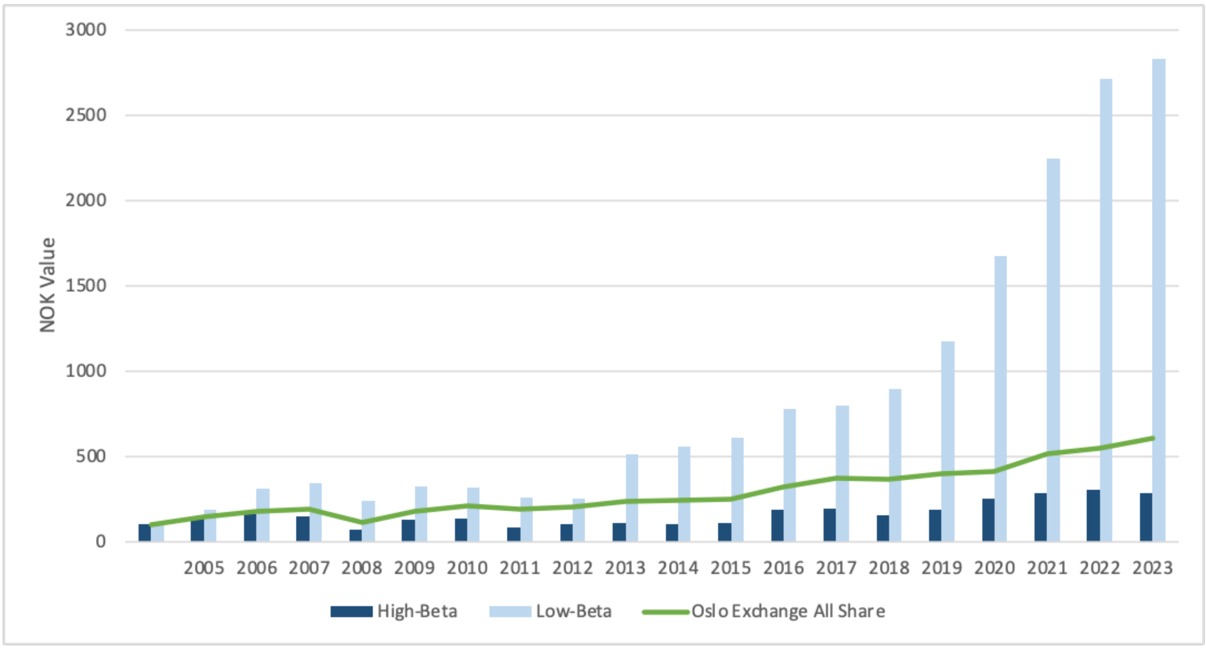

Figure 4: The cumulative return of the 100 NOK investment in the high- and low-beta portfolio and the benchmark Oslo Exchange All Share in 2005, and the development when reinvesting it in reconstructed portfolios each year through 2023.

Figure 5 illustrates the returns for the high- and low-beta portfolios. The low-beta portfolio outperformed the high-beta portfolio in 14 out of 19 years, in 2005-2008, 2011, 2013- 2015, and 2018-2023. The low-beta portfolio experienced positive returns in 15 out of 19 years, in 2005-2007, 2009, and 2013-2023. The high-beta portfolio had positive returns in 13 out of 19 years, in 2005-2006, 2009-2010, 2012-2013, 2015-2017, and 2019-2022.

The low-beta portfolio experienced high returns in the first two years, 2005 and 2006, on 90% and 62%, respectively, which resulted in higher investment amounts the following years (Figure 5). The high-beta portfolio had a return of 36% and 20% in 2005 and 2006, followed by negative returns at -11% and -52% in the two following years. The high- and low-beta portfolio both experienced negative returns in 2008 and 2011, as a result of the financial crisis and the debt crisis in Europe.

The high-beta portfolio had some extreme returns of 81% and 70% in 2009 and 2016 (Figure 5). In 2009, the main drivers of the extreme return were PGS and Jinhui Shipping and Transportation with returns of 217% and 255%. The main drivers in 2016 were Questerre Energy with a return on 490% and Bluenord with a return on 300%. The low-beta portfolio had some extreme returns of 90% and 106% in 2005 and 2013. In 2005, this was mainly due to the performance of Axactor ASA with an annual return of 474%. This while the main drivers in 2013 were AMSC and Arcticzymes Technologies, with returns on 1391% and 137%, respectively. The average returns of the high- and low-beta portfolio in the sample period was 10% and 23%.

The returns in the high- and low-beta portfolio were at its most similar levels in 2017, with 4% for the high-beta portfolio and 2% for the low-beta portfolio (Figure 5). The differences were at its highest in 2013, where the high-beta portfolio had a return on 3% and the low-beta portfolio had a return of 106%. The results indicated that there was a low-beta anomaly in OSEAX from 2005-2008, 2011, 2013-2015, and 2018-2023 – in 14 out of 19 years. The number of stocks in the high- and low-beta portfolio the first years was low, with 8 stocks each in 2005 and the result for the first years must therefore be taken with caution.

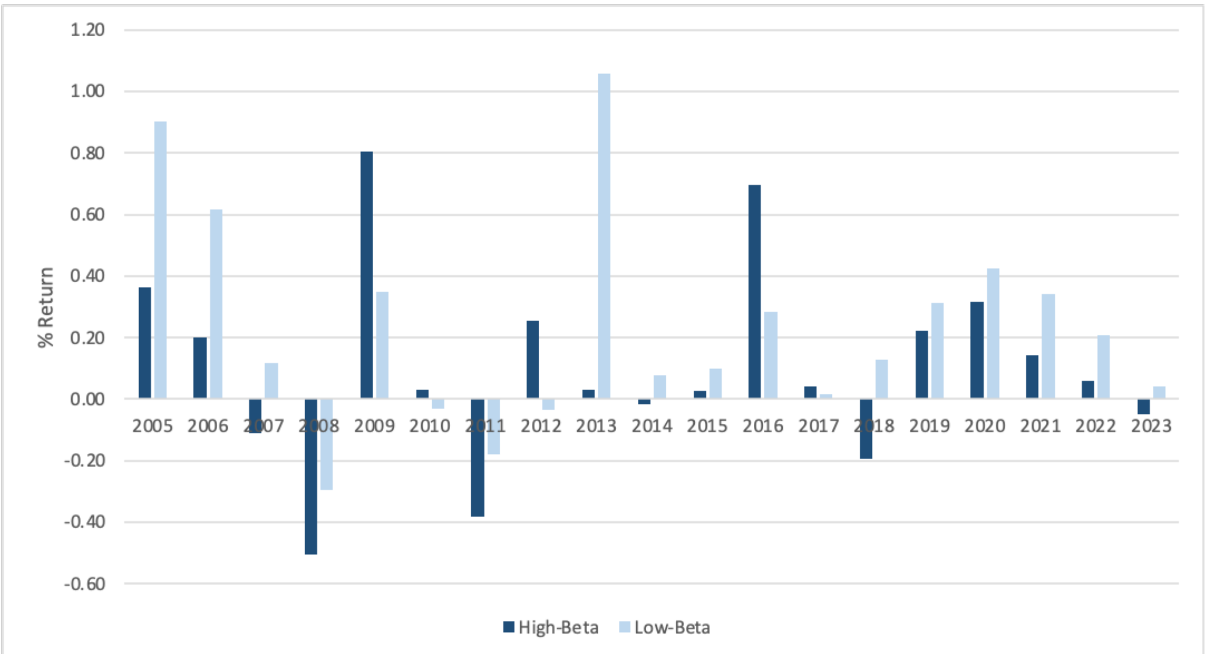

Figure 5: The annual portfolio returns for the high- and low-beta portfolio from 2005 through 2023 in Norway.

Table 1 illustrates the annual Sharpe ratio for the high- and low-beta portfolio from 2005 to 2023. In the high-beta portfolio the Sharpe ratio varied from -0.77 at its lowest in 2011, to 0.43 at its highest in 2006. For the low-beta portfolio the Sharpe ratio varied from -1.04 at its lowest in 2008, to 0.77 at its highest in 2019. All the Sharpe ratios were below 1 and is therefore all considered sub-optimal. The Sharpe ratio was positive in 5 out of 19 years for the high-beta portfolio, in 2005-2006, 2009, 2012, and 2016. For the low-beta portfolio, it was positive in 8 out of 19 years, in 2005-2006, 2009, 2013, 2016, and 2019-2021. The Sharpe ratio was at its most similar levels in 2022, with -0.19 for the high-beta portfolio and -0.17 for the low-beta portfolio. The largest differences between the two portfolios were in 2013, with -0.53 for the high-beta portfolio and 0.43 for the low-beta portfolio, and in 2019 with -0.18 for the high-beta portfolio and 0.77 for the low-beta portfolio. The low-beta portfolio yielded a higher risk adjusted return than the high-beta portfolio in 12 out of 19 years, in 2005-2007, 2011, 2013, 2015, and 2018-2023.

Table 1: The annualized Sharpe ratio for the high- and low-beta portfolio from 2005 through 2023. The Sharpe ratio was calculated by using the annualized average monthly returns, the standard deviation of the average monthly returns and the 10-year government bond for Norway.

	Sharpe Ratio	
Year	High-Beta Portfolio	Low-Beta Portfolio
2005	0.17	0.73
2006	0.04	0.50
2007	-0.52	-0.39
2008	-0.67	-1.04
2009	0.43	0.27
2010	-0.17	-0.28
2011	-0.77	-0.73
2012	0.03	-0.30
2013	-0.53	0.43
2014	-0.45	-0.49
2015	-0.41	-0.15
2016	0.37	0.31
2017	-0.09	-0.25
2018	-0.34	-0.03
2019	-0.18	0.77
2020	-0.01	0.21
2021	-0.05	0.46
2022	-0.19	-0.17
2023	-0.50	-0.32

Table 2 illustrates the average moving 60 months beta values for the stocks in the high-beta and low-beta portfolio from 2005 to 2023, both prior to the holding period and when including the holding period. All the average betas in the low-beta portfolio stayed below 0 and the betas in the average high-beta portfolio stayed above 1. The biggest change between the betas prior to the holding period and when including the holding period for the high-beta portfolio was for the beta calculated from 2015-2020 and the beta calculated from 2016-2021, where the beta values went from 1.68 to 2.15. In 2016-2021, the average beta when including the holding period for the high-beta portfolio was more than twice as high as the market beta, which also was the highest average 60 months moving beta in the sample period. The biggest changes for the low-beta portfolio were for the beta calculated from 2015-2020 and 2016-2021, where the average beta increased from 0.17 to 0.58. The portfolio betas remained high and low when including the years, we held the portfolio.

Table 2: The average 60 months moving beta in the high-beta and low-beta portfolio from 2005 to 2023 in Norway. The first two columns illustrate the average 60 months moving betas in each portfolio, prior to the holding period. The last two columns on the right side of the table illustrates the average 60 months moving betas where the last 12 months was the holding period.

	Avg. High-Beta	Avg. Low-Beta		Avg. High-Beta	Avg. Low-Beta
Period	60M Prior to Holding Period	60M Prior to Holding Period	Period	60M Including Holding Period	60M Including Holding Period
2000 - 2005	1.58	0.37	2001 - 2006	1.54	0.38
2001 - 2006	1.73	0.34	2002 - 2007	1.52	0.34
2002 - 2007	1.52	0.36	2003 - 2008	1.25	0.46
2003 - 2008	1.53	0.39	2004 - 2009	1.07	0.35
2004 - 2009	1.45	0.41	2005 - 2010	1.38	0.39
2005 - 2010	1.51	0.37	2006 - 2011	1.49	0.40
2006 - 2011	1.45	0.39	2007 - 2012	1.45	0.38
2007 - 2012	1.51	0.36	2008 - 2013	1.57	0.36
2008 - 2013	1.61	0.36	2009 - 2014	1.50	0.44
2009 - 2014	1.65	0.29	2010 - 2015	1.55	0.36
2010 - 2015	1.71	0.31	2011 - 2016	1.47	0.30
2011 - 2016	1.65	0.33	2012 - 2017	1.57	0.30
2012 - 2017	1.61	0.19	2013 - 2018	1.58	0.07
2013 - 2018	1.64	0.17	2014 - 2019	1.74	0.01
2014 - 2019	1.68	0.17	2015 - 2020	1.83	0.23
2015 - 2020	1.68	0.17	2016 - 2021	2.15	0.58
2016 - 2021	1.65	0.41	2017 - 2022	1.60	0.49
2017 - 2022	1.61	0.44	2018 - 2023	1.56	0.76
2018 - 2023	1.69	0.57	2019 - 2024	1.67	0.57

5.2 Sweden

Figure 6 illustrates the cumulative return from 2005-2023, when investing 100 SEK in the high- and low-beta portfolio in 2005. The portfolios consist of 25-60 stocks from 2005-2023 when the companies with the 20% highest and lowest betas are included. The investment grew larger for the low-beta portfolio in Sweden. The high-beta portfolio investment ended up at 461 SEK in 2023, while the low-beta portfolio investment ended up at 672 SEK, as seen in figure 6. The benchmark, OMX Stockholm, ended up at 270 SEK, in other words both the high- and low-beta portfolio outperformed the benchmark.

The low-beta portfolio investment outperformed the investment in the high-beta portfolio from 2006-2008 and from 2012-2023 (Figure 6). The investment dropped to its lowest in 2008 during the financial crisis, with 88 SEK for the high-beta and 107 SEK for the low-beta portfolio. In the three following years, after the financial crisis, the high-beta portfolio outperformed the low-beta portfolio. The investment was at its highest for both the high- and low-beta portfolios in 2021, with 571 SEK in the high-beta portfolio and 857 SEK in the low-beta portfolio. For Sweden, both the high- and low-beta portfolio outperformed the benchmark most years. The portfolios follow the benchmark more closely during the earlier years before the portfolios gain more momentum during the later years. The benchmark outperformed the low-beta portfolio from 2009-2012, whereas the high-beta portfolio was outperformed by the benchmark in 2008 and 2012.

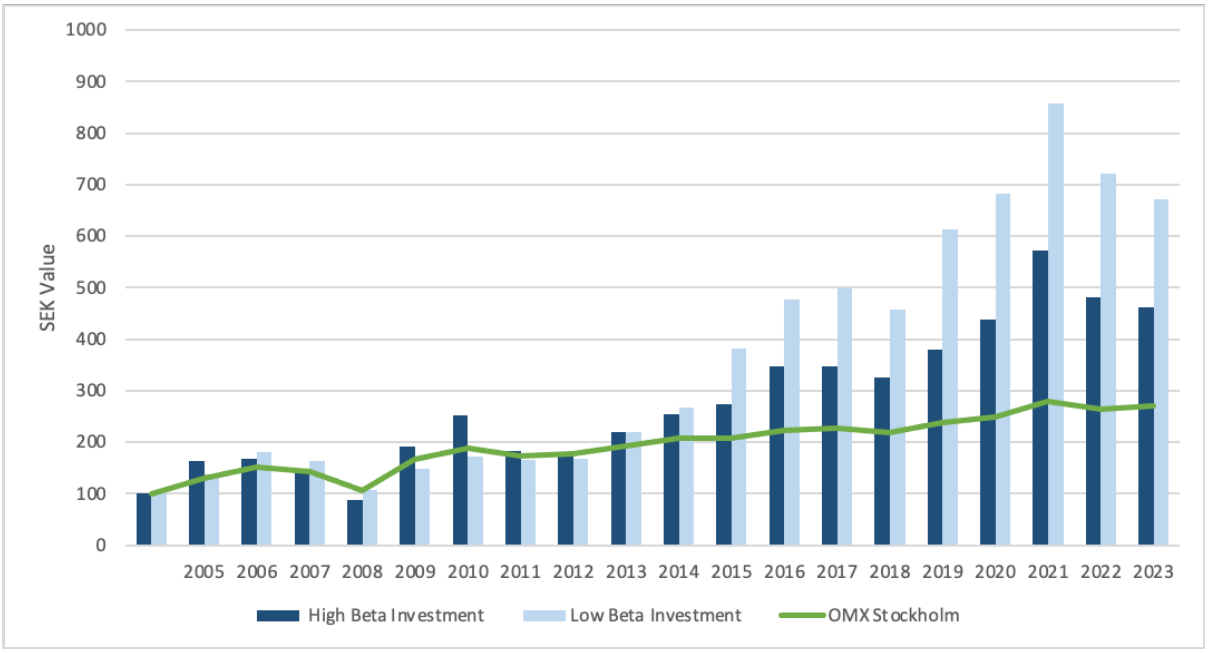

Figure 6: The cumulative return of the 100 SEK investment in the high- and low-beta portfolio and the benchmark OMX Stockholm in 2005, and the development when reinvesting it in reconstructed portfolios each year through 2023.

Figure 7 displays the annual portfolio return from 2005 to 2023 for Sweden (Figure 7). The low-beta portfolio yielded higher return than the high-beta portfolio in 10 out of 19 years, in 2007-2008, 2011-2015, 2017, and in 2019. The portfolio return was positive in 12 out of 19 years for high-beta portfolio, and positive in 13 out of 19 years for the low-beta portfolio. For the high-beta portfolio the returns were positive from 2005-2006, 2009-2010, 2013-2017, and 2019-2021. For the low-beta portfolio the returns were positive from 2005-2006, 2009-2010, 2012-2017, and from 2019-2021. The average return for all portfolio years was 13% both for the high- and low-beta portfolio.

The high-beta portfolio yielded higher returns than the low-beta portfolio the first year and the low-beta yielded higher returns the next three years from 2006-2008 (Figure 7). The returns for the two portfolios were at their most similar in 2022, with -15.7% for the high-beta portfolio and -15.8% for the low-beta portfolio. The largest difference in the return between the high- and low-beta portfolio was in 2009, with 118% for the high-beta and and 38% for the low-beta portfolio. The high-beta portfolio had a particularly high return in 2009 after the financial crisis in 2008, with a return on 118%. Some of the stocks with highest return in the high-beta portfolio in 2009 were Boliden, Bilia and Hexagon with returns of 437%, 312%, and 283%, respectively. The low-beta portfolio had its highest return in 2015 with 43%. The best performing companies in the low-beta portfolio in 2015 were Invisio, Vitec Software Group and Anoto Group with returns of 478%, 181%, and 100%, respectively. The results indicate that the low-beta anomaly was present from 2007-2008, 2011-2015, 2017, and in 2019.

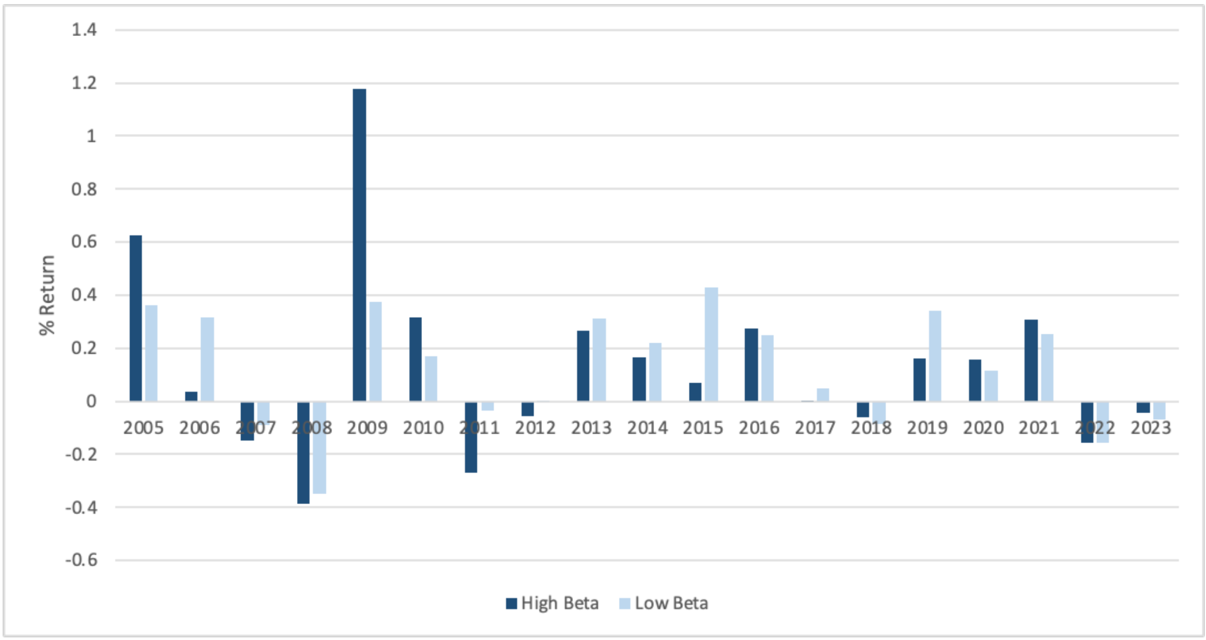

Figure 7: The annual portfolio returns for the high- and low-beta portfolio, 2005-2023 in Sweden.

Table 3 displays the Sharpe ratios for each high- and low-beta portfolio from 2005 to 2023 for Sweden. The Sharpe ratio varied from -0,73 in the 2007 to 0.68 in 2009 for the high-beta portfolio. For the low-beta portfolio the Sharpe ratio varied from -0.87 in 2008 during the year of the financial crisis to 0.89 in 2019. The Sharpe ratio was positive in 10 out of 19 years for the high-beta portfolio, in 2005, 2009, 2010, 2013, 2014, 2015, 2016, 2019, 2020, and 2021. For the low-beta portfolio the Sharpe ratio was positive in 12 out of 19 years, in 2005, 2006, 2009, 2010, 2013, 2014, 2015, 2016, 2017, 2019, 2020, and 2021. The Sharpe ratio was most similar for the high- and low-beta portfolio in 2012 with -0.25 for the high-beta portfolio and -0.24 for the low-beta portfolio, and in 2020 with 0.06 for the high-beta portfolio and 0.05 for the low-beta portfolio. The largest difference was found in 2006 with -0.14 for the high-beta portfolio and 0.38 for the low-beta portfolio. The low-beta portfolio did yield a higher risk adjusted return (Sharpe ratio) than the high-beta portfolio in 10 out of 19 years, in 2005-2007, 2011-2015, 2017, and 2019.

Table 3: The annualized Sharpe ratio for the high- and low-beta portfolio from 2005 through 2023. The Sharpe ratio was calculated by using the annualized average monthly returns, the standard deviation of the average monthly returns and the 3-month government bond for Sweden.

	Sharpe Ratio	
Year	High-Beta Portfolio	Low-Beta Portfolio
2005	0.42	0.83
2006	-0.14	0.38
2007	-0.73	-0.66
2008	-0.65	-0.87
2009	0.68	0.63
2010	0.22	0.15
2011	-0.52	-0.34
2012	-0.25	-0.24
2013	0.55	0.86
2014	0.33	0.65
2015	0.06	0.54
2016	0.57	0.54
2017	-0.07	0.05
2018	-0.16	-0.27
2019	0.18	0.89
2020	0.06	0.05
2021	0.43	0.37
2022	-0.29	-0.41
2023	-0.39	-0.48

Table 4 displays the average 60 months moving beta in the low-beta and high-beta portfolio. For Sweden, the average estimated high-beta for the portfolio stayed above one for all periods, both for the periods used to form the portfolios and when including the holding period. The biggest changes in average beta for the high-beta portfolio was for the average beta calculated from 2003-2008 to the average beta calculated from 2004-2009 where the estimated average high-beta went from 1.46 to 1.15. For the low-beta portfolio the biggest change in average portfolio beta was where the estimated average beta went from 0.39 (2015-2020) to 0.74 (2016-2021). There were some changes in the beta values from the period prior to holding and to the period including the holding period, but not to a degree where the average beta was no longer high/low. However, some companies would have been replaced with others if the beta estimation was not based on historical returns.

Table 4: The average 60 months moving beta in the low-beta and high-beta portfolio from 2005 to 2023 in Sweden. The first two columns illustrate the average 60 months moving betas in each portfolio, prior to the holding period. The last two columns on the right side of the table illustrated the average 60 months moving betas where the last 12 months was the holding period.

	Avg. High-Beta	Avg. Low-Beta		Avg. High-Beta	Avg. Low-Beta
Period	60M Prior to Holding Period	60M Prior to Holding Period	Period	60M Including Holding Period	60M Including Holding Period
2000-2005	1.60	0.23	2001-2006	1.49	0.34
2001-2006	1.55	0.32	2002-2007	1.48	0.47
2002-2007	1.49	0.41	2003-2008	1.22	0.60
2003-2008	1.46	0.45	2004-2009	1.15	0.71
2004-2009	1.49	0.52	2005-2010	1.48	0.47
2005-2010	1.52	0.43	2006-2011	1.52	0.43
2006-2011	1.50	0.43	2007-2012	1.55	0.43
2007-2012	1.53	0.41	2008-2013	1.54	0.41
2008-2013	1.49	0.37	2009-2014	1.45	0.45
2009-2014	1.50	0.40	2010-2015	1.37	0.48
2010-2015	1.50	0.40	2011-2016	1.36	0.51
2011-2016	1.40	0.44	2012-2017	1.23	0.40
2012-2017	1.35	0.38	2013-2018	1.34	0.41
2013-2018	1.36	0.38	2014-2019	1.34	0.61
2014-2019	1.46	0.48	2015-2020	1.36	0.48
2015-2020	1.43	0.39	2016-2021	1.33	0.74
2016-2021	1.65	0.58	2017-2022	1.55	0.62
2017-2022	1.58	0.56	2018-2023	1.40	0.67
2018-2023	1.56	0.57	2019-2024	1.59	0.58

5.3 Denmark

Figure 8 illustrates the development in the 100 DKK investment in the high- and low-beta portfolio, as well as investing 100 DKK in the benchmark. The high- and low-beta portfolio consisted of 15-21 stocks each. The low-beta portfolio outperformed the high-beta portfolio in the long run, with the 100 DKK investment. The portfolios ended up with 181 DKK for the high-beta portfolio and 351 DKK for the low-beta portfolio. The cumulative return for the high-beta portfolio was at its lowest in 2012 at 61 DKK, while the low-beta portfolio was at its lowest in 2008 at 114 DKK. The results show that the benchmark, OMX Copenhagen, outperformed the low-beta and high-beta portfolio in the long run from 2005 to 2023. While the high- and low-beta portfolio ended at 181 DKK and 351 DKK, the benchmark ended up with 471 DKK.

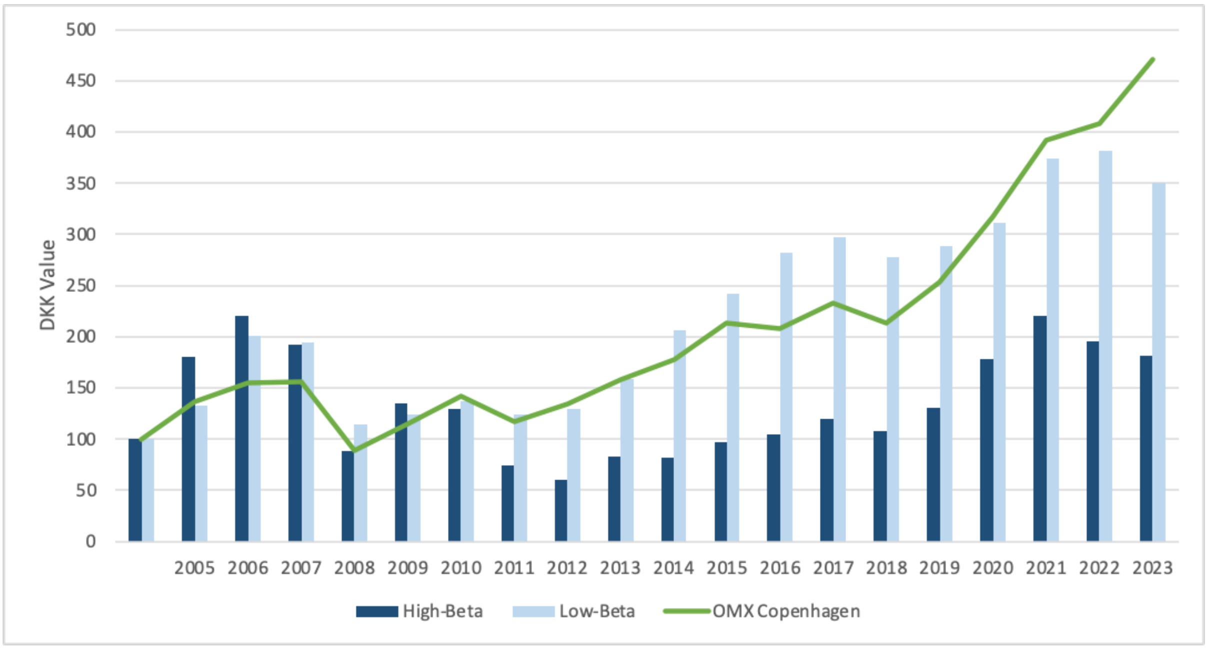

Figure 8: The cumulative return of the 100 DKK investment in the high- and low-beta portfolio and the benchmark OMX Copenhagen in 2005, and the development when reinvesting it in reconstructed portfolios each year through 2023.

Figure 9 illustrates the annual returns for the high- and low-beta portfolio. The low-beta portfolio outperformed the high-beta portfolio in 9 out of 19 years, 2006-2008, 2010-2012, 2014, 2018, and 2022. The low-beta portfolio yielded a positive return in 14 out of 19 years, in 2005-2006, 2009-2010, 2012-2017, and 2019-2022. The high-beta portfolio yielded positive returns in 10 out of 19 years, in 2005-2006, 2009, 2013, 2015-2017, and 2019-2021.

Both the high- and low-beta portfolio had positive returns the two first years of 32% and 52% for the low-beta portfolio and 80% and 22% for the high-beta portfolio (Figure 9). The two portfolios experienced negative returns the two following years. The high-beta portfolio experienced negative returns in 2010, 2012, 2014, and 2022, where the low-beta portfolio yielded a positive return. The two portfolios both experienced negative returns in 2007, 2008, 2011, 2018, and 2023, following crises and uncertainty in the market, such as the financial crisis and the debt crisis in Europe.

The high-beta portfolio experienced its highest portfolio return in 2005, of 80% (Figure 9). This was mainly due to the extreme performance of Newcap Holding, North Media, and Agat Ejendomme, of 487%, 170% and 120%, respectively. The low-beta portfolio, on the other hand, did not experience such extreme returns. The low-beta portfolio had its highest return in 2006 of 52%. The average return for the high- and low-beta portfolio from 2005 to 2023 was 10% and 9%.

The biggest difference in the performance between the high- and low-beta portfolio was in 2005, with a return of 80% for the high-beta portfolio and 32% for the low-beta portfolio (Figure 9). The return in the high-beta and low-beta portfolio was most similar in 2015 with 18% for the high-beta portfolio and 17% for the low-beta portfolio and in 2023 with -7% for the high-beta portfolio and -8% for the low-beta portfolio. The results suggest the presence of the low-beta anomaly in Denmark's OMX Copenhagen stock exchange in 9 out of 19 years – in 2006-2008, 2010-2012, 2014, 2018, and 2022.

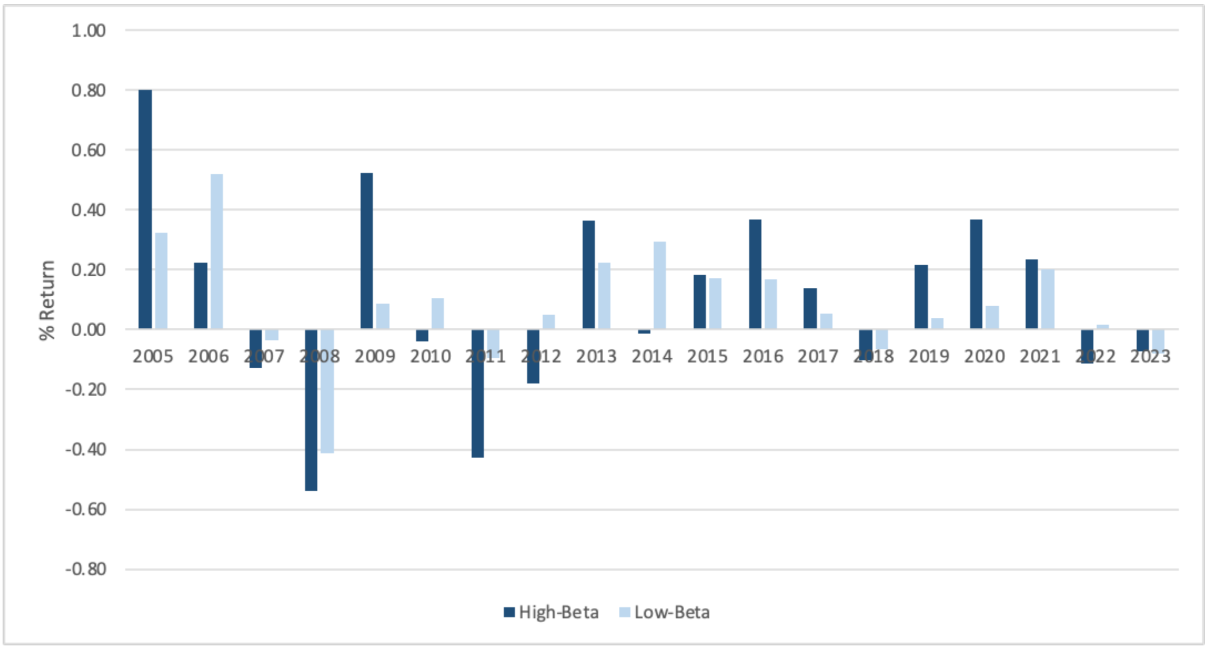

Figure 9: The annual portfolio returns for the high- and low-beta portfolio from 2005 through 2023 in Denmark.

Table 5 illustrates the annual Sharpe ratio for the high- and low-beta portfolio, from 2005 to 2023. In the high-beta portfolio, the Sharpe ratio varied from -1.13 at its lowest in 2011, to 0.71 at its highest in 2005. For the low-beta portfolio, the Sharpe ratio varied from -1.31 at its lowest in 2023, to 0.76 at its highest in 2021. All the risk adjusted returns were below 1 and are considered sub-optimal. The Sharpe ratio in the high-beta portfolio was positive in 10 out of 19 years, in 2005-2006, 2009, 2013, 2015-2017, and 2019-2021. In the low-beta portfolio, the Sharpe ratio was positive in 12 out of 19 years, in 2005-2006, 2010, 2012-2017, and 2019-2021. The risk adjusted returns were at its most similar levels in 2017 with 0.15 for the high-beta portfolio and 0.22 for the low-beta portfolio, and in 2022 with -0.19 for the high-beta portfolio and -0.12 for the low-beta portfolio. The biggest differences in the risk adjusted return between the two portfolios were in 2023, with -0.40 for the high-beta portfolio and -1.13 for the low-beta portfolio. The low-beta portfolio did yield a higher risk adjusted return than the high-beta portfolio in 12 out of 19 years, in 2006, 2010-2017, 2019, 2021-2022.

Table 5: The annualized Sharpe ratio for the high- and low-beta portfolio from 2005 through 2023. The Sharpe ratio was calculated by using the annualized average monthly returns, the standard deviation of the average monthly returns and the 3-month government bond for Denmark.

	Sharpe Ratio	
Year	High-Beta Portfolio	Low-Beta Portfolio
2005	0.71	0.47
2006	0.10	0.48
2007	-0.63	-0.72
2008	-0.80	-1.08
2009	0.23	-0.01
2010	-0.19	0.14
2011	-1.13	-0.48
2012	-0.41	0.07
2013	0.36	0.73
2014	-0.44	0.73
2015	0.05	0.45
2016	0.22	0.45
2017	0.15	0.22
2018	-0.34	-0.47
2019	0.17	0.39
2020	0.22	0.14
2021	0.32	0.76
2022	-0.19	-0.12
2023	-0.40	-1.31

Table 6 illustrates the average 60 months moving beta for the high- and low-beta portfolio, both prior to and including the 12 months holding period. The average low-beta in the portfolio stays low when the holding period is included in the beta estimation. The same goes for the average high-betas, where most of the betas stay above 1.

For the high-beta portfolio the beta calculated from 2018-2022 prior to the holding period had an average beta of 1.69 and dropped to 0.43 when including the holding period (2019-2023) – causing the high-beta portfolio to transition to a low-beta portfolio. The biggest change between the calculation prior to the holding period and when including the holding period in the low-beta portfolio were in the betas calculated from 2003-2008 to 2004-2009, where the beta went from 0.28 to 0.70. The average betas for the high-beta portfolio prior to the holding period was at their lowest for the betas calculated from 2012-2017, 2013-2018, and 2014-2019, at 1.13, 1.10, and 1.12, respectively. Despite most of the average high- and low-beta values in the portfolios remaining high and low, there were some differences in the beta values at the end of the holding period. This change was causing the reinvestment to be allocated into reconstructed portfolios, consisting of different stocks.

Table 6: The average 60 months moving beta in the high-beta and low-beta portfolio from 2005 to 2023 in Denmark. The first two columns illustrate the average 60 months moving betas in each portfolio, prior to the holding period. The last two columns on the right side of the table illustrates the average 60 months moving betas where the last 12 months was the holding period.

	Avg. High-Beta	Avg. Low-Beta		Avg. High-Beta	Avg. Low-Beta
Period	60M Prior to Holding Period	60M Prior to Holding Period	Period	60M Including Holding Period	60M Including Holding Period
2000 - 2005	1.49	0.11	2001 - 2006	1.44	0.18
2001 - 2006	1.46	0.15	2002 - 2007	1.24	0.22
2002 - 2007	1.35	0.17	2003 - 2008	1.34	0.34
2003 - 2008	1.46	0.28	2004 - 2009	1.46	0.70
2004 - 2009	1.50	0.41	2005 - 2010	1.61	0.42
2005 - 2010	1.65	0.44	2006 - 2011	1.64	0.41
2006 - 2011	1.69	0.35	2007 - 2012	1.61	0.35
2007 - 2012	1.64	0.34	2008 - 2013	1.62	0.34
2008 - 2013	1.64	0.34	2009 - 2014	1.69	0.31
2009 - 2014	1.53	0.23	2010 - 2015	1.22	0.26
2010 - 2015	1.48	0.18	2011 - 2016	1.17	0.22
2011 - 2016	1.31	0.16	2012 - 2017	1.04	0.15
2012 - 2017	1.13	0.10	2013 - 2018	1.08	0.25
2013 - 2018	1.10	0.13	2014 - 2019	1.06	0.10
2014 - 2019	1.12	0.11	2015 - 2020	1.14	0.13
2015 - 2020	1.26	0.11	2016 - 2021	1.49	0.40
2016 - 2021	1.59	0.25	2017 - 2022	1.71	0.40
2017 - 2022	1.69	0.32	2018 - 2023	0.43	0.35
2018 - 2023	1.61	0.29	2019 - 2024	1.60	0.28

From 2017-2019, the unweighted 60 months moving average beta for the stocks in OMX Copenhagen was, after filtering, at 0.56, 0.57 and 0.58, respectively - all below unity. This resulted in 6-7 stocks with betas less than 1 in the high-beta portfolio these years. Due to the limited number of stocks with betas above 1 in this period, we have kept these stocks in the portfolio. The unweighted average beta was therefore also lower compared to the other portfolio years. The results for Denmark in this period must therefore be interpreted with caution. For this reason, we have constructed new portfolios for 2017, 2018 and 2019, and removed the stocks with betas less than 1 – this to investigate if it affects the results. The number of stocks in our sample for Denmark were 91, 92, and 94. In the first year, 2005, the unweighted average beta was 0.60 with a number of stocks of 75. The last year, 2023, the average unweighted beta was at 0.88 with a total number of stocks of 106.

Table 7 illustrates the portfolio returns for Denmark from 2017 to 2019 after the reconstruction. This with the high-beta portfolio only consisting of stocks with 60 months moving betas above 1. This as some of the stocks in the high-beta portfolio in the period were below 1. When removing the same number of stocks in the low-beta portfolio, we got the results as illustrated in table 6. The average high-beta was then on 1.22, 1.20, and 1.21 from 2017 to 2019. The average 60 months moving beta in the low-beta portfolio were 0.08, 0.09, and 0.08, all below the levels before reconstructing the three portfolios. Compared to before the reconstruction, the results now suggest that there was a low-beta anomaly in 2017 and 2018 and not in 2019. Whereas the results before the reconstruction said that it was a no anomaly in 2017 and low-beta anomaly in 2018 and 2019.

Table 7: The annual portfolio returns and the average 60 months moving betas in the high- and low-beta portfolio from 2017 to 2019, after reconstruction. The high beta portfolio has been reconstructed with stocks that have a beta above 1. The same number of stocks is filtered out from the low-beta portfolio, with selection based on the highest low-beta values.

Table 7: The annual portfolio returns and the average 60 months moving betas in the high- and low-beta portfolio from 2017 to 2019, after reconstruction. The high beta portfolio has been reconstructed with stocks that have a beta above 1. The same number of stocks is filtered out from the low-beta portfolio, with selection based on the highest low-beta values.

	High-Beta Portfolio		Low-Beta Portfolio	
	Return	Avg. Beta	Return	Avg. Beta
2017	0.085	1.216	0.088	0.080
2018	-0.136	1.202	-0.078	0.090
2019	0.165	1.211	0.057	0.080

5.4 Finland

Figure 10 illustrates the development in the 100 EUR investment in the high- and low-beta portfolio and benchmark. The portfolio for Finland consists of 12-23 stocks, with the first years having fewer stocks and the later years having the most as the number of listed companies increased. The low-beta portfolio ended up at 88 EUR in 2023, while the high-beta portfolio ended up at 152 EUR. The benchmark ended up at 165 EUR. Investing in low-beta stock was therefore not profitable for the entire period from 2005 to 2023. The 100 EUR investment dropped to its lowest to 47 EUR for the high-beta portfolio in 2008 during the financial crisis. For the low-beta portfolio the investment dropped to its lowest to 88 EUR in 2023. The investment in the low-beta portfolio outperformed the high-beta portfolio investment from 2005-2020, but from 2021-2023 the investment in the high-beta portfolio gained momentum and outperformed the low-beta portfolio. The benchmark, OMX Helsinki, outperformed both the high- and low-beta portfolio most years for Finland. The low-beta portfolio outperformed the benchmark the first two years from 2005-2006. Benchmark outperformed both the high- and low-beta portfolio from 2007-2023.

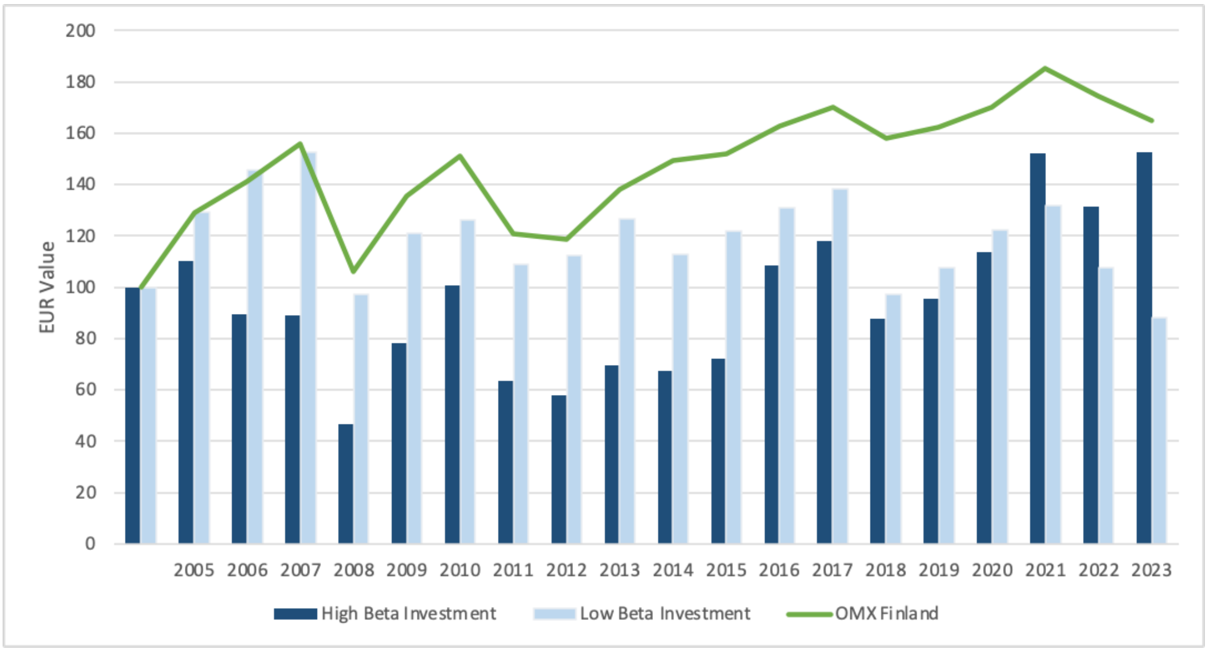

Figure 10: The cumulative return of the 100 EUR investment in the high- and low-beta portfolio and the benchmark OMX Helsinki in 2005, and the development when reinvesting it in reconstructed portfolios each year through 2023.

Figure 11 displays the annual portfolio returns from 2005-2023. For Finland the low-beta portfolio only yielded higher returns than the high-beta in 8 out of 19 portfolio years. The return was higher for the low-beta in the years 2005-2008, 2011-2012, 2015, and 2019. For the high-beta portfolio, 10 out of 19 years yielded positive returns. The return was positive in 2005, in 2009-2010, 2013, 2015-2017, and in 2019-2021. The low-beta stock portfolio yielded positive returns in 13 out of 19 years. The return for the low-beta portfolio was positive in the years 2005-2007, 2009-2010, 2012-2013, 2015-2017, and 2019-2021. The average return for all portfolio years from 2005-2023 was 4% for the high-beta and 1% for the low-beta portfolio.

The highest return for the high-beta portfolio out of all the years from 2005-2023 was in 2009 (Figure 11). The best performing stocks in the high-beta portfolio for 2009 were YIT, Metsa Board and Nokian Renkaat/Tyres with returns of 205%, 137%, and 131%. The highest return for the low-beta portfolio was found in the first portfolio in 2005. Some of the stocks with the highest returns in this portfolio were Finnair, Raute and Apetit with returns of 99%, 72% and 40%, respectively. For the high-beta portfolio some of the best performing companies the first year were Nokia, Tietoevry and Valoe with return of 30%, 35% and 93%. Nokia is one of the best performing stocks in the high-beta portfolio for the first years from 2005-2007.

The low-beta portfolio yielded higher returns the first four years, before the high-beta performed well in 2009 (Figure 11). The largest difference between the portfolio return for the high-beta portfolio and the low-beta was in the year 2009, after the financial crisis. The high-beta portfolio had a return of 68 % in 2009, while the return for the low-beta portfolio was 24 % in 2009. The returns for the high- and low-beta portfolio were most similar in 2015 with 6,7% for high-beta and 8,4% for low-beta. The results indicate that the low-beta anomaly is present from 2005-2008, 2011-2012, 2015, and in 2019 for Finland.

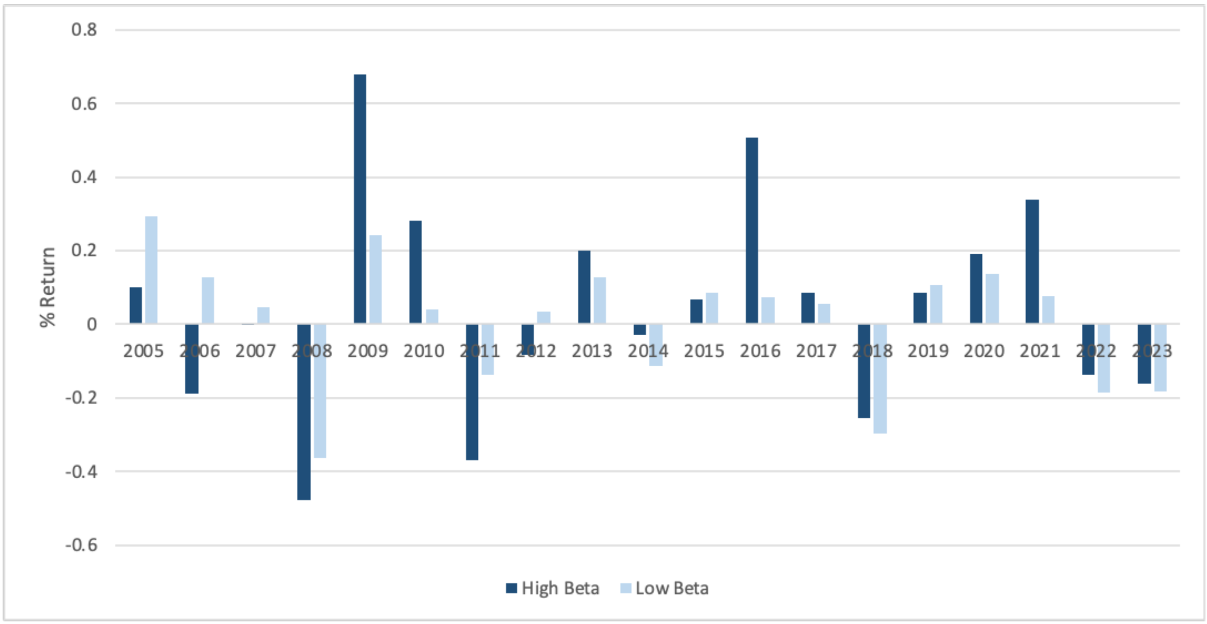

Figure 11: The annual portfolio returns for the high- and low-beta portfolio from 2005 through 2023 in Finland.

Table 8 displays the Sharpe ratios for each portfolio from 2005 to 2023. For the high-beta portfolio the Sharpe ratio varied from -1.16 in the 2008 portfolio during the financial crisis to 0.70 in 2016. For the low-beta portfolio the Sharpe ratio varied from -1.36 in 2023 to 0.29 in 2019. The Sharpe ratio was never above 1 for the high- or low-beta portfolio. The Sharpe ratio was positive in 10 out of 19 portfolio years for the high-beta, in 2009-2010, 2013, 2016-2017, and 2019-2021. For the low-beta portfolio the Sharpe ratio was positive in 6 out of 19 portfolio years, in 2005, 2009, 2015, and 2019-2021. The Sharpe ratio was most similar for the high- and low-beta portfolio in 2020, with 0,13 for the high-beta portfolio and 0,14 for the low-beta portfolio. The largest difference was found in 2006 with -0.97 for the high-beta portfolio and -0.06 for the low-beta portfolio. The low-beta portfolio yielded a higher risk adjusted relative return (Sharpe ratio) than the high-beta portfolio in 7 out of 19 years, in 2005-2006, 2011-2012, 2015, 2019, and 2020.

Table 8: The annualized Sharpe ratio for each high- and low-beta portfolio from 2005 through 2023. The Sharpe ratio was calculated by using the annualized average monthly returns, the standard deviation of the average monthly returns and the 10-year government bond for Finland.

	Sharpe Ratio	
Year	High-Beta Portfolio	Low-Beta Portfolio
2005	-0.162	0.256
2006	-0.974	-0.059
2007	-0.316	-0.356
2008	-1.159	-1.179
2009	0.395	0.220
2010	0.185	-0.263
2011	-0.969	-0.871
2012	-0.267	-0.191
2013	0.069	-0.117
2014	-0.395	-0.950
2015	-0.005	0.096
2016	0.699	-0.010
2017	0.130	-0.029
2018	-0.631	-1.325
2019	0.064	0.286
2020	0.129	0.136
2021	0.355	0.146
2022	-0.349	-0.665
2023	-0.612	-1.356

Table 9 displays the estimated average portfolio beta. The average unweighted 60 month beta for all companies in Finland was low. This was most likely due to certain companies having a large market share. Nokia was one of the companies that had high market share. Nokia's market share was especially high during the earlier years, the market capitalization grew from 9% to 72% from 1993-2004 and averaged 53% the last three years (Lally and Swidler, 2008). We found an unweighted average beta of 0.29 with the price index from 2000-2005, with 73 stocks in total (prior to filtering). The unweighted average beta for all 117 stocks in the price index data was 0.98 from 2018-2023, the last five years used to calculate betas for the last portfolio. As few companies had a beta above 1 some of the years and this led to many of the stocks in the high-beta portfolio having relatively low betas when including the 20% highest betas, considering high-beta should be above 1. For the first portfolio in 2005 only four companies had a beta above one. We could have chosen to set a criterion for high-beta being above one, but this would have resulted in a too small portfolio in earlier years. The high-beta portfolio for Finland included some companies with betas below 1 up until 2013. In 2013, 3 out of 18 companies had betas of 0.9. However, we chose to include the 20% highest out of all available data in our portfolio in order to get a decent size portfolio and follow a standard procedure throughout all portfolio years for all countries. Some stocks in the high-beta portfolio may therefore have a beta slightly below one.

For the first portfolio the average beta for the high-beta portfolio was below one as there was limited data and few companies with estimated beta above one (Table 9). For the betas calculated from 2004-2009 and 2005-2010 the average portfolio beta for the high-beta portfolio decreased to under one. The other years, the average high-beta stayed above one for the years used to form the portfolio and for the five years including the holding period. The average high-beta increased over the years. The average low-beta stayed relatively low, with the highest being 0,58 for the beta calculated from 2016-2021 when including the holding period. The low-beta increased some from the period prior to holding to the 60 months and when including the holding period. The average estimated portfolio betas were generally lower during the earlier years and increased over the years. The first portfolio (2005) for Finland included 12 companies and the last portfolio (2023) included 23 companies. The biggest changes in average beta for the high-beta portfolio was for the average beta calculated from 2003-2008 prior to the holding period to the average beta calculated from 2004-2009 including the holding period, where the high-beta went from 1.07 to 0.82. For the low-beta portfolio the biggest change in average portfolio beta was for the beta calculated from 2015-2020 to the beta calculated from 2016-2021, where the beta went from 0.30 to 0.58.

Table 9: The average 60 months moving beta in each low-beta and high-beta portfolio from 2005 to 2023 in Finland. The first two columns illustrate the average 60 months moving betas in each portfolio, prior to the holding period. The last two columns on the right side of the table illustrates the average 60 months moving betas where the last 12 months was the holding period.

Table 9: The average 60 months moving beta in each low-beta and high-beta portfolio from 2005 to 2023 in Finland. The first two columns illustrate the average 60 months moving betas in each portfolio, prior to the holding period. The last two columns on the right side of the table illustrates the average 60 months moving betas where the last 12 months was the holding period.

	Avg. High-Beta	Avg. Low-Beta		Avg. High-Beta	Avg. Low-Beta
Period	60M Prior to Holding Period	60M Prior to Holding Period	Period	60M Including Holding Period	60M Including Holding Period
2000-2005	0.97	0.05	2001-2006	0.96	0.11
2001-2006	1.00	0.08	2002-2007	1.02	0.18
2002-2007	1.12	0.11	2003-2008	1.04	0.28
2003-2008	1.07	0.19	2004-2009	0.82	0.43
2004-2009	1.03	0.31	2005-2010	0.96	0.33
2005-2010	1.11	0.26	2006-2011	1.08	0.28
2006-2011	1.12	0.26	2007-2012	1.11	0.26
2007-2012	1.15	0.27	2008-2013	1.17	0.29
2008-2013	1.18	0.28	2009-2014	1.16	0.30
2009-2014	1.28	0.29	2010-2015	1.27	0.39
2010-2015	1.32	0.32	2011-2016	1.31	0.41
2011-2016	1.40	0.30	2012-2017	1.34	0.31
2012-2017	1.33	0.26	2013-2018	1.35	0.26
2013-2018	1.41	0.23	2014-2019	1.41	0.42
2014-2019	1.39	0.33	2015-2020	1.45	0.37
2015-2020	1.36	0.30	2016-2021	1.17	0.58
2016-2021	1.48	0.43	2017-2022	1.42	0.48
2017-2022	1.55	0.47	2018-2023	1.46	0.50
2018-2023	1.53	0.47	2019-2024	1.50	0.47

5.6. Summary of The High- and Low-Beta Portfolios

In this section, we will analyze several risk measures and the risk adjusted returns of the high- and low-beta portfolio for each country. We will look at the portfolio betas, the total risk, the proportion of systematic and unsystematic risk, as well as the annualized average monthly

Sharpe ratio for each portfolio. Lastly, we discuss our results and approach compared to previous studies about the low-beta anomaly. We will look at potential implication with our approach and discuss alternative methods.

Table 10 illustrates the portfolio betas, the total risk, the systematic and unsystematic risk, and the risk adjusted return for the high- and low-beta portfolio for each country, from 2005 through 2023. The portfolio betas in the high- and low-beta portfolio in Norway was at 1.23 and 0.58. The high-beta portfolio had an annualized total risk (standard deviation) of 29%, where the proportion unsystematic risk (1-R^2) was 37%. The low-beta portfolio had a total risk 17% in the period, with a proportion of unsystematic risk 59%. The total risk was higher in the high-beta portfolio than in the low-beta portfolio. The high proportions of unsystematic risk could be mitigated by holding a more well-diversified portfolio by investing in a broader range of assets across different industries and sectors. The proportion of systematic risk (R^2) for the high-beta portfolio was 63%, while the proportion of systematic risk for the low-beta portfolio was 41%. The movements in the high-beta portfolio are highly explained by the variation in the benchmark. The proportion of systematic risk was higher than the proportion of unsystematic risk for the high-beta portfolio, while the unsystematic risk was highest for the low-beta portfolio. The risk adjusted return (Sharpe ratio) for the high-beta portfolio was at -0.19, while it was at -0.30 for the low-beta portfolio.

The portfolio beta for the high-beta portfolio in Sweden was 1.18 (Table 10). The portfolio beta for the low-beta was 0.78. The high-beta portfolio for Sweden had a total risk of 22% with a 15% proportion of unsystematic risk. The low-beta portfolio had a total risk of 16%, with a proportion of 30% unsystematic risk. The systematic risk for the portfolios in Sweden was 85% for the high-beta and 70% for the low-beta portfolio. Indicating that the benchmark explains 85% (high-beta) and 70% (low-beta) of the variation in portfolio returns. The high-beta portfolio in Sweden had a Sharpe ratio of -0.028, whereas the low-beta portfolio had a positive Sharpe ratio of 0.015.

The portfolio betas for the high- and low-beta portfolio in Denmark was 1.27 and 0.55 (Table 10). The total risk for the high-beta portfolio was 24%, whereas the proportion of unsystematic risk (1-R^2) was 29%. The total risk for the low-beta portfolio was 13%, whereas the proportion of unsystematic risk was 54%. The total risk was higher for the high-beta portfolio than the low-beta portfolio. The proportion of systematic risk was 71% for the high-beta portfolio, while it was 46% for the low-beta portfolio. This indicated that the movement in the high-beta portfolio was highly explained by the movements in the benchmark. The proportion of systematic risk in the high-beta portfolio was higher than the proportion of the unsystematic risk. In the low-beta portfolio, the proportion of unsystematic risk was higher than the proportion of systematic risk - which could be mitigated by holding a more well-diversified portfolio. The Sharpe ratio for the high-beta portfolio was at -0.12, while it was at -0.003 for the low-beta portfolio.

The portfolio beta for the high-beta portfolio in Finland was 0.93 (Table 10), which was a low high-beta. As discussed earlier this is due to few companies having a beta above 1 as some companies hold a large market share during several years. The low-beta portfolio had a beta of 0.55. The total risk for the high-beta portfolio was 22%, while the total risk for the low-beta portfolio was 14%. For Finland the systematic risk was 65% for the high-beta portfolio and 57% for the low-beta portfolio. The variation in portfolio returns deviated some from the movements in the respective benchmark. The unsystematic risk was 35% for the high-beta and 43% for the low-beta. In other words, the low-beta portfolio carried unsystematic risk that could have been removed with a more diversified portfolio. The Sharpe ratio for Finland was negative for both portfolios with -0.174 for the high-beta portfolio and -0.243 for the low-beta portfolio.

For all countries, the high-beta portfolio seemed to follow the movements of their respective benchmarks more closely than the low-beta portfolio (Table 10). The high-beta portfolio had a higher amount of total risk for each country, as expected. We observed that the low-beta portfolio for all countries included a larger proportion of unsystematic risk than the high-beta portfolio. The low-beta portfolio had betas further away from the market beta of 1, resulting in lower systematic risk and higher unsystematic risk compared to the high-beta portfolio. However, both the high- and low-beta portfolio had a large portion of unsystematic risk that could have been avoided by building a more well-diversified portfolio taking various industries into account.

The results suggest that the high- and low-beta portfolio for Sweden has a small proportion of unsystematic risk compared to Norway, Denmark, and Finland, as expected, since the sample for Sweden was the largest among the four countries (Table 10). This makes the portfolio for Sweden more diversified. In Norway and Denmark, the proportion of systematic risk was higher than the proportion of systematic risk for the high-beta portfolios, while the proportion of unsystematic risk was highest in the low-beta portfolio. For Finland, the proportion of systematic risk was higher than the proportion of unsystematic risk for both the high- and low-beta portfolio. Sweden was the only country that realized a positive Sharpe ratio, where the low-beta had a Sharpe ratio of 0.015.

Table 10: The Portfolio Beta, Total Risk (standard deviation), Proportion of Systematic Risk (R^2), and the Proportion of Unsystematic Risk (1-R^2) for the high- and low-beta portfolio for each country, 2005-2023. Regressions based on monthly returns for the high- and low-beta portfolio. The Sharpe ratio is calculated based on the annualized average monthly returns, the corresponding risk-free rate, and the standard deviation of the average return.

Table 10: The Portfolio Beta, Total Risk (standard deviation), Proportion of Systematic Risk (R-squared), and the Proportion of Unsystematic Risk (1-R-suared) for the high- and low-beta portfolio for each country, 2005-2023. Regressions based on monthly returns for the high- and low-beta portfolio. The Sharpe ratio is calculated based on the annualized average monthly returns, the corresponding risk-free rate, and the standard deviation of the average return.

	Portfolio Beta	Total Risk (Standard deviation)	Proportion Systematic Risk (R-Squared)	Proportion Unsystematic Risk (1-R-Squared)	Sharpe Ratio
Norway					
High-Beta Portfolio	1.230	0.292	0.628	0.372	-0.185
Low-Beta Portfolio	0.584	0.173	0.405	0.595	-0.031
Sweden					
High-Beta Portfolio	1.180	0.220	0.850	0.150	-0.028
Low-Beta Portfolio	0.780	0.160	0.700	0.300	0.015
Denmark					
High-Beta Portfolio	1.274	0.242	0.706	0.294	-0.117
Low-Beta Portfolio	0.552	0.129	0.464	0.536	-0.003
Finland					
High-Beta Portfolio	0.930	0.220	0.650	0.350	-0.174
Low-Beta Portfolio	0.550	0.140	0.570	0.430	-0.243

6. CONCLUSION

The Capital Asset Pricing Model (CAPM), introduced by Traynor (1961), Sharpe (1964), Litner (1965) and Mossin (1966), is a fundamental model in finance that describes the relationship between systematic risk and expected return for assets. Investors expect higher return when taking on higher risk. The CAPM implies that there is a linear relationship between expected return and beta. However, studies have found that the relation between beta and average return is flatter than predicted by the CAPM (Fama & French, 1992).

Our results suggests that the low-beta anomaly is present in Norway in 2005-2008, 2011, 2013-2015, and 2018-2023, 14 out of 19 years. For Sweden, the results indicate that the low-beta anomaly is present in 2007-2008, 2011-2015, 2017, and 2019, 10 out of 19 years. The low-beta anomaly was present in Denmark from 2006-2008, 2010-2012, 2014, 2018, and 2022, 9 out of 19 years. For Finland the low-beta anomaly was present in 2005-2008, 2011-2012, 2015, and in 2019, 8 out of 19 years. The low-beta anomaly was strongest in Norway. The 100 NOK/SEK/DKK/EUR investment in the low-beta portfolio outperformed the high-beta portfolio in the long run for Norway, Sweden, and Denmark. In Finland, the high-beta portfolio outperformed the low-beta portfolio. In other words, it's not necessarily always profitable to take higher risk.

In Norway, the low-beta portfolio did yield a higher risk adjusted return (Sharpe ratio) than the high-beta portfolio in 2005-2007, 2011, 2013, 2015, and 2018-2023, 10 out of 19 years. In Sweden the low-beta portfolio yielded a higher risk adjusted return (Sharpe ratio) than the high-beta portfolios in 2005-2007, 2011-2015, 2017, and 2019, 10 out of 19 years. In Denmark, the risk adjusted returns were higher in the low-beta portfolio in 2006, 2010-2017, 2019, and 2021-2022, 12 out of 19 years. For Finland the low-beta portfolio yielded a higher risk adjusted return (Sharpe ratio) than the high-beta portfolio in 2005-2006, 2011-2012, 2015, 2019, and 2020, 7 out of 19 years. When adjusting for the risk, the low-beta anomaly was strongest in Norway and Sweden.

The high-beta portfolio for each country had a higher total risk than the low-beta portfolio, as expected. We observed that most of the high- and low-beta portfolios had a high proportion of unsystematic risk, where the low-beta portfolio carried more unsystematic risk than the high-beta portfolio. The high proportion of unsystematic risk tells us that the portfolios could have been more well-diversified. This could be achieved by investing in a broader range of assets across different industries and sectors, rather than consequently choosing companies with the highest/lowest beta values. Testing the low-beta anomaly with more emphasis on diversifying the high- and low-beta portfolio could serve as a basis for further research, as less diversified portfolios may contribute to the presence of the low-beta anomaly.

Few studies have commented on the low-beta values for Finland considering that few companies had a beta above 1, especially during earlier years, and how this affected the construction of the high-beta portfolio. Despite several authors conducting analyses across various countries and years, including Finland, few have commented on the size of the high-beta values for each period included within these regions or countries. However, Frazzini and Pedersen (2004) stated that they constructed portfolios based on the betas below/above the asset class median for each country.

When estimating betas, we assumed that betas was static as our estimates are based on the past five years. This is one of the assumptions by the CAPM that have been discussed by researchers such as Lewellen and Nagel (2006). Ignoring variation in beta could impact the results. However, Lewellen and Nagel (2006) found that the beta variation alone was not enough to explain asset pricing anomalies. We used monthly data, as Novy-Marx and Velikov (2022) suggested that beta estimation by using daily data tend to be downward biased due to nonsynchronous trading issues (when the prices are assumed to be recorded at fixed intervals but are actually recorded at intervals of varying lengths).

The CAPM assumes that investors are risk averse. When investing in only the high/low-beta stocks the portfolio become less diversified, and the presence of the low-beta anomaly could come as a result of this. When the portfolios are solely constructed based on beta values, this may result in many companies from the same sectors being included in the same portfolios. Our research does not take factors such as market capitalization, momentum, leverage, book-to-market ratio, price-to-earnings ratio, market risk premium, and liquidity into account. Including such factors could lead to more well-diversified portfolios and ensure a more realistic approach. Bradriana (2023) and Fama and French (1992) found that the strength in the beta anomaly was stronger when controlling for size and value factors.

Investors realize above-average return by taking on risk above the average in an efficient market. The belief that risky stocks may yield higher return may prompt investors to take on additional risk and lead to higher demand for high-beta stocks. Investors may overestimate their capability of beating the market and be somewhat irrational. Extreme returns and lottery-like stocks affects the portfolio return in many of the years. This can be an explanation for the anomaly, as pointed out by Bali et al. (2017). Our use of equally-weighted portfolios as in Blitz and Vliet (2007) may lead to stocks with extreme returns driving the overall portfolio performance. The portfolio return would be highly affected by such extreme returns. One could also look at the median return instead of the average, as suggested by Bergh (2023), as this would not be as affected by the extreme returns. The equally-weighted portfolios can also lead to overexposure of small-cap stocks, which can be more volatile compared to large-cap stocks, and thus increase the risk. Furthermore, the use of equal weights on each stock in the portfolios could also reduce the impact of the single stock return, and therefore minimize the risk. While Lewellen and Nagel (2006) used value-weighted portfolios in their studies, Frazzini and Pedersen (2014) used rank-weighted portfolios. Frazzini and Pedersen (2014) were later criticized by Novy-Marx and Velikov (2021) for using rank-weighted portfolios, as they found that the portfolios would not be profitable if the stocks were value weighted.

Most studies followed a “betting against beta” (BAB), as in Frazzini and Pedersen (2014), Cederburg and O’Doherty (2016), Bali et al. (2017), Hwang et al. (2020), Barroso et al. (2020), Novy-Marx and Velikov (2022), and Bradriana et al. (2023). We analysed long positions for both the high- and low-beta portfolio to see which portfolio outperformed the other in the Nordic countries. The results suggested that the low-beta anomaly was present in the majority of the years in Norway and Sweden. In Denmark and Finland, we found that the low-beta anomaly was present in certain years, but not the majority.

Our results were in line with Bradriana et al. (2023) for the Nordic countries. They studied 22 developed markets, including the Nordic countries, and found that the beta anomaly was present in 14 out of 22 countries from 1990-2021. Blitz and Vliet (2007) also suggested that the volatility anomaly was present for Europe, but they did not test on country level. Frazzini and Pedersen (2014) found positive excess return for the Nordic countries, statistically significant for Sweden. However, they did not find statistically significant alphas for the Nordic countries, from 1984-2012. Prior studies have tried to find plausible explanations for the low-beta anomaly. These suggested that the low-beta anomaly was explained by lottery-like stocks (Bali et al., 2017), leverage constraints (Blitz and Vliet, 2007, Frazzini and Pedersen, 2014) or behavioral explanations, such as investors overconfidence (Hwang et al., 2020, Blitz and Vliet, 2007). Our use of equally-weighted portfolios may have affected our results as stocks with extreme returns may drive the overall portfolio performance. Ignoring variation in beta may also be a contributing factor to the explanation of the low beta anomaly, as suggested by Lewellen and Nagel (2006).

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