Niko Pukkila

Inflation-Adjusted Momentum: Analyzing Finnish Markets

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Author: Niko Pukkila
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ABSTRACT:
Momentum is a widely known anomaly in financial markets. The anomaly refers to the tendency of assets that have done well in the past, continue to do well in the near future and vice versa. However, little is known about the relationship between momentum returns and inflation. This thesis explores the relationship of momentum strategies and inflation within the Finnish stock market, addressing a gap in existing literature. Inspired by papers on inflation and stock market returns, the study explores whether momentum strategies can generate excess returns and act as hedges during different inflation regimes.

The central aim is to scrutinize three well-established momentum strategies—Standard 12-1, Novy-Marx, and J&T 6-6—in the Finnish context. The primary hypothesis challenges conventional financial market efficiency, assuming that the momentum anomaly exists in Finland. The secondary hypothesis explores the strategies' potential as hedges against short-term unexpected inflation. Using a dataset spanning from 2000 to January 2023, the study includes both active and inactive stocks, excluding the bottom 10% by market capitalization. Employing Jegadeesh and Titman's (1993) and Novy-Marx's (2013) methodologies, the research evaluates the relative performance of stocks over fixed ranking and holding periods. The analysis includes Winner Minus Loser (WML) momentum returns and explores their correlations with the Consumer Price Index (CPI) as a proxy for short-term unexpected inflation.

Further examination focuses on the correlation between inflation and momentum strategies using OLS regression. The findings suggest no statistically significant relationship between momentum returns and short-term unexpected inflation. Subsequent analyses, including rolling correlations, quantile regression, and asset pricing model regressions (CAPM and Fama-French 5 factors), provide nuanced insights into the strategies' performance across different inflation scenarios. The results showcase significant mean excess returns for all three momentum portfolios—Standard 12-1, Novy-Marx, and J&T 6-6. Additionally, noteworthy is the statistically significant relationship between the portfolio returns and CPI changes, indicated by robust regression and QR models, particularly in the tails of the conditional distribution.

KEYWORDS: Momentum strategies, Inflation, Stock Market, Anomalies

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TIIVISTELMÄ:
Momentum on laajasti tunnettu anomalia rahoitusmarkkinoilla. Ilmiö viittaa siihen, että omaisuuserät, jotka ovat menestyneet menneisyydessä, jatkavat hyvää suoriutumistaan myös lähitulevaisuudessa ja päinvastoin. Kuitenkin, momentum-tuottojen ja inflaation välisestä suhteesta tiedetään hyvin vähän. Tämä tutkielma käsittelee momentumstrategioiden ja inflaation välistä suhdetta Suomen osakemarkkinoilla, paikaten aukon olemassa olevassa kirjallisuudessa. Inspiroituneena tutkimuksista inflaation ja osakemarkkinatuottojen välillä, tutkimus selvittää, voivatko momentum-strategiat tuottaa ylijäämätuottoja ja toimia suojana erilaisissa inflaatiotilanteissa.

Tutkielman keskeisenä tavoitteena on tarkastella kolmea vakiintunutta momentumstrategiaa - Standard 12-1, Novy-Marx ja J&T 6-6 - Suomen kontekstissa. Ensimmäinen hypoteesi haastaa perinteisen markkinoiden tehokkuuden oletuksella, että momentum-ilmiö esiintyy Suomessa. Toisen hypoteesin tavoitteena on tutkia strategioiden mahdollisuuksia suojautua lyhyen aikavälin odottamattomalta inflaatiolta. Käyttäen aikaväliä 2000-2023, tutkimus sisältää sekä aktiiviset että kuolleet osakkeet, poissulkien markkina-arvoltaan alimman 10 prosentin. Jegadeeshin & Titmanin (1993) sekä Novy-Marxin (2013) menetelmiä hyödyntäen, tutkimus arvioi osakkeiden suhteellista suoriutumista kiinteiden sijoittelu- ja säilytysjaksojen yli. Analyysi sisältää voittaja miinus häviäjä (WML) -momentumtuotot ja tutkii niiden korrelaatiota Kuluttajahintaindeksin (CPI) kanssa, joka toimii lyhyen aikavälin odottamattoman inflaation mittarina.

Jatkotutkimus keskittyy inflaation ja momentumstrategioiden väliseen korrelaatioon käyttäen OLS-regressiota. Tulokset viittaavat siihen, ettei momentum-tuottojen ja lyhyen aikavälin odottamattoman inflaation välillä ole tilastollisesti merkittävää suhdetta. Seuraavat analyysit, mukaan lukien liukuva korrelaatio, kvantiiliregressio ja hinnoittelumallin regressiot (CAPM ja Fama-French 5), antavat näkemyksiä strategioiden suorituksesta eri perspektiiveissä. Tulokset osoittavat merkittäviä keskimääräisiä ylijäämätuottoja kaikille kolmelle momentum-portfolioille - Standard 12-1, Novy-Marx ja J&T 6-6. Lisäksi huomionarvoista on robust- ja QR-mallien osoittama tilastollisesti merkittävä suhde portfolion tuottojen ja CPI-muutosten välillä, erityisesti ehdollisen jakauman ääripäissä.

AVAINSANAT: Momentum strategia, Inflaatio, Osakemarkkina, Anomaliat

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1 Introduction

Numerous studies have suggested a notable negative association between inflation and the stock market. These include works by Fama & Schwert (1977), Schwert (1981), and Fama (1981). However, there is a gap in the literature regarding the potential for certain investment strategies or styles to produce alpha in high inflation environments. This research aims to investigate the potential for momentum strategies to generate returns and offer diversification benefits during periods of high inflation.

The concept of momentum or trend investing is based on the premise that an asset's performance will continue in the same direction. Carhart (1997) studied this concept in detail for individual equity market securities and expanded the Fama-French Three-Factor Model (market, size, value) to include momentum. He found that positive and negative trends had an average continuation period of three to 12 months. Yet, it was Jegadeesh & Titman (1993) who first recognized the momentum anomaly in their paper "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency." This definition of momentum has become the standard in the finance literature, with one variation - the 12-month calculation excludes the latest month to appropriately account for short-term reversal effects or the delayed implementation of the momentum signal in the portfolio.

Despite the extensive research on momentum investing, little is known about how momentum strategies perform in different inflation environments. This thesis aims to investigate the relationship between inflation and momentum-based investment strategies, as high inflation can affect the economy in various ways and lead to a decline in purchasing power, eroding returns on investments. Therefore, understanding how momentum strategies perform during periods of different inflation rates can be beneficial for investors and portfolio managers.

This thesis's primary research question is whether momentum strategies are able to generate positive returns in the Finnish stock market, and if the strategies have the

ability to hedge high inflation periods and whether any adjustments are necessary to maintain their effectiveness. Historical stock market data will be analysed to assess momentum strategy performance during different inflation periods. This empirical analysis will provide insight into whether momentum strategies generate positive returns during high inflation environments and whether any adjustments are necessary to maintain their effectiveness.

This thesis's findings will provide valuable insights for investors and portfolio managers who use momentum strategies and may be affected by high inflation. This research will help better understand the relationship between high inflation and momentum strategies, allowing more informed investment decisions. Additionally, this study will contribute to the finance literature by providing new insights into how momentum strategies perform in high inflation environments.

1.1 Purpose of the Study

The central aim of this research is to examine the presence of a momentum anomaly in the Finnish stock market during different inflation levels. By scrutinizing three well-established momentum strategies—inspired by Jegadeesh and Titman (1993) and Novy-Marx (2012)—the thesis seeks to empirically test the existence of systematic abnormal returns associated with these strategies. The primary hypothesis (H0) posits the existence of a momentum anomaly in Finland, challenging conventional financial market efficiency.

A key focus of the thesis is to assess the alpha-generating potential of the three selected momentum strategies, and to see if the possible returns differ in various inflation environments. Drawing inspiration from seminal works such as Fama & French (1992) and Jegadeesh & Titman (1993), the thesis aims to complete a comprehensive analysis of historical market data, and provide insights into the strategies' ability to consistently

outperform the market. Aligning with the findings of these well-known studies, the alternative hypothesis (H1) asserts that all examined strategies have the capacity to generate excess returns, challenging the notion of market efficiency and emphasizing the exploitable opportunities within the Finnish stock market.

Building upon the work by Miffre & Rallis (2007), the thesis investigates into the strategies' efficacy as potential hedges for inflation fluctuations. This approach aligns with the secondary hypothesis (H2), which posits that the examined momentum strategies lack the ability to serve as effective hedges against short-term unexpected inflation. By assessing correlations with the Consumer Price Index (CPI), the research aims to uncover whether momentum strategies exhibit resilience during periods of inflationary pressures.

Hypotheses are as follows:

H0: Momentum strategies do not generate excess returns in the Finnish markets.

H1: All examined momentum strategies can generate excess returns, challenging market efficiency.

H2: The momentum strategies do not possess the ability to act as effective hedges for inflation fluctuations.

1.2 Intended Contribution

This research attempts to contribute to the existing body of literature by conducting a diligent cross-country comparison. Many studies have investigated momentum strategies in different regions, such as the U.S. (Jegadeesh & Titman, 1993), Asia (Hameed & Kusnadi, 2002), and Europe (Bird & Whitaker, 2003). However, these papers fail to include Finland as part of the sample, leaving room for explanation. By focusing on the Finnish stock market, the study not only explores the unique dynamics of this market but also makes comparisons with broader international trends possible, which Fama &

French (2008) stated to be of paramount importance. The findings offer insights into how momentum strategies perform in a specific regional context, adding nuance to the understanding of cross-country variations in momentum profitability.

The thesis includes a comprehensive literature review, unifying existing research on momentum as an anomaly. By providing a comprehensive overview of the historical development and key findings of momentum in the literature, this study contributes to the consolidation of knowledge in the financial research. It identifies gaps and inconsistencies in the current body of literature, allowing continuation to future research.

Fama & Schwert (1977) explain that bonds, bills, and real estate can act as good hedging assets against inflation, but stock returns, on the other hand, tend to decrease with inflation. By incorporating momentum strategies into stock returns, this thesis tries to explore the possible linkage between certain characteristics of stocks and unexpected inflation. By measuring the correlations between Winner Minus Loser (WML) portfolios and the percentage changes in the Consumer Price Index (CPI), the research offers valuable insights into the potential role of momentum strategies in mitigating the impact of short-term unexpected inflation. By this approach, the study intends to extend the application of momentum strategies beyond traditional risk and return considerations.

In addition to academic contribution, this research provides practical implications for portfolio managers and investors operating within the Finnish investment landscape. By understanding the nuances of the local market and tailoring momentum strategies accordingly, practitioners can enhance their decision-making processes. The study offers insights into the practicality and effectiveness of incorporating momentum strategies within investment portfolios, providing theoretical guidance for those navigating the Finnish financial markets.

1.3 Structure of the study

The study aims to investigate the performance of three different momentum strategies during period of 2000 to 2023, and their potential hedge against inflation. To achieve this, the study will be divided into six main chapters. First and second chapters will provide an introduction to the study, presenting the research problem, research questions, hypotheses and the limitations of the study. Additionally, the theoretical framework of the study is laid out, including Modern Portfolio Theory, Fama-French three-factor model, Carhart four-factor model, and finally the Fama-French five- and six-factor models. Moreover, this section briefly introduces and provides explanations for a subset of other anomalies.

In the third chapter, an extensive review of the relevant literature is conducted. The review focuses mainly on momentum as an anomaly, different momentum strategies, and previous studies on the relationship between momentum strategies and inflation. Following this, Chapter four will describe the methodology used to collect and analyze the data. This chapter will explain the data sources, the sample selection criteria, and the empirical methods used to analyze the data. Additionally, this chapter will describe the variables used in the analysis.

After the methodology, chapter five will present the results of the study. This chapter will provide descriptive statistics of the sample and the performance of momentum strategies with respect to inflation rates. The chapter will also present the regression results, including the regression with CAPM and Five-factor model. The final chapter will discuss the results of the study and their implications. This chapter will compare the results of the study with previous research and will highlight the main findings of the study. Additionally, this chapter will discuss the limitations of the study and suggest avenues for future research.

1.4 Limitations

Despite the widely used methodologies employed in this thesis, it is important to acknowledge certain inherent limitations that may affect the universality and robustness of the findings. Understanding these limitations enhances the context within which the results should be interpreted.

The study is based on data from the Finnish stock market, which, due to its relatively small size and unique characteristics, may limit the generalization of results to other regions or countries. The features of the Finnish market, e.g. lower liquidity compared to larger markets, market structure and macroeconomic conditions may influence the performance of momentum strategies differently. In addition, the study covers a period from 2000 to 2023. This period includes three notable volatile periods—the dotcom bubble, the global financial crisis (GFC), and the COVID-19 pandemic. These unconventional market conditions may introduce unique results that cannot be explained by the study. The influence of these events on reversals and the consequential momentum performance requires careful consideration.

The implementation of stock selection and portfolio construction in momentum strategies are influential. Changes in these rules or varying sensitivities to different market conditions could impact the returns. The study's results are contingent on the selected implementation rules, and variations in these rules could yield different results.
External factors, such as changes in monetary policy, geopolitical events, or shifts in investor sentiment, can have a significant impact on momentum returns. The study does not comprehensively account for all external variables, and future research may benefit from exploring these dynamics in greater detail.

In conclusion, while the findings of this study contribute valuable insights into momentum profits in the Finnish stock market, these limitations underscore the need for caution in applying the results to other contexts. Future research endeavours should strive

for larger sample sizes, consider diverse market conditions, and explore the robustness of momentum strategies across different regions and time periods.

2 Theoretical Background

2.1 Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) is a fundamental idea in finance that has been comprehensively researched by both academics and practitioners. The EMH proposes that the markets are efficient and that prices reflect all available information (Fama, 1970). This chapter inspects the EMH and its applicability to momentum strategies.

The EMH has three forms weak, semi-strong, and strong. The weak form suggests that prices mirror all past prices and returns, while the semi-strong form suggests that prices reflect all publicly accessible information, containing news and announcements. According to the strong form, prices reflect all information, public or private.

Figure 1. Three Forms of EMH.

Fama (1970) investigated the argument and empirical studies on efficient capital markets and concluded that the data supported the EMH. He discovered that in efficient markets,

active trading tactics such as momentum are unlikely to provide extra returns because all accessible information is already reflected in market prices. Malkiel (2003) investigated the EMH and its detractors, analyzing the various sorts of market inefficiencies observed by research. While occasional abnormalities and market inefficiencies have been found, he contends that the data demonstrates that financial markets are generally efficient.

Lo and MacKinlay (1999) produced evidence against the EMH, claiming that markets are not always efficient and that momentum strategies can create excess returns. After accounting for transaction costs, they discovered that a basic momentum strategy including buying past winners and selling past losers can provide excess returns. Jensen (1978) provided some unusual data about market efficiency, implying that markets may be inefficient in the short run. He discovered that there are some market inefficiencies that investors might take advantage of, though they may be minor and brief. Fama (1991) then re-evaluated the EMH and claimed that the evidence still supports the assumption that financial markets are efficient, despite the possibility of some anomalies and market inefficiencies that investors can exploit. He discovered that momentum strategies are not always profitable, and that their profitability may be related to factors other than market inefficiencies, such as risk and liquidity.

The EMH has major implications for momentum strategies. If financial markets are truly efficient, momentum methods should not create excess profits because market prices already reflect all relevant information. If markets are inefficient, momentum strategies may be able to generate alpha by capitalizing on market inefficiencies. The research on market efficiency and momentum methods is conflicting. While some studies, such as Fama (1970) and Malkiel (2003), contend that financial markets are generally efficient and that momentum strategies are unlikely to generate excess returns, Lo and MacKinlay (1999) contend that markets are not always efficient and that momentum strategies can be profitable.

Finally, the EMH is an essential topic in finance that has been thoroughly researched by both researchers and practitioners. According to the literature, financial markets are generally efficient, yet there may be certain anomalies and market inefficiencies that investors can exploit. When employing momentum strategies, it is critical to evaluate the different forms of the EMH as well as the empirical evidence on market efficiency and momentum strategies. While some research indicates that markets are generally efficient and that momentum strategies are unlikely to provide excess returns, other research indicates that markets are not always efficient and that momentum methods can be profitable, especially when transaction costs are considered.

2.2 Modern Portfolio Theory

Modern Portfolio Theory (MPT) is a framework introduced by Markowitz (1952) for constructing investment portfolios by maximizing expected return and minimizing the investment risk. The core idea is to reduce risk of any portfolio by selecting a weighted collection of assets that together contribute to lower risk than individual assets. The model model is also often referred as mean-variance analysis, as the risk is measured as variance of individual asset variances and covariances between the assets of the portfolio. Markowitz (1952) explains that the selection of assets should be based on the overall risk-reward characteristics of the portfolio. This means that, in the context of MPT, assets are chosen not only based on their individual expected returns but also considering how their combination influences the overall risk of the portfolio. The goal is to achieve an optimal balance that maximizes returns for a given level of risk or minimizes risk for a targeted level of return, ultimately aligning with the foundational principles of MPT.

Integral concept to MPT is the Capital Market Line (CML). CML acts as a graphical representation that symbolizes the risk-return tradeoff for portfolios that include both a risk-free asset and a diversified portfolio of risky assets. The CML guides investors in determining optimal allocations between risk-free and risky assets, providing a visual framework for achieving the highest expected return for a given level of risk.

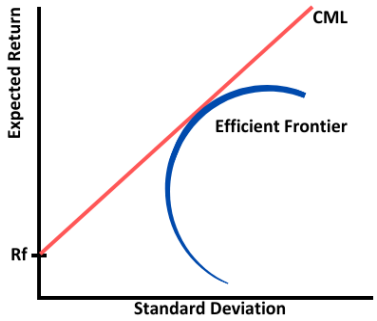

Figure 2. CML & Efficient Frontier.

2.3 Capital Asset Pricing Model

The Capital Asset Pricing Model (CAPM) is a financial model that helps investors calculate the expected return of a portfolio of assets based on the risk-free rate, forecasted market return, and the beta of the asset. Sharpe (1964) developed the concept, with additional contributions from John Lintner and Fischer Black. CAPM is founded on the foundation that investors will only take on more risk if they can expect a bigger return. In other words, the predicted return on an asset is proportional to its risk.

The CAPM formula is as follows :

$$R\epsilon = Rf + \beta\epsilon(Rm - Rf) \quad (1)$$

Where :

$Re = Expected\ return\ on\ a\ security$

$Rf = Risk\text{-}free\ rate$

$\beta a = Beta\ of\ the\ security$

$Rm = Expected\ return\ of\ the\ market$

Over the years, the CAPM has been subjected to significant empirical testing. Fama and MacBeth (1973) did one of the early empirical assessments, testing the relationship between risk and expected return using data from the NYSE. Their findings backed up the CAPM, indicating that beta was positively connected to predicted returns.

Ross (1976) improved the CAPM further by introducing the concept of arbitrage pricing theory (APT). APT implies that the return on an asset can be explained by more than just market risk. Ross contended that the CAPM was too simple of a model and failed to account for other factors such as inflation, interest rates, and business cycles. The APT model offers a more general framework for asset pricing that can take into consideration a broader range of criteria. Fama and French (1993) published another noteworthy study about CAPM. They proposed the concept of common risk variables, proposing that factors other than beta could explain the difference in stock returns. They discovered that size, book-to-market ratio, and momentum were major determinants in explaining stock return variation. Chen, Roll, and Ross (1986) piloted a study that questioned the CAPM's validity. They discovered that the stock market was influenced by economic causes other than market risk, such as inflation, money supply, and changes in interest rate term structure. They claim that these considerations should be taken into account when calculating expected returns.

Regardless of the limitations and improvements to the CAPM over the years, it remains a key tool for investors to assess a portfolio's projected return based on its level of risk. The concept has been widely employed in the finance industry and is still being researched.

Several research have been conducted to study the relationship between momentum and CAPM. For example, Jegadeesh and Titman (1993) discovered that the CAPM cannot explain momentum profits and that strong momentum portfolios had excess returns even after controlling for beta. Similarly, Rouwenhorst (1998) demonstrated that exposure to the Fama-French three-factor model does not explain momentum profits. The

evidence suggests that momentum strategies question the CAPM's validity, as they create abnormal returns that cannot be explained by market beta exposure. This emphasizes the need of including factors other than beta in asset pricing models.

2.4 Fama-French three factor model

The Fama-French three factor model is an asset pricing model that extends the idea of Capital Asset Pricing Model (CAPM) by adding two new factors that take into account the impacts of (firm) size and value on stock returns. The model is predicated on the idea that investors should be compensated not only for taking on market risk (as in the CAPM), but also for taking on risks associated with smaller firms and companies with lower valuations. It was established by Fama and French (1993) as an addition to the CAPM model.

The Fama-French three factor model is written as follows:

$$R\epsilon - Rf = \beta e\ x\ (Rm - Rf) + \beta_2 SMB + \beta_3 HML \quad (2)$$

$SMB = Small\ minus\ big\ factor\ (Size)$
$HML = High\ minus\ low\ factor\ (Value)$
$\beta_x = factor\ coefficients$

SMB and HML factors obtain the effects of firm size and value on stock returns, as stated in the above formula. SMB is the difference between the returns of small companies and big companies, and HML is the difference between the returns of high book- to- market ratio firms and low book- to- market ratio firms. The Fama- French three factor model has been subject to broad empirical testing. The original paper by Fama and French (1992) showed that the model explained the cross-section of stock returns better than the CAPM, and that the size and value factors were significant in explaining returns. The authors also found that the size and value factors were correlated with other firm characteristics, such as profitability and investment.

Since the initial paper, a number of academics have researched the validity of the Fama-French three factor model. Some studies have found that the model is robust to different sample periods and regions, while others have found that the size and value factors may be fake or can be explained by other factors. For example, some studies have shown that the size effect may be related to liquidity risk or market frictions, rather than a reward for taking on size risk.

2.5 Carhart four factor model

Carhart (1997) Extended the three-factor model by adding fourth factor called momentum. The momentum variable is designed to capture the tendency of stocks with strong recent performance to continue to perform well in the near future, and vice versa. Carhart based the model on the findings of Jegadeesh & Titman.

The Carhart four factor model can be expressed as follows:

$$R\epsilon = Rf + \beta_1(Rm - Rf) + \beta_2 SMB + \beta_3 HML + \beta_4 WML \quad (3)$$

$$WML = Winner\ minus\ loser\ (Momentum)$$

The Carhart model has been extensively used in studies of asset pricing, especially in the evaluation of mutual fund performance. Carhart (1994) tested the model using monthly mutual fund returns from 1963 to 1993 and found that it explained the variations in returns across portfolios better than the three-factor model.

One of the early applications of the Carhart model was in a study by Grinblatt and Titman (1995). The authors used the model to measure the performance of mutual funds. The results indicated that funds with high momentum exposure outperformed their peers in most cases - even after controlling for other model variables such as size and value. Further studies have provided more evidence for the effectiveness of the Carhart model

in explaining the cross-section of stock returns. For example, Fama and French (2015) demonstrated that the model performed well in a global setting, with momentum being a significant factor in international equity markets.

Similar to Fama-French three-factor model, the Carhart model has been subject to criticism and refinement. Some authors argue that the model may suffer from data mining biases, as the selection of factors and the sample period can greatly influence the results. Another argument is that the model may not capture all of the relevant risk factors, and that there may be additional factors beyond the four identified by Carhart.

2.6 Fama-French five factor model

The Fama- French Five Factor Model is an expansion of the three- factor model. The five-factor model expands on the initial model by including two new factors profitability and investment. The profitability factor compares the returns of companies with high operating profitability to those that possess low operating profitability. The investment factor compares the results of firms that invest highly with those that invest little. These characteristics are predicated on the assumption that profitable enterprises and firms with few investment prospects have a higher expected return.

The Fama- French Five Factor Model is stated as follows :

$$R\epsilon - Rf = \beta e\ x\ (Rm - Rf) + \beta_2 SMB + \beta_3 HML + \beta_4 RMW + \beta_5 CMA \quad (4)$$

$$RMW = Robust\ minus\ weak\ (Profitability)$$

$$CMA = Conservative\ minus\ aggressive\ (Investment)$$

The SMB factor captures the excess returns of small- cap stocks relative to large- cap stocks, while the HML factor captures the redundant returns of value stocks relative to growth stocks. The RMW factor captures the redundant returns of enterprises with high profitability relative to enterprises with low profitability, and the CMA factor captures

the redundant returns of enterprises with conservative investment programs relative to those with aggressive programs.

The Fama- French Five Factor Model has been subject to expansive empirical testing. For illustration, Fama and French(2015) tested the model using data from 1926 to 2013 and set up that it handed a better explanation of stock returns than the three- factor model. They also set up that the profitability and investment factors were significant in explaining the sampling of stock returns. Although it is a model that has more explatonary power, many papers such as (Blitz, Hanauer & Vidojevic, 2018) argue that the model fails to capture the momentum returns that are widely accepted in todays research.

However, the five factor Model has been extensively used in finance research, and has important implications for asset pricing and portfolio management. For example, the addition of the profitability and investment factors provides a more complete picture of the reasons of stock returns, allowing investors to understand and manage their portfolios better.

2.7 Fama-French six factor model

The initial Three Factor Model includes market risk, size, and value as factors that explain stock returns. The Four Factor Model added a fourth factor called momentum, to capture the sentiment of stocks. Still, these models were argued to fail to capture other important factors that affect stock returns.

The Six Factor Model includes the same three factors as the Three Factor Model (market risk, size, and value), the momentum factor from the Four Factor Model, and two new factors: profitability and investment. The profitability factor captures the tendency of stocks with high profitability to outperform those with low profitability, and the investment factor captures the tendency of stocks with low investment to outperform those with high investment.

The six factor model can be expressed as follows :

$$R\epsilon - Rf = \beta e\, x\, (Rm - Rf) + \beta_2 SMB + \beta_3 HML + \beta_4 RMW + \beta_5 CMA + \beta_6 WML \quad (5)$$

The model was designed to better address the reasoning behind stock returns than those such as, CAPM, CCAPM or 3-factor model (Fama & French, 2018). The model has been studied by several researchers. Papers, such as (Barillas & Shanken, 2018) compare the 6-factor model with other models such as FF5, and explain that the 6-factor model and other similar models that include momentum are more precise than the FF5.

2.8 Anomalies

This chapter shortly introduces few of the most well-known anomalies in the financial markets and describes the explanations and potential sources for the anomalies. The study acknowledges the extensive scope of anomalies, but focuses on examination of the foremost ones and their implications for the financial markets.

The Halloween Effect, also known as "Sell in May and Go Away," implies stronger stock performance from November to April and less favorable conditions from May to October. Studies, such as those by Hirsch (2001), validate this historical tendency.

The Turn-of-the-Month Effect indicates that stock prices are likely to go up on the final trading day of the month and the initial three days of the following month. Agrawal & Tandon (1994) have documented this predictable pattern.

The Turn-of-the-Year Effect describes an increase in stock prices and trading volume in late December and early January. Agrawal & Tandon (1994) support this by pointing out the seasonal patterns around the turn of the year.

Moving Averages involve calculating the average price of a security over a specific period to identify trends. This technique is widely used in technical analysis, as endorsed by researchers like Brock & Josef (1992), and Lakonishok et al. (1992).

The Trading Range Break strategy identifies price levels where a security historically faces difficulty moving beyond, with breakouts considered significant signals. This strategy is acknowledged by papers like Brock & Josef (1992), and Lakonishok et al. (1992) in technical analysis literature.

Goodel, Kumar & Rao (2023) theorize that anomalies emerge because of different emotions, mood and social interactions between investors, particularly affecting a specific group that previously experienced success. The overlooked qualitative aspect in social sciences, as noted by Frankfurter & McGoun (2001), may contribute significantly to the manifestation of anomalies. Jensen (1978) perceives anomalies as a result of our limited exposure to available information, anticipating that in-depth anomaly studies can substantially enhance our comprehension of market efficiency.

From a behavioral perspective, anomalies are seen as consequences of various models' failure to rationalize asset behavior. Fama & French's (1993) three-factor model lacks explanatory power for long-term effects and momentum returns, according to Daniel & Titman (1997). Berk et al.'s (1996) non-linear model encounters challenges in reproducing certain effects. Boudoukh et al. (1994) categorize explanatory approaches into revisionist, loyalist, and heretic schools of thought. Revisionists and loyalists uphold market efficiency, while heretics, identified as behaviorists, attribute anomalies to psychological factors influencing decision-making.

Further classification by Wouters (2006) distinguishes rationalists and behaviorists within the loyalists and heretics categories, respectively. Rationalists attribute anomalies to chance or overlooked common risk factors, while behaviorists emphasize sentiments as the driving force behind market mispricing. The observed overreaction and

underreaction in the financial market, according to Wouters (2006), can be traced back to investors' psychological reasons. Barberis & Sheilfer (1998) argue that underreaction results from investor conservatism, while overreaction is influenced by representativeness bias, where investors overvalue securities based on recent information. This intricate interplay of psychological factors and model limitations underscores the multifaceted nature of anomalies in financial markets.

3 Literature review

Numerous research endeavors have delved into the importance of momentum in elucidating global stock returns. Hou, Karolyi, and Kho (2011) substantiated that the momentum anomaly persists within global stock markets, wherein stocks that exhibit superior performance persistently outshine those with inferior performance over a relatively brief to moderate period. Their study ascertained that momentum plays a noteworthy role in elucidating global stock returns and that an augmented momentum loading is linked with heightened returns. The persistence of the momentum effect throughout diverse regions implies its universality as a phenomenon within global stock markets. The research paper puts forth the claim that the momentum anomaly, which refers to the persistence of momentum in stock returns, cannot be accounted for by conventional asset pricing models alone. It asserts that the inclusion of supplementary factors, such as momentum itself, is essential to elucidate this phenomenon. Moreover, it aligns with behavioral finance theories, which propose that investors tend to engage in herd mentality and excessively react to recent news and events. This behavior ultimately leads to the continuation of momentum in stock prices. According to the paper, momentum factor should be considered in global asset allocation and investment strategies, as it has important implications for investors.

Fama and French (2012) explain that the momentum factor is highly influential in explaining international stock returns. Interestingly, this influence is even stronger in emerging markets compared to developed markets. This finding suggests that the momentum effect is not confined to a particular region or country, but rather it permeates all major global equity markets. Moreover, the momentum effect remains resilient and enduring, even when accounting for other factors such as size, value, and market risk. The authors propose that behavioral finance theories offer an explanation for this phenomenon, suggesting that investors tend to follow the herd and react excessively to recent news and events, thus perpetuating momentum. When combined with size and value factors, momentum has low correlation with these factors and provides diversification benefits which reduce exposure to market risk, according to the study.

Novy-Marx (2012) conducted an examination to determine the durability of the momentum anomaly. This investigation aimed to uncover whether the momentum effect was influenced primarily by past returns or other underlying factors. The findings of this study revealed that the momentum anomaly remained steadfast and enduring even when controlling for alternative factors. These results strongly suggest that momentum is truly an abnormality and not influenced by external factors such as liquidity, risk, or market complexities. The paper puts forth the argument that investor underreaction may provide an explanation for the presence of the momentum effect. It proposes that investors fail to adequately incorporate all pertinent information into their investment decisions, thereby allowing momentum to persist. Furthermore, the study asserts that market complexities and liquidity are not responsible for driving the momentum effect, as it continues to exist even when accounting for trading costs. The paper shows that in smaller, less liquid markets, the momentum effect is stronger, investor underreaction is more pronounced, and it is more difficult for investors to fully incorporate all available information into their investment decisions. Research shows that the momentum effect is not driven by risk because momentum portfolios are not highly correlated with traditional risk factors such as beta, size, or value.

Asness, Moskowitz & Pedersen (2013) studied the effectiveness of combining value and momentum strategies across different asset classes. The authors conclude that value and momentum strategies are complementary and can be combined to increase returns and reduce risk. Utilizing both value and momentum strategies has proven to be highly effective in various asset classes, such as equities, bonds, currencies, and commodities. The authors suggest that investors should contemplate incorporating a combination of value and momentum strategies into their portfolios to attain superior risk-adjusted returns.

Time series momentum, as described by Moskowitz, Ooi, and Pedersen (2012 in their study, is a strategy that entails purchasing assets that have demonstrated positive

returns within a specific time frame and selling assets that have shown negative returns during that same period, unlike the cross-sectional momentum that measures the performance against its peers. The researchers discovered that time series momentum is a consistent and resilient phenomenon across various asset classes, including equities, bonds, commodities, and currencies. They suggest that investors should contemplate incorporating time series momentum into their investment portfolios as a supplementary approach alongside established strategies like value and momentum.

The study titled "Momentum and Autocorrelation in Stock Returns" by Lewellen (2015) investigates the correlation between momentum and autocorrelation in stock returns. According to the author's findings, there exists a significant positive relationship between momentum and autocorrelation in stock returns. The research provides empirical evidence supporting the robustness of this relationship across various time periods and stocks. The author proposes that this connection can be attributed to behavioral biases exhibited by investors, such as herding behavior and anchoring. Ultimately, the paper concludes that the relationship between momentum and autocorrelation holds important implications for investors, as it suggests that utilizing momentum strategies can exploit autocorrelation in stock returns and result in superior returns.

During times of market instability or ambiguity, such as economic downturns, market collapses, or elevated interest rates, momentum strategies have proven to be particularly advantageous (Barroso & Santa-Clara, 2015). Conversely, when the market is stable or predictable, such as during periods of economic growth or when interest rates are low, momentum strategies tend to yield lower returns and exhibit greater volatility (Barroso & Santa-Clara, 2015).

Barroso and Santa-Clara (2015) state that the level of market efficiency, investor attention, and investor sentiment all play a role in determining the effectiveness of momentum strategies. Additionally, behavioral biases manifested by investors, including herding, overconfidence, and availability bias, further contribute to the success of momentum

strategies (Barroso & Santa-Clara, 2015). Therefore, according to the paper, it is advisable for investors to incorporate momentum strategies into their diversified investment portfolios (Barroso & Santa-Clara, 2015).

Momentum is seen as a factor-based model that is able to generate excess returns compared to the market index (Hou, Xue, Zhang, 2015). The empirical evidence points out that momentum anomaly is a persistent and robust factor that is able to generate excess returns in different markets and time periods (Hou et al., 2015). Hou et al explain that momentum can be combined with other factor-based strategies, e.g. value or profitability, to construct a well-diversified portfolio that is able to provide higher alpha than a conventional market-cap weighted index.

Investor behaviour has been a focus on authors such as Cujean & Hasler, (2017) who point out that the tendencies of investors may have an impact on momentum returns during bad times. Market participants may be more prone to overreact to negative news, which leads to continued negative performance for stocks that have poor recent trend. According to the paper, this may ultimately lead to herding behaviour, leading to more correlation between individual assets. These phenomenons may have a contribution on the persistence and strenght of momentum effects during higher volatility or recessions.

Studies such as (Badreddine & Clark, 2021; Apergis et al., 2020) have investigated the role of industry-specific aspects in momentum returns, such as, the presence of the anomaly and reverse effects. The papers find industry-specific volatility to have assymetric effects on momentum returns, in which the high volatility leads to higher returns and weaker momentum for losers. The paper attaches the phenomenon to behavioral finance theory, suggesting that investors tend to underreact to positive news and announcements and overreact to negative ones. Apergis et al find that in US, UK and Japan there is a clear evidence pointing out that on an industry level there is a clear momentum effect, with winners outperforming losers at the industry level over a short to

intermediate period. The paper suggests that there may be a possibility to create a sector rotation strategy based on the findings.

Pitkäjärvi et al., (2020) explores the potential of combining cross-asset signals and time series momentum. The paper indicates that by combining the two, the strategy can be improved especially during periods of high market volatility. The authors base their finding on the fact that common macroeconomic factors have an impact across different asset classes. It is also pointed out that, managing transaction costs and considering the impact of market frictions is important when implementing such strategies.

Dashan Huang et al,. (2020) study time series momentum and its existence in different asset classes, such as, equities, commodities, bonds and foreign exchange markets. The study points out that time series momentum exists and is statistically significant in all of the asset classes except in foreign exchange markets. The paper also associates its findings with the fact that investors tend to underreact to new information.

Patton and Weller (2020) investigates a practical aspect of the potential costs of trading anomalies in financial markets. These anomalies include momentum, value and profitability. The study highlights the fact, that the excessive returns of these anomalies can be significantly reduced by transaction costs. He points out that most people underestimate the amount of transaction costs associated with these strategies. They also discuss other factors that may have an impact on the profitability of trading anomalies. These include liquidity, short-selling constraints and microstructure of the market. They offer practical insights into managing costs and other frictions of the markets when evaluating their profitability.

Bryan et al. (2021) study the profitability of value and momentum strategies in equity markets and the main sources of the profitability. The study finds that value and momentum strategies are able to create strong and consistent performance across different markets and periods. The paper provides insightful information about the mechanisms

that drive the profitability of these strategies, including investor overreaction and underreaction to information, similar to Dashan Huang et al, ;Apergis et al,. The study also indicates that value and momentum strategies have the ability to complement each other in a well-diversified portfolio. The paper also addresses that these strategies have limitations in the implementation, including transaction costs and liquidity.

Factor momentum refers to the momentum in the factor returns, contrary to the traditional momentum strategy that is based on past stock returns. Ehsani & Linnainmaa (2022) study the performance and relationship between factor momentum and the traditional one. The authors point out that factor momentum stronly predicts future factor returns and exhibits similar momentum effects like the traditional momentum. Ehsani & Linnainmaa also link their findings to the behavioural theory, that investors tend to over- and underreact to new information about the factor performances. The paper suggests that by including factor momentum and the traditional momentum into a portfolio, it may enhance the performance of the portfolio and also provide diversification benefits. It is also noted that the implementation of these factor momentums comes with transaction costs similarly to Bryan et al.

3.1 Momentum strategies

Exploring the profitability and underlying factors of momentum methods is an important area of study. Jegadeesh and Titman (1993) provided the groundwork for this investigation by finding that companies with good previous returns continue to exhibit robust performance in the near future (3-12 months holding period), but those with bad past returns tend to continue underperforming. This momentum effect extends its influence beyond the US equity market (Chan et al., 1996; Rouwenhorst, 1998; Schiereck et al., 1999; Jegadeesh and Titman, 2001; Griffin et al., 2003; Hon and Tonks, 2003; Balvers and Wu, 2006; Muga and Santamara, 2007). Various combinations of formation and holding durations have repeatedly confirmed the ideal 6/6 momentum investment strategy (6 months formation and 6 months holding).

Novy-Marx's (2012) concept contradicts the traditional view of momentum as a never-ending ascent for winners and a continuing drop for losers. His nuanced perspective show that recent winners with an intermediate track record of underperformance tend to underperform recent losers with an intermediate track record of success. This concept goes beyond US equities, including other regions.

Novy-Marx's observations challenge commonly held behavioral and intellectual explanations for momentum. Instead of positive short-lag autocorrelations due to news underreaction, the analysis reveals considerable information in historical performance over a period of 12 to seven months. When considering intermediate horizons, recent returns lose relevance, calling existing models into question. Recognizing the importance of intermediate-horizon previous performance in driving momentum opens the door to more refined trading techniques. Ignoring recent performance improves momentum approach greatly. Sharpe ratios, particularly in liquid and large-cap companies, reflect the segment's latent potential. Novy-Marx's discoveries provokes rethinking of traditional momentum methods, paving the way for alternative techniques with higher efficacy and risk-adjusted returns.

Academic research extends beyond traditional stock markets and into asset classes such as mutual funds, corporate bonds, currencies, commodities, exchange-traded funds, and real estate investment trusts (Grinblatt et al., 1995; Chui et al., 2003; Okunev and White, 2003; Sapp and Tiwari, 2004; Miffre and Rallis, 2007; Derwall et al., 2009; Beracha and Skiba, 2011; Menkhoff et al. This broad use emphasizes the momentum effect's universality and success.

In response to the difficulties encountered during the Global financial crisis and recovery phase, researchers have rapidly researched alternate momentum tactics that outperform standard approaches, particularly in volatile circumstances. George and Hwang (2004) pioneered the 52-week high momentum strategy, which has been shown to outperform standard momentum in numerous experiments (George and Hwang, 2004;

Marshall and Cahan, 2005). Furthermore, Blitz et al. (2011) proposed residual momentum, which selects stocks based on their residual return and outperforms traditional momentum during crises (Chang et al., 2018; Lin, 2019)

The introduction of time-series momentum, or absolute momentum, by Moskowitz et al. (2012) gained popularity by picking financial assets based on their own previous performance, regardless of the performance of other financial assets. Papers such as (He and Li, 2015; Bird et al., 2017) looked into the profitability of time-series momentum techniques. Volatility scaling schemes have been proposed to limit losses during adverse periods (Wang and Xu, 2015; Barroso and Santa-Clara, 2015). Barroso and Santa-Clara (2015) presented risk-managed momentum strategies based on continuous volatility scaling, whereas Daniel and Moskowitz (2016) advocated for a dynamic volatility scaling momentum framework. Furthermore, other papers investigated integrated investing strategies, such as combining value and momentum, cross-sectional and time-series momentum, and demonstrated their superiority to solo momentum strategies (Serban, 2010; Asness et al.2013).

3.2 Understanding inflation hedge: Asset classes and strategies

Allocating funds to diverse asset classes has been continuously researched as an approach to minimize risks associated with unusual market conditions, notably inflation and interest rate fluctuations. Usually this is linked to assets that have low correlation with the stock market, allowing for portfolio diversification. Baur & Lucey, (2010) studied gold as a hedge for periods of elevated inflation. Other papers have studied assets such as real estate (Hartzell, Hekman & Miles, 1987), commodity futures (Gorton & Rouwenhorst, 2006), and inflation-linked bonds to hedge the potential inflation. The idea behind these studies lies in the exploration for alternative assets that demonstrate resilience or even appreciation during challenging economic periods. These ideas are based on the modern portfolio theory that focuses on the dynamics of various assets to act as diversifiers in various market conditions. A lot of papers focus on exploring different asset

classes as potential hedges against market conditions, but there is a limited amount of research on specific active investment strategies for this purpose.

Despite the limited research on the direct correlation between inflation and momentum strategies, we can examine momentum profits during periods of high and low inflation. Daniel & Moskowitz (2016) show that following the Great Depression in 1929 to 1939 and the financial crisis of 2008-2009 the loser portfolios significantly outperform the winner portfolios, and WML portfolios beta is significantly negatively related with similarly realized market returns. The paper argues that the strategy can act as a short call option on the market. These findings can be used to draw observations on the patterns and behaviour of momentum strategies, as inflation rates similarly were volatile in the mentioned periods. During great depression there was significant deflation and during financial crisis the rate was rather high at first, then virtually zero.

Min & Kim (2016) display that during times when the marginal value of wealth i.e. expected market risk premium is most significant, a momentum strategy focusing on winner stocks tends to result in substantial underperformance, exposing investors to heightened downside risk. This observation invites a speculative interpretation that during periods when the marginal value of wealth is most significant, it is often a sign of economic conditions where inflation is high, indicating that slight changes in wealth may have notable impact on financial decisions.

Neville, Draaisma, Funnell, Harvey & Van Hemert (2021) investigated various asset classes and active strategies during periods when inflation exceeds 5%, spanning historical events known for their elevated inflation rates such as WW2, the Korean War, OPEC oil crisis, etc. Their findings indicate that trend-based strategies focusing on equities, commodities, foreign exchange and bonds demonstrate consistent performance across the inflation episodes, offering a significant level of protection compared to alternative assets or factors.

Paper by Miffre and Rallis (2007) focuses on momentum strategies in commodity futures. They find that given strategies do not offer a statistically significant hedge against short-term unexpected inflation. They use correlations between momentum returns and the percentage change in the consumer price index (CPI) to study the potential for momentum-based hedging strategies against elevated inflation. Despite the fact, that the strategies yeilded excess returns and diversification benefits, there is no clear evidence to suggest that the strategies would safeguard against inflation.

4 Data and Methodology

4.1 Data

The dataset utilized in this study spans from 2000 to January 2023 and is exclusively focused on stocks listed on Helsinki's stock exchange. To mitigate survivorship bias, the dataset includes not only active stocks but also those that are no longer publicly traded i.e. dead stocks (Banz & Breen, 1986). Following the methodology proposed by Silvasti, Grobys, and Äijö (2021), the dataset excludes companies comprising the bottom 10% based on market capitalization. Similarly, to Leivo & Pätäri (2011) if a company has been issued more than once, only the more liquid stock is included in the data. Additionally, stocks that do not have at least 12 months of return data during the sample period are excluded from the calculations, since they would be contributing to only one of the calculated strategies on a given period. This could significantly impact the risk and return characteristics of the other strategy, as newly listed stocks are known to be volatile (McGuinness, 2015).

Recognizing the relatively small sample size, financial companies are intentionally included in the dataset, contrary to most studies. This comprehensive approach ensures a whole representation of Helsinki's stock exchange, fostering a more robust foundation for subsequent analyses. Additionally, a monthly consumer price index (cpi) was retrieved for similar period to measure the effects of inflation rates in momentum strategy returns. Both the monthly stock closing prices and the CPI figures are retrieved from Datastream.

Euribor 1M, short for Euro Interbank Offered Rate, represents the annualized interest rate for one-month interbank deposits within the Eurozone. It provides a theoretical risk-free rate of return for this study, based on the findings of (Vaihekoski, 2007). The data is from Finnish Central Bank (Suomen Pankki).

In line with Grobys & Huhta-Halkola (2019), we utilize the monthly returns of OMX Helsinki to calculate a benchmark. Given that all stocks within the momentum portfolios originate from the Finnish Exchange, the use of OMX Helsinki is deemed the most suitable for this purpose. Additionally, Fama/French 5 European factor data is retrieved from Kenneth French data library for the regression tests, following Novy-Marx (2015).

4.2 Methodology

The research methodology employed in the investigation of cross-sectional momentum within Finnish markets aligns closely with the most fundamental approaches pioneered by Jegadeesh & Titman (1993) and Novy-Marx (2013). The central focus is on evaluating the relative performance of stocks over a fixed ranking period of J, followed by different holding periods H.

Firstly, monthly logarithmic returns are calculated for each stock as follows:

$$R(m) = \ln(\frac{Pt}{\mathrm{Pt}-1}) \quad (6)$$

$R(M) = Monthly\ return\ of\ a\ stock$

$ln = Natural\ logarithm$

$Pt = Closing\ stock\ price\ at\ the\ end\ of\ the\ month$

$Pt - 1 = Opening\ stock\ price\ at\ the\ beginning\ of\ the\ month$

Next, securities are categorized into portfolios according to their historical excess returns. Three different portfolio strategies are constructed from the returns. All securities are equally weighted in the portfolios. First, implements the most commonly utilized strategy in academic paper – following Jegadeesh & Titman (1993). In the methodology adopted, portfolios are constructed based on the performance of stocks in the top 20% and bottom 20% over the preceding 12 months, excluding the most recent month. This approach aims to create a winner portfolio consisting of stocks with the highest returns and a loser portfolio comprising stocks with the lowest returns, mitigating the impact of

short-term reversals and minimizing the potential for abnormal returns (Jegadeesh & Titman 1993, 2001).

Utilizing a 2-12 formation period, a commonly employed technique in momentum studies (Jegadeesh & Titman, 1993), portfolios are assembled by selecting stocks with the most significant cumulative returns (top 20%) and those with the lowest cumulative returns (bottom 20%) during the specified formation period J. This process is executed monthly throughout the sample period.

The momentum strategy involves buying stocks from the winner portfolio and selling those from the loser portfolio. This strategy is maintained for the subsequent K months, and cumulative returns for both portfolios are computed across mentioned holding periods.

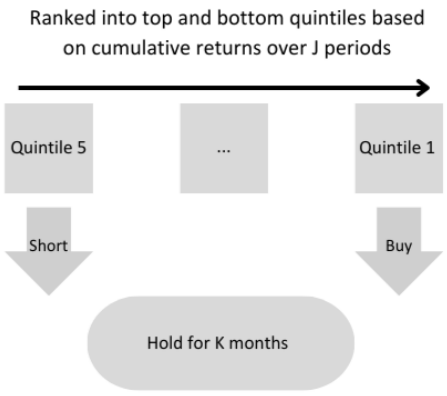

Figure 3. Logic of Portfolio formation.

In tandem with the conventional 2-12 methodology, an additional exploration involves a 6-month formation period followed by a 6-month holding period. This alternative approach broadens the scope, introducing a different timeframe for portfolio construction and evaluation. By incorporating a 6-6 formation and holding period, this exploration

seeks to offer a nuanced perspective on the persistence and effectiveness of momentum strategies across various temporal dimensions.

Expanding the spectrum of investigation, an additional dimension is introduced by examining Novy-Marx's strategy based on intermediate past performance. In this variant, the formation period spans from t-12 to t-7, encompassing a distinctive 6-month period that navigates through the intermediate historical performance of stocks.

Following the Novy-Marx approach, the long position is taken on stocks exhibiting the highest cumulative returns during this period, while a short position is assumed for those with the lowest cumulative returns. This strategic move aims to capture the potential market signals embedded in the intermediate-term performance of stocks, providing insights into the dynamics that unfold during this specific timeframe. Portfolio analysis is performed in Matlab.

Following the creation of different momentum strategies, the study proceeds to the measurement of momentum profits and their effectiveness as a hedge against inflation. The study follows the methodology pioneered by Miffre and Rallis (2007). This approach has been selected due to its close alignment with the methods employed in this research, and the paucity of previous studies directly investigating the relationship between various momentum strategies and inflation hedging.

Drawing inspiration from Miffre and Rallis (2007), the analysis focuses on the Winner Minus Loser (WML) momentum returns, probing their correlations with the percentage change in the Consumer Price Index (CPI). The CPI is employed as a proxy for short-term unexpected inflation, providing a relevant metric to assess the potential of momentum strategies in mitigating the impact of inflationary pressures.

Moreover, the regression model facilitates the exploration of potential non-linear relationships or threshold effects, allowing for a more nuanced understanding of how

different inflation regimes might impact momentum returns. By categorizing inflation levels into distinct groups (e.g., low, moderate, high), the study could potentially uncover whether the relationship between inflation and momentum returns varies across these different contexts. However, it is essential to note that while this approach could provide a more sophisticated answer in the context of investor behavior, the current study does not implement such categorizations or explore threshold effects. Achieving a consensus on what constitutes high, moderate, or low inflation is a complex task and was not explicitly addressed in the present analysis. The regression models between inflation and momentum returns include a standard OLS model, followed by iteratively reweighted least squares (IRLS). Furthermore, time-varying correlations, and finally a quantile regression model is tested against the variables. Additionally, different regression models between CAPM and Fama-French 5 factors are applied to each momentum portfolio to assess the impact of these multifactor models on explaining the variations in portfolio returns.

5 Results

5.1 Returns among strategies

Table 1 presents the monthly mean excess returns of various momentum portfolios, offering insights into the performance differentials between strategies.

Table 1. Mean excess returns.

Strategy	Mean Excess Return	T-stat
Standard 12-1	1.40%	(4.877)**
Novy-Marx	1.03%	(4.338)**
J&T 6-6	1.38%	(4.977)**

This table reports the mean excess returns for three different portfolios during the sample period from 2000 to 2023. Returns are expressed as percentages, and significance levels are indicated by t-statistics (*: 10%, **: 5%, ***: 1%).

Notably, the Novy-Marx strategy exhibited a mean excess return of 1.03%, with a t-statistic of 4.338, denoting its statistical significance at the 5% level. In comparison, the Jegadeesh and Titman (J&T) 6-6 strategy outperformed with a mean excess return of 1.38%, supported by a higher t-statistic of 4.977. The Standard 12-1 strategy displayed a mean excess return of 1.40% and a t-statistic of 4.877, further emphasizing its robust performance.

The observed excess returns align with previous studies in the field, confirming the persistence of momentum effects in financial markets. Notably, these results indicate that momentum strategies, especially J&T 6-6 and Standard 12-1, generate positive excess returns, providing evidence in favor of their effectiveness in capturing trends in Finnish asset prices.

Comparisons with studies conducted in other regions reveal interesting variations. While momentum strategies have demonstrated consistent profitability globally, the magnitude of excess returns may differ across markets. Factors such as market structure, investor behavior, and economic conditions can contribute to these variations. It is essential to acknowledge that regional nuances may influence the performance of momentum portfolios, and the study's findings within the context of the Finnish market contribute valuable insights to the broader understanding of momentum strategies.

The substantial t-statistics accompanying the mean excess returns underscore the statistical significance of the observed performance, reinforcing the conclusion that momentum strategies, particularly J&T 6-6 and Standard 12-1, generate economically and statistically meaningful excess returns in the Finnish market.

5.2 Descriptive statistics

Table 2 represents descriptive statistics for each portfolio.

Table 2. Descriptive Statistics.

Strategy	Novy-Marx	J&T 6-6	Standard 12-1
Statistic			
Std	0.039	0.044	0.046
Kurtosis	4.062	6.918	9.395
Skewness	-0.479	-0.733	-0.977
Min	-0.137	-0.233	-0.28
Max	0.125	0.145	0.154
Sharpe	0.267	0.306	0.3

This table presents descriptive statistics for all three portfolios—Novy-Marx, J&T 6-6, and Standard 12-1—during the sample period. The statistics include standard deviation (Std), kurtosis, skewness, minimum (Min), maximum (Max), and Sharpe ratio.

The Novy-Marx (NM) portfolio displays a lower annual standard deviation (3.9%), suggesting relatively lower volatility compared to the J&T 6-6 and Standard 12/1 portfolios. However, its Sharpe ratio (0.267) implies lower risk-adjusted returns compared to risk-free assets.

Moving to the Jegadeesh and Titman 6/6 (J&T 6-6) portfolio, it exhibits a higher annual standard deviation (4.4%) and positive kurtosis (6.918), indicating more extreme price fluctuations in comparison to NM. The negative skewness (-0.733) implies a distribution where extreme losses are more prevalent than extreme gains. Notably, it achieves the highest Sharpe ratio (0.306), indicating relatively better risk-adjusted performance compared to the other portfolios.

The Standard 12/1 portfolio demonstrates the highest annual standard deviation (4.6%) and kurtosis (9.395), reflecting increased volatility and more extreme values in returns. Its negative skewness (-0.977) suggests a distribution where the most significant losses surpass the most substantial gains. The Sharpe ratio (0.3) suggests modest risk-adjusted performance compared to the other strategies.

Analyzing the minimum and maximum returns, NM shows the smallest minimum return, suggesting a relatively lower downside risk. Conversely, Standard 12/1 exhibits the largest minimum return, indicating higher potential losses.

5.3 Asset pricing model regressions

On this chapter, we test different asset pricing model's and their regressions with the 3 respective momentum strategies. The following table includes the regressions of CAPM.

Table 3. CAPM & Portfolios

Strategy	Novy-Marx	J&T 6-6	Standard 12-1
Statistic			
Alpha	0.01	0.014	0.014
p-value	3.47E-06	1.79E-06	3.72E-06
Beta	-0.029	0.016	-0.021
p-value	0.424	0.71	0.635

This table reports the results of Capital Asset Pricing Model (CAPM) regressions for the Novy-Marx, J&T 6-6, and Standard 12-1 momentum portfolios. The table includes statistics such as alpha, beta, and their respective p-values.

The alpha of 0.01 for Novy-Marx portfolio indicates that the portfolio has an excess return of 1% beyond what could be predicted by the model. The respective beta value suggests that only a minor portion of variability in the Novy-Marx portfolio can be explained by market risk factor. The relatively high p-values for beta indicate that market risk factor does not explain significant portion of the excess returns. Similarly, for J&T portfolio the alpha of 0.014 implies significant excess returns beyond the CAPM model. The accompanying p-value is also in line with the results for Novy-Marx portfolio, as it is low, indicating an influence of other factors. Additionally, the Standard momentum that is implemented in most papers, demonstrates the strategy's ability to generate excess returns beyond of the explanation of CAPM model.

The positive alphas across all three momentum portfolios indicate that these strategies are generating excess returns beyond what the CAPM model predicts based on market risk. However, the relatively high p-values for each portfolio suggest that the market risk factor does not offer a robust explanation of their excess returns. This supports the idea that other factors, not captured by the CAPM, play a significant role in the performance of these momentum portfolios - in line with the findings of (Fama & French, 1992; Jegadeesh & Titman, 1993).

In the table 4, is the regressions with Fama-French 5 factors. Statistically significant findings at 1% level includes all the portfolios with CMA factor, indicating that there is a consistent relationship between these portfolios and companies with conservative investment strategies relative to aggressive ones. For example, a percentage change in CMA factor would increase momentum profits for standard momentum strategy of 1%. RMW also had a significant correlation with Standard momentum portfolio during the sample period at a 1% significance level. Notable mentions are also RMW with J&T portfolio at 5% significance level and RMW with Novy-Marx at 5%. The statistically significant coefficients provide evidence of the portfolios' sensitivity to specific factors, while non-significant coefficients suggest a lack of robust relationship in those cases.

Table 4. FF-5 Factors & Portfolios

Strategy	Novy-Marx	J&T 6-6	Standard 12-1
Factor			
Intercept	0.008	0.009	0.008
	(3.07)***	(3.33)***	(2.99)***
Mkt-RF	0.001	0.0008	0.0006
	(1.74)*	(1.32)	(0.98)
SMB	0.001	0.003	0.003
	(0.83)	(2.48)*	(1.87)*
HML	-0.001	0.002	0.001
	(-0.76)	(0.97)	(0.47)
RMW	0.004	0.005	0.009
	(2.21)**	(2.35)**	(4.23)***
CMA	0.005	0.009	0.01
	(2.88)***	(3.93)***	(4.72)***

This table reports the Fama-French 5 Factors (Mkt-RF: Market Risk Premium, SMB: Size, HML: Value, RMW: Profitability, CMA: Investment) regression results for the Novy-Marx, J&T 6-6, and Standard 12-1 momentum portfolios. The table includes intercepts and factor coefficients along with their respective t-statistics in parentheses.

5.4 Inflation and momentum strategies

The following Table 5 shows the calculated correlation coefficients for each portfolio and their respective p-values.

Table 5. OLS Regression

Strategy	Reg. Type	Intercept	Coeff.	p-value	RMSE	R^2	F-stat
Novy-Marx	OLS	0.011	-0.64	0.36	0.04	0.003	0.83
Standard 12-1	OLS	0.014	0.29	0.73	0.05	0.001	0.12
J&T 6-6	OLS	0.014	0.18	0.83	0.05	0.0001	0.05

This table displays the Ordinary Least Squares (OLS) regression results for the three momentum strategies—Novy-Marx, Standard 12-1, and J&T 6-6. The regressions assess the relationship between Winner Minus Loser (WML) monthly mean returns and monthly changes in the Consumer Price Index (CPI). The table includes information on regression type, intercept, coefficient, p-value, Root Mean Squared Error (RMSE), R-squared (R2), and F-statistic.

Novy-Marx Portfolio:

The OLS regression for Novy-Marx portfolio reveals a negative coefficient of -0.64, indicating a potential inverse relationship between momentum returns and short-term unexpected inflation. However, the finding is not statistically significant, with p-value being 0.36.

Jegadeesh and Titman (J&T) Portfolio:

Contrastingly, the J&T momentum strategy exhibits a positive coefficient of 0.18, implying a slight positive correlation with inflation. Nevertheless, the high p-value of 0.83 suggests a lack of statistical significance, underscoring the challenge in establishing a meaningful relationship.

Standard Momentum Portfolio:

For the Standard momentum portfolio, the correlation coefficient is 0.29, signaling a modest positive correlation with short-term unexpected inflation. The associated p-value of 0.73 reinforces the notion that this correlation lacks statistical significance, questioning the reliability of any observed relationship.

The findings align with the results from Miffre & Rallis, indicating an unsignificant correlations between the strategies and inflation. Meaning that the strategies studied in this paper do not offer statistically significant hedge against unexpected short-term fluctuations in inflation. We can further analyze the relationship between the variables, by doing robust regression analysis, which is less sensitive to outliers. The analysis is performed in Matlab using function that uses iteratively reweighted least squares (IRLS). The following table presents the respective robust regression results for each strategy.

Table 6. Robust Regression

Strategy	Coeff.	Robust SE	p-value
Novy-Marx	-0.564**	0.037	0.011
Standard 12-1	0.333**	0.04	0.011
J&T 6-6	-0.322**	0.039	0.011

This table summarizes the Robust Regression results for three momentum strategies—Novy-Marx, Standard 12-1, and J&T 6-6. The coefficients represent the estimated impact of each strategy on Winner Minus Loser (WML) monthly mean returns, accompanied by their respective Robust Standard Errors (Robust SE) and p-values. Significance levels are denoted by asterisks, with ** indicating a 5% significance level.

The robust regressions show an inverse relationship for Novy-Marx and J&T 6-6 strategies and a positive relationship for Standard strategy, all statistically significant on a 5% level. These findings indicate that OLS may be sensitive to outliers and the robust regression may provide a more stable regression estimate by down-weighting the impact of

extreme observations. This supports the notion by Schwert & Seguin (1990) that stock price data often exhibits heteroscedasticity.

Following our OLS and robust regressions, our objective was to investigate the impact of inflation changes in momentum returns in greater detail. To achieve this, the paper employs a time-varying correlation analysis using different lengths of 12 and 24 months. In the following figures, the rolling correlations for J&T 6-6 strategy are presented, showcasing the 12- and 24-month rolling correlations.

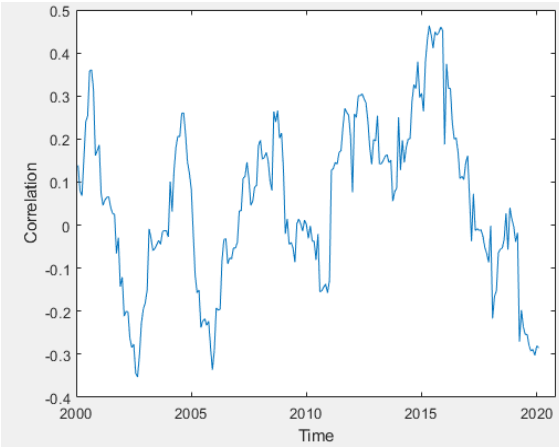

Figure 4. 24-month rolling correlation

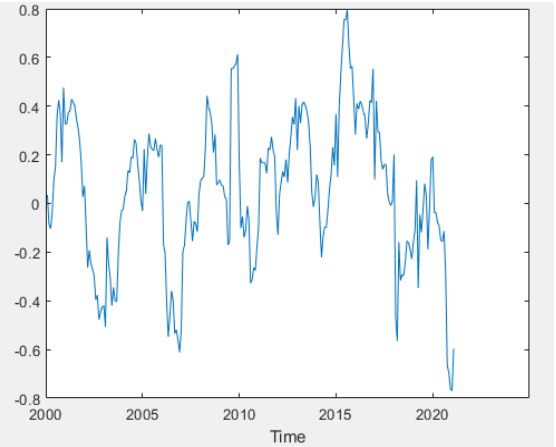

Figure 5. 12-month rolling correlation

From the figures, we can see that the rolling correlations are at their highest during 2015 for both 24-month and 12-month rolling correlation, when inflation rates are close to, or below zero. Equally, they are at their lowest during 2003, 2006 and 2020, when inflation rates have dropped or rose significantly. These findings may indicate that momentum returns drop when inflation rates change drastically one way. It is also notable, that stock markets were at their all-time high in 2015. The high correlation during stock market highs could be linked to investor behaviour during favourable market conditions. For example, Demirer, Lien & Zhang (2015) point out that taking a long position in high herding winner portfolios leads to highly significant positive subsequent returns over the next following months. All the lower correlated periods occur shortly after some significant

macroeconomic events, such as dot-com bubble, GFC and Covid-19. This may be due to investors increased risk aversions, where investors seek known safe-haven assets.

For Novy-Marx portfolio, both the 12-month and the 24-month rolling correlation peeked during 2011 and had the lowest coefficient during 2013. In 2011, inflation was almost at its 10-year all-time high, indicating that Novy-Marx portfolio does particularly well in elevated inflation environment. The high rolling correlation during peaks of inflation is worth investigating since other models suggests an inverse relationship. This could be influenced by specific factors or characteristics of the strategy. For example, the loser stocks may contribute to the strategy's relative performance, indicating that the short positions could act as a hedge or provide a source of returns during these periods. The thesis recommends further research on investigating the characteristics of the loser portfolio in the Novy-Marx portfolio during periods of elevated inflation. The peaks of negative correlations are observed during periods where inflation rates have dropped significantly, similarly to J&T 6-6 strategy. Standard 12-1 strategy on the other hand had similar highs and lows as J&T 6-6. None of the corresponding t-statistics and p-values were statistically significant at 10% level, hence strong conclusions cannot be drawn.

When examining the rolling correlation figures, it is essential to account for lagged effects. For example, a significant economic event that affect inflation rates might not immediately affect the correlation in response to this event. The study encourages future research to explore shorter time windows around macroeconomic events to minimize lag effects.

Finally, the paper employs quantile regression (QR) to delve into the heterogeneous impact of macroeconomic events. The regressions are employed at various percentiles of 90^{th}, 95^{th} and 99^{th}. This approach allows for the identification of potential tail risks or opportunities that may be obscured in traditional linear models. The following table presents the QR results and their corresponding standard errors (SE).

Table 7. Quantile Regressions

	Novy-Marx			Standard 12-1			J&T 6-6		
%	*90th*	*95th*	*99th*	*90th*	*95th*	*99th*	*90th*	*95th*	*99th*
QR	-0.006	-0.03*	-0.05*	0.003	0.003	0.004	0.001	0.002	0.002
SE	0.009	0.01	0.029	0.005	0.009	0.016	0.003	0.004	0.009

This table presents the results of Quantile Regressions (QR) for Winner Minus Loser (WML) returns and monthly changes in the Consumer Price Index (CPI) for the Novy-Marx, Standard 12-1, and J&T 6-6 momentum strategies. The table displays coefficient estimates at different percentiles (90th, 95th, and 99th) along with their corresponding standard errors (SE).

From the QR table, we can see that only Novy-Marx coefficient estimates are statistically significant, indicating a negative relationship between the portfolio returns and cpi changes. As we progress towards higher percentiles for Novy-Marx portfolio, the slope becomes increasingly negative. To provide a visual representation of these relationships, Figure 6 presents the quantile regression fit for the strategy, adding a 95% confidence band.

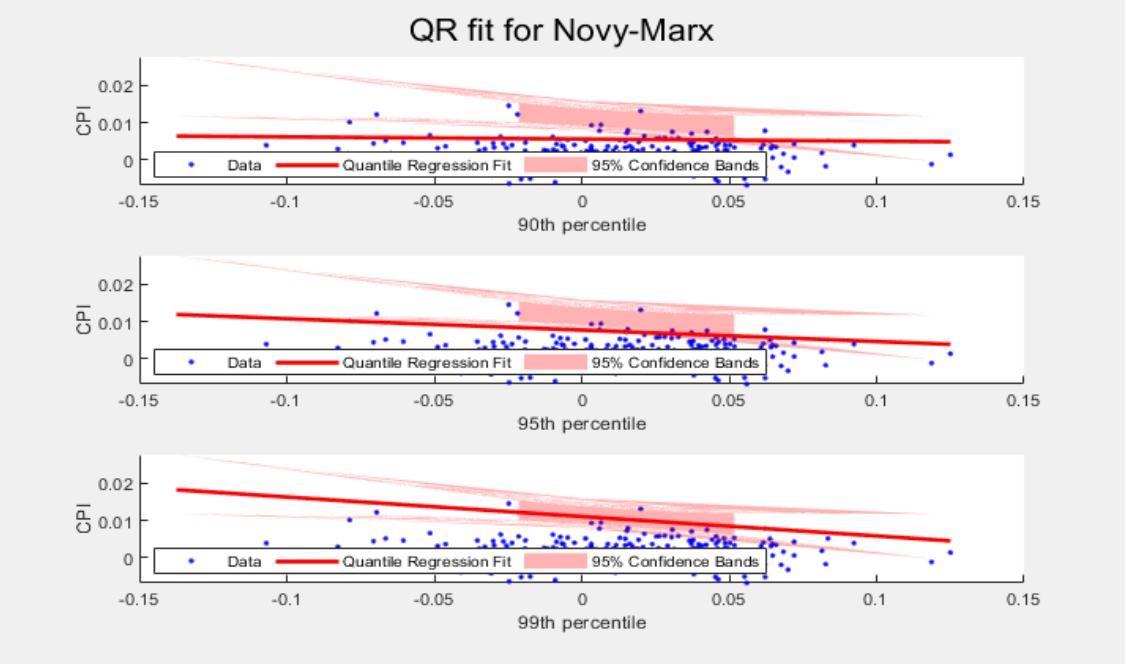

Figure 6. QR fit for Novy-Marx portfolio.

The widening spread of the slope indicates an increasing negative trend for the Novy-Marx portfolio and cpi changes. This implies that there is potentially stronger inverse

relationship in the tails of the conditional distribution. In conclusion, OLS regression gave the thesis a foundation, showcasing statistically unsignificant varying correlations for each strategy. Robust regression better highlighted the sensitivity to outliers, providing statistically significant correlations for all strategies. Furthermore, the rolling correlations illustrated some notable patterns during certain macroeconomic conditions, ultimately failing to provide anything on a statistically significant level. Finally, a QR model was employed to investigate the tail risks more closely. In line with findings of Jareño & Ferrer (2016) The QR model suggests a statistically significant negative relationship between Novy-Marx strategy and inflation.

6 Conclusions

The research methodology employed in this study closely aligns with fundamental approaches pioneered by Jegadeesh & Titman (1993) and Novy-Marx (2013), focusing on cross-sectional momentum within the Finnish markets. The exploration of various momentum strategies, including Jegadeesh and Titman's 6-6 and Standard 12-1, as well as Novy-Marx's intermediate-term performance strategy, provided valuable insights into their effectiveness in capturing trends in asset prices.

The results indicated that all the three studied momentum strategies, especially J&T 6-6 and Standard 12-1, generated positive and statistically significant excess returns in the Finnish market. The substantial t-statistics accompanying the mean excess returns underscored the statistical significance of the observed performance. These findings contribute to the broader understanding of momentum strategies, emphasizing their persistence and effectiveness in the context of the Finnish market. The exploration of descriptive statistics gives us a better understanding on the risk-return characteristics of each momentum portfolio. The nuanced understanding of their performance, considering factors such as standard deviation, kurtosis, skewness, and Sharpe ratio, provides a comprehensive overview of their individual characteristics over various holding periods.

The examination of factor correlations further enriches our understanding of the dynamics surrounding momentum strategies in the Finnish financial markets. In tandem with the positive and statistically significant excess returns observed for momentum portfolios, the investigation into CAPM and Fama-French 5 factors reveals intriguing relationships. The mean excess returns decrease gradually when factoring for market risk and Fama-French factors, similar to Ammann, Moellenbeck & Schmid (2011). Particularly noteworthy is the consistent and statistically significant positive correlation of the momentum portfolios with the CMA (Conservative Minus Aggressive) factor. This finding implies that the examined momentum strategies, including J&T 6-6 and Standard 12-1,

exhibit a tendency to perform well in conjunction with companies adopting conservative investment practices relative to their aggressive counterparts. The robust positive coefficients associated with the CMA factor underscore a persistent association between these momentum portfolios and firms characterized by cautious and prudent investment strategies. Additionally, the Standard Momentum strategy has positive and statistically significant exposure at 1% level to the RMW factor, indicating that the standard strategy tends to do better when companies with higher profitability are included in the sample.

In investigating the relationship between momentum strategies and inflation, the OLS correlation analysis revealed weak and statistically insignificant correlations for all portfolios. The Novy-Marx strategy exhibited a weak negative correlation, while Jegadeesh and Titman's strategy showed a slight positive correlation. The Standard Momentum portfolio displayed an extremely weak positive correlation with short-term unexpected inflation. These results align with the ones by Miffre and Rallis (2007), indicating that the studied strategies do not provide statistically significant hedge against unexpected short-term fluctuations in inflation. However, the robust regression shows an inverse relationship with J&T 6-6 and Novy-Marx between inflation and positive relationship for Standard strategy – all statistically significant at 5% level. As demonstrated by Guerard, Xu & Markowitz (2018) robust regression model is a relevant method to construct equity selection models. Conversely, the rolling correlation model estimates that Novy-Marx strategy does particularly well in high-inflation environments, J&T 6-6 does well in close to zero inflation regime, all lacking statistical significance. In line with robust regression, the QR model shows that Novy-Marx strategy is negatively affected by inflation elevations, and a widening spread as we move towards higher percentiles of the sample data. The QR models findings are statistically significant on a 10% level, Indicating growing confidence in the robust model compared to other models lacking statistical significances.

The study encourages future research to explore additional variables or refine methodologies to find answers to the nuanced dynamics between momentum strategies and inflation. This thesis focused on a period, which can historically be categorized as having low inflation rates. A further study could be conducted on different time periods such as 1970s oil crisis, early 1980s recession etc., where inflation rates have exceeded 10%. This time-varying approach could give better understanding of the performance of the momentum strategies during different inflation regimes. Additionally, an alternative measure of inflation could be useful such as producer price indices or commodity price indices. This could capture the different aspects of inflation that may affect momentum returns. Furthermore, as demonstrated by Apergis et al., (2020) momentum returns can be sensitive to specific sectors. The impact of elevated inflation could be investigated in sector-specific momentum returns to get a better understanding of the dynamics of momentum returns within each industry. Given that momentum is widely believed to be partly driven by herding behaviour (Barroso & Santa-Clara, 2015; Cujean & Hasler, 2017) inflation could be classified to certain regimes (e.g. high, normal, low). This approach could provide an opportunity to investigate the underlying behavioral aspects that drive momentum. High inflation may for example, amplify herding tendencies as investors seek better returns in response to economic conditions. In addition, the analysis could be extended to cross-country perspective across different countries, considering variations in monetary policies, economic structures, and inflationary pressures. A practical exploration could be conducted into momentum portfolio construction strategies that account for inflation, by seeking dynamic asset allocation informed by inflation forecasts, to investigate how the adjustments impact the risk-adjusted performance of momentum strategies.

In conclusion, the findings of this study provide compelling evidence supporting the alternative hypothesis (H1) that all examined momentum strategies indeed generate statistically significant excess returns in the Finnish markets throughout the period of 2000-2023. The rejection of the null hypothesis underscores the presence of a momentum anomaly, challenging the notion of market efficiency within the Finnish stock market

context. Contrary to the initial assessment from OLS regression, the robust and QR models yielded statistically significant relationship between momentum portfolios and changes in CPI figures. This challenges the validity of the second hypothesis (H2) of the thesis that momentum strategies are not effective in hedging elevated inflation. The findings reveal that the studied strategies indeed may have the ability to mitigate the impact of inflation fluctuations. Further research is needed to fully understand the role of inflation in relation to momentum strategies.

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