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Cross-Asset Analysis
The Impact of Value and Momentum Strategies

Master of Science in Business, Major in Finance
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Master Thesis

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Abstract

This thesis performs a comprehensive analysis of momentum and value strategies across four asset classes, identifying a consistent decline in momentum returns relative to historical performance. The study demonstrates robustness of value and momentum in combination. Cross-asset correlations are identified, which challenge conventional co-movement frameworks and factor structures. We present compelling evidence of an improved Sharpe ratio for the zero-cost long-short portfolio of Global Equity Indices. By modifying the portfolio's weighting, we substantially increase returns for the combined factor portfolio of commodities. We find evidence of a persisting factor structure across all asset classes, excluding currencies, supported by the correlation between assets. Our empirical results provide new evidence of a negative correlation between the VIX index and momentum, with diminishing effect over time. These findings suggest incorporating market volatility in strategies could result in increased momentum returns, encouraging further research to develop a comprehensive momentum prediction model.

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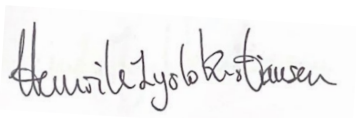
We would like to express our gratitude to Professor Paul Ehling, whose insightful guidance and support have been valuable throughout our thesis. This has inspired us to assess and validate our own methodologies and calculations with precision and awareness. In addition, we are grateful to the BI Norwegian Business School for providing the resources essential for our research.

Henrik Lyslo Kristiansen



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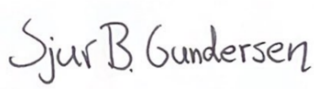

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1. Introduction

The pursuit for abnormal returns has provoked a vast debate challenging Fama's perspectives. According to the Efficient Market Hypothesis (Fama & French, 1970), share prices reflect all accessible information, which, in theory, should preclude the opportunity for abnormal returns. Despite this theory, investors frequently encounter contradictory results. According to the article "*Value and Momentum Everywhere*" by Asness, Moskowitz, and Pedersen, higher returns can be achieved by utilizing value and momentum strategies. Our thesis complement existing research, while simultaneously examining previously unexplored interactions, which illuminate the significance of momentum and value strategies.

The article "*Value and Momentum Everywhere*" by Asness, Moskowitz, and Pedersen, which studies the persistent value and momentum return premia across eight diverse asset classes and markets, has a significant impact on our portfolio constructions and serves as a main inspiration for our thesis. For simplicity we hereafter refer to the article of Asness et al. as "VME".

Consistent with Asness et al., the article "*Momentum Crashes*" suggest that momentum premia relates to behavioral biases and is used as an additional inspiration for this thesis. Daniel and Moskowitz's compelling argument that momentum crashes occur in periods of market distress sparked a central question of our study (Daniel & Moskowitz, 2016). Inspired by their theory, we embarked on an exploration of the relationship between momentum returns and the VIX index, using the VIX as a measure of fear. By extending their theories to our research context, we conclude by providing direct insights to the constantly evolving field of finance.

This thesis provides robust evidence supporting the existence of value and momentum returns within the asset classes of Individual Stocks, Global Equity Indices, and Commodities, between 1980 and 2022. We employ rank-weighted, zero-cost long-short factor portfolios that yield positive returns for both value and momentum strategies. We find unique evidence that Global Equity Indices derive the highest profit from an equally weighted 50/50 allocation between momentum and value factors, with a significant increase in returns. In our joint analysis of value and momentum, we predominantly employ an approach with equal weighting. The evidence is adequately explained by discrete value and momentum factors, both of which generate positive returns that are negatively correlated. Despite slight differences in returns across asset classes, the value-momentum combination remains robust due to a consistent negative correlation both within and across assets. Furthermore, the positive cross-asset correlation observed for both value and momentum strategies across assets, contradicts conventional comovement and factor structure theories.

Our research supports the existence of a common factor structure across asset classes, except for currencies. This thesis reflects prior research, such as "*Do Momentum Strategies Work in Foreign Currency Markets?*", by highlighting the difficulties of employing momentum strategies to currencies (Okunev & White, 2003). Multiple portfolios exhibit consistent Sharpe ratio patterns, and both commodity and individual stock portfolios provide positive alphas, with commodity factor portfolios obtaining the highest. By applying a new weighting approach, that allocates 75% of the combined factor portfolios to value strategies, we observe a substantial increase in the returns for the combined factor portfolio of commodities. Within and across asset classes, a persistent negative correlation is observed between value and momentum strategies, with the exception of the correlation between the commodity value strategy and the individual stocks momentum strategy. This coherence facilitates the establishment of a common factor structure, and encourages considerable asset class comovement.

This thesis differs from previous research by encompassing an extended and more recent data period. Following the aftermath of the 2008 financial crisis and the Covid-19 pandemic, the period from 2011 to 2022 is essential for current asset management and is not covered by the VME article. We differ from prior research by considering the diminished momentum returns, by implementing a weighting scheme designed to strengthen the focus on value strategies. We highlight the transformative potential of value and momentum strategies by discovering new evidence of a significant return increase for the combined commodity factor portfolio. This has the potential to challenge commodity investment theories.

The relationship between momentum and volatility is not frequently investigated in existing research. Conducting both a regression and a VAR model, we determine whether a decrease in momentum returns is due to increased volatility, measured by the VIX index. We find comprehensive evidence suggesting an increase in the VIX index accounts for a subsequent decrease in momentum. In addition, we provide unique evidence that three lags of momentum provide significant influence on current momentum. Our new and distinctive findings contribute towards the construction of effective momentum strategies, while simultaneously expanding the limits of future research in the theoretical and behavioral fields of finance.

The pursuit of understanding the relationship between value and momentum returns is a timely topic, and of great relevance. Our thesis offers valuable insights into these investment strategies, and the optimal application of their synergistic use. New evidence will contribute considerably to both academic knowledge and the formulation of practical investment strategies.

The thesis proceeds with a literature review, followed by a detailed explanation of the data and methodology employed, along with an overview of the markets and data types utilized, in chapter 3. The empirical analysis in chapter 4 discusses the portfolio's performance, and examines tendencies and correlations. In chapter 5 the thesis addresses diminished momentum returns, introduces a new weighting scheme, and provides a unique examination of the relationship between the CBOE VIX Index and momentum.

2. Literature Review

Under the efficient market hypothesis, an investor theoretically should not achieve excess returns, as all information is presumed to be perfectly reflected in security prices (*Efficient Capital Markets*, 1970). This concept has grown increasingly influential in finance, and investors have sought to challenge its foundations. There is no incentive for investors to spend resources searching for information, if such efforts do not increase investment returns (Grossman & Stiglitz, 1980).

Both value and momentum are well-known asset management strategies that seek to outperform the market. The objective of this thesis is to challenge Fama's efficient market hypothesis. We seek to assess whether the combination of value and momentum strategies can yield profits across four distinct asset classes from the perspective of an American investor.

"*Value and Momentum Everywhere*" by Asness, Moskowitz and Pedersen examines the consistent value and momentum return premia across eight distinct asset classes and markets, and serves as a main inspiration for our portfolio constructions. The study contributes to existing literature by revealing that value and momentum strategies are effective not only within individual markets, but also across diverse markets. Asness et al., identify that the value and momentum factors have a positive relationship across asset classes and markets, implying these variables may be driven by uniform sources of risk. The research discovered that value and momentum returns are negatively correlated both within and across asset classes, with the correlation being higher across asset classes, compared to passive exposures on the asset class.

The momentum strategy accentuates acquiring well-performing recent assets while selling those exhibiting recent underperformance, forming a critical foundation of momentum based investment strategies. VME discovers that momentum strategies frequently succeed during periods of market stability, and economic growth, because investors continue to acquire assets that already perform well (Asness et al., 2013). Empirical evidence supports the potential for higher returns with a long-short equity strategy, which consists of taking long positions in historically high-performing stocks (*'winners'*) and short positions in low-performing stocks (*'losers'*) (Jegadeesh & Titman, 1993). In their article, Jegadeesh and Titman provide a momentum portfolio strategy, which entails buying and selling stocks based on their performance over the preceding 12 months and maintaining a three-month holding period. Using the US stock market as a source of empirical data, Jagadeesh and Titman developed the 12x3 momentum strategy, which has become widely employed in momentum investing. Thus, the momentum strategy is trend-following and aims to profit from market fluctuations by going long assets that are currently trending upward, with significant short-term growth potential (Asness et al., 2013).

In the paper "*International Momentum Strategies*", K. Geert Rouwenhorst found that a risk-adjusted, globally diversified portfolio of past medium-term Winners, outperforms a portfolio of past medium-term Losers between 1980 and 1995, by more than 1.00% per month. This observation persisted consistently for approximately one year, after which a rebalancing of the momentum strategy might be required. In addition, they find independent evidence of correlation between global momentum returns and U.S. momentum returns, suggesting that exposure to a common factor may fuel the profitability of momentum strategies (Rouwenhorst, 1998).

Various researchers explain momentum premia as the behavioral finance concept of risk compensation (Asness et al., 2014). For momentum an exaggerated response to new information could result in increased returns. The opportunity to gain returns for momentum investors, according to Jagadeesh and Titman, depends on timing and recognising how the financial system adjusts to new information. There are significant opportunities for momentum investors if the market has not adequately adjusted to information that clearly encourages an upwards trending price.

A value strategy is an investment approach that entails purchasing assets that are deemed underpriced, relative to their intrinsic value, and short assets that are overvalued. VME discovers that value investments yield greater results in market instability, as investors abandon momentum strategies (Asness et al., 2013). By purchasing undervalued assets with solid fundamentals and long-term development potential, value investing is a contrarian strategy to the momentum strategy, that aims to profit from market inefficiencies (Asness et al., 2013). There is existing evidence that value stocks have higher average returns than growth stocks, which have low book-to-market ratios (De BONDT & Thaler, 1985, Fama & French, 1992, Lakonishok et al., 1994)

Daniel and Moskowitz confirm in their study "*Momentum Crashes*" that value strategies often beat momentum strategies when momentum is said to be in a crash. These momentum crashes often occur in distress markets, after declines or periods of high volatility, and correlate with market recoveries (Daniel & Moskowitz, 2016). Based on conditional betas and option-like payoffs of losers, these momentum crashes are predictable according to Daniel and Moskowitz. Based on these findings, an optimal dynamic strategy can outperform other well-known factors, or other momentum strategies, proposed in the literature. In context of these perspectives, it is possible to hypothesize that an effective combination of value and momentum strategies might have the potential to serve as a resilient hedge against significant market fluctuations.

Similar to momentum premium, value premium is explained as a risk compensation (Fama & French, 1998). Volatile earnings and share prices tend to explain value stocks, which frequently represent distressed companies (Chen & Zhang, 1998). The fundamental principle accounting for this premium suggests that value stocks, as a result of their elevated risk relative to growth stocks, should generate higher returns as compensation. Lakonishok, Shleifer, and Vishni dispute this explanation of the value premium by asserting that behavioral finance can explain most of the value premium (Lakonishok et al., 1994)

The integration of momentum and value strategies highlights the benefit of balance and diversification in a portfolio. According to VME, combining value and momentum strategies can generate higher returns and lower risk than adopting either approach independently. The reason is that value and momentum strategies frequently have a negative correlation, implying that while one strategy fails, the other approach may be superior. Consequently, a combination of value and momentum strategies can offer a steady and consistent return profile across a range of market circumstances and asset classes. This is argued based on the research finding a value-momentum strategy produces higher sharpe ratios than either a pure value or pure momentum strategy. VME further identifies difficulties, regarding asset pricing theories, in explaining the return premium of a combined value and momentum portfolio across assets. (Asness et al., 2013)

The study "*Cross-Sectional Return Dispersion and Time Variation in Value and Momentum Premiums*" report that an increase in return dispersion, as measured by the standard deviation of prior three-month portfolio returns, is predictive of a decrease in future momentum profits. They suggested dispersion to be a state indicator, predictive of future market volatility. In addition, their analysis suggested that the incorporation of this variable is superior to the predictiveness of macro factors and the market state (Cooper et al., 2004; Chordia et al., 2002).

3. Data and Methodology

3.1.1 Hypothesis

The purpose of this thesis is to identify and acquire a thorough examination of the factors driving value and momentum returns, isolated and in combination, both within and across asset classes. Finding consistent value and momentum profits across multiple markets and asset classes suggests that these strategies are not specific to distinct asset classes, but are instead robust and widely applicable. These possible findings might have important implications for investors, as it suggests that value and momentum strategies may be profitable. We have formulated our main hypothesis as follows:

Hypothesis 1: *Value and Momentum strategies, within and across four asset classes, yield profitable returns.*

In addition, the potential existence of a common factor structure among returns, suggests there may be underlying factors influencing the returns of these distinct strategies and assets. This potential structure can be utilized to develop more efficient investment models. We formulated our second hypothesis as follows:

Hypothesis 2: *A common factor structure can be established between the two distinct strategies.*

Highlighted in the literature review, there is evidence that momentum strategies perform poorly during periods of high volatility and considerable uncertainty (Daniel & Moskowitz, 2016). Analyzing the impact of volatility can improve risk managers' proficiency, when implementing efficient portfolio diversification and enhance the precision of risk assessments, which are essential for achieving success in comprehensive risk management. We consider the VIX index as an appropriate predictive variable for momentum returns, as we interpret momentum profit to be a result of common irrationality (Asness et al., 2014). Examining the relationship between the VIX index and momentum returns offers the opportunity to assess how external market factors and investor psychology influence momentum strategies. This might provide valuable insights for enhancing the performance of momentum strategies during periods of increased market volatility. Consequently, Hypothesis 3 is an essential part of our investigation.

Hypothesis 3: *The CBOE VIX Index has a negative relationship with regards to momentum returns.*

3.2.1 Choice of Markets

This study emphasizes the U.S. market due to its size and data availability, both of which contribute to providing sufficient evidence on value and momentum structures. While the main focus lies on the US. Individual Stock market, we enhance our analysis by constructing portfolios for indices, commodities, and currencies. By incorporating a global perspective via cross-asset validation, we broaden our analysis to include various asset classes and evaluate the robustness of value and momentum strategies. This analysis seeks to complement previous research conducted on the U.S. market by providing a comprehensive examination of value and momentum (Asness et al., 2013). By including currencies, commodities, and indices, we have the ability to compare value and momentum strategies across asset classes. This comparative analysis enhances our understanding and permits us to evaluate the efficacy of these strategies in a variety of market environments. These findings will benefit investors who seek to diversify their portfolios, or implement value and momentum strategies, for specific markets or assets.

3.3.1 Choice of Time Period

The period from 1980 to 2022 is selected in order to guarantee a comprehensive examination of momentum and value investment strategies. The time period permits the utilization of an extensive data sample, thereby providing a solid foundation for our analysis (Jegadeesh & Titman, 1993). The study "*International Momentum Strategies*", (Rouwenhorst, 1998) illustrates the existence of a momentum effect across various geographical and temporal contexts, highlighting the importance of an extended time perspective. Due to the Covid-19 pandemic, and significant fluctuations during the extended period of our research (2011-2022), we argue that the subsequent ten years will provide valuable insights when examining the efficiency of value and momentum strategies.

The selected time period features significant events, including monetary policy changes, geopolitical developments, and technological advancements, which may influence value and momentum investing, and the potential establishment of a common factor structure. By analyzing the effects of these occurrences, investors may acquire an improved understanding when navigating in volatile markets. Our analysis seeks to examine if initial findings of Aasnes, Moskowitz and Pedersen still hold, or whether new patterns have emerged. Verifying the efficiency of value and momentum strategies in a dynamic market can support in identifying new variables and metrics, that may be beneficial for each strategy.

3.4.1 Data Types

Our empirical analysis relies on monthly data obtained from the Bloomberg Terminal and FRED St. Louis Fed. Multiple factors justify the utilization of monthly data, including the quantity of economic, financial, and market information, which is easily accessible on a monthly basis. The short-term fluctuations and noise, present in daily or intraday data, can be mitigated by monthly data. By consolidating data into monthly intervals, we seek to focus on underlying trends and patterns, omitting the influence of short-term volatility. Monthly data provides a larger sample size than quarterly data, which may result in more trustworthy statistical estimates and valid conclusions. This is consistent with the method used by Asness et al. The data imported from Bloomberg primarily consists of market pricing for the assets we utilize. For stocks and indices we retrieved price to book ratios, and converted them to book-to-market estimates, by calculating the inverse. We obtain data from the Federal Reserve Economic Data (FRED), St. Louis Fed, for risk-free interest rate in the United States, and the other currencies we examine. Additionally, we import data for the CPI, which is utilized for inflation estimates.

3.4.2 US. Individual Stocks

We include the largest shares by utilizing the S&P 500 Index, when examining the asset class of the US. Individual Stocks. Since the S&P 500 Index rebalances its constituents, it's crucial to rebalance our portfolios monthly, to ensure the largest and most liquid shares presence. This method is conservative, consistent with VME (Asness et al., 2013), excluding the effect of smaller stocks on value and momentum premia.

3.4.3 Currencies

We obtain data on spot exchange rates and interest rates for nine distinct currencies, from following countries: Australia, Canada, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the Eurozone[1]. We have data for all nine currencies for the entire study period. All currencies are denominated in US Dollars for uniformity and comparative consistency. In terms of value calculation, CPI data for the countries is retrieved to measure the relative purchasing power parity compared to the US.

3.4.4 Commodities

We collect commodity future prices for 14 distinct commodities. We have futures for the London Metal Exchange-listed metals Nickel (LN1), Aluminium (LA1), Copper (HG1), Zinc (LOZSDY), and Lead (LOSNDY). We have obtained futures for gold (GC1) and silver (SI1) which are listed on the New York commodities exchange. Futures for WTI Crude Oil (CO1) and Brent Oil (CL1) are quoted on the New York Mercantile exchange and the Intercontinental exchange, respectively. On the Chicago Board of Table, we obtain futures for soybeans (S1), wheat (W1), and soy meal (C1), as well as futures for sugar (SB) and coffee (KC) on the New York Board of Table. We have a minimum of seven commodity future prices available at any time. All 14 commodities are available from mid 1996.

3.4.5 Global Equity Indices

We examine 15 developed equity markets and obtained spot exchange rates. We have obtain spot prices for these countries, represented by their respective indices: Australia (AS51), Austria (ATX), Belgium (BEL20), Canada (TSX), France (CAC), Germany (DAX), Hong Kong (HSI), Italy (FTSE MIB), Japan (NKY), Norway (OSB), Portugal (PSI), Spain (IBEX), Sweden (OMXS30), United Kingdom (FTSE UKX), and the United States (S&P 500). We have data of all indices for the entire sample period, 1980 to 2022.

3.5.1 Measures of Momentum and Value

For the momentum measure of individual stocks, we use the 12-month raw returns, excluding the most recent month (Jegadeesh and Titman, 1993). By employing the MOM2-12 technique, which is frequently applied in the momentum literature. This method omits the 1-month reversal in stock returns,

[1] Prior to the Euro's introduction in the late 1990s, the authors of the study in "value and momentum everywhere" use Germany's currency as a proxy for the euro.

which may be related to liquidity issues (Jegadeesh, 1990, Grinblatt and Moskowitz, 2004).

The value measure of individual stocks is determined, utilizing their book-to-market (BE/ME) ratio. BE/ME ratios are calculated by the inverse of retrieved price-to-book ratios. The application of the BE/ME ratio, as a measure of stock value, is based on theories indicating investors neglect stocks with higher book values than market values (Fama & French, 1992, 1993) (Lakonishok et al., 1994). To guarantee data availability, the computation entails lagging the BE/ME ratio by six months, to reflect the most recent market values[2]. This approach ensures robust quantification of individual stocks throughout our analysis.

We attempt to define equivalent value and momentum measures for Currencies, Commodities, and Global Equity Indices[3]. The momentum measure is calculated as the return over the previous 12 months, excluding the most recent month, and is consistent for all asset classes[4]. This method ensures that we maintain a uniform method for measuring momentum. Achieving uniformity in the value measurement is challenging, as not all asset classes have a measure of book value. For asset classes without book values, we attempt to employ straightforward and consistent value measures. For Global Equity Indices, we simply employ the previous month's BE/ME. The value measure for commodities is defined as the log of the average spot price from 4.5 to 5.5 years ago, divided by the most recent spot price. This is essentially the negative of the spot return over the last 5 years (Asness et al., 2013). We estimate the value measure of currencies as the 5-year change in purchasing power parity. This is executed by the negative of the 5-year return on the exchange rate, which is the log of the average spot exchange rate from 4.5 to 5.5 years ago divided by the spot exchange rate today, minus the log difference in change of CPI between the foreign country and the United States (Asness et al., 2013).

The Fama-French three-factor model is utilized to characterize different portfolio returns, depending on three distinct factors. (*Kenneth R. French*, n.d.). For stocks and indices, we utilized the market risk premium, the outperformance of high

[2] *Asness et.al (2013) claim that the choice between contemporary market values and lagging prices, in the calculation of the BM-ratio, has little impact on the value measure.*
[3] *We utilize a momentum measure based on the MOM2-12-month return. Novy-Marx (2012) illustrates this method beeing superior to other measures, such as using returns from the previous 7- to 12-months.*
[4] *Asness et al. (2013) state that momentum returns for these asset classes are in fact greater if the most recent month is not omitted, thus the results are conservative.*

book-to-market value, and the overall market as the three factors. When conducting a three factor model for currencies we interpreted relative purchasing power parity as one of the determinants.

3.6.1 Portfolios of Momentum and Value

We utilize the method of VME to construct multiple value and momentum portfolios for all asset classes, in accordance with our value and momentum measurements. Based on the value and momentum scores, we divide the data into three equally weighted groups. We divide our assets into high, middle, and low portfolios. Additionally, we create a spread portfolio, which is basically the high minus the low portfolio. As stated in VME, this spread portfolio has zero costs and is constructed for both momentum and value, separately (Asness et al., 2013).

3.7.1 Factors of Momentum and Value

Factor portfolios for both value and momentum are constructed as zero-cost long-short portfolios, which utilize the entire cross section of available data within the asset class (Asness et al., 2013).

The value factor portfolio is constructed using a composite measure of value, including book-to-market ratio, ranking securities based on this measure. We proceed to proportionally allocate weightings on the securities in accordance with their cross-sectional ranking, derived by subtracting the cross sectional average rank from the signal (value or momentum), further described with Equation 1 and 2 in appendix. The result is a zero-cost long-short portfolio which acquires undervalued assets, and shorts the overvalued. To create the momentum factor portfolio, we rank securities according to their 12-month returns, excluding the most recent month. We employ the same weighting methodology for momentum as for value (Asness et al., 2013). Currencies distinct from the other asset classes, with a value factor pursuing undervalued currencies that are anticipated to appreciate over time, while the momentum factor seeks to identify currencies that have displayed strong recent performance, and are anticipated to continue performing well.

3.8.1 Filtering Data

In the process of data filtering we refine data to match the study by removing outliers and focusing on specific time periods relevant for our thesis. The data is time-sorted, and zeros are replaced with "NaN" to eliminate bias. Winsorization is utilized, which consists of replacing extreme outliers with values from particular percentiles, which thereby limit their potential to influence the subsequent analysis disproportionately.

4. Empirical Analysis

In this section, we examine both the methodology utilized, and our results. Once the necessary data was retrieved, Python was utilized to perform all calculations, portfolio construction, and regressions. In addition Microsoft Excel has been used to cross-check the Python results.

The momentum, value, and factor portfolios are constructed identically to how portfolios were constructed in VME. Asness, Moskowitz and Pedersen provide extensive evidence on the return premium to value and momentum strategies across asset classes and identify a strong common factor structure among their returns. In addition, the article's methodology is transparent and replicable, making it suitable for new data. Hence, the method is applicable for our extended time-period.

4.1.1 Value and Momentum Portfolio Performance

Figure 1 reports the main results for all asset classes, where we study Individual Stocks from the US.market, Currencies, Commodities and Global Equity Indices. After creating portfolios for value and momentum, the two strategies were divided into groups of low, middle and high, based on their respective scores. Figure 1 reports the annualized mean return, corresponding t-statistic, standard deviation, and sharpe ratio[5]. Spread portfolios (high - low) and rank-weighted factor portfolios for both value and momentum are presented. The factor portfolios are constructed by applying a long-short strategy, where each asset is weighted in proportion to its rank. The alphas and corresponding t-statistic, are reported from

[5] Sharpe ratios are computed using constant volatility equal to 10% as it enables for a reasonable comparison of risk-adjusted returns across various assets or portfolios (Asness et al., 2013).

a time-series regression of each individual return series, on the market index. The market index applied for the Individual Stocks and Global Equity Indices is the S&P 500. For Currencies and Commodities the market index applied is an equal-weighted basket of assets in the corresponding asset class, consistent with the VME article.

When calculating the Sharpe ratios, a constant level of volatility is utilized. Craig L. Israelsen introduced a modified Sharpe ratio in his 2010 article "*Refining the Sharpe Ratio"*, where he introduced a constant volatility measure to facilitate comparisons across asset classes (*Refining the Sharpe Ratio (Digest Summary)*, 2010.). He illustrated graphical and statistical correlations of U.S. equity fund rankings with the two distinct Sharpe measures, observing stronger correlations when the modified Sharpe ratio is employed. We implement constant volatility of 10% in accordance with VME, assuring a uniform framework for comparison.

The last two columns of Figure 1 report the statistical measures for the combined portfolios, which comprise an equal weight for both factor and spread portfolios individually. For each Panel, the final row reports the correlation between value and momentum returns, derived from calculating the zero-cost residual returns from the asset-specific benchmarks.

Figure 1. Value and Momentum Portfolio Performance

		Value portfolios					*Momentum portfolios*					*50/50 Combination*	
		Low	*Middle*	*High*	*Spread*	*Factor*	*Low*	*Middle*	*High*	*Spread*	*Factor*	*Spread*	*Factor*
Panel A	***Annualized Mean Return***	1,01%	8,04%	13,68%	12,67%	5,92%	5,55%	7,85%	9,19%	3,64%	7,06%	7,99%	6,43%
	AMR t-stat	*0,65*	*5,52*	*9,73*	*4,54*	*4,14*	*5,15*	*5,41*	*6,41*	*5,22*	*5,45*	*4,88*	*4,77*
US. Individual Stocks 1980-2022.	***Standard deviation***	8,86%	8,35%	8,07%	4,61%	8,21%	6,08%	8,20%	8,10%	3,94%	7,32%	3,17%	7,62%
	Sharpe ratio	0,07	0,77	1,34	1,24	0,56	0,53	0,76	0,89	0,34	0,68	0,80	0,64
	Alpha/Intercept	-0,29%	0,19%	0,44%	0,73%	0,67%	0,20%	0,33%	0,39%	0,19%	0,49%	0,40%	0,59%
	Alpha t-stat	*-2,46*	*1,81*	*5,66*	*7,14*	*7,77*	*2,11*	*4,89*	*4,62*	*1,83*	*3,43*	*5,96*	*8,26*
												Correlation (Val, Mom) = - 0,14	
Panel B	***Annualized Mean Return***	0,84%	1,06%	1,25%	0,41%	4,02%	0,33%	1,36%	1,57%	1,24%	4,07%	0,72%	4,01%
	AMR t-stat	*0,61*	*0,84*	*0,85*	*0,37*	*0,66*	*0,25*	*1,01*	*1,22*	*1,28*	*0,67*	*0,92*	*0,64*
Currencies 1980-2022	***Standard deviation***	8,40%	8,31%	8,93%	6,85%	19,77%	8,46%	8,81%	8,32%	6,29%	11,35%	4,84%	11,06%
	Sharpe ratio	0,04	0,06	0,08	-0,01	0,35	-0,02	0,09	0,11	0,08	0,36	0,02	0,35
	Alpha/Intercept	-2,65%	-1,71%	-0,87%	1,78%	0,27%	-2,68%	-2,10%	-0,74%	1,94%	0,65%	0,58%	-0,96%
	Alpha t-stat	*-2,42*	*-1,57*	*-0,74*	*1,98*	*0,93*	*-2,95*	*-2,26*	*-0,78*	*0,84*	*1,87*	*0,91*	*-1,73*
												Correlation (Val, Mom) = - 0,08	
Panel C	***Annualized Mean Return***	2,90%	5,88%	12,63%	9,73%	6,84%	4,52%	5,30%	7,18%	2,66%	6,85%	6,00%	2,17%
	AMR t-stat	*0,90*	*1,71*	*4,24*	*3,09*	*2,52*	*1,34*	*2,05*	*2,06*	*0,63*	*2,54*	*2,37*	*0,94*
Commodities 1980-2022	***Standard deviation***	19,68%	20,89%	18,11%	19,15%	16,50%	21,86%	16,75%	22,61%	27,24%	17,54%	15,39%	17,46%
	Sharpe ratio	0,25	0,55	1,23	0,94	0,65	0,41	0,48	0,67	0,22	0,64	0,60	0,21
	Alpha/Intercept	0,48%	0,58%	0,70%	0,21%	1,36%	0,20%	0,84%	0,92%	0,72%	1,59%	0,47%	1,48%
	Alpha t-stat	*1,26*	*1,38*	*1,54*	*0,48*	*1,73*	*0,47*	*1,93*	*2,88*	*1,72*	*2,14*	*1,81*	*1,92*
												Correlation (Val, Mom) = - 0,18	
Panel D	***Annualized Mean Return***	1,40%	7,09%	9,47%	7,54%	6,52%	6,98%	8,54%	9,89%	2,91%	5,18%	5,73%	9,09%
	AMR t-stat	*0,32*	*1,70*	*2,59*	*2,90*	*2,51*	*2,40*	*2,80*	*3,02*	*1,26*	*2,01*	*3,63*	*2,41*
Indices 1980-2022	***Standard deviation***	22,08%	20,94%	18,39%	13,21%	13,07%	18,83%	19,78%	21,19%	14,96%	12,95%	7,93%	12,40%
	Sharpe ratio	0,12	0,69	0,93	0,79	0,63	0,65	0,81	0,94	0,25	0,50	0,57	0,91
	Alpha/Intercept	-0,76%	-0,45%	-0,18%	0,58%	0,51%	-0,27%	-0,21%	-0,06%	0,21%	0,65%	0,40%	0,58%
	Alpha t-stat	*-2,21*	*-1,68*	*-0,99*	*1,87*	*1,67*	*-1,00*	*-0,87*	*-0,18*	*0,51*	*2,11*	*1,96*	*1,98*
												Correlation (Val, Mom) = - 0,18	

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4.2 Individual Stocks

4.2.1 Results

Reported in Panel A are the results for the US. Individual Stocks. We employ a one-sample t-test to determine whether the returns are statistically significant. Consistent with previous research, we observe significant returns for the middle- and high-value portfolios. We report insignificant returns for the low-value portfolio, contrary to results in VME. Additionally, we identify a return of 12.67% for the value spread portfolio, which is higher compared to Asnees, Moskowitz and Pedersen (2013). This is a result of weak returns for the low value portfolio. Further we observe a factor portfolio with significant returns, slightly higher than results reported in VME. This could influence the interpretation of these benchmark models in terms of time periods and market conditions.

Momentum strategies yield profitable and significant returns for all portfolios. Compared to reported results in VME, we report lower returns for all constructed portfolios. This observation highlights the influence different time periods can exert on the profitability of momentum strategies. However, we observe a higher significant return for the combined factor portofolio, due to strong returns of the value factor portfolio. Panel A reports a return of 7.99% for the combined spread portfolio, caused by a relatively wide spread between the high and low portfolios in the value strategy. This is primarily due to the weak returns of the low-value portfolio.

Reported are Sharpe ratios, which indicate risk-adjusted performance for all respective portfolios. High Sharpe ratio indicates a portfolio's superior performance, consistently observed for the US. Individual Stocks. Persistent profitability is observed for both momentum and value strategies. The robust Sharpe ratio of 1.34 for the high-value portfolio is particularly enlightening, significantly higher compared to VME. Considering momentum portfolios, we identified patterns similar to those discovered in VME, including consistent results for Sharpe ratios. Providing a common denominator for evaluating risk-adjusted returns, the Sharpe ratio is overall an useful metric for comparing portfolio results to prior research.

All portfolios report significant alphas at a 5% significance level, with the exception of the value middle portfolio, and the momentum spread portfolio. Unexpectedly, the portofolio alphas are significantly closer to zero than the regression results in the VME article, suggesting a weaker relationship between the independent and dependent variables in the Fama-French three-factor model.

The final row reports a negative correlation between value and momentum of 0.14, within the asset class. Our observed correlation is weaker compared to VME, which could be a consequence of lower momentum returns across all portfolios, indicating weaker momentum profitability in recent years.

Our findings regarding the presence of the value effect in the U.S. stock market are consistent with those of Fama and French (Fama & French, 1992). Fama and French discovered uniformly positive returns across all value portfolios, even when constructing their portfolios applying ten deciles. However, the variance in return magnitude may be related to the selection of distinct time periods.

4.3 Currencies

4.3.1 Results

Panel B reports the same statistics for Currencies as for the US. Individual Stocks. The same tendencies apply for Currencies, with increasing returns and corresponding t-statistic in ascending order. The absence of statistical significance in the portfolio returns imply that value and momentum strategies are not successful for currencies, with no t-statistic exceeding 1.28.

Interpreted from the spread portfolios of both value and momentum, there are minor distinctions between the high and low portfolios compared to other asset classes. It is challenging to identify undervalued or overvalued currencies, which may explain why spread portfolios for value and momentum are generating modest returns. Consistent with VME, the factor portfolios for value and momentum produce insignificant results.

The Sharpe ratios for the majority of portfolios have values slightly higher than zero, indicating the portfolio returns are closely aligned with the risk-free rate. The exception is the momentum low portfolio displaying a negative Sharpe ratio. Momentum and Value factor portfolios exhibit improved Sharpe ratios at 0.36 and

0.35, respectively. Except for the factor portfolios, our results are highly consistent to those of Asness et al., with relatively low Sharpe ratios.

We observe a significant negative alpha for the low portfolio of both value and momentum, with respective values of -2.65% and -2.60%. Contrary to our expectations, the high portfolios do not exhibit positive alphas. The alphas for the value spread portfolio is significant at 1.78 %, implying an effective spread strategy[6].

4.4 Commodities

4.4.1 Results

Reported in Panel C are the results of the Commodities asset class. We find significant returns for the high value portfolio of 12.63%, implying increased profitability for the value strategy in the period extended beyond VME. Panel C reports significant returns for both the spread and factor portfolios, with reported returns of 9.73% and 6.84%, respectively. As observed for U.S. Individual Stocks, the low value portfolio generates insignificant returns, which impacts the interpretation of the spread portfolio. The value factor portfolios are marginally less profitable than the VME portfolios, however statistically significant.

For the momentum strategy, we find significant returns for the middle and the high portfolio. Interesting is the substantially lower returns generated by our momentum portfolios. The momentum factor portfolio generated less profitable returns of 6.85%, compared to 11.5% in VME. The decline in momentum profitability is consistent with results by Daniel and Moskowitz in "*Momentum Crashes*", considering a time frame characterized by high volatility markets and distressed short term situations. Due to the poor performance of the momentum spread portfolio, our combined spread portfolio's return of 6.00% falls short of the value spread portfolio's return.

Panel C reports high Sharpe ratios for all value portfolios, with respect to the momentum portfolios. While observing minor differences in the intercepts of the value portfolios, we observe a wider spread for the momentum portfolios.

[6] Despite individual factor positive alphas, the combined factor alphas can be negative, likely due to negative correlations between factors or their volatilities. In these cases, the factors could offset each other's alphas.

The correlation between value and momentum is -0.18. Consistent with our previous findings, we observe a reduced correlation between value and momentum for commodities compared to prior research. Compared to the conclusion in the VME article, we observe a significant decline in the profitability of momentum strategies for Commodities. This observation indicates a potential shift in the efficiency and application of momentum strategies, within commodity markets.

4.5 Global Equity Indices

4.5.1 Results

Panel D reports consistent positive return across all portfolios in the asset class of Global Equity Indices. We find significant returns for the value high portfolio of 9.47%. Panel D further reports significant returns for both the value spread and factor portfolio, with 7.54% and 6.52%, respectively.

For momentum we find significant returns for low, middle, high and factor portfolios. For the aforementioned portfolios we observe diminished returns relative to prior literature. This trend is consistent with our previous observations. When combining the momentum and value factors, we report a significant increase in profitability with a return of 9.09%, compared to momentum and value factors separately[7].

Both the high value and momentum portfolios exhibit high Sharpe ratios, with values of 0.93 and 0.94, respectively. We further observe an enhanced Sharpe ratio, when combining the factor portfolios, consistent with the increased profitability. The negative correlation between value and momentum of 0.18 is reported in the final row of Panel D. The magnitude of negative correlation between value and momentum is reduced compared to previous research. The weakened correlation is consistent with previously observed correlation coefficients.

[7] Although we find increased profitability when combining factors, we have lower profitability compared to prior literature. This is due to our weak momentum factor.

4.6 Findings and Interpretation

Our study indicates a significant decline in momentum profitability, relative to the findings in VME. Our results indicate diminished returns for the majority of the momentum portfolios. Additionally, all currency-related portfolios report statistically insignificant returns. This might indicate a paradigm shift for momentum strategies during the period we analyze, which is supported by the study "*Momentum Crashes*". Daniel and Moskowitz offer insight into momentum strategies under market stress, while examining the occurrence of infrequent, but persistent negative returns, during periods of high volatility. This research indicates that momentum strategy returns are regime-dependent and differ significantly based on market conditions, which is aligned with our findings (Daniel & Moskowitz, 2016).

Consequently, the returns of momentum strategies may be skewed and susceptible to unexpected, substantial decrease of profitability. This observation is intriguing, as the period from 2011 to 2022 is characterized by relatively high volatility, which could impact momentum strategies. Daniel and Moskowitz displayed this argument, by illustrating the interaction between the bear market indicator and market volatility, indicating that momentum strategies perform poorly in bear markets with high volatility (Daniel & Moskowitz, 2016). The above mentioned study does not particularly address the recent decline in momentum strategy returns, but provides a conceptual framework for comprehending how market stress, and higher volatility, may affect momentum strategies. This insight facilitates the interpretation of our decrease in momentum profitability and identifies potential vulnerabilities and shifts in the performance of momentum strategies. Specifically we observe weaker zero-cost long-short portfolios for the US. Individual Stocks and Global Equity Indices, compared to historical performance.

Positive Sharpe ratios persist across all asset classes, although they are comparatively lower for currencies, given the difficulty of identifying overvalued or undervalued currencies. With evidence of consistent Sharpe ratios for value portfolios, our findings indicate a level of covariation among value strategies across Commodities, Indices, and Individual Stocks.

We discover significant empirical evidence that combining the value and momentum factors significantly enhance the Sharpe ratio for Global Equity Indices. This implies that combining two strategies, with positive returns and negative correlation, can substantially enhance the Sharpe ratios. (Asness et al., 2013). Our findings provide additional evidence of profitability across asset classes, indicating the existence of a global risk factor from 1980 to 2022, which could be a subject for further research. This occurrence corresponds to the initial conclusion made by Asness, Moskowitz, and Pedersen, regarding the potential common global risks among their returns.

Addressing alphas and corresponding t-statistics, currencies consistently diverge from the other asset classes we have examined. We consistently find positive alphas for both Commodity and Individual Stock portfolios, with the highest alpha reported for the Commodity factor portfolio. This is consistent with Switzer and Jiangs research from 2010 emphasizing the results of commodity-based long-short (factor) portfolios, which contribute to profitability, by reducing portfolio costs (Switzer & Jiang, 2010). The article proceeds to explain that the positive performance of Commodity portfolios may be attributed to momentum strategies' trading of liquid contracts with nearby maturities, which are unaffected by the short-selling restrictions that are typical of other assets. The substantial momentum, carry, and low-volatility factor premiums in the commodity market, motivate investors to account for these when constructing portfolios. In addition, they concluded that commodity factor portfolios outperform other individual Commodity portfolios, in terms of risk-adjusted performance, adding significant value to traditionally allocated portfolios. These arguments support our results, indicating that value and momentum strategies consistently generate positive returns regarding Commodity factor portfolios, indicating their efficiency in the Commodity markets.

4.7 Comovement

4.7.1. Value and Momentum Strategies Across Asset Classes

Table 1 in appendix presents the correlation across asset classes, between value and momentum returns[8]. Existing literature that queries the theoretical explanations for momentum and value strategies might be supported, if a

[8] *We exclude the correlation of individual stocks correlation with itself, when averaging the portfolio returns.*

significant degree of comovement is discovered between asset classes. Potential findings may suggest that intrinsic structures affect portfolio returns.

Table 1 further reports the relationship between average stock strategies and non-stock asset classes[9]. The majority of value strategies exhibit a consistent positive correlation across the asset classes, which is complemented by similar findings for the momentum strategies. In contrast, we observe a negative correlation between value and momentum strategies, except for the correlation between the Commodity value strategy and the momentum strategy for Individual Stocks. Particularly interesting is the high correlation between momentum returns of Individual Stocks and Indices, compared to our other findings. Our findings contribute to the establishment of a correlation structure across asset classes (Asness et al., 2013).

To examine joint significance of the distinct correlations within each asset class, we conduct an F-test, where * denotes statistically significant correlations at a 5% significance level. This procedure is robust even when multiple value measurements are utilized to specify the value measures for the distinct asset classes. As indicated by Asness et al. (2013), a consistently negative correlation between value and momentum strategies is observed across multiple asset classes, despite utilizing different measures of value.

4.7.2 Common Factor Structure

To illustrate and describe the existence of a common factor structure between value and momentum, we examine the possibility of combining the strategies to generate significant returns.

Due to a consistent negative correlation between value and momentum across assets, the combination of value and momentum exhibits persistence. Multiple theoretical frameworks, such as those proposed by Liu, Whited, and Zhang (2009), Sagi and Seasholes (2007), Johnson (2002), and Berk, Green, and Naik (1999), identify consistent patterns in value and momentum effects across diverse asset classes and markets, supports our empirical findings (Berk et al., 1999; Johnson, 2002; Liu et al., 2009; Sagi & Seasholes, 2007).

[9] *Asness et al. illustrate that even when using the stock's 5-year past return as a value measure, as applied on the other asset classes, there is still a consistent negative correlation between value and momentum strategies.*

With the exception of Currencies, our study uncovers consistent Sharpe ratios across all asset classes. This consistency provides evidence, supporting patterns of risk-adjusted performance, supporting the establishment of a common structure. Reported alphas are positive across the majority of asset classes, which emphasizes alpha's influence on developing a common factor structure across asset classes. The alpha capturing returns beyond those explained by identified risk factors, supporting the quantitative approach when establishing a common structure. The persistent positive alphas may indicate a common unpriced risk factor, or simply illustrate the efficiency of value and momentum strategies. Our findings provide support to the identification of a common factor structure regarding our four distinct asset classes.

5. Considering the Decline in Momentum Returns

5.1.1 New Weighting Technique for the Combined Factor Portfolio

Our analysis indicates that regardless of the profitability, the momentum portfolios exhibit a consistent and significant decrease relative to previous research. The study "*Momentum has its Moments*" by Barroso and Santa emphasizes the vulnerability of momentum, with respect to severe crashes, despite momentum strategies generating higher Sharpe ratios relative to market, value, and size factors, over extensive periods of time (Barroso & Santa-Clara, 2015). For investors who seek to reduce skewness and kurtosis, this vulnerability reduces the appeal of momentum strategies. Their research illustrates a 73.42% decline in momentum over a three month period in 2009. This suggests that risk-averse investors may find the returns of momentum strategies not to be adequately compensating for the risk. The observed decrease in momentum returns across asset classes is a highly intriguing topic for our research.

Concurrent with our findings of declining momentum returns, we observe strong value portfolio returns across all asset classes, with the exception of currencies, which exhibit consistent insignificant negative returns. This incentives the exploration of alternative weighting options for the combined portfolios, as opposed to the initial 50/50 allocation. As described in the VME article, we initially constructed factor portfolios using a rank-weighted, zero-cost long-short methodology, with equal weighting.

Figure 2:

In order to provide further evidence for the decreasing momentum effect observed, we decide to examine factor portfolios with a 75/25 composition, for value and momentum respectively. Figure 2 reports these 75/25 portfolios.

	Combined rank-weighted Factor Portfolios (75/25)			
	US. Individual Stocks	***Currencies***	***Commodities***	***Indices***
Annualized Mean Return	5,65%	0,71%	5,69%	3,32%
AMR t-stat	*4,41*	*0,65*	*2,64*	*1,63*
Standard Deviation	7,37%	7,13%	14,17%	13,38%

This combination intends to investigate the prospect of enhanced returns through the construction of factor portfolios that combine momentum and value, as opposed to pursuing a value or momentum strategy solely. The following section evaluates the results of combining portfolios with a 75% weight on the value factor and a 25% weight on the momentum factor.

Positive returns are observed across all four asset classes, with the exception of currencies. This is consistent with our previous findings of insignificantly low currency returns. The article, "*Currency and Momentum Strategies*", reports the difficulty in achieving significant currency returns can be partially attributed to efficient arbitrage constraints that prevent the simple utilization of momentum returns in these currency markets (Menkhoff et al., 2012). Further, they suggest that traditional risk factors do not adequately account for the cross-sectional variance in returns between historically undervalued and overvalued currencies.

A particularly interesting finding is the significant increase in returns for the combined factor portfolio for commodities, as compared to a 50/50 weighting. This is consistent with our reported correlation of -0.18 between value and momentum within the commodity asset class, due to possible upside from adjusting the factor weightings. In contrast, we observe insignificant returns for the Indices factor portfolio, which are presumably unfavorable of the rebalanced weighting. This might be a result of the significant returns generated across the low, middle, and high momentum portfolios for Indices, and the momentum factor portfolio, which is now assigned lower weights in the portfolio composition.

Considering individual stocks, we observe a slight decrease in returns as a consequence of the adjusted weighting, whereas the combined factor portfolio continues to generate significant returns. This is presumably a direct consequence of the momentum factor portfolio generating higher returns than the value factor portfolio, indicating that individual stocks actually might benefit from an opposite weighting, specifically an increased weighting on the momentum factor. However, the disparity in return magnitude and statistical significance could be related to choice of market, volatility, and choice of time period.

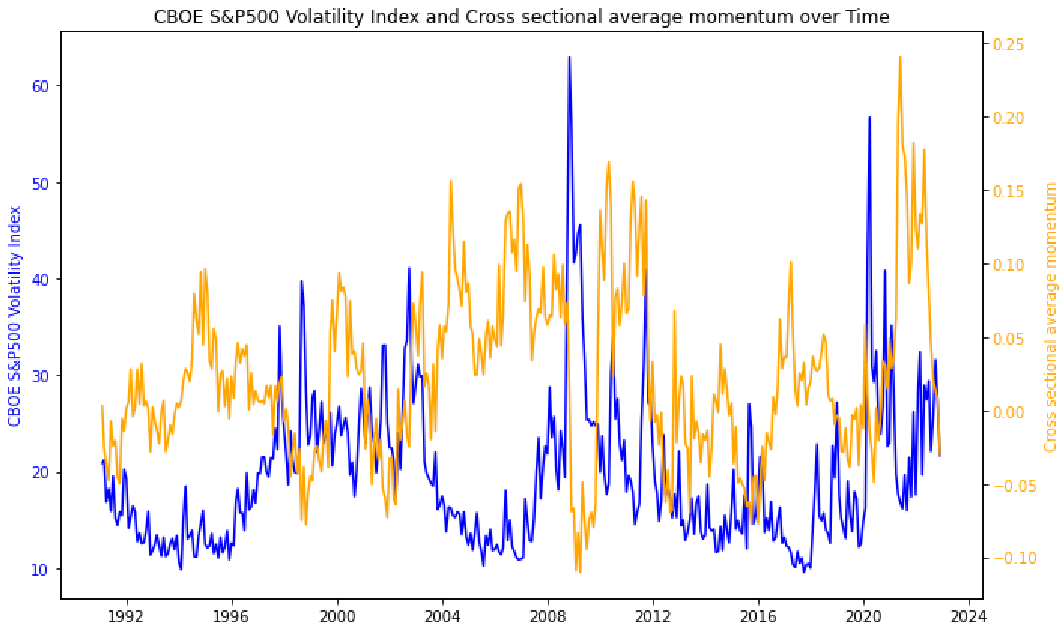
5.2.1 The Relationship between CBOE's VIX Index and Momentum

Given that the momentum premium is frequently associated with behavioral finance (Asness et al., 2013), and our reported decline in momentum returns, we find it interesting to examine whether the VIX Index can be used to explain future momentum. We consider the VIX index as an appropriate predictive variable for momentum returns, as we interpret momentum profit to be a result of common irrationality (Asness et al 2014.,). Therefore, a frequently employed index should have a greater influence on investors' psychology and investment decisions. The VIX index is a measure of potential market volatility as opposed to current volatility (Huang et al., 2023), and is therefore an indicator of the common opinion regarding the volatility of the short-term market.

The Chicago Board Options Exchange's VIX Index provides a risk-neutral measure of the expected 30-day volatility of the S&P 500 index (Huang et al., 2023). Previous research indicates that momentum strategies are inefficient during periods of high volatility, known as momentum crashes (Daniel & Moskowitz, 2016). Fan, Kearney, Li, and Liu discover in their article "*Momentum and the Cross Section of Stock Volatility*" that the origin of high uncertainty, associated with momentum returns, is the cross sectional volatility of stocks. According to their findings, momentum returns diminish during periods of high volatility (Fan et al., 2022). This may indicate a relationship between the VIX index and momentum, illustrated in Figure 3.

Figure 3:

Figure 3 presents the relationship between 30-day volatility as measured by the CBOE Vix index and average portfolio momentum in our study. The graph illustrates that momentum is considerably weakened in periods with high VIX volatility.



To analyze this relationship, we performed an OLS regression (Appendix, table 2), and a VAR model, to determine if there are significant relationships between high measured volatility on the VIX index and diminished momentum. According to our findings, an increase in the VIX index is associated with a significant decrease in momentum.

An OLS regression is conducted, uncovering a statistically significant negative correlation between the VIX index and momentum, underscored by a VIX coefficient and a p-value presented in appendix (Table 3 and 4). Further we apply a VAR model with three lags to reflect the dynamic relationships between the variables, and to omit autocorrelation. The findings of the VAR model support the regression results. At the first lag, the VIX index indicated a significant influence on momentum. This suggests an inverse relationship between the VIX index and momentum at the first lag, demonstrating that an uptrend in market volatility is associated with a decrease in momentum, hence we can confirm our third hypothesis.

At the second and third lags, however, the influence of VIX on momentum was statistically insignificant. This indicates that the impact of VIX on momentum diminish over time. The coefficients for momentum at lag 1, lag 2 and 3 are all significant. These findings suggest the momentum in previous periods, especially lag 1, positively influence the momentum in the current period. This indicates that the momentum effect is robust and consistent over time, but tends to diminish as we move further back in time.

Before implementing the VAR model, it was essential to ensure that the two time series were stationary, which is necessary for the model's validity. To confirm this, a Dickey-Fuller test was conducted on both series (Appendix, table 5). The test results establish that both time series are stationary, and justifies utilization of a VAR model.

Our empirical results provide new evidence for the short-term influence of the VIX index on momentum. The results have significant effects for investment strategies, indicating that investors may increase their returns by considering market volatility, when employing momentum strategies. This finding only explains a certain amount of the variance in momentum, revealing that momentum is a phenomenon influenced by an extensive number of factors.

These new empirical findings provide opportunities for further research regarding the asserted influence of the VIX index on momentum. There is a possibility that the VIX index will maintain a stronger relationship with asset pricing, which could accordingly transmit an indirect influence on momentum returns via asset pricing mechanisms. Further research may seek to integrate additional variables in order to develop a more complete model of predicting momentum returns.

To broaden the understanding, in the context of momentum portfolio management, it would be valuable to explore the high VIX levels, which frequently indicate heightened market volatility and the potential amplification of tail risk. Kelly and Jiang present a dynamic measure of tail risk that overcomes previous barriers by employing the cross-section of individual stock returns to measure conditional tail risk over time (Kelly & Jiang, 2014)[10]. High VIX levels

[10] Kelly and Jiang intended to develop an aggregate measure of tail risk dynamics comparable with the dynamic volatility estimated by the GARCH model. However, in a univariate time series model, estimating tail risk is difficult due to the absence of high-volatility events. To overcome this limitation, they proposed a panel estimation method that accounts for the shared variation in tail risk among individual stocks.

indicate heightened market volatility, making momentum strategies susceptible to sudden market shifts. During periods of severe market shifts, associated with increased tail risk, these measures are of particular interest. Examining this correlation improves both our theoretical understanding of risk-return tradeoffs under volatile market conditions and our ability to mitigate risk for momentum portfolios. Analyzing the relationship between momentum strategies, the VIX index, and potential market losses is crucial for portfolio management. This uncharted territory represents a promising topic for future research, with the potential to complement our understanding of market dynamics and strengthen the correlation between the VIX Index and momentum.

The research conducted by Huenag et al. on intraday momentum in the VIX futures market corroborates and supports our empirical findings (Huang et al., 2023). Their research displays conclusively how intraday momentum exists in the VIX futures market. Although a direct comparison with our findings might not be feasible, their findings support the notion that momentum strategies, applied to the VIX index, may identify correlations and contribute to predicting future price fluctuations. In addition, their work emphasizes the importance of hedging demand[11]. They provide compelling evidence on how the demand for gamma-hedging VIX options has the ability to explain intraday volatility in the VIX futures market. This empirical finding provides insights on which factors that influence the VIX market's momentum. This comprehension facilitates future research to investigate the potential impact of market participants hedging activities on the relationship between the VIX index and momentum.

In order to further enhance the understanding of the VIX index influence on momentum returns, it would be of considerable interest to conduct further research encompassing two significant factors: The mean-reversion effect and the risk premium effect. The mean-reversion effect emphasizes an inverse relationship between the VIX index and the market, suggesting that volatile market movements tend to revert to normal levels over time[12] (Whaley, 1993). The risk premium effect implies that investors who assume volatility risk can anticipate higher returns (Lee et al., 2017). Depending on market conditions and return

[11] Hedging demand is the requirement for securities to offset consumption risk. An increase in gamma hedging demand indicates that market participants are actively seeking protection against fluctuations in an options delta.

[12] An increase in the market index corresponds to a drop in the VIX index, and vice versa.

patterns, the impact of the VIX index on momentum returns might fluctuate, with a more pronounced influence observed during unfavorable market conditions. Further research on the VIX index will enable investors and portfolio managers to gain a deeper understanding of market expectations and make potential adjustments to their momentum strategies. Particularly in the context of hedging against momentum crashes and understanding the complex relationship between the VIX index and momentum returns.

6. Conclusion

This thesis performs a comprehensive profitability analysis of momentum and value strategies across four distinct asset classes, with portfolio construction inspired by Asness, Moskowitz and Pedersen (2013). Our research uncovers a consistent and significant decline in momentum portfolio returns relative to historical performance. Despite asset-specific variations in profitability, the value-momentum combination remains robust, supported by a consistent negative correlation within and across asset classes. We identify significant cross-asset correlation across both strategies, challenging existing theories on comovement, and the possibility of establishing a factor structure. In accordance with previous research, currency portfolios frequently produce insignificant results. We present compelling evidence of an improved Sharpe ratio for the zero-cost long-short portfolio of Global Equity Indices, when combining the momentum and value strategies. We discover new insights, by applying a different weighting scheme, especially for the Commodity factor portfolio. Allocating 75% of the factor portfolio's weight to the value strategy, the returns for the combined Commodity factor increase significantly.

We provide evidence of a persistent factor structure across all asset classes, except for Currencies. The consistent negative correlation between value and momentum, both within and across assets, promotes the establishment of a common factor structure. This indicates considerable comovement between the asset classes. While existing behavioral theories predominantly concentrate on individual stocks, our discovered correlations across distinct assets indicate the need for a more comprehensive framework.

Utilizing an OLS regression and a VAR model, we analyzed the relationship between the VIX index and momentum. The relationship is supported by a significant negative correlation between increased VIX volatility and decreased momentum. The first lag in the VAR model confirmed this inverse relationship, whereas the second and third lags were statistically insignificant, indicating that the VIX's influence on momentum diminish over time. We discovered unique evidence that past momentum positively influence existing momentum, illustrating robustness of the momentum effect. The Dickey-Fuller test validates the stationarity of the time series, confirming the validity of the VAR model and strengthening the theoretical explanation.

Our findings indicate that short-term momentum is affected by market volatility, suggesting that strategies accounting for this factor might generate higher returns. While the VIX index only accounts for a small portion of momentum's variance, it certainly offers intriguing possibilities. Subsequent research could analyze the impact of asset pricing mechanisms on momentum, while incorporating additional variables to develop a more comprehensive model for momentum prediction. This examination has the potential to considerably enhance our understanding of the complex dynamics governing financial markets, marking an exciting unique frontier in financial research.

7. Appendix

Table 1: *Correlation between value and momentum returns across asset classes:*

	Value Commodities	Momentum Commodities	Momentum Currencies	Value Currencies	Momentum indices	Value indices
Momentum US. Stocks	0,006	0,0156	0,042	-0,078	0,456*	-0,197*
Value US. Stocks	0,072	-0,193*	-0,033	0,024	-0,132*	-0,047

Table 2: *OLS regression, VIX and Momentum:*

	OLS Regression (VIX)
Coefficient	-0,0014
P-value	0,009

Table 3: *VAR-model, VIX lags:*

	VAR Vix lag 1	VAR Vix lag 2	VAR Vix lag 3
Coefficient	-0,001216	0,000388	0,000339
P-value	0	0,379	0,335

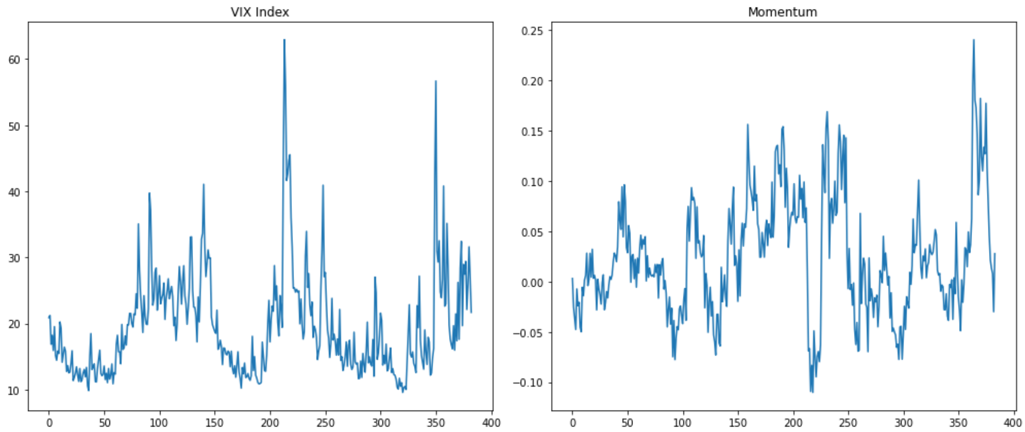
Table 4: *VAR-model, Momentum lags:*

	VAR Momentum lag 1	VAR Momentum lag 2	VAR Momentum lag 3
Coefficient	0,661222	0,116806	0,102098
P-value	0	0,072	0,056

Table 5: *Dickey Fuller test*

	Momentum	Vix Index
Dickey-Fuller	-4,212774	-4,723288
P-value	0,000627	0,000076

Table 6: *VIX index and momentum displayed separately:*



Equation 1:

$$w_{it}^{s} = c_t(rank(S_{it}) - \sum_i rank\,(S_{it})/N)$$

We proportionally weight each security i = 1, . . . , N at time t based on their signal Sit (value or momentum) rank minus its average rank, which reduces outliers' influence. Using raw signals gives similar but marginally better results (Asness et al., 2013).

Equation 2:

$$r_t^S = \sum_i w_{it}^S r_{it}, \;\; where\ S \in (Value, Momentum)$$

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