Handelshøyskolen BI

GRA 19703 Master Thesis

Thesis Master of Science 100% - W

Predefinert informasjon

Startdato:	09-01-2023 09:00 CET	**Termin:**	202310
Sluttdato:	03-07-2023 12:00 CEST	**Vurderingsform:**	Norsk 6-trinns skala (A-F)
Eksamensform:	T		
Flowkode:	202310||11184||IN00||W||T		
Intern sensor:	(Anonymisert)		

Deltaker

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Informasjon fra deltaker

Tittel *:	A Study on the Causal Relationships between Cross-Sectional Momentum Strategies and Macroeconomic Variables Pre- and Post-2008 Financial Crisis.
Navn på veileder *:	Paul Ehling

Inneholder besvarelsen konfidensielt materiale?:	Nei	**Kan besvarelsen offentliggjøres?:**	Ja

Gruppe

Gruppenavn:	(Anonymisert)
Gruppenummer:	241
Andre medlemmer i gruppen:	

A Study on the Causal Relationships between Cross-Sectional Momentum Strategies and Macroeconomic Variables Pre- and Post-2008 Financial Crisis.

Master Thesis

by

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MSc in Business, Major in Finance

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Oslo, June 29th 2023

Abstract

This master's thesis examines cross-sectional momentum strategies in the context of changes in macroeconomic variables preceding and following the 2008 financial crisis. Testing the hypothesis that there may be an altered causal relationship between the variables M2 money supply, risk-free rate, CPI, gold, and WTI on cross-sectional momentum strategies after 2008. We find evidence that the cross-sectional momentum strategy generated abnormal returns prior to 2008 but lost its efficacy after 2008. We provide significant empirical evidence documenting a shift in the influence of the economic variables on the momentum returns using simple OLS regressions and a multivariate VAR model.

Acknowledgments

We want to thank our supervisor, Professor Paul Ehling, who has provided us with guidance and assistance throughout the process of writing the Master Thesis. We are grateful to BI Norwegian Business School for providing access to academic resources, databases, and analytical tools.

Table of Contents

1. Introduction

The Efficient Market Hypothesis (EHM) proposes that all available information, including past prices and trading volumes, is entirely incorporated into current prices. The hypothesis implies that it should be impossible to obtain consistently abnormal returns. Empirical evidence demonstrated that relative-strength or cross-sectional momentum strategies have generated returns that consistently exceed the market's, thus challenging the hypothesis. N.-F. Chen et al., (1986) note that the EHM and rational asset pricing theory suggest that prices of assets depend on exposures to the state variables that describe an economy. This paper examines the various economic variables as systematic influences on momentum returns.

The significance of this research is highlighted by a void in the literature, understanding the relationship between macroeconomic variables and momentum returns that this study seeks to fill. Such an understanding has far-reaching implications, not only for academic research but also for investors in practice. We proceed to provide evidence for the change in the influence of economic variables on momentum returns.

Examining relevant empirical literature can lead to credible prospects of trend strategies systematically beating the market. One significant example of such literature is the paper "Returns to buying winners and selling losers" (Jegadeesh & Titman, 1993). They document strategies that buy stocks that have performed well in the past and sell stocks that have performed poorly in the past to generate significant returns over 3-to 12-month holding periods. We implement this methodology in an evolving economic landscape, revealing how the once robust momentum effect has decreased over time, particularly after the 2008 financial crisis. The study "When and why momentum works – and not work?" by Berkin (2021) discovered that returns in the decade of 2010 were 2,89% annually in the US equity markets, not as strong as in the past positive decades. Our exploration of this deuteriation contributes to the evolving narrative surrounding the EMH. It provides new empirical evidence of macroeconomic variables' influence on momentum before and after the 2008 financial crisis.

Following the financial crisis, the US Federal Reserve initiated the first phase of quantitative easing in November 2008, in general a more expansionary policy with lower interest rates and increasing money supply. From 1983 to 2008, the S&P 500 provided an annual average return of 11.27%. After the introduction of monetary easing on November 30, 2008, which defines our pre- and post-financial crisis sub-periods, the annual average yield on the S&P 500 increased substantially to 13.87%, underscoring the effect expansionary monetary policy has on the asset prices of large-cap firms in the U.S. In the same period, momentum strategies have seen declining returns, even as the S&P 500 outperforms its pre-crisis average yield.

The relationship between macroeconomic variables and stock returns is a key area of financial economics. Merton's (1973) paper hypothesized that variations in variables, which can alter future opportunities or consumption equilibrium, can indirectly influence asset prices by changing corporate investment opportunities. However, the variable's influence on momentum has not been widely studied. Pícha's (2017) paper showed through a VAR analysis that money supply exercises an influence on the valuation of the S&P 500 index with a 6-month lag.

This study investigates whether there is a change in the causal relationship before and after the financial crisis of 2008 between M2, risk-free rate, inflation, gold, and WTI prices on a cross-sectional momentum constructed on S&P 500 constituents. The S&P 500 index comprises the 500 largest value companies in the US equity markets. Since momentum strategies are sensitive to high-volatility (Berkin, 2021), we focus on large-cap companies to mitigate the volatility of mid-and small-cap companies.

The thesis adds to the existing literature on the momentum anomaly by presenting new tables on the performance of cross-sectional momentum strategies constructed on S&P 500 constituents pre- and post-2008, analyzing a total sample period from 1982 - 2022. Additionally, the thesis differs from previous research by examining the performance of momentum strategies in relation to macroeconomic variables, providing momentum investors with new evidence to recalibrate their strategies in line with macroeconomic changes.

We find empirical evidence that momentum returns prior to 2008 provided significant returns, across several of the strategies, similar to the findings by Jegadeesh and Titman (1993). Conforming with Berkin's (2021) study, we observed a significant reduction in momentum returns post-2008, underscoring a decrease in the momentum strategy's capability to exploit over and under-reactions on the constituents within S&P 500.

OLS regressions provide evidence of a contemporaneous shift between the two subperiods. We discovered that changes in M2, gold, and WTI shifted to being significant post-2008, whereas the change in risk-free rate became substantially less significant across the different strategies.

Employing a VAR model, we found evidence that before November 2008, the changes in gold, M2, CPI, and WTI had a significant non-contemporaneous influence on the returns of momentum strategies. After November 2008, we found evidence that changes in M2, risk-free rate, CPI, and WTIs significantly influenced the momentum strategies returns negatively, notably M2 having a more significant and consistent negative influence than before. The evidence was further supported by Granger causality tests, which indicated a unidirectional predictive relationship, with M2 lags functioning as an indicator of future momentum returns.

The subsequent sections of this article are structured as follows: *Section 2* examines the existing literature and theoretical frameworks related to the subject. *Section 3* delineates the methodology, outlining how we construct a cross-sectional momentum portfolio, utilize OLS and the VAR model, and perform Granger causality tests. *Section 4* describes the dataset and transformations. *Section 5* presents empirical results and analysis. *Section 6* concludes our study and presents the final takeaways.

2. Literature Review and Theory

2.1 Momentum

Narasimhan Jegadeesh and Sheridan Titman published the article Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency in 1993 (Jegadeesh & Titman, 1993). This article holds central importance in any study concerned with the momentum effect, and as such, it is imperative to undertake a detailed examination of it within this thesis. This investment strategy entails purchasing stocks from the highest decile, representing high performers, and short-selling stocks comprising underperformers from the lowest decile. The methodology is based on a formation period of 3 to 12 months and then holding the portfolio for 3 to 12 months. The study was performed on the US market from 1965 to 1989, and their analysis of the strategies revealed that a portfolio formed of the top decile of calculated stocks could generate returns approximately 1% higher than the market average. Their research shows that momentum returns are temporary, with high-performing portfolios declining after a 12-month hold and a downturn persisting until the 31st month.

While earlier papers find that momentum has been a profitable strategy, Berkin (2021) provides evidence of the contrary. The article "When and Why Does Momentum Work – and Not Work?" (Berkin, 2021) highlights the conditions under which momentum typically underperforms or fails. The article posits that momentum strategies are ineffective post-decimalization, after bear markets, and during periods of heightened volatility. When value stocks outperformed the first decade of the 2000s, characterized by these conditions, they notably witnessed a decline in momentum returns. Berkin (2021) attributes this to changes in market friction due to decimalization, easing trading costs, and increased arbitrage activity. Simultaneously, the behavioral response to cheaper trading might reduce momentum's efficacy. This perspective aligns with Daniel and Moskowitz's (2016) documentation of “momentum crashes”. These crashes are particularly likely during periods of market stress, characterized by high volatility and market downturns. These studies collectively underline market conditions as a critical determinant of momentum performance.

2.2 Efficient Market Hypothesis

Fama's seminal 1970 research, "Efficient Capital Markets," (Fama, 1970) introduced the Efficient Market Hypothesis, which is predicated on three key assumptions: the absence of transaction costs in securities trading, the universal access to cost-free information, and the consistency in the interpretation of such information. EMH argues that market prices reflect all relevant information, leading to price adjustments with any new information. This implies that achieving abnormal market returns is unachievable without added risk, which is a perspective that contradicts momentum strategies conditional on market over- and underreactions.

The Efficient Market Hypothesis is divided into three forms. Under the weak form of the Efficient Market Hypothesis, it is assumed that all publicly available information is fully reflected in asset prices, thereby negating the predictive value of historical price and volume data. This hypothesis suggests that technical analysis relies on historical data and cannot consistently generate superior returns. As it focuses on new and non-public information, the weak form of EMH does not rule out the possibility of fundamental analysis outperforming the market average. The semi-strong form of the Efficient Market Hypothesis rejects both technical and fundamental analysis' predictive power. It extends the assumptions of the weak form by asserting that security prices quickly incorporate all new public information, thereby negating the ability of fundamental analysis to predict future price fluctuations.

Furthermore, the strong form of the Efficient Market Hypothesis asserts that asset prices consistently reflect all available public and private information. It states that this includes all public information - historical, current, and new, and insider knowledge, even if this information is restricted to key company figures. Thus, the strong form of the Efficient Market Hypothesis posits that all such information is always reflected in the current stock price.

2.3 Macroeconomic Variables

N.-F. Chen et al., (1986) studied the influence of macroeconomic variables on asset prices, implying that the efficient market hypothesis and rational expectations asset pricing theory should reflect the exposure to macroeconomic variables. They investigated the systematic impacts of various economic state variables on the US stock market using a Vector Autoregressive (VAR) model. They found that certain types of systematic economic news influence US stock returns. Chen discovered that industrial production, inflation, risk premium, and term premium are important variables priced in the US stock market returns. Kaneko and Lee (1995) revised this study in the US and Japanese stock markets, extending the variable set to include changes in terms of trade, oil prices, exchange rates, and excess stock returns. By applying the same VAR model, they found that news on term premiums, risk premiums, and industrial production growth rates are significant in the US stock market returns, while oil news impacted the Japanese stock market returns.

Picha's (2017) study on the money supply's impact on the S&P 500 highlighted that changes in money supply, with lagged effects of six months, significantly influenced the S&P 500 asset values. This effect persists over the long term, contributing to a general increase in the prices of all examined asset classes and subsequently driving the price of the S&P 500. The study found that a $1 billion money supply increase could increase the S&P 500 index by 0.14 points over time by conceivably inflating asset prices. Caginalp et al., (1998) supported these findings and found evidence that experimental asset markets indicate that a higher cash-to-asset ratio tends to increase asset prices. Their study identified that specific investment communities believe that an increase in money supply, commonly known as "cheap money," drives market prices upward, thus affirming the belief that an increased money supply correlates with an upward trend in asset prices.

The article Oil and Stock Market Momentum (C.-D. Chen et al., 2017) investigates oil return predictability on the momentum returns in the Chinese stock market, suggesting that the predictive power of oil over momentum payoffs is contingent on investor sentiment. This sentiment increases the demand for winning stocks during uncertain times, as indicated by the volatility of the oil return. An oil-based momentum strategy can generate significant abnormal returns and outperform conventional momentum strategies. Arguing that oil market dynamics can exacerbate stock market inefficiencies.

3. Hypothesis and Methodology

3.1 Hypothesis

Cross-Sectional momentum strategies have been characterized as trading strategies that deliver abnormal returns by identifying and exploiting over- and underreactions in the market (Jegadeesh & Titman, 1993). After the 2008 financial crisis, the S&P 500 average returns exceeded the 40-year average. In the same period, there has been a favorable economic environment with expansionary monetary policies such as low-interest rates and quantitative easing. Seen in conjunction with the expansive monetary policy driven by the Federal Reserve, intuitively, one would expect that momentum strategies should have significantly positive returns given the expansive growth in the S&P 500. However, empirical evidence provided by Berkin (2021) demonstrates a reduction in the returns of momentum strategies within the U.S. equity markets over the past decade. Pícha (2017) and Kaneko and Lee (1995) argue that monetary easing, specifically low-interest rates and increased money supply, can stimulate asset prices positively. Therefore the disparity between increasing S&P 500 returns and a reduction in momentum returns following the financial crises and evidence of economic variables affecting stock returns motivates us to research whether there is a change in the influence of the macroeconomic variables on momentum.

This leads us to our hypothesis on whether there exists a change in the causal relationship between the variables; M2 money supply, risk-free rate, CPI, gold, WTI, and cross-sectional momentum strategies pre- and post-2008. Accordingly, we test the strategy's viability and examine whether there is a change in the influence of economic variables on the strategy in the two subperiods.

3.2 Methodology

This study rests primarily on the cross-sectional momentum strategy proposed by Jegadeesh and Titman (1993). The primary objective is to analyze the causal relationships between momentum returns and economic variables and identify their predictive power. We first employ a simple OLS regression with the individual variables on the strategies. A VAR model is applied as the methodological framework to capture the non-contemporaneous relationships between these variables effectively. We complement the VAR with a Granger causality test to establish predictability. Note our data is organized in Microsoft Excel and carried out into Python to carry out the analysis.

3.2.1 Construction of the Cross-Sectional Momentum Portfolios

The portfolios are constructed on Jegadeesh and Titman's (1993) cross-sectional momentum strategy methodology. Cross-sectional momentum exploits price trends in assets and is defined as the performance of an asset relative to its peers. It assumes that underperforming assets will continue to underperform relative to their peers in the following periods and vice versa for the outperformers. To examine how short-term effects influence the momentum strategy, we also add the *1x1* portfolio. We believe that this may yield valuable insight into how the short-term performance of the momentum strategy changes post-2008.

The portfolio is formed based on the *J* months lookback period and subsequently held for a duration of *K* months. The formation period, represented by *J*, looks back at *J* months and ranks the winners and losers into deciles based on their cumulative log returns. The holding period, represented by *K*, corresponds to the interval during which the portfolio is held. The buy-sell portfolio is constructed by buying the top decile, *winners*, and selling the lowest decile, *losers*. The strategies consider *J* = *[1, 3, 6, 9, 12]* and *K* = *[1, 3, 6, 9, 12]*, presented in months, providing 25 strategies in total. Throughout the remainder of the study, the strategies are referred to as *JxK*. We transform the data into log returns for the formation periods to ensure that the data fits within the classification of a symmetric distribution. For the *JxK* return calculations, we transform the stock price data into simple returns to match the methodology of Jegadeesh and Titman (1993).

The strategy enables overlapping holding periods, which allows the strategy to be reimplemented monthly. In any month t, the strategies could accommodate a variety of portfolios started in the current month and the previous *K-1* months. The strategy closes the *t-K* position each month and rebalances the portfolio to maintain equal weightings. We weigh each stock when forming the portfolios equally, and we revise the weights on $\frac{1}{K}$ of the securities in any given month and carry over the rest from the previous month. This allows the strategy to maintain up to *K* active portfolios, with *K-1* carried over from previous months and the final portfolio created at time *t*. The mathematical expression for the cross-sectional momentum strategy can be expressed as

$$E_{buy}\left(r_{i,t} - \bar{r}_{i,t} \mid r_{i,t-1} - \bar{r}_{i,t-1} > 0\right) > 0$$
$$E_{sell}\left(r_{i,t} - \bar{r}_{i,t} \mid r_{i,t-1} - \bar{r}_{i,t-1} < 0\right) < 0$$

Where $r_{i,t}$is the return of asset *i* at time *t*, and $\bar{r}_{i,t-1}$ is the average cross-sectional returns for the corresponding period.

We replicate the construction of the portfolios and divide the returns into two tables, to compare returns before and after QE1 took place in November 2008. According to Toumanoff (1984), transaction costs impact the trading analysis significantly. Transaction costs are usually hard to predict precisely and are modeled proportionally. This study does not investigate momentum strategies in practical trading approaches, thus, transaction costs during portfolio liquidation and rebalancing will not be considered.

3.2.2 Simple OLS Regressions

In the simple regression analysis, we separately regress each variable on all *JxK* strategies (1). The aim is to get insight into the explanatory power of each macroeconomic variable on the cross-sectional momentum strategies.

$$r_{t,JxK} = \alpha + \beta_1 * variable_{i,t} + \varepsilon_t \qquad (1)$$

Where *i* = logged changes in M2, risk-free rate, CPI, Gold, and WTI.

3.2.3 Vector Autoregressive Model

Autoregressive models make predictions using only past values of the endogenous variables plus an error term and have the assumption that the variables are stationary (Brooks, 2019, p. 341). To identify the optimal lag count for our model, we apply the Multivariate Akaike Information Criterion (MAIC), which effectively reduces the overfitting risk.

$$MAIC = ln|\hat{\Sigma}| + \frac{2k'}{T} \qquad (2)$$

A Vector Autoregressive (VAR) model is an extension of an Autoregressive (AR) model with multiple endogenous dependent variables. When 'g' variables are present, a VAR(k) model is presented. For g variables, we have a VAR(k) model in the form.

$$\underset{(g \times 1)}{y_t} = \underset{(g \times 1)}{\beta_0} + \underset{(g \times g)(g \times 1)}{\beta_1 \, y_{t-1}} + \cdots + \underset{(g \times g)(g \times 1)}{\beta_k \, y_{t-k}} + \underset{(g \times 1)}{u_t} \qquad (3)$$

Under VAR, we allow our y predictions to depend on more than their initial values. The model attempts to measure everything, necessitating that all variables maintain identical orders of integration, which is an inherent drawback. The Ordinary Least Squares (OLS) and Modified Akaike's Information Criterion (MAIC) estimate each equation in the VAR to determine the optimal number of lags (*k*).

A primary limitation of VAR is that the number of observations (n) must exceed the number of variables (*p*). The solution to the equation must pass the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) and Augmented Dickey-Fuller (ADF) tests for stationarity for VAR to function correctly. Choosing the optimal lag length of the ADF and KPSS is based on the Akaike information criterion. Cointegration between variables is possible if y_t has a unit root, indicating that some or all variables are integrated of order one. Nevertheless, the concept of cointegration may become redundant if each series exhibits stationarity on its own. This is because the linear combination would unfairly favor stationary series, thereby reducing the impact of cointegration.

3.2.4 Granger Causality Test

In the following sub-section, we complement the VAR model with the Granger Causality test for investigating the time-lagged relationships between macroeconomic variables and *JxK* returns.

Granger's causality presupposes that past events influence the future but not vice versa (Granger, 1969). The concept posits that variable y_1 Granger-causes variable y_2 if the prediction of y_2 improves when using historical data from y_1 and y_2, rather than y_2's historical data alone. However, it does not mean that movements in one variable cause movements in another; it refers to the correlation between the current value and the past values of it (Chris Brooks, 2019, p. 421). The null hypothesis posits that one variable does not predict another. The Granger Causality test applies the F-test framework to assess whether lags of variable y_2 explain current variable y_1.

$$F\ test\ statistic = \frac{RRSS\text{-}URSS}{URSS} \times \frac{T\text{-}K}{m}$$

Separate OLS estimates are derived to obtain the unrestricted RSS, followed by re-estimation under imposed restrictions for the restricted RSS. The test employs joint tests on all lags of a specific macroeconomic variable in the equation rather than by studying individual coefficient estimates.

4. Data

This section introduces the raw- and secondary data applied to this study. The data is utilized to construct a comprehensive empirical analysis. The selected sample period extends from January 1982 to December 2022. For a nuanced analysis, we divide the data samples into pre- and post-November 2008, when the QE1 was deployed in the US. *Appendix A* shows the descriptions of variables and the corresponding sources from which these variables have been derived.

4.1 S&P 500

This study employs data from large-cap companies in the US stock market, specifically within the S&P 500 index. Efforts to mitigate survivorship bias include integrating as many of the extinct or excluded companies into the dataset, thus rendering a more accurate depiction of the S&P 500 index's performance over the sample period. The inclusion criterion requires firms to have at least 12 months of past returns, resulting in a total of 819 companies. The weekly end prices are obtained from Bloomberg. The data is converted into monthly units to match the macroeconomic variables and the structure of the momentum strategies.

4.2 Macroeconomic Variables

The macroeconomic variables are retrieved from the Federal Reserve Economic Data (FRED), except for gold spot prices obtained from Bloomberg. The sample period is between January 1982 to December 2022. We use non-seasonally adjusted data to capture the raw movements and relationships between the variables. Based on theory and prior literature, we choose five different variables: Money Supply (M2), three-month Treasury Bills (RF), Consumer Price Index (CPI), West Texas Intermediate (WTI), and Gold.

4.2.1 M2 Money Supply

The weekly M2 money supply is obtained from FRED. M2 is a measure of the U.S. money supply that incorporates M1 (physical currency and coins in possession of non-bank public, negotiable deposit accounts, and travelers' checks) as well as savings deposits, minor time deposits, and stakes in retail money market mutual funds (Board of Governors of the Federal Reserve System (US), 1980). The Federal Reserve controls the monetary base through open market operations by buying or selling securities. When the Fed purchases securities, it effectively increases the monetary base as the receiving bank's reserves grow. Conversely, when the Fed sells securities, the purchasing bank's balance at the Fed reduces, decreasing the monetary base (Thornton, 2023). As established by previous empirical research, the money supply does influence asset price movements and is, therefore, essential to answer our hypothesis.

4.2.2 Risk-Free Rate

The Federal Reserve's interest rates correlate with the risk-free rate (Board of Governors of the Federal Reserve System (US), 1934). The Federal Reserve controls the risk-free rate by adjusting the interest rate in the economy. Due to the short-term behavior of the momentum strategy, three-month Treasury bills are deemed the appropriate measure for this study. Given its foundational role in asset valuation, the risk-free rate is an essential variable within the framework of our hypothesis.

4.2.3 Consumer Price Index

The Consumer Price Index (CPI) measures the economy's overall price levels and is the primary indicator of inflation in the United States (U.S. Bureau of Labor Statistics, 1913). The CPI is affected by variables such as the money supply, oil prices, and interest rates, which link it to economic expansion, and, thereby, potential momentum returns. Unanticipated inflation may have a negative impact on stock prices through unexpected price level changes and by impacting the discount rate, thereby decreasing the present value of future corporate cash flows. Initially, a rise in inflation may reduce corporate profits due to cost increases and gradual output price adjustments, thereby decreasing profits and asset prices (Humpe & MacMillan, 2009).

4.2.4 West Texas Intermediate

West Texas Intermediate (WTI) is crude oil extracted from the US (Federal Reserve Bank of St. Louis, 1946). Due to the diversity of the US industries, the influence of oil prices on the US economy is bidirectional. On the one hand, rising oil prices may stimulate job growth and investment in the energy sector. This is primarily because as oil prices rise, the economic capability of exploiting cost-intensive shale oil deposits increases, encouraging growth within oil corporations. On the other hand, rising oil prices exert upward pressure on operating expenses in several industries. When oil prices fall, unconventional oil activities may bear the brunt, but this trend will likely benefit industries with high energy or fuel costs. This dual effect of oil prices illustrates the intricate and multifaceted relationship between energy markets and the broader economic performance (*What Are the Possible Causes and Consequences of Higher Oil Prices on the Overall Economy?*, 2007). Given that the WTI significantly influences expenditures across a wide range of sectors, it inherently correlates strongly with the CPI.

4.2.5 Gold

Gold's value as a safe haven asset is fundamentally based on market perception, which makes it vulnerable to volatility. As market sentiment fluctuates between risk-on and risk-off, gold may appreciate during mild market volatility but depreciate when investors flee to safer assets. Notably, Erb and Harvey's "The Golden Dilemma" (Erb & Harvey, 2013) demonstrates gold's positive price elasticity, a character without traditional fundamentals in which demand can drive its price regardless of the economic or monetary context.

4.3 Descriptive Statistics

We convert the macroeconomic variables into logged differences, as is commonly applied when studying the returns (Lütkepohl & Xu, 2012). Due to stationarity in, we differenced again, including the *JxK* strategies to incorporate the VAR. Following this transformation, all variables were stationary (*Appendix F)*. *Table 1* presents the descriptive statistics for the total period. Descriptive statistics for the *JxK* strategies pre and post are shown in *Appendix B.*

Table 1:

Descriptive statistics for economic variables during the period from 1982-2022.

	ΔNatural Logarithm of the variables				
	RF	**M2**	**CPI**	**Gold**	**WTI**
Observations	468	468	468	468	468
Mean	-0.0016	0.00491	0.0023	0.00334	0.00205
SD	0.26776	0.00928	0.00329	0.04309	0.09661
Min	-1.84583	-0.0207	-0.01934	-0.19392	-0.56813
Median	0	0.00483	0.00232	0.00024	0.01076
Max	1.79176	0.07017	0.01364	0.12234	0.54562
Skewness	-0.18475	0.68967	-0.67195	-0.03178	-0.67704
Kurtosis	17.08809	5.17009	4.83795	1.00684	7.38859

	Δ of the ΔNatural Logarithm of the variables				
	RF	**M2**	**CPI**	**Gold**	**WTI**
Observations	467	467	467	467	467
Mean	0.00008	0.00003	-0.00002	0.00015	-0.00024
SD	0.33637	0.01377	0.00328	0.06296	0.1159
Min	-2.10006	-0.04344	-0.01376	-0.24961	-0.41889
Median	-0.00418	0.00065	-0.00001	0.00401	-0.01021
Max	3.31216	0.06145	0.01474	0.31626	1.11375
Skewness	1.77955	-0.19756	-0.03225	-0.07866	2.00219
Kurtosis	28.48559	0.60423	1.93088	2.08748	18.02556

5. Empirical Results and Analysis

This section presents significant results and discusses whether the macroeconomic variables' relationship with the *JxK* strategies has changed pre- and post-2008. By systematically following our methodology, we form a conclusion from our results to answer the thesis hypothesis. First, we present *JxK* returns corresponding to the pre-and post-2008 periods. We then proceed to the simple regression results to better understand the individual contemporaneous relationship between one variable and the momentum returns. Further, we present our non-contemporaneous results employing the VAR model and the Granger causality test, divided into two subperiods.

5.1 Momentum Returns

Table 2 reports the mean returns of the individual buy and sell portfolios and the zero cost, buy minus sell portfolios for the 25 strategies. The pre-2008 returns correspond to the levels of profitable returns that Jegadeesh and Titman (1993) found in their research. excluding the portfolios with mean negative returns. All buy-sell strategies that employ holding periods of 9 and 12 months consistently generate negative returns. These findings highlight a likely increase in the efficiency of the S&P 500 constituents in adapting economic information, thus limiting the extent of market over- and underreactions. This trend is observable in the period following the 2008 crisis. These results hold substantial significance for our study and provide a compelling background for further analysis.

Table 2 further reveals that none of the buy-sell *JxK* portfolios post-2008 have statistically significant returns different from zero. Providing evidence of a weakening in the buy-sell portfolio's capability to exploit market over- and under-reactions. The table further displays a decrease in the buy portfolios' effectiveness in selecting stocks that maintain their upward momentum weakened in the period following 2008. Furthermore, the findings suggest that the market has become more efficient in incorporating economic news, complementing the EMH(Fama, 1970). However, the buy and sell portfolios stand significant on their own, therefore, it is not apparent that a more efficient market can explain the insignificant returns. The difference in returns between the buy and sell portfolios has become smaller, suggesting that the difference is being arbitraged away, effectively reducing the profitability of the zero-cost buy-sell portfolio.

Table 2

The table presents mean returns for all combinations of J and K (where J is the formation period and K is the holding period) in both pre-and post-2008 periods. Mean returns for Buy and Sell portfolios are provided, with T-statistics shown in parentheses below the respective JxK, buy, sell, and buy-sell mean returns.

Pre 2008

J=	K =	1	3	6	9	12
1	Buy	0,0218	0,0196	0,0207	0,0178	0,0172
		(5,88)	(5,45)	(5,94)	(5,28)	(4,96)
1	Sell	0,0162	0,0175	0,0167	0,0188	0,0182
		(3,94)	(4,77)	(4,68)	(5,45)	(5,28)
1	Buy-Sell	0,0056	0,0021	0,0041	-0,0010	-0,0010
		(1,78)	(0,95)	(2,61)	(-0,86)	(-0,88)
3	Buy	0,0239	0,0221	0,0223	0,0177	0,0170
		(6,37)	(5,62)	(6,05)	(4,77)	(4,62)
3	Sell	0,0171	0,0167	0,0165	0,0189	0,0188
		(3,93)	(4,22)	(4,40)	(5,13)	(5,25)
3	Buy-Sell	0,0068	0,0054	0,0058	-0,0012	-0,0018
		(1,86)	(1,63)	(2,44)	(-0,64)	(-1,00)
6	Buy	0,0246	0,0254	0,0216	0,0168	0,0164
		(6,04)	(6,36)	(5,54)	(4,31)	(4,29)
6	Sell	0,0169	0,0171	0,0186	0,0211	0,0199
		(3,75)	(4,04)	(4,48)	(5,41)	(5,39)
6	Buy-Sell	0,0078	0,0083	0,0030	-0,0043	-0,0034
		(1,88)	(2,28)	(1,02)	(-1,70)	(-1,51)
9	Buy	0,0270	0,0245	0,0196	0,0171	0,0167
		(6,49)	(6,04)	(4,84)	(4,25)	(4,23)
9	Sell	0,0168	0,0164	0,0197	0,0208	0,0208
		(3,75)	(3,72)	(4,58)	(5,26)	(5,51)
9	Buy-Sell	0,0102	0,0081	-0,0001	-0,0038	-0,0041
		(2,34)	(2,15)	(-0,02)	(-1,32)	(-1,56)
12	Buy	0,0247	0,0227	0,0192	0,0168	0,0161
		(5,93)	(5,41)	(4,63)	(4,10)	(3,92)
12	Sell	0,0165	0,0177	0,0201	0,0205	0,0223
		(3,50)	(3,87)	(4,66)	(5,16)	(5,69)
12	Buy-Sell	0,0082	0,0050	-0,0009	-0,0037	-0,0062
		(1,86)	(1,24)	(-0,27)	(-1,23)	(-2,16)

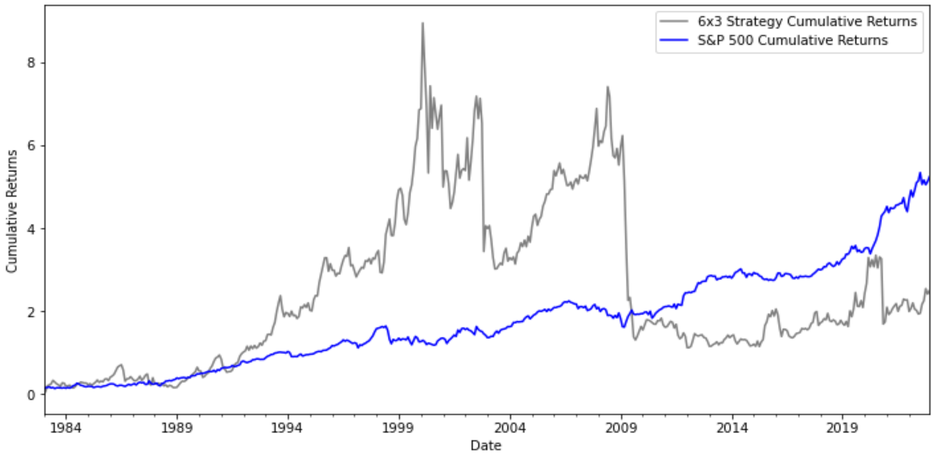
Post 2008

J=	K =	1	3	6	9	12
1	Buy	0,0165	0,0169	0,0154	0,0144	0,0140
		(3,13)	(3,17)	(3,23)	(2,98)	(2,88)
1	Sell	0,0147	0,0143	0,0151	0,0151	0,0154
		(2,21)	(2,57)	(2,72)	(2,90)	(3,00)
1	Buy-Sell	0,0017	0,0026	0,0003	-0,0007	-0,0014
		(0,35)	(1,15)	(0,14)	(-0,53)	(-1,03)
3	Buy	0,0178	0,0162	0,0158	0,0138	0,0150
		(3,46)	(3,18)	(3,34)	(2,96)	(3,16)
3	Sell	0,0146	0,0144	0,0147	0,0165	0,0174
		(2,26)	(2,38)	(2,58)	(3,00)	(3,12)
3	Buy-Sell	0,0032	0,0018	0,0012	-0,0027	-0,0024
		(0,70)	(0,53)	(0,41)	(-1,12)	(-0,93)
6	Buy	0,0176	0,0173	0,0142	0,0138	0,0141
		(3,38)	(3,47)	(3,03)	(2,97)	(2,95)
6	Sell	0,0135	0,0142	0,0148	0,0183	0,0181
		(2,07)	(2,06)	(2,45)	(2,99)	(3,10)
6	Buy-Sell	0,0041	0,0031	-0,0005	-0,0045	-0,0041
		(0,85)	(0,62)	(-0,14)	(-1,17)	(-1,12)
9	Buy	0,0189	0,0153	0,0151	0,0134	0,0137
		(3,74)	(3,22)	(3,28)	(2,82)	(2,78)
9	Sell	0,0134	0,0134	0,0184	0,0200	0,0183
		(1,88)	(1,95)	(2,72)	(3,10)	(3,09)
9	Buy-Sell	0,0055	0,0019	-0,0033	-0,0066	-0,0046
		(0,99)	(0,40)	(-0,69)	(-1,41)	(-1,14)
12	Buy	0,0163	0,0169	0,0155	0,0138	0,0138
		(3,35)	(3,56)	(3,26)	(2,83)	(2,77)
12	Sell	0,0133	0,0156	0,0193	0,0203	0,0178
		(1,85)	(2,14)	(2,81)	(3,16)	(3,04)
12	Buy-Sell	0,0030	0,0013	-0,0039	-0,0065	-0,0039
		(0,56)	(0,25)	(-0,75)	(-1,32)	(-0,93)

Figure 1 presents a clear visual representation of the decline in momentum returns, particularly noticeable in the period following the 2008 financial crisis. The figure illustrates the contrast between the successful performance of the momentum strategy pre-crisis, which generated abnormal returns surpassing the S&P 500, and its post-crisis struggles. Despite a steady increase in S&P 500 returns, the momentum strategy failed to generate significant profits in this period, underlining its diminished effectiveness. This observation aligns with Berkin's (2021) research, further confirming the claim that the efficacy of momentum strategies has decreased in recent years.

Figure 1

This graph illustrates the cumulative returns of the 6x3 momentum strategy for the entire sample period. The blue line represents the cumulative returns of the S&P 500 index, with the 6x3 momentum returns illustrated in grey.



5.2 Correlations

Table 3 exhibits a shift in the correlation between the returns of the 6x3 momentum strategy and the S&P 500, moving from positive to negative following the expansive monetary policy implemented by the Federal Reserve in 2008. This suggests that the S&P 500 and momentum returns tend to move in opposite directions more often after 2008. This supports the observed decline in returns, exhibited in *Table 2*. Despite the low correlation, the shift from a positive to a negative correlation provides evidence of a disconnect between the S&P 500 and the cross-sectional momentum strategy.

In the pre-2008 period, the slight positive correlation between the *6x3* momentum strategy and M2 suggests that the strategy may have benefited from the conditions of higher money supply, as it could capitalize on market over- and underreactions. We observe a distinctly higher positive correlation between the *6x3* strategy and M2 for the post-2008 period. Suggesting that the increased money supply in this period, had a while the momentum returns yielded less.

The negative correlation between M2 and CPI indicates that the Federal Reserve decelerates the money supply as inflation increases to avoid further inflation. Additionally, the strong positive correlation between CPI and WTI in both periods suggests a resilient relationship between oil prices and inflation, supporting the evidence of oil prices as a significant factor in inflationary dynamics.

These dynamics do not reflect causality or lagged effects. To understand how the strategy responds to changes in the set of variables, we proceed with a simple OLS (*Section 5.3*), VAR, and Granger-causality test (*Section 5.4*).

Table 3

Correlation matrixes between the 6x3 strategy returns and returns of macroeconomic variables pre- and post-November 2008.

Pre 2008

	SPX 500	*6x3*	*RF*	*M2*	*CPI*	*Gold*	*WTI*
SPX 500	1,0000	0,0165	0,0127	-0,0835	0,0561	-0,0498	-0,0138
6x3	0,0165	1,0000	0,0971	0,0625	-0,0197	0,0559	0,0624
RF	0,0127	0,0971	1,0000	-0,1800	0,3855	-0,0635	0,2632
M2	-0,0835	0,0625	-0,1800	1,0000	-0,2044	0,0098	-0,1161
CPI	0,0561	-0,0197	0,3855	-0,2044	1,0000	0,0666	0,4746
Gold	-0,0498	0,0559	-0,0635	0,0098	0,0666	1,0000	0,2051
WTI	-0,0138	0,0624	0,2632	-0,1161	0,4746	0,2051	1,0000

Post 2008

	SPX 500	*6x3*	*RF*	*M2*	*CPI*	*Gold*	*WTI*
SPX 500	1,000	-0,1372	-0,0423	0,0215	-0,0104	0,0360	0,0912
6x3	-0,137	1,0000	0,0486	0,1298	0,0363	0,0032	-0,1613
RF	-0,042	0,0486	1,0000	-0,2581	0,1951	-0,0421	0,1369
M2	0,022	0,1298	-0,2581	1,0000	-0,2393	0,0363	-0,2748
CPI	-0,010	0,0363	0,1951	-0,2393	1,0000	-0,0094	0,5097
Gold	0,036	0,0032	-0,0421	0,0363	-0,0094	1,0000	-0,0639
WTI	0,091	-0,1613	0,1369	-0,2748	0,5097	-0,0639	1,0000

5.3 Simple OLS Analysis on Macroeconomic Variables

This section examines the impact of each macroeconomic variable on the *JxK* strategies. We applied a methodological approach to verify our model's adherence to the Best Linear Unbiased Estimator (BLUE) assumptions. This included implementing the Durbin-Watson and Breusch-Pagan tests and calculating the Variance Inflation Factor (VIF). Further, we ensured that the mean residuals of all incorporated variables were equivalent to zero, demonstrating the robustness of our model's statistical conformity to the underlying assumptions. *Table 4* presents the coefficients of 250 simple regressions of the logged differenced economic variables on the *JxK* strategies returns for the five economic variables pre- and post-2008 *(1)*. *Table 5* represents the corresponding t-statistics.

The period post-2008 marked a shift in the significance of the risk-free rate showing a substantial decline in explanatory power (*Tables 4 and 5*). RF was significant with a positive influence for the 6x6 and 3x6 strategies, diverging from pre-2008, where 22 of the 25 strategies were significant with positive coefficients. The positive coefficients, imply that increased interest rates will cause a positive return and vice versa. We provide evidence of a diminished causal relationship between the risk-free rate and momentum returns post-2008. The deterioration could be explained by the post-2008 period, where risk-free rate had a consistent tendency towards zero, a trend that was discernible up until 2017 and reemerged in the phase of the COVID-19 pandemic.

The impact of the set of variables on strategy returns shifted post-2008, as observed in *Tables 4* and *5*. Notably, M2 was not significant for any strategy pre-2008. The coefficients for M2 changed from negative to positive post-2008 for strategies *1x12, 3x1,* and *3x12.* However, M2 did not display a consistent explanatory pattern across strategies post-2008. Gold followed a similar trend, remaining insignificant in the pre-2008 period and then shifting to having a significant positive influence for the 1x9, 3x9, 6x9, 9x9, and 12x6 strategies. Noticeably holding periods of 9 months were consistently significant, indicating a causal relationship between gold and the strategies with *K=9*. Note that changes in CPI did not demonstrate any significant impact during either period.

Table 4 and 5 exhibits that WTI post-2008 showed robust significance, consistently demonstrating a negative effect on 16 of the 25 strategies compared to non-pre-2008. This result indicates an inverse causal relationship between changes in WTI and the strategy returns. San Francisco Fed argues that WTI prices play a significant role in dictating the energy expenditures of several firms, specifically within the transportation and production (*What Are the Possible Causes and Consequences of Higher Oil Prices on the Overall Economy?*, 2007). Intuitively, it is expected that increases in oil prices negatively impact revenue and, in turn, profits as margin decrease and energy expenditures increase for consumers. This reduction in profitability triggers a decrease in asset prices, thereby reinforcing the inverse relationship between momentum returns and WTI.

Table 4

*Coefficients from individual OLS simple regressions. The economic variables are logged changes as displayed in (1). Significance levels are specified as 0.01´***´,0.05´**´,0,10´*´*

coef	RF		CPI		M2		GOLD		WTI	
Strategy	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**
J1-K1	-0,0065	-0,0210	1,6969	-0,0018	-0,8655	0,6827	0,1191	0,0633	0,0514	-0,1433***
J1-K3	0,0954***	-0,0063	0,0256	0,0015	0,0902	0,3748*	0,0460	-0,0267	0,0403	-0,0343
J1-K6	0,0374*	0,0079*	0,0943	-0,0002	0,3605*	0,1689	0,0350	0,0293	0,0104	-0,0392
J1-K9	0,036**	0,0046	0,3564	-0,0009	-0,0812	0,1800	-0,0010	0,0674**	0,0153	-0,0252
J1-K12	0,0324**	0,0029	0,1766	-0,0007	-0,2289	0,2685**	-0,0019	0,0465	0,0161	-0,0296***
J3-K1	0,0421	-0,0085	1,7505	0,0013	0,0221	0,3526	0,0715	-0,0675	0,0103	-0,136***
J3-K3	0,1311***	-0,0055	-0,3952	-0,0013	0,3041	0,8238**	0,0822	-0,0603	0,0518	-0,0623
J3-K6	0,0622**	0,018***	0,6111	-0,0007	0,1182	-0,0264	0,0338	0,0720	0,0248	-0,0668***
J3-K9	0,0554**	0,0058	0,7642	-0,0020	-0,3107	0,2130	0,0218	0,1126**	0,0203	-0,0548***
J3-K12	0,0525**	0,0002	0,1867	-0,0017	-0,3396	0,4279**	-0,0384	0,0816*	0,0187	-0,0502***
J6-K1	0,1238**	-0,0088	0,7354	-0,0012	0,0593	0,7880	0,0801	-0,0917	0,0259	-0,1287***
J6-K3	0,1321***	0,0058	-0,2631	-0,0019	0,4782	0,8166*	0,0812	0,0007	0,0539	-0,0943
J6-K6	0,0791**	0,0195**	1,0931	-0,0025	-0,2303	0,1862	0,0684	0,135*	0,0310	-0,0858***
J6-K9	0,0773**	0,0036	0,7937	-0,0022	-0,3974	0,4876	0,0282	0,1657**	0,0193	-0,0857***
J6-K12	0,061**	0,0015	0,0795	-0,0028	-0,4746	0,3554	-0,0655	0,1216*	0,0189	-0,0643
J9-K1	0,1461**	-0,0016	1,0192	-0,0026	0,5058	1,0426*	0,0753	-0,0280	0,0467	-0,1628***
J9-K3	0,1297***	0,0179	0,9545	-0,0029	0,1737	0,5512	0,1212	0,0889	0,0419	-0,1089***
J9-K6	0,0924**	0,0117	1,3433	-0,0029	-0,4160	0,5282	0,0832	0,1763*	0,0324	-0,1083***
J9-K9	0,0889**	0,0012	0,7392	-0,0030	-0,4083	0,6183*	-0,0043	0,1812**	0,0180	-0,1001***
J9-K12	0,0735**	0,0015	-0,0080	-0,0034	-0,6133	0,3881	-0,0968	0,126*	0,0147	-0,0621
J12-K1	0,125**	0,0077	1,6102	-0,0026	0,0428	0,8438	0,1666	0,0537	0,0474	-0,1814***
J12-K3	0,1456***	0,0158	1,4170	-0,0045	-0,2571	0,7694	0,1266	0,1001	0,0620	-0,1120
J12-K6	0,0999**	0,0108	1,3591	-0,0018	-0,3543	0,5712	0,0950	0,2072**	0,0329	-0,1272***
J12-K9	0,0991**	0,0014	0,6184	-0,0038	-0,5847	0,6126	-0,0389	0,1734*	0,0271	-0,1006***
J12-K12	0,0795**	-0,0005	0,1430	-0,0030	-0,8697	0,4289	-0,0909	0,1211	0,0245	-0,0636

Table 5

*t-stats from individual OLS simple regressions. The economic variables are logged changes as displayed in (1). Significance levels are specified as 0.01´***´,0.05´**´,0,10´*´*

t-stats	RF		CPI		M2		GOLD		WTI	
Strategy	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**
J1-K1	-0,1553	-1,9786	1,5239	-0,3698	-2,2612	1,6022	1,5927	0,6290	1,3347	-3,7575***
J1-K3	3,3041***	-1,1502	0,0325	-0,9154	0,3320	1,7085*	0,8703	-0,5110	1,4876	-1,6889
J1-K6	1,8098*	1,7239*	0,1695	-0,0029	1,888*	0,9182	0,9383	0,6730	0,5413	-2,3359
J1-K9	2,2584**	1,3493	0,8295	-0,9065	-0,5469	1,3238	-0,0330	2,1238**	1,0296	-2,0137
J1-K12	2,3118**	0,9439	0,4627	-1,6783	-1,7483	2,1934**	-0,0727	1,6072	1,2310	-2,626***
J3-K1	0,8678	-0,8021	1,3503	-0,5777	0,0492	0,8276	0,8190	-0,6740	0,2305	-3,571***
J3-K3	3,0422***	-0,6432	-0,3372	-0,4416	0,7521	2,4307**	1,0448	-0,7392	1,2834	-1,9740
J3-K6	1,9977**	2,801***	0,7280	0,0864	0,4076	-0,1008	0,5987	1,1658	0,8544	-2,8166***
J3-K9	2,2348**	1,0754	1,1355	-0,8572	-1,3400	0,9845	0,4710	2,2297**	0,8798	-2,7947***
J3-K12	2,2575**	0,0458	0,2951	-1,3502	-1,5626	2,0602**	-0,8869	1,6671*	0,8624	-2,6312***
J6-K1	2,2685**	-0,7202	0,4990	-0,2531	0,1165	1,6160	0,8097	-0,7933	0,5081	-2,9014***
J6-K3	2,7513***	0,4928	-0,2021	0,2049	1,0657	1,7391*	0,9297	0,0066	1,2014	-2,1820
J6-K6	2,0401**	2,3617**	1,0398	-0,0977	-0,6346	0,5559	0,9492	1,7198*	0,8594	-2,8304***
J6-K9	2,3569**	0,4498	0,8897	-1,3638	-1,2937	1,5499	0,4612	2,2523**	0,6311	-2,9993***
J6-K12	2,0583**	0,2106	0,0987	-1,3421	-1,7171	1,2319	-1,1899	1,8049*	0,6837	-2,4390
J9-K1	2,5385**	-0,1133	0,6547	0,2989	0,9417	1,8692*	0,7204	-0,2107	0,8686	-3,2177***
J9-K3	2,6444***	1,5627	0,7139	0,2434	0,3766	1,2010	1,3256	0,8169	0,9159	-2,6056***
J9-K6	2,1113**	1,2205	1,1319	-0,6537	-1,0161	1,3793	1,0231	1,9578*	0,7961	-3,1268***
J9-K9	2,4063**	0,1282	0,7351	-1,7209	-1,1792	1,6627*	-0,0623	2,0838**	0,5220	-2,962***
J9-K12	2,1525**	0,1849	-0,0087	-1,2974	-1,9283	1,2184	-1,5272	1,6864*	0,4626	-2,1275
J12-K1	2,1819**	0,5778	1,0357	-0,2522	0,0798	1,5847	1,5672	0,4250	0,8897	-3,8111***
J12-K3	2,8062***	1,3246	1,0014	0,1610	-0,5263	1,6116	1,3075	0,8810	1,2805	-2,5659
J12-K6	2,2537**	1,0145	1,1292	-1,2520	-0,8528	1,3462	1,1514	2,0842**	0,7959	-3,3278***
J12-K9	2,5125**	0,1382	0,5757	-1,5650	-1,5848	1,5591	-0,5279	1,8871*	0,7371	-2,8129***
J12-K12	2,1793**	-0,0648	0,1440	-1,2406	-2,5236	1,3068	-1,3157	1,5655	0,7233	-2,1102

5.4 Vector Autoregressive and Granger Causality

In this section, we present and analyze the results of the effects of the macroeconomic variables on the respective portfolios in the sub-periods and further interpret the statistically significant variables. Note we apply the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests with AIC to specify lag length in determining stationarity. Results are exhibited in *Appendix F*. The set of variables was first logged and changed, then differenced, to induce stationarity. The simple returns of the cross-sectional strategies are differenced once. The interpretation is that changes in a macroeconomic variable's growth rate either increase or decrease the growth rate of *JxK* returns. The Durbin-Watson test for autocorrelation and the White test for heteroscedasticity was applied to the VAR model’s error terms. Both pre-and post-analysis indicated non-significant findings. We applied the VAR model on the *9x1*, *12x1*, *6x3*, *6x6*, and *6x12* strategies for the sub-periods. The strategies are picked based on positive momentum returns from the pre-2008 returns and representing different combinations of formation- and holding- periods serving as a proxy for the cross-sectional methodology. We recognize that the buy-sell portfolios' lags on themselves are significant and substantial, we exclude this in the VAR analysis to focus solely on the influence of the macroeconomic variables. However, they are presented in *Appendix C* and *D*, respectively.

5.4.1 Period 1: Pre-November 2008

The VAR results in *Appendix C* reveal a significant causal relationship between lags of Gold, M2, CPI, WTI, and the cross-sectional momentum strategies before the financial crisis of 2008.

The increased growth rate in gold positively influences momentum strategies (*Appendix C)*. Positive coefficients are observed across lags in the *9x1* and *6x3* strategies implying that when gold returns have an increasing growth rate in previous periods, the increase in the growth rate of the momentum returns tends to be higher in the following one to five months. This implies that an accelerating increase in gold for these strategies led to increased returns in the following one- to five months, given the positive returns displayed in *Table 2*. As gold usually increases in periods of higher volatility as a safe-haven asset, the increased growth rate of gold could increase the growth rate of negative momentum returns (*Figure 1)* during periods of high volatility in line with the findings of (Daniel & Moskowitz, 2016).

M2 displayed negative coefficients observed at lags 1 and 2 in the *9x1* strategy and at lags 5 to 7 in the *12x1* and *6x3* strategies *(Appendix C)*. This suggests that an acceleration in the money supply in previous periods tends to reduce the growth rate of the buy-sell strategy in the current period. In other words, a more expansionary monetary policy leads to a depreciation of the growth rate in the strategies' returns. With a positive mean return on aggregate *(Table 2)*, lags of M2 indicate negative effects on the strategies.

We observe negative coefficients for CPI that are consistently observed across multiple lags in the *9x1* and *6x3* strategies *(Appendix C)*. This suggests that an increase in CPI in previous periods is associated with a decrease in the performance of the strategies in the current period. Hence, higher periods of accelerating inflation rates in the past have had a detrimental effect on the growth rate of the strategies in the present. These findings are consistent with the negative correlation found in *Table 3*.

The VAR results show the significant predictive power of WTI on the cross-sectional momentum strategies, though the influence varies across different strategies and lags *(Appendix C)*. For the *9x1* strategy, the growth rate of WTI crude oil exhibits a significant influence at lags 9, 11, 13, and 15. Positive coefficients at these lags suggest that an increasing growth rate in WTI in previous periods tends to correspond to an increased growth rate in momentum returns in the subsequent periods. Given that the strategy has a positive return on average, the results are counterintuitive to the notion that higher oil prices, signaling increased energy costs and potential economic deceleration, negatively affect the returns. For the *12x1* strategy, we observe a significant impact at the 14th lag with a negative coefficient. Given that this is the sole significant observation for this strategy, the results for oil remain inconclusive. Notably, no significant explanatory power of WTI was observed for the remaining strategies. This suggests that these strategies are less sensitive to fluctuations in oil prices due to the longer holding periods.

No significant impacts were established from the risk-free rate across the *JxK* strategies. This diverges from our findings in the simple OLS regressions indicating that the market digests economic news regarding RF quickly.

5.4.2 Period 2: Post-November 2008

The VAR results in *Appendix D* reveal a significant causal relationship between lags of M2, CPI, WTI, and the cross-sectional momentum strategies after the financial crisis of 2008.

The results reveal a significant inverse relationship between M2 and the specified *JxK* strategies. The evidence indicates that an acceleration in M2 growth leads to a decrease in the growth rate of momentum returns. This is consistent across all strategies where M2 was significant. Notably, M2's non-contemporaneous effect in pre-2008 was not consistent across all the strategies signifying that M2 has a more pronounced effect on cross-sectional momentum post-2008. This finding is supported by the increase in correlation between M2 and the *6x3* strategy (*Table 3*). This suggests that M2 post-2008 has a more substantial negative impact on cross-sectional momentum. The coefficients of M2 on the buy-sell growth rate exhibit variability, with effects consistently between lag 6 and 12 (*Appendix D*). Comparably, M2 was significant between lags 1-7 in the first sub-period (*Appendix C)*, demonstrating a change in the reaction time to changes in M2 growth rate on the proxy strategies.

Despite these findings, the lags of the cross-sectional momentum strategy in the M2 equation yielded negligible impact, with the singular exception of lag 10 in the *9x1* strategy. This observation underscores that there exists a primarily unidirectional relationship between M2 and the cross-sectional momentum strategies, apart from the noted exception. The Granger causality tests (*Appendix E*) support the unidirectional relationship and predictive power of the M2 on these strategies excluding 6x6 respectively.

The inverse relationship implies that positive changes in M2 money supply, post the 2008 financial crisis, have a negative effect on momentum returns, given a mean positive return as observed in *Table 2*.

These findings diverge from the relationship between the effects of M2 concerning Pitcha's (2017) findings that lag 6 of M2 had a positive effect on the S&P500 returns. The findings reveal a noteworthy shift in the significance of VAR results for different strategies when comparing pre-and post-2008 data. In the pre-2008 results, significant lags were only found for two strategies, while the post-2008 results imply that M2 has a broader predictive power on the momentum returns post-2008 overall.

The non-contemporaneous influence of the risk-free rate on strategies, the *6x3* and *12x1* strategies demonstrated significant unidirectionality on the buy-sell strategy. The Granger causality tests (*Appendix E*) support the predictive power of the risk-free rate on these strategies. The negative coefficients suggest that an increase in the risk-free rate can lead to lower future returns, coinciding with the financial theory that a higher risk-free rate and hence higher discount rates decrease the value of assets. Comparably the risk-free rate was not significant across any strategies pre-2008. Given that the risk-free rate has been persistently low post-2008, this finding may reflect the changing dynamics of the risk-return relationship in the post-2008 period.

The growth rate of oil returns (WTI) influenced the strategies negatively with a six-month formation period. Strategies with *J=6* had several significant unidirectional lags, including lag 6 for strategy 12x1 (*Appendix D*). Furthermore, as detailed in *Appendix E*, WTI was shown to Granger-cause cross-sectional returns for holding periods ranging from three to twelve months. This finding is corroborated by the OLS results shown in *Table 4*, where negative coefficients significant at the 1% level were consistently observed for six and nine-month holding periods when the formation periods exceeded three months. These results underscore the role of energy prices in predicting future returns, signifying that an increase in oil prices could negatively impact stock prices and momentum returns.

Significant evidence of CPI lags was noted on the *12x1 (Appendix D)*. Given the absence of any corresponding lags of the buy-sell strategy influencing CPI, we infer the relationship to be unidirectional. This relationship is uniformly negative across all lags. Furthermore, there is an influence on strategies with extended formation periods, which suggests that CPI increases impact the underlying constituents with longer formation periods. Compared to pre-2008, CPI was less significant across strategies given a period. This could be due to more variation in inflation rates and implies an increasing effect on the risk-free, implicitly decreasing valuations and potentially momentum returns.

6. Conclusion

This thesis investigated the changing influence of selected macroeconomic variables on momentum returns, focusing on two specific subperiods, pre-and post the 2008 financial crisis. We examined the causal relationship between momentum returns and the economic variables, M2 money supply, risk-free rate, CPI, gold, and WTI, providing empirical evidence on the momentum anomaly in the evolving economic landscape.

Consistent with Jegadeesh & Titman's (1993) findings, our empirical results reaffirmed the effectiveness of momentum strategies before the 2008 financial crisis. However, in alignment with the observations by Berkin (2021), we document a significant decrease in momentum returns post-2008. This finding confirmed the alteration in the landscape of momentum strategies, with a considerable decline in their capacity to generate significant returns from S&P 500 constituents post-2008.

Our OLS regressions and VAR models unraveled a significant shift in the influence of the variables on momentum returns in the two subperiods. After the financial crises, simple OLS results documented that changes in gold, CPI, WTI, and M2 money supply had a significant causal relationship with the momentum returns. Post-2008, we found the influence of the risk-free rate to be weakened. VAR revealed that post-2008 M2, CPI, and WTI growth rates negatively impacted momentum returns significantly, with M2 notably exhibiting a more consistent negative influence than in the pre-crisis period. The Granger causality tests further solidified the causal relationship between these variables and momentum returns, consistently signifying the use of M2 and WTI lags as a tool for predicting future momentum returns.

By exploring the temporal variation in the influence of macroeconomic variables on momentum returns, this study fills a gap in understanding evolving momentum effect and its systematic dependencies. It is worth highlighting that this analysis offers practical implications for momentum investors who wish to adjust their strategies in response to changing economic conditions and for economists seeking a broader understanding of momentum dynamics concerning macroeconomic variables.

Our research confirms the initial hypothesis, establishing that there is indeed a change in the causal relationship between macroeconomic variables and momentum strategies in the pre-and post-2008 periods.

However, it is important to underline that while our study provides new evidence of causal relationships, there is still much to learn about the complex interaction between macroeconomic variables and momentum returns. We recommend further research into how post-2008 macroeconomic variables and cross-sectional momentum strategies interact across various sectors and sub-time periods. A sector-specific examination could offer nuanced insights into these dynamics. A detailed temporal analysis could provide a deeper understanding of momentum returns during high market volatility periods. These investigations could shed further light on the complexities of momentum strategies and their relationship with economic variables.

In conclusion, our findings underscore the influence of macroeconomic variables on momentum returns and their inherent change. This highlights the necessity for investors to continually reassess their investment strategies in light of shifting economic landscapes and opens the door for continued research into momentum dynamics.

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Appendix

Appendix A- Data Description

Appendix A shows the variable names and a description of the variable collected from Bloomberg and FRED.

Variable Name	Source	Description
PX_LAST	Bloomberg	Weekly End Prices on S&P 500
XAU:CUR	Bloomberg	Weekly End Prices on Gold
WM2NS	Federal Reserve Economic Database	Weekly M2 Money Supply. Not seasonally adjusted
TB3MS	Federal Reserve Economic Database	3-Month Treasury Bill Secondary Market Rate, Discount Basis, Percent, Monthly, Not Seasonally Adjusted.
CPIAUCNS	Federal Reserve Economic Database	Monthly Consumer Price Index. Not seasonally adjusted
WTISPLC	Federal Reserve Economic Database	Monthly Spot End Price, West Texas Intermediate. Not seasonally adjusted

Appendix B

Descriptive Statistics for JxK Strategies

					Simple Returns *JxK* Strategies					
	JxK Strategy	Observations	Mean	SD	Min	Median	Max	Skewness	Kurtosis
Pre	6x3	309	0.000065	0.0954	-0.4529	-0.0015	0.5512	0.5361	8.6734
Pre	6x6	297	0.000346	0.0692	-0.2739	0.0017	0.2911	-0.186	3.449
Pre	6x12	297	0.000253	0.0558	-0.2249	-0.0002	0.3584	0.9863	8.4573
Pre	9x1	309	0.000263	0.1143	-0.6546	0.0023	0.6085	0.0926	9.2127
Pre	12x1	297	0.000418	0.1066	-0.4816	0.0053	0.4915	-0.0926	4.9035
Post	6x3	170	0.000187	0.0886	-0.3606	0.0071	0.3894	0.1209	3.484
Post	6x6	170	-0.000036	0.0637	-0.2238	0.0018	0.2561	-0.0391	2.2603
Post	6x12	170	-0.000015	0.056	-0.2648	0.0006	0.2141	-0.263	4.9513
Post	9x1	170	-0.000248	0.0984	-0.3548	0.0014	0.3711	-0.1028	2.3591
Post	12x1	170	-0.000078	0.0983	-0.3993	-0.0015	0.4196	-0.242	3.8209

Appendix C

Vector Autoregressive results for equation buy-sell portfolios on strategies 9x1, 12x1, 6x3, 6x6, and 6x12 pre-November 2008. The variables presented are significant at the 5% level. The term "lag" is denoted by "L" followed by a number. For example, a lag of 2 is represented as "L2".

6x3

14 lags	coefficient	std.Error	t-stat	prob
L1.longshort	-1.1258	0.0719	-15.65	0
L1.m2	-3.3797	0.8972	-3.767	0
L2.longshort	-1.0318	0.1097	-9.41	0
L2.m2	-4.675	1.4741	-3.171	0.002
L2.cpi	-7.8305	2.9643	-2.642	0.008
L2.gold	0.4193	0.1643	2.551	0.011
L3.longshort	-0.9588	0.1306	-7.34	0
L3.gold	0.5253	0.2082	2.522	0.012
L4.longshort	-0.8522	0.1452	-5.867	0
L4.gold	0.6841	0.2433	2.811	0.005
L4.cpi	-7.1745	3.6517	-1.965	0.049
L5.longshort	-0.7279	0.1549	-4.701	0
L5.gold	0.7249	0.2726	2.659	0.008
L5.m2	-5.0854	2.2837	-2.227	0.026
L6.longshort	-0.6266	0.1588	-3.946	0
L6.m2	-5.5492	2.3897	-2.322	0.02
L7.longshort	-0.572	0.1613	-3.546	0
L7.m2	-5.5197	2.4375	-2.265	0.024
L8.longshort	-0.4775	0.1621	-2.946	0.003
L8.cpi	-9.9543	4.7335	-2.103	0.035
L9.longshort	-0.4074	0.1598	-2.55	0.011
L9.cpi	-10.6224	4.7754	-2.224	0.026
L10.cpi	-10.7722	4.8618	-2.216	0.027
L10.longshort	-0.3232	0.1546	-2.091	0.037
L11.cpi	-12.2717	4.8339	-2.539	0.011
L11.longshort	-0.3564	0.1474	-2.417	0.016
L12.cpi	-11.1986	4.6445	-2.411	0.016
L12.longshort	-0.3009	0.1387	-2.169	0.03

6x6

14 lags	coefficient	std.Error	t-stat	prob
L1.longshort	-0.832	0.0708	-11.745	0
L2.longshort	-0.6455	0.0912	-7.082	0
L2.cpi	-4.7949	2.3062	-2.079	0.038
L3.longshort	-0.5827	0.1004	-5.803	0
L4.longshort	-0.4396	0.1064	-4.13	0
L5.longshort	-0.425	0.1088	-3.907	0
L6.longshort	-0.4002	0.1087	-3.683	0
L7.longshort	-0.3308	0.1096	-3.017	0.003
L8.longshort	-0.3487	0.108	-3.23	0.001
L9.longshort	-0.3595	0.1063	-3.381	0.001
L10.longshort	-0.2437	0.1043	-2.337	0.019
L11.longshort	-0.2369	0.1011	-2.342	0.019
L12.longshort	-0.1923	0.0972	-1.978	0.048

6x12

16 lags	coefficient	std.Error	t-stat	prob
L1.longshort	-0.9767	0.0736	-13.27	0
L1.gold	0.222	0.0724	3.065	0.002
L2.longshort	-0.9394	0.1033	-9.095	0
L2.gold	0.3285	0.1023	3.21	0.001
L3.longshort	-0.8729	0.124	-7.04	0
L3.gold	0.3272	0.1297	2.523	0.012
L4.longshort	-0.7157	0.1388	-5.156	0
L4.gold	0.3211	0.1488	2.158	0.031
L5.longshort	-0.686	0.1474	-4.653	0
L5.gold	0.321	0.1623	1.977	0.048
L6.longshort	-0.536	0.156	-3.436	0.001
L7.longshort	-0.5045	0.1611	-3.132	0.002
L8.longshort	-0.3808	0.1633	-2.332	0.02
L13.longshort	-0.2617	0.1331	-1.965	0.049
L16.cpi	3.8226	1.5468	2.471	0.013

9x1

16 lags	coefficient	std.Error	t-stat	prob
L1.longshort	-1.0905	0.0725	-15.042	0
L1.m2	-3.5709	1.0771	-3.315	0.001
L1.gold	0.3051	0.1405	2.172	0.03
L2.longshort	-1.0073	0.1087	-9.27	0
L2.gold	0.606	0.2005	3.023	0.003
L2.m2	-4.3677	1.7442	-2.504	0.012
L2.cpi	-7.2159	3.5615	-2.026	0.043
L3.longshort	-0.9295	0.1303	-7.132	0
L3.gold	0.7503	0.2561	2.929	0.003
L4.longshort	-0.863	0.1468	-5.879	0
L4.gold	1.0152	0.3023	3.358	0.001
L4.cpi	-9.5378	4.3818	-2.177	0.03
L5.longshort	-0.7228	0.1589	-4.55	0
L5.gold	0.9876	0.3434	2.876	0.004
L5.cpi	-9.6171	4.835	-1.989	0.047
L6.longshort	-0.6118	0.1645	-3.718	0
L7.longshort	-0.5157	0.1687	-3.057	0.002
L8.cpi	-15.064	5.6788	-2.653	0.008
L8.longshort	-0.3911	0.1705	-2.294	0.022
L9.cpi	-14.5688	5.7616	-2.529	0.011
L9.WTI	0.3155	0.158	1.996	0.046
L10.cpi	-14.4901	5.8318	-2.485	0.013
L11.cpi	-17.3893	5.8082	-2.994	0.003
L11.WTI	0.3402	0.147	2.314	0.021
L12.cpi	-14.4539	5.6036	-2.579	0.01
L13.cpi	-11.0377	5.1199	-2.156	0.031
L13.WTI	0.2652	0.1308	2.027	0.043
L14.cpi	-9.8452	4.2908	-2.294	0.022
L15.WTI	0.2141	0.1027	2.085	0.037

12x1

14 lags	coefficient	std.Error	t-stat	prob
L1.longshort	-0.9475	0.0708	-13.38	0
L1.m2	-3.1691	1.0748	-2.948	0.003
L2.longshort	-0.8592	0.0972	-8.841	0
L2.m2	-3.6767	1.7475	-2.104	0.035
L3.longshort	-0.7601	0.1144	-6.642	0
L4.longshort	-0.6337	0.126	-5.031	0
L4.gold	0.695	0.2974	2.337	0.019
L5.longshort	-0.5837	0.1337	-4.367	0
L5.m2	-5.7897	2.5325	-2.286	0.022
L6.longshort	-0.4381	0.1382	-3.17	0.002
L6.m2	-5.9299	2.6933	-2.202	0.028
L7.longshort	-0.403	0.1365	-2.952	0.003
L8.longshort	-0.3854	0.135	-2.855	0.004
L9.longshort	-0.3302	0.1334	-2.476	0.013
L10.cpi	-9.7613	4.9399	-1.976	0.048
L11.cpi	-11.6071	4.5758	-2.537	0.011
L11.longshort	-0.2497	0.1191	-2.096	0.036
L14.WTI	-0.1581	0.0802	-1.972	0.049

Appendix D

Vector Autoregressive results for equation buy-sell portfolios on strategies 9x1, 12x1, 6x3, 6x6, and 6x12 post-November 2008. The variables presented are significant at the 5% level. The term "lag" is denoted by "L" followed by a number. For example, a lag of 2 is represented as "L2".

6x3

14 lags	coefficient	std. Error	t-stat	prob
L1.longshort	-0.9654	0.1216	-7.938	0
L2.longshort	-0.7025	0.1585	-4.432	0
L3.longshort	-0.5343	0.1692	-3.157	0.002
L4.longshort	-0.4272	0.1653	-2.585	0.01
L5.longshort	-0.4652	0.1698	-2.740	0.006
L6.longshort	-0.7391	0.1747	-4.231	0
L6.m2	-2.3312	1.1817	-1.973	0.049
L7.longshort	-0.7067	0.1875	-3.769	0
L7.m2	-2.6754	1.1790	-2.269	0.023
L7.WTI	-0.3165	0.1303	-2.429	0.015
L8.longshort	-0.4633	0.1886	-2.457	0.014
L8.rf	-0.0539	0.0254	-2.123	0.034
L8.m2	-2.9812	1.1520	-2.588	0.01
L8.WTI	-0.3902	0.1357	-2.875	0.004
L9.longshort	-0.3335	0.1684	-1.980	0.048
L9.rf	-0.0557	0.0257	-2.166	0.03
L9.m2	-2.5425	1.1429	-2.225	0.026
L9.WTI	-0.2807	0.1408	-1.994	0.046
L10.longshort	-0.3492	0.1567	-2.229	0.026
L10.m2	-3.7289	1.1240	-3.318	0.001
L11.rf	-0.0511	0.0247	-2.071	0.038
L11.m2	-2.9551	1.1590	-2.550	0.011
L12.m2	-2.2611	1.1030	-2.050	0.04
L13.rf	-0.0337	0.0172	-1.957	0.05

6x6

14 lags	coefficient	std. Error	t-stat	prob
L1.longshort	-0.8923	0.1219	-7.322	0.000
L1.rf	0.0359	0.0166	2.159	0.031
L2.longshort	-0.7546	0.1707	-4.421	0.000
L3.longshort	-0.6917	0.2058	-3.361	0.001
L4.longshort	-0.4515	0.2299	-1.964	0.050
L4.m2	-2.1723	1.1086	-1.96	0.050
L4.cpi	6.1960	2.8750	2.155	0.031
L5.cpi	7.2988	3.1797	2.295	0.022
L5.WTI	-0.2838	0.1231	-2.305	0.021
L6.cpi	6.8426	3.2336	2.116	0.034
L6.WTI	-0.3760	0.1276	-2.948	0.003
L7.m2	-2.4609	1.1562	-2.128	0.033
L8.m2	-2.7384	1.1468	-2.388	0.017
L9.m2	-3.5568	1.1269	-3.156	0.002
L9.WTI	-0.3783	0.1302	-2.905	0.004

6x12

14 lags	coefficient	std. Error	t-stat	prob
L1.longshort	-0.9745	0.1222	-7.973	0
L2.longshort	-0.6484	0.1623	-3.994	0
L3.longshort	-0.4528	0.1691	-2.678	0.007
L4.longshort	-0.3436	0.1610	-2.134	0.033
L5.longshort	-0.3905	0.1596	-2.447	0.014
L6.longshort	-0.7155	0.1614	-4.434	0
L6.WTI	-0.2619	0.0969	-2.703	0.007
L7.longshort	-0.6509	0.1735	-3.751	0
L7.m2	-1.8145	0.9179	-1.977	0.048
L7.WTI	-0.2027	0.0997	-2.034	0.042
L8.longshort	-0.3817	0.1730	-2.206	0.027
L8.m2	-2.6222	0.8974	-2.922	0.003
L8.WTI	-0.2616	0.1035	-2.528	0.011
L9.m2	-2.6767	0.9024	-2.966	0.003
L9.WTI	-0.2102	0.1057	-1.988	0.047
L10.longshort	-0.3673	0.1441	-2.550	0.011
L10.m2	-3.6939	0.8974	-4.116	0
L11.longshort	-0.3626	0.1558	-2.327	0.02
L11.m2	-2.7431	0.9572	-2.866	0.004
L12.longshort	-0.2993	0.1517	-1.973	0.049
L12.WTI	-0.1582	0.0769	-2.058	0.04

9x1

14 lags	coefficient	std. Error	t-stat	prob
L1.longshort	-1.0513	0.1193	-8.812	0
L2.longshort	-1.0274	0.1477	-6.956	0
L3.longshort	-1.0013	0.1701	-5.885	0
L4.longshort	-0.8822	0.1788	-4.934	0
L4.m2	-2.9173	1.4223	-2.051	0.04
L5.longshort	-0.7048	0.1908	-3.694	0
L5.rf	-0.0599	0.0302	-1.984	0.047
L6.m2	-4.4844	1.5189	-2.952	0.003
L7.m2	-5.2236	1.5512	-3.368	0.001
L8.m2	-5.5788	1.5651	-3.565	0
L9.m2	-4.0684	1.5587	-2.610	0.009
L12.longshort	-0.3238	0.1296	-2.497	0.013
L13.longshort	-0.3194	0.1085	-2.945	0.003
L13.m2	2.6070	1.2125	2.150	0.032

12x1				
14 lags	coefficient	std. Error	t-stat	prob
L1.longshort	-0.9946	0.1244	-7.997	0
L2.longshort	-0.9848	0.1617	-6.091	0
L2.rf	0.0524	0.0237	2.210	0.027
L3.longshort	-0.9804	0.1956	-5.013	0
L4.longshort	-0.8731	0.2110	-4.139	0
L4.m2	-3.2048	1.3623	-2.353	0.019
L5.longshort	-0.6632	0.2173	-3.053	0.002
L5.rf	-0.0572	0.0286	-2.003	0.045
L6.m2	-4.3539	1.4395	-3.025	0.002
L6.cpi	7.2993	3.6632	1.993	0.046
L6.WTI	-0.4142	0.1393	-2.974	0.003
L7.rf	-0.0708	0.0321	-2.205	0.027
L7.m2	-5.279	1.4717	-3.587	0
L8.rf	-0.0659	0.0325	-2.031	0.042
L8.m2	-5.8104	1.4978	-3.879	0
L9.rf	-0.0922	0.0316	-2.921	0.003
L9.m2	-5.5004	1.5031	-3.659	0
L10.rf	-0.0657	0.0312	-2.102	0.036
L10.m2	-3.7179	1.5167	-2.451	0.014
L11.cpi	-10.3226	4.3603	-2.367	0.018

Appendix E

Results from Granger-causality test for 9x1, 12x1, 6x3, 6x6 and 6x12 post 2008.

9x1	**Lags**	**F statistic**	**prob**
M2 Granger-causes longshort	14	2.334	0,004
CPI Granger-causes RF	14	2.030	0,015
WTI Granger-causes M2	14	2.138	0,009
WTI Granger-causes CPI	14	1.803	0,036
M2 Granger-causes GOLD	14	1.766	0,041
RF Granger-causes GOLD	14	2.273	0,005

12x1	**Lags**	**F statistic**	**prob**
M2 Granger-causes longshort	14	2.293	0,005
WTI Granger-causes longshort	14	3.146	0
CPI Granger-causes longshort	14	2.152	0,009
CPI Granger-causes RF	14	1.925	0,022
WTI Granger-causes M2	14	1.727	0,048
M2 Granger-causes GOLD	14	2.061	0,013
WTI Granger-causes GOLD	14	1.980	0,018
RF Granger-causes GOLD	14	2.303	0,005
CPI Granger-causes GOLD	14	1.749	0,044

6x3	Lags	F statistic	prob
M2 Granger-causes longshort	14	2.293	0,005
WTI Granger-causes longshort	14	3.146	0
CPI Granger-causes longshort	14	2.152	0,009
CPI Granger-causes RF	14	1.925	0,022
WTI Granger-causes M2	14	1.727	0,048
M2 Granger-causes GOLD	14	2.061	0,013
WTI Granger-causes GOLD	14	1.980	0,018
RF Granger-causes GOLD	14	2.303	0,005
CPI Granger-causes GOLD	14	1.749	0,044

6x6	Lags	F statistic	prob
WTI Granger-causes longshort	14	0.002	0,002
M2 Granger-causes RF	14	0.009	0,009
GOLD Granger-causes RF	14	0.041	0,041
CPI Granger-causes RF	14	0.043	0,043
WTI Granger-causes M2	14	0.013	0,013
M2 Granger-causes GOLD	14	0.029	0,029
WTI Granger-causes GOLD	14	0.003	0,003
RF Granger-causes GOLD	14	0.034	0,034
CPI Granger-causes GOLD	14	0.021	0,021

6x12	Lags	F statistic	prob
M2 Granger-causes longshort	14	2.010	0,016
WTI Granger-causes longshort	14	2.028	0,015
WTI Granger-causes M2	14	1.925	0,022
WTI Granger-causes CPI	14	2.186	0,008
longshort Granger-causes CPI	14	2.463	0,002
M2 Granger-causes GOLD	14	2.603	0,001
WTI Granger-causes GOLD	14	2.682	0,001
RF Granger-causes GOLD	14	2.307	0,005
CPI Granger-causes GOLD	14	1.844	0,031

Appendix F

Augmented Dickey-Fuller and KPSS results for 9x1, 12x1, 6x3, 6x6 and 6x12

	ΔNatural Logarithm of the variables			
	Pre 2008		Post 2008	
	ADF	KPSS	ADF	KPSS
9x1 Momentum	✓	✓	✓	×
Risk Free (RF)	×	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	×	✓	×
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

	Δ of the ΔNatural Logarithm of the variables			
	Pre 2008		Post 2008	
	ADF	KPSS	ADF	KPSS
9x1 Momentum	✓	✓	✓	✓
Risk Free (RF)	✓	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	✓	✓	✓
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

	ΔNatural Logarithm of the variables			
	Pre 2008		Post 2008	
	ADF	KPSS	ADF	KPSS
6x3 Momentum	✓	✓	✓	✓
Risk Free (RF)	×	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	×	✓	×
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

	Δ of the ΔNatural Logarithm of the variables			
	Pre 2008		Post 2008	
	ADF	KPSS	ADF	KPSS
6x3 Momentum	✓	✓	✓	✓
Risk Free (RF)	✓	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	✓	✓	✓
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

ΔNatural Logarithm of the variables

	Pre 2008		Post 2008	
	ADF	**KPSS**	**ADF**	**KPSS**
12x1 Momentum	✓	✓	✓	✓
Risk Free (RF)	✕	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	✕	✓	✕
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

Δ of the ΔNatural Logarithm of the variables

	Pre 2008		Post 2008	
	ADF	**KPSS**	**ADF**	**KPSS**
12x1 Momentum	✓	✓	✓	✓
Risk Free (RF)	✓	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	✓	✓	✓
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

ΔNatural Logarithm of the variables

	Pre 2008		Post 2008	
	ADF	**KPSS**	**ADF**	**KPSS**
6x6 Momentum	✓	✓	✓	✓
Risk Free (RF)	✕	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	✕	✓	✕
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

Δ of the ΔNatural Logarithm of the variables

	Pre 2008		Post 2008	
	ADF	**KPSS**	**ADF**	**KPSS**
6x6 Momentum	✓	✓	✓	✓
Risk Free (RF)	✓	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	✓	✓	✓
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

ΔNatural Logarithm of the variables

	Pre 2008		Post 2008	
	ADF	**KPSS**	**ADF**	**KPSS**
6x12 Momentum	✓	✓	✓	✓
Risk Free (RF)	✕	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	✕	✓	✕
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓

Δ of the ΔNatural Logarithm of the variables

	Pre 2008		Post 2008	
	ADF	**KPSS**	**ADF**	**KPSS**
6x12 Momentum	✓	✓	✓	✓
Risk Free (RF)	✓	✓	✓	✓
M2 USA	✓	✓	✓	✓
CPI	✓	✓	✓	✓
Gold	✓	✓	✓	✓
WTI	✓	✓	✓	✓