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# Does market sentiment influence time-series momentum strategies: Examining Western equity indices and other sets of asset classes

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# Abstract

This thesis aims to shed further light on the impact of sentiment on both time-series momentum and cross-sectional momentum in which the main focus of this thesis is on time-series momentum. Literature of Moskowitz et al (2012) and Asness et al (2013) are used as a source for the formation of portfolios and to calculate time-series momentum returns as well as cross-sectional momentum returns. The results show that sentiment is not able to explain time-series momentum returns for the non-stock asset classes which is in line with the results found by Moskowitz et al (2012). However, some results are found for five time-series momentum portfolios based on individual Western country equity indices suggesting that sentiment has more impact on less diversified portfolios. The main conclusion of the empirical results is that sentiment does not influence time-series momentum returns.



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**JEL Classifications:** G12, G14, G15

# Content

# I. Introduction

The aim of this research is to find a relation between momentum strategies and market sentiment. The main goal of this research is to examine whether market sentiment is able to explain time-series momentum returns. This relation will be investigated in five Western equity indices, namely in Germany, France, the Netherlands, the United Kingdom, the United States, and in addition on four other asset classes.

Moskowitz et al (2012) examined time-series momentum which is explained as a different asset pricing anomaly than the traditional 'momentum' effect found in a cross-section of individual stock returns. But according to the findings of Moskowitz et al (2012), time-series momentum (TSmom) is significantly related to cross-sectional momentum (CSmom), with a correlation of 0.66, t-statistic of 15.17, and $R^2$ of 44%. Moskowitz shows that time-series momentum is not fully captured by cross-sectional momentum due to a significant and positive alpha of 0.76%.

This examination focuses on a relative new, and ambiguous area of financial economics known as time-series momentum in which the relationship with behavioural aspects will be discussed. Investor sentiment is examined to see whether time-series momentum returns affects asset pricing for a wide range of assets. In addition to the examination of time-series momentum the traditional momentum (cross-sectional momentum) will be examined as well to complement the subject. The main objective of this thesis is to investigate whether time-series momentum depends on market sentiment. The relation of sentiment and time-series momentum, and cross-sectional momentum, respectively are examined with the same dataset for all asset classes using two different sentiment proxies.

This thesis provides insight into the effect of different states of sentiment on time-series momentum returns. Subsequently, different sentiment proxies are incorporated in this thesis to see whether time-series momentum returns are influenced. Moreover, a distinction is made between a diversified momentum portfolio for the overall global equity index as used in Moskowitz et al (2012) and individual self-contained equity indices of Western countries.[1] The relation of sentiment for time-series momentum is thus examined for five selected Western countries indices and four other set of assets which are examined by Moskowitz et al (2012). The same four assets classes are used by Asness et al (2013) to examine the effect of sentiment on "non-stock assets" at the cross-sectional momentum level.

[1] The set-up of this thesis provides the reader insight in the impact of market sentiment on a time-series momentum strategy of a single equity index and on a diversified time-series momentum global equity index. The diversified global equity index is classified as other asset class. All other assets classes which are based on Moskowitz et al (2012) are diversified portfolios.

Cross-sectional momentum and its relation with market sentiment has been examined in many previous studies. Examples of prominent literature in this field of research are Baker and Wurgler (2006), Stambaugh et al (2012), Baker et al (2012), Antoniou et al (2013) and Cooper et al (2004). The striking findings of the described literature indicate a positive relation between cross-sectional momentum and stock market sentiment. As an extension in this research, the potential relation between cross-sectional momentum and sentiment is examined for "non-stock assets" to the example of Asness et al (2013). Moreover, following the example of Stambaugh et al (2012) the relation of sentiment regarding the long-leg and short-leg of cross-sectional momentum will be investigated. Cross-sectional momentum is tested only at the "non-stock assets" or four other sets of assets, because there are many studies who examine stock market sentiment in relation with cross-sectional momentum. The four other sets of assets which are based on Asness et al (2013) are global equity indices, currencies, fixed income, and commodities.

To construct a thorough foundation for the research question four hypotheses are formed which will be described hereinafter. The first hypothesis predicts that the relation between time-series momentum and sentiment is positive, and moreover that momentum returns are higher in optimistic states of the market. Existing literature regarding momentum and the impact of sentiment on returns in different states of the market is solely examined on cross-sectional momentum. Antoniou et al (2013) consider whether sentiment affects the profitability of momentum strategies, and therefore investigate the relationship between price momentum and sentiment. The empirical results of Antoniou et al (2013) indicate that momentum profits are significant only when investors are optimistic, the $6^{th}$-month momentum strategy yields significant profits of 2.00% per month.

Other examples of leading literature in this subject is Cooper et al (2004) which test the short-run overreaction and long-run reversal in the cross-section of stock returns. Cooper et al (2004) find empirical evidence that up-states of the market has a positive influence on cross-sectional momentum returns. The relation between anomalies and sentiment is examined by Stambaugh et al (2012) at the cross-sectional level of stocks returns, showing empirical evidence that a long-short strategy is more profitable following high levels of sentiment. With high levels of sentiment the momentum return is 2.03% per month, while following low levels of sentiment it is only 1.09% per month.

In order to test all hypotheses this research uses two sentiment proxies, a so-called alternative proxy and a reference proxy. The idea for the alternative proxy for investor sentiment is based on Antoniou et al (2013). The alternative proxy is built with the help of the Consumer Confidence Index (CCI) which is taken from OECD Data. The proxy for investor sentiment as constructed by Baker and Wurgler (2006) is used as a reference proxy and often used in other literature. To verify whether time-series momentum is affected by the state of sentiment three dummy variables are formed for each proxy, namely optimistic, mild, and pessimistic. The alternative developed sentiment proxy as well as the

reference proxy of Baker and Wurgler (2006) are then further tested to verify whether time-series momentum returns differ in each state of sentiment.

Hypothesis 1: *An optimistic state of sentiment is followed by higher time-series momentum profits than a pessimistic state*

Baker and Wurgler (2006) and Stambaugh et al (2012) focused on cross-sectional momentum on individual stocks, while using different underlying behavioural concepts and market imperfections to explain the relation of cross-sectional momentum and sentiment. Baker and Wurgler (2006) used the underlying behavioural concept whereby the investigated stocks are "hard to value and hard to arbitrage". However, classical finance theory leaves no role for investor sentiment in asset pricing (Baker and Wurgler, 2006). Classical finance theory argues rational investors will reach an equilibrium in which the cross-section of expected returns will solely vary with systematic risk. Baker and Wurgler (2006) study and others show that mispricing in markets can occur and anomalies such as momentum strategies can persist. These results are inconsistent with the classical finance theory, hence the efficient market hypothesis (EMH) as described by Fama (1970), which states that mispricing in markets will be identified and exploited by rational traders.

Next to Baker and Wurgler (2006) another example is the study of Stambaugh et al (2012), in which the sentiment proxy from Baker and Wurgler is used combined with the concept of "short-selling restrictions", imposing restrictions on investor portfolios as previously mentioned. Evidence from Stambaugh et al (2012) suggest that rational traders are not able to exploit overpricing due to limitations on short-selling. Moskowitz et al (2012) argue that time-series momentum plays a prominent role to match predictions of behavioural and rational asset pricing theories. In order to support this statement Moskowitz et al (2012) provide their finding of positive time-series momentum, which partially reverses over the long term, with initial under-reaction and delayed over-reaction.

In this research an alternative proxy based on the idea of Antoniou et al (2013) is constructed in order to examine another behavioural explanation for the link between sentiment and momentum profits, namely overconfidence, and thus the underlying behavioural concept of "investor overconfidence" is also examined. Baker and Wurgler (2006) and Stambaugh et al (2012) both use the argument that overpricing should be more prevalent than underpricing combined with sentiment. Following these examples, this thesis also focuses whether consumer confidence in the form of overconfidence is represented in market-wide sentiment. The concept of overconfidence has been applied many times in finance in other contexts; Chuang and Lee (2006) give a thorough overview of the theory and findings regarding overconfidence.

In sum, the explanations for why the two sentiment proxies can explain stock returns are each based on different underlying behavioural concepts and market imperfections. The performance of the sentiment proxies are compared to verify which one can best explain time-series momentum for equity

indices and other sets of asset classes. Moreover, using two alternative sentiment proxies will strengthen the overall conclusion regarding the relation of time-series momentum and sentiment for all investigated assets. Likewise, it will be done in order to see whether differences in composition of sentiment proxies have an effect on the statistical results in terms of significance and magnitude. Until now, the study of Baker et al (2012) is among the few papers who examined the (de)composition of investor sentiment.

Hypothesis 2: *Both sentiment proxies, motivated by different underlying behavioural concepts and market imperfections, can explain time-series momentum profits*

After examining the impact of different states of sentiment and the composition of proxies with different underlying behavioural concepts on time-series momentum, the thesis will investigate differences in momentum profits, and in relation with sentiment, among multiple assets classes. At first, risk factors are taken into account in order to determine whether these factors can explain momentum profits. The expectation of regressing Fama and French (1992) risk factors on cross-sectional momentum and time-series momentum is that significant results are absent. In previous studies these factors cannot explain cross-sectional momentum profits (Fama and French, 2012). The expectation regarding the relation of sentiment and all assets classes is that Western equity indices and the global equity index generate higher momentum profits than other asset classes. This expectation is based on the fact these two type of assets are relatively easier accessible for all investors, and especially unsophisticated individual investors. Due to easy access I expect that investor sentiment plays a greater role in driving Western stocks and equity indices rather than commodity future markets, for instance. Hence, investors who are relatively more rational than other investors do have the opportunity to exploit this and thus achieve higher momentum profits.

Empirical evidence regarding anomalies and investor sentiment is found in the paper of Baker et al (2012) and Garcia (2013). Together with empirical findings of this research a broad supported conclusion is presented about the relationship of investor sentiment and time-series momentum on both stock level 'Western markets' as the non-stock assets. Moskowitz et al (2012) fail to find a relation between time series momentum and measures of investor sentiment constituted out of existing literature of Baker and Wurgler (2006), and Qiu and Welch (2006) for the non-stock assets.

Hypothesis 3: *The positive effect of sentiment on time-series momentum profits is expected to be stronger in stock markets compared to other sets of asset classes*

Previous literature examining time-series momentum such as Moskowitz et al (2012) solely take into account long-short momentum profits and sentiment. Stambaugh et al (2012) is among the few who examined the short-leg and long-leg separately in combination with sentiment for cross-sectional momentum. This relation is only examined at the cross-sectional momentum level, due to the fact it is not possible to examine at time-series momentum level. Firstly, Stambaugh et al (2012) found empirical evidence of a more profitable short-leg for momentum strategies following a high level of sentiment.

When sentiment is high the short-leg momentum returns drop significantly with -1.24%, which is good for investors since they 'borrowed' assets to go short and have to pay back the assets for a lower price. Secondly, sentiment exhibits no relation to long-leg momentum returns. Stambaugh et al (2012) investigated these relations for individual stocks on the cross-sectional level with the underlying concept of short-selling restrictions. This thesis will replicate parts of Stambaugh et al (2012) with the cross-sectional momentum portfolio data of Asness et al (2013).

Hypothesis 4: *The short-leg time-series momentum profits should be higher in an optimistic state of sentiment than in a pessimistic state*

Altogether the main research question can thus be defined as: *Does investor sentiment influence time-series momentum in Western equity markets and other sets of asset classes?*

In general, this thesis main focus is solely on the relation between time-series momentum and proxies of sentiment. The relationship between time-series and cross-sectional momentum and their underlying drivers will not be investigated due to several meaningful findings of respected researchers in the field of financial economics.[2] This research is relevant for multiple reasons. Firstly, different states of sentiment are regressed on time-series momentum to verify whether different states of sentiment affect the magnitude and significance of momentum returns. Previous literature of Moskowitz et al (2012) examined this relation solely with the Baker and Wurgler index. This research extends the evidence to time-series momentum and multiple assets.

Secondly, multiple underlying behavioural concepts and market imperfections are reflected in the sentiment proxies used in this research. Using two different sentiment proxies provides insight whether differences in the constitution of sentiment proxies have influence on time-series momentum profits. The forming of an alternative proxy combined with the use of a reference proxy regressed on the same data is increasing the usefulness of this research and a contribution to existing literature. In others words, this research helps to determine whether behavioural concepts and market imperfections such as hard to value and hard to arbitrage stocks, short-selling restrictions, and overconfidence are reflected in investor sentiment. Thirdly, this thesis will provide findings for both the Western equity indices as well as other asset classes. Thereby, it is possible to compare results within Western equity indices and non-stock assets, which is valuable since most literature regarding this subject examined stock markets, equity indices or other sets of asset classes separately. The dataset used is from the period

[2] To understand the relationship between cross-sectional momentum and time-series momentum, decomposing of momentum returns is required in order to identify underlying drivers as Moskowitz (2012) described. To obtain the underlying drivers Moskowitz (2012) used the framework of Lo and MacKinlay (1990) and Lewellen (2002). Both papers contributed to the understanding of the underlying drivers of cross-sectional momentum and time-series momentum. See Section II for more background information.

01-1972 till 12-2010[3]. The same period of data is used as in Moskowitz et (2012) in order to compare the results of the non-asset classes with the Western equity markets. Fourthly, the short-leg and long-leg are investigated next to the long-short momentum strategy for all asset classes at the cross-sectional level as well.

The results of the hypothesis are not as expected, however striking results are found. The first hypothesis is the only hypothesis which is accepted, while the other three hypotheses are rejected. This means that can be concluded that the optimistic (OPT) state generate higher time-series momentum returns than the pessimistic (PESS) state. The results regarding the main research question are in line with the results found by Moskowitz et al (2012) that there is no relation of sentiment on time-series momentum for non-stock assets classes. Although, there are some results for the five Western Equity Indices portfolios. In general, the main conclusion of this thesis is that market sentiment does not influence time-series momentum strategies.

The remainder of this paper is organised as follows. Section II reviews the previous literature in the field of momentum and investor sentiment. Additionally, in that section the aim is to provide the reader with relevant information regarding time-series momentum, and its relation with cross sectional momentum. Besides, prominent literature which contributed to investor sentiment models and proxies are discussed as well. Section III outlines the data and methodology used in this study. Section IV will present the results of time-series momentum whereby the underlying relation with investor sentiment proxies between various asset classes and the Western equity markets will be shown. Section V concludes and discusses the results of this paper, and also includes recommendations for further research.

# II. Literature

In this section the main literature on time-series momentum (TSmom), a review of cross-sectional momentum (CSmom), and the existing literature on the role of investor sentiment is presented. The existing knowledge and limitations in this field of research are described by giving a thorough overview of the developments of research in momentum strategies in the past. Also, the latest development is described in which researchers try to find a relation between time-series momentum and measures of investor sentiment.

[3] The beginning period of commodities is 01-1972. The beginning period of other classes differs which is in line with the methodology used in Asness et al (2013). The data used of Moskowitz et al (2012) ranges from 01-1985 to 12-2010. See Section III.A for a more detailed description.

## II.A Time-series momentum

Time-series momentum is a relative new anomaly in the field of financial economics. Moskowitz et al (2012) find time-series momentum in equity indices, currencies, commodities and bond futures. As previously mentioned in the introduction, Moskowitz et al (2012) could not find a relation between time-series momentum and the Baker and Wurgler sentiment index for non-stock assets. A brief summary of the main conclusions of Moskowitz et al (2012) is presented hereinafter.[4]

The definition of time-series momentum is that a security's past return predicts its future return. The difference with cross-sectional momentum is that time-series momentum looks at the signs of returns of previous months for one specific asset, while cross-sectional momentum ranks multiple assets in deciles based on their returns in order to perform a momentum strategy. The motivation to investigate time-series momentum is based on three subjects following Moskowitz et al (2012). Firstly, time-series momentum is a direct test of the random walk hypothesis, which basically implies that knowing that whether a price went up or down in the past, should not be informative for predicting returns in the future. Secondly, it is a most direct test of continuation and delayed reversal theories, since both behavioural and rational theories are about absolute returns, not relative returns. Thirdly, time-series momentum can be analysed globally for all asset classes which are stocks, currencies, commodities, and bonds. Examining time-series momentum has therefore an advantage, because not only general return patterns that apply to stocks are challenged, such as under-reaction and over-reaction, for instance.

The main result of Moskowitz et al (2012) indicate that time-series momentum is a strong predictor for equity, currency, commodity and bond futures. Moreover, the results prove that time-series momentum is different from standard cross-sectional momentum. Additionally, time-series momentum could not be explained by standard risk factors, crash risk or transaction costs. There are still large abnormal time-series momentum returns even when the Fama and French risk factors are taken into account. Crash risk is not an explanation due to good performance of time-series momentum strategies in extreme markets. Evidence point into the direction of initial under-reaction and delayed over-reaction, which is consistent with sentiment theories, and hedging pressure as explanations for time-series momentum. Moskowitz et al (2012) find that speculators profit from time-series momentum strategies at the expense of hedgers.

The simple 12-month time-series momentum trading strategy of Moskowitz et al (2012) suggest that investors take a long position if the excess return over the past twelve months was positive or a short position whether the return is negative. Moskowitz et al (2012) apply this strategy in which the position of the ex-ante volatility is rescaled to 0.40%. The performance of the diversified time-series

[4] Next to the paper of Moskowitz et al (2012), I use their presentation which summarizes the main conclusions of the paper which is obtained from: http://pages.stern.nyu.edu/~lpederse/papers/TSMOM_Slides.pdf.

momentum strategy shows evidence of a highly significant alpha, hence abnormal momentum profits. Empirical results provide evidence for significant performance of time-series momentum strategies with different look-back and holding periods in each asset class. Moreover, cross-sectional momentum seems to explain part of the time-series momentum strategy. However, there remains a positive and significant alpha of 0.66% with a t-statistic of 5.64 and a $R^2$ of 45%, after controlling for cross-sectional momentum.

Moskowitz et al (2012) started by looking at each asset class separately, which are the portfolios of commodities, currencies, equity indices, and fixed income and then pool the assets together into a diversified TSmom portfolio. The 12-month time-series momentum strategy with a holding period of 1-month is applied throughout the research of Moskowitz et al (2012). To set-up this strategy each position, long or short respectively, is sized in such a way it had an ex-ante annualized volatility of 40%. The reason a 40% ex-ante volatility is chosen is to make the position's risk comparable to the risk of an average individual stock. Moreover, after adding several individual momentum positions into a portfolio, the overall diversified TSmom factor has an annualized volatility of approximately 12%. The level of volatility exhibited by other factors, for instance Fama and French factors, is roughly the same. The position size is thus chosen to be 40% divided $\sigma_{t-1}$ whereby the ex-ante volatility is estimated with a simple univariate GARCH model. To ensure no-look-ahead bias contaminates the results the volatility estimates at $t_{-1}$ are applied to form portfolios at time *t*.

The ex-ante annualized variance for each instrument is calculated to determine the ex-ante volatility. Moskowitz et al (2012) compute the annualized variance as follows:

$$\sigma_t^2 = 261 * \sum_{i=0}^{\infty} (1-\delta)\, \delta^i\, (r_{t-1-i} - \overline{r}_t\ )^2$$

The factor 261 scales the variances to be annual, the weights $(1-\delta)\delta^i$ sums up to 1, and $\overline{r}_t$ is the exponentially weighted average return. The parameter $\delta$ is by Moskowitz et al (2012) set so that the center of the mass of the weights is $\sum_{i=0}^{\infty}(1-\delta)\,\delta^i = \frac{\delta}{\delta-1} = 60$ days.

The return on the TSmom strategy for any instrument *s* is formulated by Moskowitz et al (2012) as:

$$r_{t,t+1}^{TSMOM,s} = sign(r_{t-12,t}^{s}) \frac{40\%}{\sigma_t^2} r_{t,t+1}^{s}$$

With the help of the returns of any instrument *s* the return on the TSmom strategy for the overall aggregate and the four asset classes aggregates, which are commodities, currencies, equity index, and bond futures that are diversified across the $S_t$ securities available at time *t*, is as follows:

$$r_{t,t+1}^{TSMOM} = \frac{1}{S_t} \sum_{s=1}^{S_t} sign(r_{t-12,t}^{s}) \frac{40\%}{\sigma_t^2} r_{t,t+1}^{s}$$

Furthemore, Moskowitz et al (2012) decompose time-series momentum and cross-sectional momentum in order to understand the relation between time-series momentum and cross-sectional momentum. Moskowitz et al (2012) examine the underlying drivers of both momentum strategies. Cross-sectional momentum, expected returns, are decomposed following Lo and MacKinlay (1990) and Lewellen (2002) into auto-covariance, cross-variance, and the mean effect. The decomposition of time-series momentum is quite similar, there are two components, auto-covariance and the mean square effect. The decomposition shows that the auto-covariance, the own past 12-months return which co-varies with next month return, explains most of the returns for both cross-sectional and time-series momentum for most asset classes. Similar to Lewellen (2002) auto-covariance plays a major part as driver of momentum returns. This research does not focus on underlying drivers of momentum, but rather focusses on time-series momentum strategies with different underlying behavioural concepts, or as Moskowitz et al (2012) calls it, theories of sentiment.[5]

## II.B Cross-sectional momentum

Nowadays, many trading strategies based on past returns are proposed due to the discovery of possible return predictability in the literature and by market participants. Returns appear to be predictable enabling investors to select relatively attractive stocks or assets with positive abnormal expected returns (alpha). For example, a well-known strategy of investors is the momentum strategy in which investors invest solely into past winners with relatively high expected abnormal returns taking a long position, while taking a short position in past losers, stocks or assets with relatively low expected abnormal returns. In fact, momentum strategies are the opposite of contrarian strategies whereby investors purchase prior losers and sell prior winners in order to achieve an abnormal return.

These types of strategies can be distinguished into two categories. Firstly, there is return continuation or momentum, and secondly there is return reversal. The momentum effect is observed in the short to medium-run. Stocks that outperformed (underperformed) over a horizon of 6 to 12 months will continue to perform well (poor) in the future. Empirical evidence of Jegadeesh and Titman (1993) shows an average return of approximately 1% per month for the following 3 to 12 months. The academic literature nowadays often employs a 12-month momentum strategy, which looks at returns over the trailing 12-month period excluding the most recent month to form momentum portfolios. Further, the holding period for the portfolios is typically 1 month recently. An example can be found in Gong (2015) in which for comparison between the intermediate past momentum strategy (12 to 7 months) and the recent past momentum strategy (6 to 2 months) the holding period is fixed at one month. The returns of

[5] See Appendix A Table 1 which presents related literature, the difference in approach, and the main focus of this thesis.

the past horizon from 12 to 7 months ($MOM_{12, 7)}$ and 11 to 7 months ($MOM_{11, 7)}$ are compared showing in both cases significant momentum profits. Cross-sectional momentum could thus be explained as a security's outperformance relative to peers that predicts future relative outperformance.

Extreme returns tend to reverse in the long-run over a period of 3 to 5 years. De Bondt and Thaler (1985) found the reversal effect by employing the so-called contrarian strategy to realize a positive abnormal return. De Bondt and Thaler (1985) find that prior 3-year losers outperform prior winners in the next 36 months. Thereafter, Jegadeesh and Titman (1993)[6] support the empirical findings of De Bondt and Thaler (1985) for the reversal effect and extended with the examination of the momentum effect. Jegadeesh and Titman (2001) find an average negative return for 13 to 60-month momentum strategies. De Bondt and Thaler (1985) explain the abnormal return of this contrarian strategy as stock market overreaction. However, a consensus about the interpretation of the abnormal return has not been reached yet in academic literature.

Risk and the size effect are examples of often used explanations and examined by Chan (1988) and Zarowin (1990). A few years after these results, Chopra et al (1992) did not find the size effect as an explanation, based on an insignificant overreaction at the biggest 20 percent companies in their sample. After long term abnormal returns from contrarian strategies were found, research began to focus on returns on the short term, hence momentum strategies. Jegadeesh (1990) puts forward three possible explanations for the abnormal return of momentum strategies or contrarian strategies on a short term basis.

The first one of those being a size-based risk adjustment. For instance, Banz (1981) suggests that the market model does not adequately adjusts for certain size-related risk. The second explanation is provided by time-varying market risk. Chan (1988) hypothesizes that the expected market returns are different over the different three-year holding periods of the portfolios formed, based on the paper of De Bondt and Thaler (1985), and hence estimates the betas separately over each holding period. Jegadeesh (1990) does not support this hypothesis. Fama and French (1998) did not test their three-factor model with respect to this short-term phenomenon, hence momentum strategies. The bid-ask spread and thin trading are used as a third explanation. Ball, Kothari and Wasley (1995) describe the bid-ask bias for profits of contrarian investment strategies. They point out that simulated contrarian portfolios tend to buy at bid and short at ask, which is not implementable for most investors. Their results suggests the bias in estimated contrarian portfolio returns is severe. When the bias is removed, the

[6] Jegadeesh and Titman (2001) have found empirical results that cross-sectional differences in expected return explain almost none of the momentum profits. Additionally, Jegadeesh and Titman (2001) looked at serial covariance of factor returns and lead-lag effects, which both not contribute to momentum profits. In other literature of Jegadeesh and Titman (2002) the determinants of cross-sectional and time-series momentum returns are examined. In short, momentum profits are attributable to time-series dependence in returns.

apparent short-term profitability of contrarian trading largely disappears. The foregoing indicates that it is very difficult to explain the observed momentum profits with a risk based model.

Thereafter, many research studies were conducted in the area of cross-sectional momentum strategies. Chan et al (1996) documented momentum and try to explain momentum strategies via under-reaction, while Jegadeesh and Titman (1993) suggest that the interpretation of De Bondt and Thaler (1985) in which prices overreact to information is still being debated. The debated explanations for momentum vary from time-varying expected returns to behavioural explanations on market frictions and investor psychology as documented by Hong and Stein (1999) and Daniel et al (1998). Therefore, researches have turned to behavioral models to explain momentum (Jedadeesh and Titman, 2001).[7]

Broadly supported way to form momentum portfolios is described first by Jegadeesh and Titman (1993) and then reexamined for a slightly different sample by Jedadeesh and Titman (2001). This is done to ensure that the results are not driven primarily by small or illiquid stocks or by bid-ask bounce. Therefore, small and low priced stocks are excluded. Most studies follow the methodology of Jegadeesh and Titman (1993) and therefore rank at the end of each month the stocks on their past six months returns, which can be seen as month $t_{-5}$ to month $t_0$ and then group the stocks into 10 equally weighted portfolios based on these ranks. Thereafter, the portfolios are held for six months, respectively month $t_1$ to month $t_6$ following the ranking period. The post-holding period is from month $t_{13}$ to month $t_{60}$. Often to increase the power of the test for momentum overlapping portfolios are constructed. In overlapping portfolios of a random momentum decile portfolio in any particular month holds stocks ranked in that decile in any of the previous six ranking periods in which each monthly cohort is assigned an equal weight in this particular portfolio (Jegadeesh and Titman, 2001).

Cross-sectional momentum strategies are then further examined for other assets than solely stocks. An enumeration of further research is presented hereinafter. Liew and Vassalou (2000) are one of the numerous researchers who find momentum in the US equity market. Rouwenhorst (1998) and Fama and French (2012) examined momentum in equity markets in other countries than the US, mostly Western equity markets. Next to momentum in equity markets empirical evidence is found in other areas. Cross-sectional momentum in industries are documented by Moskowitz and Grinblatt (1999). Cross-sectional momentum is also found in equity indexes (Bhojraj and Swaminathan, 2006). Moreover, it is found in currencies by Shleifer and Summers (1990), in commodities by Erb and Harvey (2006) and Gorton et al (2008), and finally for global bond futures (Asness et al, 2013).

[7] See Sections II.D and II.E for more information regarding momentum returns and behavioural explanations for momentum.

## II.C Sentiment measures

Market sentiment can be described as a 'state of mind' of the current thoughts of investors which can either be positive when investors are speculative or negative when investors are conservative during periods. In the literature there is no common definition of sentiment. DeLong (1990) defines sentiment as the difference between the beliefs of sentiment-driven traders and correct beliefs conditional on the available information. Another definition of investor sentiment is the propensity to speculate. In other words, sentiment drives the relative demand for speculative investments, which causes cross-sectional effects, despite of the fact that arbitrage forces are the same across stocks (Baker and Wurgler, 2006). Hence, Baker and Wurgler (2006) suggest that the main factor of sentiment is the subjectivity of investor valuations. On the other hand, investor sentiment can also be defined as optimism or pessimism about stocks in general. This definition of sentiment implicitly says that random waves of sentiment affect the cross-section only whenever arbitrage forces are relatively weaker in a subset of stocks (Baker and Wurgler, 2006).[8] Following the example of Baker and Wurgler (2006), Baker et al (2012) argue that market investors include a common time-varying sentiment component which has market-wide effects on equity prices. To strengthen their sentiment definition, Baker et al (2012) use the market imperfection of short-selling restrictions mentioned by Miller (1977), who suggests that short-selling limits the ability of investors to exploit overpricing.

A broader defined definition of sentiment refers to whether an individual feels excessively optimistic or pessimistic about a situation (Antoniou et al, 2013). The empirical findings of Antoniou et al (2013) indicate that people with positive (negative) sentiment make optimistic (pessimistic) choices and judgements (Bower, 1981). Numerous studies exhibit that individual's current sentiment affects the judgement of future events (Johnson and Tversky, 1983). Thus, sentiment from all individual investors is reflected in market-wide sentiment. In this research market-wide sentiment is examined and no further distinction is made between local and global sentiment as described in Baker et al (2012).[9]

Investor sentiment is not directly observable, and therefore sentiment proxies are applied in the literature. How investor sentiment is typically measured in the literature depends on the definition of sentiment. Prior work suggest to use a number of proxies for sentiment. For example, Baker and Wurgler (2006) construct a sentiment index based on six underlying proxies for sentiment. Baker and Wurgler includes the dividend premium, closed-end fund discount, NYSE turnover, the equity share in total new issues and the number and the first day returns of IPO's into their sentiment index. These six underlying

[8] See Aghion and Stein (2004) of how investors interpret sentiment. In the developed model of Aghion and Stein (2004) investors with both rational expectations or bounded rationality periodically emphasize growth over profitability.

[9] A selection of studies committing to market-wide sentiment include DeLong et al (1990), Lee et al (1991), Barberis et al (1998), Shiller (2000), Brown and Cliff (2005), Baker and Wurgler (2006), Frazzini and Lamont (2008), Yu and Yuan (2011), Baker et al (2012), and Antoniou et al (2013).

proxies for sentiment all measure subjectivity in investor valuations. There are other variables that one could include in a sentiment index, for instance, insider trading (Baker and Wurgler, 2006).[10]

Antoniou et al (2013) measure sentiment differently and indicate whether investors are relatively optimistic or pessimistic in the formation period in order to test whether sentiment in each state generates equivalent momentum profits. Antoniou et al (2013) measures sentiment using the residuals of a regression of Consumer Confidence which is measured by the Confidence Board (CB), and the Chicago Fed National Activity Index (CFNAI).

Furthermore, there are private investors and institutional investors, and both types of investors can be sentiment-driven. Kumar and Lee (2006) have done research to interpret systematic factors in transactions of individual investors which are consistent with the influence of sentiment. Institutional investors on the other hand can participate in sentiment-driven trading as well (Stambaugh et al, 2012). As one knows from classical finance theory there is no role for investor sentiment in asset pricing (Baker and Wurgler, 2006). In short, the classical finance theory argues that competition among rational investors will lead to an equilibrium price that accurately reflects all available information. In this equilibrium, prices are equal to the rationally discounted value of expected cash flows. Also, the cross-section of expected returns depends only on the cross-section of systematic risks (Baker and Wurgler, 2006). Even if there are investors which can be classified as irrational, classical finance theory argues that irrational investors have no significant impact on prices. According to the efficient market hypothesis (EMH) of Fama (1970), trading strategies using publicly available information should not yield any abnormal return after correcting for risk. However, empirical results indicate sentiment has either a positive or negative impact on returns depending on the market state.[11]

## II.D The relation between investor sentiment and momentum returns

Cross-sectional momentum in relation with market sentiment is examined in several studies. Prominent literature in this field of research are Baker and Wurgler (2006), Stambaugh et al (2012),

[10] In this thesis a previous dataset version of the investor sentiment data provided by Jeffrey Wurgler is used. In the newest dataset version the investor sentiment data runs to 09/2015, which is almost five years more than in the previous version which runs from 07/1965 to 12/2010. In the updated version NYSE turnover has been dropped as one of the six indicators. The sentiment index now and going forward is based on five indicators. As an explanation Jeffrey Wurgler mentioned the following: "Turnover does not mean what it ones did, given the explosion of institutional high-frequency trading and the migration of trading to a variety of venues". As a result the sentiment index gives other values for the period 07/1965 to 12/2010 than before due to the removal of NYSE turnover. In order to replicate the results of previous studies such as Moskowitz et al (2012) for example, this thesis uses the previous dataset version.

[11] See the studies of Antoniou et al (2013), Asness et al (2013), Baker and Wurgler (2006), Baker et al (2012), Cooper (2004), Garcia (2013), Moskowitz et al (2012), Stambaugh et al (2012), and Yu and Yuan (2011) which show that sentiment influences returns.

Baker et al (2012), Antoniou et al (2013) and Cooper et al (2004). Empirical results indicate a positive relation between market sentiment and cross-sectional momentum for stocks. The findings of Cooper et al (2004) demonstrate that momentum returns are captured for a large portion by lagged market returns of stocks. Cooper et al (2004) come up with an explanation of momentum in relation with up and down market states. The two market states are defined as UP (DOWN) when the lagged 3-year market return is non-negative (negative). The 6-month momentum strategy generates a significant monthly profit of 0.93% following UP markets, while an insignificant result of -0.37% is found after DOWN markets. The empirical results of Cooper et al (2004) indicate that there is a nonlinear relation between momentum profits and lagged market states. Whenever the lagged market return increases, momentum increases, and reaches a peak which slowly declines thereafter. However, when the lagged market returns is highest there remain significant momentum profits. The lagged market return is a robust predictor of time-series of momentum profits (Cooper et al, 2004). Moreover, the results of Jegadeesh and Titman (2001) of a long-term momentum reversal is confirmed by Cooper et al (2004) finding a negative significant result of -0.36% per month in the UP market state considering the mean return spread between prior winners and losers over a holding period of 13 to 60 months.

Antoniou et al (2013) examine the relationship between cross-sectional momentum and market sentiment and confirmed the results of Cooper et al (2004). Antoniou et al (2013) empirically show that sentiment has incremental power to explain momentum profits after adjustments for market returns have been made. The empirical results indicate that when sentiment is optimistic the $6^{th}$-month momentum strategy yields significant profits of approximately 2.00% per month, while when sentiment is pessimistic the mean return of this momentum strategy is insignificant and drops to an average of 0.34% per month.

Baker et al (2012) extended the research of Baker and Wurgler (2006) and constructed investor sentiment indices for six major stock markets and decompose them into six local sentiment indices, and thereafter one global sentiment index. To validate these local sentiment indices Baker et al (2012) use dual listed shares which are positively related. Empirical results from Baker et al (2012) show that when sentiment is high, future returns are low on relatively hard to value and difficult to arbitrage stocks. With respect to the question whether sentiment is contagious across countries Baker et al (2012) find that local and global sentiment both predict momentum returns for stock markets in the cross-section.

This research contributes to a growing literature studying the role of investor sentiment. In this research the relation for cross-sectional momentum and sentiment for other sets of asset classes (non-stock level) are also examined as an extension within the same dataset. The main objective of this thesis is examining the relation of sentiment on time-series momentum. The momentum literature focusses on the relative performance of securities in the cross-section (CSmom), rather than focus on time-series momentum (TSmom) in which the focus is purely on a security's own return.

Before the study of Moskowitz et al (2012) earlier research was done in which Lemmon and Portniaguina (2006) examine the (time-series) relationship between investor sentiment and the small stock premium, using consumer confidence as a measure of investor optimism. Lemmon and Portniaguina retrieved data from two surveys. The first one is a survey of the University of Michigan considering consumer sentiment and the second survey comes from the Conference Board which collects data about consumer confidence. Each survey has 5 specific questions randomly sent towards a number of household where after the relative score of each question is determined. The scores for the first survey are then calculated as percent of favourable replies minus the percent of unfavourable replies plus 100. For the second survey the scores are calculated somewhat different as the percent of favourable replies divided by the sum of favourable and unfavourable replies. Thereafter, Lemmon and Portniaguina (2006) sorts similar questions to form multiple indices, for instance, an index of Consumer Expectations and an index of current Economic Conditions.

The data Lemmon and Portniaguina (2006) use to measure sentiment resembles at the data for the alternative sentiment proxy which is used in this thesis. The concluding remarks of the study of Lemmon and Portniaguina are very interesting. Lemmon and Portniaguina (2006) find that the sentiment component of confidence forecasts returns on stocks held by individual investors. Besides, an more striking finding is that the sentiment component of consumer confidence is not strongly related to the composite measure of Baker and Wurgler (2006). Lemmon and Portniaguina (2006, p. 29) "suggests that the different measures either capture some unrelated components of investor sentiment or perhaps fail altogether to capture some important aspects of sentiment". Eventually, no evidence is found regarding a relation between confidence-based measure of sentiment and time-series variation for momentum strategies.

## II.E Discussion and hypotheses

This research uses two sentiment proxies to investigate the presence of sentiment effects on time-series momentum with three different underlying behavioural concepts which are examined separately in existing literature. Moskowitz et al (2012) suggested that the partial reversal of the positive time-series momentum may be consistent with initial under-reaction and delayed over-reaction. Comparing return patterns of market-wide sentiment with return patterns of under-reaction and over-reaction theories indicate similar patterns are produced.

Therefore, one needs to consider which approach of build-up is desirable to construct sentiment proxies. One measures investor sentiment using biases in individual psychology to explain how individual investors underreact or overreact to past returns or fundamentals, rather than an overall

sentiment index. The models in which biases are used to measure sentiment rely on different opinions across investors, eventually leading to misevaluation (Baker and Wurgler, 2006).

At first, a short overview of leading literature for the phenomena of under-reaction and over-reaction is presented. Since the introduction of the efficient market hypothesis, it has often been rejected in favour of an alternative hypothesis. Examples of those alternative hypotheses are under-reaction and over-reaction which are examined in relation with momentum strategies. In the literature different behavioural or cognitive biases are examined to explain anomalies such as momentum. The phenomena of under-reaction and over-reaction both affect momentum traders and are mentioned hereinafter. Next, the differences in approach to explain the phenomena of under-reaction or over-reaction in relation to sentiment is discussed.

There are many studies that try to explain the phenomena of under-reaction. The literature did not find a unified explanation for under-reaction. Hong and Stein (1999) develop a behavioural theory to explain momentum which is based on initial under-reaction to information and subsequent over-reaction. For instance, under-reaction can result from slow diffusion of news. Due to gradually diffusing news through the market there is initial under-reaction, which attracts the attention of momentum traders resulting in eventual overreaction to news (Hong and Stein, 1999).

Moreover, under-reaction is explained by the disposition effect in which investors tend to sell winning assets (stocks) too early and holding losing assets (stocks) too long. Shefrin and Statman (1985) examined the disposition effect using a framework which include elements of mental accounting, regret aversion, self-control, and tax considerations. Frazzini (2006) examine whether the disposition effect could explain the under-reaction of news. Conservativeness and anchoring biases can cause under-reaction as well (Tversky and Kahneman, 1974). The phenomena of over-reaction on the other hand is also explained by multiple behavioural theories. It seems that different theories all explain a part of the broader picture of under-reaction or over-reaction, respectively.

Barberis et al (1998) and Tversky and Kahneman (1974) find that the representativeness heuristic leads to overreaction. To follow up, overreaction can be caused due to overconfidence and self-attribution confirmation biases. Daniel et al (1998) assume that investors are overconfident about their private information and overreact to it. This overreaction is even stronger when investor have a self-attribution bias which means that investors attribute success to their own skill more than they should and attribute failure to external noise. The increase in overconfidence strengthen the initial overreaction and generates momentum returns. Hence, increased overconfidence leads to short-run momentum and long-run reversal (Daniel et al, 1998). Other explanations for overreaction are positive feedback trading which is examined by DeLong (1990) and Hong and Stein (1999). Moreover, Bikhchandani et al (1992) and Hirshleifer et al (1994) introduce the herding effect which means that investors only focus at a subset of securities while neglecting other securities with identical characteristics. Last but not least, empirical

results indicate that general sentiment which is examined by Baker and Wurgler (2006) is also an explanation of over-reaction.

To specify what is meant by general (market-wide) sentiment which is used in this research and previously by Baker and Wurgler (2006) a comprehensive explanation is required. The theories of under-reaction and over-reaction are classified by Baker and Wurgler (2006) as a "bottom-up approach". As previously mentioned, this approach measures investor sentiment using biases in individual psychology to explain how individual investors underreact or overreact to past returns or fundamentals. To quote Baker and Wurgler (2006, p130) "When aggregated, these models make predictions about patterns in worldwide investor sentiment, stock prices, and volume".[12]

The investor sentiment proxies which are either used or developed in this research are different from the bottom-up approach and hence based on a "top-down and macroeconomic" approach. The top-down approach focusses on an aggregate sentiment and instead of using behavioural biases it traces its effects to market returns and individual stocks. To conclude the top-down approach of Baker and Wurgler (2006) uses as a foundation two irrefutable assumptions (behavioural concepts) in the area of behavioural finance: sentiment and limits to arbitrage.[13] This is the first underlying behavioural concept in this research. Another conclusion drawn from Baker and Wurgler (2006) is that securities with similar characteristics tend to be hard to arbitrage. When the effects of sentiment on "bond-like" stocks are examined one expects these stocks are less driven by sentiment (Baker and Wurgler, 2007). Important to keep in mind for this research is only general sentiment (market-wide sentiment) plays a central role, and further referrals will be named as sentiment.

The study of Stambaugh et al (2012) explores the role of sentiment in a broad set of anomalies in which market-wide sentiment is combined with the argument that overpricing should be more prevalent than underpricing due to short-selling limitations, which represents the second concept in this research. The difference in set-up of this concept is Stambaugh et al (2012) adjusted the underlying behavioural concept of limits to arbitrage in the research of Baker and Wurgler (2006) into the market imperfection of short-selling restrictions. Empirical results from Stambaugh et al (2012) indicate that long-short strategies exploits the anomalies. Moreover, each anomaly is stronger following high-levels of sentiment. The short-leg of each strategy is more profitable following high-sentiment, while no relation is found for the long-leg strategy.

[12] Previous literature exhibit the importance of behavioral theories that produced clear cross-sectional predictions about the effects of sentiment.

[13] In addition to examination of aggregated sentiment to the level of stock prices, Baker and Wurgler (2006) added limits to arbitrage in order to find evidence which kind of stocks are most affected by sentiment. Striking evidence is found for stocks that have one or more of the following characteristics. In particular, young stocks, unprofitable, non-dividend paying, growth companies, low capitalization, high volatility or stocks of firms in financial distress are affected by waves of sentiment. See Baker and Wurgler (2007) for a more detailed analysis of sentiment in the stock market.

The third behavioural concept of investor overconfidence is described in the research of Antoniou et al (2013). In the paper individual investors are seen as sentiment-driven traders which trade consistent with the influence of sentiment. The main result of Antoniou et al (2013) is that bad news diffuses slow during optimistic periods, while negative news causes cognitive dissonance in optimistic investors. Additionally, the results show that momentum profits are significant only when investors are optimistic, thus when the sentiment measure is high (Antoniou et al, 2013). In this research one tries to shed light on the impact of difference states of sentiment on time-series momentum profits.

To conclude, the sentiment proxy of Baker and Wurgler (2006) is used as an reference proxy representing the behavioural concept of limits to arbitrage and the market imperfection of short-selling limitations. The alternative proxy on the other hand which is based on Antoniou et al (2013) represents the behavioural concept of investor overconfidence. The existing literature in which the role of sentiment is examined always construct or uses a single sentiment proxy.

Hereinafter, the four hypotheses and the main research question of this thesis are presented ones more for the convenience of the reader. To summarize the hypotheses, this thesis starts to examine time-series momentum profits for different states of sentiment. The expectation is that momentum returns are significantly higher following optimistic states of sentiment. Secondly, the momentum profits for different states of sentiment are compared for the newly developed sentiment proxy and the Baker and Wurgler sentiment proxy. Despite differences in build-up of the sentiment proxies the expectation is that both sentiment proxies explain time-series momentum profits. The third hypothesis is about the positive effect of sentiment on time-series momentum returns and especially whether time-series momentum profits are positive and stronger for the five individual Western Countries Equity Indices and the diversified TSmom portfolio. The first three hypotheses help to draw a conclusion regarding time-series momentum.

The last and fourth hypothesis is based on cross-sectional momentum returns. The last hypothesis is incorporated into this thesis because previously literature regarding the relation of sentiment and cross-sectional returns examines only the long-short cross-sectional momentum strategies. For cross-sectional momentum returns only, it is interesting to see the impact of sentiment on the short-leg and long-leg separately. At last, the main research question is presented which simply suggests that sentiment influences time-series momentum strategies. With the help of the hypotheses this thesis provides empirical results to give an answer at the research question.

Hypothesis 1: *An optimistic state of sentiment is followed by higher time-series momentum profits than a pessimistic state*

Hypothesis 2: *Both sentiment proxies, motivated by different underlying behavioural concepts and market imperfections, can explain time-series momentum profits*

Hypothesis 3: *The positive effect of sentiment on time-series momentum profits is expected to be stronger in stock markets compared to other sets of asset classes*

Hypothesis 4: *The short-leg time-series momentum profits should be higher in an optimistic state of sentiment than in a pessimistic state*

The main research question: *Does investor sentiment influence time-series momentum in Western equity markets and other sets of asset classes?*

# III. Data and Methodology

## III.A Data

This section presents an overview of the data used in this research. To find a well-founded answer to the main research question it is important to collect data on sentiment proxies and (time-series) momentum portfolios from previous literature. The dataset of Asness et al (2013) in which momentum portfolios for the non-stock level assets are constructed on cross-sectional level, and Moskowitz et al (2012) to examine time-series momentum is obtained and applied in this thesis.[14] Data which is used by Antoniou et al (2013) and Baker and Wurgler (2006) to construct sentiment proxies will be applied in this thesis too. All regressions are performed with Eviews. Besides performing regressions with the whole range of data for each portfolio, there are also regressions included with parts of the data for each portfolio, respectively a before-crisis-period (BCP) and crisis period (CP).

Next, a comprehensive overview of the characteristics of the gathered data is presented. First details of the data of Moskowotz et al (2012) is described followed by the data of Asness et al (2013). The datasets of Asness et al (2013) and Moskowitz et al (2012)[15] are used as a source and to calculate time-series momentum and cross-sectional momentum returns for equity indices, currencies, fixed income, and commodities. A thorough description of how the time-series momentum and cross-sectional returns are determined is described in these sections. At first, the description of the time-series momentum returns will be explained and later on the cross-sectional momentum returns so that others are capable to replicate the results. The dataset of Asness et al (2012) is adjusted and further prepared

[14] Asness et al (2013) is a revised version of the paper, the earlier version of 2010 inspired Moskowitz et al (2012) to investigate time-series momentum strategies.

[15] In order to replicate the results from Moskowitz et al (2012) this thesis uses the dataset from the website of Lasse Pedersen, one of the authors of the previous mentioned literature, which is taken from his website: http://www.lhpedersen.com/data. There is a monthly updated dataset of Moskowitz et al (2012) available at: https://www.aqr.com/library/data-sets/time-series-momentum-factors-monthly.

to examine time-series momentum by Moskowitz et al (2012)[16]. Eventually, a thorough description of the sentiment proxy data of the OECD and Baker and Wurgler (2006) is presented.

### III.A1 Time-series momentum portfolios

The data for the time-series momentum portfolios is obtained from the website of Lasse Pedersen which is also the source for the cross-sectional momentum portfolios. Hereinafter, I will briefly summarize the data sources and the construction of the returns for the time-series momentum portfolios used in Moskowitz et al (2012). Starting with the time-series currency portfolio which consist of currency forwards who cover the following ten exchange rates, namely Australia, Canada, Germany spliced with the Euro, Japan, New Zealand, Norway, Sweden, Switzerland, UK and US. Spot and forward interest rates from Citigroup are used to calculate currency returns going back to 1989. Furthermore, spot exchange rates are used from Datastream and Interbank Offered Rate (IBOR) short rates from Bloomberg to calculate returns (Moskowitz et al, 2012).

With respect to the time-series commodity portfolio Moskowitz et al (2021) covered 24 different commodity futures.[17] The time-series equity indices portfolio consist of the following nine developed equity markets: AEX (Netherlands), CAC 40 (France), DAX (Germany) , FTSE/MIB (Italy), FTSE 100 (UK), IBEX 35 (Spain), SPI 200 (Australia), S&P 500 (US), and TOPIX (Japan). MSCI country level index returns are used prior to the availability of futures returns (Moskowitz et al, 2012).

At last, the time-series fixed income portfolio is described consisting of 13 developed bond markets, which are the Australia 3-year Bond, Australia 10-year Bond, Canada 10-year Bond, Euro Schatz, Euro Bobl, Euro Bund, Euro Buxl, Japan 10-year Bond (TSE), Long Gilt, as well as the US 2-year Note, US 5-year Note, US 10-year Note, and US Long Bond. Future returns are taken from Datastream. Moreover, Moskowitz et al (2012) use JP Morgan country-level index returns prior to the availability of futures returns. Daily returns are scaled daily to a constant duration of 2 years for 2 and 3-year bond futures, subsequently 4 years for 5-year bonds, 7 years for 10-year bond futures, and 20 years for 30-year bond futures (Moskowitz et al, 2012).

Moskowitz et al (2012) uses the following methodology to construct return series for each instrument, each day the daily excess return of the most liquid futures contracts are computed, and then compound

[16] See literature section II.A for more information regarding the procedure to examine time-series momentum.
[17] Data on Aluminium, Copper, Nickel, Zinc are from the London Metal Exchange (LME). Subsequently Brent Crude, Gas Oil, Cotton, Coffee, Cocoa and Sugar are taken from the Intercontinental Exchange (ICE). Third, Live Cattle and Lean Hogs are obtained from the Chicago Mercantile Exchange (CME). Fourth, Corn, Soybeans, Soy Meal, Soy Oil, and Wheat are taken from Chicago Board Trade (CBOT). Furthermore, WTI Crude, RBOB Gasoline, Heating Oil, and Natural Gas are from New York Mercantile Exchange (NYMEX). Fifth, Gold and Silver are from the New York Commodities Exchange (COMEX). At last, Platinum data is taken from Tokyo Commodity Exchange (TOCOM) (Asness et al, 2013).

the daily returns to a cumulative return index from which returns can be computed at any horizon. Furthermore, for the equity indices, the return series of Moskowitz et al (2012) is almost perfectly correlated with the corresponding returns of the underlying cash indices, in excess of the Treasury bill rate (Moskowitz et al (2012). Moskowitz looks for each asset at different look-back periods and holding periods as can be seen in Moskowitz et al (2012) Table 2. However, in this thesis the focus is on time-series momentum returns in which the look-back period is 12 months, skipping the previous month, thus 12-2 months which is standard in momentum literature. The holding period is one month. After one month the portfolios are rebalanced. With respect to the time-series momentum strategy the compound sign of the returns of the previous12 months is important for investors whether they should take a long or a short position.

Next, the reason to examine five individual Western Equity Indices will be explained. The reader may wonder what the underlying principle is to examine individual Western equity markets on time-series momentum level, because these countries are already represented in the diversified equity indices portfolio of Moskowitz et al (2012). The reason why these Western equity markets are also examined separately is to test whether the influence or the presence of sentiment is affected by a more diversified portfolio. Moreover, the influence of using the alternative proxy for a single Western market or a diversified portfolio of markets is interesting to examine. The alternative proxy does not consist of individual measures of sentiment with respect to stocks like the reference proxy of Baker and Wurgler. The data for the Western markets are obtained from Datastream. The following equity indices are taken: the DAX (Germany), CAC (France), AEX (Netherlands), FTSE (United Kingdom), and S&P 500 (United States). This thesis use total returns with re-invested dividends for the five equity indices. Again the same procedure following the look-back period and holding period will be applied. Data on Fama and French factors are taken from the website of Kenneth French[18]. For the market return the M.S.C.I. World index (expressed in US dollars) will be used as a proxy which is taken from Datastream. All returns are calculated using continuous compounding.

All portfolios of the Western equity indices have, as expected with equity indices, excess kurtosis and negative skewness. The Jarque-Bera statistic which represent whether the portfolios are normal distributed shows significant results indicating that the Western equity indices are not normal distributed. Excess kurtosis is implying that the tails of the distribution are fatter than normal, meaning that larger returns could occur more regularly. Skewness is a measure of asymmetry, all Western

[18] The Fama and French Factors SMB, HML and UMD are viewed at the website of Kenneth French, available at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. Moreover, in the dataset of Asness et al (2013) which is provided by Lasse Pedersen, the Fama and French factors are also taken into account and probably taken from Kenneth French website as well. In this thesis the Fama and French factors as used by Asness et al (2013) will be used for this research too.

portfolios have negative skewness which implies that the tail on the left-hand side is longer than at the right-hand side.

Furthermore, Table 1 shows similar results for the five TSmom portfolios. However, there is one exception regarding the TSmom portfolio of all assets in which the portfolios of commodities, currencies, equity indices and fixed income are pooled. The TSmom all assets portfolio shows an insignificant result for the Jarque-Bera statistics implying that returns in this portfolio are normally distributed.

### III.A2 Cross-sectional momentum portfolios

Data is obtained from the website of Lasse Pedersen which is used in the research of Asness et al (2013), in which cross-sectional momentum strategies for non-stock level assets are examined.[19] Specifically, the sample includes momentum portfolios for equity indices, currencies, commodities and fixed income indices. Pedersen took return data for global equity indices and book values from MSCI and Bloomberg. The global equity index dataset consist of 18 developed equity markets: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Spain, Sweden, Switzerland, The United Kingdom, and the United States for the period of January 1978 till July 2011 (Asness et al, 2013). The returns on the country equity index futures do not include any returns on collateral from transacting in future contracts. The returns are comparable to returns in excess of the risk-free rate.

The momentum portfolios for currencies are based on data obtained from Datastream covering spot exchange rates for 10 currencies, Australia, Canada, Germany (spliced with the Euro), Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States. Returns are from currency forward contracts, MSCI spot price data or Libor rates, where currency returns are all denominated and include the local interest rate differential (Asness et al, 2013). The data to construct the momentum portfolio for currencies is the period of January 1979 to July 2011.

Subsequently, the data which was needed to construct the momentum portfolio for commodities comes from several sources and consist of 27 commodities.[20] The data covers the period January 1972

[19] Data for the non-stock level assets which is used in the paper of Asness et al (2013) comes again from the website of Lasse Pedersen, also one of the authors of Asness et al (2013), http://www.lhpedersen.com/data. Moreover, the data used in Asness et al (2013) is extended at: https://www.aqr.com/library/data-sets.

[20] At first, the data on Aluminium, Copper, Nickel, Zinc, Lead and Tin are from the London Metal Exchange (LME). Subsequently Brent Crude and Gas Oil are taken from the Intercontinental Exchange (ICE). Third, Corn, Soybeans, Soy Meal, Soy Oil, and Wheat are obtained from the Chicago Board of Trade (CBOT). Fourth, Live Cattle, Feeder Cattle, and Lean Hogs are from the Chicago Mercantile Exchange (CME). Fifth, Gold and Silver are from the New York Commodities Exchange (COMEX). Sixth, WTI Crude, RBOB Gasoline, Heating Oil and Natural Gas are from the New York Mercantile Exchange (NYMEX). The following commodities Cotton, Coffee, Cocoa, and Sugar are from the New York Board of Trade (NYBOT). At last, Platinum data is taken from Tokyo Commodity Exchange (TOCOM) (Asness et al, 2013).

to July 2011 (Asness et al, 2013). Returns for commodity futures are calculated as follows. For every day the daily excess return of the most liquid future contracts are computed, which is typically the nearest or next nearest-to- delivery contract. Thereafter, the daily returns are compound to a total return index from which the monthly returns are computed (Asness et al, 2013). All returns are denominated in US dollars and do not include the return on collateral associated with the futures contract.

Momentum portfolio for fixed income is based on bond index returns which come from Bloomberg and Morgan Markets, short rates and 10-year government bonds yields are from Bloomberg, and Consensus Economics is the source of inflation forecasts. Government bond data is covered for the period January 1982 to July 2011 obtained for the following countries: Australia, Canada, Denmark, Germany, Japan, Norway, Sweden, Switzerland, the United Kingdom, and the United States (Asness et al, 2013).

Asness et al (2013) have constructed diversified momentum portfolios for equity indices, currencies, commodities and fixed income to examine cross-sectional momentum. To construct the portfolios Asness et al (2013) use the common measure of the 12-month cumulative raw return on the assets, which is the same procedure as Jegadeesh and Titman (1993), skipping the most recent months return in order to avoid the 1-month reversal in stock returns. The look-back period in Asness et al (2013) is thus 12 months minus 1, the previous month. The portfolio holding period is one month, after this month the sorting for all assets is repeated and the portfolios are rebalanced.

In this thesis I will use as well a portfolio holding period of one month as well as a look-back period of 12 months skipping the previous month which is the standard in literature and also followed by Asness et al (2013) for cross-sectional momentum strategies. The descriptive statistics for the cross-sectional momentum portfolios in Table 1 give mixed results for skewness. There is positive skewness for commodities and fixed income and negative skewness for currencies and equity indices. Moreover, all cross-sectional momentum portfolios have excess kurtosis and a non-normal distribution.

**Table 1 – Descriptive Statistics**

This table shows summary statistics of monthly momentum strategy returns. The number of observations, mean, median, standard deviation, the minimum value, the maximum value, the level of kurtosis, the level of skewness, and the Jarque-Bera statistic together with its probability for all of the portfolios. There are respectively 10 portfolios for time-series momentum, and 4 for cross-sectional momentum. Next, all the sample periods will be enumerated. Starting with the sample periods of the 5 Western countries. The sample period of the AEX is from 02/1983 to 03/2016, CAC 40 from 01/1988 to 03/2016, DAX 30 from 01/1965 to 03/2016, FTSE 100 from 01/1986 to 03/2016, and the S&P500 from 02/1988 to 03/2016. Subsequently, the sample period of the reported descriptive statistics of the TSmom portfolios are all from 01/1985 to 12/2013. At last, the sample period of the reported CSmom portfolios of commodities is from 01/1972 to 07/2011, currencies from 01/1979 to 07/2011, equity from 01/1978 to 07/2011, and fixed income from 01/1982 to 07/2011.

Descriptive Statistics TSmom 5 Western Countries

| | AEX INDEX (NL) | CAC 40 (FR) | DAX 30 (GER) | FTSE 100 (UK) | S&P500 (US) |
|---|---|---|---|---|---|
| Mean | 0.010064 | 0.008525 | 0.006526 | 0.008253 | 0.008925 |
| Median | 0.014755 | 0.014918 | 0.007796 | 0.010480 | 0.012871 |
| Maximum | 0.175185 | 0.245494 | 0.213778 | 0.145305 | 0.114356 |
| Minimum | -0.274899 | -0.174899 | -0.254222 | -0.259460 | -0.167951 |
| Std. deviation | 0.057608 | 0.056167 | 0.056082 | 0.044540 | 0.041631 |
| Skewness | -0.772580 | -0.139695 | -0.361208 | -0.791490 | -0.561950 |
| Kurtosis | 5.576450 | 3.797229 | 4.847664 | 6.365729 | 4.148325 |
| Jarque-Bera | 149.6747 | 10.08006 | 100.8535 | 209.2386 | 36.36035 |
| Probability | (0.000000) | (0.006474) | (0.000000) | (0.000000) | (0.000000) |
| Observations | *398* | *339* | *615* | *363* | *338* |

Descriptive Statistics TSmom (Moskowitz et al, 2012)

| | Commodities | Currencies | Equity | Fixed Income | All Assets |
|---|---|---|---|---|---|
| Mean | 0.010650 | 0.010413 | 0.017867 | 0.018311 | 0.013140 |
| Median | 0.012525 | 0.012513 | 0.019572 | 0.016654 | 0.014075 |
| Maximum | 0.165628 | 0.203798 | 0.326054 | 0.311592 | 0.116681 |
| Minimum | -0.196828 | -0.181931 | -0.350338 | -0.259073 | -0.117612 |
| Std. deviation | 0.040813 | 0.053662 | 0.080495 | 0.084818 | 0.035604 |
| Skewness | -0.305363 | -0.067820 | -0.055164 | -0.060873 | -0.137803 |
| Kurtosis | 4.845174 | 4.323329 | 4.423324 | 3.877360 | 3.411644 |
| Jarque-Bera | 54.77599 | 25.65917 | 29.55133 | 11.37646 | 3.558433 |
| Probability | 0.000000 | 0.000003 | 0.000000 | 0.003386 | 0.168770 |
| Observations | *348* | *348* | *348* | *348* | *348* |

Descriptive Statistics CSmom (Asness et al, 2013)

| | Commodities | Currencies | Equity | Fixed Income |
|---|---|---|---|---|
| Mean | 0.010296 | 0.003025 | 0.007077 | 0.000347 |
| Median | 0.010247 | 0.005367 | 0.006514 | 0.000871 |
| Maximum | 0.303619 | 0.095176 | 0.105582 | 0.085324 |
| Minimum | -0.280791 | -0.106621 | -0.116181 | -0.061412 |
| Std. deviation | 0.066950 | 0.029382 | 0.034044 | 0.017060 |
| Skewness | 0.040503 | -0.520790 | -0.166822 | 0.107869 |
| Kurtosis | 5.515273 | 4.191782 | 3.893794 | 6.156477 |
| Jarque-Bera | 125.3438 | 40.81443 | 15.28356 | 148.0629 |
| Probability | (0.000000) | (0.000000) | (0.000480) | (0.000000) |
| Observations | *475* | *391* | *403* | *355* |

*Table 1*

III.A3 Sentiment proxies

Data collected by the Organisation for Economic Co-operation and Development (OECD) will be used to form an alternative sentiment proxy. To construct the sentiment proxy the monthly time-series of the Consumer Confidence Index (CCI) of the OECD countries is used. There are 34 OECD countries which each contribute to the CCI.[21] Data is obtained from January 1973 through April 2016. The Consumer Confidence Index is based on household plans for major purchases and the economic situation of the households. Data for both, the current situation and the expectations for the immediate future is gathered. The opinions are then compared to a "normal" state and collected. The difference between positive and negative answers provide a qualitative index on economic conditions.[22]

Unfortunately, data collected by the Confidence Board (CB), and the Chicago Fed National Activity Index (CFNAI) introduced by Antoniou et al (2013) could not be retrieved and used as an alternative sentiment measure. However, the build-up of the Consumer Confidence Indices from Antoniou et al (2013) and the OECD are quite similar. The build-up of the CB survey is as follows: the questionnaire is randomly sent towards 5000 selected households in the United States in which participants are asked about the prospects of the economy. In order to form the overall Consumer Confidence Index the scores for each of the five questions are calculated as the number of favourable replies divided by the sum of favourable and unfavourable replies and then combined (Antoniou et al, 2013).[23]

In Figure 1 the alternative sentiment measure drops in 1973 which can be explained by the first oil crisis. The second major oil crisis starting in 1979 is also reflected in the developed sentiment measure due to a huge decrease of the proxy. Moreover, positive sentiment towards the decennium is presented as well as negative sentiment which can be contributed to the impact of the credit crisis during 2008-2010.

[21] An enumeration of countries belonging to the OECD: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

[22] The alternative sentiment index data which runs from 01/1973 to 04/2016 is taken from https://data.oecd.org/leadind/consumer-confidence-index-cci.htm.

[23] It is useful to know how Antoniou et al (2013) uses the Consumer Confidence Index (CCI) based at data from the CB and CFNAI in their research, because the same data is used previously by Lemmon and Portniaguina (2006) to create a sentiment proxy. Antoniou et al (2013) purge the effects of macroeconomic conditions from the CB index. The CB index is regressed on six macroeconomic indicators: growth in industrial production, growth in employment, National Bureau of Economic Research (NBER) recession indicator, real growth in durable consumption, and nondurable consumption. The residuals from this regression is used by Antoniou et al (2013) as their sentiment proxy.

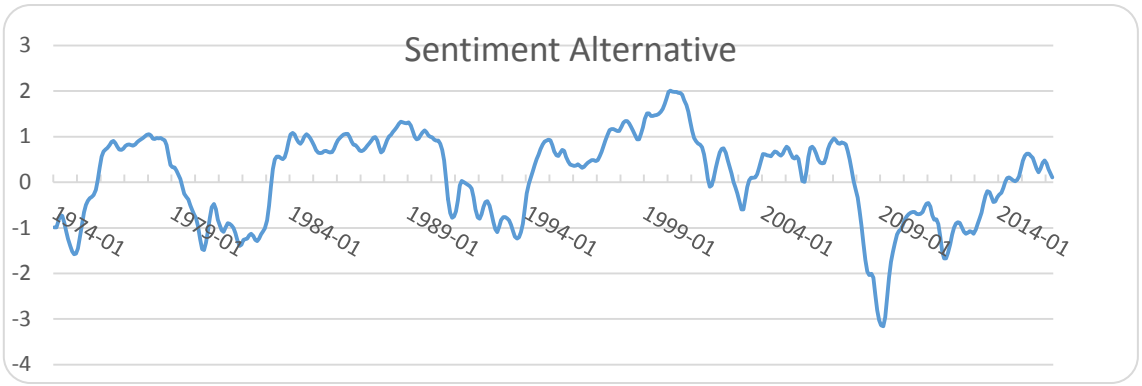


Figure 1

Data from Baker and Wurgler (2006) is used in this research as a reference sentiment proxy.[24] The sentiment proxy is constructed using the monthly market-based sentiment series of Baker and Wurgler (2006). The Baker and Wurgler (BW) index ranges from July 1965 till December 2010. To form the BW index, Baker and Wurgler (2006) took the first principal component of six individual measures of sentiment. The principal component is analysed at first and filters out idiosyncratic noise in the six measures making it possible to capture a common component of sentiment. The six measures which are analysed are the dividend premium, closed-end fund discount, NYSE turnover, the equity share in total new issues and the number and the first day returns of IPO's (Baker and Wurgler, 2006). Figure 2 shows that the period of the main data of the sentiment index of Baker and Wurgler (2006) matches with prominent United States stock market bubbles. For instance, the late 1990s bubble in technology stocks in which investor sentiment was at a high level before the bubble started to burst in 2000. Compared with Figure 1, Figure 2 show similar patterns, although the credit crisis is not reflected as much as in Figure 1.

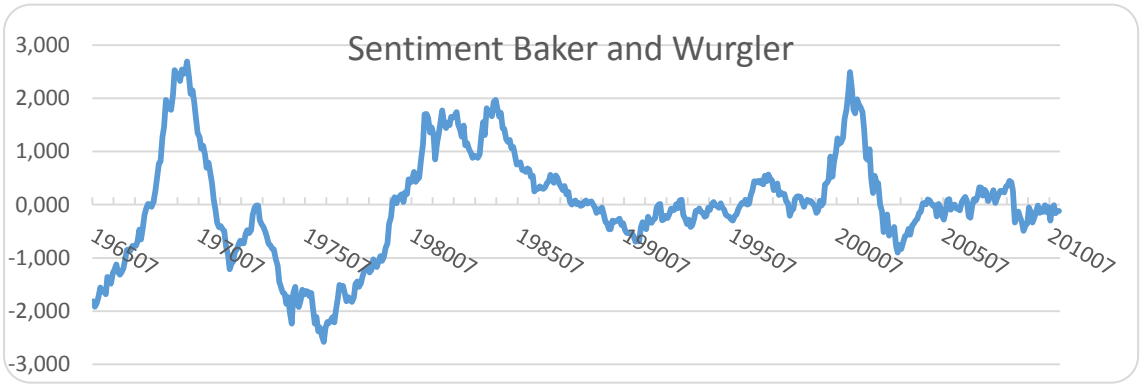


Figure 2

Next, a more detailed description of the individual sentiment measures is provided. To understand why Baker and Wurgler choose this measures and how the measures are eventually formed

[24] The Baker and Wurgler sentiment index data which runs from 07/1965 to 12/2010 is taken from pages.stern.nyu.edu/~jwurgler/data/Investor_Sentiment_Data_v23_POST.xlsx. The most recent data on the Baker and Wurgler sentiment index can be retrieved from http://people.stern.nyu.edu/jwurgler/. See also Footnote 11.

into an overall BW sentiment index I refer the reader to Baker and Wurgler (2006). The dividend premium is the log difference of the average market-to-book ratios of payers and nonpayers. This variable is used to proxy the relative investor demand (sentiment) for dividend-paying stocks. The closes-end fund discount (CEFD) is the average difference between the net asset values (NAV) of closed-end stock fund shares and the corresponding market prices, respectively (Baker and Wurgler, 2006). NYSE share turnover, or basically liquidity, is based on the ratio of reported share volume to averages shares listed from the NYSE Fact Book. The share of equity issues in total equity and debt issues may also capture sentiment. At last, there is the number of IPO's (NIPO) and the average first-day returns (RIPO) which are often viewed as sensitive to sentiment and therefore taken into account (Baker and Wurgler, 2006).

## III.B Methodology

This section introduces and elaborates on methodology and theoretical concepts that are used throughout this research. The main research objective is examining whether investor sentiment does explain part of the time-series momentum profits. To answer the main research objective four hypotheses are formed. This thesis uses data of previous literature from Moskowitz et al (2012) and Asness (2013), and Datastream allowing to construct momentum portfolios for a set of asset classes. Subsequently, with the obtained momentum portfolios this thesis is capable to examine time-series momentum. An important note: in the equations underneath, subscript *i* indicates the amount of time-series momentum portfolios or cross-sectional momentum portfolios respectively, and subscript *j* indicates that either the Baker and Wurgler index or the newly developed sentiment index is used.

### III.B1 Time-series momentum regressions

At first, the summary statistics of the time-series momentum portfolios are generated with Eviews. In the summary statistics the mean of the excess return, the standard deviation, the Sharpe ratio, and alpha from the 1-factor market model are shown. The Sharpe ratio represents the risk-adjusted performance of a portfolio and can be determined with the mean of the excess return and standard deviation (Sharpe, 1966). Next to the summary statistics it is important to see whether the returns are significantly different from zero. The alphas are included for each portfolio as well and can be found in Table 2. A significant and positive alpha means that the market could not entirely explain the return. The alpha represents thus the return that is left unexplained by the market (Jensen, 1968). The rest of the research tries to explain the alpha of time-series momentum strategies by adding factors. The

regressions are tested for heteroskedasticity and autocorrelation, and when present the standard errors are corrected using White and or Heteroskedasticity Autocorrelation Consistent (HAC) standard errors (Newey and West, 1987).

Subsequently, the sentiment proxies are tested to see whether the average monthly time-series momentum returns in each state of sentiment are equal to zero. To verify whether time-series momentum is affected by the state of sentiment three dummy variables are formed, namely optimistic, mild and pessimistic. The described methodology is partly based on Cooper et al (2004), Stambaugh et al (2012), and Antoniou et al (2013). Hence, the time-series momentum monthly profits from each asset is regressed on three dummy variables for sentiment, without intercept. There are 10 time-series momentum portfolios, the four asset classes and an overall diversified time-series momentum portfolio, and the five individual Western Equity Indices portfolios. There are two sentiment proxies which are regressed on the ten time-series momentum portfolios. Eventually there are three data periods for which the different states of sentiment are examined, namely the whole sample period, before-crisis-period, and the crisis period. Thus equation (1) is performed 10 times 2 times 3.

Following Antoniou et al (2013), to identify whether a formation period is optimistic or pessimistic, a weighted (3/6th of t-1, 2/6th of t-2 and 1/6th of t-3) rolling average of the sentiment index is calculated for the three months previous to the end of the formation period. During this thesis a 3-month rolling average of the sentiment index is used unless indicated otherwise. A period is considered optimistic (pessimistic), if the rolling average ending in month t belongs to the top (bottom) 30% of the rolling average sentiment time-series. Because the whole sample is used to calculate the percentiles this introduces a light form of look-ahead bias. This thesis uses 1-month non-overlapping portfolio returns. Equation (1) is estimated for the first impression regarding differences in states of sentiment, showing the impact of all sentiment states with the corresponding coefficients and t-statistics.

$$TSmom_{i,t} = D_1 Sentiment_{jOptimistic,t} + D_2 Sentiment_{jMild,t} + D_3 Sentiment_{jPessimistic,t} + \varepsilon_t \quad (1)$$

In addition to equation (1) the following equation is estimated, which is somewhat different. Equation (2) includes a constant and two dummies, namely optimistic and mild. By doing this, the difference between the average returns in optimistic and pessimistic states is reflected in coefficient $D_1^{TSO}$. I expect that optimistic states of sentiment generate higher time-series momentum profits than pessimistic states of sentiment: $D_1^{TSO} > 0$. Equation (1) is performed including the pessimistic state. Equation (2) is a standard procedure in the literature using a base category which is represented by the constant in the model.

$$TSmom_{i,t} = \alpha + D_1^{TSO} Sentiment_{jOptimistic,t} + D_2^{TSM} Sentiment_{jMild,t} + \varepsilon_t \quad (2)$$

The next equation will estimate the alpha of the time-series momentum strategies, based on a factor model. This factor model includes the factors of the Fama and French 3-factor model, a cross-

sectional momentum factor (UMD) and sentiment. The relation of sentiment on time-series momentum will be investigated in the five individual Western Equity Indices, four other sets of assets classes as well as the overall diversified TSmom portfolio. The MSCI world index (MSCI) is used as a proxy for the market. The Fama & French (1992) factors will be briefly explained. The market risk is reflected as the beta of the returns of the market minus the risk free return (RMRF). The other factors are Small Minus Big market capitalization (SMB), which measures the historic returns of small caps over big caps, and the High Minus Low book-to-market ratio (HML), which measure the historic excess return of value stocks over growth stocks.

Again subscript *i* of TSmom indicates that time-series momentum is tested for one of the five individual Western markets indices, four other asset classes, and the overall diversified strategy. For instance, TSmom EQ (TSmom global equity indices) or TSmom DAX. Furthermore, subscript *j* of sentiment means that either the alternative sentiment proxy or the Baker and Wurgler sentiment index is used. As in equation (1) three samples periods will be examined. Equation (3) will be performed in order to verify whether risk factors explain part of the time-series momentum. Equation (3) is estimated 10 times 2 times 3 similar to equation (1). The expectation of regressing the Fama and French (1992) risk factors on time-series momentum is that significant betas are absent.

The expectation regarding the time-series momentum assets classes is that the five Western markets and the global equity index would have higher significant results due to the fact these type of assets are relatively easier accessible for all investors. Subsequently, differences in influencing time-series momentum profits by two different composed sentiment proxies are investigated as well. I expect that both, the alternative developed sentiment proxy and the Baker and Wurgler sentiment index show positive significant impact on time-series momentum. Appendix B shows a summary of all possibilities for subscript *i* and subscript *j* as well as all the factors which are used in this thesis.

$$TSmom_{i,t} = \alpha + \beta_1 RMRF_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \beta_5 Sentiment_{j,t} + \varepsilon_t \quad (3)$$

Next equation (4) is regressed to sum up how much of the time-series momentum profits is explained by cross-sectional momentum and sentiment. It is interesting to see whether there is still a significant alpha, and moreover it is done as a simple confirmation that TSmom differs from CSmom.

$$TSmom_{i,t} = \alpha + \beta_1 CSmom_{i,t} + \beta_2 Sentiment_{j,t} + \varepsilon_t \quad (4)$$

III.B2 Cross-sectional momentum regressions

In this section the equations for cross-sectional momentum will be described. This thesis uses the same underlying methodology as Asness et al (2013) in which the cross-sectional momentum portfolios are sorted in three equal groups. Hence, there are three portfolios for each asset class, a high

(P1), middle (P2), and low group (P3). Next to these portfolios, the zero-cost portfolios (P3-P1) are created in which the losers are sold short and a long position in the winners is taken. After the creation of the different groups the dataset is ready to run regressions on the cross-sectional momentum portfolios. A momentum strategy buys an asset if lagged returns in the look-back period are positive and short sells the asset if lagged returns are negative with an look-back period of 12 months skipping the most recent month, and a holding period of 1-month. Next the summary statistics of the cross-sectional momentum portfolios are generated in which the mean of the excess return, the standard deviation, the Sharpe ratio, and alpha are shown. The summary statistics of the cross-sectional momentum strategies are presented in Table 8.

Subsequently, the sentiment proxies are tested ones more to see whether the average monthly in each state of sentiment are equal to zero, instead this time it is done for cross-sectional momentum returns. To verify whether cross-sectional momentum is affected by the state of sentiment the same procedure as by time-series momentum is followed. Three dummy variables are formed, namely optimistic, mild and pessimistic. The cross-sectional average monthly profits from each asset is regressed on three dummy variables for sentiment, without intercept. However, this time the relation of different states of sentiment on the short leg (P1) and long-leg (P3) are also examined on cross-sectional level. There are four non-stock asset class cross-sectional momentum portfolios which are examined. These portfolios are then divided into P1, P2, P3, and P3-P1. Furthermore, the three previously described sample periods are investigated, the whole sample period, before-crisis-period, and the crisis period. Thus equation (5) is performed 4 times 4 times 3 times 2.

$$CSmom_{i,t} = D_1 Sentiment_{jOptimistic,t} + D_2 Sentiment_{jMild,t} + D_3 Sentiment_{jPessimistic,t} + \varepsilon_t \quad (5)$$

Next to equation (5) the following equation will estimate the difference between the average returns in optimistic and pessimistic states which is reflected in coefficient $D_1^{CSO}$ as shown in equation (6). Equation (6) is a more standard procedure in the literature in which a base category is used represented by the constant in the model, exactly the same procedure as with time-series momentum.

$$CSmom_{i,t} = \alpha + D_1^{CSO} Sentiment_{jOptimistic,t} + D_2^{CSO} Sentiment_{jMild,t} + \varepsilon_t \quad (6)$$

The build-up for time-series momentum and cross-sectional momentum regressions is exactly the same. Thus, the next equation will estimate the alpha of the cross-sectional momentum strategies, based on a factor model. As previously described cross-sectional momentum will be investigated in four sets of assets classes. The MSCI world index which is a proxy for the market (RMRF) along with the Fama & French (1992) factors SMB and HML will be regressed on cross-sectional momentum. Subscript *i* of CSmom indicate that cross-sectional momentum is tested for one of the four asset classes. Subscript *j* of sentiment means that either the alternative sentiment proxy or the Baker and Wurgler sentiment index is used. Equation (7) will be performed in order to verify whether risk factors explain

part of the cross-sectional momentum. The expectation of regressing the Fama and French (1992) risk factors on cross-sectional momentum is that significant betas are absent due to previous research.

As mentioned earlier the same regression is estimated for cross-sectional momentum as for time-series momentum before, namely equation (3), however there are some slight differences. The difference with equation (3) is that for equation (7) not only the long-short momentum strategy is investigated. The influence of sentiment on the cross-sectional momentum long-leg and short-leg are investigated too. Equation (7) is therefore performed 4 times 4 times 3 times 2. The UMD factor is not incorporated into the regression, because incorporating the UMD, cross-sectional momentum factor, could influence the cross-sectional momentum results. This thesis applies the same methodology used in Asness et al (2013) for investigating the long-short cross-sectional momentum profits, while the long-leg, and time-series momentum short-leg profits are investigated following the example of Stambaugh et al (2012). Furthermore, I expect that the short-leg time-series momentum profits are significantly higher than long-leg time-series momentum returns. Again I refer Appendix B which summarizes all possibilities for subscript *i* and subscript *j* as well as all the factors used in this thesis.

$$CSmom_{i,t} = \alpha + \beta_1 RMRF_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 Sentiment_{j,t} + \varepsilon_t \quad (7)$$

# IV. Results

In this section all main empirical results are presented. The results section starts with the results found for time-series momentum strategies and ends with empirical results for the cross-section momentum strategies. In this section I test the four hypotheses for the TSmom strategies and the CSmom strategies. As previously mentioned, the results regarding time-series momentum strategies are the most important. An important note: this thesis looks at a significance level of 5% which is indicated in all tables as *. However, there are results which are significant at the 10% level. These results are indicated as **.

## IV.A Time-series momentum strategies

### IV.A1 Performance time-series momentum portfolios

The first results that are presented in this thesis are the performance of all time-series momentum portfolios from the period 01/1985 to 12/2010. Table 2 presents the mean excess returns which are all positive and significant for all non-stock assets classes in Panel A. This are the same portfolios as used

in Moskowitz et al (2012). The excess mean is between 14.97% and 24.91% per annum and for all values significant. As expected, the TSmom EQ portfolio shows the highest mean and also the highest standard deviation. Furthermore, the Sharpe ratios of the strategies vary between 0.80 and 1.49. Most importantly, all alphas are positive and significant between 1.16% and 1.68% per annum for the non-stock asset classes in Panel A. The TSmom all assets portfolio shows the highest Sharpe ratio of 1.49, and the highest t-statistic corresponding with the alpha.

In Panel B the results for the TSmom portfolios of the 5 Western Countries are presented in which the most influential Equity Indices of these countries are examined. These five portfolios show similar results as the TSmom EQ portfolio. This is as expected, because the five Western countries are incorporated into the diversified TSmom EQ portfolio. Similar to Panel A, the excess mean of all portfolios are significant. The standard deviation of the Western countries Equity Indices portfolios varies between 15.01% and 22.20%. To follow up, the alphas are all significant just as in Panel A. However, as one can see in Panel B, the alphas for the AEX, DAX and FTSE are significant at the 10% level. The positive and significant alphas justifies to further examine all strategies, because the market is not able to explain the time-series momentum returns.

### IV.A2 Performance of sentiment dummies

To answer hypothesis one, this thesis examined the individual performance of the sentiment dummies. At first, the mean of each individual state of sentiment, namely optimistic (OPT), mild (MILD) and pessimistic (PESS) are tested to be equal to zero, in order to verify which states of sentiment differs from zero. Empirical results from Table 3 show that there are differences at the significance of states of sentiment for both sentiment proxies. The Baker and Wurgler sentiment index show significant results for each data period for the OPT and PESS state. However, the alternative sentiment proxy shows significant results for all sentiment states and data periods, including the MILD state. Especially, in the whole data period and the before-crisis-period the t-statistics of the MILD state are really high and among the highest in Table 3. Hypothesis one cannot be answered yet. Table 4A and 4B provides more information to come to a final statement.

### IV.A3 Performance of time-series momentum strategies for different sentiment states

The following subsection will described the difference in time-series momentum returns with OPT states compared to PESS states. In the previous subsection Table 3 showed that the different states has each a different impact in terms of percentages for all sample period. This section focusses whether

**Table 2 – Performance Time-series Momentum Portfolios**

This table presents the annualized mean excess returns and the corresponding t-statistic between parentheses, the standard deviation, the Sharpe (1966) ratio in each asset class: commodities, currencies, equity indices and fixed income. Also reported are the annualized alphas with their t-statistic between parentheses from a time-series regression of each return series on the return of the market index for each asset class. The benchmark index for the investigated assets classes is an equal-weighted basket of the securities in each asset class. Despite the statistics are computed from monthly return series all returns are reported as annualized numbers. In panel A the diversified TSmom strategy is also included which includes the four asset classes together. Panel B presents the same result for the equity index portfolios of the five Western countries. The reported numbers of all portfolios are from the sample period of 01/1985 to 12/2010.

| Panel A: Non-stock asset class portfolios – Time-series Momentum | | | | | |
|---|---|---|---|---|---|
| | TSmom | TSmom CM | TSmom EQ | TSmom FI | TSmom FX |
| Mean | 18.28% | 15.32% | 24.91% | 24.68% | 14.97% |
| *(t-stat)* | (7.58)* | (5.65)* | (4.49)* | (4.24)* | (4.08)* |
| Std. deviation | 12.30% | 13.83% | 28.28% | 29.71% | 18.71% |
| Sharpe ratio | 1.49 | 1.11 | 0.88 | 0.83 | 0.80 |
| Alpha | 1.39% | 1.21% | 1.68% | 1.91% | 1.16% |
| *(t-stat)* | (6.45)* | (5.25)* | (3.27)* | (3.46)* | (3.65)* |

| Panel B: Western countries equity indices – Time-series Momentum | | | | | |
|---|---|---|---|---|---|
| | AEX INDEX (NL) | CAC (FR) | DAX (GER) | FTSE (UK) | S&P500 (US) |
| Mean | 10.08% | 10.79% | 9.51% | 8.68% | 11.81% |
| *(t-stat)* | (2.50)* | (2.85)* | (2.18)* | (2.72)* | (4.01)* |
| Std. deviation | 20.53% | 19.33% | 22.20% | 16.26% | 15.01% |
| Sharpe ratio | 0.49 | 0.56 | 0.43 | 0.53 | 0.79 |
| Alpha | 0.83% | 0.85% | 0.75% | 0.58% | 0.88% |
| *(t-stat)* | (1.68)** | (2.36)* | (1.85)** | (1.76)** | (3.07)* |

*Table 2*

the different states differ in term of magnitude when regressed on the TSmom portfolios, especially whether the OPT state generates higher returns than the PESS state. The results of regressions of different sentiment dummies on the excess returns of the TSmom all assets class, and the four assets classes are presented in Table 4A and Table 4B.

The results of Table 4A show that the Baker and Wurgler sentiment dummies are almost all significant for each state, optimistic, mild, and pessimistic, for the period 1985-2010. The same results are found in the first subperiod of 1985-2006. However, there is a huge difference in significance of results in the second subperiod of 2006-2010, which can be interpreted as the crisis period. During the subperiod of 2006-2010 none of the sentiment dummies, hence states of sentiment, of Baker and Wurgler are significant. Interesting results are found in the PESS state of the Equity Indices class for each of the Equity Indices class for each investigated period. The PESS states are insignificant and the

**Table 3 – Sentiment Dummies Compared to the Mean of Zero**

Table 3 shows empirical results for each of the sentiment states which will be tested separately whether they are equal to zero. In order to test the means of each sentiment state of both proxies the one sample two tailed T-test is used. Thus, for each state of the market there are dummies for the Baker and Wurgler sentiment proxy and the Alternative sentiment (newly developed) proxy, which are optimistic (OPT), mild (MILD), and pessimistic (PESS). For each proxy the results regarding the returns of the sentiment states for the whole period of 01/1985 to 12/2010 is presented. Furthermore, there are presented results for two subperiods, which are the before-crisis-period from 01/1985 to 12/2006 and the crisis-period from 01/2007 to 12/2010.

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | OPT | MILD | PESS | OPT | MILD | PESS |
| 1985-2010 | Mean | 0.72% | 0.01% | -0.35% | 1.22% | 0.59% | -0.84% |
| | St. dev | 0.53% | 0.09% | 0.17% | 0.32% | 0.19% | 0.78% |
| | Observations | 94 | 124 | 94 | 94 | 124 | 94 |
| | (t-stat) | (13.25)* | (1.02) | (-19.81)* | (37.12)* | (34.61)* | (-10.54)* |
| 1985-2006 | Mean | 0.80% | 0.01% | -0.37% | 1.28% | 0.67% | -0.28% |
| | St. dev | 0.54% | 0.09% | 0.17% | 0.31% | 0.14% | 0.48% |
| | Observations | 79 | 106 | 79 | 79 | 106 | 79 |
| | (t-stat) | (13.31)* | (1.17) | (-18.89)* | (36.32)* | (48.79)* | (-5.18)* |
| 2007-2010 | Mean | 0.28% | 0.00% | -0.23% | 0.56% | -0.87% | -2.33% |
| | St. dev | 0.07% | 0.10% | 0.09% | 0.46% | 0.25% | 0.54% |
| | Observations | 15 | 18 | 15 | 15 | 18 | 15 |
| | (t-stat) | (14.69)* | (0.13) | (-9.67)* | (4.70)* | (-14.79)* | (-16.70)* |

*Table 3*

momentum profits drop heavily in comparison with the significant optimistic state. An example of the TSmom Equity Indices in the full range period is the sensitivity of 4.24% in the optimistic state, while the pessimistic state is only 0.37%.

Furthermore, the OPT dummy is higher than the PESS dummy for all assets except Fixed Income. For instance, the Baker and Wurgler sentiment OPT dummy for the diversified all assets TSmom strategy is equal to 2.06%, while the PESS dummy equals 1.04%. This indicates that the excess return of the diversified TSmom strategy in optimistic states of the market is twice as high than in pessimistic states of the market for the whole sample period.

The alternative sentiment proxy shows somewhat different results. For example, the MILD state is higher for each strategy than the OPT state for almost every asset and data period. Exceptions are the TSmom Fixed Income crisis period and all periods for the TSmom Currencies strategy. The alternative sentiment proxy shows similar results as the Baker and Wurgler index for the crisis period. There are no significant results found for none of the sentiment states. For the alternative sentiment index the diversified TSmom strategy shows for the MILD state almost twice as high returns than in the PESS state for the whole sample period.

Moreover, the TSmom Equity Indices results are quite similar as well, showing only a difference in the OPT state for the whole sample period and before-crisis-period. The OPT state for the TSmom Equity Indices for these periods become insignificant for the alternative proxy. Moreover, it is interesting to see that the OPT, and PESS state for the TSmom Currencies are almost similar and significant, 1.24% compared to 1.22%, respectively. Moreover, all sentiment states for the TSmom Commodities and TSmom Currencies are significant for the whole sample period.

The conclusion regarding Table 4A is that market sentiment does affect the performance of time-series momentum returns. The same conclusions can be found in Appendix D Table 3 in the first column in which a robustness check is presented for the Baker and Wurgler sentiment index. In Appendix D Table 3 the results are presented of the original sentiment returns of Baker and Wurgler instead of the rolling average sentiment returns which are used in Table 4A. All states of sentiment, OPT, MILD, and PESS in the crisis period are insignificant, except for the TSmom all assets strategy MILD state with a 10% level significant result of 1.23% per month.

In comparison with Table 4A there are some more assets in which the OPT state is less in magnitude than the PESS state, especially for the fixed income strategies. Next to the TSmom fixed income OPT and MILD states for the whole period and the before-crisis-period to have lower returns per month which is presented in Table 4A, Appendix D Table 3 shows that the TSmom Fixed Income strategy in the crisis period for the OPT state generates lower returns as the PESS state. This is also the case for TSmom Currency strategy in the before-crisis-period. Moreover, the results for all the TSmom strategies in the OPT state for the whole period and the before-crisis-period are significant similar to Table 4A. A closer look at the TSmom Equity Indices strategy shows that the returns in the MILD state become insignificant for the whole period and the before-crisis-period which is not the case with the rolling average of sentiment.

Appendix Table 4A shows the results for the five individual Western Countries Equity Indices and the impact of the different sentiment states OPT, MILD, and PESS for the Baker and Wurgler sentiment index and the newly developed sentiment index. The Baker and Wurgler index shows significant results for all strategies for the whole sample period for the OPT and MILD states. The same holds for almost all strategies for the before-crisis-period, only a few OPT or MILD states are insignificant. There are no significant results for the PESS state for all strategies with the Baker and Wurgler sentiment index, and moreover there are no results for the sentiment states in the crisis period for all strategies. However, there is one exception for the OPT state in the crisis period for the TSmom S&P strategy which shows a positive impact on returns of 2.82%. The Baker and Wurgler index shows again as in Table 4A that this proxy follows a natural pattern, which is expected, having higher OPT states which decline in the MILD state and even less in the PESS state. This is not the case for the alternative proxy similar, as in Table 4 the MILD state is often higher than the OPT state.

Furthermore, next to the states of sentiment of the Baker and Wurgler index the results of the newly developed index will be discussed. The MILD state is for almost every asset class significant, except for the TSmom CAC for which there are no significant result for any period. The TSmom CAC strategy is somewhat surprising. Significant results are found for the OPT state as well as the PESS state for both the whole sample period and the before-crisis-period. The OPT state for the whole sample period shows a positive impact on returns of 0.88% and with respect to the before-crisis-period impact of 1.46%. The PESS state shows a sensitivity of 1.22% and 1.82%, respectively. This is a good example to show the reader that the PESS state is sometimes higher than the OPT state with the alternative proxy. The MILD state is for almost all strategies and periods significant and often higher than the OPT state.

Above, all the results are described using equation (1), which is useful due to coefficients and t-statistics of the PESS state can be presented. Hereinafter, the results regarding equation (2) will discussed and presented in Table 4B which is more like the standard procedure in literature. The set-up differs from equation (1), Table 4B shows the difference between the average returns in optimistic and pessimistic states by looking at coefficient $D_1^{TSO}$ which must be greater than zero and at the same time significant.

The results for Table 4B shows less significant results for the optimistic state for the non-stock asset class strategies. For the following strategies positive and significant OPT states are found for the Baker and Wurgler sentiment returns, namely the for the TSmom al assets whole sample period with a return of 1.02%, and for the TSmom EQ whole sample period and before-crisis-period with a return of 3.87% and 3.41%, respectively. For the TSmom EQ strategies similar results are presented in Table 4A. Furthermore, a negative result of -2.37% is found for the MILD state. The second column in Appendix D Table 3 founds for all the TSmom EQ sample periods a positive significant result for the OPT states. The results in Appendix Table 3 are a robustness check with the original Baker and Wurgler sentiment returns.

Next the results regarding the alternative sentiment index are discussed. There are not any significant results for the alternative sentiment index with respect to the OPT states. A closer look at these results indicates that more negative returns for OPT states are found for the alternative sentiment index, apart from significance. However, significant MILD states are found for the whole sample period and before-crisis-period for TSmom all assets, and TSmom EQ strategies.

In Appendix D Table 4B the results for the five Wester Equity Indices TSmom strategies are presented. First the results regarding the Baker and Wurgler sentiment index will be described. To start with the OPT state of the TSmom AEX which is in the crisis period significant on the 10% significance level with an impact of 4.63%. Subsequently, empirical results are shown for the TSmom CAC which have significant positive OPT states as well of 2.62% and 2.23% for the whole sample and before-crisis-period. For the same periods the TSmom CAC shows also positive significant MILD states.

Furthermore, positive significant results for the OPT state are found for TSmom DAX strategy for the whole sample period of 1.83%. Next for the TSmom FTSE strategy only a significant result for the MILD state is found on the 10% significance level of 1.27%. At last, a significant OPT state is founded for the TSmom S&P strategy of 1.59% for the whole sample period, while for the before-crisis-period a significant result for the MILD state is found of 1.03%.

Next the results regarding the OPT states and MILD states using the newly developed sentiment index on the five Western Equity Indices TSmom strategies will be discussed. In short, there are no significant returns found for the OPT states for any of the strategies. Interesting is that the TSmom CAC the before-crisis period show a significant result for both the constant of 1.82%, while the MILD state is also significant, but negative with -1.80%. The constant of the whole sample period is significant with 1.22% too. Furthermore, TSmom DAX, TSmom FTSE, and TSmom S&P do have some significant results for the MILD state. The reader maybe noticed that in the tables with respect to equation (1) the PESS state equals the constant in the tables with equation (2). This is as expected because the beta of PESS of equation (1) and the constant from equation (2) are exactly the same. The empirical results from equation (2) are consistent with equation (1).

The overall conclusion for hypothesis one is that the OPT state generate higher returns than the PESS state. Although, the alternative sentiment proxy shows a few contradictory results when the OPT and PESS state are compared for the non-stock assets and the Western Countries Equity Indices as well. The Baker and Wurgler sentiment index shows a more natural pattern for the sentiment states than the alternative sentiment proxy. Especially, the MILD state for the strategies for the alternative sentiment proxy is often higher compared to the other states. The MILD states for both proxies are often significant as well.

### IV.A4 Performance of time-series momentum strategies considering a factor model

The fourth subsection examines the factor model which is explained in the methodology section in equation (3). Hypothesis one investigated the different sentiment states for both proxies and the impact on TSmom returns. The next step is to examine hypothesis two and three and check whether sentiment returns for both proxies are significant when regressed together with the MSCI, which is a proxy for the market RMRF, the Fama and French risk factors SMB and HML, and the UMD factor.

**Table 4A – Sentiment Dummies and the Time-series Momentum Strategies**

In this table the results from monthly regressions of the excess return of the TSmom strategy for the four assets classes and the overall TSmom strategy is presented in which dummies for each state of the market, namely optimistic (OPT), mild (MILD), and pessimistic (PESS) are taken into account. The dummies are regressed for both of the sentiment proxies which are respectively the sentiment index of Baker and Wurgler and the alternative (newly developed) sentiment index. For each asset class the data period of 01/1985 to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from 01/1985 to 12/2006 and the crisis-period from 01/2007 to 12/2010. As robustness check for the Baker and Wurgler index each state of sentiment is examined with the original Baker and Wurgler sentiment returns as well, instead of the rolling average, which can be found in the first column of Appendix D Table 3.

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | OPT | MILD | PESS | OPT | MILD | PESS |
| TSmom | Coefficient | 2.06% | 1.19% | 1.04% | 1.25% | 1.90% | 0.92% |
| 1985-2010 | (t-stat) | (4.772)* | (4.295)* | (3.000)* | (3.435)* | (5.983)* | (2.512)* |
| TSmom | Coefficient | 2.04% | 1.31% | 1.25% | 1.21% | 2.11% | 1.02% |
| 1985-2006 | (t-stat) | (4.400)* | (4.610)* | (3.348)* | (3.143)* | (6.334)* | (2.641)* |
| TSmom | Coefficient | 1.53% | 0.98% | -0.01% | 1.11% | 1.08% | 0.28% |
| 2007-2010 | (t-stat) | (1.438) | (1.007) | (-0.123) | (1.034) | (1.106) | (0.263) |
| TSmom CM | Coefficient | 1.22% | 1.35% | 0.97% | 1.17% | 1.51% | 0.80% |
| 1985-2010 | (t-stat) | (2.967)* | (3.745)* | (2.339)* | (2.835)* | (4.214)* | (1.951)** |
| TSmom CM | Coefficient | 1.36% | 1.38% | 1.13% | 1.22% | 1.35% | 1.33% |
| 1985-2006 | (t-stat) | (3.190)* | (3.758)* | (2.658)* | (2.850)* | (3.655)* | (3.114)* |
| TSmom CM | Coefficient | 0.33% | 1.08% | 0.31% | 1.31% | 1.41% | -1.08% |
| 2007-2010 | (t-stat) | (0.254) | (0.880) | (0.236) | (1.020) | (1.198) | (-0.843) |
| TSmom EQ | Coefficient | 4.24% | 1.21% | 0.37% | 1.05% | 3.59% | 0.43% |
| 1985-2010 | (t-stat) | (5.123)* | (1.678)** | (0.445) | (1.258) | (4.950)* | (0.520) |
| TSmom EQ | Coefficient | 4.08% | 1.65% | 0.67% | 0.47% | 4.75% | 0.13% |
| 1985-2006 | (t-stat) | (4.514)* | (2.111)* | (0.743) | (0.529) | (6.221)* | (0.148) |
| TSmom EQ | Coefficient | 3.88% | -0.19% | -1.44% | -0.00% | 0.90% | 1.13% |
| 2007-2010 | (t-stat) | (1.406) | (-0.140) | (-0.778) | (-0.003) | (0.651) | (0.327) |
| TSmom FI | Coefficient | 2.41% | 0.60% | 2.96% | 1.53% | 2.27% | 1.64% |
| 1985-2010 | (t-stat) | (2.684)* | (0.725) | (2.871)* | (1.499) | (3.267)* | (1.453) |
| TSmom FI | Coefficient | 2.34% | 0.70% | 3.16% | 1.90% | 2.48% | 1.21% |
| 1985-2006 | (t-stat) | (2.193)* | (0.754) | (2.758)* | (1.625) | (2.966)* | (0.958) |
| TSmom FI | Coefficient | 1.95% | 1.33% | 1.14% | 1.38% | 0.69% | 2.47% |
| 2007-2010 | (t-stat) | (1.073) | (0.805) | (0.628) | (0.766) | (0.421) | (1.368) |
| TSmom FX | Coefficient | 1.35% | 1.35% | 0.75% | 1.24% | 1.07% | 1.22% |
| 1985-2010 | (t-stat) | (2.079)* | (2.814)* | (1.630) | (2.227)* | (2.200)* | (2.190)* |
| TSmom FX | Coefficient | 1.17% | 1.38% | 1.14% | 1.20% | 1.10% | 1.48% |
| 1985-2006 | (t-stat) | (1.925)** | (2.624)* | (1.876)** | (1.968)* | (2.099) | (2.443)* |
| TSmom FX | Coefficient | 1.69% | 1.30% | -0.84% | 1.23% | 0.98% | -0.00% |
| 2007-2010 | (t-stat) | (0.850) | (1.139) | (-0.997) | (0.846) | (0.742) | (-0.002) |

*Table 4A*

**Table 4B – Sentiment Dummies and the Time-series Momentum Strategies**

In this table the results from monthly regressions of the excess return of the TSmom strategy for the four assets classes and the overall TSmom strategy is presented in which a constant and two dummies, namely optimistic (OPT) and mild (MILD) are taken into account. The dummies are regressed for both of the sentiment proxies which are respectively the sentiment index of Baker and Wurgler and the alternative (newly developed) sentiment index. Equation (2) is used to perform the regressions. The null hypotheses is $D_1^{TSO} \leq 0$ and the alternative hypotheses is therefore $D_1^{TSO} > 0$. If the null hypothesis is rejected the average return of OPT states is higher than PESS states, because the base category (PESS state) is represented by the constant. For each asset class the data period of 01/1985 to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from 01/1985 to 12/2006 and the crisis-period from 01/2007 to 12/2010. As robustness check for the Baker and Wurgler index each state of sentiment is examined with the original Baker and Wurgler sentiment returns as well, which can be found in Appendix D Table 3 in the second column.

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | C | OPT | MILD | C | OPT | MILD |
| TSmom | Coefficient | 1.04% | 1.02% | 0.15% | 0.92% | 0.34% | 0.98 |
| 1985-2010 | (t-stat) | (3.000)* | (1.843)** | (0.336) | (2.512)* | (0.653) | (2.034)* |
| TSmom | Coefficient | 1.25% | 0.79% | 0.06% | 1.02% | 0.19% | 1.09% |
| 1985-2006 | (t-stat) | (3.348)* | (1.328) | (0.128) | (2.641)* | (0.355) | (2.140)* |
| TSmom | Coefficient | -0.01% | 1.54% | 0.99% | 0.28% | 0.83% | 0.80% |
| 2007-2010 | (t-stat) | (-0.013) | (1.026) | (0.688) | (0.263) | (0.546) | (0.552) |
| TSmom CM | Coefficient | 0.97% | 0.26% | 0.38% | 0.80% | 0.36% | 0.71% |
| 1985-2010 | (t-stat) | (2.339)* | (0.657) | (0.695) | (1.951)** | (0.625) | (1.296) |
| TSmom CM | Coefficient | 1.13% | 0.23% | 0.25% | 1.33% | -0.11% | 0.02% |
| 1985-2006 | (t-stat) | (2.658)* | (0.376) | (0.444) | (3.114)* | (-0.187) | (0.031) |
| TSmom CM | Coefficient | 0.31% | 0.02% | 0.75% | -1.08% | 2.39% | 2.49% |
| 2007-2010 | (t-stat) | (0.236) | (0.013) | (0.419 | (-0.843) | (1.317) | (1.430) |
| TSmom EQ | Coefficient | 0.37% | 3.87% | 0.84% | 0.43% | 0.61% | 3.15% |
| 1985-2010 | (t-stat) | (0.445) | (3.308)* | (0.766) | (0.520) | (0.522) | (2.858)* |
| TSmom EQ | Coefficient | 0.67% | 3.41% | 0.98% | 0.13% | 0.34% | 4.62% |
| 1985-2006 | (t-stat) | (0.743) | (2.666)* | (0.817) | (0.148) | (0.270) | (3.953)* |
| TSmom EQ | Coefficient | -1.44% | 5.32% | 1.25% | 1.13% | -1.14% | -0.24% |
| 2007-2010 | (t-stat) | (-0.778) | (1.621) | (0.531) | (0.327) | (-0.295) | (-0.064) |
| TSmom FI | Coefficient | 2.96% | -0.56% | -2.37% | 1.64% | -0.10% | 0.63% |
| 1985-2010 | (t-stat) | (2.871)* | (-0.402) | (-1.738)** | (1.453) | (-0.069) | (0.467) |
| TSmom FI | Coefficient | 3.16% | -0.81% | -2.46% | 1.21% | 0.69% | 1.27% |
| 1985-2006 | (t-stat) | (2.758)* | (-0.515) | (-1.631) | (0.958) | (0.403) | (0.833) |
| TSmom FI | Coefficient | 1.14% | 0.81% | 0.19% | 2.47% | -1.09% | -1.78% |
| 2007-2010 | (t-stat) | (0.628) | (0.314) | (0.079) | (1.368) | (-0.426) | (-0.727) |
| TSmom FX | Coefficient | 0.75% | 0.60% | 0.59% | 1.22% | 0.00% | -0.15% |
| 1985-2010 | (t-stat) | (1.630) | (0.750) | (0.890) | (2.190)* | (0.026) | (-0.207) |
| TSmom FX | Coefficient | 1.14% | 0.03% | 0.24% | 1.49% | -0.29% | -0.38% |
| 1985-2006 | (t-stat) | (1.876)** | (0.034) | (0.295) | (2.443)* | (-0.336) | (-0.478) |
| TSmom FX | Coefficient | -0.84% | 2.54% | 2.14% | -0.00% | 0.01% | 0.99% |
| 2007-2010 | (t-stat) | (-0.997) | (1.171) | (1.509) | (-0.002) | (0.600) | (0.502) |

*Table 4B*

Table 5 shows the results for the non-stock assets classes with the Baker and Wurgler index where a rolling average is used for the sentiment returns. Similar results are found as in Moskowitz et al (2012). The Baker and Wurgler sentiment index is only significant with the TSmom EQ strategy for the whole sample and the before-crisis-period with an impact of 2.298% and 2.129%, respectively. Furthermore, the $R^2$ for some strategies are pretty high. For instance, the TSmom whole sample period has a $R^2$ of 32.7%, while sentiment is insignificant. The sentiment returns vary a lot from each other for the non-stock assets. The highest impact is 6.529% for the TSmom whole sample period and the lowest impact is -2.104% for the TSmom crisis period. Although, this results are not significant.

Next to the sentiment returns a pattern can be found for the Intercept and the UMD factor. For all strategies the Intercept and the UMD are significant. This confirms the findings of Moskowitz et al (2012) that cross-sectional momentum has a huge impact on time-series momentum. Secondly, a significant Intercept or alpha, indicates that there must be another factor or factors that cause the time-series momentum returns. Looking at the other factors there are somewhat surprising results for the MSCI and the SMB factor which were expected to be absent. The MSCI is significant for the TSmom EQ strategy for the whole sample (0.362%) and the before-crisis-period (0.540%). The SMB factor is significant at the 10% level for the TSmom EQ crisis period (0.595%), the TSmom FI whole sample period (-0.238%) and the crisis period (-0.806%).

Appendix D Table 5 which is a robustness check for the non-stock assets in which sentiment index returns are not included shows only a result for the SMB factor for the TSmom FI whole sample period. Moreover, the Intercept or alpha and the UMD factor are significant for all strategies. Table 5 shows for each strategy a much higher $R^2$ despite the insignificance of the added sentiment proxy of Baker and Wurgler. Appendix D Table 6 show highly similar results with Table 5 in which the original sentiment index of Baker and Wurgler is used instead of a rolling average. Again, sentiment is significant for the TSmom EQ whole sample period 2.128%, and the before crisis period 2.041%.

The impact of the alternative sentiment index on the TSmom non-stock asset strategies is presented in Appendix D Table 7 and show no significant result for sentiment which is consistent with the results of Moskowitz et al (2012). Furthermore, the alternative sentiment index differs from Baker and Wurgler in Table 5, because Appendix D Table 7 show for most of the strategies and periods a negative impact of sentiment. All other factors remain the same.

The following paragraphs will present the results of the factor model for the TSmom Western Equity Indices. Due to a significant result for the TSmom EQ strategy in the whole sample and before sample period the expectation is to find some results for the five Western Countries Equity Indices which are incorporated into the diversified TSmom EQ strategy. Appendix D Table 8 show one significant result for the Baker and Wurgler proxy for the TSmom DAX whole sample. The impact of the TSmom DAX strategy of Baker and Wurgler sentiment is 1.063% and is significant at the 10% level. The highest

$R^2$ is found for the TSmom DAX crisis period with an explanatory power of 48.9%. Again such high result is found without a significant sentiment factor. The UMD factor is for all strategies and periods significant. The alpha in Appendix D Table 8 are all insignificant, except for the TSmom S&P strategy, suggesting that the UMD factor can explain all of the TSmom returns. Moreover, an interesting results is found for TSmom S&P whole sample period in which each factor is significant, except for sentiment.

The newly developed sentiment index regressed on the five Western Countries Equity Indices are shown in Appendix D Table 9 and shows for each strategy, except TSmom FTSE a significant result. The following strategies with their corresponding data periods are significant, namely the TSmom AEX crisis period with an impact of -1.546% and a $R^2$ of 39%. The TSmom CAC before-crisis period and the crisis period are both significant. Interesting is that the before-crisis-period show a positive impact of 0.992%, while in the crisis period the impact is -1.467% and thus negative. The TSmom DAX crisis period is significant on the 10% level with an explanatory power going through the 50 percent barrier of 52.2%. The TSmom S&P crisis period also shows a 10% significant result of -1.088%.

To conclude it seems that the newly developed proxy has a negative impact on the TSmom strategies, while the Baker and Wurgler shows a positive impact. Moreover, from the results it seems that individual Equity Indices could be profitable with the newly developed proxy. The TSmom EQ strategy shows no results with the alternative proxy, indicating that sentiment is not explaining any of the returns when the portfolio is diversified. The Baker and Wurgler sentiment returns does only show a result for the TSmom EQ for the whole and before-crisis-period sample. Exactly the same results for all strategies are found with the Baker and Wurgler index for the non-stock assets as in Moskowitz et al (2012) with an exception for the TSmom EQ as described above.

With the described results of this section hypothesis two and three can be answered. Overall, both proxies could not explain time-series momentum returns. The different build-up of the sentiment proxies with different underlying behavioural concepts and market imperfections fail to explain time-series momentum returns. However, there are a few exceptions in which sentiment can explain time-series momentum returns. The Baker and Wurgler sentiment index has a significant result for the diversified TSmom EQ. The alternative index have multiple significant results for the individual Western Countries Equity Indices. Moreover, the impact of the Baker and Wurgler sentiment index is positive, while the newly developed index shows often a negative impact. The alternative sentiment index based on consumer confidence seems to be better with less diversified strategies, while the Baker and Wurgler sentiment index seems to be better for more diversified strategies. Hypothesis three indicates that the positive impact of sentiment in time-series momentum is stronger in stock markets than in other assets. This is partly correct, as explained above only the TSmom EQ is significant with the Baker and Wurgler index which has a positive and stronger impact on the momentum profits than

other assets. However, the impact of the alternative proxy is as said, negative but it still has a strong impact.

**Table 5 – Performance of Time-Series Momentum Strategies**

This table presents the results from time-series regressions of monthly returns on the TSmom strategies, namely the four sets of asset classes which are commodities, currencies, equity indices, and fixed income. Furthermore, the overall diversified TSmom strategy in which the four assets are incorporated, which is also examined by Moskowitz et al (2012), is presented as well. In addition to Appendix D Table 6, the Baker and Wurgler sentiment index of average rolling returns is added to the factor model (BWRol). The other dependent variables regressed on the TSmom strategies remains the same, namely the MSCI World (a proxy for the market return), and the Fama and French factors (respectively proxies for size, value and cross-sectional momentum). For each asset class the data period of 01/1985 to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from 01/1985 to 12/2006 and the crisis-period from 01/2007 to 12/2010.

| **TSmom All Assets** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| 01/1985 | Coefficient | 1.128% | 0.086% | -0.051% | -0.031% | 0.263% | 0.575% | 14.1% |
| 12/2010 | (t-stat) | (5.3902)* | (1.4197) | (-0.7323) | (-0.4580) | (5.5228)* | (1.293) | |
| 01/1985 | Coefficient | 1.129% | 0.129% | -0.030% | 0.006% | 0.240% | 0.528% | 11.5% |
| 12/2006 | (t-stat) | (4.7269)* | (1.6090) | (-0.3866) | (0.0759) | (4.3105)* | (1.1476) | |
| 01/2007 | Coefficient | 0.998% | 0.011% | -0.091% | 0.044% | 0.299% | 0.140% | 26.5% |
| 12/2010 | (t-stat) | (1.8000)** | (0.1202) | (-0.3696) | (0.2006) | (3.1776)* | (0.0495) | |
| **TSmom Commodities** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
| 01/1985 | Coefficient | 1.056% | 0.021% | 0.006% | -0.022% | 0.187% | 0.116% | 5.4% |
| 12/2010 | (t-stat) | (4.4979)* | (0.4228) | (0.0898) | (-0.2775) | (3.9762)* | (0.2679) | |
| 01/1985 | Coefficient | 1.200% | -0.014% | -0.005% | -0.052% | 0.147% | 0.151% | 3.2% |
| 12/2006 | (t-stat) | (4.7364)* | (-0.2338) | (-0.0693) | (-0.5815) | (2.7470)* | (0.3583) | |
| 01/2007 | Coefficient | 0.706% | 0.069% | 0.129% | 0.015% | 0.323% | -2.104% | 15.7% |
| 12/2010 | (t-stat) | (0.9671) | (0.5646) | (0.4006) | (0.0533) | (2.6067)* | (-0.5664) | |
| **TSmom Currencies** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
| 01/1985 | Coefficient | 1.082% | 0.037% | -0.055% | -0.034% | 0.141% | -0.113% | 17.3% |
| 12/2010 | (t-stat) | (3.3422)* | (0.5505) | (-0.5542) | (-0.3150) | (2.1749)* | (-0.1892) | |
| 01/1985 | Coefficient | 1.093% | 0.100% | 0.002% | 0.061% | 0.089% | -0.269% | 1.0% |
| 12/2006 | (t-stat) | (2.9932)* | (1.1433) | (0.0199) | (0.4760) | (1.1620) | (-0.4442) | |
| 01/2007 | Coefficient | 0.793% | 0.025% | -0.093% | -0.165% | 0.193% | 2.192% | 11.7% |
| 12/2010 | (t-stat) | (1.4033) | (0.1947) | (-0.3149) | (-0.5598) | (2.0164)* | (0.5893) | |
| **TSmom Equity Index** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
| 01/1985 | Coefficient | 0.962% | 0.362% | 0.022% | -0.164% | 0.645% | 2.298% | 20.2% |
| 12/2010 | (t-stat) | (1.9603)* | (2.3264)* | (0.1536) | (-1.0684) | (6.6987)* | (2.5921)* | |
| 01/1985 | Coefficient | 0.806% | 0.540% | 0.024% | -0.080% | 0.636% | 2.129% | 20.7% |
| 12/2006 | (t-stat) | (1.4127) | (2.6208)* | (0.1343) | (-0.3849) | (5.5720)* | (2.2543)* | |
| 01/2007 | Coefficient | 1.303% | 0.089% | 0.595% | -0.020% | 0.632% | 6.529% | 29.2% |
| 12/2010 | (t-stat) | (1.1603) | (0.2775) | (1.7859)** | (-0.0429) | (3.3565)* | (1.0801) | |
| **TSmom Fixed Income** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
| 01/1985 | Coefficient | 1.658% | 0.016% | -0.238% | 0.130% | 0.264% | 0.151% | 32.7% |
| 12/2010 | (t-stat) | (2.8488)* | (0.1041) | (-1.7065)** | (0.8549) | (2.6389)* | (0.1528) | |
| 01/1985 | Coefficient | 1.550% | 0.075% | -0.178% | 0.197% | 0.291% | 0.121% | 29.6% |
| 12/2006 | (t-stat) | (2.1270)* | (0.3384) | (-1.1089) | (1.0113) | (2.1380)* | (0.1106) | |
| 01/2007 | Coefficient | 1.933% | -0.103% | -0.806% | 0.273% | 0.158% | -1.428% | 12.0% |
| 12/2010 | (t-stat) | (1.8835)** | (-0.5936) | (-1.7748)** | (0.6790) | (0.9083) | (-0.2734) | |

*Table 5*

### IV.A5 Confirmation time-series momentum is different from cross-sectional momentum

This last subsection about time-series momentum briefly describes that time-series momentum is an anomaly which is different from traditional cross-sectional momentum in a very simple way following equation (4). Moreover, two additional factors are added to the factor model as described in the previous section to verify whether these two factors may be able to explain some of the time-series momentum returns.

Table 6 Panel A shows a positive significant alpha indicating that next to cross-sectional momentum and both sentiment proxies other factors should explain time-series momentum returns. Although, cross-sectional momentum has a really high impact on time-series momentum. Interesting fact is that the Baker and Wurgler sentiment index shows a positive significant return as well. This might indicate that sentiment is somehow absorbed into the RMRF, SMB, and HML factors. Panel A shows again the positive impact of sentiment with the Baker and Wurgler index. Despite an insignificant value the impact of the alternative index is negative as described in the previous subsection.

Furthermore, Table 6 Panel B show an extended factor model in which the TED and VIX spread are added to the original factor model in Table 5. The TED spread is the difference between interest rates on interbank loans and short-term US government debt. The returns for the TED spread are calculated as the difference between the 3-month London Interbank Offered Rate (LIBOR) and the 3-month T-bill interest rate. VIX spread is a popular measure of the implied volatility of S&P 500 index options which is calculated based on historical returns. Panel B shows very interesting result, finding a positive significant return of 0.07% for the VIX spread (market volatility). Moreover, the alpha is no longer significant which means it is even more interesting to examine the VIX spread in relation with time-series momentum returns.

## IV.B Cross-sectional momentum strategies

### IV.B1 Performance cross-sectional momentum portfolios

This first subsection on cross-sectional momentum gives insight in the performance of the cross-sectional momentum portfolios. In Table 7 one can see the performance of the non-stock asset class portfolios. Table 7 presents the mean, the standard deviation, Sharpe ratio (1966) and the alpha in which all returns are reported annually. The non-stock assets classes show surprising results in that matter. Concerning the long-short CSmom strategies (P3-P1) the means and alphas are significant for CSmom CM, CSmom EQ, and CSmom FX, except for CSmom FI. The significant means vary between 3.69% for currencies to 13.07% for commodities with a t-statistic of 2.05 and 3.55, respectively.

**Table 6 – Time-Series Momentum Compared to Cross-Sectional Momentum**

Table 6 describes in Panel A whether cross-sectional momentum is a different anomaly than time-series momentum regressing a CSmom overall diversified factor as used in Asness et al (2013) and the Baker and Wurgler sentiment index and the newly developed sentiment index on TSmom. In Panel B the factor model in Table 5 is extended with two additional factors which seems plausible to investigate whether these factors can influence time-series momentum returns. The TED spread is the difference between interest rates on interbank loans and short-term US government debt and calculated as the difference between the 3-month London Interbank Offered Rate (LIBOR) and the 3-month T-bill interest rate. VIX spread is a popular measure of the implied volatility of S&P 500 index options.

Panel A: Confirmation time-series momentum is different from standard cross-sectional momentum

*Baker and Wurgler sentiment index*

| | | | | | |
|---|---|---|---|---|---|
| TSMOM | 1985-2010 | C | CSMOM | SENT BW | $R^2$ |
| all assets | Coefficient | 0.009 | 1.518 | 0.006 | 47.1% |
| | (t-stat) | (5.990)* | (16.428)* | (2.361)* | |

*Alternative sentiment index*

| | | | | | |
|---|---|---|---|---|---|
| TSMOM | 1985-2010 | C | CSMOM | SENT ALT | $R^2$ |
| all assets | Coefficient | 0.010 | 1.526 | -0.001 | 46.2% |
| | (t-stat) | (4.485)* | (16.221)* | (-0.735) | |

Panel B: Adding TED and VIX to factor model

| TSMOM | Intercept | MSCI | SMB | HML | UMD | SENT^ | TED | VIX | R2 |
|---|---|---|---|---|---|---|---|---|---|
| all assets | (t-stat) | (t-stat) | (t-stat) | (t-stat) | (t-stat) | (t-stat) | (t-stat) | (t-stat) | |
| ^BW | 0.29% | 0.00% | -0.05% | -0.00% | 0.25% | 0.08% | -0.92% | 0.07% | 16.0% |
| | (0.4726) | (0.133) | (-0.800) | (-0.029) | (5.486)* | (0.165) | (-1.463) | (2.393)* | |
| ^ALT | 0.23% | 0.00% | -0.05% | 0.00% | 0.24% | 0.06% | -0.94% | 0.07% | 16.1% |
| | (0.378) | (0.121) | (-0.7413) | (0.012) | (5.342)* | (0.294) | (-1.485) | (2.584)* | |

*Table 6*

The numbers are somewhat different as reported in Asness et al (2013) Table 1 Panel B. However, the same results are found with respect to significance. A plausible reason is that the data is adjusted over time. Another reason could be that a final dataset is available instead of raw data. For instance the CSmom FI strategy has an insignificant mean of 0.42% and alpha of 0.02% whereas Asness et al (2013) presents an insignificant mean of 1.0% with a t-statistic of 0.88 and alpha of 0.10% with a t-statistic of 0.08. Completely in line with Asness et al (2013) some results are found for portfolios P1, P2, and P3 as well. Surprisingly high significant results are found for the P3 portfolio means for the commodities and equity indices asset class with respectively 14.66% and 11.49%. A reason for the insignificant alpha for fixed income is that due to measures of central banks the opportunities for investors are narrowed, making it more plausible that the market is capable of estimating the returns for fixed income.

**Table 7 – Performance of Cross-Sectional Momentum Portfolios**

This table presents the annualized mean excess returns and the corresponding t-statistic between parentheses, the standard deviation, the Sharpe (1966) ratio in each asset class: commodities, currencies, equity indices and fixed income. Also reported are the annualized alphas with their t-statistic between parentheses from a time-series regression of each return series on the return of the market index for each asset class. The benchmark index for the investigated assets classes is an equal-weighted basket of the securities in each asset class. For each asset class the universe of securities is sorted by momentum, and then broken into three equal groups based on those sorts to form three portfolios, low, middle, and high which corresponds to portfolios P1, P2, and P3, respectively. The securities are equal-weighted within the formed portfolios. The high minus low spread in returns (P3-P1) is reported as well. Despite the statistics are computed from monthly return series all returns are reported as annualized numbers.

| | | P1 | P2 | P3 | P3-P1 |
|---|---|---|---|---|---|
| Commodities | Mean | 1.41% | 6.61% | 14.66% | 13.07% |
| (CM) | *(t-stat)* | (0.47) | (2.61)* | (4.26)* | (3.55)* |
| | Std. deviation | 19.03% | 15.92% | 21.66% | 23.19% |
| 01/1972 to | Sharpe ratio | 0.07 | 0.42 | 0.68 | 0.56 |
| 07/2011 | Alpha | -0.04% | 0.40% | 0.98% | 1.02% |
| | *(t-stat)* | (-0.16) | (1.44) | (2.66)* | (3.13)* |
| Currencies | Mean | -0.19% | 0.85% | 3.49% | 3.69% |
| (FX) | *(t-stat)* | (-0.12) | (0.60) | (2.40)* | (2.07)* |
| | Std. deviation | 9.43% | 8.06% | 8.31% | 10.18% |
| 01/1979 to | Sharpe ratio | -0.02 | 0.11 | 0.42 | 0.36 |
| 07/2011 | Alpha | -0.20% | -0.09% | 0.15% | 0.35% |
| | *(t-stat)* | (-1.32) | (-0.66) | (1.15) | (2.62)* |
| Equity Indices | Mean | 2.46% | 6.25% | 11.49% | 8.83% |
| (EQ) | *(t-stat)* | (0.88) | (2.36)* | (4.01)* | (4.34)* |
| | Std. deviation | 16.14% | 15.37% | 16.59% | 11.79% |
| 01/1978 to | Sharpe ratio | 0.15 | 0.41 | 0.69 | 0.75 |
| 07/2011 | Alpha | -0.47% | -0.14% | 0.24% | 0.71% |
| | *(t-stat)* | (-3.08)* | (-0.95) | (1.47) | (4.56)* |
| Fixed Income | Mean | 3.84% | 3.76% | 4.27% | 0.42% |
| (FI) | *(t-stat)* | (3.56)* | (3.56)* | (3.43)* | (0.38) |
| | Std. deviation | 5.78% | 5.75% | 6.78% | 5.91% |
| 01/1982 to | Sharpe ratio | 0.66 | 0.65 | 0.63 | 0.07 |
| 07/2011 | Alpha | 0.30% | 0.27% | 0.32% | 0.02% |
| | *(t-stat)* | (2.70)* | (2.55)* | (2.59)* | (0.24) |

*Table 7*

IV.B2 Performance of sentiment dummies

The second subsection describes the performance of the sentiment dummies on the cross-sectional momentum portfolios. At first, the impact of the three states of sentiment namely OPT, MILD, and PESS on the CSmom CM portfolios are presented in Table 8 following equation (5). This includes the whole sample period, before-crisis period and crisis period for the CM portfolios P1 (short-leg), P2, P3 (long-leg) and the commonly known long-short (P3-P1) cross-sectional momentum strategy.

Subsequently, based on the same principle the CSmom EQ, CSmom FI and CSmom FX portfolios are presented. Results found for the CSmom EQ, CSmom FI, and CSmom FX portfolios can be found in Appendix E Table 10, respectively. Hypothesis four will be tested with empirical results presented in Table 8 and Appendix E Table 10A and 10B. Hypothesis four states that the short-leg time-series momentum profits should be higher in an optimistic state compared to a pessimistic state. This hypothesis is based on the results of Stambaugh et al (2012) as previously mentioned.

Table 8A show similar results for the CSmom CM P3-P1 strategy for the Baker and Wurgler (2006) sentiment index as well as the alternative sentiment index. Both proxies show significant results for the whole sample and before-crisis-period regarding the MILD state of similar magnitude of respectively 1.67% and 1.51% for the whole sample period. Only one significant result is found in the P1 portfolio for the OPT state. A closer look at the CSmom CM P1 portfolio shows a significant result on the 10% level for the Baker and Wurgler sentiment OPT state of -0.81% with a negative t-statistic of -1.850. The OPT state results of P1 are almost all negative for both proxies similar to Stambaugh et al (2012). Whenever the OPT state has negative values in the short-leg, investors gain money since they have to repay less for the amount the investors shorted. The CSmom P3 portfolio indicates a relation of sentiment on the long-leg, especially in PESS states. The Baker and Wurgler sentiment index shows for all sample periods positive significant results, while the alternative sentiment index only shows a negative significant value for the crisis-period.

The next portfolios that are discussed are the CSmom EQ portfolios presented in Appendix E Table 10A. Striking results are found with respect to the P3-P1 EQ strategy. For all sentiment states for both proxies and sample periods there are significant results, except for the MILD and PESS state for the crisis-period for both proxies. There are no significant results for both proxies with respect to the P1 portfolio. The P3 CSmom EQ portfolio shows an interesting result for the before-crisis-period for both proxies because the OPT, MILD and PESS state are significant. This is direct evidence that a more diversified global equity portfolio build-up of hundreds maybe thousands of stocks gives very different results as the portfolio of Stambaugh et al (2012) with only a few individual stocks.

I continue with the CSmom FI portfolios which are presented in Appendix E Table 10A showing again striking results. The OPT state of Baker and Wurgler for P1 shows significant results for the whole sample period and the before-crisis-period of 0.43% and 0.36%, while the PESS state for the alternative proxy is significant for all periods and even higher in the whole sample period, namely 0.58%. Moreover, for the different P3 portfolios it seems that there is a relation of sentiment on the cross-sectional momentum returns. However, the way of impact either positive or negative, differs among the asset classes. For the CSmom FI P3 portfolio significant results are found for the Baker and Wurgler sentiment index for the OPT state in the whole sample and before-crisis period, while the alternative proxy shows significant results for the PESS state for the whole sample and before-crisis-period in P3.

At last, the results regarding the CSmom FX portfolios. The P1 portfolio of CSmom FX show for each proxy one significant result. The Baker and Wurgler index shows a negative impact of -0.54% in the whole sample period. The OPT state with respect to the newly developed proxy is 0.61% for the crisis period. The CSmom FX P3 portfolio show two significant results for the PESS state which is contradictory with the CSmom FI P3 portfolio, for instance.

**Table 8A – Sentiment Dummies and the Cross-Sectional Momentum Strategies**

In this table the results from monthly regressions of the excess return of the CSmom strategy for the four assets classes are presented in which dummies for each state of the market, namely optimistic (OPT), mild (MILD), and pessimistic (PESS) are taken into account. The dummies are regressed for both of the sentiment proxies which are respectively the sentiment index of Baker and Wurgler and the alternative (newly developed) sentiment index. For each asset class the data period of the beginning period to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from the beginning period to 12/2006 and the crisis-period from 01/2007 to 12/2010. The beginning periods of the CSmom portfolios have different starting dates. Next to the high minus low momentum strategy for all asset classes in which the dummies of the two sentiment proxies are regressed (P3-P1), the low (P1) portfolio "short-leg", the middle (P2) portfolio and the high (P3) portfolio "long-leg" are shown as well. See Appendix E Table 10A for the results of currencies (FX), equity indices (EQ), and fixed income (FI). Below are presented the results for commodities (CM).

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | OPT | MILD | PESS | OPT | MILD | PESS |
| | **P3-P1** | | | | | | |
| CSmom CM | Coefficient | 0.31% | 1.67% | 0.93% | 1.27% | 1.51% | 0.50% |
| 1972-2010 | (t-stat) | (0.600) | (3.784)* | (1.361) | (2.358)* | (3.525)* | (0.745) |
| CSmom CM | Coefficient | 0.67% | 1.44% | 1.20% | 1.31% | 1.32% | 1.10% |
| 1972-2006 | (t-stat) | (1.247) | (3.039)* | (1.604)** | (2.217)* | (2.921)* | (1.515) |
| CSmom CM | Coefficient | 0.26% | 0.24% | -0.09% | 1.59% | 0.92% | -2.23% |
| 2007-2010 | (t-stat) | (0.182) | (0.186) | (-0.060) | (1.168) | (0.740) | (-1.638) |
| | **P1** | | | | | | |
| CSmom CM | Coefficient | -0.81% | 0.35% | 0.74% | -0.53% | 0.47% | -0.52% |
| 1972-2010 | (t-stat) | (-1.850)** | (0.986) | (1.351) | (-1.221) | (1.441) | (-0.919) |
| CSmom CM | Coefficient | -0.65% | 0.13% | 0.59% | -0.59% | 0.32% | -0.69% |
| 1972-2006 | (t-stat) | (-1.435) | (0.348) | (1.005) | (-1.242) | (0.936) | (-1.221) |
| CSmom CM | Coefficient | -1.71% | 1.48% | 2.77% | 1.22% | 2.18% | -1.00% |
| 2007-2010 | (t-stat) | (-1.106) | (1.500) | (1.794)** | (0.773) | (1.511) | (-0.632) |
| | **P2** | | | | | | |
| CSmom CM | Coefficient | -0.52% | 0.62% | 1.44% | 0.16% | 0.65% | -0.31% |
| 1972-2010 | (t-stat) | (-1.107) | (1.955)** | (2.942)* | (0.566) | (2.446)* | (-0.610) |
| CSmom CM | Coefficient | -0.24% | 0.45% | 1.60% | 0.20% | 0.52% | -0.06% |
| 1972-2006 | (t-stat) | (-0.714) | (1.538) | (3.307)* | (0.640) | (1.953)** | (-0.123) |
| CSmom CM | Coefficient | -3.08% | 0.81% | 1.89% | 0.95% | 1.86% | -3.40% |
| 2007-2010 | (t-stat) | (-1.201) | (0.844) | (2.417)* | (1.057) | (2.822)* | (-1.073) |
| | **P3** | | | | | | |
| CSmom CM | Coefficient | -0.50% | 2.02% | 1.67% | 0.74% | 1.98% | -0.03% |
| 1972-2010 | (t-stat) | (-0.852) | (3.773)* | (2.795)* | (1.744)** | (4.877)* | (-0.041) |
| CSmom CM | Coefficient | 0.02% | 1.56% | 1.79% | 0.73% | 1.64% | 0.41% |
| 1972-2006 | (t-stat) | (0.053) | (2.732)* | (2.685)* | (1.504) | (3.458)* | (0.548) |
| CSmom CM | Coefficient | -1.45% | 1.72% | 2.69% | 2.81% | 3.10% | -3.23% |
| 2007-2010 | (t-stat) | (-0.548) | (1.055) | (2.535)* | (1.533) | (1.852)** | (-1.759)** |

*Table 8A*

**Table 8B – Sentiment Dummies and the Cross-Sectional Momentum Strategies**

In this table the results from monthly regressions of the excess return of the CSmom strategy for the four non-stock assets classes are presented in which a constant and two dummies, namely optimistic (OPT) and mild (MILD) are taken into account. The dummies are regressed for both of the sentiment proxies which are respectively the sentiment index of Baker and Wurgler and the alternative (newly developed) sentiment index. Next to the high minus low momentum strategy for all asset classes in which the dummies of the two sentiment proxies are regressed (P3-P1), the low (P1) portfolio "short-leg", the middle (P2) portfolio and the high (P3) portfolio "long-leg" are shown as well. See Appendix E Table 10B for the results of currencies (FX), equity indices (EQ), and fixed income (FI). Below are presented the results for commodities (CM). For each asset class the data period of the beginning period to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from the beginning period to 12/2006 and the crisis-period from 01/2007 to 12/2010. The beginning periods of the CSmom portfolios have different starting dates. Equation (6) is used to perform the regressions. The null hypotheses is $D_1^{CSO} \leq 0$ and the alternative hypotheses is therefore $D_1^{CSO} > 0$. If the null hypothesis is rejected the average return of OPT states is higher than PESS states, because the base category (PESS state) is represented by the constant. This holds for the P2, P3 portfolios and the (P3-P1) strategy. For P1 portfolio the null and alternative hypothesis must be exactly the opposite, because in the P1 portfolio investors take short positions.

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | C | OPT | MILD | C | OPT | MILD |
| | **P3-P1** | | | | | | |
| CSmom CM | Coefficient | 0.93% | -0.62% | 0.74% | 0.50% | 0.77% | 1.01% |
| 1972-2010 | (t-stat) | (1.361) | (-0.732) | (0.908) | (0.745) | (0.898) | (1.128) |
| CSmom CM | Coefficient | 1.20% | -0.53% | 0.23% | 1.10% | 0.21% | 0.22% |
| 1972-2006 | (t-stat) | (1.604) | (-0.572) | (0.263) | (1.515) | (0.227) | (0.254) |
| CSmom CM | Coefficient | -0.09% | 0.35% | 0.33% | -2.23% | 3.82% | 3.15% |
| 2007-2010 | (t-stat) | (-0.060) | (0.171) | (0.170) | (-1.638) | (1.984)* | (1.708)** |
| | **P1** | | | | | | |
| CSmom CM | Coefficient | 0.74% | -1.55% | -0.38% | -0.52% | -0.00% | 0.99% |
| 1972-2010 | (t-stat) | (1.351) | (-2.210)* | (-0.589) | (-0.919) | (-0.012) | (1.513) |
| CSmom CM | Coefficient | 0.59% | -1.24% | -0.46% | -0.69% | 0.11% | 1.01% |
| 1972-2006 | (t-stat) | (1.005) | (-1.674)** | (-0.669) | (-1.221) | (0.146) | (1.529) |
| CSmom CM | Coefficient | 2.77% | -4.48% | -1.29% | -1.00% | 2.22% | 3.18% |
| 2007-2010 | (t-stat) | (1.794)** | (-2.051)* | (-0.617) | (-0.632) | (0.993) | (1.485) |
| | **P2** | | | | | | |
| CSmom CM | Coefficient | 1.44% | -1.96% | -0.83% | -0.31% | 0.47% | 0.96% |
| 1972-2010 | (t-stat) | (2.942)* | (-2.888)* | (-1.453) | (-0.610) | (0.808) | (1.687)** |
| CSmom CM | Coefficient | 1.60% | -1.84% | -1.15% | -0.06% | 0.25% | 0.58% |
| 1972-2006 | (t-stat) | (3.307)* | (-3.136)* | (-2.037)* | (-0.123) | (0.448) | (1.059) |
| CSmom CM | Coefficient | 1.89% | -4.96% | -1.08% | -3.40% | 4.35% | 5.26% |
| 2007-2010 | (t-stat) | (2.417)* | (-1.905)** | (-1.031) | (-1.073) | (1.321) | (1.616) |
| | **P3** | | | | | | |
| CSmom CM | Coefficient | 1.67% | -2.17% | 0.35% | -0.03% | 0.76% | 2.00% |
| 1972-2010 | (t-stat) | (2.795)* | (-2.589)* | (0.444) | (-0.035) | (0.884) | (2.429)* |
| CSmom CM | Coefficient | 1.79% | -1.77% | -0.23% | 0.41% | 0.32% | 1.23% |
| 1972-2006 | (t-stat) | (2.685)* | (-2.207)* | (-0.259) | (0.548) | (0.363) | (1.327) |
| CSmom CM | Coefficient | 2.69% | -4.14% | -0.96% | -3.23% | 6.04% | 6.33% |
| 2007-2010 | (t-stat) | (2.535)* | (-1.451) | (-0.495) | (-1.759)** | (2.328)* | (2.548)* |

*Table 8B*

Hereinafter, the results following Table 8B following equation (6) are presented. At first, the CSmom CM results are discussed. The CSmom CM strategy (P3-P1) shows no significant results with respect to the Baker and Wurgler index. Many results are found for the P1, P2, and P3 portfolios. To start with, the P1 portfolio has for all data periods negative significant OPT states in chronical order of -1.55%, -1.24% and -4.48%, respectively. In the P1 portfolios results are negative for the OPT state which is preferred in the short-leg and consistent with the results of Stambaugh et al (2012). The CSmom CM P2 portfolios shows interesting results finding for all sample periods a significant constant as well as a significant OPT state. However, the OPT states are all negative as in P1, while the constant is positive. This finding is contradictory with Stambaugh et al (2012). The CSmom CM P2 before-crisis period has for each term a significant result including the MILD state. The CSmom CM P3 portfolio shows again for all data periods positive significant results for the constant and negative significant result for the OPT state, except for the crisis period.

The results for the CSmom CM strategy and portfolios are very different for the alternative sentiment index as can be seen in Table 8. The CSmom CM long-short strategy shows a significant result of 3.82% for the OPT state as well as a significant result of 3.15% for the MILD state in the crisis period. Furthermore, there are two MILD states which are significant, the whole sample period of the P2 and P3 portfolio. Very interesting is that the CSmom Cm P3 portfolios for the crisis period for each term shows significant results, namely -3.23% for the constant on a 10% significance level and 6.04% for the OPT state and 6.33% for the MILD state which are really high.

I will continue with the results presented in Appendix E Table 10B. The CSmom EQ strategy and the P1, P2 and P3 portfolios show each significant results for the OPT state during the crisis period regarding the Baker and Wurgler sentiment index. For instance, the OPT state in P1 of -6.28% and in P3 of -4.61%. All the constant results for the CSmom EQ P3 portfolio are significant. The alternative sentiment index does not show any significant results for the OPT and MILD state.

Appendix E Table 10B shows no significant results for the CSmom FI strategy or portfolios for the Baker and Wurgler sentiment index returns. However, there are many significant results for the alternative sentiment index for the CSmom FI portfolios. To start with, the CSmom FI strategy show a significant result of 1.32% for the OPT state in the crisis period. The P1 portfolio shows for the OPT state a significant result of -0.57% and -1.02% for the whole sample period and the crisis period. Very interesting results are found for the CSmom FI P2 portfolio which has for the constant, OPT state, and MILD state for almost all sample periods significant results. The P3 portfolio shows a significant result of -0.53% for the OPT state for the whole sample period.

At last, the results of the CSmom FX strategy and portfolios are discussed. The Baker and Wurgler index shows for the OPT state in P1, P2 and P3 for all samples periods negative significant results, except for the CSmom FX P3 crisis period. The CSmom FX P1 portfolio has for the constant,

OPT state, and MILD state significant results regarding the whole sample period. With respect to the alternative sentiment index the CSmom FX P2 as the CSmom FX P3 before-crisis-period show negative significant results of -0.52% and -0.56%.

The short-leg P1 does show some results in which the OPT state is higher than the constant for the Baker and Wurgler index, but shows almost no results for the alternative sentiment index. Furthermore, there seems to be a relation of sentiment on the long-leg which has often a negative impact. The different results can be explained by the difference in portfolios. Stambaugh et al (2012) use cross-sectional momentum portfolios considering individual stocks, while the data used to construct the cross-sectional momentum portfolios in this thesis are diversified non-stock asset class portfolios. The methodology of determining high (OPT) and low (PESS) states of sentiment is different as well. Stambaugh et al (2012) classifies a high sentiment month and a low sentiment month if the values of the Baker and Wurgler sentiment index in the previous month is above or below median values. The findings of Stambaugh et al (2012) did not seem to hold for diversified portfolios. It is thus ambiguous that the short-leg (P1) is profitable following high sentiment (OPT state) for the assets examined in this thesis. Furthermore, there statement about no relations to returns on the long legs (P3) does not hold either.

### IV.B3 Performance of cross-sectional momentum non-stock asset classes strategies considering a factor model

The first cross-sectional subsection introduces the portfolios by showing the means and alphas, the second subsection shows the impact of different states of sentiment on cross-sectional momentum returns. This section will provide insight in the explanation of cross-sectional momentum returns using a factor model in which a market factor, Fama and French risk factors, and the Baker and Wurgler sentiment index or newly developed sentiment index is included. The empirical results can be found in Table 9 and Appendix E Table 11 and Table 12.

In Table 9 can be seen that sentiment cannot explain the momentum returns of the long-short (P3-P1) strategies for the non-stock asset classes with a $R^2$ varying between 0.5% for CSmom CM and 2.5% for the CSmom FI. The intercept for these long-short strategies are significant, except for fixed income which is assumable, because of earlier results of an insignificant mean and alpha. Worth mentioning is the fact that for the portfolios P1, P2 and P3 for the CSmom CM and CSmom FX strategies negative significant results are found for Baker and Wurgler sentiment index using a 3-month rolling average. This is against all expectations, because I expected to find positive significant results.

Almost exactly the same results are presented in Appendix E Table 11 in which the original Baker and Wurgler returns are used instead of the rolling average. Appendix E Table 12 show highly similar results as Table 9. For the CSmom CM P3-P1 strategy a positive significant result of 0.59% for

the alternative sentiment index at the 10% level is found with a t-statistic of 1.677 as well as a positive significant alpha. Moreover, the CSmom CM P3 shows also a positive impact of the newly developed sentiment index at the 10% significance level. The CSmom FI P1 and P2 both show a positive significant alpha as well as a negative significant value for sentiment. A striking outcome occurs in the CSmom EQ P3 portfolio for which all regressed variables are positive and significant, only sentiment is insignificant. Nevertheless, a $R^2$ of 53.3% is found, what is surprising because of the significant alpha. Overall, it can be concluded that sentiment is insignificant in the factor model for cross-sectional momentum which is consistent with the findings for the time-series momentum factor model.

# V. Conclusion & Recommendations

In this thesis the relation of sentiment on time-series momentum and cross-sectional momentum is analysed. Time-series momentum strategies are examined with the help of ten constructed time-series momentum portfolios. There are four non-stock assets class portfolios, namely commodities, currencies, global equity index and fixed income portfolios, and an overall diversified time-series momentum strategy in which the four portfolios are pooled. These portfolios are from the dataset of Moskowitz et al (2012). Furthermore, in this thesis five time-series momentum portfolios are formed of Western country Equity Indices, which are incorporated into the diversified global equity index of Moskowitz et al (2012). The relation of sentiment on time-series momentum and cross-sectional momentum are tested with a reference sentiment proxy, the Baker and Wurgler (2006) sentiment index and a newly developed sentiment index.

First of all, the different states of sentiment are examined. The first conclusion from this thesis regarding the different states of sentiment is that the OPT states generate higher returns than the PESS states for the examined time-series momentum portfolios. Although, the alternative sentiment proxy shows a few contradictory results when the OPT and PESS state are compared for the non-stock assets and the Western Countries Equity Indices as well. The Baker and Wurgler sentiment index shows a more natural pattern for the sentiment states than the alternative sentiment proxy.

Next, the relation of sentiment is tested in a factor model in which both proxies could not explain time-series momentum returns. The different build-up of the sentiment proxies with different underlying behavioural concepts and market imperfections fail to explain time-series momentum returns. However, there are a few exceptions in which sentiment can explain time-series momentum returns. Moreover, the impact of the Baker and Wurgler sentiment index is positive, while the newly developed index shows often a negative impact. The alternative sentiment index based on consumer confidence seems to be

better with less diversified strategies, while the Baker and Wurgler sentiment index seems to be better for more diversified strategies.

Furthermore, the factor model tested whether the positive impact of sentiment in time-series momentum is stronger in stock markets than in other assets. This is partly correct, as only the TSmom EQ is significant with the Baker and Wurgler index which has a positive and stronger impact on the momentum profits than other sets of asset classes. However, the impact of the alternative proxy is as said negative, but it still has a strong impact. The main conclusion of the empirical results is that sentiment does not influence time-series momentum returns which is consistent with the results of Moskowitz et al (2012).

At last, as an extension this thesis also examined cross-sectional momentum using four non-stock asset class portfolios from the dataset of Asness et al (2013). The relation of sentiment is tested on the short-leg and long-leg for cross-sectional momentum portfolios following Stambaugh et al (2012) instead of the long-short momentum strategy. Empirical results show that the short-leg P1 does show some results in which the OPT state is higher than the constant (PESS state) for the Baker and Wurgler index, but shows almost no results for the alternative sentiment index. Furthermore, there seems to be a relation of sentiment on the long-leg which has often a negative impact. The different results can be explained by the difference in portfolios. The findings of Stambaugh et al (2012) did not seem to hold for commodities, currencies, equity indices, and fixed income. It is thus ambiguous that the short-leg (P1) is profitable following high sentiment (OPT state) for the assets examined in this thesis. Furthermore, there statement about no relations to returns on the long legs (P3) does not hold either.

One limitation of this research could be that in the chosen data samples, which run to the end of 2010, most recent data is not incorporated into this research. Further research could take data of 2011 to 2016 into account to see whether the impact of sentiment on time-series momentum changes over time. A second limitation could be the formation of the sentiment proxies. Due to the fact sentiment is not directly observable it is hard to determine whether a sentiment proxy covers all sentiment. Recommendations for further investigation with respect to the relation of sentiment on time-series momentum is to examine the same portfolios which are used in this thesis with the adjusted Baker and Wurgler sentiment index and to include recent data. Furthermore, it could be interesting to add more factors in the factor model, especially the relation of the VIX spread on time-series momentum could be very interesting to investigate further.

**Table 9 – Performance of Cross-Sectional Momentum Strategies**

This table presents the results of monthly regressions of the excess returns of the CSmom strategy for different asset classes. The risk factors of Fama and French which are used in Baker and Wurgler (2006) including the sentiment index with rolling average is regressed on the CSmom excess returns. In addition in Appendix E Table 11 one can see the results for all variables and the original Baker and Wurgler index instead of the rolling average.

| | | P1 | P2 | P3 | P3-P1 |
|---|---|---|---|---|---|
| Commodities | Intercept | -0.05% | 0.33% | 1.05% | 1.10% |
| | (t-stat) | (-0.2009) | (1.2686) | (2.8430)* | (3.2419)* |
| 01/1972 to | RMRF | 0.14% | 0.15% | 0.14% | -0.00% |
| 12/2010 | (t-stat) | (1.9622)** | (1.8065)** | (1.3230) | (-0.0782) |
| | SMB | 0.09% | 0.02% | 0.07% | -0.03% |
| | (t-stat) | (0.8655) | (0.3229) | (0.6466) | (-0.1809) |
| | HML | 0.16% | 0.23% | 0.00% | -0.15% |
| | (t-stat) | (1.5218) | (2.6084)* | (0.0527) | (-1.0818) |
| | Sentiment | -0.66% | -0.61% | -0.85% | -0.20% |
| | (t-stat) | (-1.9696)* | (-2.0911)* | (-2.3895)* | (-0.4352) |
| | $R^2$ | 3.2% | 4.5% | 3.0% | 0.5% |
| Currencies | Intercept | 0.01% | 0.12% | 0.32% | 0.31% |
| | (t-stat) | (0.0977) | (0.9020) | (2.4160)* | (1.9445)** |
| 01/1979 to | RMRF | 0.12% | 0.09% | 0.07% | -0.05% |
| 12/2010 | (t-stat) | (2.6961)* | (2.3869)* | (2.3307)* | (-1.1303) |
| | SMB | 0.02% | -0.00% | -0.03% | -0.05% |
| | (t-stat) | (0.4653) | (-0.0703) | (-0.6764) | (-1.0362) |
| | HML | 0.07% | 0.03% | 0.04% | -0.03% |
| | (t-stat) | (1.2109) | (0.7693) | (0.9650) | (-0.4887) |
| | Sentiment | -0.55% | -0.51% | -0.38% | 0.16% |
| | (t-stat) | (-2.4874)* | (-2.9967)* | (-2.0639)* | (0.7544) |
| | $R^2$ | 5.5% | 5.4% | 2.7% | 1.1% |
| Equity Indices | Intercept | -0.28% | -0.00% | 0.39% | 0.68% |
| | (t-stat) | (-1.5629) | (-0.0004) | (2.0882)* | (4.1613)* |
| 01/1978 to | RMRF | 0.79% | 0.78% | 0.78% | -0.00% |
| 12/2010 | (t-stat) | (14.5809)* | (20.2067)* | (15.2616)* | (-0.1309) |
| | SMB | 0.03% | 0.13% | 0.12% | 0.09% |
| | (t-stat) | (0.4701) | (2.3826)* | (1.7664)** | (1.3735) |
| | HML | 0.20% | 0.21% | 0.22% | 0.02% |
| | (t-stat) | (3.0118)* | (3.9453)* | (3.7556)* | (0.2376) |
| | Sentiment | -0.14% | -0.10% | -0.04% | 0.10% |
| | (t-stat) | (-0.7468) | (-0.5393) | (-0.1977) | (0.5248) |
| | $R^2$ | 5.6% | 6.3% | 5.3% | 0.7% |
| Fixed Income | Intercept | 0.29% | 0.19% | 0.23% | -0.06% |
| | (t-stat) | (2.8118)* | (1.6701)** | (1.8451)** | (-0.6242) |
| 01/1982 to | RMRF | 0.02% | 0.06% | 0.06% | 0.04% |
| 12/2010 | (t-stat) | (0.5608) | (1.9709)* | (1.4223) | (1.6729)** |
| | SMB | -0.06% | -0.04% | -0.11% | -0.05% |
| | (t-stat) | (-1.8605)** | (-2.0540)* | (-2.5161)* | (-1.6098) |
| | HML | -0.02% | 0.00% | -0.00% | 0.02% |
| | (t-stat) | (-0.5843) | (0.1130) | (-0.0176) | (0.6671) |
| | Sentiment | 0.09% | 0.37% | 0.34% | 0.25% |
| | (t-stat) | (0.5593) | (1.9197)** | (1.6830)** | (1.4193) |
| | $R^2$ | 1.3% | 4.3% | 5.0% | 2.5% |

*Table 9*

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# Appendix A

Table 1 shows in which area of finance the main focus of this thesis belongs to, and exhibits related literature of coherent finance areas.

| | Cross-sectional | Time-series |
|---|---|---|
| *N* months predicts *N* months | NA | "*Auto correlation*"<br>Fama and French (1988)<br>Lo and MacKingley (1990) |
| *M* months predict *N* months | "*Standard momentum*"<br>Jegadeesh and Titman (1993)<br>Asness et al (2013) | "*Time-series momentum*"<br>Moskowitz et al (2012) |

Table 1

# Appendix B

This table presents factors which are used in the regressions. For the CSmom factors only the long-short momentum factors are presented. For equation (4) and (5) CSmom short-leg (P1) and CSmom long-leg factors (P3) are also used. For instance, CSmom_EQ_P1 is the subscription of the CSmom short-leg and CSmom_EQ_P3 of the TSmom long-leg for the global equity index.

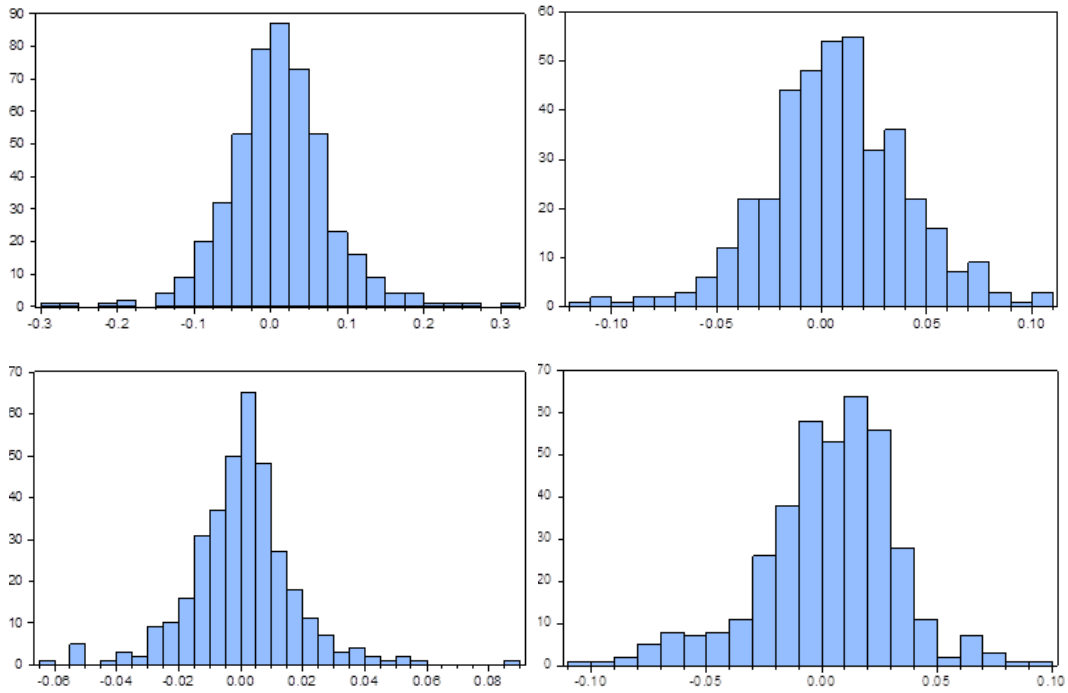
| ***Possibilities of subscription i*** (TS/CSmom) **and *j*** (Sentiment) | ***Full name of the factors*** | ***Used in equation:*** |
|---|---|---|
| TSmom_EQ | Time-series momentum global equity index | 1, 2, |
| TSmom_FI | Time-series momentum fixed income | 1, 2, |
| TSmom_CO | Time-series momentum commodities | 1, 2, |
| TSmom_FX | Time-series momentum currencies | 1, 2, |
| Tsmom_DAX | Time-series momentum equity index Germany | 1, 2, |
| TSmom_CAC | Time-series momentum equity index France | 1, 2, |
| TSmom_AEX | Time-series momentum equity index the Netherlands | 1, 2, |
| TSmom_FTSE | Time-series momentum equity index United Kingdom | 1, 2, |
| TSmom_S&P | Time-series momentum equity index United States | 1, 2, |
| TSmom_all_assets | Time-series momentum diversified non-stock assets | 1, 2, 3 |
| CSmom_EQ | Cross-sectional momentum global equity index | 4, 5 |
| CSmom_FI | Cross-sectional momentum fixed income | 4, 5 |
| CSmom_CO | Cross-sectional momentum commodities | 4, 5 |
| CSmom_FX | Cross-sectional momentum currencies | 4, 5 |
| CSmom_all_assets | Cross-sectional momentum diversified non-stock assets | 3, 5 |
| Sentiment_BW | Sentiment proxy Baker and Wurgler | 1, 2, 3, 5 |
| Sentiment_ALT | Sentiment proxy alternative | 1, 2, 3, 5 |
| Sentiment_BW_OPT | Sentiment Baker and Wurgler optimistic state | 1, 4 |
| Sentiment_BW_MILD | Sentiment Baker and Wurgler mild state | 1, 4 |
| Sentiment_BW_PESS | Sentiment Baker and Wurgler pessimistic state | 1, 4 |
| Sentiment_ALT_OPT | Sentiment alternative optimistic state | 1, 4 |
| Sentiment_ALT_MILD | Sentiment alternative state | 1, 4 |
| Sentiment_ALT_PESS | Sentiment alternative pessimistic | 1, 4 |
| RMRF | Excess return | 2, 5 |
| SMB | Small (market capitalization) minus Big | 2, 5 |
| HML | High (book-to-market ratio) minus Low | 2, 5 |
| UMD | Monthly premium on winners minus losers | 2, 5 |

Table 2

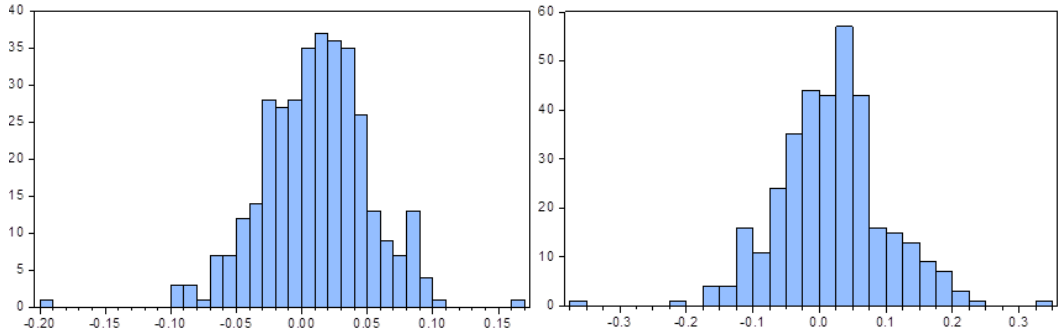
# Appendix C

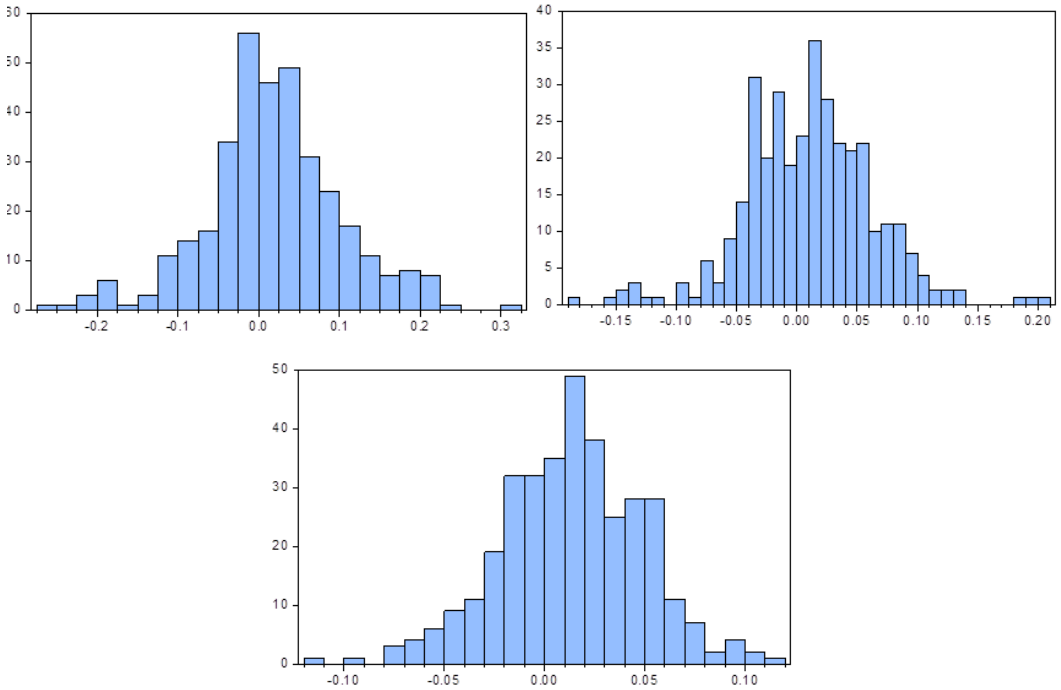
These graphs are an addition to Table 1 from which the distribution of the returns of all investigated portfolios can be seen graphically. The first four graphs are cross-sectional momentum portfolios of Asness et al (2013), in order of CSmom CM, CSmom EQ, CSmom FI, and CSmom FX. Next, the graphs of the five time-series momentum portfolios are shown in order of TSmom CM, TSmom EQ, TSmom FI, TSmom FX and the diversified al assets TSmom portfolio. At last the return distribution of the five Western equity indices portfolios are presented. The portfolios are shown in the following order AEX, CAC, DAX, FTSE and the S&P500.

Cross-sectional momentum portfolios Asness et al (2013)

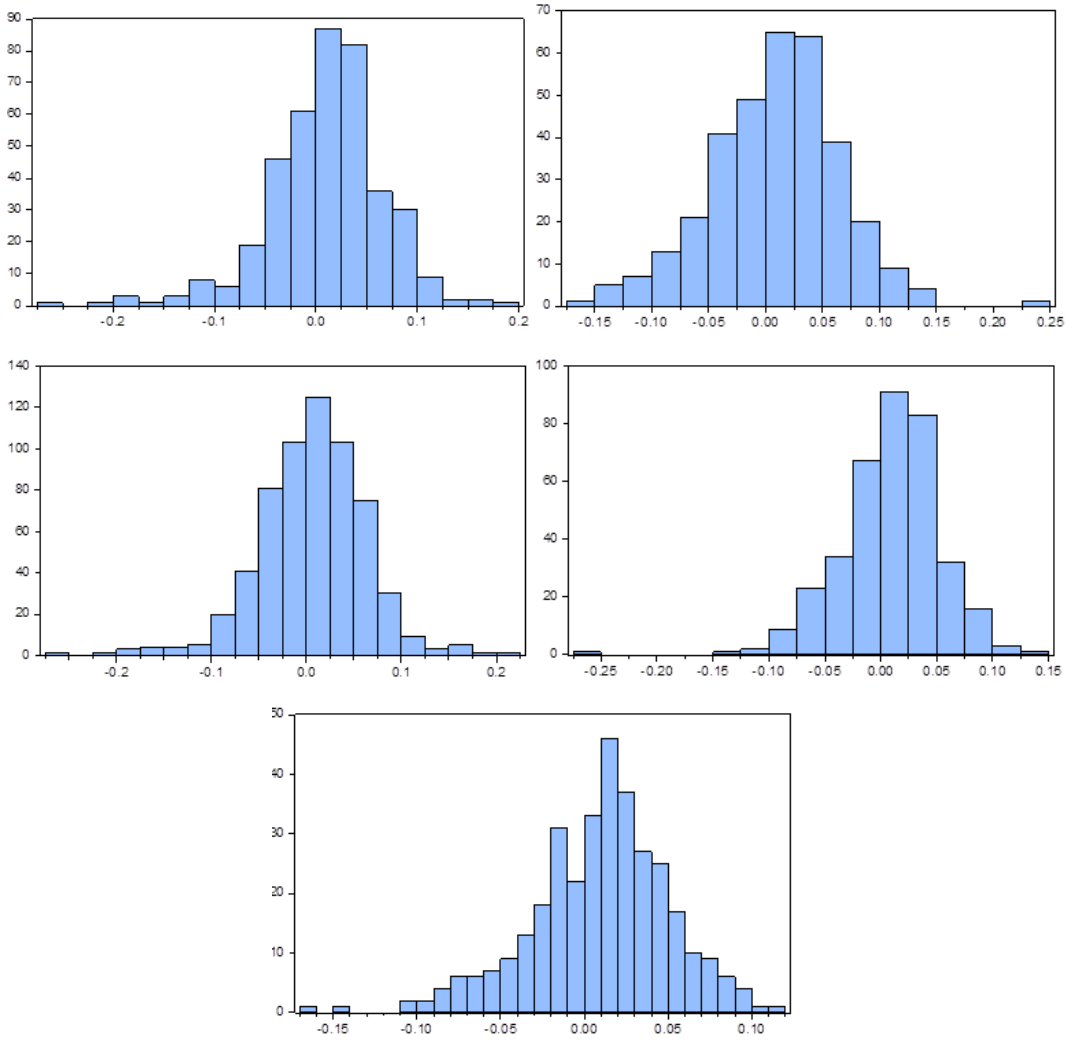


Time-series momentum portfolios Moskowitz et al (2012)





Western equity indices portfolios



# Appendix D

**Table 3 – Sentiment Dummies and the Time-Series Momentum Strategies**

In this table the results from monthly regressions of the excess return of the TSmom strategy for the four assets classes and the overall TSmom strategy is presented in which dummies for each state of the market, namely optimistic (OPT), mild (MILD), and pessimistic (PESS) are taken into account in the first column. The difference with Table 4 is that the Baker and Wurgler sentiment returns are used instead of a rolling average as explained in the data section. In the second column the results for the TSmom non-asset class strategies are presented in which a constant and two dummies, namely optimistic (OPT), mild (MILD) are taken into account for the original sentiment index returns of Baker and Wurgler. Equation (2) is used to perform the regressions. The null hypotheses is $D_1^{TSO} \leq 0$ and the alternative hypotheses is therefore $D_1^{TSO} > 0$. If the null hypothesis is rejected the average return of OPT states is higher than PESS states, because the base category (PESS state) is represented by the constant. This table is thus presented as a robustness check in which sentiment returns can be compared to the results with a rolling average of sentiment for which the dummies are regressed at the original sentiment index returns of Baker and Wurgler. Again for each asset class the data period of 01/1985 to 12/2010 is presented together with the two subperiods, which are the before-crisis-period from 01/1985 to 12/2006 and the crisis-period from 01/2007 to 12/2010.

| | | Baker and Wurgler sentiment index | | | Baker and Wurgler sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | OPT | MILD | PESS | C | OPT | MILD |
| TSmom | Coefficient | 1.96% | 1.18% | 1.15% | 1.15% | 0.81% | 0.03% |
| 1985-2010 | (t-stat) | (5.681)* | (4.553)* | (3.237)* | (3.132)* | (1.465) | (0.075) |
| TSmom | Coefficient | 2.31% | 0.98% | 1.43% | 1.43% | 0.89% | -0.45% |
| 1985-2006 | (t-stat) | (6.024)* | (2.952)* | (3.716)* | (3.716)* | (1.632) | (-0.884) |
| TSmom | Coefficient | 1.10% | 1.23% | 0.10% | 0.10% | 1.00% | 1.13% |
| 2007-2010 | (t-stat) | (0.880) | (1.722)** | (0.088) | (0.087) | (0.588) | (0.834) |
| TSmom CM | Coefficient | 1.11% | 1.37% | 1.04% | 1.04% | 0.07% | 0.33% |
| 1985-2010 | (t-stat) | (2.690)* | (3.825)* | (2.523)* | (2.523)* | (0.118) | (0.609) |
| TSmom CM | Coefficient | 1.61% | 1.12% | 1.25% | 1.25% | 0.36% | -0.13% |
| 1985-2006 | (t-stat) | (3.773)* | (3.032)* | (3.929)* | (2.929)* | (0.597) | (-0.236) |
| TSmom CM | Coefficient | 0.02% | 1.96% | -0.46% | -0.46% | 0.48% | 2.43% |
| 2007-2010 | (t-stat) | (0.016) | (1.669) | (-0.359) | (-0.359) | (0.265) | (1.391) |
| TSmom EQ | Coefficient | 4.33% | 0.99% | 0.57% | 0.57% | 3.76% | 0.42% |
| 1985-2010 | (t-stat) | (5.235)* | (1.371) | (0.692) | (0.692) | (3.213)* | (0.379) |
| TSmom EQ | Coefficient | 4.54% | 0.99% | 1.10% | 1.10% | 3.44% | -0.10% |
| 1985-2006 | (t-stat) | (5.041)* | (1.281) | (1.219) | (1.219) | (2.702)* | (-0.086) |
| TSmom EQ | Coefficient | 4.05% | -0.26% | -1.53% | -1.53% | 5.57% | 1.27% |
| 2007-2010 | (t-stat) | (1.506) | (-0.171) | (-1.093) | (-1.093) | (1.957)* | (0.687) |
| TSmom FI | Coefficient | 2.22% | 1.00% | 2.61% | 2.61% | -0.39% | -1.61% |
| 1985-2010 | (t-stat) | (2.656)* | (1.308) | (2.467)* | (2.467)* | (-0.291) | (-1.254) |
| TSmom FI | Coefficient | 2.66% | 0.57% | 3.02% | 3.02% | -0.36% | -2.45% |
| 1985-2006 | (t-stat) | (2.676)* | (0.627) | (2.731)* | (2.731)* | (-0.244) | (1.739)** |
| TSmom FI | Coefficient | 1.03% | 0.79% | 2.70% | 2.70% | -1.67% | -1.91% |
| 2007-2010 | (t-stat) | (0.890) | (0.439) | (1.184) | (1.489) | (-0.654) | (-0.781) |
| TSmom FX | Coefficient | 1.24% | 1.21% | 1.04% | 1.04% | 0.19% | 0.17% |
| 1985-2010 | (t-stat) | (1.886)** | (2.651)* | (2.121)* | (2.121)* | (0.237) | (0.248) |
| TSmom FX | Coefficient | 1.25% | 1.16% | 1.35% | 1.35% | -0.09% | -0.18% |
| 1985-2006 | (t-stat) | (2.058)* | (2.217)* | (2.214)* | (2.214)* | (-0.110) | (-0.228) |
| TSmom FX | Coefficient | 1.13% | 1.37% | -0.37% | -0.37% | 1.50% | 1.74% |
| 2007-2010 | (t-stat) | (0.738) | (1.037) | (-0.254) | (-0.254% | (0.733) | (0.887) |

Table 3

**Table 4A – Sentiment Dummies and the Time-Series Momentum Strategies**

In this table the results from monthly regressions of the excess return of the TSmom strategy for the five Western Countries Equity Indices are presented in which dummies for each state of the market, namely optimistic (OPT), mild (MILD), and pessimistic (PESS) are taken into account. The dummies are regressed for both of the sentiment proxies which are respectively the sentiment index of Baker and Wurgler and the alternative (newly developed) sentiment index. For each asset class the data period of the beginning period of the Equity Indices to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from the beginning period to 12/2006 and the crisis-period from 01/2007 to 12/2010. The beginning periods of the Equity Indices have different starting dates.

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | OPT | MILD | PESS | OPT | MILD | PESS |
| TSmom AEX | Coefficient | 1.24% | 0.94% | 0.18% | 0.32% | 1.26% | 0.69% |
| 1985-2010 | (t-stat) | (1.749)** | (2.022)* | (0.306) | (0.483) | (2.228)* | (0.848) |
| TSmom AEX | Coefficient | 0.99% | 0.91% | 0.46% | 0.32% | 1.50% | 0.35% |
| 1985-2006 | (t-stat) | (1.203) | (1.452) | (0.702) | (0.441) | (2.207)* | (0.544) |
| TSmom AEX | Coefficient | 3.79% | -0.29% | -0.84% | -0.30% | 1.39% | 1.23% |
| 2007-2010 | (t-stat) | (2.143)* | (-0.182) | (-0.487) | (-0.237) | (1.004) | (0.484) |
| TSmom CAC | Coefficient | 2.12% | 1.34% | -0.50% | 0.88% | 0.49% | 1.22% |
| 1985-2010 | (t-stat) | (2.937)* | (2.585)* | (-0.881) | (2.102)* | (0.806) | (1.873)** |
| TSmom CAC | Coefficient | 1.73% | 1.93% | -0.50% | 1.46% | 0.02% | 1.82% |
| 1985-2006 | (t-stat) | (2.155)* | (3.433)* | (-0.823) | (3.744)* | (0.029) | (2.458)* |
| TSmom CAC | Coefficient | 2.23% | -0.75% | -0.64% | -0.76% | 0.27% | -0.05% |
| 2007-2010 | (t-stat) | (1.451) | (-0.537) | (-0.416) | (-0.545) | (0.211) | (-0.036) |
| TSmom DAX | Coefficient | 1.51% | 1.00% | -0.31% | 0.86% | 1.24% | 0.03% |
| 1985-2010 | (t-stat) | (2.299)* | (1.746)** | (-0.477) | (1.299) | (2.155)* | (0.041) |
| TSmom DAX | Coefficient | 1.24% | 1.14% | -0.27% | 0.75% | (1.82%) | -0.69% |
| 1985-2006 | (t-stat) | (1.710)** | (1.832)** | (-0.379) | (1.044) | (2.935)* | (-0.964) |
| TSmom DAX | Coefficient | 3.13% | -0.16% | -0.29% | 0.08% | 1.75% | 0.47% |
| 2007-2010 | (t-stat) | (1.947)** | (-0.125) | (-0.146) | (0.057) | (1.546)* | (0.209) |
| TSmom FTSE | Coefficient | 1.32% | 0.93% | -0.08% | 0.41% | 1.38% | 0.16% |
| 1985-2010 | (t-stat) | (1.811)** | (2.853)* | (-0.158) | (0.691) | (4.013)* | (0.304) |
| TSmom FTSE | Coefficient | 0.99% | 1.22% | -0.05% | 0.33% | 1.95% | -0.22% |
| 1985-2006 | (t-stat) | (1.598) | (2.732)* | (-0.091) | (0.626) | (4.056)* | (-0.434) |
| TSmom FTSE | Coefficient | 1.89% | 0.12% | -0.64% | 0.08% | 1.07% | 0.01% |
| 2007-2010 | (t-stat) | (1.465) | (0.134) | (-0.403) | (0.096) | (0.940) | (0.007) |
| TSmom S&P | Coefficient | 1.80% | 1.05% | 0.27% | 1.03% | 1.21% | 0.58% |
| 1985-2010 | (t-stat) | (2.645)* | (2.930)* | (0.600) | (1.808)** | (3.474)* | (1.165) |
| TSmom S&P | Coefficient | 1.31% | 1.37% | 0.34% | 1.00% | 1.80% | 0.17% |
| 1985-2006 | (t-stat) | (1.746)** | (3.662)* | (0.803) | (1.565) | (4.569)* | (0.433) |
| TSmom S&P | Coefficient | 2.82% | -0.16% | -0.28% | -0.26% | 1.55% | 0.75% |
| 2007-2010 | (t-stat) | (1.703)** | (-0.164) | (-0.154) | (-0.294) | (1.595) | (0.275) |

Table 4A

**Table 4B – Sentiment Dummies and the Time-Series Momentum Strategies**

In this table the results from monthly regressions of the excess return of the TSmom strategy for the five Western Countries Equity Indices are presented in which a constant and two dummies, namely optimistic (OPT) and mild (MILD) are taken into account. The dummies are regressed for both of the sentiment proxies which are respectively the sentiment index of Baker and Wurgler and the alternative (newly developed) sentiment index. Equation (2) is used to perform the regressions. The null hypotheses is $D_1^{TSO} \leq 0$ and the alternative hypotheses is therefore $D_1^{TSO} > 0$. If the null hypothesis is rejected the average return of OPT states is higher than PESS states, because the base category (PESS state) is represented by the constant. For each asset class the data period of the beginning period of the Equity Indices to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from the beginning period to 12/2006 and the crisis-period from 01/2007 to 12/2010. The beginning periods of the Equity Indices have different starting dates.

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | C | OPT | MILD | C | OPT | MILD |
| TSmom AEX | Coefficient | 0.18% | 1.06% | 0.76% | 0.69% | -0.37% | 0.57% |
| 1985-2010 | (t-stat) | (0.294) | (0.899) | (0.910) | (0.848) | (-0.358) | (0.563) |
| TSmom AEX | Coefficient | 0.46% | 0.53% | 0.45% | 0.35% | -0.03% | 1.15% |
| 1985-2006 | (t-stat) | (0.702) | (0.491) | (0.474) | (0.544) | (-0.026) | (1.159) |
| TSmom AEX | Coefficient | -0.84% | 4.63% | 0.55% | 1.23% | -1.53% | 0.16% |
| 2007-2010 | (t-stat) | (-0.487 | (1.854)** | (0.230) | (0.484) | (-0.539) | (0.055) |
| TSmom CAC | Coefficient | -0.50% | 2.62% | 1.84% | 1.22% | -0.34% | -0.72% |
| 1985-2010 | (t-stat) | (-0.881) | (2.854)* | (2.396)* | (1.873)** | (-0.434) | (-0.811) |
| TSmom CAC | Coefficient | -0.50% | 2.23% | 2.43 | 1.82% | -0.36% | -1.80% |
| 1985-2006 | (t-stat) | (-0.829) | (2.215)* | (2.937)* | (2.458)* | (-0.434) | (-1.772)** |
| TSmom CAC | Coefficient | -0.64% | 2.87% | -0.11% | -0.05% | -0.71% | 0.32% |
| 2007-2010 | (t-stat) | (-0.416) | (1.321) | (-0.054) | (-0.036) | (-0.360) | (0.169) |
| TSmom DAX | Coefficient | -0.31% | 1.83% | 1.32% | 0.03% | 0.83% | 1.21% |
| 1985-2010 | (t-stat) | (-0.477) | (1.963)* | (1.507) | (0.041) | (0.890) | (1.384) |
| TSmom DAX | Coefficient | -0.27% | 1.51% | 1.42% | -0.69% | 1.44% | 2.51% |
| 1985-2006 | (t-stat) | (-0.372) | (1.477) | (1.484) | (-0.964) | (1.420) | (2.648)* |
| TSmom DAX | Coefficient | -0.29% | 3.43% | 0.13% | 0.47% | -0.39% | 1.28% |
| 2007-2010 | (t-stat) | (-0.146) | (1.393) | (0.053) | (0.173) | (-0.125) | (0.453) |
| TSmom FTSE | Coefficient | -0.08% | 1.40% | 1.01% | 0.16% | 0.25% | 1.23% |
| 1985-2010 | (t-stat) | (-0.158) | (1.579) | (1.569) | (0.304) | (0.322) | (1.979)* |
| TSmom FTSE | Coefficient | -0.05% | 1.04% | 1.27% | -0.22% | 0.55% | 2.17% |
| 1985-2006 | (t-stat) | (-0.091) | (1.285) | (1.855)** | (-0.460) | (0.678) | (3.505)* |
| TSmom FTSE | Coefficient | -0.64% | 2.52% | 0.75% | 0.01% | 0.07% | 1.06% |
| 2007-2010 | (t-stat) | (-0.403) | (1.256) | (0.418) | (0.007) | (0.036) | (0.499) |
| TSmom S&P | Coefficient | 0.27% | 1.54% | 0.78% | 0.58% | 0.45% | 0.64% |
| 1985-2010 | (t-stat) | (0.600) | (1.886)** | (1.363) | (1.165) | (0.597) | (1.049) |
| TSmom S&P | Coefficient | 0.34% | 0.97% | 1.03% | 0.17% | 0.83% | 1.63% |
| 1985-2006 | (t-stat) | (0.803) | (1.124) | (1.824)** | (0.433) | (1.100) | (2.902)* |
| TSmom S&P | Coefficient | -0.28% | 3.09% | 0.12% | 0.75% | -1.01% | 0.80% |
| 2007-2010 | (t-stat) | (-0.154) | (1.328) | (0.061) | (0.275) | (-0.352) | (0.274) |

Table 4B

**Table 5 – Performance of Time-Series Momentum Strategies**

This table presents the results from time-series regressions of monthly returns on the TSmom strategies for non-stock asset classes, namely the four sets of asset classes which are commodities, currencies, equity indices, and fixed income. Furthermore, the overall diversified TSmom strategy in which the four assets are incorporated, which is also examined by Moskowitz et al (2012), is presented as well. The dependent variables regressed on the TSmom strategies are MSCI World (a proxy for the market return), and the Fama and French factors (respectively proxies for size, value and cross-sectional momentum). For each asset class the data period of 01/1985 to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from 01/1985 to 12/2006 and the crisis-period from 01/2007 to 12/2010.

| **TSmom All Assets** | | Intercept | MSCI | SMB | HML | UMD | $R^2$ |
|---|---|---|---|---|---|---|---|
| 01/1985 | Coefficient | 1.190% | 0.082% | -0.046% | -0.014% | 0.268% | 13.4% |
| 12/2010 | (t-stat) | (5.6565)* | (1.3589) | (-0.6636) | (-0.2235) | (5.5440)* | |
| 01/1985 | Coefficient | 1.191% | 0.129% | -0.022% | 0.026% | 0.242% | 10.8% |
| 12/2006 | (t-stat) | (4.9606)* | (1.6094) | (-0.2850) | (0.3226) | (4.2438)* | |
| 01/2007 | Coefficient | 1.001% | 0.010% | -0.092% | 0.046% | 0.301% | 26.5% |
| 12/2010 | (t-stat) | (1.8443)** | (0.1112) | (-0.3833) | (0.2218) | (3.3782)* | |
| **TSmom Commodities** | | Intercept | MSCI | SMB | HML | UMD | $R^2$ |
| 01/1985 | Coefficient | 1.069% | 0.020% | 0.007% | -0.018% | 0.188% | 5.3% |
| 12/2010 | (t-stat) | (4.6489)* | (0.4102) | (0.1037) | (-0.2389) | (4.0139)* | |
| 01/1985 | Coefficient | 1.218% | -0.014% | -0.003% | -0.047% | 0.147% | 3.2% |
| 12/2006 | (t-stat) | (4.9089)* | (-0.2345) | (-0.0396) | (-0.5284) | (2.7644)* | |
| 01/2007 | Coefficient | 0.651% | 0.093% | 0.152% | -0.024% | 0.302% | 15.1% |
| 12/2010 | (t-stat) | (0.9070) | (0.8128) | (0.4797) | (-0.0880) | (2.5732)* | |
| **TSmom Currencies** | | Intercept | MSCI | SMB | HML | UMD | $R^2$ |
| 01/1985 | Coefficient | 1.070% | 0.038% | -0.056% | -0.037% | 0.140% | 1.7% |
| 12/2010 | (t-stat) | (3.3764)* | (0.5618) | (-0.5655) | (-0.3493) | (2.1702)* | |
| 01/1985 | Coefficient | 1.061% | 0.100% | -0.002% | 0.051% | 0.088% | 0.91% |
| 12/2006 | (t-stat) | (2.9681)* | (1.1455) | (-0.0172) | (0.4059) | (1.1502) | |
| 01/2007 | Coefficient | 0.850% | -0.000% | -0.117% | -0.124% | 0.215% | 11.0% |
| 12/2010 | (t-stat) | (1.0185) | (-0.0011) | (-0.3421) | (-0.3854) | (2.0074)** | |
| **TSmom Equity Index** | | Intercept | MSCI | SMB | HML | UMD | $R^2$ |
| 01/1985 | Coefficient | 1.209% | 0.349% | 0.042% | -0.099% | 0.664% | 18.0% |
| 12/2010 | (t-stat) | (2.4465)* | (2.2209)* | (0.2851) | (-0.6843) | (6.7478)* | |
| 01/1985 | Coefficient | 1.057% | 0.540% | 0.056% | -0.001% | 0.645% | 18.7% |
| 12/2006 | (t-stat) | (1.8359)** | (2.5962)* | (0.3136) | (-0.0061) | (5.3723)* | |
| 01/2007 | Coefficient | 0.848% | -0.061% | 0.297% | 0.171% | 0.636% | 27.3% |
| 12/2010 | (t-stat) | (0.6207) | (-0.1801) | (0.7672) | (0.2873) | (3.0302)* | |
| **TSmom Fixed Income** | | Intercept | MSCI | SMB | HML | UMD | $R^2$ |
| 01/1985 | Coefficient | 1.674% | 0.015% | -0.237% | 0.134% | 0.265% | 3.3% |
| 12/2010 | (t-stat) | (2.9735)* | (0.0993) | (-1.6968)** | (0.9111) | (2.6819)* | |
| 01/1985 | Coefficient | 1.564% | 0.075% | -0.176% | 0.201% | 0.292% | 3.0% |
| 12/2006 | (t-stat) | (2.2000)* | (0.3390) | (-1.0965) | (1.0519) | (2.1511)* | |
| 01/2007 | Coefficient | 1.896% | -0.086% | -0.790% | 0.246% | 0.144% | 11.8% |
| 12/2010 | (t-stat) | (1.8983)** | (-0.5775) | (-1.5231) | (0.6631) | (1.3029) | |

Table 5

**Table 6 – Performance of Time-Series Momentum Strategies**

This table presents the results from time-series regressions of monthly returns on the TSmom strategies for non-stock asset classes, namely the four sets of asset classes which are commodities, currencies, equity indices, and fixed income. Furthermore, the overall diversified TSmom strategy in which the four assets are incorporated, which is also examined by Moskowitz et al (2012), is presented as well. In addition to Appendix Table 5 the original Baker and Wurgler sentiment index (Sent BW) is added to the factor model. The other dependent variables regressed on the TSmom strategies remains the same, namely the MSCI World (a proxy for the market return), and the Fama and French factors (respectively proxies for size, value and cross-sectional momentum). For each asset class the data period of 01/1985 to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from 01/1985 to 12/2006 and the crisis-period from 01/2007 to 12/2010.

| **TSmom All Assets** | | Intercept | MSCI | SMB | HML | UMD | Sent BW | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| 01/1985 | Coefficient | 1.140% | 0.085% | -0.052% | -0.034% | 0.262% | 0.523% | 14.0% |
| 12/2010 | (t-stat) | (5.3836)* | (1.4040) | (-0.7390) | (-0.5016) | (5.5071)* | (1.2018) | |
| 01/1985 | Coefficient | 1.132% | 0.129% | -0.032% | 0.000% | 0.239% | 0.559% | 11.6% |
| 12/2006 | (t-stat) | (4.6905)* | (1.6117) | (-0.4043) | (0.0047) | (4.3286)* | (1.2513) | |
| 01/2007 | Coefficient | 1.072% | -0.016% | -0.106% | 0.137% | 0.348% | -3.009% | 28.8% |
| 12/2010 | (t-stat) | (1.9691)** | (-0.1754) | (-0.4415) | (0.6193) | (3.5673)* | (-1.1629) | |
| **TSmom Commodities** | | Intercept | MSCI | SMB | HML | UMD | Sent BW | $R^2$ |
| 01/1985 | Coefficient | 1.053% | 0.021% | 0.006% | -0.024% | 0.186% | 0.162% | 5.4% |
| 12/2010 | (t-stat) | (4.5035)* | (0.4273) | (0.0776) | (-0.3112) | (3.9504)* | (0.3714) | |
| 01/1985 | Coefficient | 1.194% | -0.014% | -0.007% | -0.057% | 0.146% | 0.229% | 3.3% |
| 12/2006 | (t-stat) | (4.7282)* | (-0.2306) | (-0.0915) | (-0.6303) | (2.7316)* | (0.5379) | |
| 01/2007 | Coefficient | 0.731% | 0.064% | 0.137% | 0.081% | 0.357% | -3.466% | 17.1% |
| 12/2010 | (t-stat) | (1.0135) | (0.5419) | (0.4297) | (0.2746) | (2.7603)* | (-1.0102) | |
| **TSmom Currencies** | | Intercept | MSCI | SMB | HML | UMD | Sent BW | $R^2$ |
| 01/1985 | Coefficient | 1.089% | 0.037% | -0.054% | -0.030% | 0.142% | -0.191% | 17.5% |
| 12/2010 | (t-stat) | (3.3745)* | (0.5448) | (-0.5413) | (-0.2744) | (2.1881)* | (-0.3178) | |
| 01/1985 | Coefficient | 1.090% | 0.100% | 0.003% | 0.064% | 0.090% | -0.270% | 1.0% |
| 12/2006 | (t-stat) | (2.9945)* | (1.1407) | (0.0255) | (0.4898) | (1.1682) | (-0.4399) | |
| 01/2007 | Coefficient | 0.879% | -0.011% | -0.123% | -0.086% | 0.234% | -1.248% | 11.3% |
| 12/2010 | (t-stat) | (1.0762) | (-0.0516) | (-0.3595) | (-0.2631) | (1.9835)** | (-0.3648) | |
| **TSmom Equity Index** | | Intercept | MSCI | SMB | HML | UMD | Sent BW | $R^2$ |
| 01/1985 | Coefficient | 1.007% | 0.361% | 0.018% | -0.179% | 0.641% | 2.128% | 19.8% |
| 12/2010 | (t-stat) | (2.0272)* | (2.2996)* | (0.1196) | (-1.1586) | (6.7019)* | (2.5305)* | |
| 01/1985 | Coefficient | 0.841% | 0.542% | 0.020% | -0.093% | 0.632% | 2.041% | 20.5% |
| 12/2006 | (t-stat) | (1.4481) | (2.6104)* | (0.1148) | (-0.4496) | (5.6164)* | (2.2666)* | |
| 01/2007 | Coefficient | 0.791% | -0.040% | 0.308% | 0.098% | 0.598% | 2.4454% | 27.7% |
| 12/2010 | (t-stat) | (0.5951) | (-0.1200) | (0.8071) | (0.1724) | (2.7608)* | (0.5994) | |
| **TSmom Fixed Income** | | Intercept | MSCI | SMB | HML | UMD | Sent BW | $R^2$ |
| 01/1985 | Coefficient | 1.668% | 0.016% | -0.238% | 0.131% | 0.264% | 0.068% | 3.3% |
| 12/2010 | (t-stat) | (2.8572)* | (0.1009) | (-1.702)** | (0.8456) | (2.5942)* | (0.0633) | |
| 01/1985 | Coefficient | 1.541% | 0.075% | -0.180% | 0.191% | 0.290% | 0.218% | 3.0% |
| 12/2006 | (t-stat) | (2.1138)* | (0.3389) | (-1.1277) | (0.9741) | (2.1221)* | (0.1905) | |
| 01/2007 | Coefficient | 2.072% | -0.150% | -0.825% | 0.475% | 0.264% | -7.567% | 16.9% |
| 12/2010 | (t-stat) | (2.0833)* | (-0.9217) | (-1.8818)** | (1.1734) | (1.4792) | (-1.6004) | |

Table 6

**Table 7 – Performance of Time-Series Momentum Strategies**

This table presents the results from time-series regressions of monthly returns on the TSmom strategies for non-stock asset classes, namely the four sets of asset classes which are commodities, currencies, equity indices, and fixed income. Furthermore, the overall diversified TSmom strategy in which the four assets are incorporated, which is also examined by Moskowitz et al (2012), is presented as well. The difference with Table 5 is that the sentiment rolling average of the newly developed index is added to the factor model instead of the Baker and Wurgler sentiment index rolling average. The other dependent variables regressed on the TSmom strategies are again the MSCI World (a proxy for the market return), and the Fama and French factors (respectively proxies for size, value and cross-sectional momentum). For each asset class the data period of 01/1985 to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from 01/1985 to 12/2006 and the crisis-period from 01/2007 to 12/2010.

| **TSmom All Assets** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| 01/1985 | Coefficient | 1.205% | 0.083% | -0.048% | -0.014% | 0.270% | -0.047% | 13.4% |
| 12/2010 | (t-stat) | (5.4150)* | (1.3697) | (-0.6780) | (-0.2168) | (5.3334)* | (-0.2147) | |
| 01/1985 | Coefficient | 1.187% | 0.129% | -0.022% | 0.026% | 0.242% | 0.006% | 10.8% |
| 12/2006 | (t-stat) | (4.0228)* | (1.6043) | (-0.2783) | (0.3217) | (4.2002)* | (0.0228) | |
| 01/2007 | Coefficient | 0.857% | 0.044% | -0.019% | 0.058% | 0.356% | -0.330% | 28.1% |
| 12/2010 | (t-stat) | (1.7653)** | (0.5374) | (-0.0976) | (0.3241) | (4.0491)* | (-0.8169) | |
| **TSmom Commodities** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
| 01/1985 | Coefficient | 1.013% | 0.017% | 0.014% | -0.020% | 0.180% | 0.182% | 5.5% |
| 12/2010 | (t-stat) | (4.1903)* | (0.3362) | (0.1967) | (-0.2606) | (3.7554)* | (0.7589) | |
| 01/1985 | Coefficient | 1.187% | -0.014% | -0.001% | -0.045% | 0.147% | 0.053% | 3.2% |
| 12/2006 | (t-stat) | (3.7439)* | (0.2232) | (-0.0186) | (-0.5133) | (2.7358)* | (0.1573) | |
| 01/2007 | Coefficient | 1.053% | 0.092% | 0.203% | 0.051% | 0.317% | 0.212% | 15.5% |
| 12/2010 | (t-stat) | (1.5362) | (0.7956) | (0.7318) | (0.2052) | (2.5535)* | (0.3706) | |
| **TSmom Currencies** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
| 01/1985 | Coefficient | 1.084% | 0.039% | -0.058% | -0.037% | 0.142% | -0.046% | 1.7% |
| 12/2010 | (t-stat) | (3.1530)* | (0.4464) | (-0.5883) | (-0.3296) | (2.2601)* | (-0.1289) | |
| 01/1985 | Coefficient | 1.221% | 0.096% | -0.010% | 0.046% | 0.092% | -0.275% | 1.0% |
| 12/2006 | (t-stat) | (2.6745)* | (1.1043) | (-0.0908) | (0.3593) | (1.1926) | (-0.5645) | |
| 01/2007 | Coefficient | 0.881% | -0.002% | -0.112% | -0.127% | 0.221% | 0.039% | 11.1% |
| 12/2010 | (t-stat) | (0.8728) | (-0.0110) | (-0.3169) | (-0.3676) | (1.6804) | (0.0482) | |
| **TSmom Equity Index** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
| 01/1985 | Coefficient | 1.301% | 0.355% | 0.031% | -0.096% | 0.677% | -0.297% | 18.2% |
| 12/2010 | (t-stat) | (2.4733)* | (2.2964)* | (0.2098) | (-0.6688) | (6.4859)* | (-0.5927) | |
| 01/1985 | Coefficient | 0.871% | 0.543% | 0.065% | 0.005% | 0.640% | 0.320% | 18.7% |
| 12/2006 | (t-stat) | (1.2087) | (2.6022)* | (0.3580) | (0.0273) | (5.3170) | (0.4746) | |
| 01/2007 | Coefficient | -0.625% | 0.033% | 0.055% | 0.306% | 0.803% | -1.903% | 33.2% |
| 12/2010 | (t-stat) | (-0.3761) | (0.1115) | (0.1494) | (0.5449) | (3.2525)* | (-1.6103) | |
| **TSmom Fixed Income** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
| 01/1985 | Coefficient | 1.833% | 0.025% | -0.256% | 0.139% | 0.287% | -0.516% | 3.6% |
| 12/2010 | (t-stat) | (3.2694)* | (0.1599) | (-1.7797)** | (0.9402) | (2.5854)* | (-0.9495) | |
| 01/1985 | Coefficient | 1.905% | 0.068% | -0.193% | 0.189% | 0.299% | -0.587% | 3.2% |
| 12/2006 | (t-stat) | (2.1315)* | (0.3072) | (-1.1742) | (0.9812) | (2.1443)* | (-0.6482) | |
| 01/2007 | Coefficient | 0.374% | -0.026% | -0.708% | 0.245% | 0.288% | -1.359% | 13.9% |
| 12/2010 | (t-stat) | (0.3994) | (-0.1620) | (-1.8638)** | (0.7158) | (1.6931)** | (-1.7429) | |

Table 7

**Table 8 – Performance of Time-Series Momentum Strategies**

This table presents the results from time-series regressions of monthly returns on the TSmom strategies for the five Western countries Equity Indices. In addition to Table 5, the Baker and Wurgler sentiment index of average rolling returns is regressed (BWRol) on the five Western Equity Indices, namely the AEX (NL), CAC (FR), DAX (GER), FTSE (UK), and S&P (US). The other dependent variables regressed on the TSmom strategies remains the same, namely the MSCI World (a proxy for the market return), and the Fama and French factors (respectively proxies for size, value and cross-sectional momentum). For each asset class the data period of the beginning period to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from the beginning period to 12/2006 and the crisis-period from 01/2007 to 12/2010. The beginning periods of the Equity Indices have different starting dates.

| **TSmom AEX** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| 01/1985 | Coefficient | 0.481% | 0.047% | -0.022% | -0.141% | 0.438% | 0.510% | 14.4% |
| 12/2010 | (t-stat) | (1.0143) | (0.3022) | (-0.1955) | (1.0974) | (4.4983)* | (1.0149) | |
| 01/1985 | Coefficient | 0.321% | 0.147% | -0.051% | -0.117% | 0.415% | 0.440% | 11.7% |
| 12/2006 | (t-stat) | (0.6920) | (0.9076) | (-0.3603) | (-0.6758) | (4.1943)* | (0.7464) | |
| 01/2007 | Coefficient | 1.004% | -0.115% | 0.344% | 0.051% | 0.473% | 4.303% | 33.2% |
| 12/2010 | (t-stat) | (1.4021) | (-0.5956) | (1.3492) | (0.1596) | (4.2426)* | (1.0418) | |
| **TSmom CAC** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
| 01/1985 | Coefficient | 0.547% | 0.119% | -0.081% | -0.230% | 0.395% | 1.081% | 16.5% |
| 12/2010 | (t-stat) | (1.5846) | (1.1686) | (-0.7642) | (-1.5733) | (5.3360)* | (1.4278) | |
| 01/1985 | Coefficient | 0.477% | 0.266% | -0.045% | -0.097% | 0.360% | 1.020% | 12.8% |
| 12/2006 | (t-stat) | (1.1660) | (1.8156)** | (-0.3523) | (-0.5210) | (3.6558)* | (1.2703) | |
| 01/2007 | Coefficient | 0.145% | -0.039% | 0.253% | -0.410% | 0.417% | 1.343% | 40.7% |
| 12/2010 | (t-stat) | (0.1981) | (-0.3152) | (0.7802) | (-1.4325) | (3.3583)* | (0.3604) | |
| **TSmom DAX** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
| 01/1985 | Coefficient | 0.234% | 0.125% | -0.038% | -0.125% | 0.561% | 1.063% | 19.9% |
| 12/2010 | (t-stat) | (0.6052) | (1.0980) | (-0.3192) | (-0.9544) | (7.3838)* | (1.6629)** | |
| 01/1985 | Coefficient | -0.124% | 0.282% | 0.014% | 0.051% | 0.565% | 1.019% | 17.6% |
| 12/2006 | (t-stat) | (-0.2736) | (1.7751)** | (0.0995) | (0.2964) | (5.4794)* | (1.5099) | |
| 01/2007 | Coefficient | 0.824% | -0.085% | 0.171% | -0.438% | 0.480% | -0.077% | 48.9% |
| 12/2010 | (t-stat) | (0.8937) | (-0.4501) | (0.6427) | (-1.3245) | (4.8663)* | (-0.0194) | |
| **TSmom FTSE** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
| 01/1985 | Coefficient | 0.394% | 0.260% | -0.130% | -0.135% | 0.335% | 0.626% | 18.2% |
| 12/2010 | (t-stat) | (1.1456) | (2.6000) | (-1.3589) | (-1.2590) | (5.3355)* | (1.1874) | |
| 01/1985 | Coefficient | 0.138% | 0.455% | -0.110% | 0.005% | 0.291% | 0.558% | 22.3% |
| 12/2006 | (t-stat) | (0.4012) | (3.6861) | (-1.0671) | (0.0371) | (3.8701)* | (0.9749) | |
| 01/2007 | Coefficient | 0.412% | -0.041% | 0.292% | -0.106% | 0.377% | 1.134% | 32.8% |
| 12/2010 | (t-stat) | (0.5889) | (-0.2827) | (1.1342) | (-0.3011) | (3.5293)* | (0.3549) | |
| **TSmom S&P** | | Intercept | MSCI | SMB | HML | UMD | BWRol | $R^2$ |
| 01/1985 | Coefficient | 0.641% | 0.207% | -0.216% | -0.225% | 0.382% | 0.517% | 26.6% |
| 12/2010 | (t-stat) | (2.3448)* | (2.0670)* | (-2.2335)* | (-1.9860)* | (7.0151)* | (0.8849) | |
| 01/1985 | Coefficient | 0.371% | 0.445% | -0.194% | -0.066% | 0.373% | 0.478% | 34.4% |
| 12/2006 | (t-stat) | (1.4049) | (4.5354)* | (-2.0497)* | (-0.5590) | (5.4961)* | (0.7547) | |
| 01/2007 | Coefficient | 0.680% | -0.106% | 0.234% | -0.256% | 0.357% | 1.526% | 36.4% |
| 12/2010 | (t-stat) | (0.9178) | (-0.6675) | (0.8866) | (-0.8728) | (3.4186)* | (0.4741) | |

Table 8

**Table 9 – Performance of Time-Series Momentum Strategies**

This table presents the results from time-series regressions of monthly returns on the TSmom strategies for the five Western countries Equity Indices. The difference with Appendix D Table 8 is that the sentiment rolling average of the newly developed index is added to the regression instead of the Baker and Wurgler sentiment index rolling average. The alternative sentiment index of average rolling returns is regressed (ALT sent) on the five Western Equity Indices, namely the AEX (NL), CAC (FR), DAX (GER), FTSE (UK), and S&P (US). The other dependent variables regressed on the TSmom strategies are again the MSCI World (a proxy for the market return), and the Fama and French factors (respectively proxies for size, value and cross-sectional momentum). For each asset class the data period of the beginning period to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from the beginning period to 12/2006 and the crisis-period from 01/2007 to 12/2010. The beginning periods of the Equity Indices have different starting dates.

| **TSmom AEX** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| 01/1985 | Coefficient | 0.736% | 0.057% | -0.042% | -0.120% | 0.470% | -0.650% | 15.2 |
| 12/2010 | (t-stat) | (1.5381) | (0.3840) | (-0.3961) | (-1.0105) | (4.7237)* | (-1.4410) | |
| 01/1985 | Coefficient | 0.595% | 0.143% | -0.055% | -0.108% | 0.422% | -0.382% | 11.7% |
| 12/2006 | (t-stat) | (1.1148) | (0.8816) | (-0.3923) | (-0.6455) | (4.0889)* | (-0.8161) | |
| 01/2007 | Coefficient | -0.325% | -0.106% | 0.175% | 0.237% | 0.653% | -1.546% | 39.0% |
| 12/2010 | (t-stat) | (-0.3300) | (-0.5610) | (0.5026) | (0.5586) | (4.3943)* | (-2.0732)* | |
| **TSmom CAC** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
| 01/1985 | Coefficient | 0.574% | 0.102% | -0.064% | -0.196% | 0.397% | 0.112% | 15.6% |
| 12/2010 | (t-stat) | (1.5877) | (0.9838) | (-0.5842) | (-1.4115) | (4.8943)* | (0.3155) | |
| 01/1985 | Coefficient | 0.018% | 0.274% | 0.004% | -0.030% | 0.347% | 0.992% | 13.5% |
| 12/2006 | (t-stat) | (0.0354) | (1.8405)** | (0.0316) | (-0.1647) | (3.5263)* | (2.0392)* | |
| 01/2007 | Coefficient | -0.956% | 0.019% | 0.051% | -0.282% | 0.559% | -1.467% | 47.3% |
| 12/2010 | (t-stat) | (-1.138) | (0.1632) | (0.1629) | (-1.0599) | (4.4762)* | (-2.3272)* | |
| **TSmom DAX** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
| 01/1985 | Coefficient | 0.455% | 0.126% | -0.042% | -0.092% | 0.585% | -0.348% | 19.4% |
| 12/2010 | (t-stat) | (1.1799) | (1.1240) | (-0.3519) | (-0.7351) | (7.2003)* | (-0.9686) | |
| 01/1985 | Coefficient | -0.231% | 0.287% | 0.041% | 0.097% | 0.564% | 0.389% | 17.0% |
| 12/2006 | (t-stat) | (-0.4131) | (1.7753)** | (0.2835) | (0.5712) | (5.3327)* | (0.7343) | |
| 01/2007 | Coefficient | -0.006% | -0.031% | 0.036% | -0.364% | 0.573% | -1.070% | 52.2% |
| 12/2010 | (t-stat) | (-0.0066) | (-0.2338) | (0.1523) | (-1.2133) | (4.9913) | (-1.697)** | |
| **TSmom FTSE** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
| 01/1985 | Coefficient | 0.450% | 0.257% | -0.132% | -0.115% | 0.349% | -0.225% | 18.0% |
| 12/2010 | (t-stat) | (1.3805) | (2.6156)* | (-1.3900) | (-1.1291) | (5.2369)* | (-0.6726) | |
| 01/1985 | Coefficient | 0.029% | 0.454% | -0.094% | 0.031% | 0.289% | 0.263% | 22.1% |
| 12/2006 | (t-stat) | (0.0700) | (3.6469)* | (-0.8939) | (0.2534) | (3.8063)* | (0.6872) | |
| 01/2007 | Coefficient | -0.206% | -0.012% | 0.173% | -0.026% | 0.462% | -0.837% | 35.6% |
| 12/2010 | (t-stat) | (-0.3018) | (-0.0900) | (0.6349) | (-0.0715) | (3.8767)* | (-1.6538) | |
| **TSmom S&P** | | Intercept | MSCI | SMB | HML | UMD | ALT Sent | $R^2$ |
| 01/1985 | Coefficient | 0.752% | 0.207% | -0.224% | -0.205% | 0.405% | -0.412% | 27.1% |
| 12/2010 | (t-stat) | (2.5268)* | (2.1962)* | (-2.2947)* | (-1.896)** | (7.0528)* | (-1.2486) | |
| 01/1985 | Coefficient | 0.318% | 0.442% | -0.180% | -0.043% | 0.372% | 0.150% | 34.1% |
| 12/2006 | (t-stat) | (1.0468) | (4.4658)* | (-1.8420)** | (-0.3620) | (5.3551)* | (0.5118) | |
| 01/2007 | Coefficient | -0.122% | -0.070% | 0.079% | -0.151% | 0.467% | -1.088% | 40.3% |
| 12/2010 | (t-stat) | (-0.1595) | (-0.4739) | (0.2890) | (-0.5382) | (3.7799)* | (-1.913)** | |

Table 9

# Appendix E

**Table 10A – Sentiment Dummies and the Cross-Sectional Momentum Strategies**

Continuation of Table 8A for currencies (FX), equity indices (EQ) and fixed income (FI). In this table the results from monthly regressions of the excess return of the CSmom strategy for the four assets classes are presented in which dummies for each state of the market, namely optimistic (OPT), mild (MILD), and pessimistic (PESS) are taken into account. The dummies are regressed for both of the sentiment proxies which are respectively the sentiment index of Baker and Wurgler and the alternative (newly developed) sentiment index. For each asset class the data period the beginning period to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from the beginning period to 12/2006 and the crisis-period from 01/2007 to 12/2010. Next to the high minus low momentum strategy for all asset classes in which the dummies of the two sentiment proxies are regressed (P3-P1), the low (P1) portfolio "short-leg", the middle (P2) portfolio and the high (P3) portfolio "long-leg" are shown as well.

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | OPT | MILD | PESS | OPT | MILD | PESS |
| | **P3-P1** | | | | | | |
| CSmom EQ | Coefficient | 0.94% | 0.60% | 0.65% | 0.66% | 0.77% | 0.71% |
| 1978-2010 | (t-stat) | (3.568)* | (2.365)* | (2.405)* | (2.105)* | (3.467)* | (2.505)* |
| CSmom EQ | Coefficient | 0.86% | 0.69% | 0.75% | 0.71% | 0.65% | 0.95% |
| 1978-2006 | (t-stat) | (3.135)* | (2.278)* | (2.688)* | (2.033)* | (2.832)* | (2.993)* |
| CSmom EQ | Coefficient | 1.42% | 0.15% | -0.25% | 0.91% | 0.45% | -0.09% |
| 2007-2010 | (t-stat) | (3.838)* | (0.358) | (-0.412) | (1.968)** | (0.783) | (-0.093) |
| | **P1** | | | | | | |
| CSmom EQ | Coefficient | -0.11% | 0.14% | 0.63% | 0.35% | 0.16% | 0.15% |
| 1978-2010 | (t-stat) | (-0.193) | (0.389) | (1.372) | (1.052) | (0.435) | (0.229) |
| CSmom EQ | Coefficient | 0.37% | 0.28% | 0.32% | 0.23% | 0.41% | 0.28% |
| 1978-2006 | (t-stat) | (0.869) | (0.756) | (0.763) | (0.542) | (1.126) | (0.666) |
| CSmom EQ | Coefficient | -3.68% | -0.58% | 2.60% | -1.28% | 0.30% | -0.85% |
| 2007-2010 | (t-stat) | (-1.458) | (-0.561) | (1.869)** | (-1.066) | (0.346) | (-0.237) |
| | **P2** | | | | | | |
| CSmom EQ | Coefficient | 0.41% | 0.44% | 0.75% | 0.58% | 0.69% | 0.24% |
| 1978-2010 | (t-stat) | (0.781) | (1.221) | (1.729)** | (1.388) | (1.784)** | (0.475) |
| CSmom EQ | Coefficient | 0.66% | 0.61% | 0.52% | 0.47% | 0.92% | 0.31% |
| 1978-2006 | (t-stat) | (1.352) | (1.359) | (1.209) | (1.001) | (2.176)* | (0.776) |
| CSmom EQ | Coefficient | -1.96% | -0.16% | 2.12% | -0.67% | 0.78% | -0.30% |
| 2007-2010 | (t-stat) | (-1.419) | (-0.131) | (1.533) | (-0.610) | (0.857) | (-0.115) |
| | **P3** | | | | | | |
| CSmom EQ | Coefficient | 0.83% | 0.75% | 1.27% | 1.01% | 0.93% | 0.86% |
| 1978-2010 | (t-stat) | (1.430) | (1.874)** | (3.446)* | (2.198)* | (2.342)* | (1.547) |
| CSmom EQ | Coefficient | 1.23% | 0.97% | 1.08% | 0.94% | 1.07% | 1.23% |
| 1978-2006 | (t-stat) | (2.677)* | (2.414)* | (2.349)* | (2.045)* | (2.673)* | (2.684)* |
| CSmom EQ | Coefficient | -2.25% | -0.43% | 2.36% | -0.37% | 0.75% | -0.93% |
| 2007-2010 | (t-stat) | (-1.588) | (-0.330) | (1.663) | (-0.291) | (0.774) | (-0.462) |

Table 10A

**Table 10A (Continued) – Sentiment Dummies and the Cross-Sectional Momentum Strategies**

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | OPT | MILD | PESS | OPT | MILD | PESS |
| | **P3-P1** | | | | | | |
| CSmom FI | Coefficient | 0.13% | 0.02% | -0.05% | 0.05% | 0.03% | 0.01% |
| 1982-2010 | (t-stat) | (0.563) | (0.152) | (-0.299) | (0.326) | (0.233) | (0.069) |
| CSmom FI | Coefficient | 0.24% | -0.03 | -0.00% | 0.04% | 0.04% | 0.09% |
| 1982-2006 | (t-stat) | (0.947) | (-0.265) | (-0.034) | (0.281) | (0.263) | (0.387) |
| CSmom FI | Coefficient | -0.20% | -0.01% | -0.19% | 0.53% | -0.12% | -0.79% |
| 2007-2010 | (t-stat) | (-0.701) | (-0.048) | (-0.661) | (2.078)* | (-0.506) | (-3.131)* |
| | **P1** | | | | | | |
| CSmom FI | Coefficient | 0.43% | 0.28% | 0.22% | 0.01% | 0.33% | 0.58% |
| 1982-2010 | (t-stat) | (2.576)* | (1.958)** | (1.317) | (0.081) | (2.266)* | (3.503)* |
| CSmom FI | Coefficient | 0.36% | 0.29% | 0.25% | -0.07% | 0.47% | 0.18% |
| 1982-2006 | (t-stat) | (1.974)* | (1.826)** | (1.380) | (-0.367) | (2.974)* | (2.448)* |
| CSmom FI | Coefficient | 0.44% | 0.46% | 0.10% | -0.03% | 0.13% | 0.98% |
| 2007-2010 | (t-stat) | (1.186) | (1.361) | (0.279) | (-0.089) | (0.386) | (2.753)* |
| | **P2** | | | | | | |
| CSmom FI | Coefficient | 0.59% | 0.19% | 0.20% | 0.03% | 0.26% | 0.66% |
| 1982-2010 | (t-stat) | (2.963)* | (1.380) | (1.083) | (0.171) | (1.997)* | (3.162)* |
| CSmom FI | Coefficient | 0.65% | 0.17% | 0.22% | -0.07% | 0.47% | 0.53% |
| 1982-2006 | (t-stat) | (2.921)* | (1.305) | (1.203) | (-0.408) | (3.002)* | (2.938)* |
| CSmom FI | Coefficient | -0.06% | 0.60% | 0.13% | -0.03% | 0.02% | 0.79% |
| 2007-2010 | (t-stat) | (-0.185) | (1.965)** | (0.373) | (-0.103) | (0.079) | (2.398)* |
| | **P3** | | | | | | |
| CSmom FI | Coefficient | 0.55% | 0.30% | 0.17% | 0.06% | 0.36% | 0.59% |
| 1982-2010 | (t-stat) | (2.295)* | (2.030)* | (0.823) | (0.336) | (2.203)* | (2.517)* |
| CSmom FI | Coefficient | 0.60% | 0.26% | 0.25% | -0.02% | 0.51% | 0.54% |
| 1982-2006 | (t-stat) | (2.102)* | (1.561) | (1.065) | (-0.115) | (2.696)* | (1.890)** |
| CSmom FI | Coefficient | 0.24% | 0.45% | -0.09% | 0.50% | 0.00% | 0.19% |
| 2007-2010 | (t-stat) | (0.580) | (1.192) | (-0.209) | (1.193) | (0.023) | (0.456) |

Table 10A

**Table 10A (Continued) – Sentiment Dummies and the Cross-Sectional Momentum Strategies**

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | OPT | MILD | PESS | OPT | MILD | PESS |
| | **P3-P1** | | | | | | |
| CSmom FX | Coefficient | 0.55% | 0.25% | 0.12% | 0.25% | 0.34% | 0.08% |
| 1979-2010 | (t-stat) | (2.005)* | (1.068) | (0.419) | (0.800) | (1.570) | (0.253) |
| CSmom FX | Coefficient | 0.34% | 0.45% | 0.20% | 0.11% | 0.39% | 0.16% |
| 1979-2006 | (t-stat) | (1.178) | (1.780)** | (0.706) | (0.362) | (1.455) | (0.545) |
| CSmom FX | Coefficient | 1.00% | -0.02% | -0.89% | 0.07% | 0.55% | -0.64% |
| 2007-2010 | (t-stat) | (1.154) | (-0.025) | (-1.028) | (0.084) | (1.064) | (-0.550) |
| | **P1** | | | | | | |
| CSmom FX | Coefficient | -0.54% | -0.03% | 0.46% | -0.32% | 0.01% | -0.20% |
| 1979-2010 | (t-stat) | (-1.672)** | (-0.150) | (2.189)* | (-1.180) | (0.057) | (-0.630) |
| CSmom FX | Coefficient | -0.47% | -0.04% | 0.25% | -0.44% | 0.14% | -0.22% |
| 1979-2006 | (t-stat) | (1.333) | (-0.180) | (1.666)** | (-1.556) | (0.603) | (-0.675) |
| CSmom FX | Coefficient | -1.17% | 0.58% | 1.45% | 0.61% | 0.20% | 0.13% |
| 2007-2010 | (t-stat) | (-1.401) | (0.763) | (1.730)** | (2.534)* | (0.311) | (0.095) |
| | **P2** | | | | | | |
| CSmom FX | Coefficient | -0.35% | 0.08% | 0.42 | -0.30% | 0.18% | -0.29% |
| 1979-2010 | (t-stat) | (-1.626)** | (0.412) | (1.920)** | (-1.319) | (0.924) | (-1.282) |
| CSmom FX | Coefficient | -0.37% | 0.10% | 0.23% | -0.48% | 0.30% | -0.31% |
| 1979-2006 | (t-stat) | (-1.694)** | (0.547) | (1.071) | (-2.115)* | (1.489) | (-1.401) |
| CSmom FX | Coefficient | -1.17% | 0.97% | 1.28% | 1.29% | 0.12% | -0.17% |
| 2007-2010 | (t-stat) | (-1.470) | (1.334) | (1.597) | (2.384)* | (0.187) | (-0.148) |
| | **P3** | | | | | | |
| CSmom FX | Coefficient | 0.02% | 0.23% | 0.58% | -0.07% | 0.36% | -0.12% |
| 1979-2010 | (t-stat) | (0.099) | (1.020) | (2.670)* | (-0.328) | (1.717) | (-0.491) |
| CSmom FX | Coefficient | -0.13% | 0.40% | 0.46% | -0.33% | 0.53% | -0.06% |
| 1979-2006 | (t-stat) | (-0.783) | (1.849)** | (1.880)** | (-1.475) | (2.239)* | (-0.233) |
| CSmom FX | Coefficient | -0.18% | 0.56% | 0.56% | 0.68% | 0.74% | -0.51% |
| 2007-2010 | (t-stat) | (-0.222) | (0.775) | (0.704) | (0.864) | (1.037) | (-0.654) |

Table 10A

**Table 10B – Sentiment Dummies and the Cross-Sectional Momentum Strategies**

Continuation of Table 8B for currencies (FX), equity indices (EQ) and fixed income (FI). In this table the results from monthly regressions of the excess return of the CSmom strategy for the four non-stock assets classes are presented in which a constant and two dummies, namely optimistic (OPT) and mild (MILD) are taken into account. The dummies are regressed for both of the sentiment proxies which are respectively the sentiment index of Baker and Wurgler and the alternative (newly developed) sentiment index. Next to the high minus low momentum strategy for all asset classes in which the dummies of the two sentiment proxies are regressed (P3-P1), the low (P1) portfolio "short-leg", the middle (P2) portfolio and the high (P3) portfolio "long-leg" are shown as well. For each asset class the data period of the beginning period to 12/2010 is presented. Furthermore, there are presented results of two subperiods, which are the before-crisis-period from the beginning period to 12/2006 and the crisis-period from 01/2007 to 12/2010. The beginning periods of the CSmom portfolios have different starting dates. Equation (6) is used to perform the regressions. The null hypotheses is $D_1^{CSO} \leq 0$ and the alternative hypotheses is therefore $D_1^{CSO} > 0$. If the null hypothesis is rejected the average return of OPT states is higher than PESS states, because the base category (PESS state) is represented by the constant. This holds for the P2, P3 portfolios and the (P3-P1) strategy. For P1 portfolio the null and alternative hypothesis must be exactly the opposite, because in the P1 portfolio investors take short positions.

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | C | OPT | MILD | C | OPT | MILD |
| | **P3-P1** | | | | | | |
| CSmom EQ | Coefficient | 0.65% | 0.29% | -0.04% | 0.71% | -0.05% | 0.07% |
| 1978-2010 | (t-stat) | (2.405)* | (0.761) | (-0.119) | (2.505)* | (-0.110) | (0.183) |
| CSmom EQ | Coefficient | 0.75% | 0.11% | -0.07% | 0.95% | -0.24% | -0.30% |
| 1978-2006 | (t-stat) | (2.688)* | (0.268) | (-0.161) | (2.993)* | (-0.511) | (-0.732) |
| CSmom EQ | Coefficient | -0.25% | 1.67% | 0.40% | -0.09% | 1.00% | 0.54% |
| 2007-2010 | (t-stat) | (-0.412) | (2.216)* | (0.543) | (-0.093) | (0.951) | (0.486) |
| | **P1** | | | | | | |
| CSmom EQ | Coefficient | 0.63% | -0.73% | -0.48% | 0.15% | 0.20% | 0.00% |
| 1978-2010 | (t-stat) | (1.372) | (-1.023) | (-0.817) | (0.229) | (0.266) | (0.012) |
| CSmom EQ | Coefficient | 0.32% | 0.04% | -0.04% | 0.28% | -0.05% | 0.13% |
| 1978-2006 | (t-stat) | (0.763) | (0.075) | (-0.078) | (0.666) | (-0.087) | (0.239) |
| CSmom EQ | Coefficient | 2.60% | -6.28% | -3.18% | -0.85% | -0.44% | 1.15% |
| 2007-2010 | (t-stat) | (1.572) | (-2.680)* | (-1.419) | (-0.237) | (-0.116) | (0.317) |
| | **P2** | | | | | | |
| CSmom EQ | Coefficient | 0.75% | -0.34% | -0.31% | 0.24% | 0.34% | 0.45% |
| 1978-2010 | (t-stat) | (1.729)** | (-0.500) | (-0.552) | (0.475) | (0.514) | (0.707) |
| CSmom EQ | Coefficient | 0.52% | 0.14% | 0.09% | 0.31% | 0.15% | 0.61% |
| 1978-2006 | (t-stat) | (1.209) | (0.219) | (0.147) | (0.776) | (0.249) | (1.047) |
| CSmom EQ | Coefficient | 2.12% | -4.08% | -2.28% | -0.30% | -0.36% | 1.08% |
| 2007-2010 | (t-stat) | (1.533) | (-2.087)* | (-1.220) | (-0.115) | (-0.127% | (0.389) |
| | **P3** | | | | | | |
| CSmom EQ | Coefficient | 1.27% | -0.44% | -0.53% | 0.86% | 0.15% | 0.08% |
| 1978-2010 | (t-stat) | (3.446)* | (-0.652) | (-0.979) | (1.547) | (0.208) | (0.111) |
| CSmom EQ | Coefficient | 1.08% | 0.15% | -0.11% | 1.23% | -0.29% | -0.16% |
| 1978-2006 | (t-stat) | (2.349)* | (0.232) | (-0.183) | (2.684)* | (-0.452) | (-0.266) |
| CSmom EQ | Coefficient | 2.36% | -4.61% | -2.78% | -0.93% | 0.56% | 1.68% |
| 2007-2010 | (t-stat) | (1.663)** | (-2.299)* | (-1.450) | (-0.462) | (0.235) | (0.751) |

Table 10B

**Table 10B (Continued) – Sentiment Dummies and the Cross-Sectional Momentum Strategies**

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | C | OPT | MILD | C | OPT | MILD |
| | **P3-P1** | | | | | | |
| CSmom FI | Coefficient | -0.05% | 0.17% | 0.06% | 0.01% | 0.03% | 0.02% |
| 1982-2010 | (t-stat) | (-0.299) | (0.634) | (0.331) | (0.069) | (0.134) | (0.070) |
| CSmom FI | Coefficient | -0.00% | 0.24% | -0.03% | 0.09% | -0.05% | -0.05% |
| 1982-2006 | (t-stat) | (-0.034) | (0.802) | (-0.129) | (0.387) | (-0.170) | (-0.175) |
| CSmom FI | Coefficient | -0.19% | -0.01% | 0.18% | -0.79% | 1.32% | 0.68% |
| 2007-2010 | (t-stat) | (-0.661) | (-0.028) | (0.456) | (-3.131) | (3.684)* | (1.971)** |
| | **P1** | | | | | | |
| CSmom FI | Coefficient | 0.22% | 0.21% | 0.07% | 0.58% | -0.57% | -0.25% |
| 1982-2010 | (t-stat) | (1.317) | (0.890) | (0.294) | (3.503)* | (-2.420)* | (-1.151) |
| CSmom FI | Coefficient | 0.25% | 0.11% | 0.04% | 0.45% | -0.51% | 0.02% |
| 1982-2006 | (t-stat) | (1.380) | (0.420) | (0.152) | (2.448)* | (-1.990)** | (0.096) |
| CSmom FI | Coefficient | 0.10% | 0.34% | 0.36% | 0.98% | -1.02% | -0.86% |
| 2007-2010 | (t-stat) | (0.279) | (0.641) | (0.711) | (2.753)* | (-2.010)* | (-1.773)* |
| | **P2** | | | | | | |
| CSmom FI | Coefficient | 0.20% | 0.39% | -0.01% | 0.66% | -0.63% | -0.40% |
| 1982-2010 | (t-stat) | (1.083) | (1.426) | (-0.059) | (3.162)* | (-2.250)* | (-1.682)** |
| CSmom FI | Coefficient | 0.22% | 0.43% | -0.05% | 0.53% | -0.61% | -0.06% |
| 1982-2006 | (t-stat) | (1.203) | (1.516) | (-0.230) | (2.938)* | (-2.366)* | (-0.256) |
| CSmom FI | Coefficient | 0.13% | -0.19% | 0.48% | 0.79% | -0.82% | -0.77% |
| 2007-2010 | (t-stat) | (0.373) | (-0.395) | (1.049) | (2.398)* | (-1.768)** | (-1.717)** |
| | **P3** | | | | | | |
| CSmom FI | Coefficient | 0.17% | 0.38% | 0.13% | 0.59% | -0.53% | -0.24% |
| 1982-2010 | (t-stat) | (0.823) | (1.185) | (0.506) | (2.517)* | (-1.791)** | (-0.846) |
| CSmom FI | Coefficient | 0.25% | 0.35% | 0.00% | 0.54% | -0.56% | -0.03% |
| 1982-2006 | (t-stat) | (1.065) | (0.956) | (0.035) | (1.890)** | (-1.589) | (-0.079) |
| CSmom FI | Coefficient | -0.09% | 0.33% | 0.54% | 0.19% | 0.31% | -0.18% |
| 2007-2010 | (t-stat) | (-0.209) | (0.558) | (0.958) | (0.456) | (0.521) | (-0.321) |

Table 10B

**Table 10B (Continued) – Sentiment Dummies and the Cross-Sectional Momentum Strategies**

| | | Baker and Wurgler sentiment index | | | Alternative sentiment index | | |
|---|---|---|---|---|---|---|---|
| | | C | OPT | MILD | C | OPT | MILD |
| | **P3-P1** | | | | | | |
| CSmom FX | Coefficient | 0.12% | 0.44% | 0.14% | 0.17% | 0.13% | 0.22% |
| 1982-2010 | (t-stat) | (0.419) | (1.122) | (0.381) | (0.763) | (0.380) | (0.719) |
| CSmom FX | Coefficient | 0.20% | 0.14% | 0.24% | 0.32% | -0.13% | 0.16% |
| 1982-2006 | (t-stat) | (0.706) | (0.334) | (0.634) | (1.359) | (-0.365) | (0.482) |
| CSmom FX | Coefficient | -0.89% | 1.88% | 0.87% | -0.64% | 0.71% | 1.19% |
| 2007-2010 | (t-stat) | (-1.028) | (1.543) | (0.742) | (-0.550) | (0.496) | (0.931) |
| | **P1** | | | | | | |
| CSmom FX | Coefficient | 0.46% | -1.00% | -0.49% | 0.16% | -0.42% | -0.15% |
| 1982-2010 | (t-stat) | (2.189)* | (-2.599)* | (-1.708)** | (0.748) | (-1.364) | (-0.544) |
| CSmom FX | Coefficient | 0.25% | -0.73% | -0.30% | 0.00% | -0.43% | 0.10% |
| 1982-2006 | (t-stat) | (1.666)** | (-1.883)** | (-1.077) | (0.025) | (-1.302) | (0.325) |
| CSmom FX | Coefficient | 1.45% | -2.62% | -0.87% | 0.13% | 0.48% | 0.07% |
| 2007-2010 | (t-stat) | (1.730)** | (-2.214)* | (-0.736) | (0.095) | (0.347) | (0.046) |
| | **P2** | | | | | | |
| CSmom FX | Coefficient | 0.42% | -0.77% | -0.34% | 0.18% | -0.41% | -0.02% |
| 1982-2010 | (t-stat) | (1.920)** | (-2.508)* | (-1.184) | (1.008) | (-1.559) | (-0.072) |
| CSmom FX | Coefficient | 0.23% | -0.60% | -0.13% | 0.09% | -0.52% | 0.18% |
| 1982-2006 | (t-stat) | (1.071) | (-1.955)** | (-0.450) | (0.499) | (-2.026)* | (0.733) |
| CSmom FX | Coefficient | 1.28% | -2.45% | -0.30% | -0.17% | 1.46% | 0.29% |
| 2007-2010 | (t-stat) | (1.597) | (-2.168)* | (-0.280) | (-0.148) | (1.153) | (0.221) |
| | **P3** | | | | | | |
| CSmom FX | Coefficient | 0.58% | -0.56% | -0.35% | 0.33% | -0.29% | 0.06% |
| 1982-2010 | (t-stat) | (2.670)* | (-1.987)* | (-1.136) | (1.795)** | (-1.088) | (0.266) |
| CSmom FX | Coefficient | 0.46% | -0.59% | -0.05% | 0.32% | -0.56% | 0.26% |
| 1982-2006 | (t-stat) | (1.880)** | (-1.990)* | (-0.164) | (1.831)** | (-2.044)* | (0.957) |
| CSmom FX | Coefficient | 0.56% | -0.74% | 0.00% | -0.51% | 1.19% | 1.26% |
| 2007-2010 | (t-stat) | (0.704) | (-0.655) | (0.002) | (-0.654) | (1.073) | (1.182) |

Table 10B

**Table 11 – Performance of Cross-Sectional Momentum Strategies**

This table presents the results of monthly regressions of the excess returns of the CSmom strategy for the non-stock asset classes. The risk factors of Fama and French which are used in Baker and Wurgler (2006) including the original Baker and Wurgler index returns are regressed on the CSmom strategies.

| | | P1 | P2 | P3 | P3-P1 |
|---|---|---|---|---|---|
| Commodities | Intercept | -0.05% | 0.33% | 1.05% | 1.10% |
| | (t-stat) | (-0.2093) | (1.2603) | (2.8344)* | (3.3889)* |
| 01/1972 to | RMRF | 0.14% | 0.15% | 0.14% | -0.00% |
| 12/2010 | (t-stat) | (1.9651)* | (1.8070)** | (1.3226) | (-0.0762) |
| | SMB | 0.09% | 0.03% | 0.07% | -0.03% |
| | (t-stat) | (0.8864) | (0.3465) | (0.6734) | (-0.1944) |
| | HML | 0.16% | 0.23% | 0.01% | -0.15% |
| | (t-stat) | (1.5754) | (2.6637)* | (0.1200) | (-1.1888) |
| | Sentiment | -0.69% | -0.65% | -0.87% | -0.18% |
| | (t-stat) | (-2.0545)* | (-2.3060)* | (-2.4013)* | (-0.4537) |
| | $R^2$ | 3.3% | 4.7% | 3.0% | 0.5% |
| Currencies | Intercept | 0.02% | 0.12% | 0.33% | 0.31% |
| | (t-stat) | (0.1584) | (0.8780) | (2.3365)* | (1.9441)** |
| 01/1979 to | RMRF | 0.12% | 0.09% | 0.07% | -0.05% |
| 12/2010 | (t-stat) | (2.6872)* | (2.3815)* | (2.2069)* | (-1.1297) |
| | SMB | 0.02% | -0.00% | -0.03% | -0.05% |
| | (t-stat) | (0.5243) | (-0.0187) | (-0.6549) | (-1.0456) |
| | HML | 0.08% | 0.04% | 0.05% | -0.03% |
| | (t-stat) | (1.3298) | (0.8721) | (1.1894) | (-0.5082) |
| | Sentiment | -0.58% | -0.51% | -0.42% | 0.16% |
| | (t-stat) | (-2.5853)* | (-2.9298)* | (-2.7469)* | (0.7014) |
| | $R^2$ | 5.7% | 5.3% | 2.9% | 1.1% |
| Equity Indices | Intercept | -0.29% | 0.00% | 0.39% | 0.67% |
| | (t-stat) | (-1.5750) | (0.0296) | (2.0489)* | (4.0793)* |
| 01/1978 to | RMRF | 0.79% | 0.78% | 0.78% | -0.00% |
| 12/2010 | (t-stat) | (14.5431)* | (24.4354)* | (15.2381)* | (-0.1300) |
| | SMB | 0.03% | 0.13% | 0.12% | 0.09% |
| | (t-stat) | (0.4749) | (2.9187)* | (1.7696)** | (1.3639) |
| | HML | 0.20% | 0.21% | 0.22% | 0.01% |
| | (t-stat) | (2.9880)* | (4.2445)* | (3.7239)* | (0.2168) |
| | Sentiment | -0.11% | -0.12% | -0.00% | 0.11% |
| | (t-stat) | (-0.5504) | (-0.6276) | (-0.0363) | (0.5400) |
| | $R^2$ | 55.8% | 63.4% | 53.1% | 0.7% |
| Fixed Income | Intercept | 0.30% | 0.19% | 0.24% | -0.06% |
| | (t-stat) | (2.8484)* | (1.6732)** | (1.8290)** | (-0.6433) |
| 01/1982 to | RMRF | 0.02% | 0.06% | 0.06% | 0.04% |
| 12/2010 | (t-stat) | (0.5558) | (1.9625)** | (1.4156) | (1.6923)** |
| | SMB | -0.06% | -0.04% | -0.11% | -0.05% |
| | (t-stat) | (-1.8533)** | (-2.0872)* | (-2.5286)* | (-1.6088) |
| | HML | -0.02% | 0.00% | -0.00% | 0.02% |
| | (t-stat) | (-0.5657) | (0.0122) | (-0.0958) | (0.5546) |
| | Sentiment | 0.07% | 0.37% | 0.34% | 0.27% |
| | (t-stat) | (0.3722) | (1.9195)** | (1.6379) | (1.5675) |
| | $R^2$ | 1.2% | 4.2% | 4.9% | 2.6% |

*Table 11*

**Table 12 – Performance of Cross-Sectional Momentum Strategies**

This table presents the results of monthly regressions of the excess returns of the CSmom strategy for the non-stock asset classes. The risk factors of Fama and French which are used in Baker and Wurgler (2006) including the newly developed sentiment proxy is regressed on the CSmom strategies. Data for the newly developed data is available from 04-1974. Commodity results will therefore be from the data range from 04-1974 to 12/2010.

| | | P1 | P2 | P3 | P3-P1 |
|---|---|---|---|---|---|
| Commodities | Intercept | -0.29% | -0.06% | 0.73% | 1.01% |
| | (t-stat) | (-0.9770) | (-0.2464) | (1.9122)** | (2.8711)* |
| 01/1972 to | RMRF | 0.14% | 0.16% | 0.15% | 0.00% |
| 12/2010 | (t-stat) | (1.9344)** | (2.3625)* | (1.5043) | (0.0674) |
| | SMB | 0.09% | 0.09% | 0.15% | 0.06% |
| | (t-stat) | (0.9800) | (1.2143) | (1.5719) | (0.5210) |
| | HML | 0.09% | 0.22% | 0.02% | -0.08% |
| | (t-stat) | (1.0363) | (2.4749)* | (0.1668) | (-0.6630) |
| | SENT ALT | 0.08% | 0.37% | 0.67% | 0.59% |
| | (t-stat) | (0.2663) | (1.4616) | (1.6581)** | (1.6771)** |
| | $R^2$ | 1.9% | 5.0% | 3.4% | 1.0% |
| Currencies | Intercept | -0.12% | -0.02% | 0.20% | 0.32% |
| | (t-stat) | (-0.7318) | (-0.1403) | (1.5742) | (1.9230)** |
| 01/1979 to | RMRF | 0.12% | 0.10% | 0.07% | -0.05% |
| 12/2010 | (t-stat) | (2.7446)* | (1.9205)** | (2.4268)* | (-1.1588) |
| | SMB | 0.01% | -0.00% | -0.03% | -0.04% |
| | (t-stat) | (0.2928) | (-0.1517) | (-0.6626) | (-0.8562) |
| | HML | 0.05% | 0.02% | 0.03% | -0.02% |
| | (t-stat) | (0.8959) | (0.3234) | (0.6953) | (-0.3913) |
| | SENT ALT | -0.04% | 0.05% | 0.10% | 0.14% |
| | (t-stat) | (-0.1972) | (0.3018) | (0.7869) | (0.7491) |
| | $R^2$ | 3.8% | 3.3% | 1.8% | 1.1% |
| (Equity Indices | Intercept | -0.34% | -0.09% | 0.32% | 0.67% |
| | (t-stat) | (-1.7834) | (-0.6136) | (1.9005)** | (4.1605)* |
| 01/1978 to | RMRF | 0.79% | 0.78% | 0.78% | -0.00% |
| 12/2010 | (t-stat) | (14.6124)* | (19.9020)* | (14.4981)* | (-0.1428) |
| | SMB | 0.03% | 0.14% | 0.13% | 0.10% |
| | (t-stat) | (0.5410) | (2.5665)* | (1.7480)** | (1.4519) |
| | HML | 0.20% | 0.20% | 0.22% | 0.02% |
| | (t-stat) | (2.9157)* | (3.8293)* | (3.3093)* | (0.2978) |
| | SENT ALT | 0.14% | 0.27% | 0.26% | 0.12% |
| | (t-stat) | (0.7045) | (1.7825)** | (1.4582) | (0.6901) |
| | $R^2$ | 55.8% | 63.8% | 53.3% | 0.7% |
| Fixed Income | Intercept | 0.39% | 0.37% | 0.38% | -0.00% |
| | (t-stat) | (3.6262)* | (3.1976)* | (2.8504)* | (-0.0210) |
| 01/1982 to | RMRF | 0.02% | 0.05% | 0.05% | 0.04% |
| 12/2010 | (t-stat) | (0.5356) | (1.9035)** | (1.3446) | (1.7044)** |
| | SMB | -0.07% | -0.05% | -0.12% | -0.05% |
| | (t-stat) | (-1.9578)** | (-2.1344)* | (-2.3843)* | (-1.5031) |
| | HML | -0.02% | 0.01% | 0.00% | 0.03% |
| | (t-stat) | (-0.5318) | (0.5163) | (0.2849) | (0.8400) |
| | SENT ALT | -0.24% | -0.28% | -0.21% | 0.02% |
| | (t-stat) | (-2.3945)* | (-2.2516)* | (-1.3812) | (0.2507) |
| | $R^2$ | 2.9% | 4.7% | 4.8% | 1.6% |

*Table 12*