May 2009

COMMODITY FUTURES AND MOMENTUM TRADING: IMPLICATIONS FOR BEHAVIOURAL FINANCE

By

Dan Calder

and

Barry O'Grady

School of Economics and Finance

Curtin University

ISSN: 1835-9450

09.01

COMMODITY FUTURES AND MOMENTUM TRADING: IMPLICATIONS FOR BEHAVIOURAL FINANCE

Dan Calder
calderdc@gmail.com

Barry O'Grady
B.OGrady@curtin.edu.au

Curtin Business School
Curtin University of Technology
GPO Box U1987
Perth
Western Australia 6845

The purpose of this paper is to expand the research on momentum strategies in the securities market. Specifically, it examines the momentum anomaly in respect to the commodity futures market, and closely follows recent work as studied by Miffre and Rallis (2007). This study identifies one statistically significant short term (1 to 12 months) momentum strategy yielding a return of 7.7% a year. This return is found to be substantially higher during specific periods of the sample. The strategy's average abnormal gain caused by the continuation of returns is shown to be robust to the risk based explanations posited by many authors of the topic. Since the risk explanations do not hold for the momentum anomaly, the alternative explanation indicates towards market inefficiency. The results from this study indicate that market inefficiency is a plausible explanation for momentum profits as realised. Specifically, the abnormal profits seem to be a consequence of irrational investor behaviour, which tends to lead to an under-reaction to new market information.

Keywords: Momentum, contrarian, efficient market hypothesis, overreaction hypothesis, under-reaction hypothesis, irrational investors

1 Introduction

The momentum anomaly remains one of the most researched patterns within average return studies. Most authors concede that it is not explainable by the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965). The most common explanation for the presence of the momentum anomaly is that stocks with high (low) realised returns will be those that have high (low) expected returns (Berk et al., 1999 and Conrad and Kaul, 1998). This suggests that momentum strategy profitability can result from the cross-sectional variability in expected returns. This variability highlights greater portfolio risk. The second popular explanation is based around irrational agents, which cause inefficiency in the market (Daniel et al., 1998; Barberis et al., 1998).

Although the continuation of returns in the equity market has been extensively studied and proven by Jegadeesh and Titman (1993) over the short-term (1-12 months), recent studies have shown evidence of this anomaly in other markets. This study builds on the findings by Miffre and Rallis (2007), who show that momentum strategies are obtainable in the commodity futures market over similar time frames as those demonstrated in the equities market.

Momentum strategies appear to be well suited to the futures market for the following reasons; firstly, transaction costs have been described by Locke and Venkatesh (1997) as being considerably less than in equities markets. Secondly, the equities research for momentum strategies uses hundreds and sometimes thousands of stocks (Miffre and Rallis, 2007). This study only uses twelve futures contracts, and therefore the cost of implementing these strategies is significantly less expensive and complicated. Finally, while equities are sometimes subject to short selling restriction (which is an integral part of these strategies), no

such restrictions apply in the futures market where taking short and long positions are seamless transactions.

Whilst the strategies do identify profitability over the sample period, they are not as numerous as Miffre and Rallis (2007) who discover 13 profitable strategies. Only one of the 16 strategies examined generates a statistically significant result. This strategy is based on a portfolio where contracts are ranked one month prior to formation and then held for one month after formation. It proves to be the most successful strategy not only over the entire sample period, but also over two of the three sub-periods analysed.

The profits generated from the momentum strategies analysed are shown to be robust to the risk-based explanation for the momentum anomaly offered by Chordia and Shivakumar (2002) and Conrad and Kaul (1998). As previously mentioned the next explanation for the continuation of returns is derived from market inefficiencies. This breach in market efficiency materialises through irrational investor's under-reacting to new information in the market, causing prices to rise (or fall) above (below) the market equilibrium or true value of the asset. This research lends support to this idea, on the grounds that momentum returns are robust to the risk explanations.

2 Literature Review

Over the last three decades a substantial amount of research has been conducted on the profitability of contrarian and momentum strategies in the equities market. Researchers have identified profits from momentum strategies within differing time horizons. Intermediate (3-12 months) horizons based on the continuation of returns, and long-run (12-36 months) contrarian strategies that rely on stock market returns have been examined for momentum/contrarian returns. More recently this research has employed futures markets (Erb and Harvey, 2006; Miffre and Rallis, 2007; Shen et al., 2007).

2.1 Under and over reaction in the stock market and market inefficiency

Over the last twenty years strong evidence has surfaced suggesting that in violation of the Efficient Market Hypothesis[1], security prices overreact to events and information (Cooper et al., 2004; Daniel et al., 1998; Barberis et al., 1998; Dissanaike, 1997). The idea that investor sentiment can be biased towards information means that it may be possible to form strategies that exceed normal profits by studying past data alone.

Strategies that exploit the notion that investors overreact to news and events, causing prices to drift away from their true value and then ultimately reverse in the long run (3-5 years), have been extensively studied by De Bondt and Thaler (1985, 1987). De Bondt and Thaler (1985) demonstrate, using the US securities market, that over holding periods of between three to five years, stocks that performed poorly over the previous three to five years achieve higher returns than stocks that displayed superior gains over the same period. This research pioneered a series of studies that examined the profitability of contrarian strategies in securities markets.

Contrarian strategies involve investing in assets exhibiting historically negative returns, and short selling those showing positive returns. The mentality behind this is that in accordance with overreaction hypothesis, prices become over or under valued and reversal back to an assets fundamental value is imminent. The Overreaction hypothesis has been described by Nam et al. (2001) as the result of investors systematically overacting to market news with both pessimism and optimism, resulting in a mispriced asset. Conrad and Kaul (1998) as well as Bayats and Cakici (1998) present profitable contrarian strategies (i.e. the utilisation of overreaction hypothesis) over long horizons (3-5 years)[2].

[1] Efficient Market Hypothesis is the theory that market prices fully reflect all information available as stated by Fama (1970). Therefore studying the past prices of an asset will provide no added benefit if this hypothesis holds in the market.

[2] For further evidence of profitable contrarian strategies see (Ball and Kothari, 1989, Chopra et al., 1992, Dissanaike, 1997, Jegadeesh and Titman, 1995, Poterba and Summers, 1988).

Momentum trading is another behaviourally driven strategy that relies on the proposal that investor behaviour can create inefficiency in the market. One of the more popular explanations for momentum profits comes from the idea that investor's under-react to information in the short run causing price continuation in the intermediate term (3-12months) (Chan et al., 1996; Hong and Stein, 1999). This anomaly has been described as being a result of prices reacting too slowly to new information or events in the market (Hong et al., 2000; Barberis et al., 1998; Chan et al., 1996). Momentum investors therefore structure their portfolios to include assets that have previously performed well and short sell those that have generated poor returns. Bernard and Thomas (1989) provide evidence of the under-reaction hypothesis[3] through studying a cross-section of returns in the US stock market.

Various authors have proposed behavioural models that account for the previously discussed anomalies shown to exist in investor rationale (Barberis et al., 1998; Daniel et al., 1998; Hong and Stein, 1999). Both Daniel et al. (1998) and Barberis et al. (1998) attempt to model the existing evidence on over/under-reaction, with a view to predicting when these inconsistencies in price behaviour will occur. Although both of these papers concede that the empirical evidence is indicative of short run continuations and long run reversals, their definitions of over/under-reactions slightly differ. Barberis et al. (1998) takes the view that under-reaction is the product of a conservatism bias, where investors are slow to change their beliefs in light of new evidence, and overreaction is the result of what is known as "representative heuristic". This has been described by Tversky and Kahneman (1974) as "the tendency for individuals to evaluate an uncertain event, or a sample to the degree to which it is similar to the parent population".

[3] Under-reaction Hypothesis is a description of investor's behavioural inclinations to under react to news causing prices to adjust slowly to the new information, which results in short term continuation. (Chan et al., 1996, Conrad and Kaul, 1998, Hong and Stein, 1999, Jegadeesh and Titman, 1993).

Barberis et al. (1998) argue that representative heuristic may lead investors to mistakenly conclude that firms realising high earnings growth will continue to do so in the future resulting in an overreaction effect.

Daniel et al. (1998) form their model around the premise that investors are overconfident about private information causing long term (3-5 year) price reversals. They account for price continuation as being the product of attribution theory (Bem, 1965), where individuals over-weight information that confirms the validity of their previous actions, resulting in an attribution bias. Hong and Stein (1999) attempt to model the same anomalies as Barberis et al. (1998) and Daniel et al. (1998), but rather than analysing the behaviour of investors, they consider two groups of investors who trade on different information sets. Specifically, "news watchers" make forecasts based on signals about future cash flows but ignore information in the past history of prices. "Momentum traders" on the other hand, trade based on a limited history of prices. In addition they do not consider fundamental information.

2.2 Momentum profits in the securities markets

In the 1990s momentum profits were extensively illustrated in the securities markets over investment periods of three to twelve months. (Jegadeesh and Titman, 1993; Jegadeesh and Titman, 2001; Conrad and Kaul, 1998; Chan et al., 1996; Rouwenhorst, 1998). Jegadeesh and Titman (1993) were perhaps the first to report significant abnormal profits based on momentum trading in the US stock market. Using a strategy that has become widely adopted in this field, at the beginning of each month they rank each stock by its previous return during a given "Ranking" period. The stocks are then sorted into deciles. A strategy is employed involving buying the stocks in the top deciles and selling those in the bottom. This position is held for up to twelve months. From a set of sixteen portfolios that range from ranking/holding periods of between three to twelve months, they report an average return of 1% per month (12% per annum nominal).

Jegadeesh and Titman (1993) demonstrate that their profits from these strategies are not derived from systematic risk, which some academics such as De Bondt and Thaler (1985) and Grundy and Martin (2001) argue are the source of momentum profits. They dismiss this claim by showing that the risk in terms of beta for the past "loser" portfolios is actually higher than that of the past "winners". Hence the abnormal returns are not a compensation for picking risky stocks. Also corresponding to under-reaction hypothesis, a contributing factor of the momentum profits found was the delayed price reaction to firm-specific information which is indicative of market inefficiency.

As further evidence of the robustness of the Jegadeesh and Titman (1993) study, Jegadeesh and Titman, (2001) demonstrate that between 1993 and 1998 momentum strategies continued to be profitable to a similar degree as those of previous research, dispelling any suggestions of data mining. Conrad and Kaul (1998) offer a rather viable description of the sources of such momentum profits. They produce evidence suggesting that momentum profits are in fact attributable to the cross-sectional variations in expected returns, rather than to any time series dependence in returns. Their bootstrap analysis suggests that the magnitude of momentum profits found in the actual data can be obtained with randomly generated data constructed to have no time-series dependence whatsoever.

Conrad and Kauls' (1998) results (in line with Berk et al., 1999) indicate that momentum profits are possible in an efficient market as long as the cross-sectional variation in unconditional expected returns is large, relative to the variation in unexpected returns. If this holds, past winners are likely to consist primarily of stocks with high expected returns and past losers are likely to consist of stocks with low expected returns, implying positive expected returns for a momentum strategy. However if the primary reason for the profitability of momentum strategies was cross-sectional differences in mean returns, then past winners (or losers) should continue to be superior (or inferior) performers indefinitely into the future

(Shen et al., 2007; Jegadeesh and Titman, 2001). Contradictory to this, many studies (Chan et al., 2000; Jegadeesh and Titman, 1993; Jegadeesh and Titman, 2001; Moskowitz and Grinblatt, 1999; Rouwenhorst, 1998) demonstrate that momentum strategies are only profitable for the first twelve months after formation.

As a direct response to the Conrad and Kaul (1998) findings, Jegadeesh and Titman (2002) released a study that specifically disproves the latter's hypothesis. They demonstrate that Conrad and Kaul's (1998) bootstrap analysis was subject to a small sample bias, and prove that without this bias, cross-sectional differences in expected returns explain little, if any, of the momentum profits. They posit these returns are attributable to the time series dependence of realised returns (also Chen and Hong, 2002). Furthermore Grundy and Martin (2001) provide evidence that cross-sectional differences in expected returns are not the primary reason for the momentum phenomenon, even though it may have some contribution to the results.

A popular rationalisation for momentum profits is that they are a simple compensation for bearing more risk (Li et al., 2008). Although it has been shown that profits from long term reversals are not robust to risk adjustments (Korajczyk and Sadka, 2004; Fama and French 1996), intermediate (3-12 months) return continuation has been a more durable anomaly for risk explanations. Fama and French (1996) note that their three factor asset-pricing model does not explain continuation in short term returns. This was confirmed by Grundy and Martin (2001) who demonstrate that the Fama and French (1996) three factor model is unable to explain mean returns from momentum strategies. In other words, the momentum strategies profitability cannot be attributed to being a reward for being exposed to the factors in the Fama and French (1993) risk factor model[4].

[4] The Fama and French (1993) market model identifies three common stock-market factors that explain the expected return on a portfolio in excess of the risk free rate: an overall market factor; factors related to firm size, and book-to-market equity.

Several studies look at the role that time-varying systematic risk plays in explaining momentum profits (Chordia and Shivakumar, 2002; Griffin et al., 2003; Grundy and Martin, 2001; Lewellen and Nagel, 2006; Wu, 2002). Chordia and Shivakumar (2002) demonstrate that profits obtained from momentum strategies may be explained by a set of common macroeconomic variables that are related to the business cycle.

They use the dividend yield, default spread, yield on three-month T-bills, and term structure spread as a standard set of macroeconomic variables known to predict market returns. Results indicate that the returns from momentum strategies diminish once these variables are accounted for. This evidence is consistent with the notion of time-varying market risk being a reasonable explanation for stock price continuation. However, in contrast to these findings, Griffin et al. (2003) find profitable momentum strategies in various markets during both strong and weak economic periods. They interpret this as evidence that macroeconomic risk does not contribute to momentum profits. Moreover, they provide international evidence that price continuation only exists in the short term (as previously cited), which is inconsistent with these risk-based explanations.

A final explanation for the momentum profits as previously shown is that they are in fact false once the transaction costs are accounted for (Korajczyk and Sadka; 2004, Lesmond et al., 2004). Lesmond et al. (2004) compares the momentum returns for Hong et al. (2000), Jegadeesh and Titman (1993, 2001). They note the estimates of transaction costs as used in these studies are based on the costs of trading relatively large liquid stocks, while the stocks that produce a large portion of the profits for the portfolios are not of this type. Therefore the trading costs used in these studies are found to be underestimated and momentum profits are actually much lower. In fact Lesmond et al. (2004) demonstrates that transaction costs exceed the momentum profits. Similarly, Korajczyk and Sadka (2004) stress the importance of

accounting for market liquidity and trading costs when evaluating momentum strategies. They further describe how although transaction costs do diminish momentum profits, they do not fully explain the persistence of past winner stocks in the strategies.

2.3 Momentum profits in the Futures market

Since the securities and futures markets are intrinsically different, there are some strong justifications for applying momentum strategies to futures contracts (Miffre and Rallis, 2007; Shen et al., 2007). There are three distinct differences in the two markets that have significant implications for the execution of momentum strategies. Firstly, the transaction costs in the futures markets are substantially lower than the stock market (Fleming et al., 1996; Locke and Venkatesh, 1997). For example, Locke and Venkatesh (1997) discovered that transaction costs in the futures markets range from 0.0004% to 0.033%, which is substantially less than the 2.3% estimated for the equity markets (Lesmond et al., 2004). As discussed previously, there is a coterie of academics (Korajczyk and Sadka, 2004; Lesmond et al., 2004) that present evidence of momentum returns being reduced by transaction costs. Therefore, the diminishing effect that transaction costs have on momentum profits in the securities markets should be less prevalent with futures contracts (Miffre and Rallis, 2007).

Another important point to discuss in the context of futures momentum is the ability to easily take short positions in their portfolios. Momentum strategies in equities rely on using the proceeds from selling assets that are falling in price to purchase assets that are believed to be increasing in price (Conrad and Kaul, 1998). This has significant implications because as Grinblatt and Moskowitz (2004), Hong et al (2000), and Lesmond et al. (2004) note, the majority of momentum returns are generated through the loser stocks which are being short sold. In the futures market, taking a short position, which is contractually agreeing to deliver the underlying commodity at a future date, incurs the same costs and effort as taking a long position (Miffre and Rallis, 2007; Shen et al., 2007).

Additionally, the futures market is generally more liquid than that of the securities market, allowing momentum trading to take place instantaneously. Momentum in the securities market has been demonstrated by Rouwenhorst (1998) to be more prevalent in smaller and less liquid stocks. On the other hand, the futures contracts studied in this work exhibit deep liquidity driven by large trading volumes.

Finally, unlike stocks, futures contracts are not linked to claims by corporations and their announcements. They also have different exposures to macroeconomic factors (Gorton and Rouwenhorst, 2006; Jensen et al., 2002; Shen et al., 2007). Furthermore, Bodie and Rosansky (1980) as well as Edwards and Park (1996) find that futures' contracts can be used as an effective hedge against inflation. Gorton and Rouwenhorst (2006) suggest that commodity futures are a better hedge against inflation than equities because they are directly linked to components of inflation. They also state that, because futures prices include information about trends in commodity prices, they rise and fall with unexpected changes from components of inflation. For these reasons momentum returns using commodity futures should be attributed to broader macroeconomic factors rather than information announcements and investor behaviour.

If this were the case, then a large portion of the securities market literature that attributes momentum profits to investor sentiment such as under-reaction hypothesis would not be applicable to the futures markets. However, both Kurov (2008) and Ma et al. (1990) demonstrate how investor sentiment is present in the futures markets. Specifically Kurov (2008) shows how feedback trading (momentum) with index futures can be attributed to investors with positive/negative sentiments towards returns. Similarly, by studying the price adjustment in futures prices to significant events Ma et al. (1990) finds evidence of under and overreaction in commodity and financial futures contracts. Therefore it would be incorrect to posit that in the futures market, investor sentiment (i.e. under-reaction hypothesis) does not

contribute to continuation in returns. This lends support to the idea that momentum returns in futures contracts are derived from inefficiencies in the market.

Although the bulk of the literature on momentum trading involves the equities market, in the last ten years there has been an incremental prevalence of research into the profitability of such strategies in the futures markets (Miffre and Rallis, 2007; Shen et al., 2007). Miffre and Rallis (2007) conducted a momentum strategy on a sample of 31 commodity futures contracts from 1979 to 2004. The strategy adopted is similar to Jegadeesh and Titman (1993), and involves the following method; each month contracts are sorted into quintiles based on their average previous return over a ranking period of 1, 3, 6, and 12 months. The strategy then buys the contracts that are in the top quintile and sells those in the bottom, holding this position for 1, 3, 6 and 12 months. This creates sixteen momentum strategies with combinations of ranking and holding periods between 1 and 12 months. All the strategies except three (rank 6 -hold 12, rank 12 - hold 6 and rank 12 - hold 12) produced significant profits. Across thirteen profitable strategies, it was found that an investor could receive an average return of 9.8% pa by consistently buying the best performing commodity futures and selling the worst ones.

Conrad and Kaul (1998) and others argue that momentum profits are a compensation for risk. To examine this Miffre and Rallis (2007) carry out a series of regressions to measure the profitability of the strategies once simple risk and time-varying risk have been accounted for. In the first regression, they measure the sensitivity of each portfolio's return to the bond, equity, and commodity futures market in order to assess each strategies abnormal performance. All of the profitable momentum strategies were shown to have positive and significant abnormal returns, thereby disregarding any suggestions of the profits being described as a compensation for the risks considered. As a collaborative result to the equities market, it was also found that momentum profits are mainly driven by the loser portfolios

(Hong et al., 2000). That is, the majority of momentum profits were generated by short selling poorly performing contracts. Miffre and Rallis (2007) further demonstrate that momentum profits are not a compensation for time-varying risks as suggested by certain researchers in the equities markets (Chordia and Shivakumar, 2002; Griffin et al., 2003; Grundy and Martin, 2001).

3 Data and Methodology

3.1 Data

The data, obtained from DataStream™, comprises the settlement prices of 12 US commodity futures contracts. The research considers 8 agricultural futures (cocoa, coffee, corn, cotton, orange juice, soybeans, sugar, and wheat), 1 livestock future (frozen pork bellies), 1 precious metal future (gold 100oz) and 2 futures on oil and gas (light crude oil and natural gas).

The data sample spans the period from January 1993 to January 2008. Because each strategy is ranked for up to twelve months, the first portfolio is actually constructed in January 1994 with a maximum ranking period that spans back to January 1993. For the same reason the last portfolio is actually determined in November 2006. The maximum holding period for the contracts in this portfolio is then calculated twelve months later in November 2007.

This research provides an examination of three separate periods; 1993 to 1997, 1998 to 2002, and 2003 to 2006. As shown in figure 1 below, each of these periods had very different amounts of activity in the commodity market. The period between 1993 to 1998 saw a relatively flat commodity market, while during the technology boom (1998-2002) commodities were scarcely traded. The recent massive commodity boom is clearly shown to start around 2001/2002. Coincidently, the last data point considered is November 2007 which is relatively untainted by the recent volatility in commodity prices derived from the current global financial crisis.

3.2 Methodology

The methodology employed in this research is similar to that as used by Jegadeesh and Titman, (1993) and Miffre and Rallis, (2007). At the end of every month a log of the average change in return (equation 1) over the previous "Ranking" period is calculated. The contracts are then sorted into one of three portfolios from best to worst based on their performance compared to the whole portfolio. The top four contracts that performed the best over the ranking period portfolio (in terms of return) are called the "winners" and the four contracts generating the worst returns are labelled the "losers".

$$return = \frac{[\ln(p)]_t - p_{t-1})}{\ln p_{t-1}} \qquad (1)$$

The strategy adopted then monitors the "winner" and loser" portfolios over a designated "Holding" period, effectively buying the winners and selling the losers. The profitability of the strategy is then defined as the difference of the winner minus the loser portfolio for each ranking and holding combination. The strategies will be referenced by Rn-Hn throughout this study. R is a representation of the ranking period for a given strategy, and H is the holding period.

The following regression is used to measure the profitability of the strategies accounting for risk. Specifically the sensitivity of each portfolio to the bond, equity, commodity futures market, and, subsequently, the abnormal performance of the momentum strategies in terms of (α) is measured.

$$R_{pt} = \alpha + \beta_B(R_{Bt} - R_{ft}) + \beta_M(R_{Mt} - R_{ft}) + \beta_C(R_{Ct} - R_{ft}) + \varepsilon_{pt} \qquad (2)$$

R_{Pt} is the return of the winner, loser, or momentum portfolio. R_{Bt}, R_{Mt}, and R_{Ct} are the returns on Datastream™ government bond index, the S&P500 composite index, and GSCI (Goldman Sachs Commodity Index) respectively, R_{ft} is the risk-free rate of return and ε_{pt} is an error term.

A further regression is employed to examine whether the SMB and HML factors from the Fama and French (1993) three factor model, offer an explanation for momentum returns.

$$R_{Pt} = \alpha + \beta_B(R_{Bt} - R_{ft}) + \beta_M(R_{Mt} - R_{ft}) + \beta_C(R_{Ct} - R_{ft}) + \beta_{SMB}SMB + \beta_{HML}HML + \varepsilon_{Pt} \quad (3)$$

SMB is a factor that relates to the performance of small stocks relative to big stocks (Small Minus Big). HML is a factor that relates to the performance of value stocks relative to growth stocks (High Minus Low). The factors have been taken from Kenneth French's web site (French, 2008), and are calculated as follows.

SMB is the average return on three small portfolios minus the average return on three big portfolios. Each portfolio is formed with NYSE, AMEX, and NASDAQ stocks using capitalisation and the book-to-market ratio.

$$SMB = \frac{1}{3(Small\ Value + Small\ Neutral + Small\ Growth)} - \frac{1}{3(Big\ Value\ |\ Big\ Neutral\ |\ Big\ Growth)} \quad (4)$$

HML is the average return on two value portfolios minus the average return on two growth portfolios.

$$HML = \frac{1}{2(Small\ Value + Big\ Value)} - \frac{1}{2(Small\ Growth + Big\ Growth)} \quad (5)$$

There is the possibility that the momentum profits are a compensation for time-varying risks as in Chordia and Shivakumar (2002), Griffin et al. (2003), Grundy and Martin, (2001), Lewellen and Nagel, (2006), and Wu, (2002). The following model therefore allows for the measures of risk and abnormal performance to vary over time as a function of $\mathbf{Z}_{t-1}$, a vector of pre-specified information variables.

$$R_{Pt} = \alpha_0 + \beta_{B0}(R_{Bt} - R_{ft}) + \beta_{B0}(R_{Bt} - R_{ft})\mathbf{Z}_{t-1} + \beta_{M0}(R_{Mt} - R_{ft})$$

$$+ \beta_{M1}(R_{Mt} - R_{ft})Z_{t-1} + \beta_{C0}(R_{Ct} - R_{ft}) + \beta_{C1}(R_{Ct} - R_{ft})Z_{t-1} + \varepsilon_{Pt} \quad (6)$$

Z_{t-1} consists of the twelve month lag return of the dividend yield on the S&P500 composite index, the term structure of interest rates, and the default spread. The term structure is measured as the difference between the yield on US Treasury Bonds with 10 years to maturity and the US three-month Treasury Bill rate. The default spread is measured as the difference in yield between Moody's Baa and Aaa-rated corporate bonds. These variables have been identified in similar studies such as Christopherson et al., (1998) to be good market predictors.

4 Results and Analysis

4.1 Momentum profits over the entire sample period (1994-2006)

Table 1 displays the summary of statistics for returns of the short term momentum strategies analysed. The columns represent the ranking periods (1 to 12 months) and the rows the holding periods (1 to 12 months). Table 1 clearly demonstrates that only the R1-H1 strategy produces abnormal returns of 7.7% pa significant at the 1% level. This result is consistent with the findings of Miffre and Rallis (2007) who observe profitable momentum returns for the rank 1 month hold 1 month strategy. The next best strategy of the period is the R12-H1 strategy yielding an annualised return of 3.74%, which is only just out of the 10% significance range. Most of the other strategies do not generate positive returns, and none produce significant statistics. Apart from the two previously mentioned strategies, the only other strategies that produced positive returns are the R1-H6, R12-H1, and the R12-H3 (however this should be analysed with some caution as they are not significant).

Over the same sample period, a long-only strategy that equally weights the 12 commodity contracts lost an average of 4.32% a year, while a short-only strategy generated gains of almost an identical amount. This result is further conveyed in table 1. Across the 16 strategies

the loser portfolio in all cases yields a negative average return that varies from a low of -7.74% pa (for the R1-H1 strategy) to a high of -2.82% pa (for the R12-H1 strategy). The data from the winner's side of the strategies is significantly less strong. The winner portfolios varies from a high of -0.045% pa (for the R1H1 strategy) to a low of -6.09% pa (for the R3-H3 strategy). Furthermore, while none of the winner portfolios show significance at the 10% level, eight of the strategies show significant negative returns for the loser portfolios.

This further corroborates the work of Hong et al. (2000) and Miffre and Rallis (2007) who determine that the continuation in the commodity futures markets is mainly driven by the losers in the portfolio. This has quite significant implications for research in the equities markets by authors such as Grinblatt and Moskowitz (2004), Hong et al. (2000) and Lesmond et al. (2004) who show that the majority of momentum profits are being derived from short selling loser stocks. Given the ease of entry and exit into short futures contracts, it could be considered that momentum trading is better suited to the futures market rather than the equities market where short selling is more difficult, restricted during times of economic turmoil, and incurs higher costs.

Since the majority of academic explanations for these momentum profits are associated with the returns being a compensation for bearing more risk, the reward-to-risk ratios are also reported in table 1. As would be expected, the strategy with the highest pay-off also has the highest risk. This is demonstrated in the rank 1 month -hold 1 month strategy, where although the return is 7.7% pa, the risk in terms of standard deviation is an astounding 38.63% pa.

As previously mentioned, commodity futures have experienced three distinct trends over the sample period. It is therefore useful to examine the risk-reward ratios the strategies produce over these sub-periods. As shown in table 2, over the entire sample period (1994-2007) there are only five strategies that provide positive return-risk ratios. With the exception of the R1-

H1 strategy, all of these ratios are extremely low, indicating that the returns generated are not very good compensation for the risk needed to execute the strategy.

It has been argued that recent institutional interest in commodity futures could decrease the accumulative profits from momentum strategies. If momentum profits have been shrinking over time, it would be expected that there would be evidence of lower levels of momentum profits over the recent periods. Although the sub period between 1998 and 2002 produced the most number of profitable strategies the later period (2003-2006) generated the same amount of positive return-risk ratios as the entire sample. It could then be construed that the profitable strategies are not being subsumed by the recent interest in institutional investors.

This should be analysed very cautiously because although these strategies are generating positive returns, they are extremely low. Any inferences here could therefore be false. This concept is discussed with more detail in later sections.

4.2 Unconditional risk explanations

The momentum anomaly has been accredited by some academics to investors bearing more risk. However, most of the recent empirical work by authors such as Miffre and Rallis (2007) finds that momentum profits are robust to risk adjustment. This section examines whether the profitable strategies (although not all statistically significant) shown previously in table 1 are a compensation for bearing more risk. This has been done using equation (2) which regresses the portfolio returns against proxies for returns in the bond, equity, and commodity markets.

Surprisingly, table 3 shows that the returns from the momentum strategies are not sensitive to the GSCI. With the exception of the R12-H1 strategy, the momentum portfolios are neutral to the risk associated with the bond market. The R1-H1 and R1-H6 strategies both demonstrate that the momentum returns are sensitive to the equities market, however the rest of the strategies show no significant relationship.

Only one strategy, the R1-H1 (rank one month – hold on month) has a positive significant alpha. It yields an annualised risk adjusted return of 8.51% a year, and is highly significant at the 1% level. The other strategies do not produce any significant *t*-statistics, although they all hold positive alphas. This indicates that they are being subsumed by the risk factors held in the three regression variables. As in table 1, the profitability of the momentum strategies is mainly driven by the losers. All of the loser portfolios produce negative alphas (two of them being significant at the 10% level), while only one strategy for the winner's portfolio (the R1-H1) has an insignificant positive return. The R-squared is also very low, indicating that the momentum returns are neutral to the risks present in the coefficients.

To further explore the risk based explanation, table 4 shows the results from equation (3). This model uses the same regression as equation (2) but also includes the Fama and French (1993) HML and SML factors. The outcomes are quite similar to those of table 3, as only one strategy (R1-H1) shows significant robust returns to all of the risk factors. As with the results of Miffre and Rallis (2007), adding these factors to the regression reduces the size and significance of the abnormal returns (α).

These results are consistent with both Grundy and Martin (2001) and Miffre and Rallis (2007) who demonstrate that momentum profits are not a compensation to these factors.

4.3 Conditional risk explanations

Studies such as Chordia and Shivakumar (2002) claim that even though momentum strategies are robust to risk factors, they can be explained by a set of macroeconomic variables that are related to the business cycle. Miffre and Rallis (2007) elaborate that the profitability of the momentum strategies could be driven by the winners having higher systematic risks than the losers in up-markets, and lower systematic risks than the losers in down-markets. To test this

conjecture, equation (6) is used to examine the sensitivities of the momentum profits to a set of time-varying risks.

Table 5 shows the alphas for the same five strategies that have been examined in table 3. The coefficients of this regression are not reported to save space and are available by request from the author. The results show that over the sample period there are two strategies that produce positive and significant alphas, the R1-H1 and the R12-H3. The fact that the R1-H1 strategy is not explained by time-varying risks supports the findings from the first regression. The second positive alpha is generated from the R12-H3 strategy, which was found to be insignificant in the first regression. Although this strategy is shown to be significant in this regression, it should be noted that in table 1 (which reports the actual momentum profits) the same strategy was not in the 10% significance range.

These results can be interpreted as the R1-H1 strategy being unexplainable to time-varying risk measures. This understanding could be given to the R12-H3 strategy if one takes into account the fact that the original profits are insignificant at the 10% level

4.4- Behavioural explanations

As a large portion of the literature attributes the momentum anomaly to irrational investors, figure 2 shows the portion of momentum profits realised over the four holding periods. Although the returns are obviously volatile, there is a trend over the profitable strategies in each of the holding periods that represents a gradual decrease in realised returns as these holding periods increase.

This distribution of profits across the holding periods is consistent with the evidence presented by Chan et al. (1996) and Hong and Stein (1999) who demonstrate that initial price continuation is evident over the short term (up to 12 months) until a price correction phase takes place. The results concur with the under-reaction hypothesis, where information is

being absorbed into prices too slowly as shown by Barberis et al. (1998) and Hong et al. (2000). This would account for the gradual decrease in average momentum returns, as investors realise that the new information is more important than the information that they have previously been using to value the contracts.

Even stronger support for the under-reaction hypothesis stems from the fact that the highest momentum profits are realised in the one month holding period. This is because if the hypothesis holds, investors are pushing up the price for the long contracts (and down for the short contracts) until they become over (or under) valued. Since the futures market is a relatively liquid market, this effect should be more pronounced in the short term (up to 4 weeks) where traders "push" up or down the prices, depending on their exposures. It would appear that the momentum profits realised in this study are consistent with investors under-reacting to good and bad news about prices, resulting in the continuation in prices.

The later holding periods are consistent with investor overreaction, as the holding period of 12 months produces negative returns over all of the ranking stages. Although this study only examines holding periods for up to 12 months, a further analysis of holding periods of up to 60 months would likely show an overreaction effect. That is, it would be expected that the short-term (1-12 months) continuation causes the prices to move away from equilibrium causing an overreaction in the long term (12-60 months). Once this overreaction is acknowledged by the market, prices corrected accordingly. This has been demonstrated in figure 2 to a degree, where the short term price continuation diminishes until the average returns are completely negative by the twelve month holding period. At this point the momentum effect is completely diminished, and contrarian strategies (buying past losers, and selling past winners) become profitable.

These results indicating short-run (1 to 12 months) continuation and long term (3 to 5 years) reversals provide further arguments towards the rejection of the risk based explanations. This is because if the conjecture by Conrad and Kaul (1998) holds, where momentum profits are obtained through the cross-sectional differences in returns, then the continuation of average returns should persist indefinitely. However as the results show, the momentum anomaly is short lived.

These observations have significant implications towards the Efficient Market Hypothesis. If prices are following a random walk, then predicting future prices by examining the past price should be of no advantage to an investor. However as demonstrated in this research, constructing a portfolio based solely on previous prices does produce abnormal profits. These profits point towards irrational investors under-reacting to information in the market. This demonstration of market inefficiency is most prevalent in a portfolio that is held for one month, and constructed using the returns for the previous month (ie the R1-H1 strategy).

5 Sub-periods

As mentioned previously, the time series data sample contains three distinct trends. For this reason the following section analyses each of these periods, to examine the effect on the profitability of the momentum strategies. The summary statistics and various tables have not been published for this section. They are available on request from the author.

5.1 1994-1997

Although during the years of 1994 and 1997 the commodity market was comparatively inactive, this period actually generated the highest profits from momentum trading. This sub-period produces two profitable momentum strategies. Interestingly, these strategies are the same two strategies as the ones identified over the entire sample period (R1-H1 and R12-H1).

Furthermore, these strategies are both positive and significant over this sub-period. In fact returns from these strategies have more than doubled to 15.6% pa for the R1-H1 strategy, and 8.85% pa for the R12-H1 strategy. As with the profits from the complete sample, momentum profits in this period are largely due to the loser portfolios.

The risk adjusted returns make further contributions to the robustness of the returns over this period. The regression analysis shows that *both* of the significant strategies discovered in this period are robust to the risk intrinsic to the bond, equities, and commodity market variables used in equation 2. The R1-H1 and R12-H1 strategies both produce positive and significant alphas, whereas the entire sample proved that, although the R1-H1 strategy was positive and significant after risk adjustments, the R12-H1 strategy was not significant, and therefore not robust to unconditional risks. The Fama and French (1993) risk adjusted results are identical. Over the sub-period the same two strategies are shown not to be a compensation for the Fama and French factors identified in their 1993 research[5]. Finally, as presented in table 5 the two strategies are not a result of the time-varying risk factors previously identified by Chordia and Shivakumar (2002).

5.2 1998-2002

The middle of the sample was a period that could be described as a lull in the commodities market. The huge investor interest in the technology industry leading up the dotcom bubble, saw a substantial drop in the trading of commodity futures. The bubble burst as a manifestation of investor over-reaction in March 2000.

The profits generated over this period have been greatly diminished compared with the previous period. Only the R1-H1 strategy produces positive returns of any statistical significance. Interestingly, the inferences drawn from table 2 were that this was the most profitable period, however upon closer examination this appears not to be the case. A further

point of significance is the change in the portion of positive returns for the winner portfolios. Although the vast majority of the strategies are not significant even at the 10% level, the ones that are at least producing positive returns are doing so mostly as a result of the performance of the winner portfolio. In fact twelve of the winner portfolios are generating positive significant returns. This indicates that over this sub-period long contracts are greatly outperforming short contracts, resulting in unprofitable momentum trading.

Both the risk adjusted and the time-varying risk adjusted results provide further support for the R1-H1 strategy[6]. All of these regressions produce positive and significant returns, indicating that the momentum profits identified for this strategy are not a compensation for bearing more risk.

5.3 2003-2006

The final sub-period represents the era of the post technologies bubble. The commodity market saw incredible growth over this period, and only with the recent global turmoil has there been any substantial volatility. The massive increase in activity across this market may be expected to bring with it an increase in the average momentum profits realised for a given strategy. However profitability of the strategies paints a very different picture of this hypothesis as it was undoubtedly the worst period for momentum returns. Unlike the previous two sub-periods, this period shows a new significant strategy (R6-H6) that generates rather poor profits. Another striking feature of this period is that absolutely none of the loser portfolios are producing negative returns, while ten of the winner portfolios generate positive and significant returns.

This result seems logical once applied to figure 1. Since the commodity futures market has seen continuous positive growth over the period, it makes sense that only the long portfolios are generating a profit. The fact that the loser portfolios are not contributing at all to the

profits for the momentum strategies could also be because of the low number of commodities used in this research.

The risk adjusted regressions demonstrate that unlike the previous periods, the profitability of this strategy is not robust to risk adjustments. Both the unconditional and time-varying risk regressions (table 2) show that the profitability of the R6-H6 strategy (however small) is subsumed by the risk factors identified in the variables used. This indicates that the true profitability momentum strategies during this period can be described as a compensation for bearing a higher level of risk.

Although table 2 indicates that the increased popularity of momentum trading by institutional investors has not reduced the accumulative profits from these strategies, a more complete analysis gives a new perspective. The reason why table 2 alludes to this is because there is an equal amount of profitable strategies between 2003-2006 as there is over the entire sample. However, upon closer examination of this period a few things become palpably clear. Out of the five profitable strategies only one of the strategies is significant, and this strategy only yields an annualised return of 2.4%. Furthermore, this negligible profit is shown not to be robust to the risk based regressions, indicating that it is likely a compensation for embracing more risk. This gives support to the argument that the increased institutional activity in momentum trading has diluted the profits realised in the commodity futures market.

6 Summary and Conclusions

Recent studies have described the momentum anomaly as being a result of the behaviour of irrational investors, or as compensation for the use of assets bearing higher risks. It has been demonstrated that there are strategies that are profitable and robust to risk explanations, namely the Rank 1 month - Hold 1 month strategy. This strategy, in particular, shows that it

is not subsumed by proxies for risks derived from the bond, equity, and commodity markets and yields an annualised return of 7.7%. Furthermore, the profitability in the returns of this momentum strategy cannot be attributed to the macroeconomic risks which have been formed using variables that have been known to be market predictors.

The second explanation posited for the momentum anomaly is the behaviour of irrational investors. This is in direct conflict with the principals of market efficiency. The behavioural analysis provides evidence that is accommodating to the under-reaction effect being a reasonable explanation for continuation in returns. The profits realised are shown to coincide with the under-reaction hypothesis, where investors irrationally react to new information, causing continuation of returns in the short-term (1-12 months).

The sub-period examination gives an interesting perspective towards the profitably momentum returns, by examining three distinct periods of activity in the commodity markets. The first period (1994-1997) proves to be the most profitable for momentum strategies. Unlike the entire sample, this sub-period generates two strategies that are significant and robust to risk adjustments. The annualised average return for these strategies is 12.13% pa. The middle sub-period (1998-2002) could be described as a volatile era for the commodity markets. Although the returns were not as prolific as the first sub-period, it still generated a return higher than the entire sample.

The last period (2003-2006) was the major bull run of the commodity markets over the sample period. Although the overall value of the commodity market has risen substantially until 2008, momentum profits were not only insufficient but they were also not robust to time-varying risks. The reason for the relative failure of momentum strategies appears to be because of the small number of contracts used to form the portfolios. Since this period coincided with a bull run, the majority of the commodities increased in value, resulting in

positive winner portfolios. However because there was only twelve contracts used, the loser portfolio did not yield any negative profits from short selling. The net result of this is extremely poor momentum returns over the sub-periods. Using a higher number of contracts would likely produce a better result for momentum strategies, as a higher number of contracts increases the change of continuation for both negative and positive returns.

These results indicate that an investor could have earned a risk-adjusted return of 7.7% per annum through buying winners and selling losers ranked up to one month prior to portfolio formation, and holding this position for one month. The results also indicate that during "flat" periods of low commodity activity, this return can be substantially increased. Momentum strategies were also found to be less profitable during bull and bear markets.

There is the possibility that these strategies could be consumed by transaction costs. Although this avenue is a possibility for future research, this explanation seems unlikely for the following reasons; Transaction costs in the futures market have been established by Locke and Venkatesh (1997) as being of between 0.0004% to 0.033%, which is much less than the estimated 0.5% by Jegadeesh and Titman (1993). Furthermore, as Miffre and Rallis (2007) point out, although short selling restrictions are often imposed in the equity markets, adopting short positions in the futures market is as easy as taking a long position. It should be noted that these ideas are only inferences as this research does not consider transaction costs.

References

Ball, R., & Kothari, S. P. (1989). Nonstationary expected returns: Implications for Tests of Market Efficiency and Serial Correlation in Returns. *Journal of Financial Economics, 25*(1), 51-74. Accessed 20 July, 2008, from http://www.sciencedirect.com.

Barberis, N., Shelifier, A., & Vishny, R. (1998). A model of investor sentiment. *Journal of Financial Economics, 49*, 307-343. Accessed 20 August, 2008, from http://www.sciencedirect.com.

Bayats, A., & Cakici, N. (1998). Do markets overreact: International evidence. *Journal of Banking & Finance, 23*, 1121-1144. Accessed 20 August, 2008, from http://www.sciencedirect.com.

Bem, D. J. (1965). An Experimental Analysis of Self-Persuasion. *Journal of Experimental Social Psychology, 1*, 199-218.

Berk, J. B., Green, R. C., & Naik, V. (1999). Optimal Investment, Growth Options, and Security Returns. *Journal of Finance, 54*(5), 1553-1607. Accessed 25 August, 2008, from http://www.jstor.org.

Bernard, V. L., & Thomas, J. K. (1989). Post-Earnings-Announcement Drift: Delayed Price Response or Risk Premium. *Journal of Accounting Research, 27*, 1-36. Accessed 15 August, 2008, from http://www.jstor.org.

Bodie, Z., & Rosansky, V., I. (1980). Risk and Return in Commodity Futures. *Financial Analysts Journal, May/June*, 27-39. Accessed 15 July, 2008, from http://web.ebscohost.com.

Chan, K., Hameed, A., & Tong, W. (2000). Profitability of Momentum Strategies in the International Equity Markets. *Journal of Financial And Quantitative Analysis, 35*(2), 153-172. Accessed 15 July, 2008, from http://proquest.umi.com.

Chan, L. K. C., Jegadeesh, N., & Lakonishok, J. (1996). Momentum Strategies. *Journal of Finance, 51*(5), 1681-1713. Accessed 10 July, 2008, from http://www.jstor.org.

Chen, J., & Hong, H. (2002). Momentum and Autocorrelation in Stock Returns. *Review of Financial Studies, 15*(2), 565-573. Accessed 28 July, 2008, from http://www.jstor.org.

Chopra, N., Lakonishok, J., & Ritter, J. R. (1992). Measuring abnormal performance: Do stocks overreact? *Journal of Financial Economics, 31*(2), 235-268. Accessed 28 September, 2008, from http://www.sciencedirect.com.

Chordia, T., & Shivakumar, L. (2002). Momentum, Business Cycle, and Time-varying Expected Returns. *Journal of Finance, 57*(2), 985-1018. Accessed 28 July, 2008, from http://www.jstor.org.

Christopherson, J. A., Ferson, W. E., & Glassman, D. A. (1998). Conditioning Manager Alphas on Economic Information: Another Look at the Persistence of Performance. *The Review of Financial Studies, 11*(1), 111-142. Accessed 10 October, 2008, from http://www.jstor.org.

Conrad, J., & Kaul, G. (1998). An anatomy of trading strategies. *Review of Financial Studies, 11*(3), 489-519. Accessed 14 July, 2008, from http://www.jstor.org.

Cooper, M. J., Gutierrez, R. C., Jr., & Hameed, A. (2004). Market States and Momentum. *Journal of Finance, 59*(3). Accessed 24 July, 2008, from http://www.jstor.org.

Daniel, K., Hirshleifer, D., & Subrahmanyam, A. (1998). Investor Psychology and Security Market Under- and Overreactions. *Journal of Finance, 53*(6), 1839-1886. Accessed 15 July, 2008, from http://www.jstor.org.

De Bondt, W. F. M., & Thaler, R. (1985). Does the Stock Market Overreact. *Journal of Finance, 40*(3), 793-807. Accessed 15 July, 2008, from http://www.jstor.org.

De Bondt, W. F. M., & Thaler, R. (1987). Further Evidence On Investor Overreaction and Stock Market Seasonality. *Journal of Finance, 42*(3), 557-581. Accessed 15 July, 2008, from http://www.jstor.org.

Dissanaike, G. (1997). Do Stock Market Investors overreact. *Journal of Business Finance & Accounting, 24*(1), 27-49. Accessed 15 October, 2008, from http://www3.interscience.wiley.com.

Edwards, F. R., & Park, J. M. (1996). Do Managed Futures Make Good Investments? *Journal of Futures Markets, 16*(5), 475-517. Accessed 15 October, 2008, from http://proquest.umi.com.

Erb, C., & Harvey, C. (2006). The Strategic and Tactical Value of Commodity Futures. *Financial Analysts Journal, 62*(2), 69-97. Accessed 10 July, 2008, from http://www.cfapubs.org.

Fama, E. (1970). Efficient capital markets: a review of theory and empirical work. *Journal of Finance, 25*(2), 383-417. Accessed 11 August, 2008, from http://www.jstor.org.

Fama, E., & French, K. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*, 3-56. Accessed 20 July, 2008, from http://www.sciencedirect.com.

Fama, E., & French, K. (1996). Multifactor Explanations of Asset Pricing Anomalies. *Journal of Finance, 51*(1), 55-84. Accessed 15 July, 2008, from http://www.jstor.org.

Fleming, J., Ostdiek, B., & Whaley, R. E. (1996). Trading Costs and the Relative Rates of Price Discovery in Stock, Futures, and Option Markets. *Journal of Futures Markets, 16*(4), 353-387. Accessed 10 October, 2008, from http://proquest.umi.com.

French, K. (2008). Fama/French Factors. Accessed 21 August, 2008 from http://mba.tuck.dartmouth.edu

Gorton, G., & Rouwenhorst, G. (2006). Facts and Fantasies about Commodity Futures *Financial Analysts Journal, 62*(2), 47-68. Accessed 1 October, 2008, from http://proquest.umi.com.

Griffin, J. M., Ji, X., & Martin, S. J. (2003). Momentum Investing and Business Cycle Risk: Evidence from Pole to Pole. *Journal of Finance, 58*(6), 2515-2547. Accessed 25 July, 2008, from http://www.jstor.org.

Grinblatt, M., & Moskowitz, T. J. (2004). Predicting stock price movements from past returns: the role of consistency and tax-loss selling. *Journal of Financial Economics, 71*, 541-579. Accessed 21 July, 2008, from http://www.sciencedirect.com.

Grundy, B. D., & Martin, S. J. (2001). Understanding the Nature of the Risks and the Source of the Rewards to Momentum Investing. *Review of Financial Studies, 14*(1), 29-78. Accessed 15 July, 2008, from http://www.jstor.org.

Hong, H., Lim, T., & Stein, J. (2000). Bad News Travels Slowly: Size, Analyst Coverage, and the Profitability of Momentum Strategies. *Journal of Finance, 55*(1), 265-295. Accessed 15 July, 2008, from http://www.jstor.org.

Hong, H., & Stein, J. (1999). A Unified Theory of Underreaction Momentum Trading, and Overreaction in Asset Markets. *Journal of Finance, 54*(6), 2143-2184. Accessed 22 July, 2008, from http://www.jstor.org.

Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *Journal of Finance, 48*(1), 65-91. Accessed 2 July, 2008, from http://www.jstor.org.

Jegadeesh, N., & Titman, S. (1995). Overreaction, Delayed Reaction, and Contrarian Profits. *The Review of Financial Studies, 8*(4), 973-993. Accessed 1 September, 2008, from http://proquest.umi.com.

Jegadeesh, N., & Titman, S. (2001). Profitability of Momentum Strategies: An Evaluation of Alternative Explanations. *Journal of Finance, 56*(2), 699-720. Accessed 2 July, 2008, from http://www.jstor.org.

Jegadeesh, N., & Titman, S. (2002). Cross-Sectional and Time-Series Determinants of Momentum Returns. *Journal of Finance, 15*(1), 143-157. Accessed 14 July, 2008, from http://www.jstor.org.

Jensen, G., Johnson, R., & Mercer, J. (2002). Tactical Asset Allocation and Commodity Futures. *Journal of Portfolio Management, Summer*, 100-111. Accessed 20 July, 2008, from http:// www.euromoneyplc.com.

Korajczyk, R. A., & Sadka, R. (2004). Are Momentum Profits Robust to Trading Costs? *Journal of Finance, 59*(3), 1039-1082. Accessed 14 September, 2008, from http://www.jstor.org.

Kurov, A. (2008) Investor Sentiment, Trading Behaviour and Informational Efficiency in Index Futures Markets. *The Financial Review,* 43, 107-127. Accessed 11 September, 2008, from http://www.jstor.org.

Lesmond, D., Schill, M., & Zhou, C. (2004). The illusory nature of momentum profits. *Journal of Financial Economics, 71*, 349-380. Accessed 12 August, 2008, from http://www.sciencedirect.com.

Lewellen, J., & Nagel, S. (2006). The conditional CAPM does not explain asset-pricing anomalies. *Journal of Financial Economics, 82*, 289-314. Accessed 22 August, 2008, from http://www.sciencedirect.com.

Li, X., Miffre, J., Brooks, C., & O'Sullivan, N. (2008). Momentum profits and time-varying unsystematic risk. *Journal of Banking & Finance, 32*, 541-558. Accessed 2 August, 2008, from http://www.sciencedirect.com.

Lintner, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics, 47*, 13-37. Accessed 2 November, 2008, from http://web.ebscohost.com.

Locke, P., & Venkatesh, P. (1997). Futures Market Transaction Costs. *Journal of Futures Markets, 17*(2), 229-245. Accessed 11 July, 2008, from http://proquest.umi.com.

Ma, C. K., Dare, W. H., & Donaldson, D. R. (1990). Testing Rationality in Futures Markets. *Journal of Futures Markets, 10*(2), 137-152. Accessed 11 August, 2008, from http://proquest.umi.com.

Miffre, J., & Rallis, G. (2007). Momentum Strategies in Commodity futures markets. *Journal of Banking & Finance, 31*, 1863-1886. Accessed 15 June, 2008, from http://www.sciencedirect.com.

Moskowitz, T., & Grinblatt, M. (1999). Do Industries Explain Momentum? *Journal of Finance, 54*(4), 1863-1886. Accessed 14 July, 2008, from http://www.jstor.org.

Nam, K., Pyun, C. S., & Avard, S. L. (2001). Asymmetric reverting behaviour of short-horizon stock returns: An evidence of stock market overreaction. *Journal of Banking & Finance, 25*(4), 807-824. Accessed 15 September, 2008, from http://www.sciencedirect.com.

Poterba, J. M., & Summers, L. H. (1988). Mean Reversion in Stock Prices: Evidence and Implications. *Journal of Financial Economics, 22*(1), 27-59. Accessed 25 September, 2008, from http://www.sciencedirect.com.

Rouwenhorst, G. (1998). International Momentum Strategies. *Journal of Finance, 53*(1), 267-284. Accessed 4 August, 2008, from http://www.jstor.org.

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance, 19*, 425-442. Accessed 2 November, 2008, from http://www.jstor.org.

Shen, Q., Szarkmay, A., C., & Sharma, S., C. (2007). An Examination of Momentum Strategies in Commodity Futures Markets. *Journal of Futures Markets, 27*(3), 227-256. Accessed 10 July, 2008, from http://www3.interscience.wiley.com.

Tversky, A., & Kahneman, D. (1974). Judgement under uncertainty: heuristics and biases. *Science, 185*, 1385-1400. Accessed 6 August, 2008, from http://www.jstor.org.

Wu, X. (2002). A conditional multifactor analysis of return momentum. *Journal of Banking & Finance, 26*, 1675-1696. Accessed 25 September, 2008, from http://www.sciencedirect.com

Figure 1

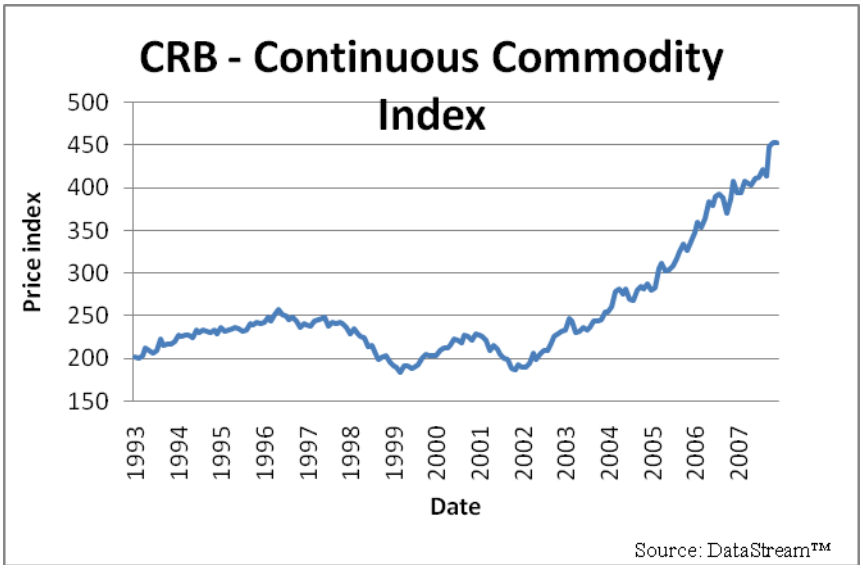

Figure 2

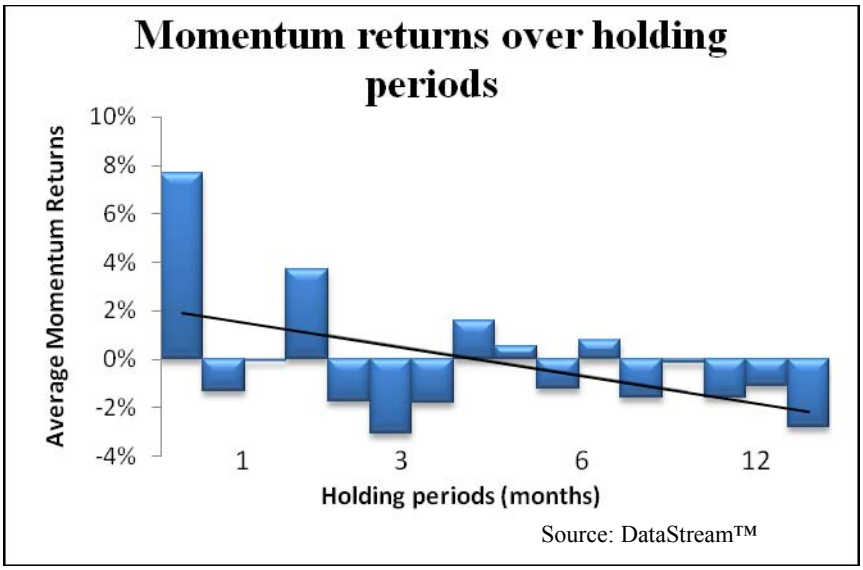

Figure 2 displays the average returns of momentum portfolios for the four ranking periods, and for holding periods of increasing length

Table 1

Summary statistics for returns of momentum strategies

1994-2006

	Ranking 1 month			Ranking 3 months			Ranking 6 months			Ranking 12 months		
	winner	loser	momentum	winner	loser	momentum	winner	loser	momentum	winner	loser	momentum
Holding period of 1 month												
Mean	-0.0005	-0.0774	0.0770	-0.0520	-0.0386	-0.0135	-0.0462	-0.0453	-0.0009	-0.0196	-0.0570	0.0374
t-stat	-(0.01)	-(1.02)	(2.48)[a]	-(0.74)	-(0.50)	-(0.44)	-(0.66)	-(0.60)	-(0.03)	-(0.28)	-(0.75)	(1.24)
Standard deviation	0.8526	0.9409	0.3863	0.8745	0.9565	0.3827	0.8764	0.9456	0.3911	0.8821	0.9469	0.3764
Reward to risk	-0.0005	-0.0823	0.1992	-0.0595	-0.0403	-0.0352	-0.0527	-0.0479	-0.0023	-0.0223	-0.0602	0.0993
Holding 3 period of 3 months												
Mean	-0.0492	-0.0315	-0.0177	-0.0609	-0.0302	-0.0307	-0.0524	-0.0342	-0.0181	-0.0334	-0.0491	0.0157
t-stat	-(1.28)	-(0.72)	-(0.89)	-(1.59)	-(0.69)	-(1.59)	-(1.34)	-(0.78)	-(0.89)	-(0.85)	-(1.11)	(0.80)
Standard deviation	0.4787	0.5456	0.2479	0.4770	0.5424	0.2401	0.4865	0.5473	0.2529	0.4881	0.5515	0.2442
Reward to risk	-0.1028	-0.0577	-0.0715	-0.1277	-0.0557	-0.1277	-0.1076	-0.0625	-0.0718	-0.0685	-0.0891	0.0643
Holding period of 6 months												
Mean	-0.0373	-0.0429	0.0056	-0.0512	-0.0393	-0.0120	-0.0401	-0.0478	0.0077	-0.0506	-0.0350	-0.0156
t-stat	-(1.35)	(-1.52)[c]	(0.43)	-(1.86)	(-1.40)[c]	-(0.96)	-(1.55)	(-1.59)[c]	(0.59)	-(1.74)	(-1.28)[c]	-(1.16)
Standard deviation	0.3454	0.3506	0.1626	0.3434	0.3504	0.1559	0.3213	0.3745	0.1618	0.3623	0.3389	0.1677
Reward to risk	-0.1081	-0.1224	0.0343	-0.1492	-0.1121	-0.0768	-0.1248	-0.1277	0.0477	-0.1397	-0.1032	-0.0933
Holding period of 12 months												
Mean	-0.0428	-0.0412	-0.0016	-0.0510	-0.0349	-0.0161	-0.0480	-0.0368	-0.0112	-0.0555	-0.0273	-0.0282
t-stat	-(2.22)	(-2.14)[b]	-(0.18)	-(2.65)	(-1.82)[b]	-(1.82)	-(2.51)	(-1.87)[b]	-(1.21)	-(2.65)	(-1.53)[c]	-(2.91)
Standard deviation	0.2401	0.2396	0.1113	0.2392	0.2396	0.1097	0.2380	0.2449	0.1149	0.2609	0.2226	0.1208
Reward to risk	-0.1781	-0.1719	-0.0142	-0.2132	-0.1458	-0.1464	-0.2015	-0.1501	-0.0974	-0.2126	-0.1225	-0.2333

The mean and standard deviations have been annualised. The reward to risk ratio is measured as the ratio of the annualised mean to the standard deviation. The definition of momentum is the return give by the winner portfolio minus the loser portfolio. *T*-statistics are reported in parenthesis.

a significant at 1% level

b significant at 5% level

c significant at 10% level

Table 2

Reward-to-Risk Ratios over sub periods

	1994-2007	1994-1997	1998-2002	2003-2006
Ranking period of 1 month				
H=1	0.1992	0.3282	0.2272	-0.0663
H=3	-0.0715	-0.1438	0.0068	-0.1073
H=6	0.0343	0.0425	0.0667	-0.0643
H=12	-0.0142	-0.0243	0.0510	-0.2392
Ranking period of 3 months				
H=1	-0.0352	-0.0302	0.0071	-0.1344
H=3	-0.1277	-0.2392	-0.0443	-0.0964
H=6	-0.0768	-0.1798	0.0357	-0.1914
H=12	-0.1464	-0.0859	-0.1858	-0.2283
Ranking period of 6 months				
H=1	-0.0023	-0.0306	-0.0369	-0.0613
H=3	-0.0718	-0.1985	-0.2462	-0.5423
H=6	0.0477	0.1289	0.1268	0.3094
H=12	-0.0974	-0.0411	-0.0395	-0.1041
Ranking period of 12 months				
H=1	0.0993	0.1922	0.0271	0.0747
H=3	0.0643	0.1375	-0.0016	0.0696
H=6	-0.0933	-0.1282	-0.1303	0.0659
H=12	-0.2333	-0.3280	-0.2824	0.0725

Table 2 reports the reward-to-risk ratios of the momentum portfolio returns over the whole sample period, and the three sub-periods of significance. The reward-to-risk ratio is measured as the portfolios annualised mean divided by is annualised standard deviation. *H* is a representation of the Holding period

Table 3

Annual risk adjusted returns for the profitable momentum strategies identified in Table 1

1994-2006

	winner	loser	momentum	winner	loser	momentum	winner	loser	momentum
	Ranking 1 month Holding 1 month			**Ranking 1 month Holding 6 months**					
α	0.0080	-0.0771	0.0851	-0.0318	-0.0397	0.0079			
t- stat	(0.11)	-(0.99)	(2.70)[a]	-(1.12)	(-1.37)[c]	(0.60)			
βm	-0.0822	0.0394	-0.1215	-0.0749	-0.0172	-0.0577			
t- stat	-(0.56)	(0.24)	-(1.86)	-(1.28)	-(0.29)	(-2.12)[b]			
βb	0.0563	0.0689	-0.0126	0.0282	0.0455	-0.0173			
t- stat	(0.46)	(0.51)	-(0.23)	(0.57)	(0.90)	-(0.75)			
βc	-0.0006	-0.0055	0.0049	0.0202	-0.0007	0.0209			
t- stat	-(0.01)	-(0.05)	(0.11)	(0.50)	-(0.02)	(1.12)			
R^2	-1.66%	-1.75%	0.41%	-0.62%	-1.41%	2.17%			
	Ranking 6 months Holding 6 months			**Ranking 12 months Holding 1 month**			**Ranking 12 months Holding 3 month**		
α	-0.0373	-0.0420	0.0047	-0.0179	-0.0495	0.0316	-0.0282	-0.0428	0.0146
t- stat	-(1.41)	(-1.36)[c]	(0.35)	-(0.25)	-(0.63)	(1.03)	-(0.70)	-(0.94)	(0.72)
βm	-0.0348	-0.0564	0.0216	0.0095	-0.0488	0.0584	-0.0239	-0.0246	0.0007
t- stat	-(0.64)	-(0.88)	(0.78)	(0.06)	-(0.30)	(0.92)	-(0.29)	-(0.26)	(0.02)
βb	0.0339	0.0422	-0.0083	0.0290	0.1088	-0.0798	0.0530	0.0759	-0.0229
t- stat	(0.73)	(0.78)	-(0.36)	(0.23)	(0.80)	(-1.48)[c]	(0.75)	(0.96)	-(0.65)
βc	0.0199	0.0007	0.0192	-0.0212	0.0109	-0.0321	-0.0212	-0.0236	0.0024
t- stat	(0.53)	(0.02)	(1.02)	-(0.21)	(0.10)	-(0.74)	-(0.37)	-(0.37)	(0.08)
R^2	-1.22%	-1.13%	-0.79%	-1.92%	-1.52%	0.24%	-1.49%	-1.27%	-1.70%

The table reports the coefficients from equation (2). α is a measure of the abnormal performance for the strategy, βm, βb, and βc measures the sensitivities of returns to the excess return on the S&P500 composite index, the government bond index, and the Goldman Sachs Commodity Index (GSCI), respectively. For an easier comparison with table 1, α has been annualised. R^2 is the adjusted R-Squared. *T*-statistics are reported in parenthesis.

a significant at 1% level

b significant at 5% level

c significant at 10% level

Table 4

Fama and French annual risk adjusted returns for the profitable momentum strategies identified in table 1

1994-2006

	winner	loser	momentum	winner	loser	momentum	winner	loser	momentum
	Ranking-1 month Holding 1 month			**Ranking 1 month Holding period of 6 months**					
α	0.0049	-0.0772	0.0821	-0.0341	-0.0403	0.0062			
t- stat	(0.07)	-(0.98)	(2.58)[a]	-(1.19)	(-1.38)[c]	(0.47)			
βm	-0.1036	0.0386	-0.1422	-0.0909	-0.0212	-0.0697			
t- stat	-(0.68)	(0.23)	(-2.08)[b]	-(1.48)	-(0.34)	(-2.48)[a]			
βb	0.0533	0.0724	-0.0191	0.0258	0.0436	-0.0178			
t- stat	(0.43)	(0.52)	-(0.34)	(0.51)	(0.85)	-(0.77)			
βc	0.0009	-0.0044	0.0053	0.0213	-0.0008	0.0221			
t- stat	(0.01)	-(0.04)	(0.12)	(0.53)	-(0.02)	(1.19)			
βsmb	0.0005	-0.0002	0.0007	0.0004	0.0002	0.0002			
t- stat	(0.25)	-(0.11)	(0.83)	(0.47)	(0.23)	(0.52)			
βhml	0.0010	0.0003	0.0007	0.0007	0.0001	0.0006			
t- stat	(0.63)	(0.17)	(0.97)	(1.15)	(0.14)	(2.20)[b]			
R^2	-2.76%	-3.07%	-0.15%	-1.07%	-2.74%	4.10%			
	Ranking -6 months Holding period of 6 months			**Ranking- 12 months Holding period of 1 month**			**Ranking- 12 months Holding period of 3 months**		
α	-0.0387	-0.0436	0.0048	-0.0203	-0.0508	0.0305	-0.0325	-0.0478	0.0153
t- stat	(-1.45)[c]	-(1.40)	(0.36)	-(0.28)	-(0.64)	(0.98)	-(0.80)	-(1.05)	(0.76)
βm	-0.0451	-0.0675	0.0224	-0.0075	-0.0583	0.0508	-0.0531	-0.0594	0.0063
t- stat	-(0.79)	-(1.01)	(0.78)	-(0.05)	(7.00)	(0.76)	-(0.61)	-(0.60)	(0.14)
βb	0.0320	0.0385	-0.0065	0.0250	0.1105	-0.0855	0.0381	0.0619	-0.0238
t- stat	(0.68)	(0.70)	-(0.27)	(0.19)	(0.79)	-(1.56)	(0.53)	(0.77)	-(0.66)
βc	0.0205	0.0008	0.0196	-0.0206	0.0124	-0.0329	-0.0224	-0.0239	0.0015
t- stat	(0.54)	(0.02)	(1.04)	-(0.20)	(0.11)	-(0.75)	-(0.39)	-(0.37)	(0.05)
βsmb	0.0003	0.0004	-0.0001	0.0005	0.0000	0.0005	0.0014	0.0014	0.0000
t- stat	(0.37)	(0.47)	-(0.37)	(0.25)	(0.00)	(0.59)	(1.28)	(1.14)	-(0.02)
βhml	0.0004	0.0003	0.0001	0.0007	0.0007	0.0000	0.0005	0.0009	-0.0004
t- stat	(0.74)	(0.51)	(0.28)	(0.41)	(0.38)	(0.00)	(0.61)	(0.92)	-(0.85)
R^2	-2.20%	-2.25%	-1.89%	-3.17%	-2.76%	-0.81%	-1.72%	-1.58%	-2.48%

The table reports the coefficients from equation (3). α is a measure of the abnormal performance for the strategy, βm, βb, and βc measures the sensitivities of returns to the excess return on the S&P500 composite index, the government bond index, and the Goldman Sachs Commodity Index (GSCI), respectively. The βhml and βsmb variables are the Fama and French (1993) factors. For an easier comparison with table 1, α has been annualised. R^2 is the adjusted R-Squared. *T*-statistics are reported in parenthesis.

a significant at 1% level

b significant at 5% level

c significant at 10% level

Table 5
Conditionally risk adjusted annual returns

Strategy		1994-2006	1994-1997	1998-2002	2003-2006
Rank 1 months - Hold 1 months	α	0.0968	0.2432	0.1637	
	t -stat	(2.87)[a]	(2.63)[a]	(2.93)[a]	
Rank 1 months - Hold 6 months	α	0.0153	0.0138	0.0180	
	t -stat	(1.09)	(0.38)	(0.64)	
Rank 6 months - Hold 6 months	α	0.0045	0.0129	0.0233	-0.0106
	t -stat	(0.32)	(0.37)	(0.82)	-(0.79)
Rank 12 months - Hold 1 months	α	0.0408	0.1623	0.0161	0.0529
	t -stat	(1.25)	(1.92)[b]	(0.26)	(1.05)
Rank 12 months - Hold 3 months	α	0.0275	0.0684		
	t -stat	(1.28)[c]	(1.17)		

The table reports the annualised conditionally risk adjusted returns of alpha for the momentum profits using equation (6). The entire sample period is shown along with the three significant sub-periods. The five strategies shown are those that were identified as profitable in table 1. *T*-statistics are reported in parenthesis. The remainder of the coefficients and their *t*-statistics are reported in appendix 1.

a significant at 1% level
b significant at 5% level
c significant at 10% level